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EMC and RadHaz measurements on board naval vessels

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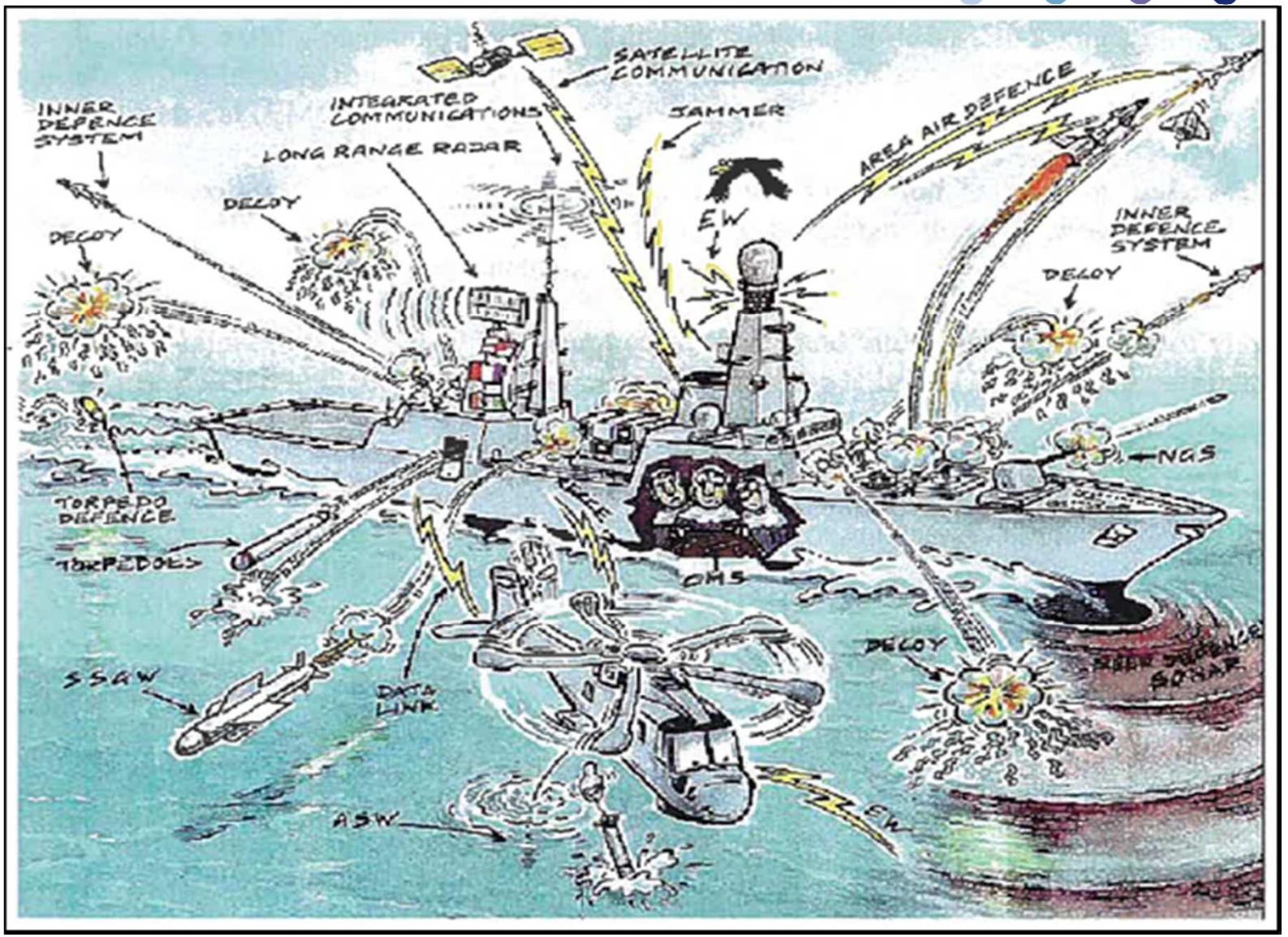
Introduction



Integrated Topside Design (ITD)

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Integrated Topside Design (ITD) engineering is:

the process of arranging above-deck systems on a ship to achieve optimised performance of the Combat System. During the ITD process the consequences of the arrangement with respect to performance, radiation hazards and electromagnetic interference are identified and recommendations provided.

