

T1/3.02

GUIDELINES FOR ENGINE-ROOM LAYOUT, DESIGN AND ARRANGEMENT

1 The Maritime Safety Committee, at its sixtieth session (6 to 10 April 1992), instructed the Sub-Committee on Ship Design and Equipment (DE) to consider engine control room design and arrangements, in order to advance work on addressing the human element for the purpose of preventing maritime casualties and pollution of the marine environment.

2 The Committee, at its sixty-eighth session (28 May to 6 June 1997), approved, in principle, the draft Guidelines for engine-room layout, design and arrangement, as prepared by the DE Sub-Committee, which provide recommendations for addressing the human/machine environment in the engine-room. However, recognizing that the draft Guidelines contain fire protection issues which might need further improvement, the Committee referred them to the Sub-Committee on Fire Protection (FP) for finalization. The annexed Guidelines incorporate, therefore, the outcome of the work of the FP Sub-Committee at its forty-second session.

3 Member Governments are invited to bring the Guidelines to the attention of ship designers, shipowners, ship operators, shipping companies, shipmasters and engine-room staff for appropriate action.

ANNEX

**GUIDELINES FOR ENGINE-ROOM LAYOUT, DESIGN
AND ARRANGEMENT****1 PREAMBLE**

Many studies have shown that, statistically, the engine-room is the most dangerous area on a ship. An efficiently operated engine-room, with appropriately located controls for pumps, power and propulsion, is also vital for co-ordinated emergency response. Therefore, it stands to reason that a well-designed engine-room will be inherently safer and will consequently contribute to a higher overall safety standard.

2 PURPOSE

The purpose of these non-mandatory guidelines is to provide ship designers, ship owners, ship operators, shipping companies, shipmasters and engine-room staff with information aiming at enhancing engine-room safety and efficiency through design, layout and arrangement.

3 SCOPE

These guidelines are intended to improve engine room safety and efficiency and overall vessel safety by facilitating good decision-making with regard to engine room layout, design and arrangement. To accomplish this goal in the most efficient manner, these guidelines are focused on the human-machine environment of the engine-room. The relevant factors used to describe the human-machine environment are:

- .1 familiarity;
- .2 occupational health;
- .3 ergonomics;
- .4 minimizing risk through layout and design; and
- .5 survivability.

4 APPLICATION

These guidelines are applicable to all ships to which chapter II-1, Part C, Machinery installations, of the International Convention for the Safety of Life at Sea, 1974 (SOLAS 74), as amended, applies. These guidelines should also apply, as appropriate, to mobile offshore units covered by the 1989 MODU Code and to high speed craft covered by the HSC Code. Not all of the provisions of these guidelines will apply to all types of engine-rooms. The provisions of these guidelines should be applied with consideration for the engine-room type - fully crewed, minimally crewed, or unattended.

5 DEFINITIONS

5.1 *Relevant factors* - Relevant factors are descriptors of a safety issue. In the case of these guidelines, the relevant factors describe engine-room safety in terms of the human element aspects that are affected by layout, design and arrangement.

5.2 *Engine room* - For the purposes of these guidelines, the engine-room is considered to be a space or spaces containing propelling machinery, boilers, oil fuel units, generators, and major electrical machinery, and

includes auxiliary machinery spaces, store rooms, workshops, machine shops, the shaft alley, and the steering gear room.

5.3 *Familiarity* - This relevant factor addresses the relationship between engine-room safety and efficiency and crew member familiarity with layout, equipment, systems, procedures, alarms, signs and symbols. Maximizing crew member familiarity will result in fewer accidents due to errors in reading instruments and mis-identifying equipment.

5.4 *Occupational health* - This relevant factor addresses the effect of engine-room environment on crew member health and performance. Enhancing workplace comfort will result in fewer accidents caused by psychological and physiological stresses.

5.5 *Ergonomics* - This relevant factor addresses the sensory connections between crew members and engine-room equipment, controls, instruments and alarms and the typical needs of personnel working in the engine-room. Considering personnel needs and designing human-machine interfaces that recognize human capabilities will minimize accidents due to human limitations and tendencies.

5.6 *Survivability* - This relevant factor addresses the crew's capability to survive an emergency in the engine-room. Giving rational consideration to possible emergency conditions, the placement of emergency equipment, and the routine duty stations of and typical routes taken by crew members, will maximize the chances of crew survival.

