

CONGRESO INTERNACIONAL DE
**V DISEÑO E
INGENIERÍA
NAVAL**

Marzo 15 - 17 de 2017

**An interference
risk-based approach
for naval vessels**

*Enfoque basado en riesgo para
la interferencia sobre buques navales*

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Jan Kees van der Ven



Frank Leferink

THALES
UNIVERSITY OF TWENTE.



Electrical System Integrator Expertise:

- Electrical and cabling design
- Integrated platform automation





- Combat System **Integrator**
ex. Integrated Topside Design

M C EMC FOR
I V FUTURE SHIPS



ElectroMagnetic Interference



ElectroMagnetic Interference



US Ship EMC Improvement Program

- More than 550 EMI issues unsolved
- Number of EMI problems growing faster than number of solutions

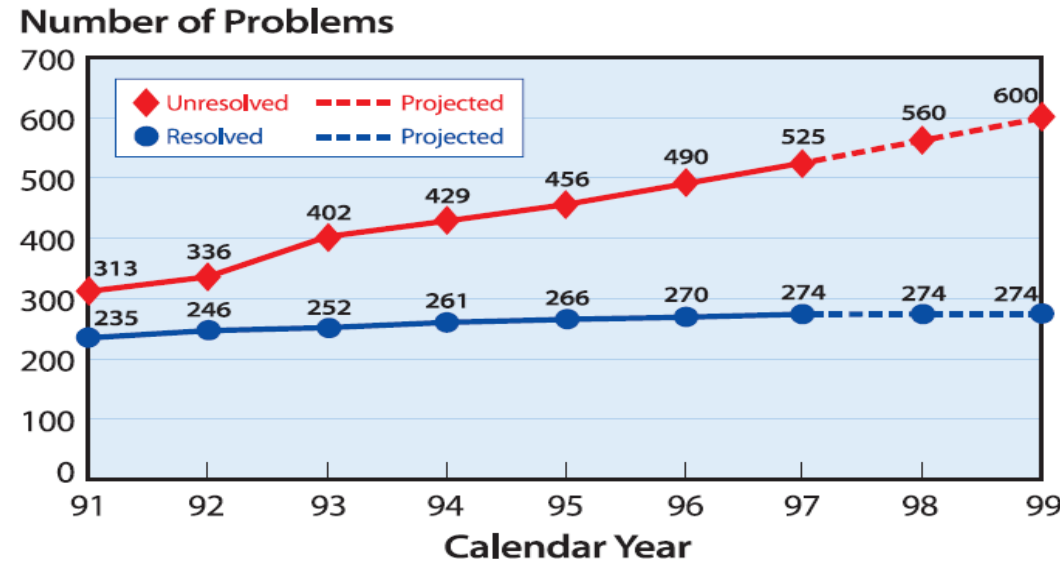


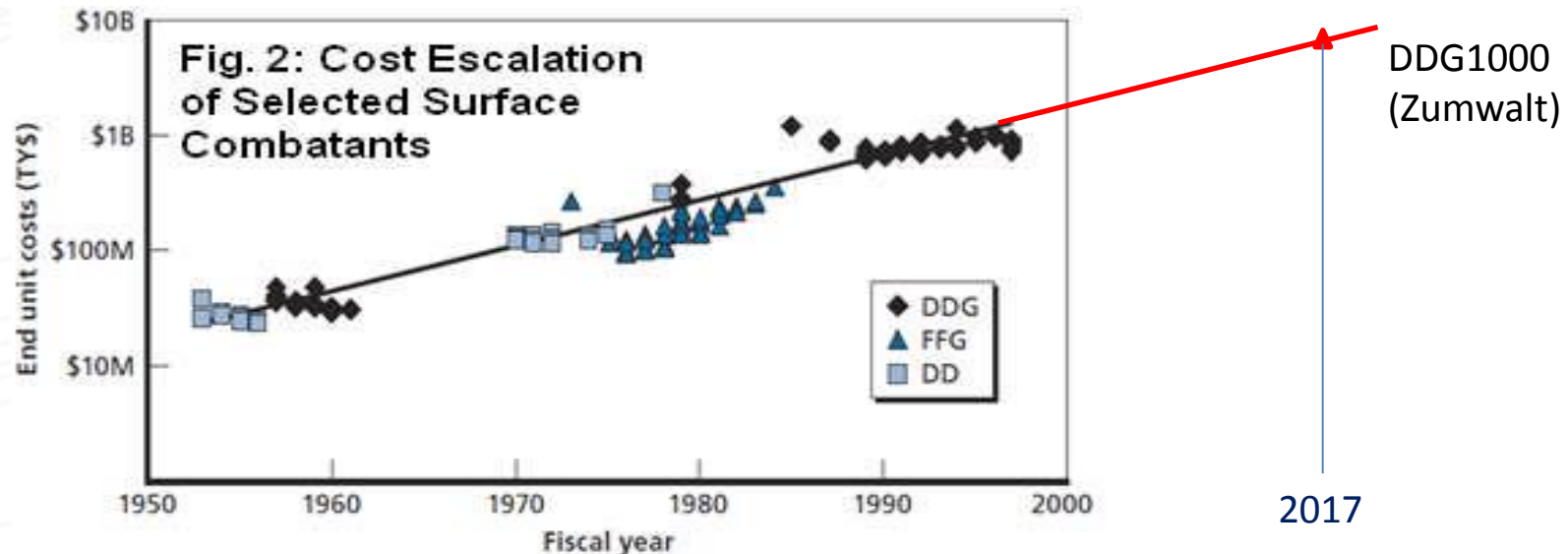
Figure 1—SEMCIP EMI Problem History

Solution (?)

Rules and Standards

USA: 'Documents for Ship Cost Reduction'

'The cost of Navy ships is escalating at an unsustainable rate'



*'A surprisingly large part of this escalation is attributable to **Standards** and **Specifications**' (~ rules)*

USA: *'Documents for Ship Cost Reduction'*

- Top 10 of cost-driver standards,
3 out of them are EMC:
 - *MIL-STD-461E Electromagnetic Interference (EMI),*
 - *MIL-STD 464A Electromagnetic Environmental Effects (E3) Requirements for Systems*
