

# INVESTIGATION OF INFLUENCE OF SHIP'S GENERATING SET ON EMITTED ACOUSTIC ENERGY

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*The article presents the investigations of influence of load variations the ordered electrical energy of ship's generating set on structure of spectrum of the hydroacoustic noise generated by ship's hull to the water environment. This joins closely with qualification of possible state of exploational ship, which is important with military regards.*

## INTRODUCTION

The Hydroacoustic Department of Naval University of Gdynia for many years deals with investigations of acoustic emission of shipping sources of underwater noise, considering the influence of individual sources on structure of hydroacoustic noise. The preliminary investigations of ship's generating sets were described in this article.

The measurements were made due to:

1. Research if vibrations of generating sets gives important information about under test object (ship).
2. Answer to the question if load of ship's generating sets is important in measurement of sources of underwater noise
3. To expand the methods of investigation of ship's sources of hydroacoustic noise about guideline to the research of ship's generating sets.

The object of investigations, method of measurements, influence of load variations the ship's generating set will be introduced in the next points, on phantom of hydroacoustic noise and guidelines to more far investigations.

## 1. OBJECT OF INVESTIGATIONS AND METHOD OF MEASUREMENTS

To the research, it was chosen a ship, with heavy current engineering system which is powered by three generating sets. This are ZE-400 model generators which consist of diesel engine with automatic ignition, type SW-400 and synchronal dynamo type GCPf-94c/1. The scheme of generating sets layout on the ship is presented in figure 1.

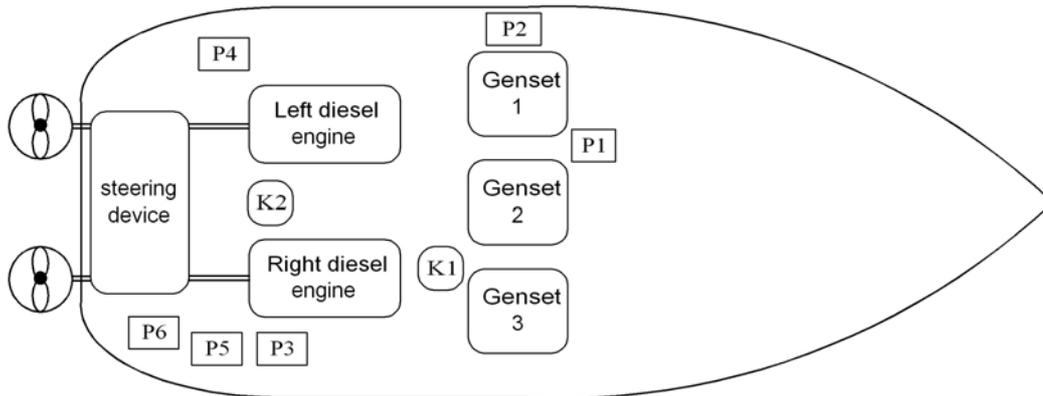


Fig. 1. Main sources of hydroacoustic field of measured ship. P1-P6 – pumps, K1,K2 - compressors

In generating set, the combustion motor as an object of control and synchronal dynamo with system of currency regulation are compose to the complex system of angular velocity's regulator of generating set. In this regulator all apart functional elements are closely related and have influence on quality of generated currents which one of main parameters is its frequency. The regulator of angular velocity is one of the main elements of this system. In ZE-400 the centrifugal regulator type Woodward is used.

For the angular velocity regulator is set the requirements for the ranges of change of inflict angular velocity. For this regulator this range is not large and its lower limit is 90% and upper limit is 105% of nominal angular velocity. The static profile of regulator was presented on figure 2. After generating set is started its angular velocity is set so frequency at 0% of load will be between 51 and 52 Hertz. At 100% of load the frequency will fall down to the value about 48 Hertz.

Usually the ship's generating sets are load to 75% of nominal power and after crossing this value the next generating set is started. This suggests that observing the change and distribution of "energetic" frequency in hydroacoustic noise spectrum, it is possible to get information about state of load of ship's heavy current engineering system.

The researches were made in a stationary condition, it means that the ship was anchored. The location of measurement probes are presented in figure 3. The measurements were made for three generating sets and for three exploational loads: 0%, 50 % and 100%. The accelerometers were positioned only on one generating set, but additionally two remaining generators were started too.

