Engine Room Simulator Applied as an Objective Examiner of Marine Engineers Skills and Knowledge

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ABSTRACT

The development of information technology, and especially the expansion of surveillance and control systems of a ship propulsion plant, has created the possibilities of reducing of the crew number on board. In consequence this led on the one hand to increased skill requirements on the other hand it has shortened the time for practical training on board due to elimination of certain posts, which were intermediate stages leading to officers ranks. One of the new forms of training complying with requirements of STCW 78/95 Convention is the training on engine room simulators.

The engine room simulator can be considered not only as training tool but also applied as an examination tool. The paper will illustrate an endeavour of using the simulator as an examining tool for marine engineers at operation and management level. To explain the approached philosophy to examine by means of the engine room simulator facilities an example of an examination test is quoted.

1. Introduction

Simulator training has been for many years an effective training method for marine engineers. A dynamic and to a high degree interactive E/R simulator can reduce the time needed to gain experience, which would otherwise require a long period of time. Since the first E/R simulators for motor ships have appeared in the end of the 1970's a great deal of progress in elaborating of more complex training systems has been achieved for multiple levels of students. The effectiveness of training a marine engineer can be mirrored by assessment of attained by him skills and knowledge.

The requirement for STCW Certification has been established as a global standard. The interpretation of these standards as they apply to engine and deck is in many cases a personalized matter. Assessing students' performance in the simulation setting is also frequently subjective since the achievement criteria can be obtained in more than one specific quantified way.

The STCW regulations require many assessments of the training, or more exactly and properly assessment of learning of future maritime officers. Each candidate for a marine engineers first licence must successfully complete 115 STCW assessments. Not all of the required STCW assessments can be completed by using simulator. Our intent is to begin with a smaller number of assessments on the engine room simulator and over time increase the number of assessments performed on the simulator.

The remaining other assessments which can not be performed on the E/R simulator are completed by the trainee in written and oral form as part of the sea project that each candidate for licence must complete while at sea on an actual commercial vessel sailing as trainee or cadet.

As already mentioned the assessment quality and standard of examination performed up to now in the majority of maritime institutions can be heavily subjective or biased. It all depends on the qualifications of the instructor, firstly whether he has got himself an enough long sea practice preferably o chief engineers licence, secondly whether he at the given moment is in the right mood to carry out an unbiased exam. The correct assessment procedure developed by us is seeking the end result based on firm examination standards, with no disqualifying effects during the assessment due to a biased judgment of the instructor. Obviously a straight forward result during trainee exam occurs if he fails to cope with some basic requirements such as loosing control of the engines during transfer from Bridge to Engine Room, total loss of electrical power, or an out-of control controller. But in many other cases of student's performance assessment a fair grading should be applied and this can be subjective.

We at SMU (Szczecin Maritime University) since late 1999 are operating the Kongsberg's Maritime Ship Systems (KMSS) PPT 2000 Engine Room Simulator consisting of an operational part with a slow speed engine (MAN-B&W-5MC90) and a Workstation section with 6 students stations containing propulsion plant software programmes for a slow speed and medium speed engine. One of the features the PPT 2000 offers besides the many training facilities is the possibility of evaluating the trainee according to manual TEC 2000 by an Evaluation Editor. Thus the current PPT 2000 simulator system should make assessment possible by enabling of trainee performance.

The STCW reviewers have requested a further improvement in STCW effectiveness by introducing a check - off list of each individual step required to complete a given task. It is our opinion that the checklist concept isn't exhausting to full extend the required skills a marine engineer should in different situation on board display. During an exam on the E/R simulator the trainee ought to exhibit a high concentration of decision making skills dealing with quick reaction types of tasks.

Generally speaking training of both procedures and decision-making skill are important for operators of complex control systems. The trainee should be aware that the available procedures (dictated by a checklist) are insufficient to resolve the immediate situation, he should be able to develop new procedures often requiring modifications to existing procedures to effectively respond to unique situations demands and unforeseen emergencies. The made above considerations are main guidelines haw to structure the assessment tests.

STCW certification is a must in present shipping; canons have been developed under the auspices of IMO. The maritime community tries to approach to these standards, interpret them, design training courses and assess student performance for compliance.

Concerning the licenced engineering officer the question arises compliance to what? The standards in the STCW Convention are insufficiently defined to understand what needs to be trained, needs to be assessed and what ultimately means compliance. But we definitely can fulfill the requirements of STCW by designing a complex E/R simulator plant with universal features even more comprehensive than a real propulsion plant focusing on response to casualties and emergencies.

The acceptance of using simulators for satisfying licence requirements is not new in other industries. We are new in the process of engine room simulator applicability concerning licensing and STCW certification. Our marine engineers applying for certification at operational or management level have already to pass a test on the E/R simulator proving the ability of marine propulsion operation skills in normal and abnormal conditions. Our Maritime Authority now makes this test compulsory during an exam for a licence whatever level.

The implementation of automated grading to support the instructor in evaluation of student's skills, when training on an E/R simulator, is of paramount importance. In the forthcoming chapter of this paper we presented (due to limited paper apace) one of the tests composed by us for evaluation of the student performance by the simulator Evaluation Editor.