 - *MIL-STD-469B Radar Engineering Interface Requirements, Electromagnetic Compatibility – Frequency Spectrum Guide for Radar.*

Canada:

'Why Has the Cost of Navy Ships Risen'

Many reports published in 2015-2016:

- *'Cost growth trend in naval ship construction since the 1960s is **twice the rate of inflation**'*
- *'Additional increase above inflation was caused by 'requirements creep' (~ rules)*

Solution (?)

Rules and Standards

Yes, it solved most interference problems

But increasing complexity and costs

Can we do it better?

Risk based approach for naval ships

- Assessment of:
 - the expected actual EM environment,
 - immunity and emission characteristics of equipment
 - necessary measures.
- Creation of an environment similar to the intended environment for which the involved systems were designed.
- No expensive hardening and testing of all individual equipment to specific standards (i.e. rule based)

Risk based approach for naval ships

- Thus:
 - Instead of **hardening the equipment**, we **specify** and **control** the EM **environment**
 - That means we accept the EMC performance of equipment as it is, but put effort in **controlling the EM environment**
 - And **keep in control** during the process



From 'rule based' to 'risk based'

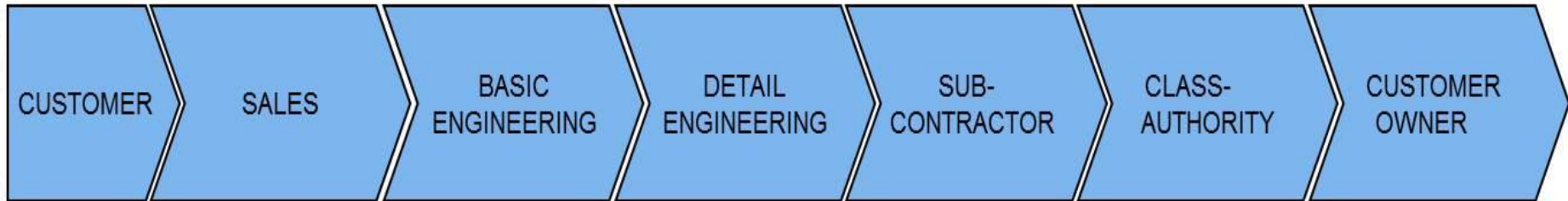
- How? M-C-I-V:
 - EMC **M**anagement (what, when, who)
 - EMC **C**ontrol (risk management)
 - EMC **I**mplementation (how)
 - EMC **V**erification



