

# THE SELECTED ASPECTS OF THE STEAM ENGINE ROOM SIMULATORS

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The author's studies on the steam power plant simulator have shown that this type of the simulator is necessary for the successful and effective training of engineering crew for the steam powered ships. The steam engine room simulators require new model course and new assessment methods. Some operational skills, necessary in a steam engine room can be trained in a diesel plant simulator, but the most important tasks like main boiler, main turbine and steam system operations have to be learned and trained in the appropriate, dedicated, steam engine room simulator.

## INTRODUCTION

The first steam turbine powered ship was "Turbinia" built in 1897 [1] and the first reversible marine diesel engine was built in 1906 [2]. At the beginning, ship turbines were much more popular than diesel engines as a ship propulsion, especially in the navies. Today most of the merchant ships are powered by diesel engines. The difference between the engine room powered by a steam turbine and the engine room powered by a diesel engine is obvious for everybody who has seen both of them. Because of that, the parallel education of the ship-engineering officers for both engine room types was a common standard until the last decade of the 20<sup>th</sup> century. However, this practice has changed in last years and the steam turbine engine room theory and operation have disappeared from many training centers and merchant marine academies. This trend causes the increasing difficulties in finding well-prepared engineering officers for the modern steam turbine ships.

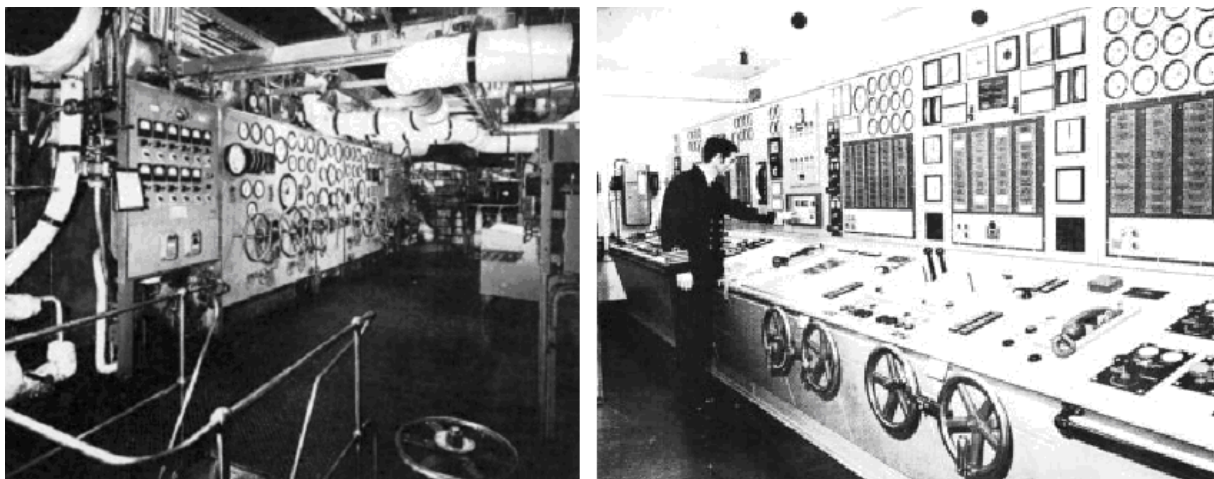


Fig. 1 Starting platform of SS Empress of Britain (1956) (left), contrasted with the control room of the Ben Avon containership (1972) [1].

## STEAM ENGINE ROOM SIMULATOR VS. STCW 95 AND IMO MODEL COURSE 2.07

STCW 95 includes not only the mandatory minimum requirements for certification of officers but also:

- General performance standards for simulators used in training and assessment of competence (Section A-III/1).
- Simulator training and assessment procedures (Section A-III/1).
- Guidance regarding the use of simulators including the list of the required simulator capabilities (Section B-I/12).

