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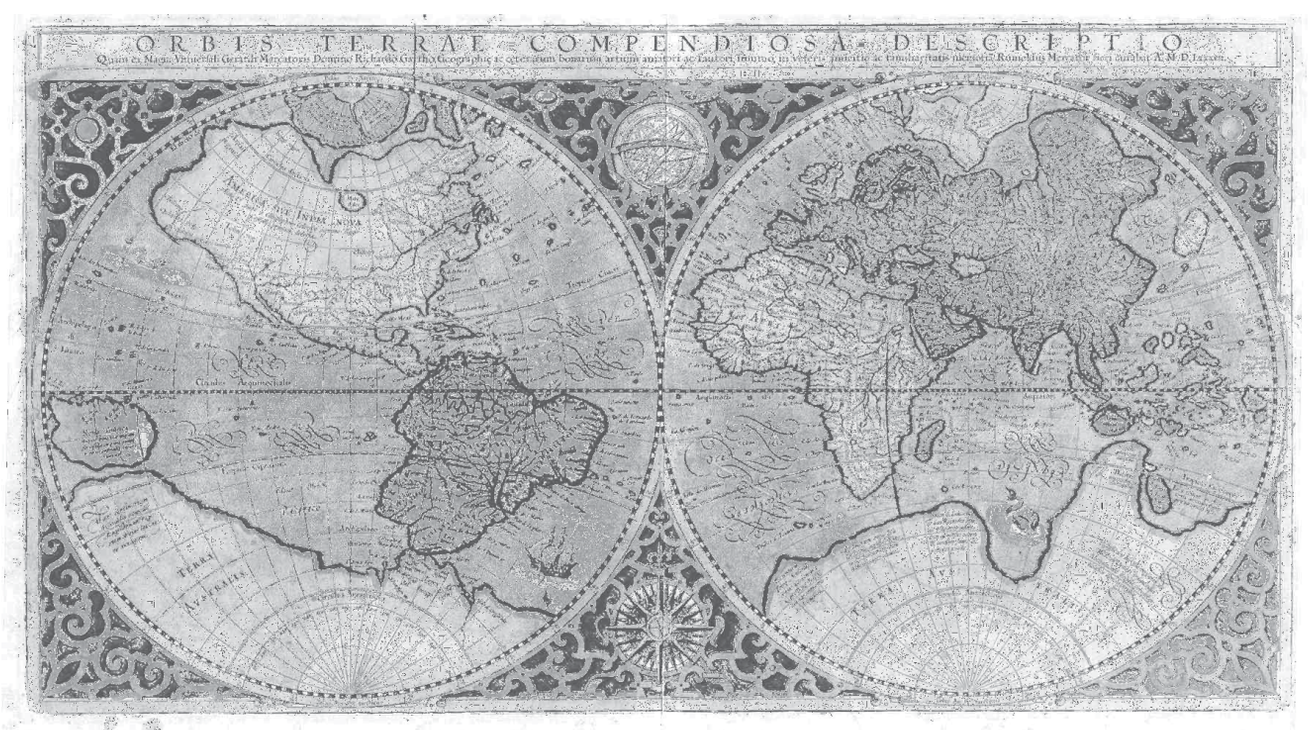

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SECTION I
NAVIGATION AND MARITIME TRANSPORT

SHIFTING OF CARGO ON BOARD SHIPS, A SERIOUS THREAT TO LOSS OF INTACT STABILITY

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[1,2]Constanta Maritime University, Romania

ABSTRACT

Ship's intact stability is one of the most important aspects that have to be taken into consideration when loading the ship as well as during the voyage. Despite the fact that many vessels left the ports with a proper intact stability, the experience proved that during the voyage, the stability has been lost. One of the factors that contributed to loss of intact stability was shifting of cargo during the voyage. In the present paper is examined the impact of cargo shifting on intact ship stability. Real case accidents involved losses of intact ship stability due to shifting of cargo are presented. Analytical equations of forces acting on a cargo piece during motion are explained.

Keywords: *cargo, shifting, stability.*

1. INTRODUCTION

Transport is the most important link in economic relations. It is involved in creating of products and delivering it to consumers, provides the link between production and consumption, between different industries, between countries and regions. It affects the development of the economy as a consumer of petroleum products, grains, metal, timber, and many other products.

Every cargo transported has particular proprieties for loading, stowage and transport. These cargo proprieties can influence the nautical qualities and the seakeeping behaviour of ship. One of the nautical qualities, which is influenced, and in many cases affected by cargo proprieties, is the ship intact stability. Inability of acknowledge the proprieties of the cargo to be loaded, in many cases, is the result of dangerous situations, even to capsize.

Safe transport of cargo is not just a matter of safe stowage and securing of cargo, solely, but is strongly related with the design and construction of the ship, her outfit, as well as with the way the ship is being operated at sea in different environmental conditions.

According to the statistics, 10% of serious stability accidents of ships are caused by the shift of cargo. These kinds of accidents are quite common for general cargo vessels, container vessels, Ro-Ro vessels and bulk carriers.

Cargo shifting is a complex phenomenon. Usually it is caused by the motions of the ship and is largely influenced by the proprieties of cargo, lashings as well as operational aspects. During the voyage, a various number of different conditions is encountered by the ship influenced by sea state, ship's speed and heading towards the waves, and loading condition. Forces acting on the cargo and ships motions will be different in each such condition. The waves will have specific proprieties and in order to response to these waves the ship will move in a certain way. These ship motions will induce forces on the cargo, and if these forces are larger than what the cargo and its lashings can withstand the cargo will shift. Thus, the probability of cargo shifting will differ in the various conditions.

Hua [3] has presented a concept of an *equivalent roll angle* and probabilistic approach to the problem of cargo shifting. He discussed the effect of linearization of the model on the predicted results.

2. CASUALTIES OF SHIPS RELATED TO SHIFTING OF CARGO

Due to various types of cargo transported, shifting of cargo is present on board of various types of ships. Here below, are presented some casualties where shifting of cargo resulted in loss on ship's intact stability

TRADEN – 8,188 GRT, Ro-Ro cargo ship

The vessel en route from Valencia to Norkoping, loaded with containers, pallets and roll trailers, occurred in emergency on 19th October 2001, due to a severe cargo shift. The cargo shifted when the ship got into storm for more than two days and into exceptionally troublesome confused seas [8].

KARIN KAT – 1,501 GRT, general cargo vessel

Vessel loaded with various stainless steel LNG cargo handling equipment was sailing from Antwerp bound for Ras Laffan. On 17th February 2003, the vessel encountered bad weather with winds up to gale force 8. The vessel was rolling 15-20 degrees and also pitching and heaving resulted in shifting of cargo inside vessel's holds. The investigations concluded that the rough weather and heavy swells, which caused the rolling, pitching and heaving of the vessel, has been a contributory cause of the foundering. Moreover, the cargo shifted because it was insufficiently secured to withstand the movement of the vessel during the prevailing rough sea [2].

ANSAC ORIENT – 16,715 GRT, bulk carrier

Vessel encountered, on 2nd February 2004, a swell on its starboard bow and rolled violently up to 20

degrees to each side. Logs fell from the after end on no.3 hatch allowing the lashing to slacken. Cargo then shifted athwartships and about 45 logs were lost overboard. Investigation revealed that the vessel's GM was of 3.38 m, the ship was very stiff and had a short period of roll [10].

SUNSHINE – 1,214 GRT, general cargo ship

The vessel loaded with marble in blocks sailed, on 22nd April 2007, in bad weather conditions, with heavy seas, north of Libyan coast. During Master's effort to maintain a reasonable course under the given circumstances, the vessel took, suddenly, excessive list and capsized within 10 minutes. The shifting of a single heavy block of marble has identified primary cause of failure [11].

RIVERDANCE – 6,000 GRT Ro-Ro trailer ferry

This vessel encountered, on 31st January 2008, stability problems in heavy weather during the course of a voyage across the Irish Sea towards the UK, and ultimately foundered on a beach on the UK coast. Among other factors that contributed to loss of ship stability, the investigations pointed out that shifting of cargo was one of the causes [9].

3. THE DYNAMIC FORCES ACTING ON A PIECE OF CARGO

The diagram of the forces acting on the cargo piece is presented in figure 1.

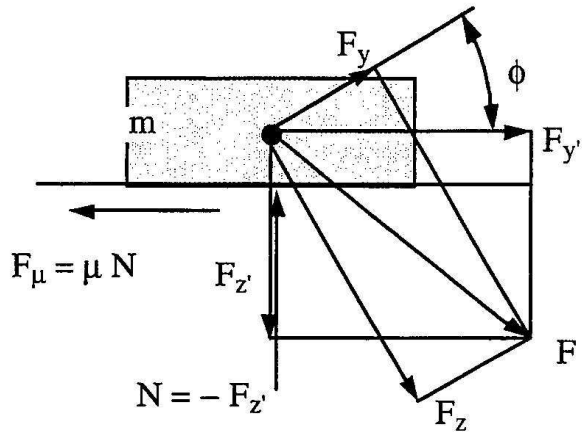

Figure1 The diagram of the forces acting on the cargo piece

F_y and F_z are the components of the total force F in the global inertial coordinate system. These components can be derived from the Lagrange's equation as follows:

$$F_y = \frac{d}{dt}\frac{\partial L}{\partial \dot{y}} - \frac{\partial L}{\partial y} =$$
$$= m\{\ddot{y} + \ddot{u}\cos\phi - \ddot{\phi}[z_g\cos\phi + (y_g + u)\sin\phi] + \quad (1)$$
$$+ \dot{\phi}^2[z_g\sin\phi - (y_g + u)\cos\phi] - \dot{u}\dot{\phi}\sin\phi\}.$$

$$F_z = \frac{d}{dt}\frac{\partial L}{\partial \dot{z}} - \frac{\partial L}{\partial z} =$$
$$= m\{\ddot{z} + \ddot{u}\sin\phi - \ddot{\phi}[z_g\sin\phi - (y_g + u)\cos\phi] - \quad (2)$$
$$- \dot{\phi}^2[z_g\cos\phi + (y_g + u)\sin\phi] + \dot{u}\dot{\phi}\cos\phi - g\}.$$

As can be seen from equations (1) and (2) force F has inertia, Coriolis and gravitational force components. The total force F is given by the components in the moving frame as

$$F_{y'} = m[\ddot{u} + \ddot{y}\cos\phi + \ddot{z}\sin\phi - \ddot{\phi}z_g - \dot{\phi}^2(y_g + u) - g\sin\phi] \quad (3)$$

$$F_{z'} = m[\ddot{z}\cos\phi - \ddot{y}\sin\phi + \ddot{\phi}(y_g + u) - \dot{\phi}^2 z_g + \dot{\phi}\dot{u} - g\cos\phi] \quad (4)$$

The equations (1) and (2) can be used for determining the required strength of the cargo lashing system. In this case, cargo shift is set to zero, i.e. $u = du/dt = d^2u/dt^2 = 0$ in equations (3) and (4), and the ship motions govern the forces acting on the cargo only.

4. THE EFFECT OF CARGO SHIFTING ON SHIP INTACT STABILITY

The effect of transversally cargo shifting is the moving of ship's centre of gravity from G to G_1, as illustrated in figure 2.

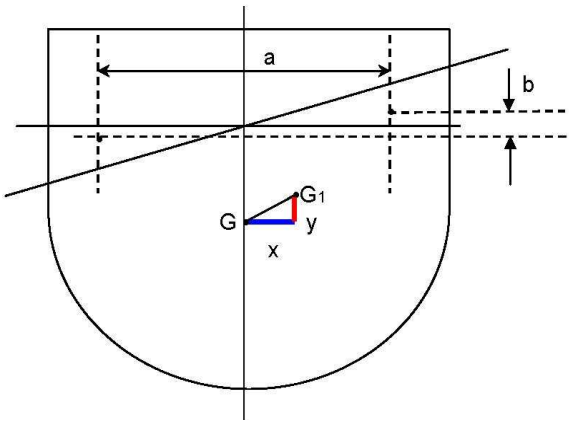

Figure 2 The effect of shifting of cargo on G

In this way, the ship's centre of gravity has two components of movement: y- vertical component and x- horizontal component. Both of components can be calculated by the formulas

$$x = \frac{w \cdot a}{\Delta}, y = \frac{w \cdot b}{\Delta} \quad (5)$$

where:

x – horizontal movement of G;
y – vertical movement of G;
Δ – displacement of ship;
w – weight of cargo shifted;

a – horizontal movement of centre of gravity of w;
b – vertical movement of centre of gravity w.

Thereafter, the new righting lever GZ will be (figure 3):

$$G_1Z_1 = GZ - x\cos\varphi - y\sin\phi \qquad (6)$$

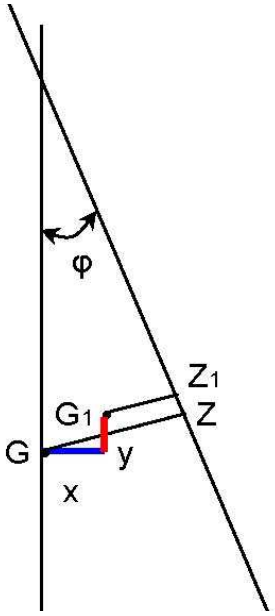

Figure 3 Reduction of righting lever due to shifting of G

In the situation when only the horizontal movement is taken into consideration the loss of righting lever will decrease as the angle of list increases. In other words, the greatest loss of righting lever will be when the ship is upright.

The ship will come to rest at the angle of list in still water condition and the horizontal movement of ship's centre of gravity will represent a negative value of righting lever when the ship is upright (figure 4).

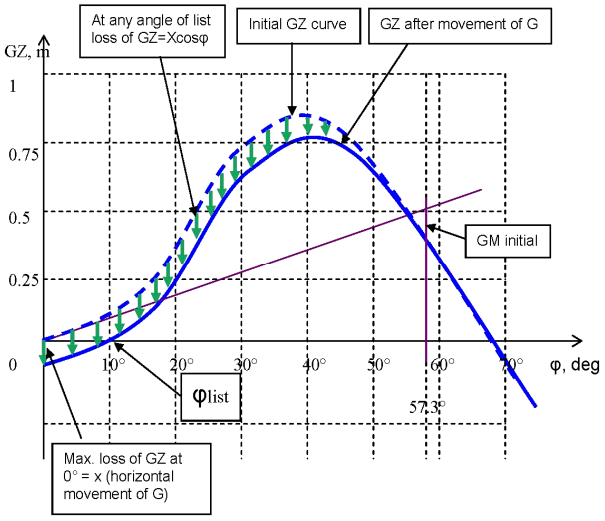

Figure 4 The effect of horizontal movement of G on stability curve

The effect of horizontal movement of G (when the vertical movement of G is ignored) is as follows [z60]:

- The initial GM remain unchanged (since only the vertical movement of G will cause this to change).
- All values of righting lever across the range of stability are reduces, particularly at the smallest angles of heel. When the ship is upright, the horizontal movement of G acts as a capsizing lever causing the ship to heel over to the angle of list.
- A reduction of dynamical stability (area under the curve). Since the ship is already listed, less work is required by the external forces to heel the ship over to dangerous angles of heel on the listed side.
- Range of stability is reduces (at both ends of the range for a ship having an initial range of stability less than 90°).
- The angle of heel at which the deck edge immersion occurs remains unchanged but there is less work required by the external forces to reach it on the listed side.

In the cases where the vertical movement of G is not ignored, the effects of cargo shifting is illustrated in figure 5.

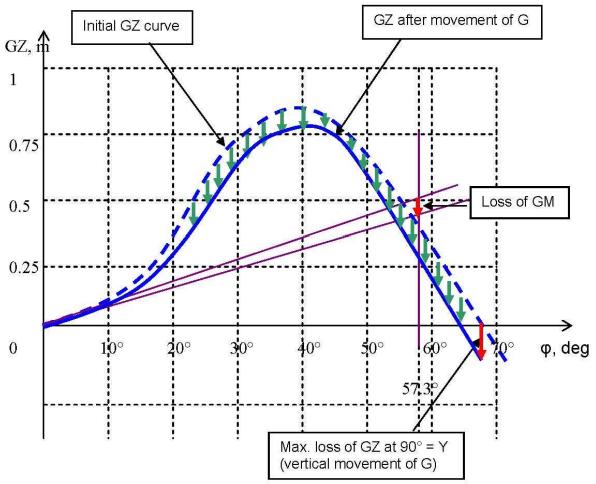

Figure 5 Effect of vertical shifting of G on stability curve

This situation involves a decreasing of GM and this effect is reflected as follows [z60]:

- All values of righting lever across the range of stability are reduced, particularly at the larger angles of heel.
- Dynamical stability (area under the curve) is reduced making the ship less able to resist heeling by external forces.
- Range of stability is reduced.
- The angle at which deck edge immersion occurs remains unchanged as freeboard has not changed.

In both situations presented above, the effect of cargo shifting revealed that most aspects of stability are worsened.

Shifting of cargo on board vessels can lead to dangerous listing and ultimately capsizing. The majority of the casualties involved the consequences of the transverse movement of cargo in heavy weather.

Cargo movement can be attributed to contributory factors like:

- Movement caused by waves hitting the stow (for deck cargo), and exacerbated by movement of the vessel in rough sea.
- Failures in the methods of stowing and lashing the cargo.

Cargo is not always stowed in compact stows and large void spaces remain. These gaps allowed the stow to move especially when vessel was rolling in heavy seas. Lashing materials (wire rods, turnbuckles, rings, etc.) are in many cases old and poor maintained. Moreover, many are not certified and not adequate to be used like lashing materials in particular cases.