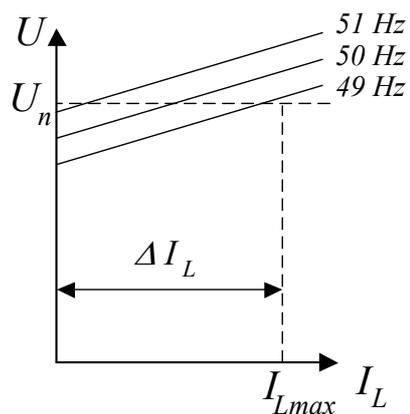


Fig. 2. Static profile of speed governor.  $U_n$  – nominal voltage of generator,  $I_L$  – current of loading

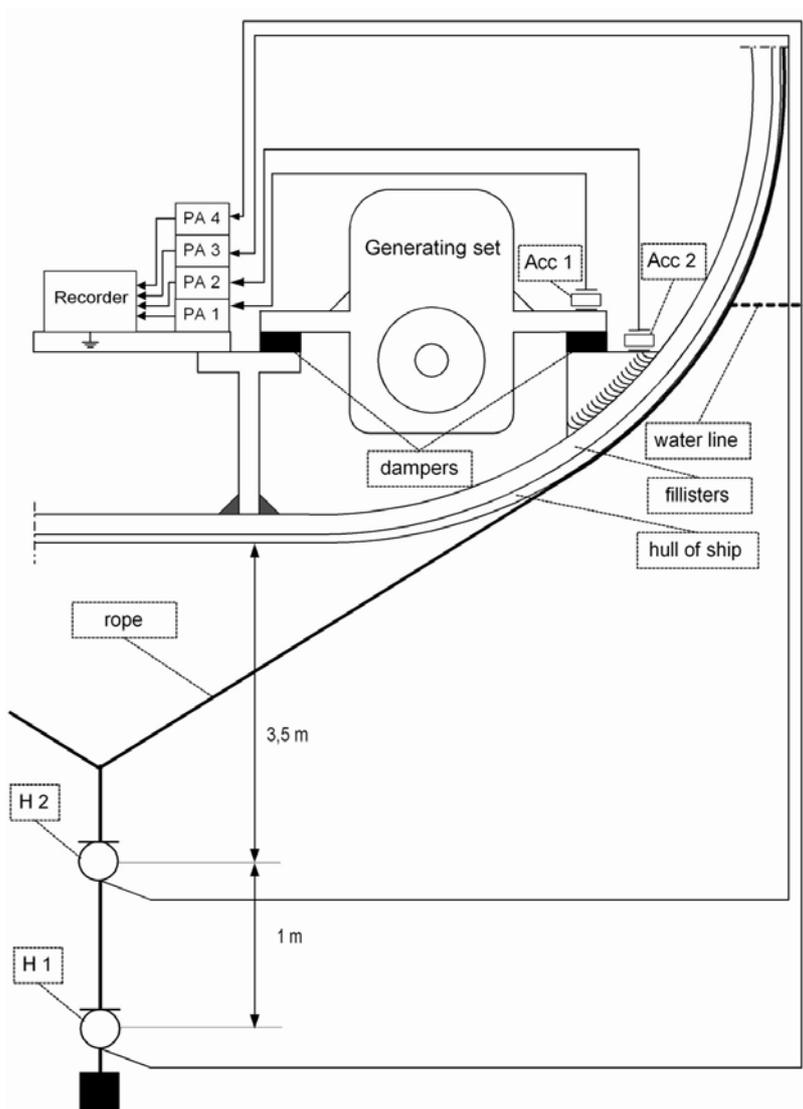


Fig. 3. The method of measurement ships generating set: H1,H2 – hydrophones, PA1-PA4 – measurement preamplifiers, Acc1, Acc2 – accelerometers

## 2. THE ANALYSIS OF MEASUREMENTS OF VIBRATION AND UNDERWATER NOISE

The velocities of vibrations and displacements of generating sets were measured for every generator for different coefficients of load (on foundation and hull of ship directly under generating sets). The load increasing of generating sets cause increasing the velocity and displacement of vibrations. The results of measurements of effective velocity's vibration for frequency 50 Hz were presented in figure 4 and in table 1. Next the spectra of effective velocities' vibrations were compared with spectra of acoustic pressure level. There were considered the characteristic cases:

1. One generating set is working (figure 5 and 6). The synchronization of generating sets cause that generator 1, 2 and 3 have the same current's frequency. The number of working generating sets is unable to be determined.
2. Two generating sets are working – one without load and not synchronized, because the hydrophone is placed directly under working generating set therefore in spectrum of hydroacoustic noise there is no peak which should become from not loaded generator.
3. Three generating sets are working – two without load and not synchronized (figure 7 and 8)