Lloyd's
Register

EMC process

SHIPBUILDING PROCESS



Required by Lloyd's NAVAL rules V2 P1 CH 3 sec 3.12



EMC DESIGN PROCESS

<http://www.damenshiprepair.com/rotterdam-schiedam/relume>

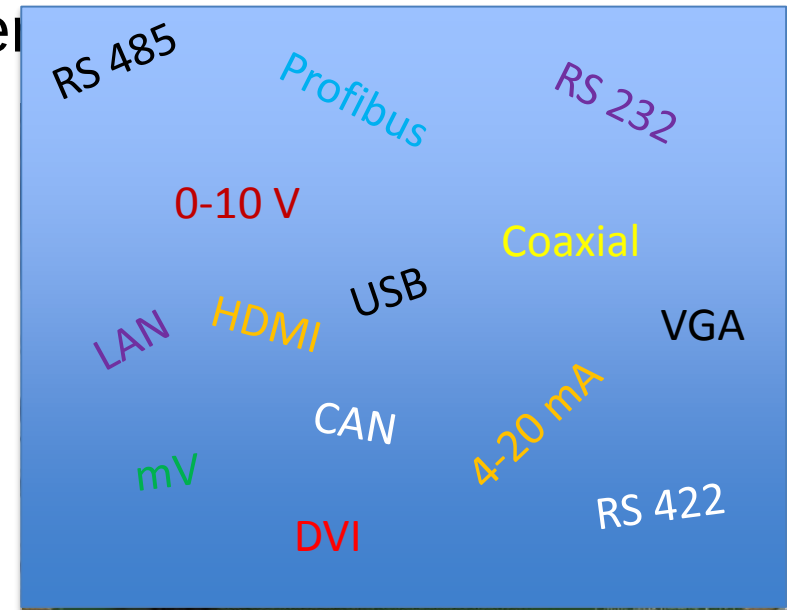


Responsibility cross reference

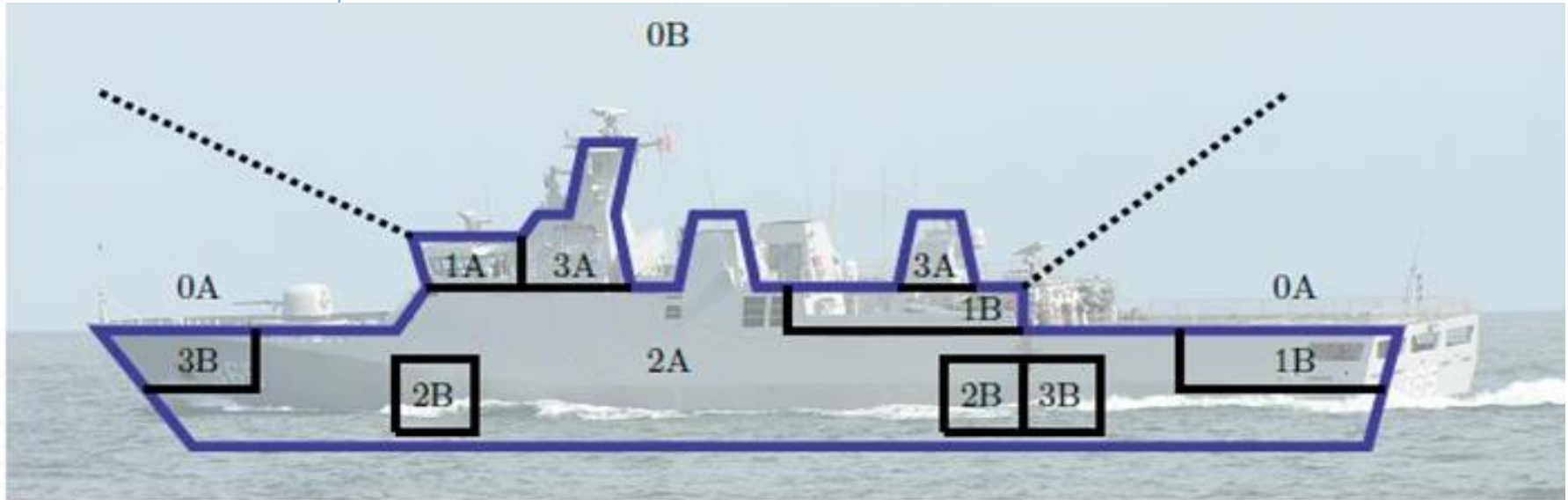
Proj. phase	Topic to be assigned in EMC management plan	CSI	ESI	Yard	Owner	Class
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EMC control plan