According to this convention the minimum standard of competence for chief engineer officers and second engineer officers on ships powered by main propulsion machinery of 3,000 kW propulsion power or more should possess the knowledge of the operating principles (and maintenance) of the ship power installations (diesel, steam and gas turbine) and refrigeration (see Table A-III/2 in [3]). Except that, there is no other requirement for the engine room simulators in the respect to the propulsion type. Also Det Norske Veritas Standard for Maritime Simulator Systems [4] requires that a simulated main engine shall replicate a system working according to one of the following principles:

- Diesel combustion
- Steam turbine
- Gas turbine

All that means that both: the engine room simulator producers and the marine training centers have a free choice of the engine room propulsion type to be modeled in the machinery simulator. Because of the high simulator investment cost and the limited training time, most of the simulator users decided to purchase only the diesel engine room simulator and to limit the training scope to this most popular propulsion system. This approach seems to be quite reasonable but its consequence is a shortage of the engineering officers trained for the steam turbine operation.

The example implementation of STCW 95 has been proposed in IMO Model Course 2.07 [5]. This course however is based on the diesel engine room only (see paragraph 1.1.7 in [5]). The recommended engine room layout includes an auxiliary steam boiler and the steam cargo turbines, but except of that, there is no other relation to the steam turbine powered ship propulsion system. As a result, IMO Model Course 2.07 cannot be directly used for the training in the steam turbine simulator environment.

## STEAM SIMULATOR AND DIESEL SIMULATOR

Many simulator users believe that a separate simulator of the steam engine room is unnecessary, because the diesel engine room simulator can be used as a (not perfect, but good enough) substitute of the first one. Let's look at the examples of the both engine room simulator types in order to check if the above-described approach is correct. Virtual Engine Room 3 (VER3) will be used as an example of the diesel engine simulator and Steam Engine Room (SER) will be used as an example of the steam turbine engine room simulator. Both Simulators have been developed by UNITEST Poland.

## Main Engine

The several common controls have been placed in the control panels of both simulators (Fig. 2 and 3): engine order telegraph, auxiliary telegraph, ME control mode switch and ME speed gauge. On the other hand the set of very important steam turbine controls like: bleed and drain switches, throttle controls, ME bearing temperatures and very important 'Rotor Stopped' alarm are missing in VER3. The reason is rather obvious: both main engines (diesel and steam turbine) have quite different operation methods and different controls. But what about the turbo generator, which has been also implemented in VER3? Fig. 4 shows the two parts of the TG control panels implemented in VER3 and it is easy to observe that many TG control is much more simple that main turbine control in SER. Also the comparison of the steam and condensate system implemented for TG in VER3 (Fig. 4) and for ME in SER (Fig. 5) confirms that TG system is too simple to be used as a training replacement for a main steam turbine. As a conclusion it is possible to state that main diesel engine control panel and TG controls cannot be used for a teaching how to operate the main steam turbine with multiple bleeds and a separate astern turbine.

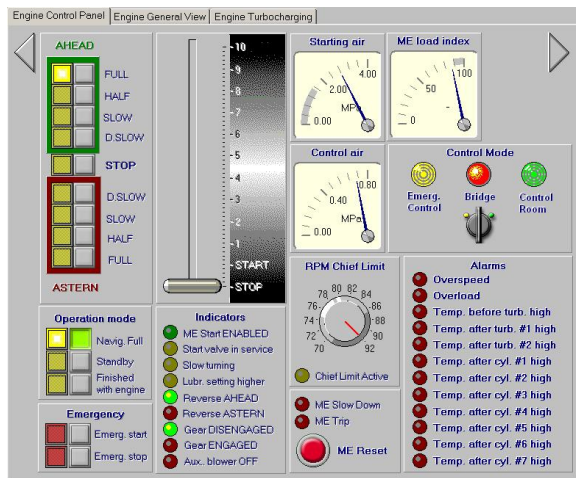


Fig.2 ME control panel in VER3.