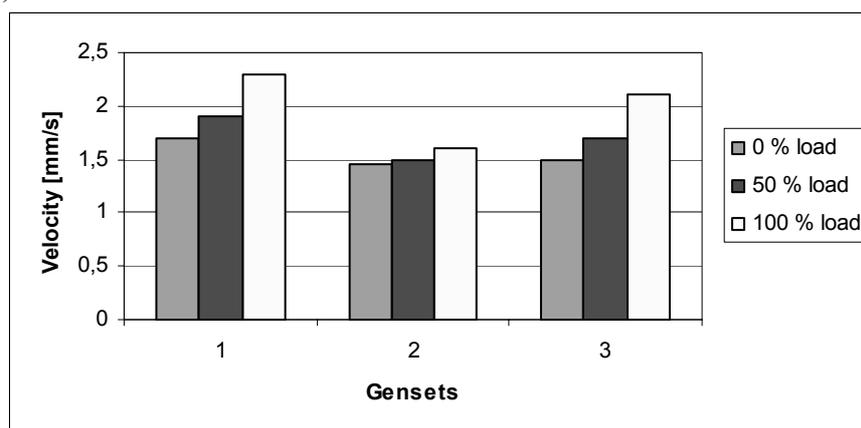


Fig. 4. Diagram effective value of velocity of vibration in function of loading gensets

Tab.1. Tables peak value of displacement of vibration in function of loading gensets

Loading gensets [%]	Measuring points		
	Genset_1 $D_p$ [ $\mu m$ ]	Genset_2 $D_p$ [ $\mu m$ ]	Genset_3 $D_p$ [ $\mu m$ ]
no-load (0)	5,6	7,1	6,1
50	8,3	7,3	7,7
100	10,7	8,0	11,8

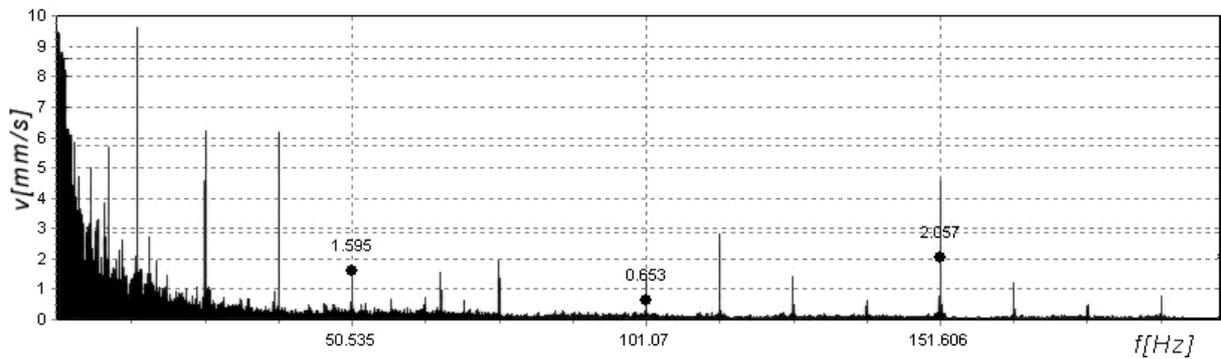


Fig. 5. The velocity spectrum shows voltage frequency generating set. Load. ca. 50 %

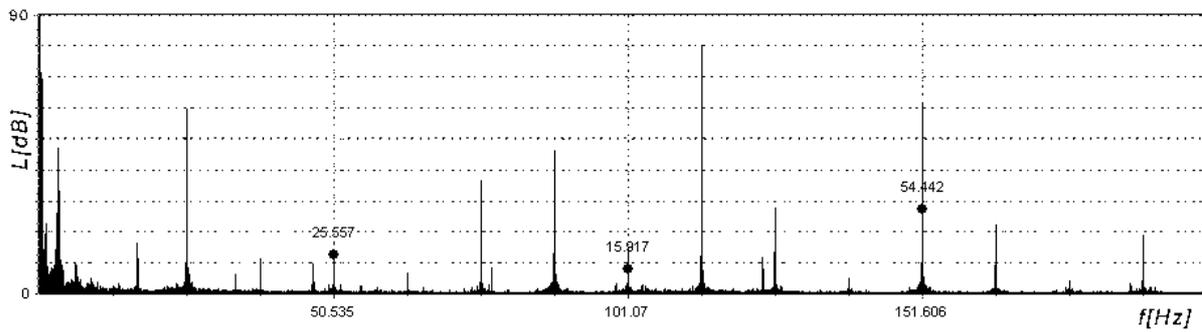


Fig. 6. The level of underwater sound pressure spectrum shows voltage frequency genset. Loading ca. 50 %