- Purpose
 - Standardization of signals to be used
 - Prevent unacceptable interference
 - Reduce radiation hazards
 - Improve electrical safety
 - Prevent damage



EMC control plan



0A: General outer deck

0B: Antenna zone

1A: Bridge and similar

1B: Hangar and similar

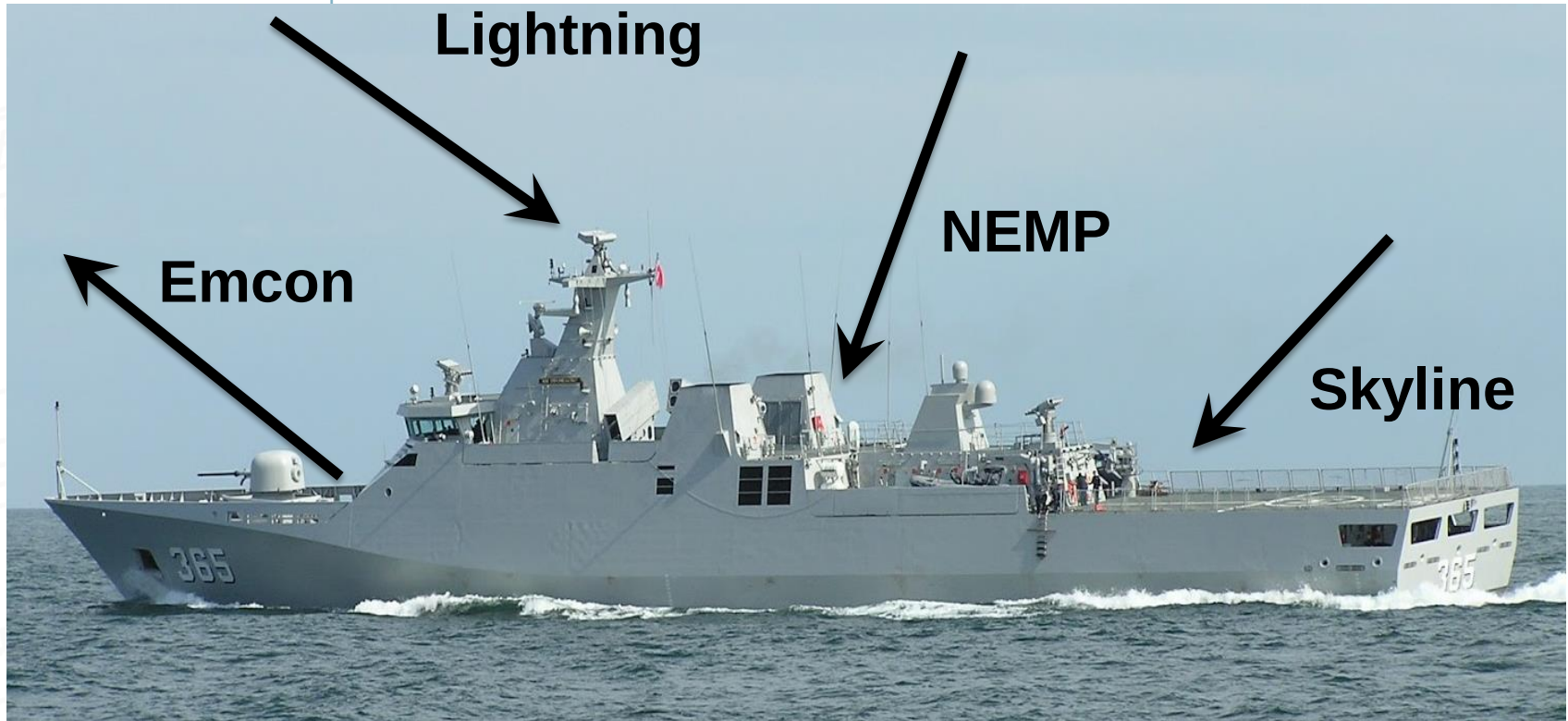
2A: General inner deck

2B: Industrial area

3A: Special zone sensitive

3B: Special zone disturbing

Source victim matrix



		Victim:	EMCON	Propulsion converter	VHF transmitter	VHF receiver	Distribution transformer	LED lighting bridge	Best Practices	
EM disturbance source	Lightning			1	1,2	1,2		1	1) Metal hull, EMC MCT's	
	Skyline			1	1	1		3	2) Surge arrestors	
	Propulsion conv.		1,3		3,5	1,3,5	4	3,5	3) Screened cables	
	VHF transmitter		7	1		6		1,3,5	4) Harmonic suppression	
	VHF receiver								5) EM zoning	
	Distr. transformer								6) Top deck design	
	LED lighting bridge		3			1,3	4		7) Procedures	22