5.7 *Minimizing risk through design, layout and arrangement* - This relevant factor addresses the affects of physical configuration on engine-room safety. Creating an engine-room configuration through a detailed, systems perspective will remove impediments to efficient engine room operations and minimize the chance that an accident involving one piece of equipment will affect the operability or performance of another piece of equipment.

6 RECOMMENDED PROCEDURES

6.1 Familiarity

6.1.1 Pipes should be colour-coded for identification of content and direction of flow. The colour-coding should also differentiate between grades of fuel. The colour-coding and direction of flow should be in accordance with recognized international standards such as ISO standard 14726-1, Ships and marine technology - Piping systems - Identification colours for content.

6.1.2 Electrical cables should be labelled with an identifying code using a durable tag which should be affixed to the cables in accordance with the following convention:

- .1 Tags should be affixed at the exit from the main switchboard, at the entrance and exit of intermediate panel boards, at the entrance and exit of junction boxes, at the entrance and exit of controllers and at the connection to the load.
- .2 Circuit breakers in switchboards and panel boards should be identified by the written name of the circuit and the circuit code.

- .3 Tags for electrical cables should correspond with the relevant ship's drawings. Any modifications of the ship's cabling should be reflected in revisions to the drawings.

6.1.3 The engine-room instrumentation and alarms required by the SOLAS Convention and other IMO instruments should be designed and installed in accordance with the requirements of resolution A.686(17) - Code on Alarms and Indicators, as amended. Classification Society requirements should also be taken into consideration.

6.1.4 Valves located below the floor plates should be fitted with indicators that are independent of the valve controls and are discernible to crew members looking at the valve, to show whether the valve is in the open or closed position. In cases where the possibility of direct manual operation is required in addition to the remote control, means of observing the valve position and the valve location are to be provided.

6.1.5 Items of machinery should be clearly identified to facilitate familiarization with their location and function.

6.2 Occupational health

6.2.1 Engine-rooms should be designed to comply with resolution A.468(XII) - Code on Noise Levels on Board Ships.

6.2.2 Engine-rooms should be designed to comply with ISO 8861, Engine-room ventilation in diesel-engined ships - Design requirements and basis of calculations, and ISO 8862 - Air-conditioning and ventilation of machinery control-rooms on board ships - Design conditions and basis of calculations. Due to the hazards to health caused by exposure to oil and inhalation of oil mist, all practicable means should be taken to avoid unnecessary exposure and special consideration should be given to the installation, location and ventilation of equipment likely to produce oil vapour and mist.

6.2.3 Enclosed control rooms, when provided, should be air conditioned to provide periodic relief from high temperatures in engine-rooms as well as to optimize the performance of electrical and electronic circuits. Other areas of engine rooms should be provided with heating or cooling facilities, as necessary, to ensure the temperature does not adversely affect the performance of personnel working in them during watchkeeping, maintenance or repairs.

6.2.4 Lighting should be adequate for the tasks of personnel working in engine rooms and associated spaces. The minimum illumination levels should be determined by the Administration, taking into account national or international standards recognized by it. In the absence of such standards, the Administration should be guided by the table given below. Adequate lighting below floor plates should also be considered.

Guidance for minimum levels of illumination¹

Area	Dekalux
Boiler rooms	22
Control stations	
General	22
Control consoles	32
Gauge and control boards	32
Switchboards	32
Engine-rooms	22
Generator and switchboard rooms	22
Fan rooms	11
Motor rooms	11
Pump room	11
Shaft alley	11
Shaft alley escape	3.2
Steering gear room	22
Workshops	
General	32
On top of work bench	54
Storerooms	5.4
Offices	
General	22
On top of desks	54

6.2.5 Machinery mountings in engine-rooms should be designed so as to minimize machinery vibration and long-term effects of vibration on personnel working in the engine-room.

6.3 Ergonomics

6.3.1 Engine-room layout, design and arrangement should provide a work environment that fosters effective procedures, work patterns, and personnel safety and health, and that minimizes factors which degrade human performance or increase the potential for error.

6.3.2 To standardize engine-room consoles and panels, the layout, design and arrangement of controls, instruments and alarms should take into consideration a recognized, international human engineering standard with regard to, at least, placement, shape, display, labelling, complexity, and control movement expectancy.