We can finally say that we have the tools in the simulator to apprehend the status, events, data, etc. but putting it all together to verify that the student has attained compliance remains another thing. And only through an immense library stock of composed tests for automatic evaluation we could approach the ideal. This is a real challenge to all maritime universities worldwide to join forces together, and IAMU is the most proper platform to elaborate an assessment library for common use by its members.

2. Example of Exam Test for Management Level

2.1 Objectives:

To check the skills of proper reaction on occurring alarms signals and determination of the primary cause of disturbances in ship propulsion operation.

2.2 Assumptions:

Marine Propulsion Plant – PPT 2000 – NORCONTROL.
Propulsion Plant Operating Condition – Full ahead (sea passage).
Weather conditions – good.

2.3 Preparation for Working out the Test

1) The instructor's and trainee's stations to be started
2) On both stations the programme for a given propulsion plant to be chosen (in this case with a B&W L90MC engine).
3) Checking and eventually changing the access range of the examined trainee (in the Operating Conditions) see Fig.1.
4) On the trainee station (on Instructor Panel) switch key to "Op" position and switch on "Operator" key.

5) On instructor's station by pressing Ctrl+C going over to main menu and selecting "CLIENT CONNECTION" in order to be connected with the trainee.
6) On the instructor's station switch on the key SCENARIO and find scenario of the particular exercise in this case it is: Scenario – EXAM TEST No. 1.
7) Enter the chosen scenario – EXAM TEST No. 1 – Fig.2 (read in)
8) Allow the trainee to familiarize with the propulsion plant operational status before starting the scenario, i. e. before switching from "FREEZE" to "RUNNING" about 10-15 min.
9) After the trainee has familiarized himself with the situation, "MALFUNCTION EDITOR" to be switched on and foreseen events in the scenario to be activated. See Fig.3.
10) Switching on the "EVALUATION EDITOR" and activating the valuation of disturbance symptoms in propulsion plant operation. See Fig.4.
11) Switch over from "FREEZE" to "RUNNING".

3. Test Run

3.1 Number and Kind of Disturbances (Failures)

In the realized test, four following events have been exemplified:
1) Oil filter No. 1 on turbo-generator fouled.
2) Low Temperature Cooling Water p/p No. 2 wear.
3) Main Engine Cyl.1 leakage on the exhaust v/v.
4) Main Engine Cyl.5 inlet ports fouled by deposits.

The events planned in the MALFUNCTION EDITOR will occur in certain time intervals in such a manner to allow the examined trainee the correct reaction to alarms. The way of events introduction, rate of increment and maximum value, which a parameter representing the particular event can achieve, are so chosen to make the situation similar to a situation occurring in real propulsion plants. Details are shown on Fig. 3.

3.2 Observed Disturbance Symptoms – Criteria of Assessment

As symptoms of ship propulsion disturbances were assumed following data:

1) Pressure drop of lubricating oil in the turbo generator below alarm level.
2) Pressure drop of cooling water in the Low Temperature Fresh Water cooling system causing problems with cooling of the charge air. The alarm of low cooling water pressure in the LTFW cooling system was chosen in such a way that it occurred after disclosing of disturbances in the charge air system. For that reason the starting pressure for the LTFW stand-by pump was also lowered. This way the examined trainee was given the chance to show his skills and control over the situation. In this case the examined trainee should switch over the pumps and has the duty to check the operation of both pumps, making as well a written note with proper conclusions.
3) Increase of exhaust gas temperature on cyl.1 and activated alarm after exceeding allowed deviation (+40^0 C).
4) Increase of cylinder head metal temperature on cyl.1.

5) Increase of exhaust gas temperature on cyl.5 and activated alarm after exceeding allowed deviation (+40^0 C).
   During the realization of the test the examined person has access to:
   - All propulsion plant parameters;
   - Inspection of alarms in all alarm groups;
   - Taking indicator cards together with analysis of these cards (Fig.10);
   - Printers which besides alarm conditions can print all actions undertaken by the examined trainee as well as the surveillance system of the propulsion plant;
   - "Snapshot Directory" function, registering in certain time intervals, the momentary condition of the propulsion plant, serves the purpose of restoring in a form of an automatic repetition, or for continuation of operation, from registered previously and restored working condition;
   - Pen recorder able to record 6 freely chosen parameters.

4. Test Assessment

The quality of the surveillance carried out by the examined trainee can be assessed in a traditional way after the establishing of general assessment criteria by the examination body or in a way recommended by the simulator maker. In the case of Norcontrol simulators according to manual TEC 2000 (Training and Evaluation Control) an EVALUATION EDITOR can be used for assessment. When using the EVALUATION EDITOR the assessment is worked out in the form of summing up points. The amount of points, in this case negative points, depends upon the absolute deviation and time of its duration.

In the EVALUATION EDITOR symptoms of incorrect operation of propulsion plant machinery should be given, which are the effect of events introduced in the MALFUNCTION EDITOR. If a parameter presenting a given symptom, being a consequence of occurring fault, exceeds the lower or upper limit then the absolute value of deviation will be integrated in time and multiplied by the weighting factor so:

Absolute Deviation = variable value – limit value,

Weighted Deviation = Absolute Deviation x Weighting Factor,

Evaluation Sum = ∫ (Weighting Factor x (variable value – limit value)).

The assessment editor can be used for creation of up to 20 criteria (symptoms). Each criterion is represented by one parameter. If for the estimation of the quality surveillance we use more criteria, estimation values of each criteria are summed up in such a situation the summed up assessment is equal:

Summed up Assessment = ∑ Value of Assessment.