Provisions stated in regulations issued by ship's administration (such as Cargo Securing Manual) or international regulations (such as IMO Code of Safe Practice for Cargo Stowage and Securing) are often ignored with intention or by rashness.

In many cases, ship's Cargo Securing Manual did not contain any instructions on stowage and securing of particular types of cargoes, or any information or guidance for the crew related to stowage and securing of cargo on deck/hatch covers.

- Inadequate friction between the cargo and ship steel structures (decks, hatch covers, etc.).

The decks and hatch covers are made from steel and usually are covered by ordinary paint coating which does not provide a non-slip surface, especially when wet. In this way, would be of great benefit in reducing the risk of cargo shift if a proprietary high friction coating is applied on top of these surfaces where the cargo is to be loaded. An alternative method can be the mixing of paint with sand which can increase considerably the friction. A particular and very often case found in practice is that steel bands strap the bundles of sawn timber. These steel bands are the contact points at the lower part of the bundle with steel tops of the hatch covers. Steel-on-steel provides a very low level of friction.

5. CONCLUSIONS

The most important aspects regarding shifting of cargo on board ships were presented in this paper.

The analysis presented revealed that the phenomenon of cargo shifting is one of the main causes of ship stability loss. It were presented the forces acting on a piece of cargo during moving as well as the aspects behind the connection of cargo shifting with loss of ship

It can be concluded the fact that shifting of cargo, developed especially during the voyage when the vessel develops large oscillations due to encountering large waves in heavy seas, is a serious threat to intact ship stability and can have a negative impact on that.

In this respect, it can state that one of the most important objective for the people who work in maritime community and have to be taken into consideration to prevent dangerous situations involving shifting of cargo, is to take precautionary measures to avoid such situations. This objective can be achieved by a continuous education and training of the ship's officers, which are directly responsible for loading, stowage and lashing of cargo on board vessel, to understand the mechanisms of cargo shifting and moreover the dangerous situations involved. Use of simulators in this respect can be a useful tool for training of ship's officers to face the real problems that affecting the safety of ships and safety of navigation [1].

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SURF-RIDING OF A SHIP IN FOLLOWING AND QUARTERING WAVES AND VULNERABILITY TO LOSS OF INTACT STABILITY

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ABSTRACT

Dynamic stability is one of the most important nautical qualities of ships. Large waves can have a negative influence over ship's stability that may lead to dangerous situations. In the present paper the surf-riding phenomenon of ships in following and quartering waves is examined. Surf-riding is one of the phenomenon that can lead to ship stability loss or even capsize in following and quartering waves. Analytical considerations of equation of surging motion in following and quartering waves explain the critical condition of surf-riding. The physics behind the connection of surf-riding with broaching and loss of ships stability resulted in capsize is explored. Practical explanation of the surf-riding on board ships is explained, followed by recommendation for assessment of dangerous situation related to surf-riding.

Keywords: *surf-riding, broaching, stability, capsize.*

1. INTRODUCTION

Ships are developing periodic motions, in following and quartering seas, and due to the fact that all their degrees of freedom are engaged correlated with the increasing of wave steepness can lead to so called surf-riding phenomenon.

Because of their direct relation to safety, the surf-riding in relation with the dynamic stability proprieties of ships are of paramount importance. The most important aspect that can be developed during surf-riding in connection with the loss of dynamic stability during this phenomenon is the possibility that the ship can capsize due to loss of steerability. Moreover, when the restoring force provided by the rudder is insufficient as to reduce the ship's oscillatory yawing motion and the vessel is in low frequency periodic motions, a similar situation can be developed. This aspect is in strong connection with the so called broaching phenomenon.

The fact that in most of the researches surf-riding was in analysed for the following wave condition, was on the basis that surge motion and their equations were essentially used. This way of approaching the problem has led to the conclusion that two states of surf-riding can be developed for every wavelength when the vessel is near the crest as well as near the through of the wave [12].

In this paper the investigation and analysis of surf-riding phenomenon is presented in connection with his influence on stability of ship.

2. ANALYTICAL EXPLANATION OF SURF-RIDING

Surf-riding is another phenomenon of following / quartering seas and is often associated with broaching and can be described as the "catching and dragging" [3] of ship by a wave approaching from stern and accelerates her to the wave celerity. Physically, surf-riding is caused by the equilibrium created by the longitudinal wave force, thrust and resistance [3].

The dynamical aspects of surf-riding have been studied by Grim [7], Ananiev [1], Makov [9], Kan [8], Umeda [16], Thomas & Renilson [14], and Spyrou [11].

Surf-riding phenomenon can be described as the acceleration of the ship to ride on the wave crest, when it is located on a steep forefront of high wave in following and quartering sea condition. When a ship is surf-ridden, the so-called broaching-to phenomenon may occur, which endangers the ship to capsize as the result of sudden change of ship's heading and unexpected large heeling [10].

When the ship is surf-ridding and when this is happen in following and quartering seas when broaching phenomenon is most likely to happen, the ship's bow tends to dig in (as the bow of the ship is close to the wave trough) but in the same time the ship's stern tends to be pushed away involving a loss of directional stability due to developing the broaching.

Surf-riding is most likely to occur when the ship's speed exceeds a certain multiple of the square root of ship's length in following and quartering sea conditions.

The key for explaining why the surf-riding is conductive to broaching, lies in the role of the nonlinear surge motion dynamics [12].

The surging motion can be written in a form of the equation [5]:

$$\Delta \frac{dV}{dt} + \mathrm{M}V = N + F\cos(\omega_e t + \varepsilon), \qquad (1)$$

where Δ is the mass of the ship, V is the ship speed including variable component, t is the time, and F and ε are the amplitude and phase of the surge exciting force respectively. M and N are defined as follows:

$$M = \{R_1 - T_1(1-\tau)\} > 0, \qquad (2)$$

$$N = \{T_0(1-\tau) - R_0\} > 0. \qquad (3)$$

where,

$$R_0 = R(V_S) - dR(V_S)/dV \cdot V_S, \quad (4)$$

$$T_0 = T(V_S) - dT(V_S)/dV \cdot V_S, \quad (5)$$

$$R_1 = dR(V_S)/dV, T_1 = dT(V_S)/dV. \quad (6)$$

where R is the resistance, T is the thrust, V_s is the ship speed concerned at the time and $1-\tau$ is the thrust deduction factor.

The static equilibrium condition is expressed when the terms of equation (1) depending on the time disappear. This condition is achieved when

$$\omega_E = 0$$

and,

$$MV = N + F\cos\varepsilon. \quad (7)$$

Since $\omega_E = 0$, means $V_s = c_w$ and the condition (7) is equal to

$$c_W = (N + F\cos\varepsilon)/M. \quad (8)$$

The analytical explanation of the occurrence of surf-riding is revealed by the fact that if the ship speed is equal to the wave speed at the time t = 0, then the ship speed can not be changed from the initial speed because the ship is in the static equilibrium condition with respect to the ship speed in equation (1). Thus, the occurrence of the surf-riding is given by the critical condition written as

$$c_w = V_m + \omega_E \zeta, \quad (9)$$

where: V_m is the mean speed, which can be assumed to be the ship speed in the still water for the same number propeller revolution, and ζ is the surge amplitude.

The critical wave steepness is obtained by using equation (9), the expression for $\omega_E = \omega(1-V_m/c_w)$ and the relation $\omega_E / c_w = 2\pi/\lambda$, as

$$\frac{H_W}{\lambda} = \frac{1}{\pi\xi\cos\alpha}, \quad (10)$$

where: H_w is the wave height, λ is the wavelength, ξ is the surge response and α is the encounter angle (α = 0 means the following wave). Although this simple expression is applicable for both deep and shallow water, the accuracy of the estimation depends on that of the surge response.

The surge amplitude is expressed as $x = F/\Lambda\omega_E^2$ by neglecting the term of the resistance in the equation of surge motion.

Using equation (9), the expressions for ζ and ω_E, and the relation $\omega c_W = g\tanh kh$, where $k = 2\pi/\lambda$ and h is the water depth, the critical speed is obtained as

$$V_m\cos\alpha = c_w[1-\{F\cos\alpha/\Lambda g\tan H_w kh\}^{1/2}] \quad (11)$$

Although the surf-riding is the case where the ship is accelerated to the wave celerity, it may occur such that the ship is decelerated to the wave celerity. One of the most dangerous situation can be considered when a large difference exists between the accelerated speed under the surf-riding condition and ship speed in the still water, since due to the decrease of the propeller slip the relative rudder force may decrease drastically.

3. SURF-RIDING ON BOARD SHIPS

During surf-riding, the vessel sails with speed equal to the wave celerity. The vessel's stay longer in the crest region and then passes quickly from the trough. In the literature this referred as *asymmetric large-amplitude surging*, or *surfing on a crest* [2]. A stationary behaviour o ship starts to coexist, in parallel, owed to the fact that the resistance force that opposes the forward motion of the ship in water, can be balanced by the sum of the thrust produced by the propeller and the wave force along the ship's longitudinal axis. This is known as surf-riding and the main feature is that the ship is forced to advance with a constant speed that equals to the wave celerity. Such mode of motion may become directionally unstable if a ship is captured at wave down slope; as a result, a ship may experience the sudden uncontrollable turn and unexpected large heeling. Hence, surf-ridding can be defined as a prerequisite to broaching.

In order for surf-ridding to occur, the wave length must be comparable with ship length and the wave celerity must be comparable with the ship speed [2]. Large ships cannot surf-ride, as waves of the necessary lengths are simply too fast compared to the ship speed.

To consider an example of surf-riding have to be assumed a wave with a length comparable to ship length has a celerity of 35 kts, while ship's speed is 25 kts in calm water (fig.1)

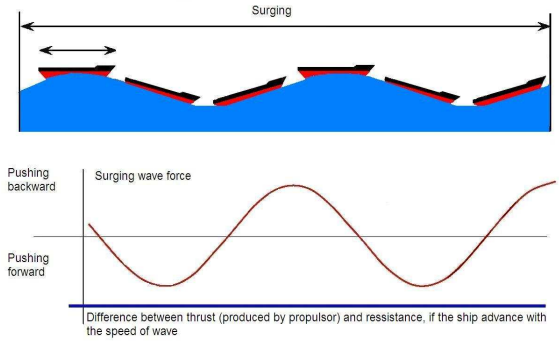

Figure 1 Surging in following waves. Surf-riding is impossible, [2]

The thrust produced by the propulsor, when sailing in calm water with a speed of 25 kts, is same as the resistance at the speed of 25 kts. At the moment of

wave overtaking the ship, the ship will surge because the axial forces push back and forth the ship and the speed of the ship become equal with the speed of the wave. The thrust provided by the ship is not sufficient to move the ship with the same speed of the wave (35 kts) and there is a difference between the resistance of the ship at the higher speed of wave and the ship's trust for 25 kts.

In the figure 1, is shown that the axial wave (surge) force is too small to compensate for this difference and surf-riding is theoretically impossible at this speed condition. Surging is the only possible mode of motion, as a result of this condition.

If the thrust setting in calm water is slightly increased, for example at 27 knots, then the difference between the resistance and produced thrust is sufficient to compensate for this difference and theoretically, if the ship is at a certain position on the wave, the surf-riding becomes possible (fig. 2).

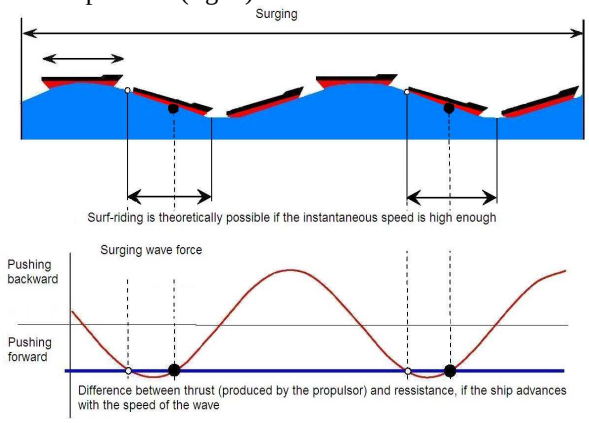

Figure 2 Both Surging and Surf-riding are possible, depending on the position on wave and instantaneous speed, [2]

In fact, surf-riding is a stable equilibrium realized when a ship is situated on the front slope of the wave close to the trough-shown here with a black dot in figure 2.

There are two possible modes of motions, surging and surf-riding, and the result are influenced by the ship's instantaneous speed and ship's location along the wave length. If the ship has sufficient instantaneous speed and is near the equilibrium then the surf-riding can occur.

There are two thresholds to enables surf-riding to be possible under certain conditions [2]:

- The 1st threshold corresponds to the thrust setting. If the ship's thrust in calm water is further increased then the difference between the resistance at the wave speed and the ship's thrust has further decreased. In order to occur the surf-riding of a ship located anywhere along the front of the wave, the axial surge force is enough. In this condition, surging is not possible and surf-riding remain the only mode of motion (fig. 3).
- The 2nd threshold corresponds to the speed setting. The situation is applying to certain value where the surging does not exist anymore and the surf-riding becomes inevitable at any instantaneous speed and at every position along the wave.

The wave steepness and wave length has influence over both speed thresholds. The likelihood of exceeding one of these thresholds can be used as a criteria because in a realistic seaway they are random figures. The 1st threshold is easy to exceed, but in order to experience surf-riding, when the ship is located at a particular position on the wave the instantaneous speed must be increased considerably. However, the probability of such a coincidence is quite low and therefore, the second threshold should be used as a criterion. The surf-riding for the particular wave is guaranteed once the threshold is exceeded.

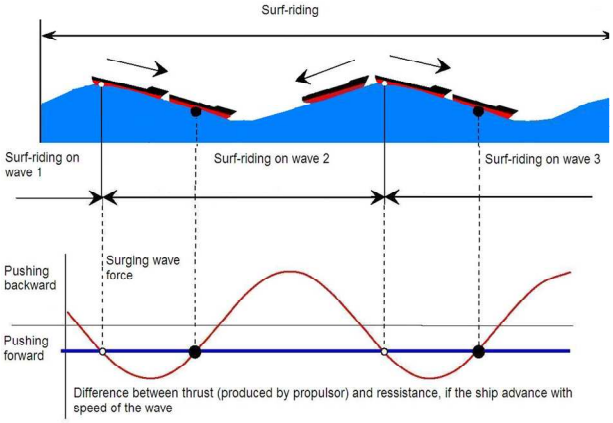

Figure 3 Surging is not possible. Surf-riding is the only option, [2]

4. RECOMMENDATIONS FOR ASSESSMENT THE POSSIBLE DANGER OF SURF-RIDING

The document MSC.1/Circ. 1228 uses the following formula as an indicator of possible danger of surf-riding and following broaching-to,

$$V \geq \frac{1.8\sqrt{L}}{\cos(180-\alpha)}, \qquad (12)$$

where L is the length of the ship and α is the wave heading, 0 being head waves.

To avoid surf-riding, and possible broaching the ship speed, the course or both should be taken outside the dangerous region as indicated in figure 4.

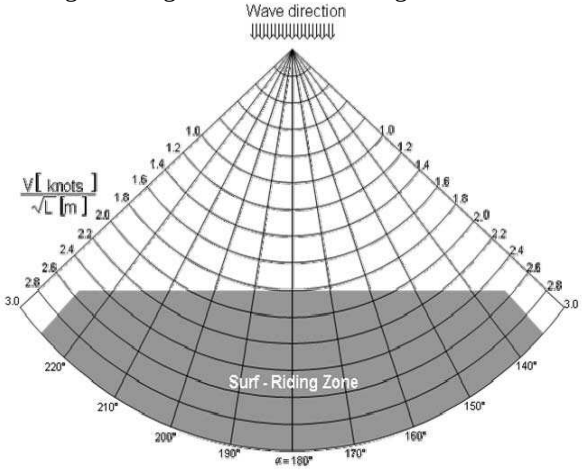

Figure 4 IMO-Diagram Indicating Dangerous Zone Due to Surf-riding

In order to determine the surf-riding threshold in regular following waves, a most suitable solution is an analytical one. Despite the fact that this solution is based on the theoretical background, it is very easy to be evaluated. One of the possible analytical solution is by assuming the proportionality between the ship velocity and the propeller and resistance thrust, where the ship resistance, propeller thrust, hull form offset, manoeuvring and roll damping coefficients and restoring moment are required. In order to develop a sustainable assessment criterion it is also necessary that deterministic thresholds for capsizing due to surf-riding to be as a function of wave parameters (height and period).

The criterion has to be applied since from the designing stage because if the proposed ship design fails to comply it is expected to apply the direct stability assessment to the subject ship design. In this case, it is very important to evaluate the risk level of the ship's design and the probability of capsizing due to surf-riding.

The necessity of development a criterion for assessment the surf-riding of ships is very important because during encountering this phenomenon a ship can be categorized as navigating in a complex situations [4] and a criterion can give valuable information for ship's master in way of how the ship will react during this situation.

5. CONCLUSIONS

The most important aspects regarding the basic nature of surf-riding of ships were presented in this paper.

The analysis presented revealed that surf-riding phenomenon states with different ship stability proprieties. It was identified the range of ship control parameters where surf-riding take place as well as the physics behind the connection of surf-riding with loss of ship stability and capsize.

It can be concluded the fact that the large oscillations developed by a ship in quartering waves has an important influence over the mechanism of losing controllability especially when the rudder oscillations reach their physical limits.