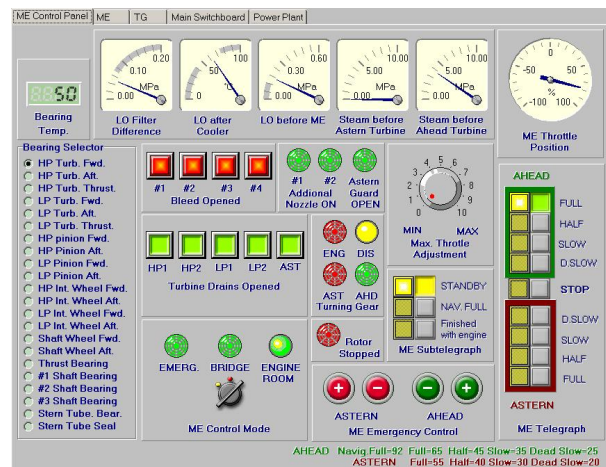


Fig.3 ME control panel in SER

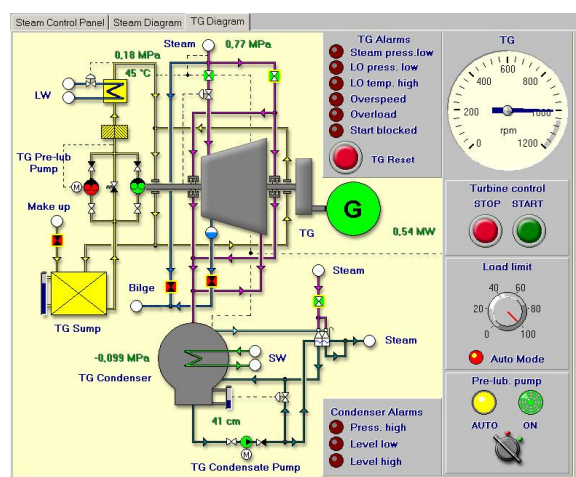


Fig.4. TG system in VER3.

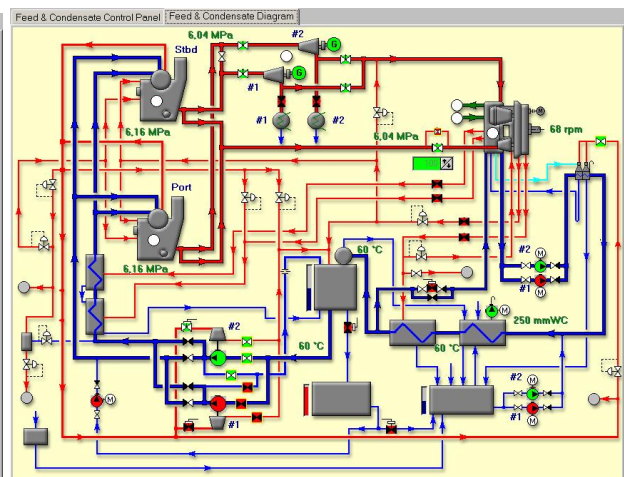


Fig.5. Steam and condensate system in SER.

## Steam System

The steam generation in a diesel engine plant has been shown on Fig. 6 and includes both: an auxiliary boiler and an exhaust boiler. The main boiler example as implemented in SER has been shown on Fig. 7 but it should be analyzed in a conjunction with the steam and condensate circulation system shown on Fig. 5. The example shows that the diesel engine steam system (even quite sophisticated) is much more simple than the main boilers, multiple heat exchangers and steam driven feed pumps in a steam turbine engine room. Considering the size of both compared boiler types, their parameters (0.8 MPa in VER3 vs. 6.1 MPa in SER), their controls shown on Fig. 8 and 9, and their starting procedures, it can be said that VER3 can not be used as substitute of SER.

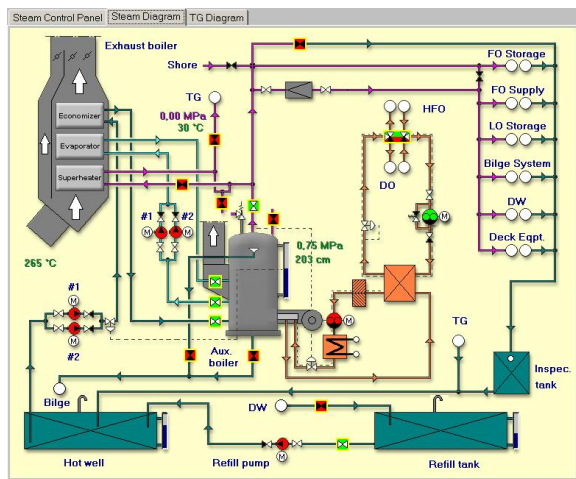


Fig.6. Steam system with boilers in VER3.

