A&QT-R 2002 (THETA 13)
2002 IEEE-TTTC International Conference on Automation, Quality and Testing, Robotics
May 23-25, 2002, Cluj-Napoca, Romania

DETERMINING OF ELECTRICAL DISTRIBUTION PARAMETERS ON VESSELS

Lucian Bălaşa, dr.ing., INSTRONICA, Constantza, Romania
Mihai Alexa, CS I dr.ing., CCSTM Constanţza, Romania
Cosmin Bucur, prep.univ.drd.ing. Ovidius University Constanța
Paul Burlacu, drd.ing., UM02003, Constantza, Romania

ABSTRACT

Shipboard electrical power systems in warships of the North Atlantic Treaty Navies must be conformal with STANAG 1008 standard witch impose the functional and quality characteristics of those electrical systems.

Due to necessity to accomplish the interoperability with NATO Navies, new equipments and battle systems are installed onboard vessels and is becoming more important to acknowledge those parameters in order to take the right actions to satisfied this standard.

In this way, incompatibilities with electrical power system are avoided, as well as risks of faults due to supply inconsistency.

In this paper are presented a series of measurements done on electrical power generators and distribution system onboard a military vessel.

1. INTRODUCTION

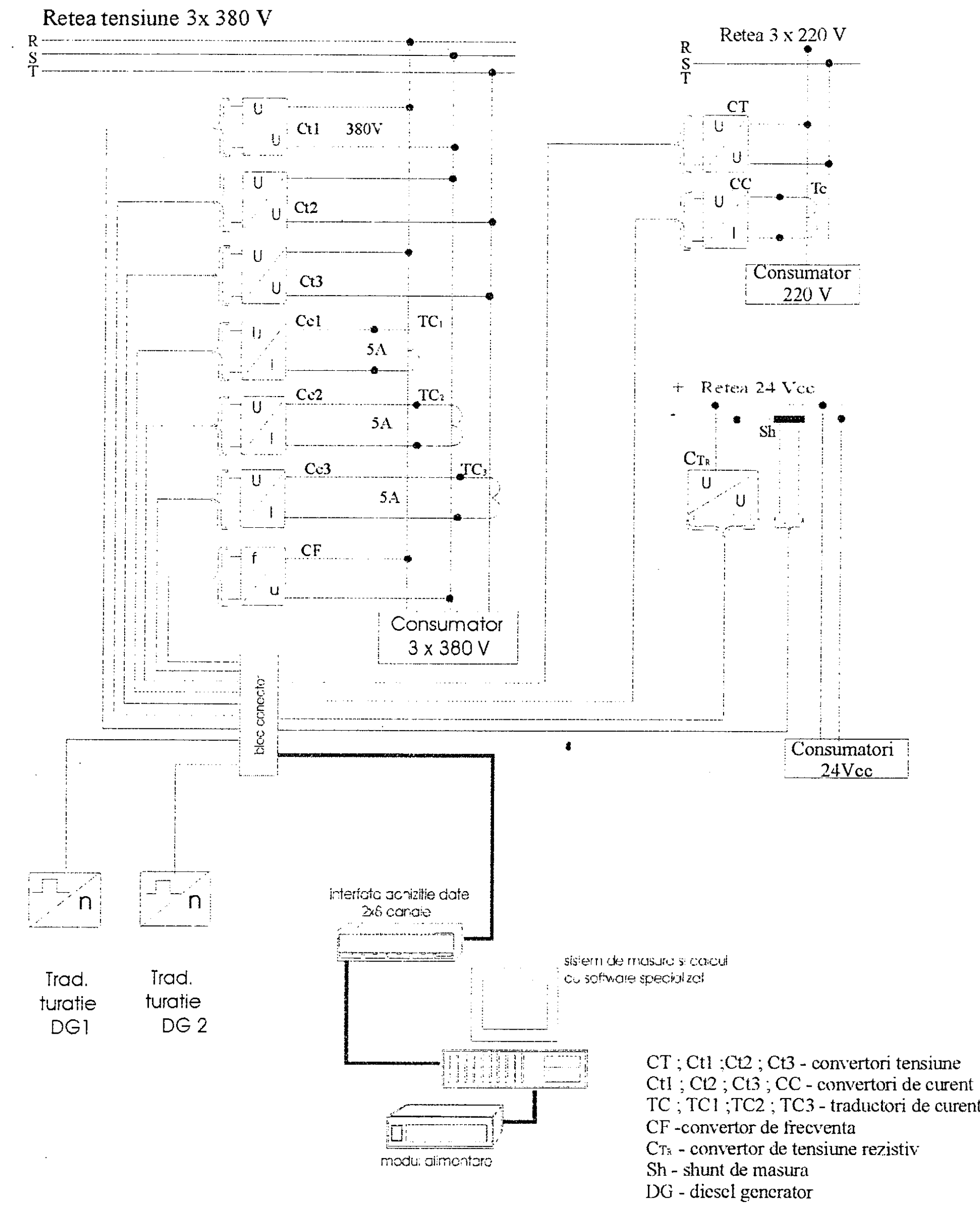
In this paper we presents the results of a series of measurements done on the power generator system onboard a military vessel and compare those results with the specifications, from STANAG 1008 standard, that those parameters must comply. The results was processed in order to compute those parameters and we try to propose adequate methods to improve those parameters.