One of the most important objectives of maritime community for the future is to develop a technical basis for the assessment of ship stability in waves, taking into consideration the full account of the large amplitude dynamics. This step could improve the present stability regulations and moreover could lead to more rational regulations in this field, by improving the ship design and issuing better guidance for Masters on how to manage such situations in adverse weather conditions.

Surf-riding is one of the three major capsizing scenarios that the new performance-oriented stability criteria is to be included by IMO into the Intact Stability Code.

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STABILITY AND RECOVERY MEASURES AFTER THE SHIP STABILITY WAS DAMAGE

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ABSTRACT

Ship damage due to maritime casualties leads to marine pollution, loss of life and properties for this the improvement of damage survivability is very important in maritime safety. The maritime casualties generally come from the rough sea and bad weather condition. Therefore the large-scaled casualties will be derived from loss of structural strength and stability due to the progressive flooding and enlargement of damage by the effect of wave and wind. To increase the safety of the ship in sailing and for the safety of life, different crews of international conferences have set certain limits the loading of ships, for different geographic areas and seasons.

Keywords: *ship stability, damage to the hull, event of damage, stability calculations in case of emergency, waterline damage, center of gravity.*

1. INTRODUCTION

The present paper presents the stability of the vessel undamaged in any versions of the charge must be large enough so that in the event of damage caused by flooding due to a number of compartments of the water holes of a size hypothetical it's stability in the final stage of flooding to the requirements damaged ship stability and additional requirements for damaged ship stability.

2. SHIP STABILITY CONDITION

Ships longer than 100 meters, damaged ship stability requirements must be met and assuming common forepeak flooding and its adjacent compartment.

Damage stability following criteria must be met by a tanker ship:

• initial metacentric height in the final stage of flooding, before taking measures to increase to at least 0.05 meters.

• waterline damage before, during and after recovery has to be at least 0.3 meters or $L_S - 10/150$ meters, whichever is the lower, the lower edge of the openings in the deck, the walls and borders by which it is possible to water penetration into the vessel;

• heeling angle in the final stage of flooding asymmetric, before taking recovery measures the ship should not exceed 25° (or 30° if no partition bridge into the water); angle of heel after taking recovery measures the ship should not exceed 17°;

• area under static stability diagram (both before and after recovery) in the range of 20° to position the equilibrium must be at least 0.0175 mrad.

The stability calculations emergency , water holes are considered to be located in both sides of the ship and in the bottom, and their dimensions are adopted as follows:

- *an extension length*: $1/3L_1^{2/3}$ or 14.5 meters, whichever results is lower, for $0,3L_1$ from forward perpendiculars and $1/3L_1^{2/3}$ or 5 meters, whichever results less any other part of the ship;

- *a transverse extent* - $B_1/6$ or 10 meters, whichever results lower for $0,3L_1$ the forward perpendicular and $B_1/6$ or 5 meters, whichever results below for any other part of the ship;

- *a vertical extent* - measured in the center line to the theoretical lines of the body: $B_1/15$ or 6 meters, whichever results are less.

Damaged ship stability requirements must be met for the following locations of the side and bottom damage:

- the oil a length L_1 greater than 225 meters at any point in the ship's length;

- tankers a length greater than 150 meters , but not exceeding 225 meters , at any point along the length of the ship, except bulkhead bounding the machinery space. To study the flooding of a compartment is generally considered in the proportion of 95 %.

The minimum values used for specific compartments on board are:

- Engine room: 85%
- Living space: 9%
- Empty ballast tanks: 98%
- Spaces for consumable liquids: 0-9%

3. DETERMINATION OF SHIPSTABILITY DAMAGE

The ship is symmetrical, the compartments being arranged symmetrically on the ship was considered only damage in one board, because the board objected damage leads to the same results will only tilt the opposite sign.

To study the stability of the ship in case of damage and determination necessary measures to be taken in such cases, stability calculation was done by software used on tanker ships.

A ship taken as example with double hull tanker VLCC category has the following features:

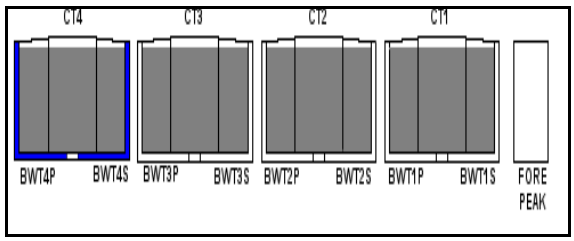
- Maximum length: 318.62 meters
- Width: 52.00 meters
- Draught: 21.11 meters
- Displacement: 246.302 tons
- Deadweight: 209.997 tons
- Empty Ship Weight: 36.300 tons

The ballast tanks are arranged in the shape of "L", the total amount including the bow ballast tank is 54 844 tones. Dimensional ballast tanks comply with international standards. Ship's emergency situation is considered as the result of a collision between the oil tanker under loading operation and another vessel. Resulting damage is considered to affect only the ballast tanks without affecting the cargo, so there is no risk of oil pollution.

The vessel before crash, meets the criteria of stability for all load situations.

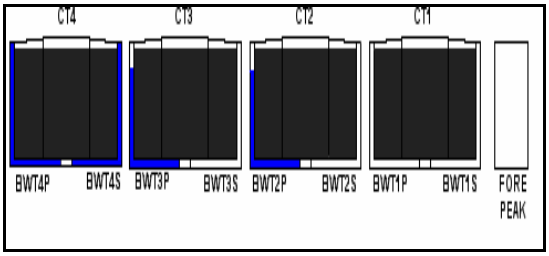
Damage to the hull when the ship fully loaded with 100 % reserves on board. Particulars of the vessel before the collision are:

- a displacement: 248 934 tons
- a deadweight: 212.637 tons
- a metacentric height (GM): 3.0 meters
- a corrected metacentric height (GM chorus): 3.03 meters
- a bow draft: 20.83 meters
- a stern draf : 21.35 meters
- a difference of tri: 0.55 meters
- a heel: 0.06 degrees
- a total ballast: 11.871 tons
- total reserves: 1750 tons



Cross section through the ship tanks before collision

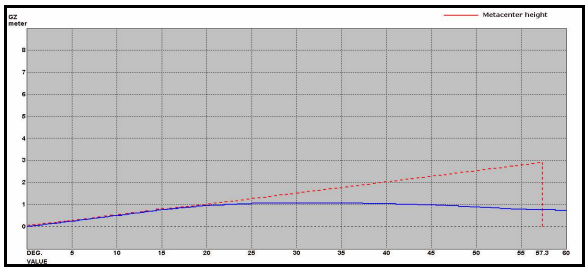
Considered damage occurred below the waterline of the ship side ballast tanks in the numbers 2 and 3 of the port board . The accident resulted in flooding of the two tanks in the ratio of 80%, an amount of about 4,500 tons of water in each tank.



Cross section of the ship after damage tanks

Following the accident record of the ship's trim changes , the heel angle, the position of the center hull and the center of gravity, the new values are:

- metacentric height corrected (GMcor): 3.09 meters
- bow draft: 22.44 meters
- aft draft: 22.15 meters
- trim difference: - 0.3 meters
- heel: - 2.58 degrees



Ship Stability after damage

Heel (deg)	GZ (m)
0	0.00
5	0.27
10	0.55
15	0.82
20	1.01
25	1.09
30	1.13
35	1.13
40	1.09
45	1.04
50	0.93
55	0.82
60	0.75
Free surface (reduction)	1.08 m
Dynamic stability (area 0-40 deg)	8.24 mrad
GM	3.1 m

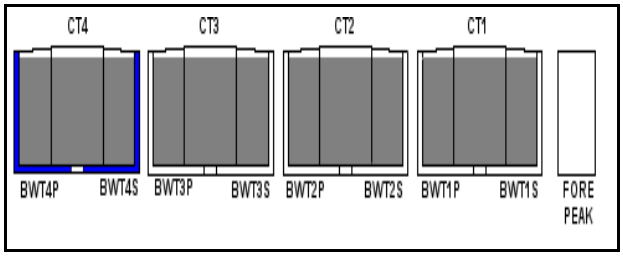
The data analysis shows that the vessel meets the criteria for stability in an emergency, the metacentric height in the final stage of flooding is greater than 0.05 meters, the angle of heel at the final stage of flooding

shall not exceed 25°, the area under the diagram the static stability in the range of 20° to equilibrium position is less than 0.0175 m rad.

Fault in the hull of the ship when fully loaded with 10% reserve board.

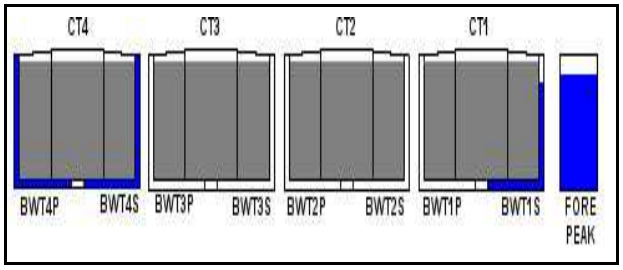
Particulars of the vessel before the collision are:

- a displacement: 248 934 tons
- a deadweight: 212.637 tons
- a metacentric height (GM): 3.2 meters
- a corrected metacentric height (GM chorus): 3.23 meters
- a bow draft : 20.83 meters
- a stern draft : 21.35 meters
- a difference of trim : 0.55 meters
- a heel : 0.06 degrees
- a total ballast: 11.871 tons
- total reserves: 175 tons



Cross section through the ship tanks before collision

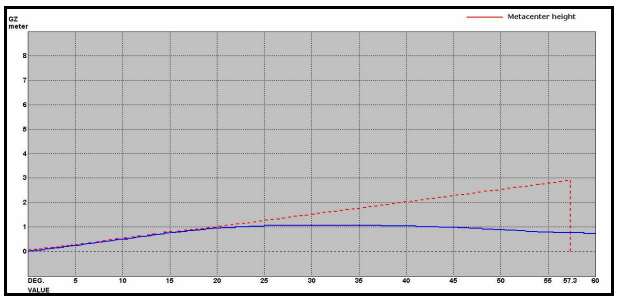
Considered damage occurred below the waterline of the ship, the bow ballast tank and ballast tank No. 1 starboard. Failure led to flooding of two tanks of 75 %, an amount of about 7000 tons ballast tank forward and 4200 tons in the side tank number 1.



Cross section of the ship after damage tanks

Following the accident record of the ship's trim changes, the heel angle, the position of the center hull and the center of gravity, the new values are:

- •metacentric height corrected (GMcor): 2.91 meters
- • bow draft: 24.99 meters
- • aft draft: 18.98 meters
- • trim difference: - 6.0 meters
- • heel: 1.47 degrees



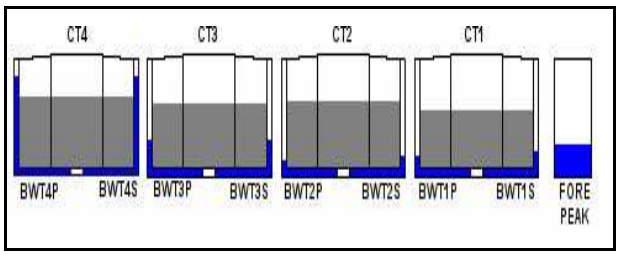
Ship Stability after damage

Heel (deg)	GZ (m)
0	0.00
5	0.25
10	0.51
15	0.77
20	0.96
25	1.04
30	1.08
35	1.08
40	1.05
45	1.00
50	0.90
55	0.79
60	0.72
Free surface (reduction)	1.33 m
Dynamic stability (area 0-40 deg)	7.79 mrad
GM	2,9 m

After damage, the stability criteria for tanker ship are met. Damage to the ship's hull when loaded 75 % and 100% reserves on board.

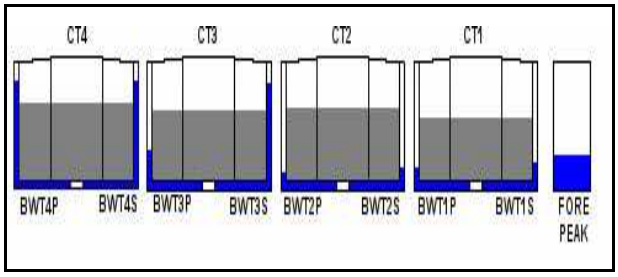
Particulars of the vessel before the crash are:

- a displacemen : 225. 952 tons
- a deadweight: 189.657 tons
- a metacentric height (GM): 5.7 meters
- a corrected metacentric height (GM chorus): 5.71 meters
- a bow draft: 19.07 meters
- a stern draf : 19.30 meters
- a difference of trim : 0.23 meters
- a heel: - 0.02 degrees
- a total ballast: 26.120 tons
- a total reserves: 1.750 tons



Cross section through the ship tanks before collision

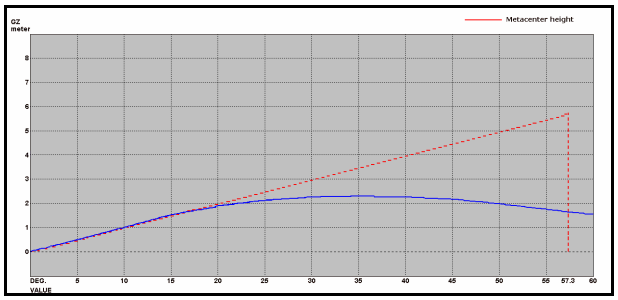
Considered damage occurred below the waterline of the ship, in the ballast tank in the starboard number 3. The accident resulted in flooding of the tank at a rate of 85%, an amount of about 4800 tons.



Cross section of the ship after damage tanks

After the crash were the following values of the trim of the ship:

•metacentric height corrected (GMcor): 5.27 meters
• bow draft: 18.61 meters
• aft draft: 19.93 meters
• difference of trim: 1.32 meters
• heel: 1.40 degrees



Ship Stability after damage

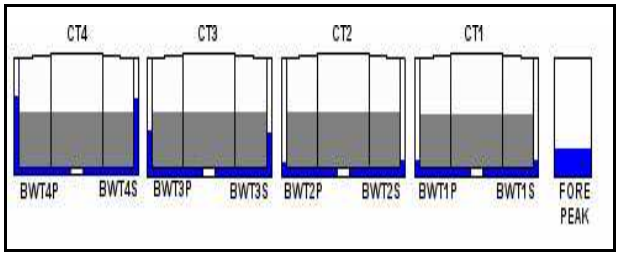
Heel (deg)	GZ (m)
0	0.00
5	0.49
10	1.00
15	1.52
20	1.89
25	2.12
30	2.26
35	2.30
40	2.28
45	2.19
50	2.00
55	1.77
60	1.55
Free surface (reduction)	2,19 m
Dynamic stability (area 0-40 deg)	15,44 mrad
GM	5,3 m

Data analysis after fault leads to the conclusion that the vessel meets the criteria for stability in an emergency.

Damage to the ship's hull where 50% and 10% loaded on board reserves.

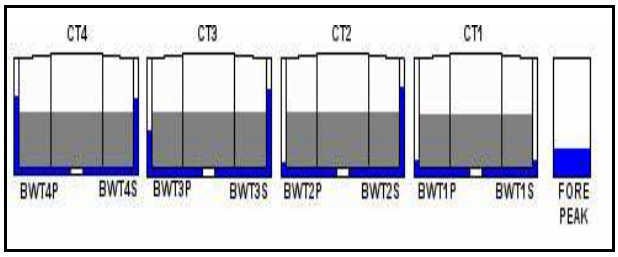
Particulars of the vessel before the crash:

- a displacement: 167 551 tons
- a deadweight: 131.251 tons
- a metacentric height (GM): 8.1 meters
- a corrected metacentric height (GM chorus): 8.12 meters
- a bow draft: 13.50 meters
- a stern draft: 15.51 meters
- a difference of trim : 2.00 meters
- a heel: 0.01 degrees
- a total deadweight : 11,400 tons
- a total reserves: 175 tons



Cross section through the ship tanks before collision

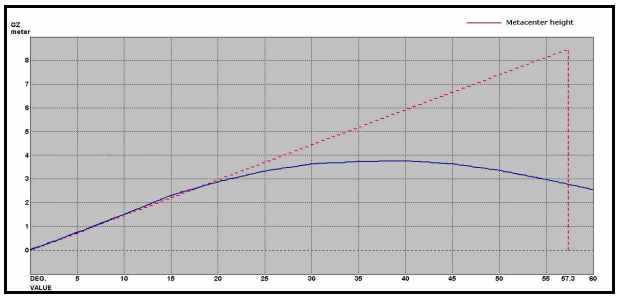
Considered damage occurred below the waterline of the ship, in the ballast number 2 and 3 starboard. The accident resulted in flooding of the two tanks in the ratio of 70%, an amount of about 4,000 tons in each tank.



Cross section of the ship after damage tanks

The ship after damage:

•metacentric height corrected (GMcor): 8.48 meters
• bow draft: 13.93 meters
• aft draft: 15.56 meters
• difference of trim: 1.63 meters
• heel: 1.29 degrees.



Ship Stability after damage

Heel (deg)	GZ (m)
0	0.00
5	0.74
10	1.50
15	2.31
20	2.88
25	3.34
30	3.63
35	3.76
40	3.79
45	3.66
50	3.39
55	3.00
60	2.57
Free surface (reduction)	3,16 m
Dynamic stability (area 0-40 deg)	23,58 mrad
GM	8,5 m

In this case the ship stability criteria are met the stability damage..

4. RECOVERY MEASURES AFTER SHIPS STABILITY DAMAGE

The study of stability for a significant tanker is the study of situations involving damage to hull, increased degree of risk situations in the operation of these vessels. Risks arising from damage to the hull of the ship take so vitality and potential polluter of these situations.

