



The Knowledge Network

ELECTROMAGNETIC COMPATIBILITY & FUNCTIONAL SAFETY

Annex D - Marine Industry

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Annex D

EMC and Functional Safety in the Marine Industry

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Abstract

To account for the effects of EMC in the marine industry the hazard and risk assessment considers the specific EMC environment. The chief sources of interference above deck are the ship's own radio transmitters. The most susceptible equipment is the ship's radio receivers. The rationale, particularly for the bridge, is that definition of the limits of emissions and immunity for the radio equipment will allow compatibility. These limits set for other equipment in and around the bridge will allow compatibility of all electrical and electronic equipment in those areas.

For the rest of the ship, the assessment of EMC risk has been built into the Rules for Ship Classification Societies*. The process identifies essential services and safety critical systems, further identifies programmable systems and other vulnerable items and requires a formalised type approval procedure which includes EMC testing.

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* Ship classification societies

Lloyds Register of Shipping (LR) is an example of a ship classification society. Ship classification societies now exist in the major mercantile nations. LR was established for the purpose of obtaining for the use of Merchants, Shipowners and Underwriters a faithful and accurate Classification of Merchant Shipping and whilst it still continues to fulfil that purpose although it now also provides many other services.

D1. Procedure for controlling safety risks due to EMC: Summary

To account for the effects of EMC in the marine industry the hazard and risk assessment considers the specific EMC environment. The chief sources of interference above deck are the ship's own radio transmitters. The most susceptible equipment is the ship's radio receivers. The rationale particularly for the bridge is that definition of the limits of emissions and immunity for the radio equipment will allow compatibility. These limits set for other equipment in and around the bridge will allow compatibility of all electrical and electronic equipment in those areas.

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D1. Guidance From the International Maritime Organisation (IMO)

IMO have produced a draft assembly resolution "IMO Resolution A.813(19): 1995," [1] for "*General Requirements for Electromagnetic Compatibility (EMC) for all electrical and electronic ship's equipment.*"

The resolution invites Governments to ensure that all ship's electrical and electronic equipment is tested to the relevant electromagnetic compatibility standards. Note is made to IEC Publications 60945 and IEC 60533.

IEC 60945, Third Edition, 1996 [2]

Maritime Navigation and Radiocommunication Equipment and Systems.

IEC 60533, Second Edition 1999 [3]

Electrical Installations of Ships and of Mobile and Fixed Offshore Units.

In addition IMO Resolution A.694(17) [4] "*Adopts the recommendation on General requirements for Shipborne Radio Equipment Forming Part of the Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids set out in the annex to the present solution*"

IEC 60945 third edition was drafted on this basis and includes within its scope;

Shipborne radio equipment forming part of the global maritime distress and safety system required by the International Convention for Safety of Life at Sea (SOLAS) as amended, and by the 1993 Protocol to the 1977 Safety of Fishing Vessels Convention;

Shipborne navigational equipment required by the International Convention for Safety of Life at Sea (SOLAS), as amended, and by the 1993 Protocol to the 1977 Safety of Fishing vessels Convention, and to other navigational aids, where appropriate; and

for EMC only, all other bridge-mounted equipment, equipment in close proximity to receiving antennas, and equipment capable of interfering with safe navigation of the ship and with radio-communications (see IMO Resolution A.813).

D2. Zones of a Ship

For EMC, a ship can be considered as;

- **Deck and Bridge Zone:** area in close proximity to receiving and/or transmitting antennas and wheelhouse as well as cargo control room, characterised by equipment for signal processing, radio communication and navigation, auxiliary equipment. Open or glassed in areas are the norm and hence structural steel screening is absent.
- **General Power Distribution Zone:** area characterised by normal consumers.
- **Special Power Distribution Zone:** area characterised by propulsion systems and bow thrusters.

D2.1 Deck and Bridge

The bridge of a ship is a particularly dense concentration of radionavigation, radiocommunication and machinery control equipment which all has to work together.

IEC 60945, makes the point that the external environment is by contrast benign. This statement does not quite hold true in port areas - see paragraph below on particular problems in the VHF band.

IEC 60945 at Annex C runs through the risks from each potential EMC threat. As an illustrative example, the emissions requirement of IEC 60945 takes into account the sensitivity of VHF receivers in the 156MHz to 165 MHz bands. Hence the profile of the emissions requirement to the standard differs from the EMC standards for land based industrial systems.

D2.2 General and Special Power Distribution Zones

IEC 60533 covers the total ship and gives a basis for analysis of the EMC risks and how to manage those risks.

The assessment of EMC risks for control systems has been built in to the Rules [5] for classification societies for some years. The process is briefly, to assess which systems are essential services or safety critical systems, to identify items of programmable electronic equipment and to specify that those items are type approved. Type Approval systems are in operation in a number of classification societies and information on the Type Approval system in one society is given in the following section.

An example of a safety critical system to which the above would apply is a main engine low lubricating pressure shutdown.

There are other provisions such as requirements on software, redundancy of plant and provisions for alternative proposals providing an equivalent level of system integrity.

These features are outwith the scope of this guidance note but guidance may be found in the Rules.

In addition it is a requirement that fire detection control units (including addressable systems), indicating panels, detector heads, manual call points and short circuit isolation units are to be type approved in accordance with LR's system.

For single computer installations used for loading instruments type approval is also required. A loading instrument is a computer based system used to ensure that hull girder shear forces and bending moments are kept within permissible limits during and at the conclusion of loading and discharging operations.