6.3.3 For shipboard spare parts, arrangements should be made, where practicable, for the storage of spare parts and supplies contiguous to the machinery or equipment for which they are intended.

¹ Extracted from standard RP-12 of the Illuminating Engineering Society of North America.

6.3.4 For shipboard spare parts, an effective transportation and parts handling system should be incorporated into the engine-room design. The transportation and parts handling system should be designed to handle heavy

machinery parts efficiently and safely and operate under the same conditions of static list, rolling, and pitching as the main propulsion machinery.

6.3.5 Sufficient space around machinery should be ensured so that maintenance, repair and housekeeping tasks can be performed efficiently with no unnecessary restrictions or risk of injury from contact with hot surfaces or rotating machinery.

6.3.6 A noise-protected communication station should be installed in the general area that most maintenance and watchkeeping activities take place, such as the engine-room lower level or pump flat, and outside the control room, when a control room is provided.

6.3.7 The layout, design and arrangement of machinery and work areas in engine-rooms should be such that the engine-room can be conveniently cleaned.

6.3.8 A supply of the tools necessary for expected tasks of personnel working in the engine-room should be maintained in a location that minimizes the distance a loaded tool box is likely to need transporting and, as much as possible, avoids the necessity of carrying tools up or down ladders.

6.3.9 A supply of consumables, such as light bulbs, flashlights, batteries, aural protection, protective goggles, disposable work clothes, gloves, rags, cups, logbooks, pens and pencils, should be maintained in the engine-room for the use of personnel working in the engine-room.

6.3.10 Engine-rooms should be provided with the type of amenities typically required by the personnel working in the engine-room during the course of their watch or duties, given the nature of the ship and the voyage, such as a changing area and toilet facilities.

6.4 Minimizing risk through layout and design

6.4.1 Machinery and equipment in the engine-room should be designed to minimize or eliminate the hazards inherent in rotating machinery, hot surfaces, and electric potential.

6.4.2 Machinery in the engine-room should be located with respect to one another in ways that minimize the risk of multiple failures from a single accident.

- .1 Consideration should be given to locating redundant machinery and equipment on opposite sides of the engine-room while giving regard to the resulting proximity to the controls, instrumentation and engine-room watch stations.
- .2 Fire-fighting equipment, watertight door electric and hydraulic services and other vital systems should be kept well clear of high risk machinery and equipment, such as turbo-generators and main engines, to minimize the risk of fire or explosion involving such machinery or equipment rendering the vital systems or equipment inoperative or inaccessible to crew members responding to an emergency.
- .3 Electrical panels, switchboards and other electrical equipment should be protected from fluids by such means as splash guards or by separating pipes from electrical apparatus.

6.4.3 Consideration should be given to orienting machinery in order to minimize the dynamic load on bearings due to ship motion.

6.4.4 A non-skid coating or covering should be provided for decks, platforms and ladder treads to prevent slipping.

6.4.5 Tripping, falling and bumping hazards, such as the top and bottom of ladders, stanchions, sills and low overheads, should be vividly marked to call their attention to personnel working in the engine-room.

6.4.6 Engine-rooms should be provided with means for collecting and disposing of oil, paper, rags and other wastes and with supplies for cleaning to minimize the potential for fire and personnel injury .

6.4.7 Pipes and cables should be supported to resist vibration and dynamic loading due to ship movements.

6.5 Survivability

6.5.1 The life jackets and immersion suits carried for engine-room watchkeepers should be located by the primary exit to the main deck from the engine-room or in another easily accessible location. This location should be well known to each of the watchkeepers.

6.5.2 Escape routes should be well marked and provided with lighting of a type that facilitates their use when visibility is reduced by smoke.

6.5.3 Emergency escape breathing devices (EEBDs) should be provided taking into account the guidelines on EEBDs to be developed by the Organization.*

6.5.4 Portable fire-fighting equipment in the engine-room should be placed in locations that are nearest to the machinery with the highest fire-risk, so that the equipment is readily available in the event of a fire.

* Refer to Guidelines on the performance, location, use and care of emergency escape breathing devices (EEBDs) developed by the FP Sub-Committee for approval by the Maritime Safety Committee at its sixty-ninth session (11 to 20 May 1998).