Ideally ITD enables each element of the sensor suite to function as designed (‘free space’) and prevents interference completely.

The process ITD leads to an optimised physical Topside Arrangement.

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Introduction

- Why an Integrated Topside Design (ITD) verification?

➢ To verify and validate the analysis (Radiation Hazards, EMC, Non Transmit Zones, Operational Procedures) made in the ITD study.

➢ On board situation can be different than the preconditions of simulation.

➢ On request of equipment supplier / shipyard / navy

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Radiaton Hazard (RadHaz)

- RADHAZ = RADiation HAZard

- HERP = Hazards of Electromagnetic Radiation to Personnel
  - Freely accessible areas (walkways)
  - Man Aloft Switch (MAS)

Tools used for verification:

- Electrical field and power density probes
- Spectrum analyser + antennas (if necessary)

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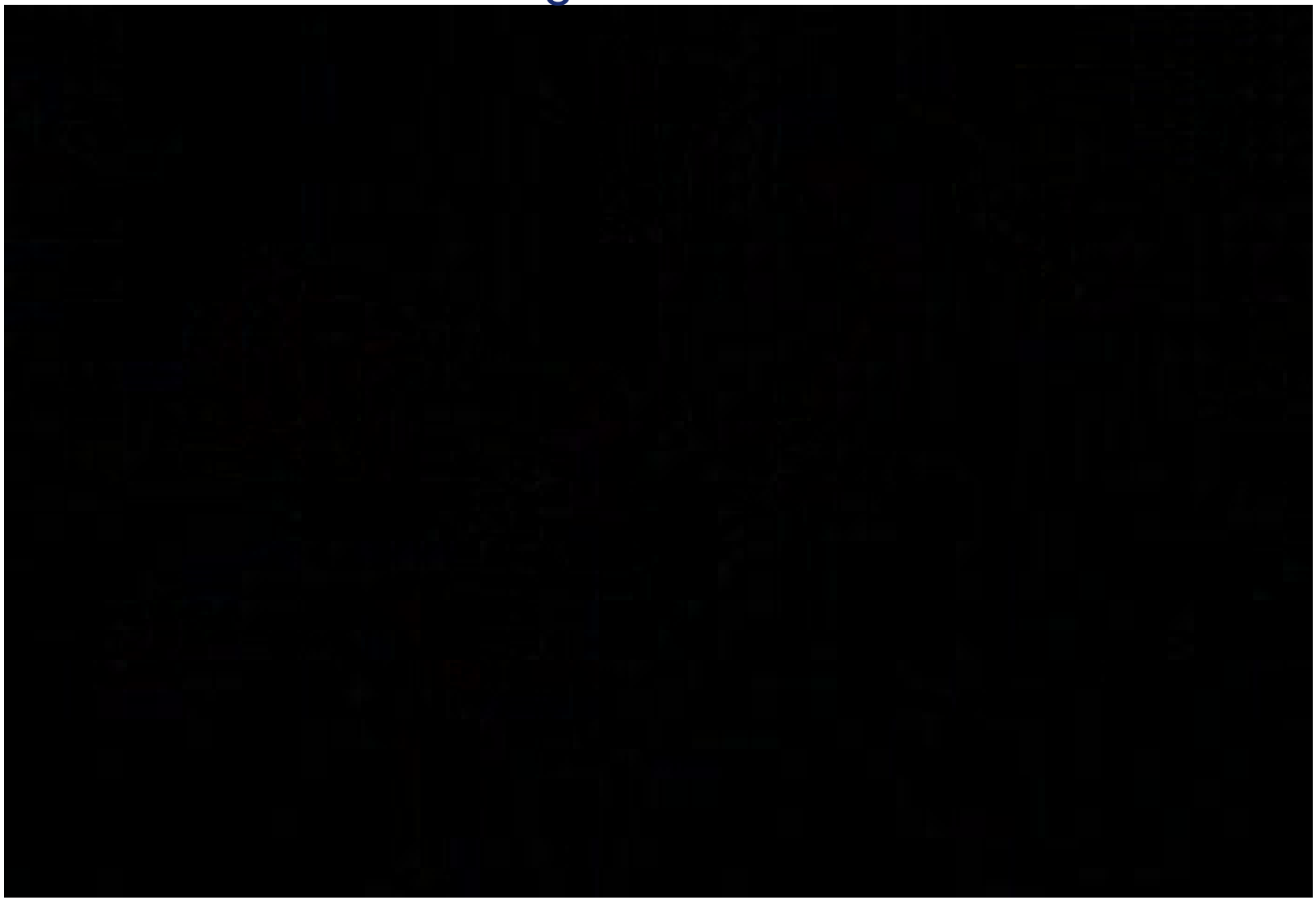
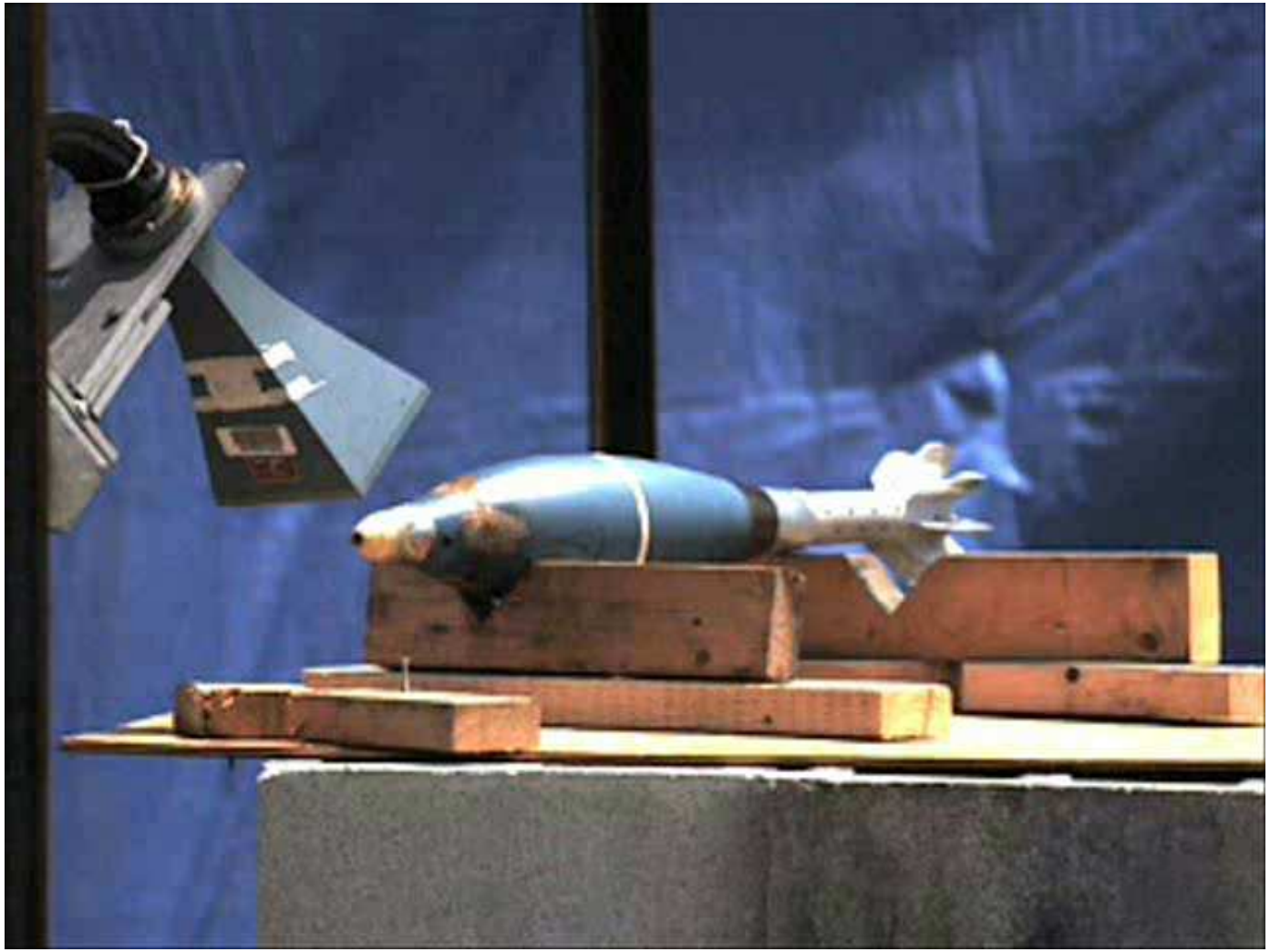
- RADHAZ = RADiation HAZard
- HERO = Hazards of Electromagnetic Radiation to Ordnance
- Hazards to Ordnance shall be prevented in areas where ordnance will be stored, handled or used