In order to execute the measurements, in conformity with STANAG 1008, some preliminary measures has been taken:

- Technical preparations of installations with high consumption of electrical energy in order to create the true working conditions in continuous, pulsating or shock manner.
- Preparing the vessel and ensuring resources for executing manoeuvres, in different operating regime and speeds, in order to determine the influences of external factors.

For executing the measurements and processing experimental data it was used equipments and software from CCTSM Constantza and few signal converters and accessories for connecting to electrical system.

The diagram of the measurement system is:



Sistem de achizitie si analiza a datelor din
sistemul de distributie electrica de putere la bordul navelor

Fig.1

3. INTERPRETING THE RESULTS

3.1 *Nominal user voltage*:

- On low load of the electrical system, voltage positive tolerance is bigger than the of ±5%, voltage is not in the according limits
- As the load increases the voltage tends to get closer to those limits
- Use of filter makes determine the voltage to be in the according limits – load of the filter it was low

3.2 *Voltage modulation*

- In all operating regimes that was analyzed, this parameter is according to imposed limits (2%)

3.3 *Voltage transient tolerance (fig,2)*

- In case of step load, of 25% on one or two generators, this parameter is not in the acceptable limits (±16%), tends to the negative values
- In the others operating regimes analyzed voltage transient tolerance is according to imposed limits

3.4 *Voltage transient recovery time (fig.3)*

- Overrun on 2 seconds limit to this parameter appears only in case of step loads (running the fire pumps or MR 123 converter)
- In other situations voltage do not overrun admissible limits ±7% Un, recovery time is 0.

3.5 *Voltage spike*

- In all operating regimes analyzed the were no voltage spike
- Voltage maximum measured on an interval of 1 ms was 360V

3.6 *Total harmonic distortion (THD) (fig.4)*

- In all operating regimes analyzed there were overruns on the standard 5% value
- In this case, using filter does not improve this parameter

3.7 *Individual harmonic*

- It was extracted 33 harmonics, none of those higher than de limit of 3% rms value of the fundamental
- Biggest record value appeared on step load and correspond to the 16th harmonics (852,5Hz)

3.8 *Deviation factor (fig.5)*

- Overrun in all cases analyzed the limit of 5%. The biggest value, up to 12% appear on step load
- In this situation the filter improve this parameter
- It can be said that this parameter leads to increase the total harmonic distortion (THD) over the 5% limit.