In emergency cases studied in this work, the vessel is considered in the operation of the offshore terminal and damage occurs due to its collision with another vessel. Even if you are placed in areas where oil terminals operating system offshore maritime safety are high risk may occur that can damage the vessel in operation , the constructive elements of terminal and inevitable stop operation for a period of time to assess and remedy the damage.

In the cases studied occurred only damage the hull in operation, with severe side ballast tank area without damaging the cargo and thus eliminating the risk of oil pollution.

Measures proposed and analyzed for recovery damaged ship include:

• a controlled ballasting operations;

• a transfer of cargo operations from ship tanks.

In emergency situations the master can intervene to ensure the stability of the ship's crash and recovery through controlled ballast tanks in the opposite board failure or transferring cargo between ships' tanks, especially the damage from the tanks of the tanks aboard the opposite board.

For emergency cases studied, recovery measures are based on the ship's ballast operations controlled ballast tanks on the opposite side of the fault. The recovery of the damaged ship cargo transfer can be achieved in cases where the ship has a load that allows for such operations.

In the first case study, damage to the ballast tanks aboard the number 2 and 3 port, recovery measures taken were the controlled ballast tanks 2 and 3 starboard, starboard ballast tank 2 and tank 50% ,3 starboard ballast 90%. The controlled ballast tanks is made of two tilt against a certain point of failure, which leads to the reduction of the balance tilt angle , the end of which is 98 degrees, causing a change in the trim of the gap 0.3 meters to 0.41 meters trim by stern. In the final stage of recovery, the metacentric height is estimated at 2.9 meters high minimum value required by the rules in force for ship damaged registry. Following recovery operations, hull stresses are within the normal hull being called longitudinal or transverse.

If the damaged tank flooding the starboard forward ballast tank number 1, the ship's recovery measures consist of controlled ballast tank number 3 of both borders, with a greater degree of filling of the tank opposite board failure. Heel of the ship after recovery will be 0.4 degrees, the difference being 5.6 meters to trim the bow. Damages due to the two tanks located in the bow of the ship trim difference will have large values both before and after recovery. Metacentric height after recovery amounts to 2.7 meters high minimum value required.

In both cases suggests a relief ship by downloading oil from the vessel tanks, ensuring the trim needed to bring the ship to the nearest port. Also, if the ship is fully loaded exclude transferring cargo between ship's cargo tanks.

The third and fourth cases crash recovery measures were the ship's ballast tanks controlled ballasting opposite fault, values final trim of the vessel afloat in ensuring optimal conditions for bringing in the nearest port. Also, given the degree of filling of cargo tanks is possible and recommended conducting cargo transfer operations to achieve stability criteria of the damaged ship.

Vessel stability requirements are provided and where the ship operates an external point, wind or wave, which produces change transverse stability of the ship.

4. CONCLUSIONS

Ship during recovery operations required special attention should be paid to the values affected by shear forces and torques developed in the hull, especially in the central area of the ship where their values approaching critical limits for ship located on the high seas. An increase their values can lead to loosening and deformation of the resistance structure of the hull, leading ultimately to phase cracking or breaking them.

Measures taken on board the ship after damage recovery should be accompanied by measures to stop operation, to ensure that the connection operation of the ship and buoy operation will not be affected, and requesting assistance to ensure the ship and bring it in port.

Due to the loading of the vessel, depending on the angle of inclination longitudinal or transverse end of the ship may cause the overflow of oil pollution from tankers cargo on deck through holes too full of cargo tanks. Limiting pollution is achieved by taking as soon as the recovery measures, such that any reduction in the level of cargo tanks below the outlet openings.

Ship survivability against capsize in heavy seas has become one of the reasons of the areas of primary concern among ship stability researchers and designers in recent years. Large amplitude vessel motions and capsize have served as hazards of the maritime community for centuries [9]. When a ship is subjected to the effect of large waves it may capsize according to a number of different scenarios, depending on the magnitude and direction of the wave excitation and the ship's own capability to resist such excitations.

Resonant or breaking waves approaching a ship from the side ("beam seas") have a potential to excite large rolling which could result in capsize, especially if the intensive oscillation of the ship causes shift of cargo or, if a considerably quantity of water is shipped on the deck.

In practice, the ships could loose intact stability under the impact of waves and wind in several ways. Typically, it is a chain of events rather than a single event. For example, due to high or abnormal waves, a ship could sustain rudder failure or even more could loose power, which might then cause it to heavily rolling in beam seas, thus in turn leading to shift of cargo and dangerous list of the vessel. Moreover, huge amount of water is shipped on deck and the worst result is capsizing.

More dangerous can be a group of steep and relatively long waves approaching a ship from the bow ("head seas") or from the stern ("following seas"). Waves of this kind are known to incur significant reductions in roll restoring capability (i.e. the tendency to return to the upright position) for many types of vessels and they instigate dangerous coupled motions.

One of the major capsizing scenarios in longitudinal following waves is broaching phenomenon. Broaching can appear as heeling during an uncontrollable, tight turn during which the stability failure caused may be "partial" or "total". This became dangerous when large angles of heel are developed in following seas.

The high interest developed among researches was also sighted by the International Maritime Organization which included broaching into the prospects for development the new–generation of intact stability criteria, as a major capsizing mode.

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SATELLITE FIX ACCURACY AND ERRORS

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ABSTRACT

Satellite positioning of the ship is done by measuring pseudo-ranges from multiple navigation satellites of which derive several satellite lines of position (LOP). At the intersection of these lines of position is obtained the satellite position of the ship, i.e. *satellite fix*. Considered to be the most accurate positioning system used in maritime navigation, a navigation satellite system may have specific operational errors that produce errors in the accuracy of the fix, which in certain technical and environmental conditions can be significant.

Keywords: *satellite, line of position, errors, accuracy.*

1. INTRODUCTION

A Global Navigation Satellite System - GNSS provides the ship over ground position, constantly and in real-time (course and speed over ground), ship drifting, the deviation from the orthodrome, as well as other navigational information (way points, etc.) [1].

The information on the position and movement of the ship is displayed on the satellite receiver, from where they are transferred to electronic navigational charts and other navigation equipment, which is interconnected in an "integrated navigation bridge" – INB [2-3].

Determining the receiver - satellite distance is done in the receiver by processing the GPS satellites continuously broadcast signal. This distance, called in the literature "pseudo-range" due to specific errors, it can be determined from [4]:

1) The time necessary for the signal continuous emitted by the satellite (encoded) to cover the satellite – receiver distance multiplied with the speed of light;

2) The signal phase analysis.

As in the determination of pseudo-range occurs the error of synchronization between satellite and receiver clocks (while the refraction error is eliminated almost completely by the dual frequency method by using a model or refraction), within the known equations of observation comes receiver clock correction. In order to determine the three coordinates of an arbitrary point (φ, λ, H) or (x, y, z) will be required four simultaneous observations as many of GPS satellites, resulting in a system of four equations with four unknowns, the 4th known as clock correction.

The real distance to an satellite navigation is:

$$Dsat = pseudo\text{-}range + Vsm \times \varepsilon_{tsv} \quad (1)$$

where:

D_{sat} - is the actual distance to the satellite;

ε_{tsv} - error of the satellite time, appeared by resulted from the differences between the GPS time and the satellite time (corrected periodically by the Command Center on the UTC time) which can be positive or negative;

V_{sm} - the signal propagation speed of transmitted by the satellite and equal to the speed of light.

When using four satellites to determine three-dimensional position of a satellite receiver, the real measured distance is given, in a general way by the formula [5]:

$$D_{real} = \sqrt{(X-x)^2 + (Y-y)^2 + (Z-z)^2} \quad (2)$$

where:

X, Y, Z are the Cartesian coordinates of the satellite;

x, y, z are the Cartesian coordinates of the satellite receiver

2. SATELLITE FIX DETERMINATION

When using position information from two satellites (Fig. 1), the receiver can be anywhere on the circle of intersection of spheres determined by signals from two satellites.

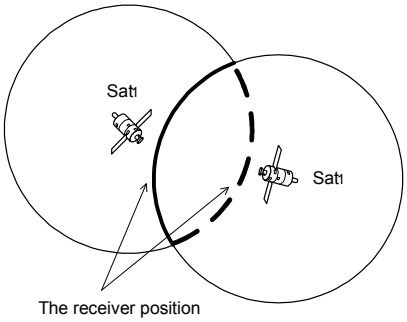

Figure 1. The position from two satellites

If information comes from three satellites (Fig. 2), the receiver is in the point determined at the intersection of three spheres from the signals emitted by the three navigation satellites.

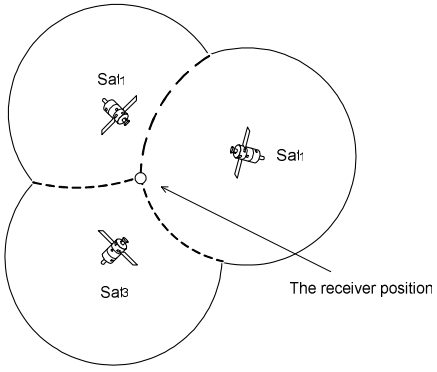

Figure 2. The position from three satellites

In order to determine the observer's position with navigation satellite observations in a Cartesian coordinate system *x, y, z* (latitude, longitude and altitude) there need to be four satellites within the range of visibility. The ship's satellite fix is plotted on the navigation chart in a same way of a radio fix with simultaneous observations. Thus, the graphical value of the error in the fix against the estimated point is determined, while the ship's course is plotted from the satellite fix. After, determine the amount of error in the dead reckoning fix, and draw the ship course from the satellite fix (Fig. 3).

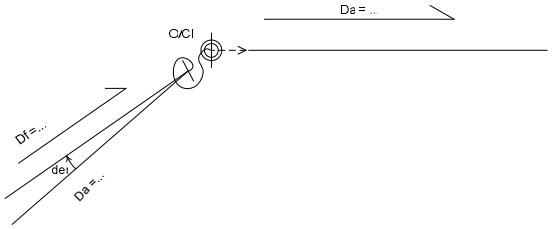

Figure 3. The plotting the ship's satellite position

The simplified algorithm for determining the satellite fix is the following:

- determine the dead reckoning point of the ship and put it on the chart;
- note the time and reading of the loch;
- determine the satellite fix (latitude and longitude from the satellite receiver are read);
- determine the course over ground - COG (read the COG value from the satellite receiver);
- determine the total drift value (read the value of the drift from the satellite receiver);
- plot the COG (COG with a thicker line than True Course);
- plot the satellite fix on the chart;
- determine the error in the fix as bearing value and distance from dead reckoning point to satellite point;
- plot the new true course in compliance with the *Passage Plan* of the ship, or the one required by navigation circumstances.

The graphic sign of the satellite fix on the chart is represented in Figure 4 (two concentric circles, the bow line drawn with a dotted line, and the line that marks a measured bearing).

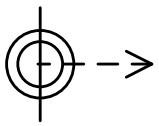

Figure 4. The graphic sign of the satellite fix

3. SATELLITE FIX ACCURACY

The accuracy of positioning with satellite observations depends on the degree of precision of a single pseudo-range expressed by error of distance (*User Equivalent Range Error*-UERE), or by standard deviation σ_r, as well as by the geometric configuration of the satellite orbits.

For Standard Positioning Service (SPS – „minimum performance level"), the total UERE is typically in the neighbordhood of 25 meters. When Selectiv Availability (SA) is turned off, total UERE could be less than 5 meters, with the actual value dominated by inospheric and multipath effects. Dual frecquency Precise Positioning Service users, with the capability to remove almost all of the ionospheric delay from the pseudo-range observations, can experince even smaller UERSs. [1]

The Geometric Dilution of Precision of a GPS fix point is denoted by DOP (Dilution of Precision). Errors in range (ε_d) produce the movement of the DOP with (s_d) values, according to the range gradient variation:

$$g_d = 1 \pm s_d = \pm \varepsilon_d \tag{3}$$

Geometric value of the error (G DOP [6-7] is given by the sum, $\sum \bar{g}_i$ .i.e., Figure 5):

$$\begin{aligned} G\ DOP &= \left| \sum \bar{g}_{ix} + \sum \bar{g}_{iy} + \sum \bar{g}_{iz} + \sum \bar{g}_t \right| = \\ &= \frac{1}{\sigma} \sqrt{\sigma_x^2 + \sigma_y^2 + \sigma_z^2 + \sigma_t^2} \left| (n-1)\,axe \right. \end{aligned} \tag{4}$$

where:

g_{ix}, g_{iy}, g_{iz} represent the gradient variation of distance on the three axes *X, Y, Z*;

g_{it} - the amount of the gradient variation of time;

$\sigma, \sigma_x, \sigma_{iy}, \sigma_{iz}$ are the standard deviation and the standard deviations on the three axes *X, Y, Z*;

σ_{it} is the time standard deviation.

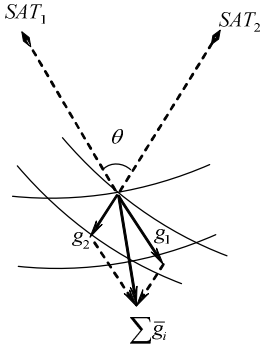

Figure 5. The geometrical dilution of position

Basically, the geometric value of *GDOP* is the sum of squares *PDOP* (Position Dilution of Precision in three dimensions) and *TDOP* (Time Dilution of Precision):

$$G\ DOP^2 = PDOP^2 + TDOP^2 \tag{5}$$

Satellite fix DOP value is given by the volume of pyramid defined by the positions of pseudo-ranges measured from satellites (Figure 6).

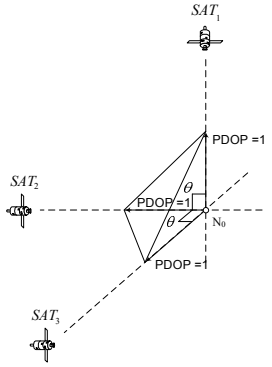

Figure 6. The DOP value

When the value of *PDOP*=1, a GNSS system is considered excellent (its accuracy is excellent); for PDOP=3...4 a GNSS system is very good; for PDOP=8 it is acceptable, and for higher than 9 value of PDOP a GNNSS system is poor.
The values of PDOP, HDOP, TDOP and VDOP are determined with [1]:

$$\begin{aligned} \text{P DOP} &= \frac{1}{\sigma}\sqrt{\sigma_x^2+\sigma_y^2+\sigma_z^2} \\ \text{H DOP} &= \frac{1}{\sigma}\sqrt{\sigma_x^2+\sigma_y^2} \\ \text{V DOP} &= \frac{\sigma_x}{\sigma} \\ \text{T DOP} &= \frac{\sigma_t}{\sigma} \end{aligned} \quad (6)$$

where:
PDOP - Position Dilution of Precision in three dimensions;
HDOP - Horizontal Dilution of Precision;
VDOP - Vertical Dilution of Precision;
TDOP – Time Dilution of Precision.

$$\text{P DOP}^2 = \text{H DOP}^2 + \text{V DOP}^2 \quad (7)$$

In navigation practice it is necessary to take into account the value of PDOP in three dimensions, HDOP and VDOP; the geometric GDOP is of interest to GNSS equipment manufacturers.

Table 1. Optimally positioned in two dimensions [2]

Errors	Three satellites	Five satellites
G DOP	1.291	1
H DOP	1.1547	0.8944
T DOP	0.5773	0.447

Table 2. Optimally positioned in three dimensions

Errors	Four satellites (elevation angle E=0°)
G DOP	$\sqrt{3}$
P DOP	$2\sqrt{2/3}$
H DOP	$2/\sqrt{3}$
V DOP	$2/\sqrt{3}$
T DOP	$1/\sqrt{3}$

The disparity between H DOP and V DOP values is larger for higher latitudes (north or south) because there are fewer satellites high in the sky. This limitation comes from the fact that the inclination of the GPS satellite orbits is about 55°, witch means that you can never have a satellite directly overhead at a north or south latitude of 55°. At the poles, the highest elevation angle possible is about 45° [8].
Analysis of the uncertainty area at the intersection of LOPs is:

1) for an angle of intersection of pseudo-ranges to the satellite close to 90°, the area of uncertainty tends towards its minimum value (Figure 7);

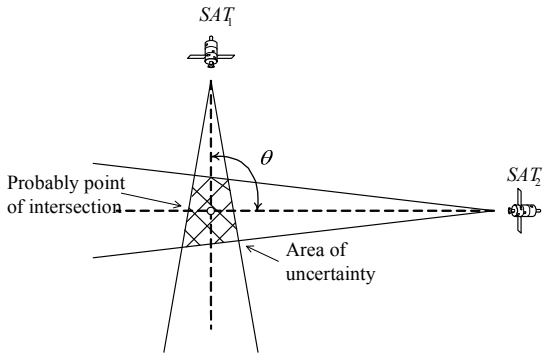

Figure 7. The uncertainty area for an angle close to 90°

2) for an angle of intersection of pseudo-ranges which goes below zero, the uncertainty area tends to its maximum value (Figure 8).

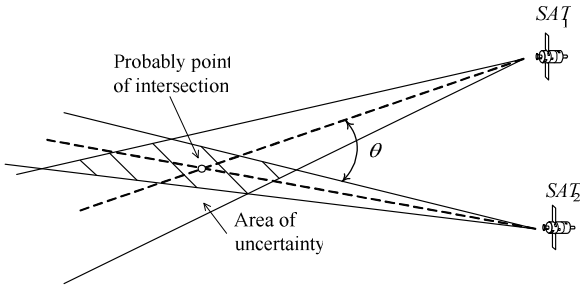

Figure 8. The uncertainty area for an angle close to 0°

4. ERRORR SOURCES OF ERROR IN THE SATELLITE FIX

Sources of errors in determining a ship's position with satellite information are: propagation errors; errors due to navigation satellites; errors due to satellite receivers.