When using the EVALUATION EDITOR it is very important to establish proper weight coefficients of each symptom. The assessment of the examined trainee behaviour and the number of points for each task are presented on Fig.5. Some explanation is required due to the occurrence in the "EVALUATION EDITOR" of load on DG 1. This is connected with the oil pressure drop in the TG. In the design of the power plant automation system it was assumed that any disturbance in operation of one running generator, and the occurrence of alarm would cause an instantaneous start of the stand-by generator having the first priority. This is to secure the propulsion plant against a black out situation. After returning of the parameter to normal value, renewed loading of the generator will follow and next switching off of the stand-by generator will take place. Working time and the magnitude of load of the stand-by generator will cause counting of the negative points.

In this concrete situation the stand-by generator will be connected in any case, whereas there will be different times of generator operation and its load. Details are shown on Fig.5.

The authors consider that after working out of all tests there should be one compact way of test presentation by the examined person. In the ship's propulsion plants operation we have many cases, in which the same symptoms could have different causes or few causes can be superimposed on each other. In such cases additional explanations are necessary.

5. Summing up of Exam Test

At the end of the exam test the examined person should give a written report of counter measures to be taken in order to rectify the faults.

1. TURBO GENERATOR - LUBRICATING. OIL FILTER No 1 (Fig.6) – to be cleaned.
2. LOW TEMPERATURE FRESH WATER PUMP No 1 (Fig.7) – to be overhauled; LTFW Pump ST-BY LIMIT – to be adjusted.
3. MAIN ENGINE CYLINDER No 5 (Fig.8) SCAVENGE AIR PORTS – to be cleaned.
4. MAIN ENGINE CYLINDER No 1 (Fig.9) EXHAUST VALVE – to be repaired or replaced.

6. Conclusions

The number of owned by various education institutions engine room simulators is today quite impressive, being well over hundred units in operation.

The last generations of engine room simulators whether coming from Norcontrol, Atlas, Mitsui or other makers have an immense potential of illustrating various ship propulsion plants operational conditions, including the possibility of introducing a large number of faults concerning specific items of machinery, or the whole systems.

The contemporary engine room simulator is however, today mainly used to demonstrate the trainees various operational patterns and faults, but it could be and should be also used as an examining tool, offering an unbiased judgment of the participant gained skills, and his ability to handle various critical situations, which may occur during various stages of ship's propulsion plant operation.

We do not know, how many users of for example the Norcontrol PPT – 2000 are using the simulator already in its dual function, i.e. teaching and examining. Assuming that this is rather a rear case if at all, we undertook the task to use our simulator, as well in the role of an objective examiner.

Well after starting the work to use the simulator as an examining tool, we became aware that it is quite a complex endeavour but nevertheless a possible one, and as well a rewarding one.

Demonstrating one example of an exam test our intention was to show how one have to approach this issue, and what are the most difficult stumbling blocks to create a realistic exam test. Firstly, the most difficult point in making a successful exam test is to <u>define with high realistic probability the weighting factor for each introduced fault or disturbance</u> in the test. Therefore, the authors of such tests have to be experienced sea going marine engineers with a long sea going practice, preferably in the rank of a chief engineer, backed up with a fair amount of theoretical academic knowledge in the field of basic technical subjects, like: thermodynamics, hydromechanics, design principles of particular machinery etc.

A simulator staff without a relevant sea practice will face tremendous obstacles in designing realistic and sound exam tests, and may have in many cases a rather unrealistic approach as far as <u>judgment of a weighing factor for specific fault or disturbance is concerned</u>.
We think that, by illustrating the process of building up one exam test, we have disclosed the way to the creation of bringing into existence a library of exam tests.

Although one should be aware, that setting up a library of exam tests, number of which may exceed hundreds, would be a time consuming job requiring a deep knowledge from the exam tests authors.

We are presently on the road to create an extensive exam test library and shall be glad to share our experience with other engine room simulator users.