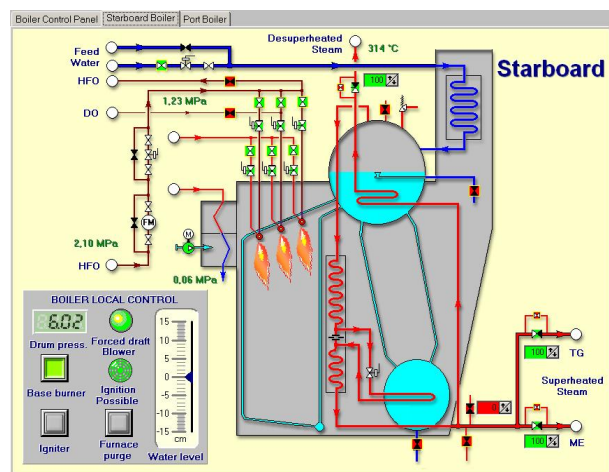


Fig.7. One of the two main boilers in SER.

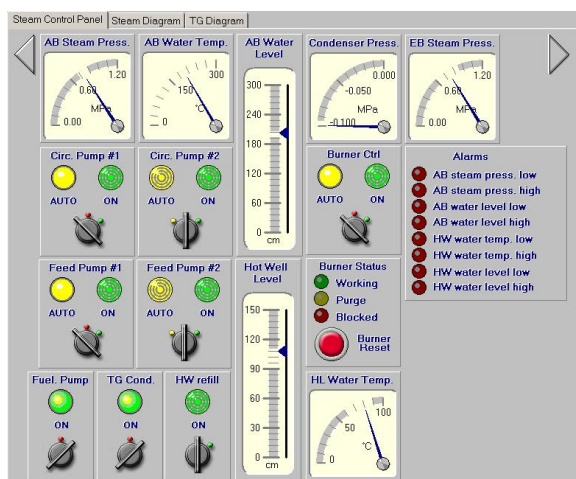


Fig.8. Steam control panel in VER3.

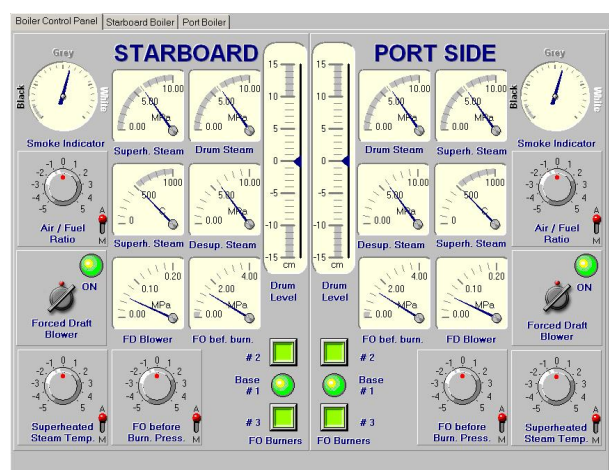


Fig.9. Main boilers control panel in SER.

## Fuel and Lubricating System

Even taking into consideration the part of the fuel system from VER3 (Fig. 10) and the whole fuel system in SER (Fig. 11) it can be said the diesel engine fuel system is not less complicated than this one used in steam engine room so keeping in mind several minor differences one can use a diesel engine plant for training the operation of the steam engine room fuel system.

The same can be said about the lubricating systems (Fig.12 and Fig.13) but again it is worth to remember that in the case of VER3, only circulation of lubrication oil has been shown. In the reality however, VER3 includes LO storage as well.

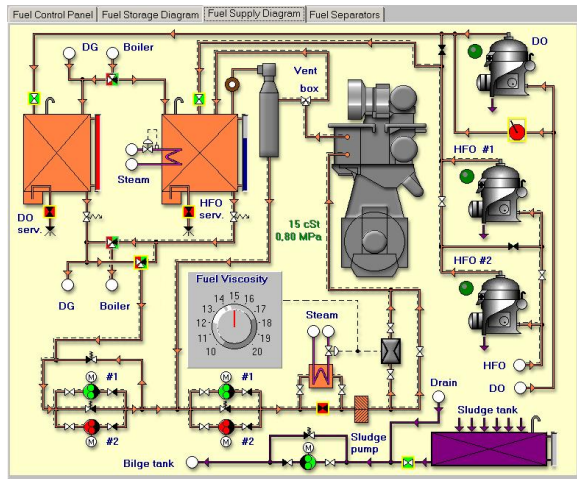


Fig.10. Fuel circulation in VER3.