Satellite signal propagation errors are: delays due to variable weather conditions; discontinuity of measurements; uncorrected refraction due to the influence of ionosphere and troposphere - correction of refraction is done completely on two-frequency receivers, partially on receivers that work in L_1 (50÷70%) frequency. The quality of the signal emitted by the navigation satellite when passing the ionosphere (50 km ... 1000 km from the Earth's surface) is affected by: the angle of incidence to the ionosphere; emission period (day or night); extent of time of solar particles emission; ionospheric disturbances; local influences of terrestrial magnetic field; satellite signal frequency. The value of the error caused by the influence of the ionosphere on calculated pseudo-ranges is 3 ... 15 m, for a satellite located at zenith, and 9 ... 45 m for a satellite at a height greater than 10^0. This error can be compensated by using differential - satellite information, transmitted to the receiver either directly, or via satellite.

Propagation errors due to the influence of the ionosphere are calculated in the ground control centres, and are transmitted in the precise code P. For commercial receivers in C/A code it is important to take

into account the error of ionosphere, which can be significant in some atmospheric conditions.

GPS satellite signal quality emitted during passing through troposphere (30 km off Earth's surface) is affected by the effect of dry land and water surfaces which influence the atmospheric humidity. The value of error caused by troposphere influence on calculated pseudo-range is 2.5 m for a satellite located at zenith, and 25 m for a satellite at a height greater than 10^0.

The signal transmitted by a navigation satellite can be received on board by direct or a reflected wave. Installing the satellite receiver antenna in a wrong/ inadequate position leads to the occurrence of satellite signal reflected waves that can affect, in a negative way, positioning accuracy. This error can't be eliminated through a differential signal, but only through a proper installation of the receiving antenna.

Errors of navigation satellites are: low level of knowledge regarding the actual orbit of satellites at a certain moment; differences between the satellite time and the time of the satellite system; interference, jamming and deliberate degradation of the satellite signal.

These errors are processed in such a way, so as the navigation satellite orbit corrections be applied; the remaining errors represent the actual behaviour of the satellite that does not fit with the theoretical model. By using differential satellite signals these errors can be substantially reduced.

The error in the satellite system time can be of seven nanoseconds, which can induce an error in measuring the pseudo-ranges of about two meters.

Interference of a received satellite signal means unintentional lowering of its performance due to electromagnetic emissions that may occur, in certain conditions or, loss of information necessary for positioning. Intentional electromagnetic interference signal is used to decrease to zero the satellite system efficiency. Intentional degradation of the satellite signal is done intentionally to induce errors in the reception of positioning information.

During the ship position determination with satellite observations, the satellite signal can be interrupted as a result of unconventional sources (TV broadcasts, damaged radar or electronic equipment, etc.), but also as a result of intentional emissions of some government or military sources.

Errors of GPS receivers are: own noise of receiver due to its construction and design; the precision of the measurements, and errors due to movement of receiver.

5. CONCLUSIONS

The methods for measuring pseudo-ranges, have by definition, as a result of natural causes or design, some degree of imprecision, which leads to changes in their values. All these are measured by the concept of internal noise of the receiver, and satellite transmission. This error has a very low value, and is significantly balanced by appropriate design solutions, and by use of differential satellite signals.

Error reduction in positioning as a result of ship's movement is done by using Kalman filters at the reception and processing of satellite signal. During the ship's maneuvering or swing, when high acceleration levels occur, this solution is no longer effective, and inertial motion sensors are required, in order to allow transmission of information necessary to quickly calculate accelerated motion of the ship's position.

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WEATHER AND OCEANOGRAPHIC INFLUENCE ON THE MARITIME NAVIGATION

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ABSTRACT

At the sea, the ship is subjected to the action of weather and oceanographic factors. These can generate dangerous phenomena (hurricanes, storms, moving ice, low visibility, huge waves - tsunamis, etc.) that makes maritime navigation extremely difficult, worsening the storage conditions of the goods on board, can lengthen the voyage, increase fuel consumption, ship's ageing, and its instability, can create stressful living conditions for the crew, and in some negative cases, can become real threats to ships and navigation safety

Keywords: *Weather and oceanographic factors, navigation safety.*

1. INTRODUCTION

During unfavourable weather and oceanographic conditions the charging and discharging port operations are stopped, along with fishing; vessels shelter in or outside anchoring areas, go to open sea or lie about.

Given that, no vessel, regardless of their robustness and power propulsion system, is not guaranteed against damage, or even its loss caused by severe weather phenomena, it is necessary to know, in depth, the influence of hydro-meteorological factors.

Analysis of ship, cargo and crew safety, is closely related to the economic factor, and to the profitability of the voyage; this is needed to be done in order to select the safest route, so as to meet the economic criteria of performance, and to prepare the ship and crew for navigation in bad weather conditions.

2. INFLUENCE OF THE WIND ON MARITIME NAVIGATION

Wind is one of the most important meteorological factors that influence navigation directly by:

- drifting of the ship;
- induced oscillations;
- ship inclination;
- formation of currents and wind waves (near coastal area they determine water aflux and deflux, which can be a dangerous for the ship, since it can cause ship's grounding) .

Depending on force and wind direction, ship speed may decrease or increase. Contrary wind can cause increase in ship's headway and decrease of its speed. With favourable wind, the headway decreases and speed increases. However, in the favourable winds of force 5 or higher, vessel speed decreases due to rough sea conditions, and to the increase of headway; this phenomenon is accompanied by the ship's roll and pitch (with negative influence on the ship's stability and propulsion system operation).

In the port a strong wind can make lashing operations more difficult, or may affect the ship's loading – unloading, finally affecting the ship's position at berth. Also, strong winds hinder industrial fishing or make it impossible.

During the voyage, in bad weather, with strong winds, ships have to avoid storm areas or find sheltered areas, which leads to increased fuel consumption, and in addition, to delays, damage to cargo and ship, damage or loss of fishing gears, etc. Generally, under wind action the ship is moved, drifted away from the planned course.

In navigation, the drift angle, the wind drift angle α , between true course drawn on the chart and course though water materialized by the moving of the gravity centre of the ship through the masses of water, is obtained by visual observations; for this, the mathematical relationship is:

$$\alpha = TC - CTW \tag{1}$$

Where:
α is wind drift;
TC is true course;
CTW is course thought water.

A simple relationship for the analytical determination of wind drift is:

$$\sin\alpha = \frac{H'}{H''}\frac{\rho_a}{\rho_0}\frac{S}{S_0}\left(\frac{V_W}{V_N}\right)^2 \sin q_W \tag{2}$$

where: α is the angle of wind drift, H' and H''- experimentally determined coefficients of each vessel, depending on its construction characteristics, ρ_a - air density, ρ_o - water density, *Vw* - wind speed, V_N- ship's speed, q_w - real wind direction, *S* - emerged surface; S_o- submerge surface;
Using K as:

$$K = 57_3^0 \frac{H'}{H''}\frac{\rho_a}{\rho_0}\frac{S}{S_0}, \tag{3}$$

the ship drift coefficient become:

$$\alpha = K\left(\frac{V_W}{V_N}\right)^2 \sin q_W \ . \tag{4}$$

To simplify the calculations we used assumptions: $\left(\frac{V_W}{V_S}\right)^2 = 1{,}2$ and $\sin q_W = 0{,}85$. The ships shown in Table 1 under the same conditions in order to study the influence of constructive parameters and weather and oceanographic conditions on the ships drift. Thus, it can be seen that LNG tankers and passenger ships have the largest angle of drift conditions studied.

It is noted, that for small wind speed, the drift calculated differences are quite small and graphs overlap. For higher speed the values can be individualized for each type of vessel from five shown. This is due to small variations of drift coefficient K which is the gradient of the graphs f(k) for each vessel in Figure 1.

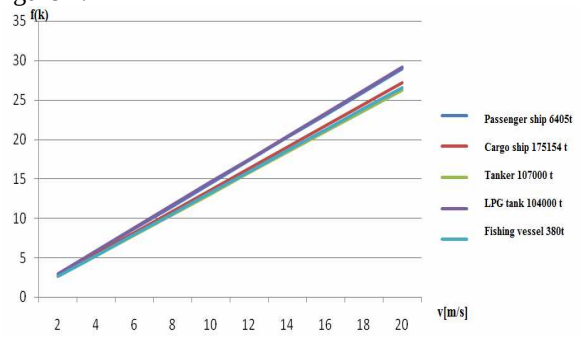

Figure 1 Drift coefficient used as a gradient of the graph f(k)

Drift coefficient is calculated or determined by observations in different navigational operational conditions. In technical documentation, it is considered K = 1.30 in most cases and is determined by a special nomograms, specific to each ship (which also comes with known arguments: ship speed, wind speed and direction and determine the angle of drift) .

In practice of navigation it is established that the size of wind drift angle, essentially depends on wind speed and direction and area ratio emerged and submerged in centre plane of the ship. The draft is greater and speed increases, than the wind drift is less.

Wind pressure (Figure 2) on a square meter emerged is:

$$P_a = \frac{1}{2} C_0 \rho_a V_W^2 \quad (5)$$

where *Pa* is the air pressure per square meter of surface emerged, *Co* - coefficient depending on the architecture construction vessel, *ρo* - density of air, *Vw* - wind speed

We can simply observe that in case of ships with low aerodynamic qualities, like the fishing vessel, the pressure is higher and will cause a higher force of drift according to fig. 2. At the same speed ships will have a different force acting on 1 m^2. That is why we should study the equipments arrangement on the main deck. Also this shows us the necessity of fluid flow study on the emerged part of the ship in air tunnels and with CFD software.

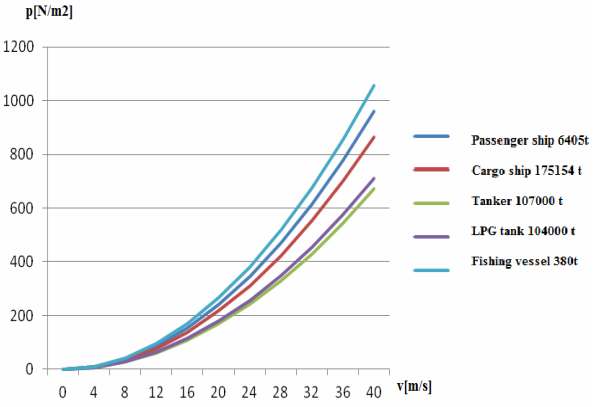

Figure 2 Pressure variation according to speed and hip type for 1m^2

Table 1 Specific values for various types of ships for the ship's service speed

Ship type	S	S_0	$\frac{S}{S_0}$	$\frac{H'}{H''}$	K	$\sin q_W$	$\left(\frac{V_W}{V_N}\right)^2$	α
Passenger ship 6405t	1506,2	1214,7	1,24	25,51	1,42	0,85	1,2	1.45
Cargo ship 175154 t	2072,3	4002,8	0,51	36,42	1,33	0,85	1,2	1.36
Tanker 107000 t	1245,4	2539,6	0,49	36,70	1,28	0,85	1,2	1.31
LPG tank 104000 t	4222,6	3007,8	1,40	14,22	1,43	0,85	1,2	1.46
Fishing vessel 380t	81,2	70,5	1,15	15,75	1,30	0,85	1,2	1.33

3. INFLUENCE OF WAVES ON MARITIME NAVIGATION

The agitation of the sea caused by wind is one of the main weather factors influencing safety of navigation and profitability of naval transport.

Wind waves produce ship's oscillations and also its drifting from the planned course. Sea agitation produced by wind is characterized by:

1. irregularity: irregular values of characteristics and shape of waves (a big wave may be followed by a small wave or even a bigger; changing shapes and directions). This complex structure of the sea is caused by uneven and turbulent winds.

2. rapid change of its elements in space and time. Regarding the size of the waves, besides speed of the wind, and its duration, the surface and form of the sea basin are equally important.

In practice, it is very important to do the statistic analysis of sea agitation, expressed numerically, between elements of waves (height, length, period, general direction of movement) and weather and oceanographic factors that generate them.

Based on various theories on wind waves, as well as on practical observations, wind diagrams and nomographs were drawn.

During navigation in dangerous waves, the greatest danger is the phenomenon of resonance. Resonance means the coincidence of the period of oscillation of the

ship with the apparent period of wind wave. The apparent period of wind wave depends on the speed of the march and the angle between the course and the wave direction.

4. INFLUENCE OF BOW/STERN WAVE ON SHIP'S STABILITY

Ship's stability depends on the course, the direction of waves, wind and ship speed ratio, wave period and the oscillation period of the ship on the wave.
Ship's oscillations on the wave give rise to harmful phenomena such as:

• introduction of forces and moments whose effects can cause the ship to capsize, due to loss of its stability. Transverse ship's oscillations, (Table 2), should not overlap wave period, as it may lead to loss of transverse stability, and may cause the change of the course.

• occurrence of inertial forces and wave blows, which can lead to partial or total destruction of the ship;

• slowing of ship's speed, because its sides, stern and bow sink in water , thus increasing friction of ship and water , which results in headway increase;

• worsening of living conditions on board, etc.

Table 2 Values of oscillation period for different types of ships

Ship type	Transverse metacentric height [m]	Longit. metacentric height [m]	Transv. oscill. period T [s]	Longit.oscill.period T' [s]
Passenger ship 6405t	0,62	223	27,03	31,20
Cargo ship 175154 t	1,25	210	30,59	40,00
Tanker 107000 t	1,68	180	24,74	32,21
LPG tank 104000 t	1,95	195	27,22	44,52
Fishing vessel 380t	0,95	30	17,93	22,43

During navigation with bow wave, the ship has a strong pitching motion, but the time the ship stays on the wave's crest is very short. With stern wave, depending on the speed of the ship, ship's stability is modified in the worst case, shallow water, when the bow wave speed equals the ship's speed (the extent of time when the ship stability is minimum theoretically infinite).
Determination of the ship's course (Table 3) in case of critical stability is obtained by the relationship:

$$\cos q_v = \frac{Vv}{V_S}\left(1 \pm \frac{\tau}{T_c}\right) \qquad (6)$$

where: q_v is the wave direction, V_S - vessel speed; Vv - wave speed, Tc - the period of ship's oscillation ; + sign corresponds navigation in stern wave and the - sign for navigation in stern wave. τ - waves period.

Table 3 Determination of stability critical course for τ = 4.4 sec

Ship type	$\frac{Vv}{V_s}$	Oscillation period T_c	*Wave direction* q_v
Passenger ship 6405t	0.5	31,20	32.52
Cargo ship 175154 t	0.45	40,00	28.47
Tanker 107000 t	0.47	32,21	30.45
LPG tank 104000 t	0.44	44,52	27.56
Fishing vessel 380t	0.23	22,43	15.68

Under given conditions V_v=7m/s and τ =4,4 sec, we calculated wave direction q_v we noticed that large ships with big displacements have a similar behaviour. The fishing vessel, due to its small size is subject to special shipping conditions, and that is why it should be studied separately.

Unfavourable situations can appear when the wave hits the stern, in case the length of the wave is 0.75-1.75 of the ship's length and $V_N \approx V_v$.
When the wave hits from the stern there can appear unfavourable situations, i.e. when the ship's speed is between 0,6...1.4 of the wave speed.

In conclusion, the movement of the ship with bow or stern wave is dangerous. Big ships must alter the course, so as to avoid the phenomenon of resonance that can lead to breaking of the ship.

4. THE LOSS OF SPEED DURING ROUGH SEA NAVIGATION

Decrease of speed during rough sea navigation are caused by:
1. increased head away due to ship's oscillations and waves;
2. changing the operating mode of the propulsion system under strong pitch influence ; such phenomena can cause total or partial emergence of propeller out of water. 3. direct influence of the horizontal displacement of the superior layers of water that participate in wave movement.

Thus, the speed variation due to wave action is expressed by: ΔV_N = f(V_N, β, Δ, λv, $\lambda v/L$, q_v), where β - is the block coefficient, Δ – is ship's displacement, h - wave height, q_v - direction of the wave movement $\lambda v/L$ – ratio between length of wave and ship.
First of all, the loss of the ship's speed during wave navigation depends on the degree of agitation of the sea and ship's structural characteristics. For example, it is shown that, for ships with $\beta \succ 0.74 \div 0.76$ with wave height of 3 to 4 m, the forward ship's speed is reduced by 40 ... 50 %, and in what wave influence is concerned it is proportional with the square of the wave height. Also, the loss of speed can be calculated by graphs, nomographs, and software specialized on types of ships, taking into account the load, ship's speed, wave height and its direction (Table 4)

Table 4 Estimated speed losses values with AutoPower Programme for Beaufort Scale 4-5 and 6-7.