3.9 *Frequency tolerance*

- In each case the frequency was determined indirectly from the THD
- In none of the analyzed cases there were no overrun on the ±3% limit

3.10 *Frequency modulation*

- In none of the analyzed cases there were no overrun on the ±4% limit

Referring to frequency:

- Step loads in all the operating regimes analyzed do not induce frequency deviation higher that admissible limits which state that speed controller on diesel generators is working well
- During data processing it was observed continuous change of measured signal phase that can effect deviation from nominal frequency
- A confirmation of frequency parameters must be done with direct frequency measurements

4. CONCLUSIONS

- Measurements and calculation of parameters is according to STANAG 1008 in limits impose by:
- Equipment used for measurements
- The technical conditions of diesel generators at the time of measurements
- Vessel is at pier
- The measurements was done on one phase of the 3x220V, 50Hz distribution system, and this conclusions apply only on this electrical system and it cannot be generalized over the entire electrical distribution system
- Because during the measurements the vessel was stationary, influences of external factors over the computed parameters was not fully taken into account
- The action of internal factors (step load) was not studied fully, because it was impossible to charge the diesel generators over the 30% limit
- The frequency parameters must be validated by direct measurement of the frequency

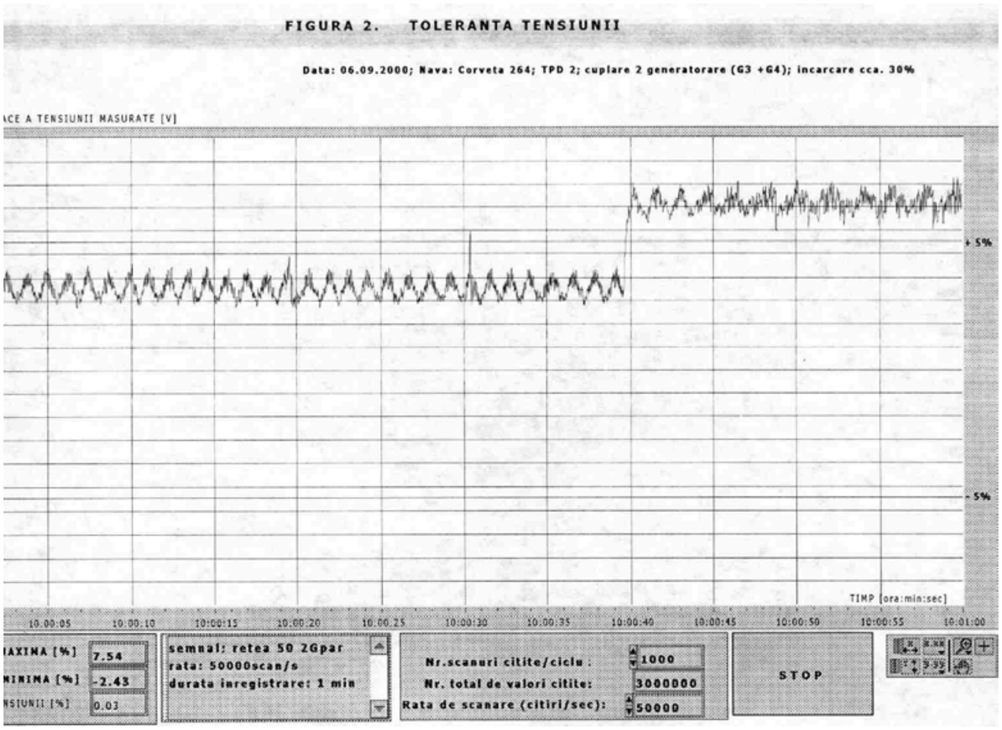


FIGURA 2. TOLERANTA TENSIUNII
Data: 06.09.2000; Nava: Corveta 264; TPD 2; cuplare 2 generatorare (G3 +G4); incarcare cca. 30%
ACE A TENSIUNII MASURATE [V]
+ 5%
- 5%
TIMP [ora:min:sec]
10:00:05
10:00:10
10:00:15
10:00:20
10:00:25
10:00:30
10:00:35
10:00:40
10:00:45
10:00:50
10:00:55
10:01:00
AXIMA [%] 7.54
INIMA [%] -2.43
NSIUNII [%] 0.03
semnal: retea 50 2Gpar
rata: 50000scan/s
durata inregistrare: 1 min
Nr.scanuri citite/ciclu : 1000
Nr. total de valori citite: 3000000
Rata de scanare (citiri/sec): 50000
STOP

