NOISE AND ELECTROMAGNETIC FIELD MEASUREMENTS FOR THE MERCHANT SHIP ALBATROS

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Abstract: The paper analyses the results of performed measurements regarding the density of electromagnetic power at various points on board a ship, the noise level determined by the operation of certain broadcasting stations and the intensity of the radiated electric field by a station of 250 MHz. We have presented thereby the sources triggering natural and artificial electromagnetic disturbances with their pertaining components.

Keywords: power density, intensity of electric field, broadcasting station, disturbing sources, noise levels

1. Introduction

The equipment of a ship with telecommunication, navigation, armament, radio transmitter, radar and power subsystems requires a full evaluation of electromagnetic compatibility problems incurred thereby. Electromagnetic compatibility is a feature specific to an electric unit enabling the latter to operate at normal parameters in its own electromagnetic environment without influencing this specific environment. [1, 8]

The units refer to equipments and subsystems. Provided these units belong to the same system, we then have an internal electromagnetic compatibility.

Due to the diverse range of electric and electronic devices used onboard ships, as well as to their power

enhancement, there has been an alarming increase in abnormalities, consisting of component wreckage, breakdowns or malfunctions during operation of circuits or equipments, affecting the personnel phenomena could not be ignored any longer without deliberately taking some risks, with negative effects on the ship, and on the seagoing personnel as well.

Therefore, we have started some research on the disturbing electromagnetic interferences aiming at highlighting the generating sources, their transmission paths, and the effects they have on electronic apparatus and the navigating personnel, with a view to finally enable us to devise adequate anti-disturbing technologies. [2, 5, 6, 7, 8, 10]

A first step would be identifying and setting up specifications for each type

of electromagnetic disturbances onboard. These disturbances may be classified according to their nature, the transmission paths, the place of occurrence, and the distance between the source and the perturbed.

According to their nature, electromagnetic disturbances may be artificial and natural. [3, 4, 9] In their turn, artificial disturbances may be divided into unintentional and intentional disturbances. From the category of unintentional disturbances we may name the following [1, 2]:

- the electromagnetic disturbances produced by short-circuits and transitory statuses of the feeding and operating gear;
- the electromagnetic disturbances produced by power electronics due to the phenomenon of commutation;
- the electromagnetic disturbances produced by electrostatic discharges;
- the electromagnetic disturbances produced by operation of radio units, radar, and navigation devices.

Among the intentional disturbances, the following are worth mentioning: the electronic interference and the electromagnetic impulse of the impulse weapon.

At present, the wide range of topics approached in the update field of electromagnetic compatibility is impressive, and it comprises [4, 9]:

a. sources of electromagnetic interference (electric and electronic units, electrostatic discharges);

b. specific values for the electric units involved by electromagnetic interferences and their respective parameters: levels and variation speeds for $\bar{H}$, $\bar{E}$, $\bar{S}$ (the power density of the field), U , I , frequency, type of modulation, polarization, wave shape, distortion factor etc;

c. paths of transmission or propagation of parasite signals among

equipment, systems, cables and the outer environment;

d. methods and techniques of measurements and testing the electromagnetic interference phenomena;

e. control of antenna electromagnetic interferences (stationary, rotating, with straight bundle) of HF, VHF, UHF;

f. techniques of anti-disturbing protection; screening, filtering, linkage to the electronic mass and the ground (the ship's hull);

g. protection of the human factor on board ships (biological effects of electromagnetic interferences).

2. Measurement of the electromagnetic power density radiated by the quarter deck of the 8000 dwt Cargo ship Albatros [11]

Fig.1 Measurement of the environmental noise level at 09:52 with emission of the JR civilian unit on board Albatros on channel 4 VHF (frequency de 156,200 MHz) modulated with a 25 W emission power - table 1.

Table 1. Main measured values, fig.1.

Frequency [MHz]	Field Strength [V/m]	Power Density [$\mu\text{W}/\text{cm}^2$]
1.56E+02	0.1766	0.0083
1.57E+02	0.1511	0.0061
1.94E+03	0.0979	0.0025

1.94E+03	0.0963	0.0025
1.55E+02	0.0948	0.0024
1.93E+03	0.0927	0.0023
1.94E+03	0.0844	0.0019
1.96E+03	0.0821	0.0018
1.94E+03	0.0789	0.0017
1.94E+03	0.0757	0.0015
1.93E+03	0.0717	0.0014
1.96E+03	0.0669	0.0012
1.96E+03	0.0655	0.0011
1.95E+03	0.0649	0.0011
1.91E+02	0.0643	0.0011
1.95E+03	0.0627	0.0010

Fig. 2. Measurement of the environmental noise level at 10:10 with emission of the JR civilian unit on board Albatros on channel 4 VHF (frequency de 156.200 MHz) modulated with a 25 W emission power

Table 2. Main measured values, fig. 2.