D3. Type Approval

An example of a type approval system is the one run for some decades by Lloyds Register. The type approval process comprises three elements-the design appraisal, testing and the factory inspection. Test Specification No 1 1996 [6] includes the requirements for EMC testing. The immunity tests have been harmonised with the appropriate Basic Standards of IEC 1000-4 (EN 61000-4) [7] series and IEC 60945 3rd edition 1996 as applicable. The need for additionally the appropriate emission testing to meet EC Directives is identified. There are additional provisions for vibration, humidity, hot and cold tests and a salt mist test. These tests are outwith the scope of this guidance note but may be found in Test Specification No 1.

Modifications to equipment, extensions of scope or application are required to be notified to the classification society and there is a programme of surveillance to maintain the validity of certification over the life of the product.

D4. Marine Equipment Directive (MED)

For European waters, the MED has an impact on testing and certification.

The current status of the MED is given by;

- Council Directive 96/98/EC [8] of 20 December 1996 published in Journal L46/25 17.02.1997
- and
- Commission Directive 98/85/EC [9] of 11 November 1998 published in Journal L315/14 25.11.98

Article 5 of the Directive refers to Annex A.1 equipment which must meet the requirements of the international instruments referred to in that Annex.

Article 7 of the Directive refers to Annex A.2 equipment and gives advance notice of the transfer of equipment into Annex A.1 when testing standards are agreed by the “International organisations including the IMO.”

Unlike the EMC Directive which applies “ horizontally “ in European Union terminology, that is across the spectrum of activity in all industries, the MED is highly specific in naming items. At Annex 1 of the Directive are listed; Life -saving appliances (which includes Survival craft two-way VHF radio telephone apparatus and 9 GHz Search and Rescue transponder) Marine-pollution prevention, Fire protection (limited number of electronic items stated at this stage), Navigation and Radio-Communication equipment. EMC requirements are given in referenced ETSI standards and IEC 60945.

Annex 2 picks up some further Navigation and Radio- Communication equipment and smoke and heat detectors. Reference is also made to a loading instrument for Bulk Carriers. Note: As Article 7 provision these items can not currently be certified under the MED.

There is no reference to programmable systems used for machinery alarm and control systems.

The impact of the MED on EMC risk assessment and management can therefore be concluded as partial and it is concluded that further Commission Directives will be published to extend the included items.

D5. Cable Systems

In addition to product certification for EMC, the cabling system should not be forgotten. IEC 60533 gives guidance on cabling, screening and earthing.

For example for instrumentation control and communication the selection of a collectively screened cable such as IEC 60092-375 [10] should be considered.

Screening measures include:

- Installation in metallic enclosures,
- Use of screened cables, including cable glands, preferably at the cable entry point of metallic enclosures,
- Utilisation of steel walls and decks for screening and grounding of cable screens at penetration points where possible.
- Earthing techniques are available in a star pattern or on a ground plane.

In the star earthing pattern, all reference conductors are connected to one single point. For a ground plane pattern, all reference conductors should be connected to the ship's structure at the closest point and at as many points as feasible. The star pattern is recommended for low frequencies dc to 10kHz. The ground plane pattern is recommended above 100kHz. Either earthing method is acceptable in the frequency range between 10kHz and 100kHz with a preference for the ground plane.

D6. Port Areas

Problems have been reported in the marine VHF band with intermodulation interference from other services out of band.

The intermodulation effect is particularly strong in port areas and has been reported in both the UK and other jurisdictions.

Improvements in RF filter performance are currently under investigation by receiver manufacturers and the Maritime and Coastguard Agency (MCA).

D7. Large Motor Loads

Non linear loading has been catered for some time with an immunity test in LR Test Specification No 1 for harmonics from the power frequency. Recent increases in motor size on frequency converter driven propulsion systems to typically 20MW has justified further research on the harmonics levels and their consequential effects in these ships. This work is currently under way.

D8. Conclusion

A methodology for addressing EMC risks has evolved in the Marine Industry over many years. The development of new technologies and changes in practices means that the EMC threat and consequential risks to safety are maintained under review.

D9. References

- [1] IMO Resolution A813(19):1995
Draft Assembly Resolution
General Requirements for Electromagnetic Compatibility (EMC) for all electrical and electronic ship's equipment
- [2] IEC 60945, Third Edition, 1996
Maritime Navigation and Radiocommunication Equipment and Systems
- [3] IEC 60533, Second Edition 1999
Electrical Installations of Ships and of Mobile and Fixed Offshore Units
- [4] IMO Resolution A694(17) 6 Nov 1991
General Requirements for Shipborne Radio Equipment forming part of the Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids
- [5] LR Rules and Regulations for the Classification of Ships Part 6
Control Electrical Refrigeration and Fire
- [6] LR Type Approval System Test Specification Number 1 1996
- [7] IEC 1000-4, now IEC 61000-4 series, Electromagnetic compatibility (EMC)-Part 4: Testing and measurement techniques
- [8] Council Directive 96/98/EC of 20 Dec 1996 published in Journal L46/25 17.02.1997
- [9] Commission Directive 98/85 of 11 November 1998 published in Journal L315/14 25.11.98
- [10] IEC 60092-375 1977 Electrical Installations in Ships, Shipboard telecommunication cables and radio-frequency cables. General instrumentation, control and communication cables.