Ship type	Summer Deadweight [t]	Scale 4-5	Scale 6-7
Passenger ship 6405t	6405	24%	35%
Cargo ship 175154 t	175154	9%	20%
Tanker 107000 t	107000	10%	25%
LPG tank 104000 t	104000	11%	25%
Fishing vessel 380t	380	35%	50%

For a ship with certain characteristics the C_B size is an important parameter, as it represents the ratio of the hull volume and the parallelepiped formed by the ship's length, width and draft. Thus, for a higher value of *CB* we will have a hull volume growth leading to higher drag.
Growth in headway can be analysed by artificially increasing the block coefficient, as follows (Figure 3):

$$C_B = f(r, C_B)$$

where C_B is the standard value of the vessel and r is a coefficient determined by the values:
- for sea - grade 3-4, r = 4.058792
- for sea - grade 5-6, r = 5.491857

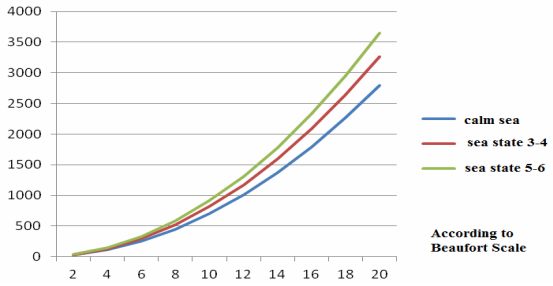

Figure 3 Increased ship resistance for different ship

In this way we can correct the block coefficient calculation inserted into relationships of headway, and will get high headway values proportional to r^2. Thus, the headway is $R' = R(1 + r^2)$ for the various sea grades. By comparison figure 3, shows the corresponding differences observed in the three cases: calm sea, sea grade 3-4, and sea grade 5-6. In figure 3, for a situation in which power of the propulsion system is the same in the three situations, we can read the corresponding velocity values in the graph.

6. INFLUENCE OOF SEA CURRENTS ON MARITIME NAVIGATION

Sea currents represent the water masses moving in one direction with a certain speed. Sea currents differ according to the forces that produce them, to the duration, depth, etc. a total current, variable, current analyzed as a variable sum of several speed vectors of some marine currents (regular, temporary – Table 5 and Table 6).

In practice there is an amount of sea currents, total current - current variable analyzed as a variable speed of several vectors of some marine currents (regular, temporary)

$$\overline{V}_t = \overline{V}_1 + \overline{V}_2 + \overline{V}_3 \qquad (7)$$

where: V_t is the total current; V_1 - permanent current; V_2 – periodic current; V_3 - current temporary.

Given these considerations, it can be shown that maritime navigation is conducted:
- in areas with permanent currents;
- in areas with varying currents.

Navigation in areas with permanent currents requires knowledge about currents, that can be found in nautical documents, at an acceptable level of precision movement of the ship over the ground can be determined graphically (course and speed over ground). Navigation in areas with varying currents is the common case in maritime navigation.

Table 5 Calculated values for temporary currents

Latitudine / Speed	**1**	**5**	**10**	**15**	**20**	**25**	**30**
0	0	0	0	0	0	0	0
1	0.095885	0.042908	0.030399	0.0249	0.021662	0.019488	0.017918
2	0.191771	0.085815	0.060798	0.049801	0.043324	0.038977	0.035837
3	0.287656	0.128723	0.091196	0.074701	0.064986	0.058465	0.053755
4	0.383541	0.171631	0.121595	0.099602	0.086648	0.077954	0.071674
5	0.479427	0.214538	0.151994	0.124502	0.10831	0.097442	0.089592
6	0.575312	0.257446	0.182393	0.149403	0.129973	0.116931	0.107511
7	0.671197	0.300354	0.212791	0.174303	0.151635	0.136419	0.125429
8	0.767083	0.343261	0.24319	0.199204	0.173297	0.155908	0.143347
9	0.862968	0.386169	0.273589	0.224104	0.194959	0.175396	0.161266
10	0.958854	0.429076	0.303988	0.249005	0.216621	0.194885	0.179184
11	1.054739	0.471984	0.334387	0.273905	0.238283	0.214373	0.197103

12	1.150624	0.514892	0.364785	0.298806	0.259945	0.233862	0.215021
13	1.24651	0.557799	0.395184	0.323706	0.281607	0.25335	0.23294
14	1.342395	0.600707	0.425583	0.348607	0.303269	0.272839	0.250858
15	1.43828	0.643615	0.455982	0.373507	0.324931	0.292327	0.268776
16	1.534166	0.686522	0.486381	0.398408	0.346593	0.311816	0.286695
17	1.630051	0.72943	0.516779	0.423308	0.368255	0.331304	0.304613
18	1.725936	0.772338	0.547178	0.448209	0.389918	0.350793	0.322532
19	1.821822	0.815245	0.577577	0.473109	0.41158	0.370281	0.34045
20	1.917707	0.858153	0.607976	0.49801	0.433242	0.38977	0.358369

Table 6 Calculated values for temporary currents (continuation)

Latitudine / Speed	**35**	**40**	**45**	**50**	**55**	**60**
0	0	0	0	0	0	0
1	0.016731	0.015807	0.015072	0.014483	0.014008	0.013626
2	0.033462	0.031613	0.030145	0.028966	0.028015	0.027252
3	0.050194	0.04742	0.045217	0.043449	0.042023	0.040877
4	0.066925	0.063226	0.060289	0.057932	0.056031	0.054503
5	0.083656	0.079033	0.075362	0.072414	0.070039	0.068129
6	0.100387	0.094839	0.090434	0.086897	0.084046	0.081755
7	0.117119	0.110646	0.105506	0.10138	0.098054	0.09538
8	0.13385	0.126452	0.120578	0.115863	0.112062	0.109006
9	0.150581	0.142259	0.135651	0.130346	0.12607	0.122632
10	0.167312	0.158065	0.150723	0.144829	0.140077	0.136258
11	0.184044	0.173872	0.165795	0.159312	0.154085	0.149884
12	0.200775	0.189678	0.180868	0.173795	0.168093	0.163509
13	0.217506	0.205485	0.19594	0.188278	0.182101	0.177135
14	0.234237	0.221291	0.211012	0.202761	0.196108	0.190761
15	0.250969	0.237098	0.226085	0.217243	0.210116	0.204387
16	0.2677	0.252904	0.241157	0.231726	0.224124	0.218012
17	0.284431	0.268711	0.256229	0.246209	0.238132	0.231638
18	0.301162	0.284517	0.271302	0.260692	0.252139	0.245264
19	0.317894	0.300324	0.286374	0.275175	0.266147	0.25889
20	0.334625	0.31613	0.301446	0.289658	0.280155	0.272516

7. INFLUENCE OF THE WIND IN NAVIGATION

One problem is that of temporary currents caused by wind, whose speed can be determined with a satisfactory relationship for the high seas and regular wind:

$$V_{temp} = \frac{0{,}0127}{\sqrt{\sin\varphi}} V_w \qquad (8)$$

Where: V_{temp} is temporary speed (wind) in m/s; φ – latitude of the place; *Vw* - wind speed in m/s.

We can observe from calculated values for temporary currents tables that the maximum value is for 20 m/s and for 1 degree latitude. The average value is 0,241 and this could be used for further approximations of temporary currents.

This relationship is valid for open ocean areas, for regular winds, and constant density of sea water.

For high wind speeds, rough sea, local configurations of the maritime basins, it is difficult to calculate the speed of the wind current. Calculated nomograms can be used; it is accepted from the very beginning that the speed of the wave at sea surface ranges in geographical latitude; it decreases at higher latitudes.

$$K_w = \frac{V_{temp}}{V_w} \qquad (9)$$

8. INFLUENCE OF TIDE ON MARITIME NAVIGATION

Sea level variations are of particular importance on navigation in shallow water areas, in coastal navigation, and ports entry areas.

Sea level variations are caused by cosmic forces that produce the phenomenon of tide, by atmospheric pressure variation, or tectonic movements.

Tidal phenomenon occurs in many sea areas, and produce sea level oscillations, which considerably influence maritime and river navigation.

This periodic oscillation is dependent on a number of general and specific factors i.e. water depth, coastal configuration, the presence of islands, etc. Thus, for the same latitude, sea level variations for certain areas changes within quite wide limits.

In some areas the tide is insignificant, while in others it can reach heights of a few meters.

Tide can produce quite big currents, with alternative character that will generate a force on current direction and a magnitude equal to the drag of the ship, in calm water at a speed rate equal to that of the current. This occurs in inland navigation or in areas with small width and narrow openings.

For a navigator it is important to calculate the tidal elements, as this will lead him to calculate the time of entering and leaving ports, canals (especially in shallow waters), and to adjust making fast of the ship, since there are movements of ship on vertical, due to ebb and flow

In this case, tidal currents are extremely important. Navigation in variable currents is also considered to be navigation in tidal currents, i.e. in coastal areas, straits, channels, port entries.

9. CONCLUSIONS

Analysis of the safety of the ship, cargo and crew is closely related to: economic factors, voyage efficiency, to the way of choosing the safest route and who fulfil the economic criteria of acceptable performance, and how to to prepare the ship and crew for navigation in bad weather conditions.

Different influences on the maritime navigation are studied and fully described in this paper. All comparisons are made for five different ship types.

For navigators is important to calculate the wave, wind and tidal elements, to be able to calculate the hours of ports, channels entry (especially in shallow areas) and to adjust the ship's ties as a result of vertical ship motion with the ebb and flow. Great importance of the tidal currents, waves and wind are assessed and this factors have huge influence on maritime navigation.

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MODERN HYPERBOLIC NAVIGATION SYSTEMS. PRESENT AND FUTURE

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ABSTRACT

Hyperbolic navigation systems are systems designed to provide long distance positioning information. LORAN C system is operating and provides position information for ships and land vehicles, too. Today, there are some modernization programmes called Eurofix, eLoran, which aim to increase the positioning accuracy, high reliability, and independence from satellite navigation systems. Theoretical accuracy of these modern systems is compatible with navigation satellite systems accuracy.

Keywords: *hyperbolic navigation systems, LORAN C, accuracy.*

1. INTRODUCTION

Hyperbolic navigation systems are designed to provide long distance positioning information. They have their origin in the third decade of the twentieth century, when they began the first research study in the realization of such a system, the precise control of aircraft and ships motion, besides opportunities of visual orientation. One such system is the LORAN system (Long Range Navigation), which is a time differential hyperbolic system. The first series of Loran transmitters (repeaters) was set to work in 1943; these would further become the hyperbolic system called LORAN A.

A chain of LORAN A series was composed of a main station (master) and several secondary stations (slave) located at a distance of 600 nautical miles from one another, with a range of 800 ... 1200 nautical miles, at daytime, and 1200 ... 1500 miles, at night time. This system worked until 1980, when it was replaced with the hyperbolic LORAN C system. The *Loran* C hyperbolic navigation system is an advanced variant of the Loran system, being a being a time and phase differential system. The main Main features of Loran C system are: working frequency 100 KHz; power output 250 ... 400 KW; 1000 nautical miles range of direct wave, and up to 2300 nautical miles range of reflected wave . This system is currently in service as Loran C[1]: chains of stations: the Saudi Arabia northern chain the China Sea southern chain, the East China Sea chain, the Korean chain, the Pacific north-western chain, the Russian eastern chain, the Russian western chain, and the European chains [1].

2. LORAN C POSITIONING ACCURACY

Loran line of position is a hyperbole which represents the locus of all points of equal time difference from two Loran transmitters, located the focal spots of the hyperbole.The Loran point of accuracy depends on the angle of intersection of the lines of position, and the accuracy with which they were determined (Fig. 1) [2].

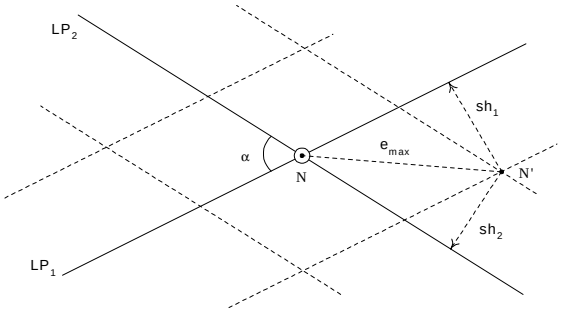

Figure 1. The Loran point

The maximum error of the Loran fix is calculated using the ratio:

$$e_{max} = \cos ec\alpha\sqrt{sh_1^2 + sh_2^2 + 2sh_1sh_2\cos\alpha} \qquad (1)$$

where:

e_{max} is the maximum error of a Loran fix;

sh_1 and sh_2 – the errors in determination of Loran lines of position;

α - the angle of intersection of Loran lines of position.

Table 1. The value of the maximum error of LORAN C fix

The angle α [^{0}]	The error point sh_1,sh_2 5 cbl e_{max} [cbl]	The error point sh_1,sh_2 4 cbl e_{max} [cbl]	The error point sh_1,sh_2 3 cbl e_{max} [cbl]	The error point sh_1,sh_2 2 cbl e_{max} [cbl]	The error point sh_1,sh_2 1 cbl e_{max} [cbl]
0	10	8	6	4	2
1	9,999	7,999	5,999	3,999	1,9999
2	9,998	7,998	5,999	3,999	1,9996
3	9,996	7,997	5,997	3,998	1,9993
4	9,993	7,995	5,996	3,997	1,9987
5	9,990	7,992	5,994	3,996	1,9980
10	9,961	7,969	5,977	3,984	1,9923
15	9,914	7,931	5,948	3,965	1,9828
20	9,848	7,878	5,908	3,939	1,9696
30	9,659	7,727	5,795	3,863	1,9318
40	9,396	7,517	5,638	3,758	1,8793
50	9,063	7,250	5,437	3,625	1,8126
60	8,660	6,928	5,196	3,464	1,7320
70	8,191	6,553	4,914	3,276	1,6383
80	7,660	6,128	4,596	3,064	1,5320
90	7,071	5,656	4,242	2,828	1,4142

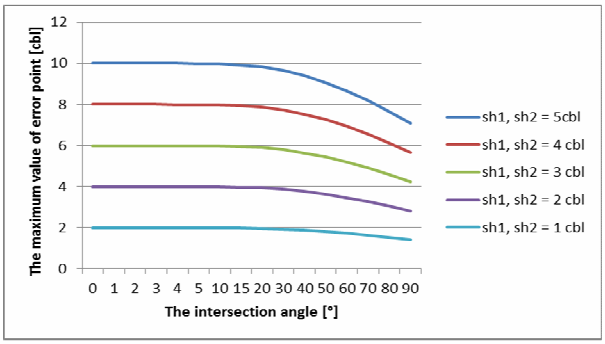

Figure 2. The errors of the Loran fix according with the angle of LOP intersection

The errors of the Loran fix depinds on the angle of LOP intersection. The error is maximum when the LOP intersection angle tends to zero and minimum when the angle is 90 degrees.

3. LORAN C HYPERBOLIC NAVIGATION SYSTEMS PERSPECIVES

There are two directions to hyperbolic navigation systems evolution: integration with other positioning systems; establishing a new, independent, modernized, system compatible with present – day satellite navigation systems, which are also in a continuous process of modernization [3-6].

Integrated LORAN C - DGPS Eurofix

The European *EUROFIX* navigation system is a modern integrated system, encompassing possibilities of the LORAN C hyperbolic system and the GPS - DGPS differential satellite system. This system is developed in western Europe where it uses the Loran C chains of transmitters on the northwestern coasts of Europe, and the chain DGPS transmitters in the area, ensuring coverage of over 1000 km, with a positioning accuracy which goes lower than five meters, and with the possibility of determining the position in three dimensions using information from three satellites only. The *Eurofix* system can work as a DGPS system using data from LORAN C corrected through GPS. Both types of position information may be received together or separately, to the same receiver : these LORAN C, and DGPS items of information, which are compared for determining the ship's position; there exist the possibility to replace each other in the event of failure of one of the systems components.

eLORAN System

The upgraded eLoran (Enhanced Loran - eLoran) is an international standard positioning service, in 2D (two dimensions), navigation and time (*Positioning, Navigation, and Timing* - PNT), on the frequency of 100 kHz, for different transport modes and other civilian positioning applications [7]. eLoran is an improved version of hyperbolic navigation system Loran C answers the requirements of performance, precision, integrity, and availability necessary for: air navigation during approach to landing; coastal navigation in intense traffic areas, during the operations of port entry, in low visibility conditions; land navigation; terrestrial positioning; telecommunications and other areas (Internet, etc.), by providing UTC reference time signals, with an accuracy of 50 ns (Table 2).

Table 2. The eLoran system performances

Accuracy	Availability	Integrity	Continuity
0,004-0,01 nm (8…20 m)	0,999-0,9999	0,999999 ($1x10^{-7}$)	0,999-0,9999 over 150 sec

The eLoran system is a hyperbolic independent system, distinct and at the same time to complementary the Global Satellite Navigation System (Global Navigation Sattelite Navigation System-GNSS). The system, still under observation, will be developed by 2020.

The first eLoran station was built in Anthor, England ($54^0$55'N; $03^0$15'W). This station has been transmitting eLoran messages with Group Repetition Interval (GRI), GRI = 67310 μs value and delay of emission of 27300 μs value since [8]. The eLoran messages sent by this station are EUROFIX type messages and contain differential Loran, differential GPS, information, as well as integrity data with reference to UTC.

The main advantages of the eLoran system are:
- civilian control;
- eLoran signal is not intentionally degraded;
- UTC synchronized transmission by a method which is independent of the satellite systems method;
- if the eLoran emission source is synchronized with the same UTC time source as the one of satellite systems, the eLoran signal can be used in combination with the satellite navigation signal;
- the eLoran signal can be received in areas where the satellite signal has no coverage;
- sending a signal, in real time (less than 10 sec), about possible damage, or loss of signal integrity;
- repeatable positioning accuracy is good;
- in addition to the Loran C system, teh signal contains a data channel that provides specific corrections about the state of the system and information integrity;
- the implementation and maintenance costs are much lower than those of satellite systems;
- it can be used to provide differential corrections for satellite systems.