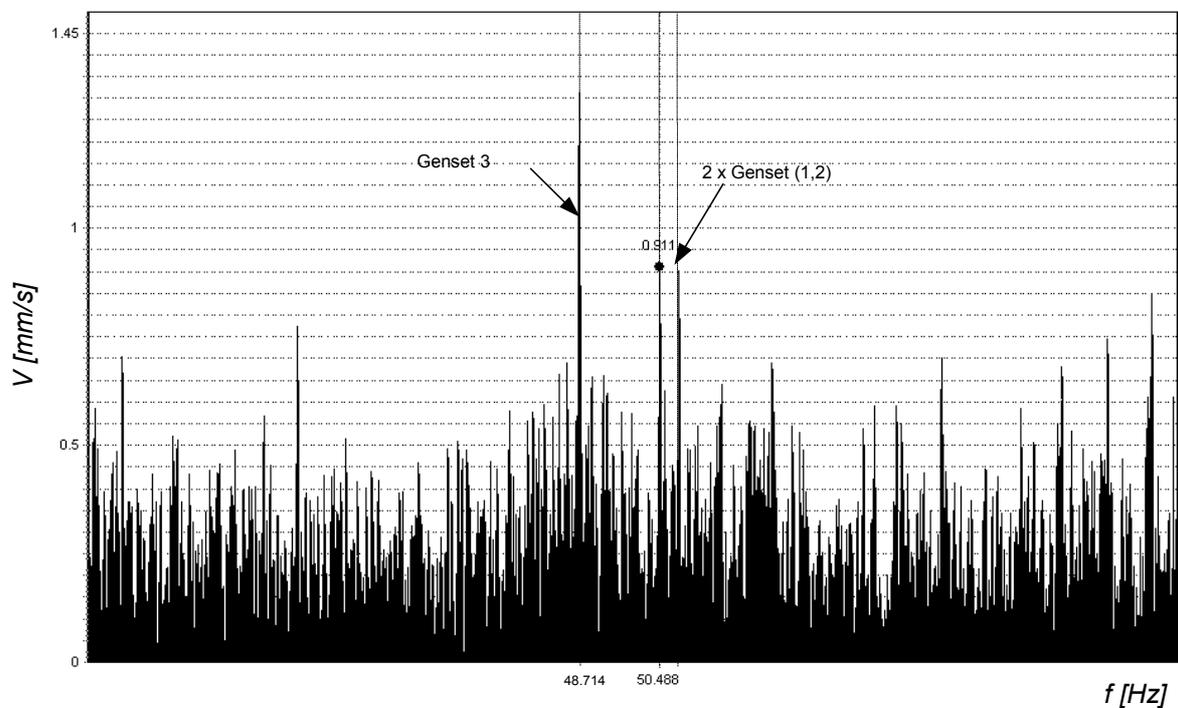


Fig. 7. The velocity spectrum shows voltage frequency for generating set 3. Loading ca. 100 %.  
Generating sets 2 and 3 worked non-synchronously

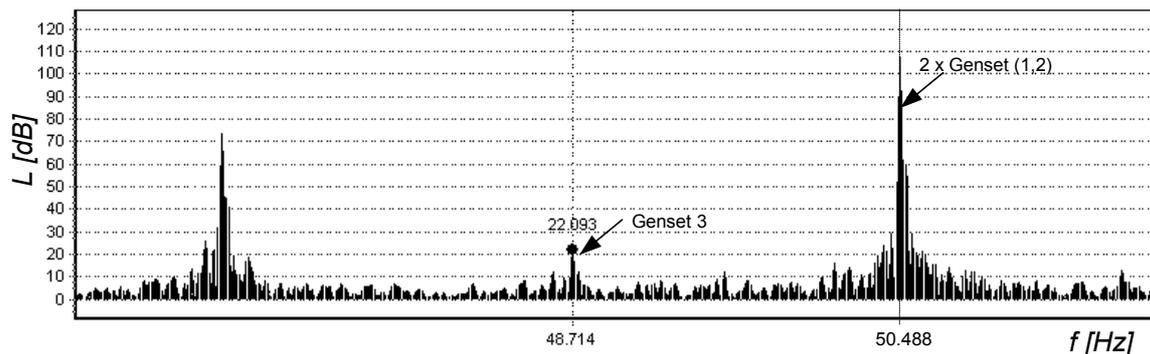


Fig. 8. The level of underwater sound pressure spectrum shows voltage frequency for generating set 3. Loading ca. 100 %. Generating sets 2 and 3 worked non-synchronously

### 3. SUMMARY

The preliminary research of vibration and hydroacoustic noise of ship's generating sets type ze-400 allows to conclude:

1. Based on the measured underwater noise generated by ship it is possible to get conclusion about state of load of ship's heavy current engineering system and about readiness for taking part of load by another working, not synchronized generating sets.
2. The experience gathered during research and analyzing measurements handle to study the detailed methodology of measurements of ship's generating sets.
3. The results of research will be considered during configuration of measurements equipment which allow for half-automated recording of vibration and underwater noise with taking into account the parameters of working main mechanisms (included the coefficient of load of ship's heavy current engineering system) and motion of ship.

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