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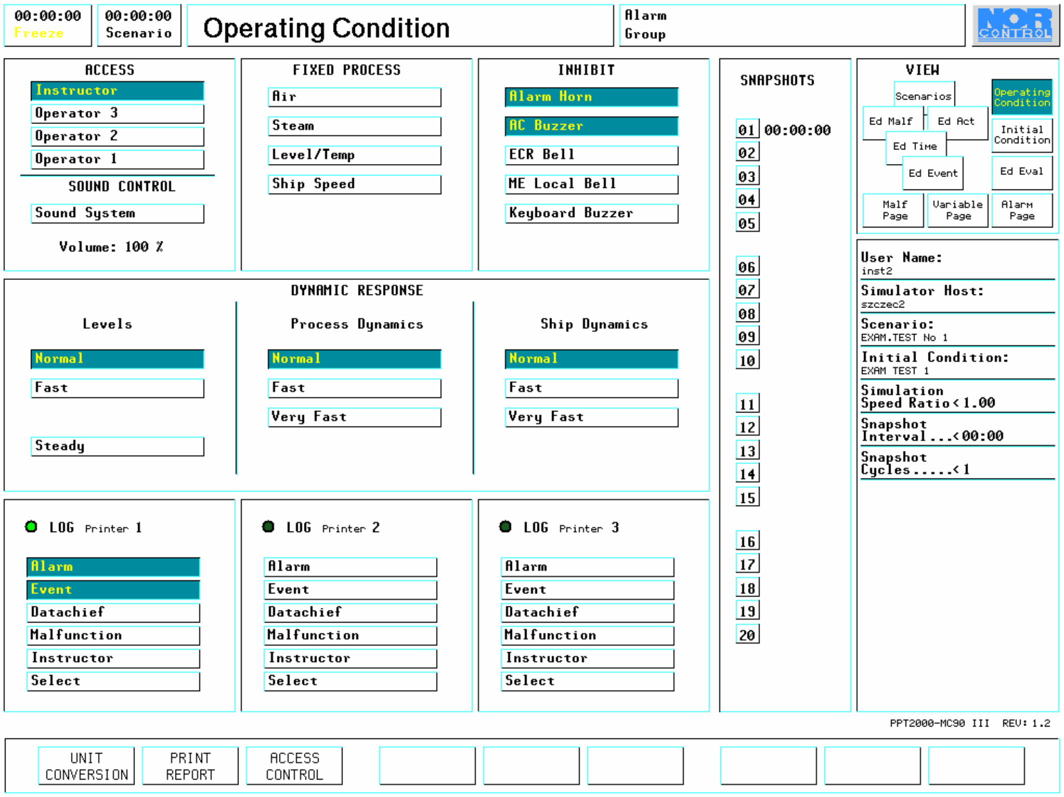