The eLoran system ensures safe and low-cost services for government and private institutions, and also for users in the aviation, maritime field, by:
- ensuring all the flight phases (take-off, free flight, approching and landing);
- providing information for eNavigation, including the use of temporary and permanent means for ensuring maritime navigation (Aids to Navigation - AtoNs) to mark dangerous water areas;
- identification of land vehicles;
- maintenance and synchronization of telecommunications wired and wireless.

eLoran is designed as a complete and complex formed off: (Fig. 3) control centers; broadcasters; monitoring points; eLoran receivers.

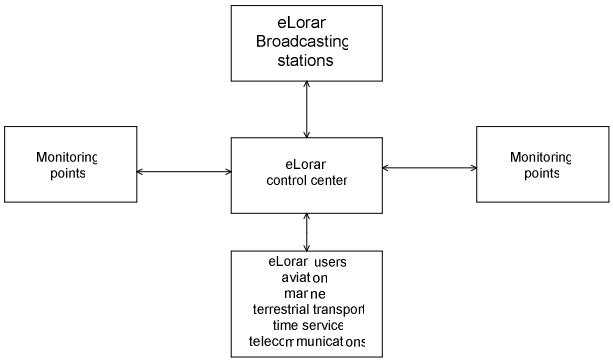

Figure 3. eLoran design

eLoran services are provided by a primary center by specialized applications. Main distributor provides original and accurate eLoran information under the operational specifications of the Loran C signal. Specialized applications for aviation, maritime and navy,etc. provide specific information by eLoran data channel (eg differential eLoran messages).

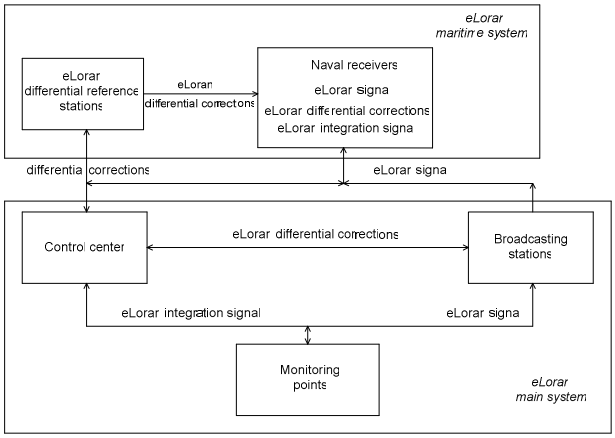

Figure 4. The eLoran main system

The eLoran signal is a complex signal that contains the following information: identification data of eLoran transmitter; The Almanac of eLoran transmitters and of monitoring points; UTC time scale reference; time difference between the eLoran time and the UTC time;the eLoran signal; warnings about abnormal radio propagation conditions due to specific atmospheric conditions; message identifying the emission eLoran users; differential -satellite corrections.

The eLoran signal for naval users has a circuit for elaboration, evaluation, verification and updating, which comes from the *Main eLoran System* and reaches the eLoran onbord receivers by the *Maritime eLoran System*. The eLoran receiver picks up eLoran signal and also the integrity signal of eLoran data, as well as the eLoran differential corrections.

The eLoran signal emission is done automatically. For eLoran signal modern SSX transmitters (Solid StateTransmitter) are used with continuous energy sources, equipped with systems of time and frequency control. The eLoran signal phase corrections are made continuously. eLoran time is provided by high performance cesium clocks or other technology of the same accuracy class with them.

Anomalies in the work of eLoran transmitter stations are signaled in a very short time, as in Loran C system, warning the user not to use eLoran information until the problem is solved.

The eLoran control centers ensure rapid resolution of faults and provide conditions for maintenance, continuity, availability of signal in accordance with the announced performance.

The system's maintenance is planned in such a way, so as to minimize the impact on transmitter stations work.

Monitoring points are designed to ensure signal integrity for all users of eLoran system. The receivers in these points permanently monitor the eLoran signal quality, throughout the area of responsibility. Some monitoring stations are used as reference stations to generate eLoran messages. Also, some monitoring stations will provide real-time differential corrections for onbord ships receivers, as well as warnings for aviation.

The eLoran receivers provide acquisition and signal tracking of eLoran messages received from several eLoran stations, in order indicate a more accurate positioning and time. Also, the eLoran receivers can ensure the correctness of each eLoran signal alone. The eLoran receivers receive and decode eLoran messages based on specific applications.

The exchange of information between the *eLoran Control Center*, eLoran emmiters, and monitoring points are shown in Fig.5.

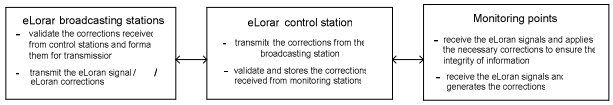

Figure 5. The exchange of informations

An eLoran receiver determines its position (latitude and longitude) and UTC time by measuring the times of receiving impulses from the last three eLoran stations within its range of visibility.The eLoran signals passing over various relief forms produce deviations of reception times called additional secondary factors (*Aditional Secundary Factors* - ASF) as compared to theoretical reception times, and hence, decreased accuracy in the point. However, by using differential information – eLoran the accuracy is growing ; it becomes very good, of about 10 meters. An ASF error of 1 μs can produce, in time, an error in distance of 300 m. An ASF chart contains the nominal values of ASF factors for a certain area and for a specific transmitter.

ASF value in μs, depending on the relief forms is as follows:

0.00 - surface of the sea;
1.65 - clay soil;
2.36 - marsh and sea ice;
4.94 - land with shrubs;
6.12 - dry;
6.62 - sand (desert);
5.61 - snow and ice.

The modern integrated eLoran receivers type eLoran – GPS LORADD can receive signals having the following technical characteristics: individual reception of an eLoran positioning message; for areas where there are ASF maps (using ASF corrections) the accuracy of the point increases; eLoran and GPS combined signal reception; by comparing the two signals, the positioning accuracy is very good; working power 4 W; 9...36 V DC voltage; 90% humidity accepted; UTC reference; antenna used: type E - for eLoran signal reception, type H - for receiving combined eLoran and GPS signals [9-11].

The eLoran applications system are based on minimum operational performance standards. For aviation, eLoran provides information for guiding in a horizontal plane and not so much information about latitude, for all phases of flight (takeoff, free flight, approach and landing). Maritime eLoran system will provide positioning information and time with high accuracy, to meet the provisions of IMO Resolution A.953/23/2003 related to global navigation system (navigation systems System-Wide World WWRNS).

These performance standards apply to the approach and entry into ports, navigation in coastal areas with heavy traffic and high risk (Table 3).

Table 3. The eLoran performance sdandards

Accuracy	Availability	Time alarm	Confidence level
10m (95%)	0,998 over 2 years	10 sec.	0,9997 over 3 hours

By applying differential - eLoran corrections, in real time, these performance standard are fulfilled. For time information,the eLoran system comes under ITU G.811/1997.

In addition, if a suitable antenna is attached to an eLoran receiver this can be used as a eLoran compass, with which eLoran bearings to the emissions stations can be measured; also, the ship's course can be read at a precision lower than 1^0, independent of the ships's position and movement.

It also envisages coupling the eLoran receivers coupled with ECDIS and AIS systems.

4. CONCLUSIONS

An eLoran system will also provide the following for the maritime navigation :

a. *enhanced safety*: it can be used with high accuracy compared to other methods and visual navigation aids, as a backup system of a satellite navigation system;

b. *security*: provides the functionality of collision warning systems, when satellite navigation systems, or traffic control systems – VTS are not working,

c. *econony of resources*:

- potential reduction in the number of collisions and groundings and hence, reducing the number of cases of oil pollution;
- assist in monitoring marine pollution;
- potential reduction of cost with the aids to navigation;
- potential increase in the quality of voyage monitoring, and safe ports entry .

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RESTRICTED VISIBILITY IN CONSTANTA. SYNOPTIC CONDITIONS AND CONSEQUENCES ON ROAD AND MARITIME TRANSPORT

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ABSTRACT

Restricted visibility is most often associated with fog, haze, but is also caused by rain and snowfalls, drizzle or blizzards. Very bad visibility, less than 200 m represents a high risk for air, road and maritime transports and for other types of economic activities. In 2014 it caused road accidents and restrictions of Constanta or other ports operations or their closing and suspension of the manoeuvres on the Danube – Black Sea canal. Bad visibility and weather phenomena frequencies during the months of January, February and March 2014 in Constanta are analyzed in this paper. The synoptic conditions during the days when bad visibility was recorded are also studied, based on GFS (re)analysis maps – SLP, 500 hPa geopotential, 2 m temperatures and precipitations, as well as on approximate soundings for Constanta.

Keywords: *visibility, weather phenomena, synoptic conditions, port operations, road transport.*

1. INTRODUCTION

Visibility on land is measured by a human observer by determining the greatest distance at which he can distinguish objects against the horizon sky with the unaided eye. At night an equivalent is obtained by using lights of known intensities at various distances. At sea the officer of the watch has no fixed reference points unless the visibility is very poor and he is using the various objects on deck. In reasonable visibility he uses his long experience by looking at the horizon and seeing how sharp it is, trying to see other vessels that he has detected on his radar etc. At night, he will use the brightness of the stars, how well he can see the cloud, the clarity of lights on board etc. [4].

Bad visibility is determined by water droplets from fog, drizzle, precipitations. The scattering of light by dust, smoke, water and other particulate matter in the air highly influences the visibility.

2. DATA and METHODS

Visibility scale used in this paper is shown in table 1 [4].

Table 1. Visibility scale

Descriptive terms	Distances
Very bad	Less than 200 m
Bad	200-500 m
Very poor	500-1000 m
Poor	0.5-1 Nm
Indifferent	1-2 Nm
Moderate	2-5 Nm
Good	5-10 Nm
Very good	10-25 Nm
Excellent	>25 Nm

Data on restricted visibility (ie bad visibility less than 1000 m and very bad visibility less than 200 m), recorded in Constanta during three months in 2014 are studied in this paper.

The measurements were made with a Present Weather Sensor PWD 22 of the Hydrographic Office of the Navy in Constanta, the sensor being installed on the Constanta Green Lighthouse, located on the north dike (designed to protect the Constanta harbour), fig. 9.

It measures visibility less than 20 km, seven different precipitation types and also reports in Metar format. This visibility sensor is based on proven forward scatter principle; it is calibrated with reference to a highly accurate transmissometer and also provided with extensive set of self-diagnostic and automatic detection of contamination. It ensures that false values are not reported. The sensor is a combination of an optical visibility sensor and a capacitive precipitation sensor: the optical measurement is relative to droplet size; the capacitive measurement (RAINCAP plate) is relative to water content of droplets. Temperature information is also used to limit some decisions and to detect freezing precipitation [5].

Data on the weather phenomena and on bad visibility were correlated for a period from January to March 2014.

The analysis of the synoptic conditions during days with visibility less than 1000 m and less than 200 m is based on the GFS reanalysis maps for sea level pressure, 500 hpa geopotential, 2 m temperatures and precipitations. The approximate soundings for M. Kogalniceanu airport, near Constanta, were very useful for the observation of the air humidity and turbulence during the fog, drizzle or rain episodes.

Data on the road accidents occurred during these three months in 2014, provided by the municipality traffic police service were also used in this paper. Grave accidents when people were injured were then selected. Their main causes are discussed and the frequency of the casualties produced because of the failure to adapt the vehicle speed to road conditions is calculated.

The periods when restrictions of port operations or Constanta port closing occurred were also correlated with bad visibility situations.

3. RESULTS

3.1. Visibility records

Data recorded by the PWD 22 sensor from the Constanta Green Lighthouse show that very bad visibility occurred (fig. 1 and table 1):

-in January 2014: visibility less than 200 m occurred on January 8, 9, 17 and 19. The longer duration was recorded on January 8, with a maximum of 6 consecutive hours (from 03 to 08 h. and from 12 to 20 h.) and on January 19 (from 14 to 22 h., 8 consecutive hours);

-in February 2014: very bad visibility was recorded on February 8, 14, 16 and 19. The longer duration (11 to 15 consecutive hours), occurred on February 14 and 19;

-in March 2014: the 3, 5, 6, 23 and 24th of March, the longer duration being recorded on March 24 (6 consecutive hours).

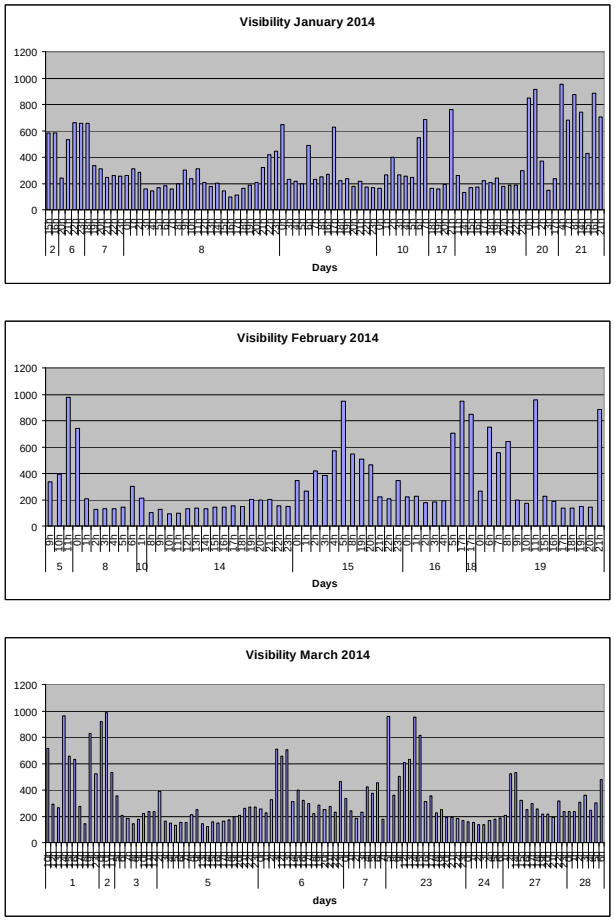


Figure 1. Visibility less than 1000 m records in Constanta, January – February 2014

Warning messages concerning the yellow code for fog and very bad visibility were issued on January 3, 7, 8 2014 and sent to the County Police Inspectorate. The warning concerned the Constanta county (on 03.01.2014) and the entire Dobrogea region (on 08 and 09.01.2014).

On January 26 and 29 rain and rain freezing, snow falls and blizzards became violent and determined a very bad visibility (almost zero on January 29 during the blizzard); consequently orange and red codes were issued by the meteorological services, for a large area in the SE Romania. These phenomena were not recorded by the PWD22 because the sensor's lenses were frozen.

The yellow code for fog and very bad visibility was sent again on February 06, 08 and 14 for Constanta County or the entire Dobrogea region (on 08.02.2014). In March 2014 very slight rain/drizzle and fog, associated with visibility less than 200 m were forecast for the 23rd and 24th of March in Dobrogea.

3.2. Weather phenomena during days with bad and very bad visibility

The main causes of the bad visibility were rain (mostly slight) and fog. Days with more than 6 consecutive hours of bad visibility are indicated in table 2 in red and underlined. In the right column the main weather phenomena (recorded by the same PWD 22 sensor) are represented using their symbols and in the order they occurred (from the top down). Only phenomena recorded in the 15 preceding minutes are shown in this table.

Table 2. Weather phenomena during days with restricted visibility

January		February		March	
Day of the month	Meteor	Day of the month	Meteor	Day of the month	Meteor
2	≡	5	✳✳	1	≡
6	●● ≡ ▽	8	≡	2	≡ ●●
7	●●	10	●●	3	▽ ≡
8	●●	**14**	≡ ≡ ▽	5	≡ ▽ ●●
9	●●	15	≡	6	●●
10	●●	16	≡ ●●	7	●●
17	●●	18	●●	23	▽ ●● ≡ ●●
19	●●	**19**	●●	**24**	●● ≡
20	●●			27	≡ ●●
21	▽ ●● ●● ≡			28	●●

Symbols:

≡	*fog or ice fog, no appreciable change during the preceding hour*
≡	*fog or ice fog has begun or has become thicker during the preceding hour*

●●	*drizzle not freezing, continuous*
●●	*rain not freezing, slight*
●●	*rain not freezing continuous at the time of observation*
✳✳	*continuous fall of snowflakes, slight at the time of observation.*
▽	*rain showers, slight*
▽	*rain showers, moderate or heavy*

Mean precipitation days > 0.1 mm (calculated for a 21 yr period) in Constanta are about 9 days in December and about 8 days in January, March, May, June and November.

Fog occurs especially in winter, the annual incidence being around 6.2 days in January, followed by December (5 days) and November (4.9 days). There are about 35 days per year when fog occurs, the frequency being calculated for a 23 yr period (1984-2006) [2].

On January 8 and 19 2014 bad visibility occurred because of rain; on February 14 the main cause was the fog and on March 24 very slight rain and fog occurred from 00 to 04 h and from 05 to 06 h respectively.

4. SYNOPTIC CONDITIONS

Fog was the main phenomena recorded on February 14 2014. The main characteristics of the atmospheric circulation were: the development of a large trough associated with an intense activity of the low pressure area over Iceland and the interaction between this transport of colder and wetter air mass from the NW Europe and the warmer air located over the study region (fig. 2).