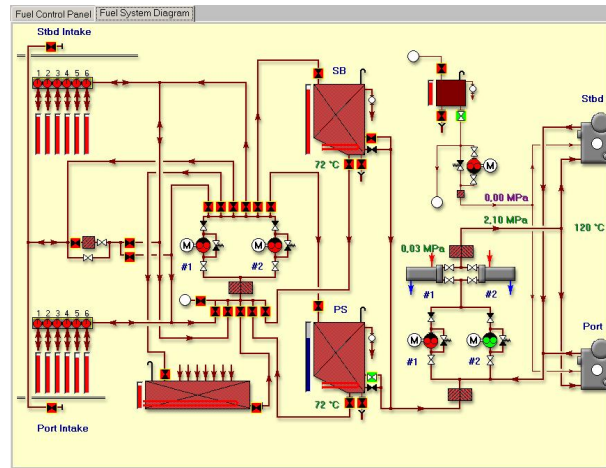


Fig.11. Fuel storage and circulation in SER.

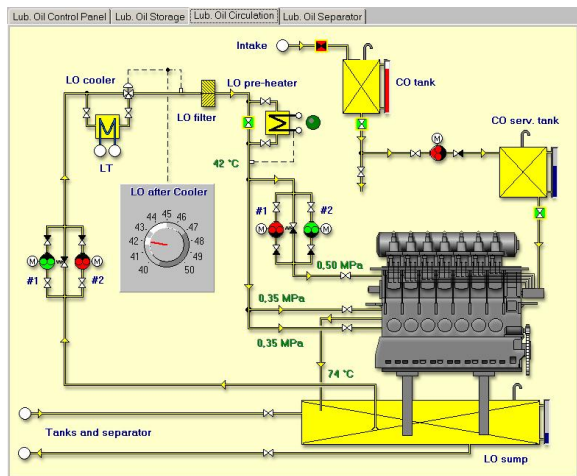


Fig.12. Lubricating system in VER3.

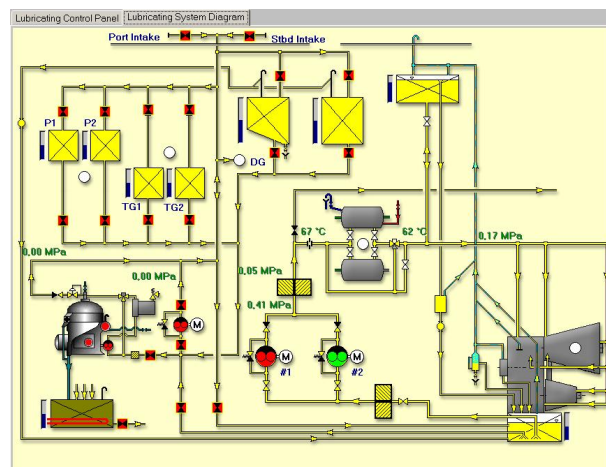


Fig.13. Lubricating system in SER.

## Cooling System

The cooling system of the modern diesel engine room consists usually of the sea water subsystem (Fig. 14) and a quite complex, fresh water central cooling system including both: low- and high temperature water circulation. The cooling system, which can be found in a steam engine room, is usually only a sea water system, with a separate, very effective cooling of the main condenser (Fig. 15). Even if this system is similar to the diesel engine seawater cooling, a special attention has to be paid to the problem of the flow control in the case of a main condenser LO cooling. Beside that, the operation skills learned in a diesel engine room simulator can be effectively used in the operation of the steam engine room cooling system.

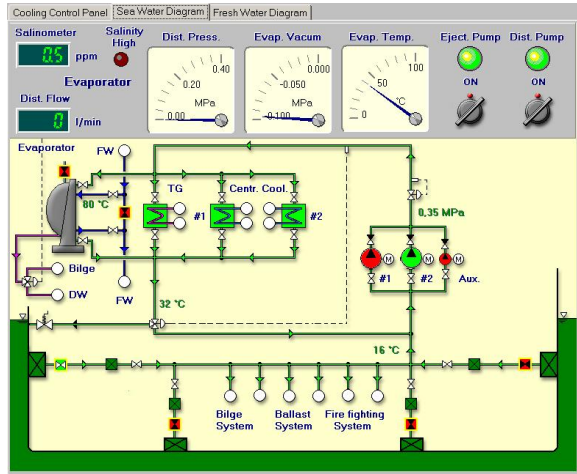


Fig.14. Sea water system in VER3.