Figure 1: Operating Condition

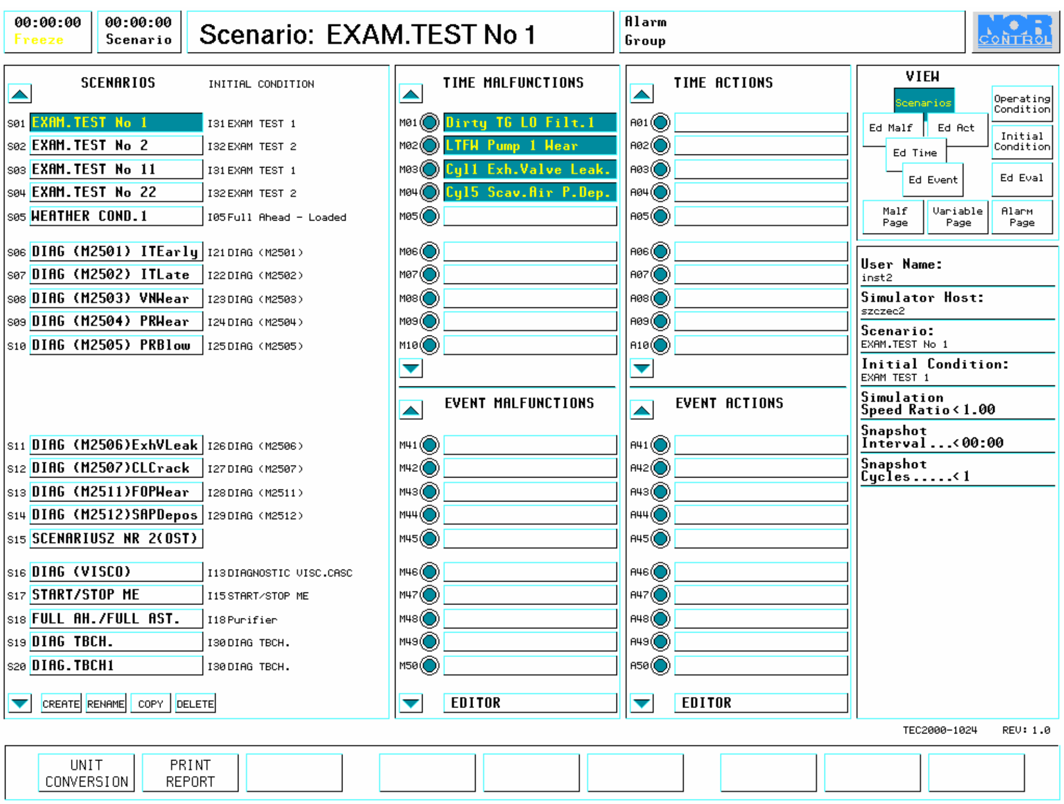

Figure 2: Scenario

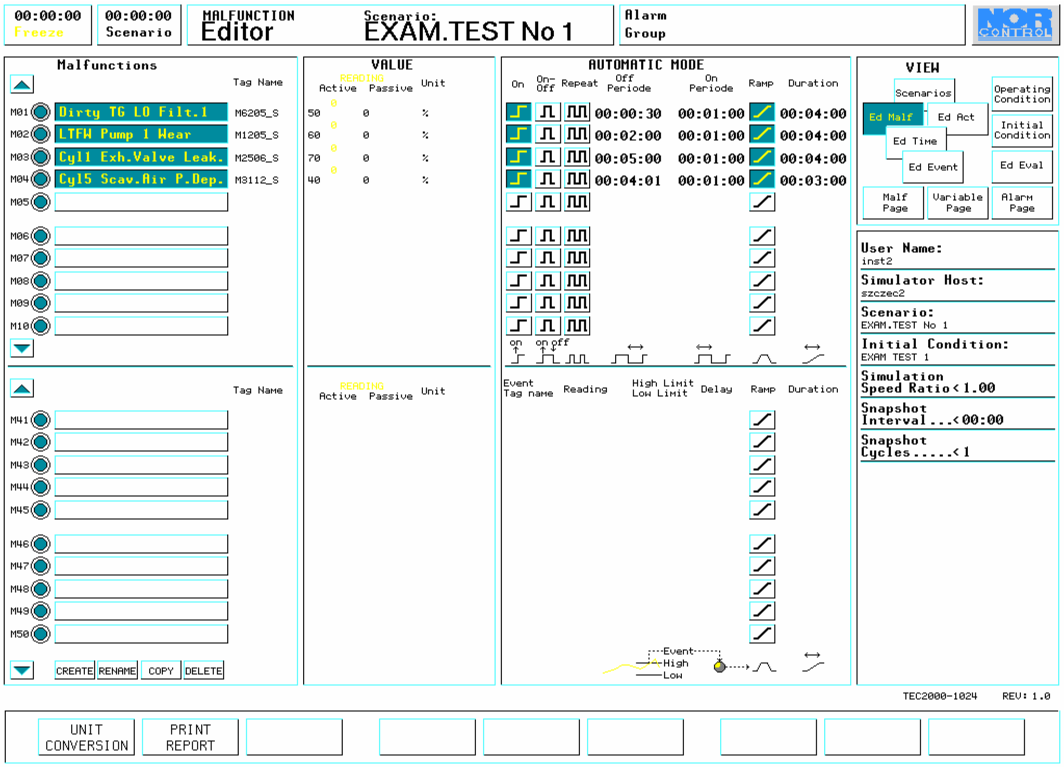

Figure 3: Malfunction Editor