Handling of Ordnance

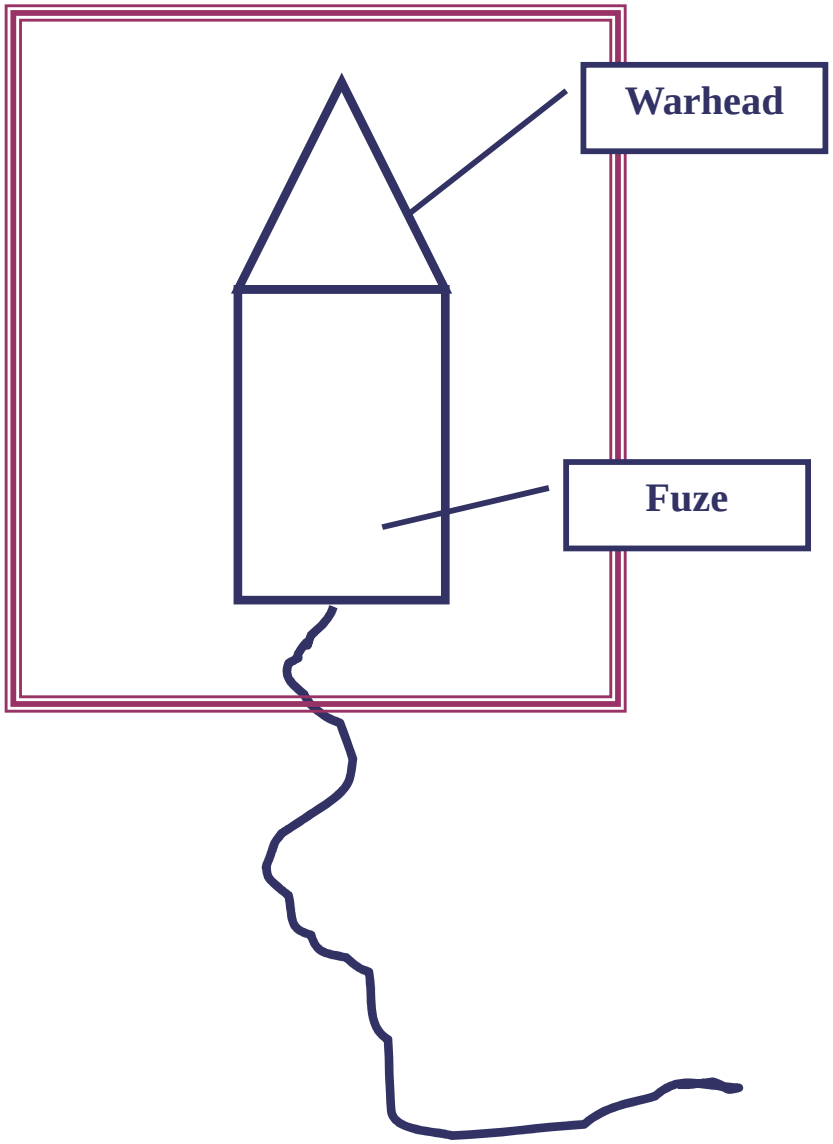


RADHAZ: Testing ordnance



- Warhead Accident

- **Occurred in Israel**
- **Projectile Warhead/Fuze**
- **Wired by Test Team to Initiate Fuze EID**
- **EID – Very Sensitive Carbon Bridge Detonator w/Coaxial Firing Circuit (Unbalanced Firing Leads)**
- **Inadvertently Initiated by Handheld Radio**
- **Six People Killed**



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Forestal Disaster: “Susceptibility problem”, HERO

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Remote weapon, out of control, HERO

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- RADHAZ = RADiation HAZard
- HERF = Hazards of Electromagnetic Radiation to Fuels
- Hazards to Fuel shall be prevented in areas where fuel will be stored, handled or used. Prevent arcing in tanks, heating of fuels to prevent fires, explosions.