Fig.2

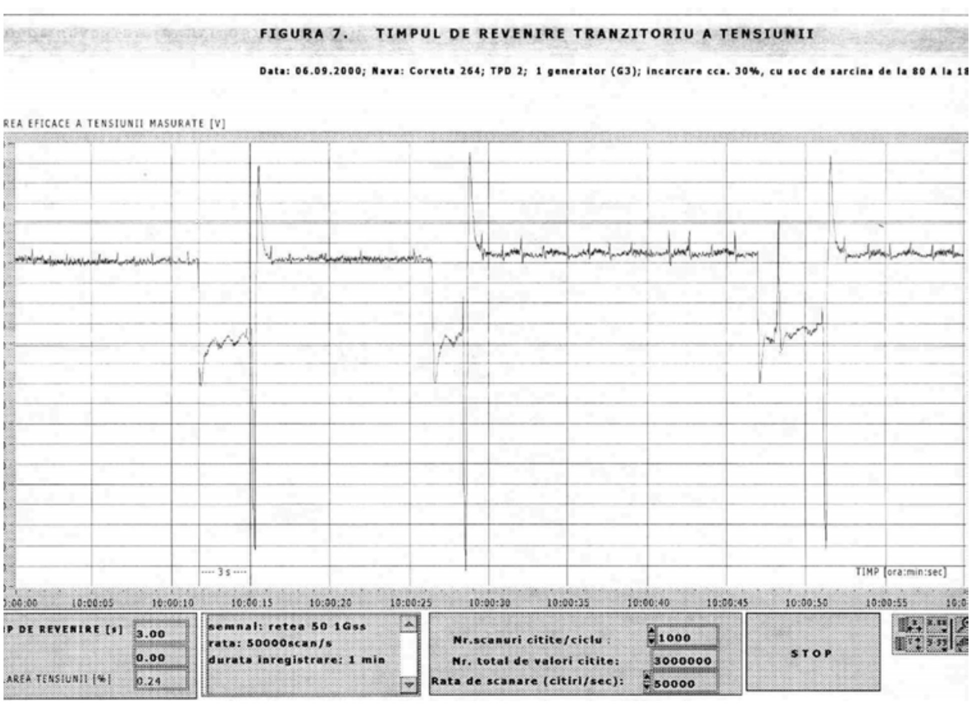


FIGURA 7. TIMPUL DE REVENIRE TRANZITORIU A TENSIUNII
Data: 06.09.2000; Nava: Corveta 264; TPD 2; 1 generator (G3); incarcare cca. 30%, cu soc de sarcina de la 80 A la 18
REA EFICACE A TENSIUNII MASURATE [V]
3 s
TIMP [ora:min:sec]
10:00:05
10:00:10
10:00:15
10:00:20
10:00:25
10:00:30
10:00:35
10:00:40
10:00:45
10:00:50
10:00:55
P DE REVENIRE [s] 3.00
0.00
AREA TENSIUNII [%] 0.24
semnal: retea 50 1Gss
rata: 50000scan/s
durata inregistrare: 1 min
Nr.scanuri citite/ciclu : 1000
Nr. total de valori citite: 3000000
Rata de scanare (citiri/sec): 50000
STOP