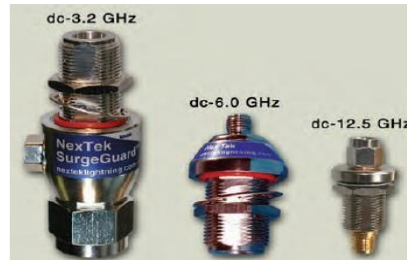
Implementation

❑ EMC-Multi Cable Transits

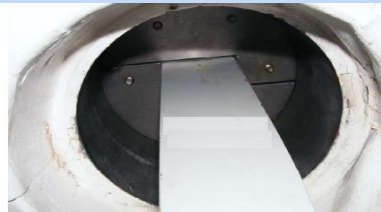


❑ Exposed cables

❑ EMP-protection



EMC Zone protection measures



❑ Waveguides

❑ Doors / hatches

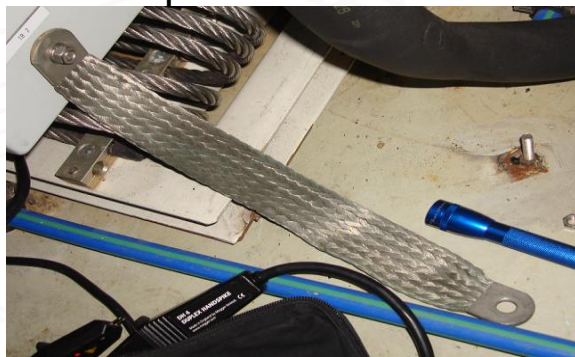


❑ Honeycomb / wire mesh / netting

Verification



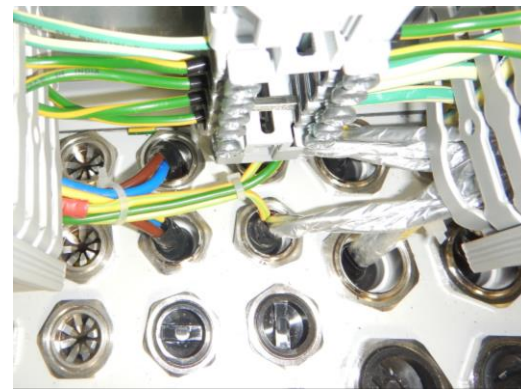
Proper Conservation



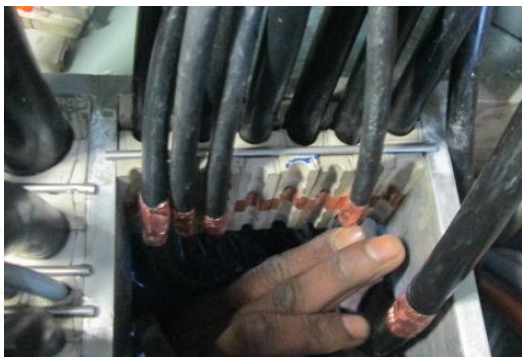
Earthing check

$R < 2.5 \text{ m}\Omega$ or $10 \text{ m}\Omega$

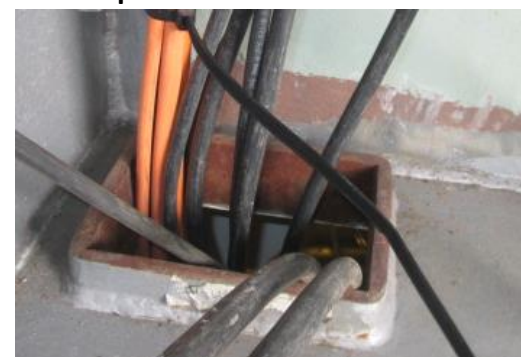
During
building
phase



Proper work methods



Proper materials



Validation

During
HAT
FAT
or
SAT



<http://www.keysight.com/main/editorial.jsp?key=1481106&id=1481106&nid=-11143.0.00&lc=dut&cc=NL>

Validation

Conclusion Risk based EMI approach

- EMC can be a cost driver
- Proposed to replace "rule based" by "risk based"
- Results in reduction of EMC related costs
- Accepted by Lloyd's Naval Rules 2017

THALES

Booth number: 58



 **RH
MARINE**

Booth number: 56

UNIVERSITY OF TWENTE.

**Thesis: “Requirements with Rationale and Quantitative Rules for EMC on Future Ships”
of Bart van Leersum available at: <http://www.leersum.net>**



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Lloyds Naval rules

- The following set of EMC documents is to be submitted and is to include, but not be limited to:
- an EMC Management Plan which details the ships operational role and defines the EM (Electromagnetic) environment, requirements and responsibilities;
- an EMC Control Plan, which defines the design and mitigation measures to be taken to achieve EMC in the agreed EM threat environment. These are to include, but are not limited to the following:
 - EM Threats, see also Vol 2, Pt 1, Ch 3, 3.3 *Electromagnetic compatibility (EMC)*, 3.3.12(b);
 - the zoning concept used;
 - a declaration of the emission levels;
 - a declaration the minimum immunity levels;