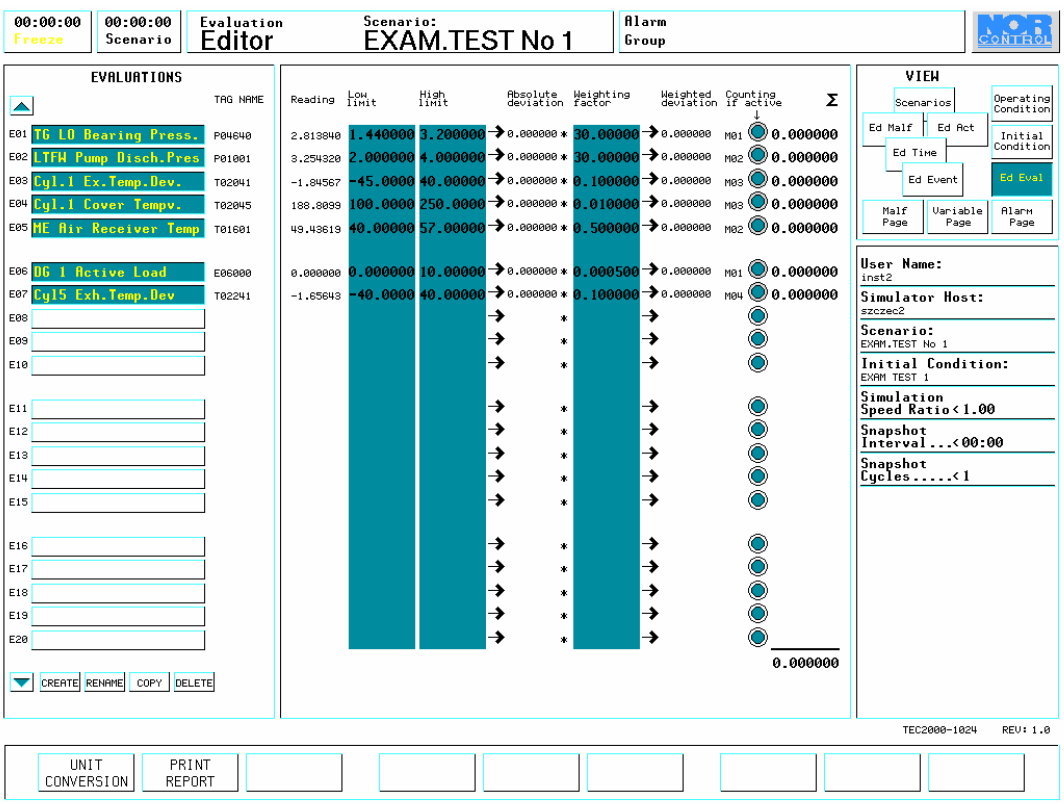

Figure: Evaluation Editor-Starting Status

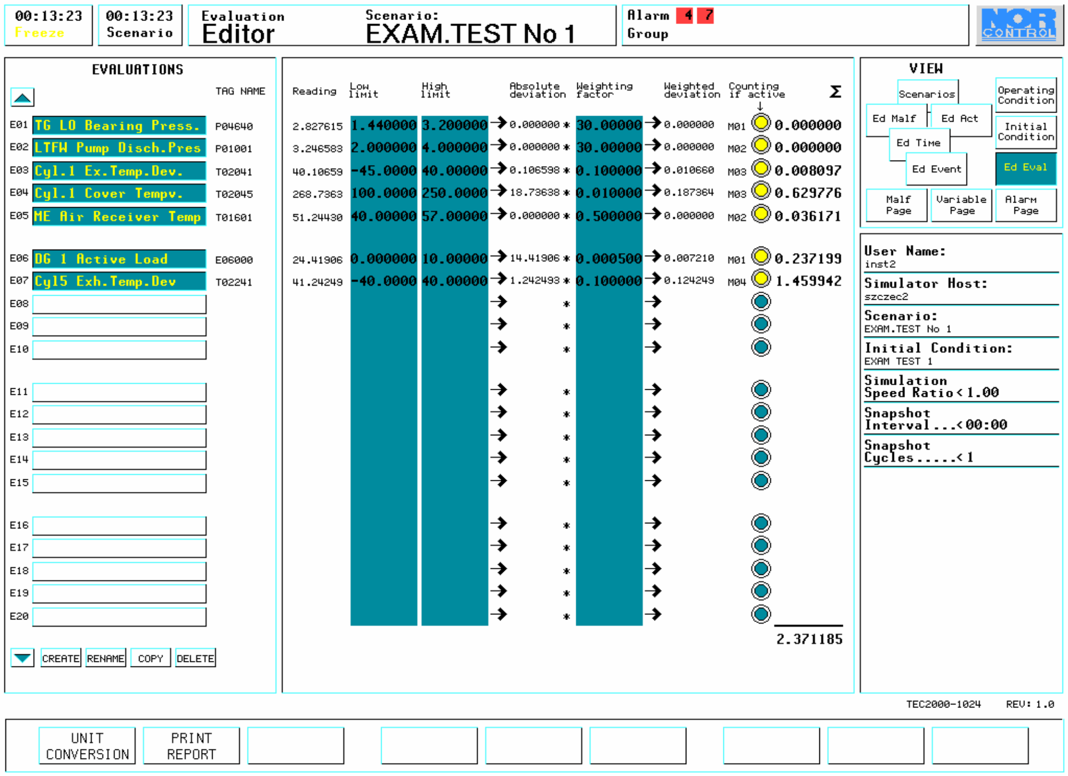

Figure 5: Evaluation Editor – Final Status

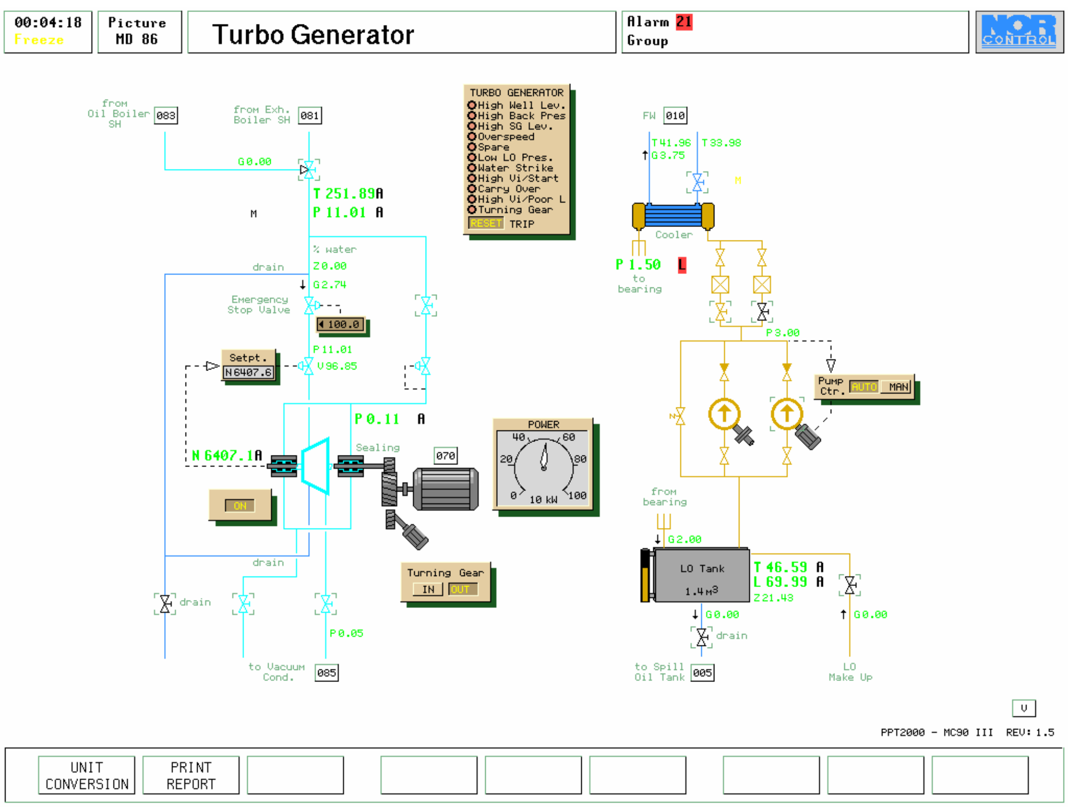