Fig.3

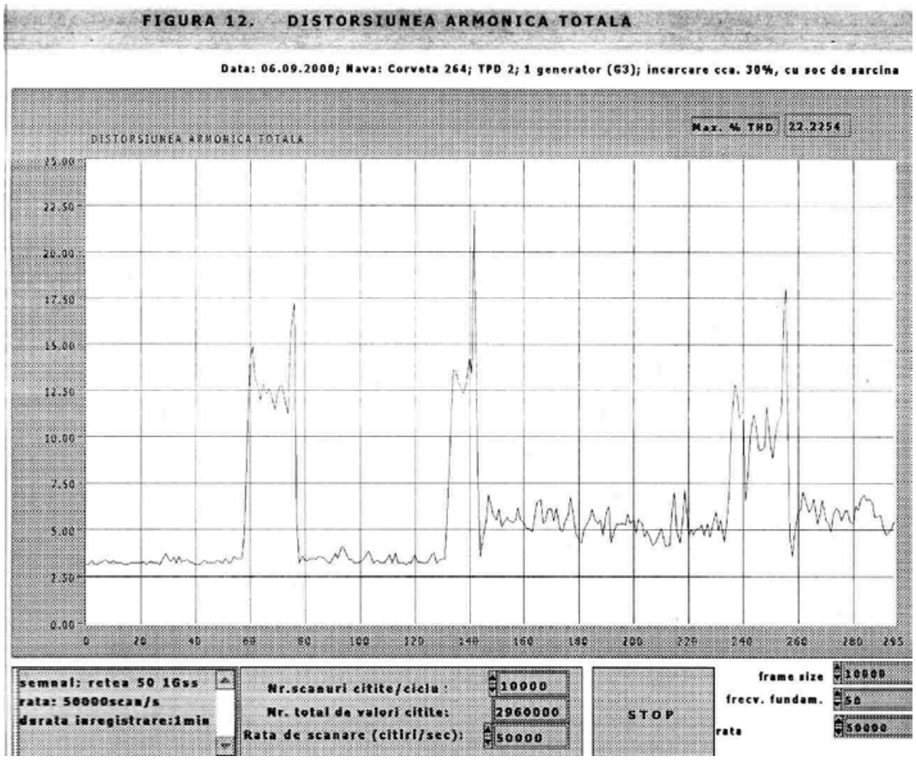


FIGURA 12. DISTORSIUNEA ARMONICA TOTALA
Data: 06.09.2000; Nava: Corveta 264; TPD 2; 1 generator (G3); incarcare cca. 30%, cu soc de sarcina
DISTORSIUNEA ARMONICA TOTALA
Max. % THD
22.2254
25.00
22.50
20.00
17.50
15.00
12.50
10.00
7.50
5.00
2.50
0.00
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 295
semnal: retea 50 1Gss
rata: 50000scan/s
durata inregistrare:1min
Nr.scanuri citite/ciclu :
10000
Nr. total de valori citite:
2960000
Rata de scanare (citiri/sec):
50000
STOP
frame size
10000
frecv. fundam.
50
rata
50000

Fig.4

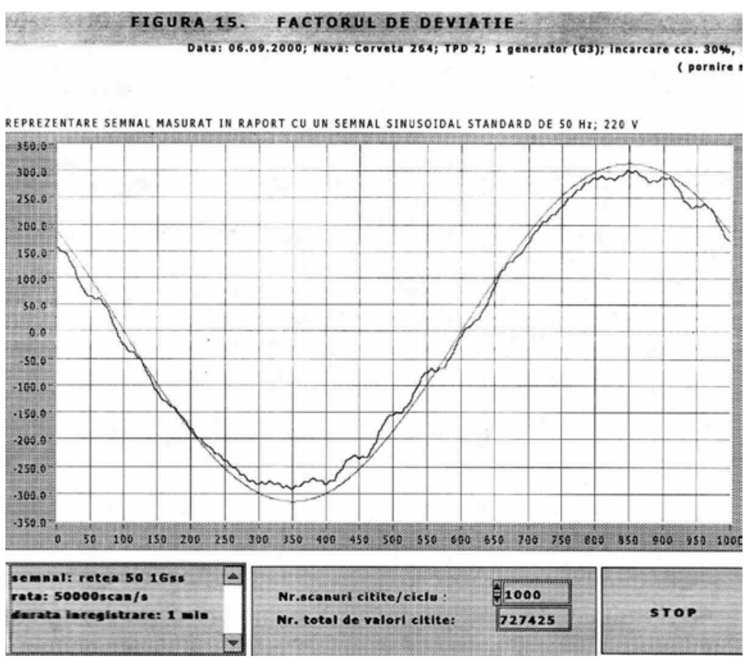


FIGURA 15. FACTORUL DE DEVIATIE
Data: 06.09.2000; Nava: Corveta 264; TPD 2; 1 generator (G3); incarcare cca. 30%,
REPREZENTARE SEMNAL MASURAT IN RAPORT CU UN SEMNAL SINUSOIDAL STANDARD DE 50 Hz; 220 V
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
-50.0
-100.0
-150.0
-200.0
-250.0
-300.0
-350.0
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950
semnal: retea 50 1Gss
rata: 50000scan/s
durata inregistrare: 1 min
Nr.scanuri citite/ciclu :
1000
Nr. total de valori citite:
727425
STOP

Fig.5