 - shielding techniques and requirements;
 - cabling requirements; and
 - filtering requirements.
- (iii) an EMC Implementation Plan, which defines the techniques to be used to mitigate the Electromagnetic (EM) threats *and the requirements of the EMC Control Plan*, including the installation techniques to be applied, see Vol 2, Pt 1, Ch 3, 4.13 *Electromagnetic compatibility (EMC)* 4.13.3; and
- (iv) an EMC Test Plan, which defines the verification and validation requirements, which are to include the analysis, inspection, demonstration and testing requirements, see Vol 2, Pt 1, Ch 3, 4.13 *Electromagnetic compatibility (EMC)* 4.13.2.
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Lloyds Naval rules

- NOTE
- Based on the submissions required above, LR will conduct appropriate inspections to verify the processes and techniques defined have been applied correctly.
-
- The EM Threats required by *Vol 2, Pt 1, Ch 3, 3.3 Electromagnetic compatibility (EMC) 3.3.12(a)(ii)* are to be defined using one of the following methods:
 - applying the requirements and guidelines of IEC 60533, *Electrical Installations in Ships, Electromagnetic Compatibility* ;or
 - applying Naval Authority requirements, as defined in an appropriate naval standard acceptable to LR; or
 - conducting an EM threat assessment which, so far as is reasonably practicable:
 - identifies all the EM threats and associated hazards;
 - identifies all the process, procedures and mitigation requirements which are to be applied to achieve the required EMC in the EM threat environment; and
 - has been agreed between shipbuilder and Naval Authority, and is acceptable to LR.
-
- The ship design must be demonstrated to have taken adequate measures to ensure the required performance of Ship Type and Mobility systems are maintained under all normal and reasonably foreseeable abnormal conditions, see *Vol 2, Pt 1, Ch 3, 4.13 Electromagnetic compatibility (EMC)*.