Technical Bulletin-0004

Electromagnetic Interference

Electromagnetic Interference: Before deployment, ships are required to pass an Electromagnetic Compatibility (EMC) certification. Electromagnetic Interference (EMI) makes it more challenging to pass the EMC certification.

EMI sources can be intermittent or incidental. An example of an intermittent source is an impulse from nearby thunderstorms. Incidental sources include power lines and motors. Functional EMI originates from sources designed to radiate electromagnetic energy as seen in Figure 1. Hull generated EMI is caused by radiated energy interacting with a ship's hull and rigging.

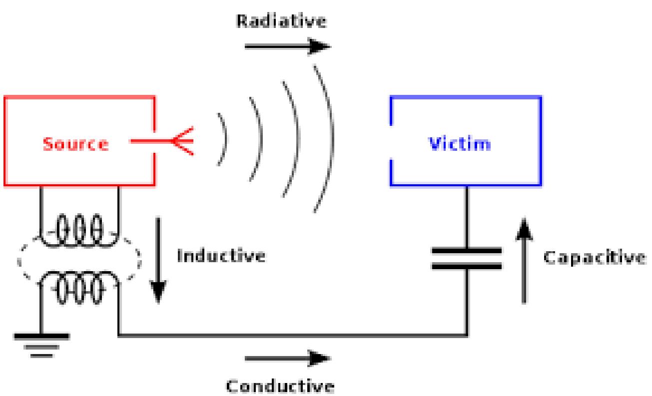

Figure 1. Electromagnetic interference[1]

Hull generated EMI can be classified into two categories: broadband noise and intermodulation interference (IMI). Broadband noise is generated when high voltages in the ship's superstructure electrically arc. IMI results when radio frequency (RF) energy transmitted by antennas is absorbed into non-linear semiconductor junctions and then re-radiated. Non-linear semiconductor junctions are formed when metal connections corrode. IMI from these sources, commonly known as ***the rusty bolt effect***, and is shown in Figure 2.

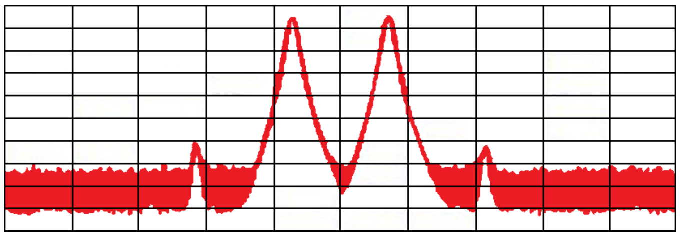

Figure 2. Amplitude spikes indicate intermodulation interference

Hynes et al. [1] noted that even though the power of the IMI is low when compared to the effective radiated power of shipboard transmissions, it is "still high enough to have a devastating impact on shipboard communications, electronic warfare, and intelligence gathering equipment."

Over 40 years ago, the Navy provided instruction to the fleet on hull generated intermodulation interference which is caused by non-linear junction formations [2]. The instruction noted that ***rusty bolts can be found on things such as corroded ladders, masts, cables stanchions, door hatches, and scuttle hinges***.

IMI is a significant issue on naval vessels because there are numerous transmitting antennas onboard and the irradiating power of those antennas is high. The problem is exacerbated by the number of potentially active rusty bolts and the number of discrete IMI frequencies that each rusty bolt could generate. These affect the ability to execute ***active*** C4ISR[2]. IMI becomes more problematic with ***passive*** C4ISR as the IMI power level is large compared to the power level of incoming signals. Extremely sensitive receivers can detect threat signals "at very low power levels ($<10^{-6}$ ν/m). Even a low level of spurious energy can compete with these signals and jam sensitive shipboard receivers. The third order IMI level aboard some ships is more than 60 dB above the ships' receivers minimum detectable signal level" [1].

Hynes et al. cite two physical and two chemical methods of IMI suppression. Physical suppression may be achieved by decoupling the junction from its natural antenna or electrically bypassing the junction. Chemical suppression could result in either the formation of a linear closed loop circuit for the RF energy or paradoxically cause additional corrosion to form an open circuit [1]. In 1984, the Naval Research Laboratory [3] noted the role of corrosion inhibitors as a component of chemical suppression. Neither of these chemical means are easy to implement and perhaps, more importantly, they are a remedial action to address corrosion.

References

[1] Hynes, R., Carhart, H. W., Cooper, J. C., Chemical Reduction of Intermodulation Interference Caused by Metal-Oxide Metal Junctions Aboard Ship, Naval Research Laboratory Report 9344, 1991

[2] Ho, R. N. S., COMSERVPAC Shipboard Electronic Equipment Engineering Support, Volume II, EMC Instructional Program, ARINC Research Corporation, Prepared for COMSERVPAC, June 1975

[3] Cooper. J. C., Panayappan, Rm., Steele, R. C., Chemically Suppressing Rusty-Bolt Intermodulation Interference, 1984 National Symposium on Electromagnetic Compatibility, 24-26 April 1984, pp 233-240

[1] Source: Wikipedia

[2] Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance

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