Other hazards?

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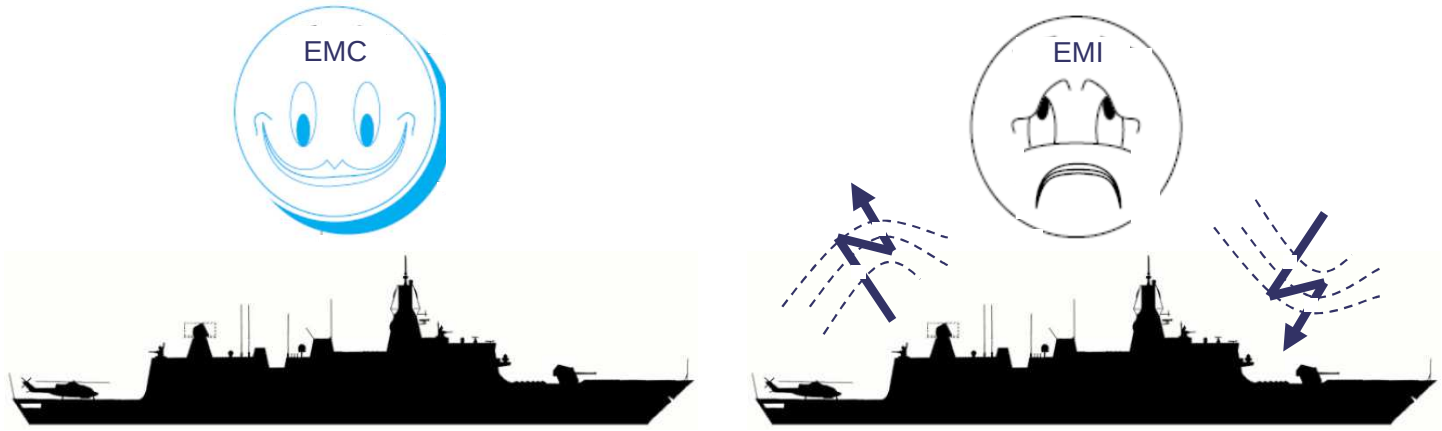
- Combined action
  - ITD, Main Integrator, EMC-experts, navy, shipyard and installer of electrical equipment



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According to ANEP-56:

equipment	*source*	*victim*
Satellite communications	1.4	1.5
Survillance Radar	11.3	8.2
CIWS	2.1	2.2
ECM	2.3	2.2
ESM	0	13.5
Fire Control Radar	5.0	8.1
HF Communications	63.9	4.5
Miscellaneous	13.7	58.2
Aircraft	0	0.5
V/UHF	0.3	1.1

Tab. 1 - EMI incident distribution (%)

U.S. Maritime Advisory 2018-014- GPS Interference in Eastern Mediterranean and Red Seas

- Significant GPS interference continues to be reported by vessels and aircraft operating in the Eastern Mediterranean Sea.
- Additional instances of similar interference were reported in October 2018 near Jeddah Port, Saudi Arabia.
- This interference is resulting in lost or otherwise altered GPS signals affecting bridge navigation, GPS-based timing and communications equipment.

DAILY COLLECTION OF MARITIME PRESS CLIPPINGS 2018 – 319

EMI & RADHAZ caused by SPY-1?

SPY-1D

Missile destroyer USS Farragut emitted radiation from its radar that **injured crew members on board** the **Norwegian Coast Guard vessel KV Nordkapp** while both were taking part in exercises in the Arctic in August.

