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The modern tanker engine room design

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Abstract

The paper analyzes the application possiblites of the Lloyd Register Provisional Rules for enhanced Availability of Engineering Systems for Propulsion and Steering and the R2-SA+ requirements of the american Bureau of Shipping, in the tanker engine-room design. The paper deals with the possible development of tanker engine room and defines the final solution of the tanker engine room design as the energetic center with the integrated functions of propulsion and cargo systems. From the IMO environmental protection regulations point of view, the final solution is not applicable at the present moment. Therefore the paper anaylyzes the design derived from the final solution. The suggested project has been analyzed from the failure mode point of view. The possibilitiy of new technology application in the tanker engine room design is shown.

1 Introduction

The paper is based on the Lloyd Register Provisional Rules for Enhanced Availabity of Engineering Systems for Propulsion and Steering, R2-SA requirements of the American Bureau of Shipping, and papers Belak [1], Roskilly [2], Belak [3] and Belak [4]. In the paper Belak [1], presented on the ISME Tokyo 2000, the tanker engine room enhanced availability has been analyzed, and ultimate solution of the tanker engine room design is defined.

Basically, the enhanced availability i.e. service reliability of the technical system can be obtained on one of two major ways:

- by increasing the quality of the system elements;
- by increasing the rendundancy of the system

Both ways are widely used in techincal practice combined with the elements or subsystem unification. The first way is to find out, and later to improve, the product inherent quality by the extensive service testings and failures analysis. This is the way that enables geting a better products and removing the low quality products from the market and maritime practice. But this is also the much more expensive way, although it is, from the science and technique development point of wiev, only one, toward the progress, directed way. The second way, that was the basis for the Rules and definition, choosen by the LR and ABS, is to impose the system rendundancy. At ultimate consequence, that means essentially to put the trash under the carpet.

It means that, according to the Rules, the better solution is to apply two pieces of certain equipment of doubtful quality than to apply one piece of the equipment of higher quality. That is a very well known practice of compromise. Any how, the Provisional Rules are here and they are to be applied in maritime and shipbuilding practice.

However this is the theoretical analysis of the engine room, and for the needs of this paper, one should neglect the most important difference between the ship engine room service realiability or enhanced availability connected to the maintenance activities, and any other tehnical transport mean or system. The ship is the only transport mean that enables the maintenance and failure repairing activities during the service.

To analyze the LR and ABS requirements and their influence on the ship engine room design, in this paper, the possibility of, during the service, maintenance activities, must be neglected.

2 The problem analysis

The paper Belak [1] analyzes the tanker engine room design possibilities according to the LR and ABS requirements and additional requests to the problem solution. The LR and ABS Rules requirements are:

- the designed energy sources consists of several main engines, placed in separated places and engaged with several propulsion systems;
- the designed system consists of several steering systems placed in separated places;
- keeping of 50% reserve propulsion that can be established in 120 seconds;
- manouvreing and vessel position keeping during the 36 hours under previously defined conditions.

The additional requests to the problem solution according to Belak [1] are :

- the energy sources unification for all prime movers of any segment of propulsion, steering, cargo and ballast system;
- the use of all the systems that could be applicable for propulsion and steering.

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After the problem analysis and the solution synthesis performed using the method presented in Belak [3], the ultimate problem solution is defined as it is shown in the Figure 1.

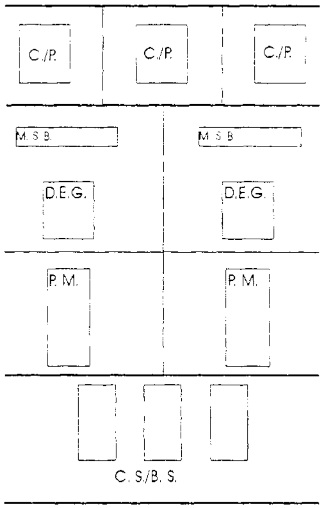

Figure 1: The tanker engine room ultimate design solution

Where there is:

P.M.	prime mover
E.G.	electric generator
M.S.B.	main switch-board
C/B/P.P.	cargo/ballast/propulsion pump
C.S./B.S.	cargo/ballast system

Figure 1 shows the tanker engine room design ultimate solution i.e. ultimate design possibility. The system consists of integrated cargo system, ballast system and tubular propulsion systems. The reserve propulsion is obtained using independent energy sources, placed in separated engine rooms. The reserve and service steering is obtained using the independent tubular propulsion system arrangement. The design shown in the Figure 1 is obviously not acceptable from the present maritime practice and environment protection international conventions.