Figure 6: Turbo Generator Layout System

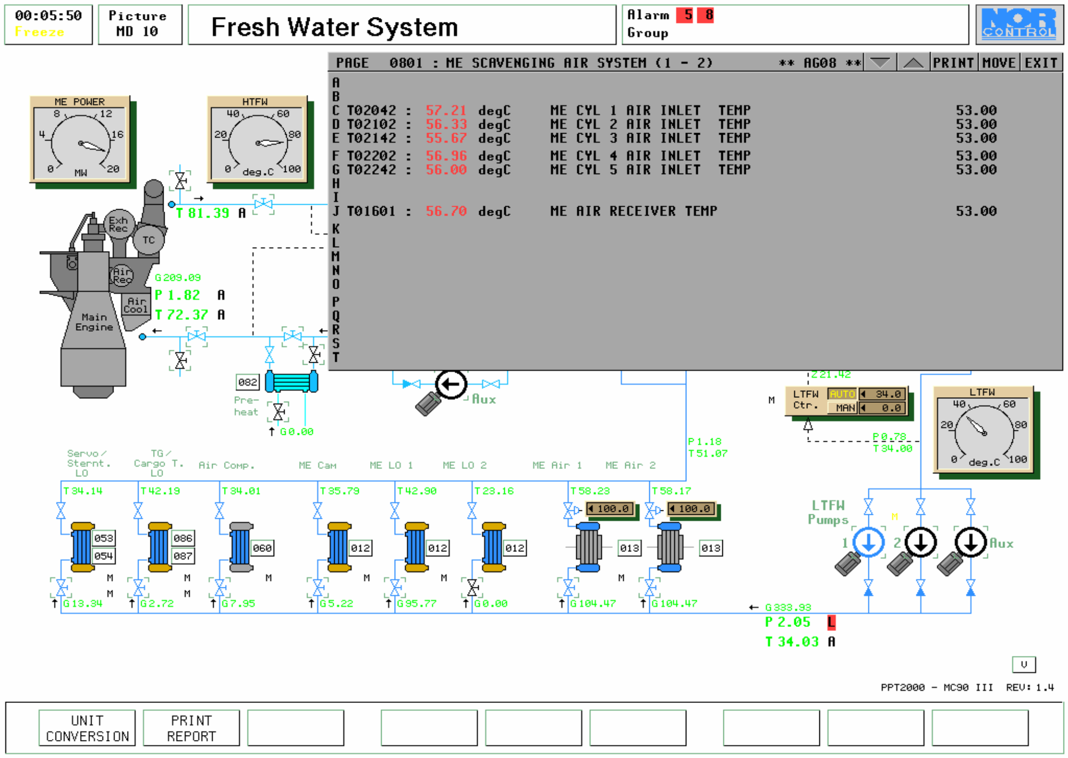

Figure 7: Fresh Water System

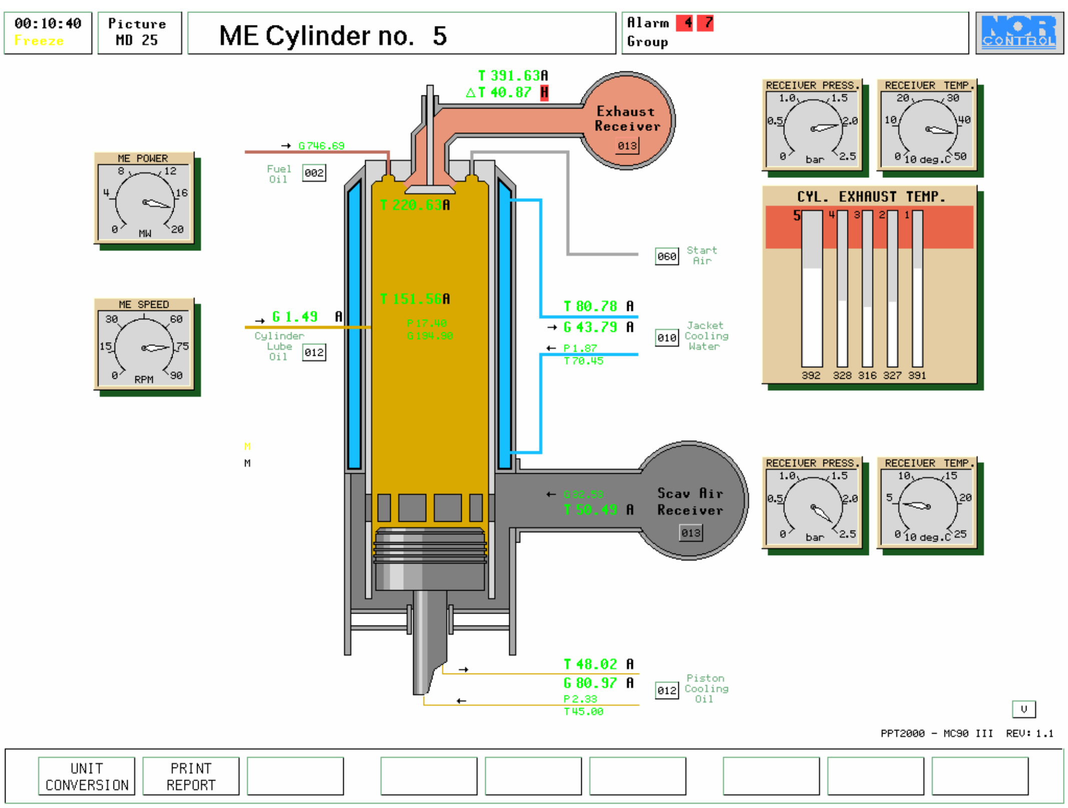