According to Scandinavian media reports, the radiation that hit the Norwegian vessel **knocked out its instruments and several of the crew members felt their skin become warm from radiation.**
Several complained of headache and other symptoms after they were exposed to radiation from an American vessel."

A report from a committee investigating the incident has now concluded that the crew was exposed to electromagnetic radiation by radar operating in the frequency band 3-4 GHZ. Initially, the U.S. Navy had said that the Farragut was equipped with a radar system that shuts itself down when other vessels are nearby.
Source : MarineLog

Missile attack

HMS Sheffield Sunk, May 4th, 1982

Argentine air attacks from *Super Etendard* fighter planes using *Exocet* air to surface missiles sink the British destroyer *HMS Sheffield* with twenty men on board lost.

http://www.youtube.com/watch?v=Q_5-5oV_HzY

http://ayup.co.uk/shuttup/shuttup2-0.html:
One history of the Falklands war says that as there were no "bogeys" on any radar screens at the time, the officers were making a satellite phone call back to Fleet HQ in England, an action that would jam the use of the ship radar. However, with other ships close by, notably the Carrier Invincible, this was not seen to be a risk. At the end of the call, reported the Guardian newspaper, the radar came back on and the two Etenards were spotted just 33km away. It was the Navy's first encounter with low-flying Exocet-carrying attack planes.

Solution: Carry out an ITD-study in order to prevent interferences!

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❑ Non Transmit Zones (NTZ)

❑ The function of a Non Transmit Zones (NTZ) is to reduce interference and to prevent radiation hazards.

❑During the verification:

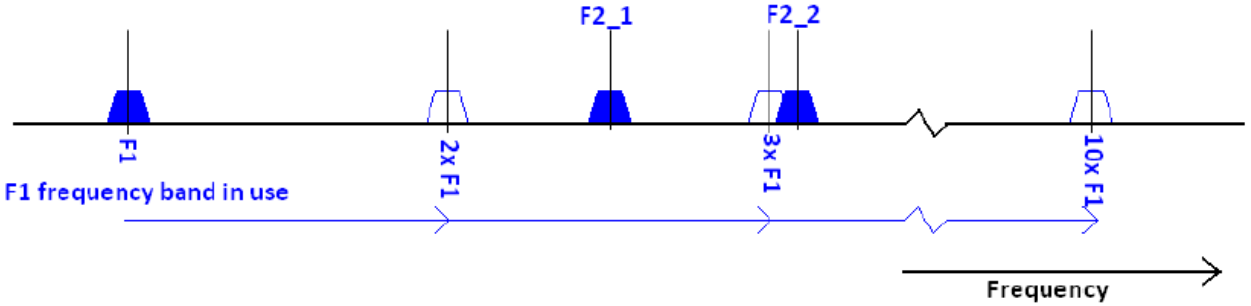
- Personnel can safely enter accessible areas such as walkways and location of MASs.
- No operational degradation of radars or other equipment occurs.
- No illumination of ordnance (or fuels) occurs.

❑ OPERATIONAL PROCEDURES

- Some negative interactions between topside equipment cannot be solved by hardware solutions, such as positioning, shielding, NTZs and blanking. These interactions require an operational procedure to reduce the risk of interference or hazards, or to improve functionality.

- Operational procedures are prescribed procedures to be followed for operating something or for dealing with a given situation.

Basic frequency selection principle to avoid problems with harmonics:



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Lloyd's Register Naval Ship Rules in January 2017

Risk based approach for naval ships

Requirements for Design, Construction, Installation and Sea Trials of Engineering Systems

Volume 2, Part 1, Chapter 3
Section 3

3.3.12 **Electromagnetic compatibility (EMC)** *See Vol 2, Pt 1, Ch 3, 4.13 Electromagnetic compatibility (EMC).*

(a) The following set of EMC documents is to be submitted and is to include, but not be limited to:

(i) an EMC Management Plan which details the ships operational role and defines the EM (Electromagnetic) environment, requirements and responsibilities;

(ii) 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:

- the EM threats, *see Vol 2, Pt 1, Ch 3, 3.3 Calculations and specifications 3.3.12*(b) below;
- 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) 4.13.4*; 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) 4.13.3*.

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