The tanker engine room design that meets all LR and ABS requirements as well as additional requirements is shown in the Figure 2.

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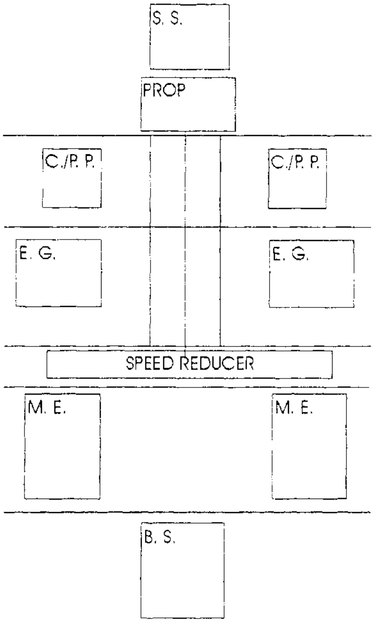

Figure 2

Where there is:

S.S.	steering system;
PROP	propeller;
C./P.P.	cargo/propulsion pump;
B.S.	ballast system;
M.E.	main engine;
E.G.	electric generator.

The basic characteristics, of the design shown in the Figure 2, and achieved goals are:

- energy sources unification;
- stand by reserve propulsion;
- stand by reserve steering.

The energy sources unification means that the electricity is the only energy source for all subsystems (cargo; ballast; steering, navigation and others). The stand by reserve propulsion means that, during the sailing, the cargo / propulsion pumps are in stand by position. Stand by reserve steering is obtained by the presence of two cargo / propulsion pumps that can be used for steering.

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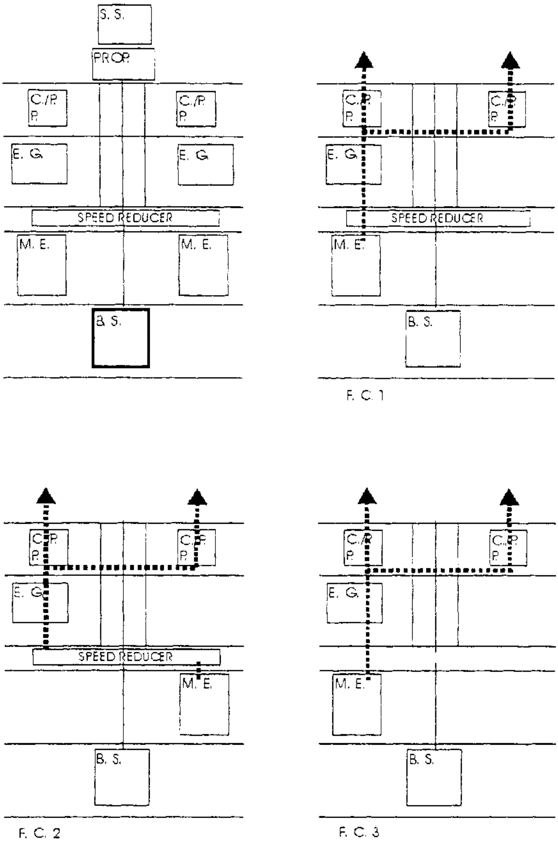

Figure 3: The system failure cases

The failure cases when four elements of the propulsion, steering , cargo and ballast system fails is shown in the Figure 3. The presented design of the engine room enables the keeping of propulsion and steering capability in analyzed failure cases. This, short, failure analysis, performed in the Figure 3, through the failure cases F.C.1; F.C.2 and F.C.3, shows the very high capability of the engine room design to keep the propulsion and steering in service condition.

Introducing the results of the paper Roskilly [2] to this analysis, the speed reducer and propeller can be omitted, and the sistem configuration is shown in the Figure 4.