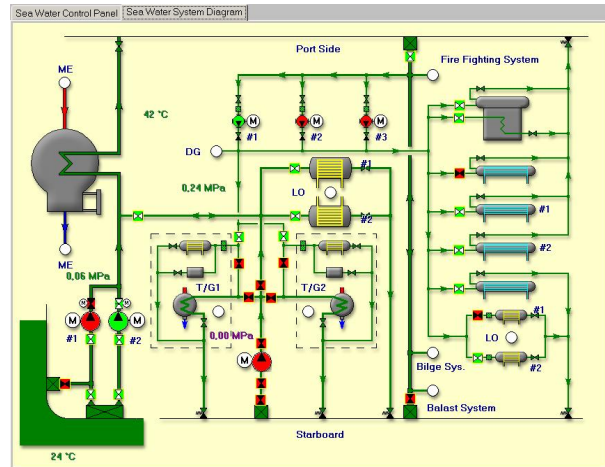


Fig.15. Sea water system in SER

## Other Systems

Because of the limited volume of this paper, the remaining engine room systems will be discussed briefly and without the appropriate pictures. Their comparison has been presented in Table 1. Please take into account that only the engine room system were taken into consideration when creating this table. It means that ship type specific systems like for example the steam cargo pumps on tankers have not been taken into account.

Tab. 1. The possibility of diesel simulator training application for the operation of the selected systems in a steam engine room.

System name	Diesel plant (VER3)	Steam engine room (SER)	Comment
Compressed Air System	Rather complicated with two main receivers, several remotely controlled valves, cut off valves and big compressors.	Very simple when compared to VER3.	Can be applied*
Electrical Power Plant	Assuming the presence of the turbo generator is very similar to steam engine room	Other consumers (pumps mainly) have been assigned to the main and emergency bus bars.	Can be applied But some additional training may be required.
Bilge System		Almost identical	Can be applied
Ballast System		Almost identical	Can be applied
Fire Fighting System		Almost identical	Can be applied
Refrigerating System		Almost identical	Can be applied
Steering Gear		Almost identical	Can be applied

\* **Can be applied:** means that the person trained on diesel plant simulator should be able to operate the corresponding system in a steam engine room without any problems.

## CHECKLISTS AND INTEGRATED ASSESSMENT

The author's experience shows that checklist can be successfully implemented and used in steam engine room simulators. They have been implemented in the diesel plant for the first time [6] but in many respects they are even more needed than in the diesel plant simulator. The steam engine room and the main boilers especially require carefully planned and time related operation. Certain operations can be done only if the system's appropriate status is reached. For example, the main steam delivery valve should be opened only if there is a proper pressure in a boiler and a starting valve has been closed. Of course, the operations supported by checklists are very different in both simulator types and they have to be split into smaller chunks as well.

The integrated assessment has been developed for the diesel plant simulator [7] and has proved to be a usable and effective assessment tool. However, the first tests showed that the typical 'snap-shot', static tests implemented in VER3 (see in [7]) cannot be used for the successful assessment in a steam engine room simulator. The aim of the static test is to verify if the plant status in a given moment is exactly as it should be. Generally, this kind of a test will not check how the given status was reached: in which sequence the valves were opened, pumps started or tank drained. Experience has shown that such a simplification is acceptable in the case of diesel power plant operation. However, the way valves are opened, turbines started or boilers heated is very important in a steam power plant, especially with a huge boilers and powerful turbines. Because of that, the author is convinced that more sophisticated, dynamic assessment methods should be developed and implemented in the steam turbine engine room simulator. Such methods are already under development.

## CONCLUSION

The presented analysis of STCW 95 requirements shows that a steam turbine engine room simulator should be considered as a full value partner of the most popular diesel engine plant simulator. A separate, steam engine room simulator model course should be developed, because IMO Model Course 2.07 is not applicable for this simulator type. Even if many operational skills, necessary in a steam engine room can be trained in a diesel plant simulator, the most important tasks like main boiler, main turbine and steam system operations have to be learned and trained in the appropriate, dedicated, steam engine room simulator. This simulator should be equipped with very effective teaching tools like the checklists and integrated assessment, but the new, time based, assessment methods have to be developed.

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