Figure 8: Main Engine Cylinder 5

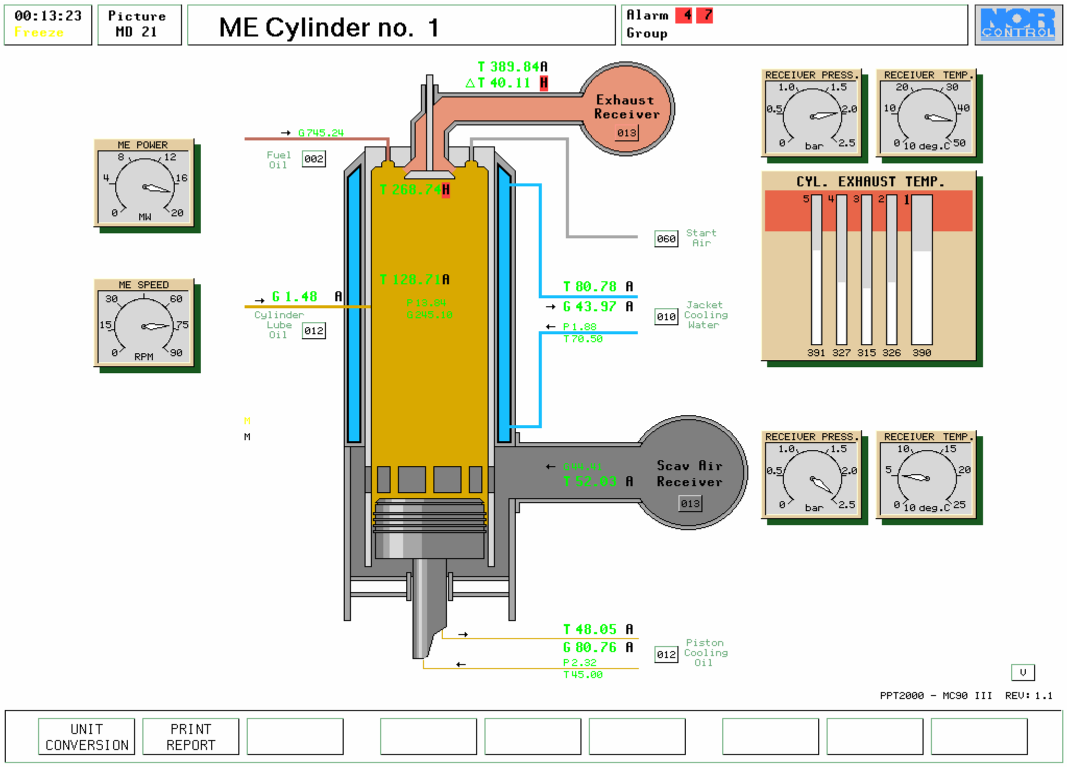

Figure 9: Main Engine Cylinder 1

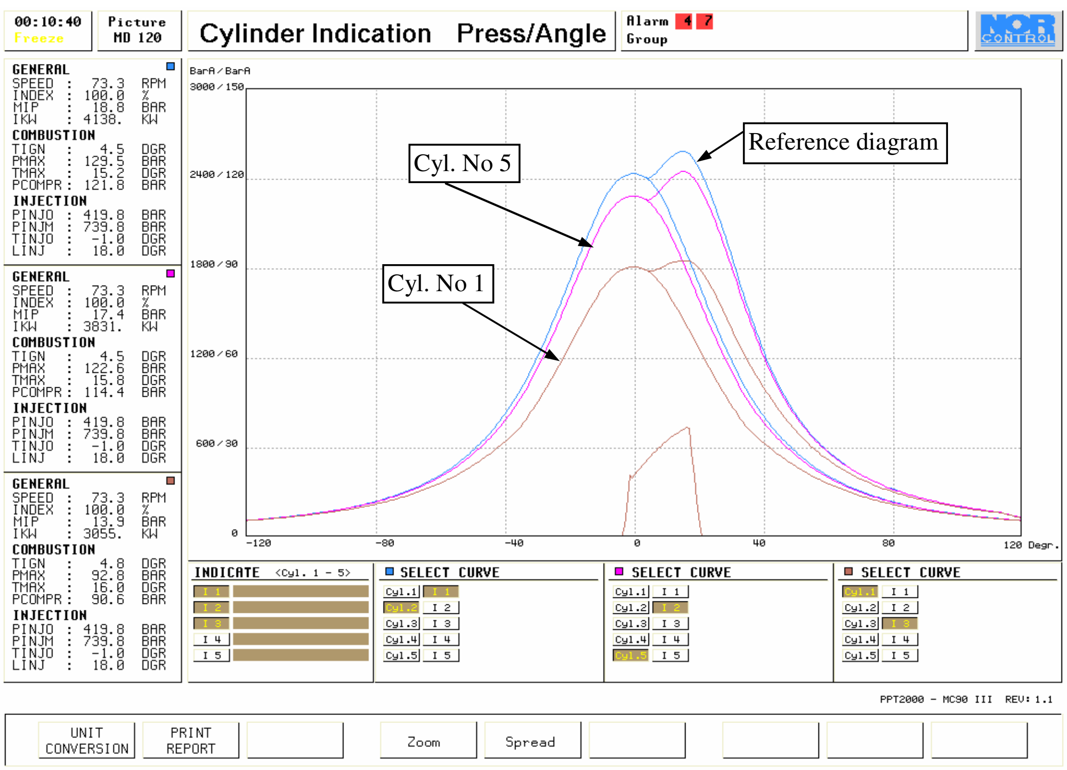

Figure 10: Cylinder Indicator Diagram