Frequency [MHz]	Field Strength [V/m]	Power Density [$\mu\text{W}/\text{cm}^2$]
1.56E+02	0.1324	0.0046
1.57E+02	0.1128	0.0034
1.95E+03	0.1092	0.0032
1.95E+03	0.1036	0.0028
1.93E+03	0.0961	0.0025
1.94E+03	0.0931	0.0023
1.94E+03	0.0897	0.0021
1.94E+03	0.0858	0.0020
1.95E+03	0.0795	0.0017
1.95E+03	0.0774	0.0016
1.94E+03	0.0772	0.0016
1.93E+03	0.0761	0.0015

1.04E+02	0.0735	0.0014
1.95E+03	0.0735	0.0014
1.96E+03	0.0714	0.0014
1.55E+02	0.0706	0.0013

3. Measurement of the electromagnetic power density radiated by the units involved in the measurement procedures

Fig.3. Measurement of radiated electromagnetic power density by a unit on a frequency of 250 MHz, modulated, for the nominal power of emission Table3. Main measured values fig. 3.

Nr. of harmonics	Frequency [MHz]	Field Strength [V/m]	Power Density [$\mu\text{W}/\text{cm}^2$]
-	2.46E+02	0.0055	0.0000
-	2.47E+02	0.0061	0.0000
-	2.48E+02	0.0109	0.0000
-	2.49E+02	0.0538	0.0008
0	2.50E+02	0.0802	0.0017
-	2.51E+02	0.0534	0.0008
-	2.52E+02	0.0102	0.0000
-	2.53E+02	0.0052	0.0000
-	2.54E+02	0.0058	0.0000
2	5.00E+02	0.0025	0.0000
3	7.50E+02	0.0015	0.0000
4	1.00E+03	0.0014	0.0000
5	1.25E+03	0.0234	0.0001
6	1.50E+03	0.0029	0.0000
7	1.75E+03	0.0040	0.0000
8	2.00E+03	0.0052	0.0000

Table4. Main measured values, fig. 4.

Nr. of harmonics	Frequency [MHz]	Field Strength [V/m]	Power Density [$\mu\text{W}/\text{cm}^2$]
-	2.47E+02	0.0054	0.0000
-	2.48E+02	0.0058	0.0000
-	2.49E+02	0.0121	0.0000
0	2.50E+02	0.0170	0.0001
-	2.51E+02	0.0113	0.0000
-	2.52E+02	0.0050	0.0000
-	2.53E+02	0.0055	0.0000
2	5.00E+02	0.0019	0.0000
3	7.50E+02	0.0014	0.0000
4	1.00E+03	0.0013	0.0000
5	1.25E+03	0.0038	0.0000
6	1.50E+03	0.0030	0.0000
7	1.75E+03	0.0040	0.0000
8	2.00E+03	0.0049	0.0000

Fig. 4. Measurement of radiated electric field by a unit on 250 MHz, non-modulated, at the nominal power of emission

In fig. 5 and table 5 we have inserted the values obtained for the intensity of the electric field for a frequency of 1.95 GHz measured in daytime in all points of measurement. This frequency was chosen as it appears in significant values of the electric field intensity (as compared to other values that have been measured) for every measurement performed.

Fig. 5. Illustration of daytime measured values of a radiated electric field intensity for a frequency of 1,95 GHz

Frequency in MHz	Intensity cp. El.in V/m	E in dB	Power density	DP in dB
1.95E+03	0.1006	-19.94598415	0.0027	-25.7094
1.95E+03	0.0686	-23.27549608	0.0012	-29.0389
1.95E+03	0.0948	-20.46644007	0.0024	-26.2299
1.95E+03	0.0676	-23.39891229	0.0012	-29.1623
1.95E+03	0.0728	-22.7619241	0.0014	-28.5253
1.95E+03	0.1048	-19.59138534	0.0029	-25.3548
1.95E+03	0.1092	-19.23724112	0.0032	-25.0007
1.95E+03	0.0982	-20.15404473	0.0026	-25.9175
1.95E+03	0.1333	-17.50241192	0.0047	-23.2658
1.95E+03	0.0863	-21.28299064	0.0020	-27.0464
1.95E+03	0.0704	-23.05359816	0.0013	-28.817
1.95E+03	0.1114	-19.06107225	0.0033	-24.8245