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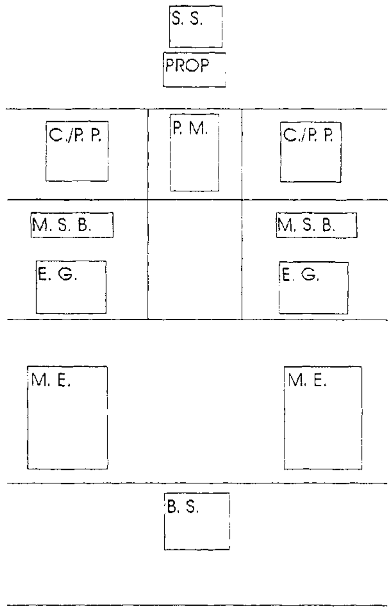

Figure 4: The propulsion system using the propulsion electro-motor

Where there is:

M.E.	prime movers;
P.M.	propulsion electro-motor;
E.G.	electric generator;
M.S.B.	main switchboard;
C./P.P.	cargo/propulsion pump;
B.S.	ballast system;
S.S.	steering system

The failure cases of the system shown in the Figure 4 are analyzed in the Figure 5.

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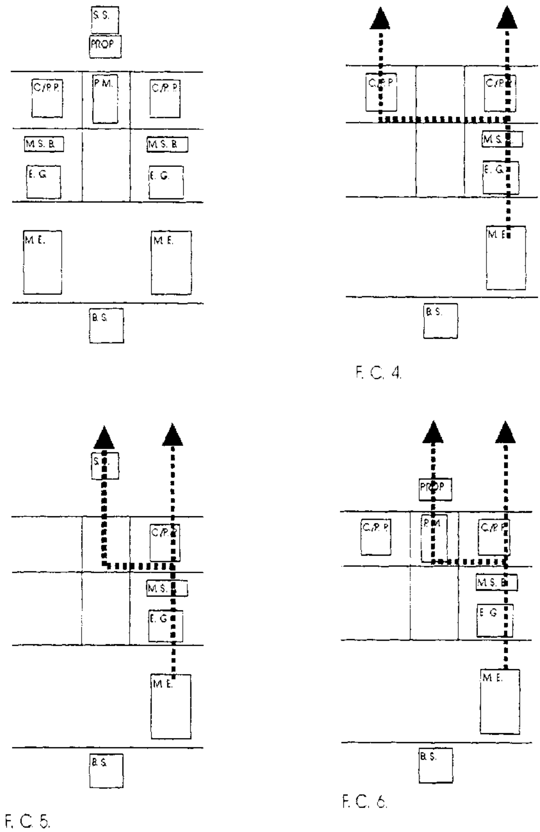

Figure 5: The system failure cases

The failure cases when five elements of the propulsion, steering , cargo and ballast system fails is shown in the Figure 5. The presented design of the engine room enables the keeping of propulsion and steering capability in analyzed failure cases. This failure analysis, performed in the Figure 5, through the failure cases F.C.4; F.C.5 and F.C.6, shows the higher capability of the engine room design to keep the propulsion and steering in service condition than the system shown in the Figure 2.

3 Conclusion

The paper is an instalment of the paper Belak [1], and performes the failure cases analysis. Besides the propulsion / cargo / steering system integration and energy sources unification the paper initiate the following directions of further research and development:

- the tubular propulsion system research;
- the propulsion and cargo system integration research.

Introducing the, during the service, unattendant engine room design, and maintenance friendly engine room design, according to the Belak [4], the possible development of the engine room could be directed to the design shown in the Figure 6.

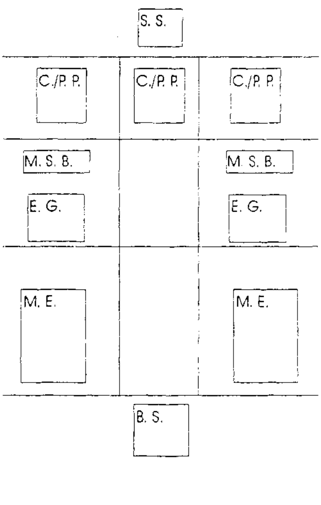

Figure 6

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