Frequ ncy in MHz	Intensity cp. El.in V/m	E in dB	Power density	DP in dB
1.95E+ 03	0.0931	- 20.62181 934	0.0023	-26.3852
1.95E+ 03	0.0423	- 27.46717 938	0.0005	-33.2306
1.95E+ 03	0.1145	- 18.82024 077	0.0035	-24.5837
1.95E+ 03	0.1217	- 18.29713 405	0.0039	-24.0605
1.95E+ 03	0.1409	- 17.01915 664	0.0053	-22.7826
1.95E+ 03	0.1082	- 19.31274 052	0.0031	-25.0762
1.95E+ 03	0.0754	- 22.45607 846	0.0015	-28.2195
1.95E+ 03	0.1008	- 19.93366 882	0.0027	-25.6971
1.95E+ 03	0.1335	- 17.48780 438	0.0047	-23.2512
1.95E+ 03	0.1169	- 18.64144 452	0.0036	-24.4049
1.95E+ 03	0.0731	- 22.72336 186	0.0014	-28.4868
1.95E+ 03	0.1084	- 19.29678 863	0.0031	-25.0602
1.95E+ 03	0.1383	- 17.18397 169	0.0051	-22.9474
1.95E+ 03	0.0954	- 20.40711 4	0.0024	-26.1705
1.95E+ 03	0.0202	- 33.88362 94	0.0001	-39.647
1.95E+ 03	0.0715	- 22.91108 384	0.0014	-28.6745
1.95E+ 03	0.0718	- 22.88064 756	0.0014	-28.6441
1,95E+ 03	0.1009	- 19.92425 631	0.0027	-25.6877
1.95E+	0.1156	-	0.0035	-24.5028

Frequ ncy in MHz	Intensity cp. El.in V/m	E in dB	Power density	DP in dB
03		18.73933 858		
1.95 E+03	0.1035	- 19.69815 031	0.0028	-25.4616
1.95E+ 03	0.0596	- 24.49497 106	0.0009	-30.2584
1.95E+ 03	0.0758	- 22.41149 497	0.0015	-28.1749
1.95E+ 03	0.0776	- 22.20678 553	0.0016	-27.9702
1.95E+ 03	0.0797	- 21.97575 12	0.0017	-27.7392
1,95E+ 03	0.0737	- 22.65149 646	0.0014	-28.4149
1.95E+ 03	0.1079	- 19.33912 481	0.0031	-25.1025
1.95E+ 03	0.1094	- 19.22119 502	0.0032	-24.9846
1.95E+ 03	0.1301	- 17.71551 915	0.0045	-23.4789
1.95E+ 03	0.1365	- 17.29484 095	0.0049	-23.0583
1.95E+ 03	0.0425	- 27.42391 188	0.0005	-33.1873
1.95E+ 03	0.0717	- 22.88696 729	0.0014	-28.6504
Averag e value	0.093688 1	- 21.04788 763	0.0025 27	-26.8113
Devian ce	0.000373 962	5.021371 507	8.6687 3E-07	5.021371 507

Observing the values on the last column of table 5, we may notice that the values of the electric field intensity and the values of the density of radiated electromagnetic power have a dispersion around the average value of 5.02 dB.

4. Conclusions

After the careful observation of the values presented in the tables, we have noticed that, during measurements with the measuring sensor, in the wave bands 1.95 GHz and 250 MHz, different values of the electric field have been registered, more specifically much higher values than the ones of the frequency used by the radio unit (250 MHz). The present-day expansion in the usage of electronic and electric apparatus in every domain has triggered a significant augmentation in the electromagnetic pollution of the environment.

The proper operation of various apparatus and equipment in the new

environmental conditions raises complex environmental issues for both designers and users alike. The preoccupation for the research of the electromagnetic fields effects has been completed with the research of its secondary effects, namely the disturbing electromagnetic interferences. Disturbances are produced by the electric field of electric condensers, which trigger unwanted capacitive couplings (disturbances by neighboring field). The transmitting aeriels produce disturbances by radiation of the electromagnetic field at large distances in the form of plane waves (disturbances by remote field).

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