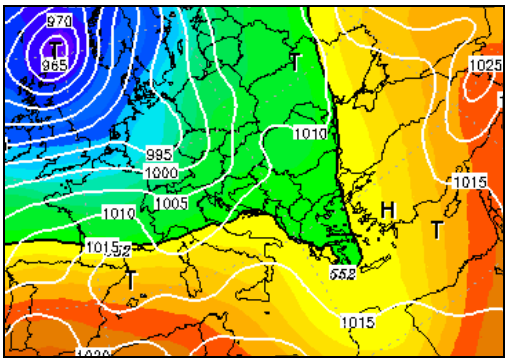


Figure 2. 500 hPa geopotential and SLP, 13.02.2014, 18 UTC, GFS reanalysis, www.wetterzentrale.de

Air temperature decreased sharply on February 14 and 15 2014 in the middle troposphere and at sea level over the Romanian Black sea coast (fig. 3). The main cause was the cold air advection from west, but also the formation and persistence of fog, with very short periods when fog became thinner and the sky visible. Maximum air temperatures recorded in Constanta were about 17°C on February 13 2014 and they decreased to 7°C on February 14 and to 3°C on February 15. Minimum air temperatures decreased from 7.5°C to 5°C and to 1°C in the same period.

The Skew-t diagram clearly shows an air mass supersaturated with water vapours in the lower troposphere near the sea level, associated with light wind (fig. 4). These conditions were favourable to the formation of the mixing fog (fig. 8).

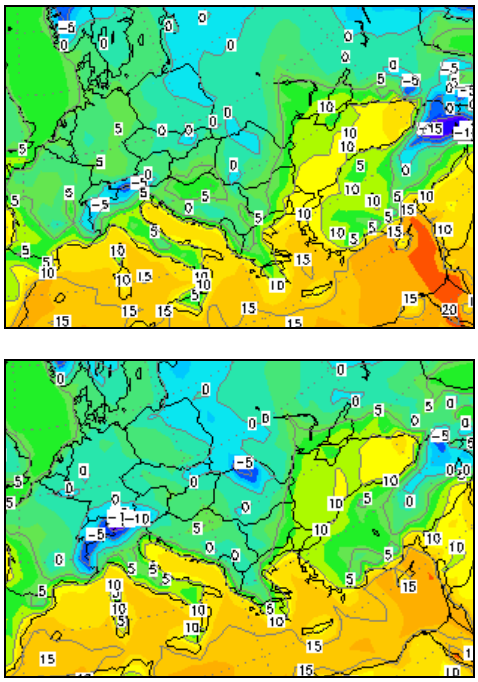


Figure 3. Temperatures at 2 m, 13.02.2014 18 UTC and 14.02.2014 06 UTC (middle and down figure respectively), GFS analysis, www.wetter3.de

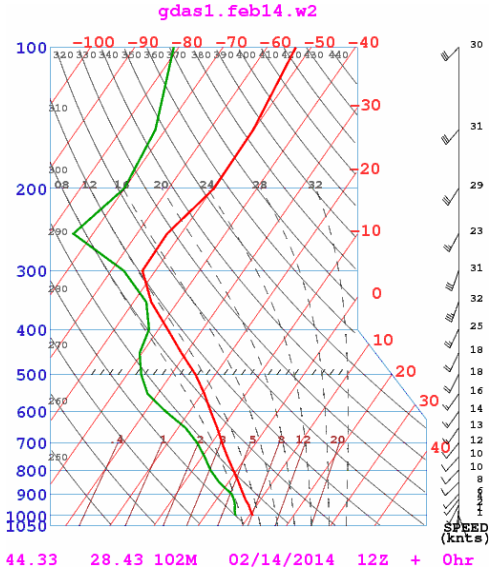
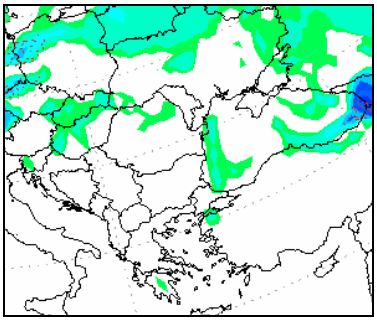


Figure 4. Approximate soundings for M.Kogalniceanu airport on 14.02.2014, 12 UTC, http://ready.arl.noaa.gov

Rainfalls from January 8 and 19, February 19 and March 24 2014 were intermittent and slight, mostly drizzle and slight rain (fig. 5 shows precipitations over 0.1 mm in green and over 0.5 mm in blue on 19.01.2014 in fig.5 b). On March 24 the main phenomena was drizzle/fog which therefore are not shown on the precipitations map in fig. 5. In all the other three situations mentioned above, the rainfalls were accompanied by advection fog with short breaks when the fog became thinner.

a)



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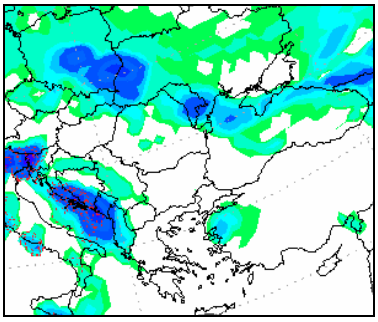

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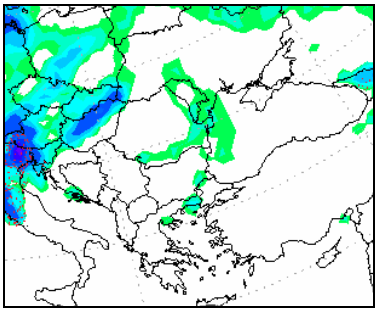

d)

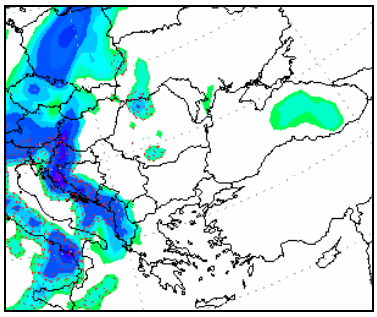

Figure 5. Rainfalls from January 8, 06UTC (a), January 19, 06UTC (b), February 19 12UTC (c) and March 24 2014 00UTC (d), GFS reanalysis, wetterzentrale.de

The super saturation of the air mass near the ground level can be better observed on the Skew-T diagrams and again at 300 - 250 mb levels (fig. 6). Winds were light near the ground and temperatures were positive, which favoured the formation of fog accompanied by drizzle or slight rain (fig. 6). The sounding from the 8th of January is not shown in figure 6, because of its high similarity to the sounding from the 19th of February 2014.

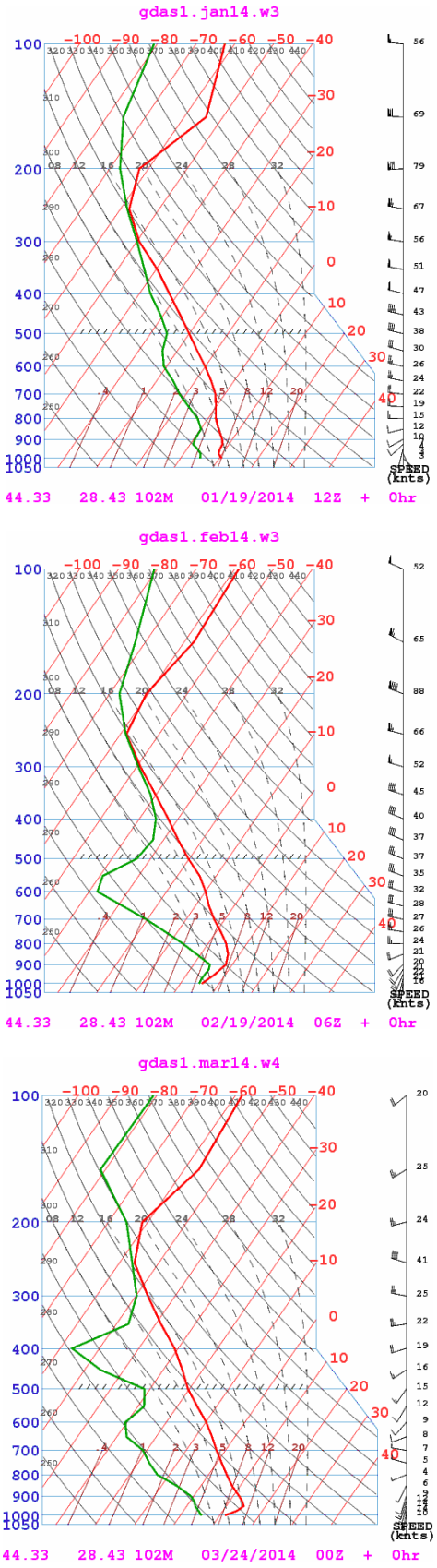

Figure 6. Approximate soundings from Jan. 19, Feb. 19 and March 24 2014, M.Kogalniceanu airport, http://ready.arl.noaa.gov

The main cause was a weak interaction between a warm and humid air mass from above the Black sea or at the periphery of a low pressure system (travelling from western Europe or located over central/eastern Mediterranean sea) and a colder air mass from continental high pressure fields in northern or eastern Europe (on January 19 and March 24) or Turkey (on February 19), fig. 7.

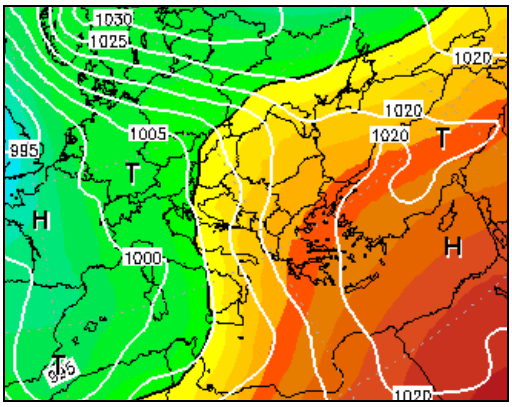

Figure 7. 500 hPa geopotential and SLP, 19.01.2014, 12 UTC, GFS reanalysis, www.wetterzentrale.de

5. CONSEQUENCES ON ROAD AND MARITIME TRANSPORT

Bad visibility and the associated weather phenomena could be one of the causes of road accidents. It influences the road transport by restricting the distances' accurate assessment by the driver. The road conditions also can be modified because of snow or freezing rain which causes a wet or slippery road.

The term used for these meteorological conditions by the Traffic Police is: "failure to adapt the vehicle's speed to road conditions".

From January to March 2014, 210 road accidents occurred within the Constanta county; 39 where very grave accidents. Accidents occurred because of: the pedestrians who crossed the street in unauthorized places, the drivers who didn't give priority to other vehicles or to the pedestrians, the drivers who were driving with high speed or the drivers' failure to adapt the vehicle's speed to road conditions.

The latter (caused by bad weather and restricted visibility) was identified as the main cause of:

-11 accidents that occurred in January 2014 in Constanta County (from 41 accidents, i.e. 26.8%). The accidents occurred the days when bad visibility and rain or fogs have been recorded. The 25, 28 and 29.01.2014 strong wind or bad visibility due to blizzards were the main meteorological phenomena.

-10 accidents (23.2% from all the monthly accidents) in February 2014;

-in March 2014 the data cover only the accidents that occurred within the city of Constanta (and not the all county). From 52 accidents, 7 (13.4%) were caused by the drivers' failure to adapt the vehicles speed to bad weather and road conditions.

Figure 8. Fog on a national road in Constanta County on February 14, 2014 [11]

These accidents happened despite the fact that the population is informed about the weather phenomena and the risks involved through the mass media, internet or by calling telephone numbers provided by the national authorities.

The yellow code* for fog and very bad visibility within the Constanta County or over the Dobrogea region was issued by the meteorological services in January 2014 (the days of 3, 7 and 8) and February 2014 (the days of 06, 08 and 14).

On March 23 and 24 2014 very slight rain/drizzle and fog, associated with visibility less than 200 m were forecast in Dobrogea.

**Yellow code meaning is:*

"the forecast weather phenomena (rain showers, thunderstorms, stronger winds, high temperatures) are common for the area but may temporarily become dangerous for specific economic activities. There is a risk for increasing river flows and levels".

In order to minimise any risk of collision, the closing of the maritime ports can be decided during the days with very bad visibility. The harbourmasters are entitled, according to international rules, to take any action they feel are required for the safety of navigation.

The PWD 22 sensor from the Constanta Green Lighthouse gave useful information on the visibility on sea and in the harbour area due to its appropriate location on the harbour protection dike (fig. 9).

Figure 9. Constanta lighthouse and meteorological station (image published the 05.03.2014 by http://www.reporterntv.ro/, [13])

The closing of the Constanta and Midia ports was decided several times in January 2014 because of bad visibility. Maritime and river traffic also were stopped the 7, the 17 and the 21.01.2014 [6], [7], [8].

Dense fog was reported on February 05 and 14 2014 and consequently the authorities decided the closing of the ports of Constanta Nord, Constanta Sud and Mangalia [14], [3].

Restricted visibility lead to the closing of the Constanta port also on March 3 [13].

On March 10 2014 the same decision was taken because of the strong winds.

Figure 10. Fog in the Romanian Black sea coastal area, http://www.revistamiscarea.ro/ceata-densa-pe-a2-si-a4-trei-porturi-au-fost-inchise/, [12]

Acknowledgements: The GFS (re)analysis maps were downloaded from www.wetterzentrale.de and www.wetter3.de archives. Data on visibility and weather phenomena are from the Hydrographic Office and have been also extracted from www.ogimet.com. The atmospheric soundings have been downloaded from http://ready.arl.noaa.gov. Data on the road accidents come from the Traffic Police Service in Constanta and from the website http://www.politiaromana.ro/infotrafic.

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SHIP-BOARD WEATHER ROUTING SYSTEMS

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ABSTRACT

Optimising a vessel's route based on environmental information such as wind, waves and current patterns can lower fuel consumption and decrease delays while also reducing structural and cargo damage claims. Weather routing software products utilize not only weather and oceanographic data but also the hydrodynamic details of the vessel to provide the ship's crew with real-time ship-specific routing advice. The paper refers to software characteristics and benefits of voyage optimization.

Keywords: *weather routing, software, routing services, waves forecast.*

1. INTRODUCTION

The resolution A.528 (13) adopted by IMO in 1983 recognizes that weather routeing - by which ships are provided with "optimum routes" to avoid bad weather - can aid safety. It recommends Governments to advise ships flying their flags of the availability of weather routeing information, particularly that provided by services listed by the World Meteorological Organization [8].

The use of modem electronics for navigation such as GPS and ECDIS has significantly improved the safety of navigation. Still, strategic weather routing and hull engine monitoring are needed to plan and execute safe and efficient passages across the ocean. The effort to develop an onboard guidance system started in the late 1970s when shipboard computers were first introduced in order to bring sea keeping knowledge to ships at sea. Several attempts were later made to develop commercial systems for the shipping industry [4]. The wind and wave forecast limitations, the high cost of computers and the lack of an effective communications system explain why these early systems were not widely accepted by shipping companies as a cost-effective means of reducing damage.

Since then the weather routing systems evolved tremendously, from simple weather routing (weather forecasts converted to routing recommendations, neglecting vessel details) to more complex decision-supporting systems. The latter take into account the vessel's behaviour in poor weather situations (computed with hydrodynamic methods) in addition to weather and oceanographic conditions.

2. PRINCIPLES OF WEATHER ROUTING

Climatological maps and tables are used when planning a route. Climate routes reflect the seasonal variation of tropical and extra tropical storm tracks, monsoon regimes, wind speed and direction, wave height frequencies and ice limits, areas of high swell, sea ice limits and prevailing ocean currents, for the major ocean basins of the world. All this information are contained in nautical publications such as: *Pilot Chart Atlases*, the *Sailing Directions (Planning Guides)*, maps included in the *Ocean Passages of the world* publication, the *Pilot books* and other climatological sources.

When the voyage starts, the short term weather variability plays an important role. Two strategies can then be used: the ship can first follow the climate route and deviate if the weather becomes better or worse or can first follow the shortest track and deviate if the weather becomes worse [2].

The shipmaster has to take the final decision in the actual and forecasted operating condition which requires different sources of information such as the weather charts, the meteorological warnings, the operational conditions, the ship design characteristics etc. All this information has to be carefully balanced and analyzed to formulate an unambiguous advice on optimum speed or heading, change of loading condition or settings of active roll stabilizers [1]. The situations become complicated if routing considering safety and economy happen to conflict. Without a reliable decision support system it is difficult to judge the conditions in an objective manner, in particular during night [6].

Weather routing software represents a very useful support system due to its different tools that provide avoidance of bad weather, optimized routing advice and optimized speed along the route, monitoring of chartered vessels for speed claims, reduced risk of damage to cargo, vessel and persons and reduced propulsion power demand.

Two general types of routing services have been identified by Bowditch, 2002 [1] : the first provides forecast conditions and computes routing recommendations, which are then broadcast to the vessel; the second assembles and processes weather and sea condition data and transmits this to ships at sea for on-board processing and generation of route recommendations. The former system allows for greater computer power to be applied to the routing task because powerful computers are available ashore. The latter system allows greater flexibility to the ship's master in changing parameters, evaluating various scenarios, selecting routes and displaying data.

3. CHARACTERISTICS OF ON BOARD ROUTING SOFTWARES

The Ship-board Weather Routing systems (SWR) are easy-to-handle systems. Various types were developed in the last years, for example: *BonVoyage System* developed by Applied Weather Technology, Inc., *Vessel Optimization and Safety System (VOSS)* developed by Ocean Systems Inc. and Oceanweather Inc., and *Vessel and Voyage Optimization Solution (VVOS)* developed by Jeppesen Marine Inc. a Boeing company.

These ship board weather systems provide decision support for the navigator regarding optimum speed and course based on limit values for relevant ship response. Furthermore, forecasted weather information is processed onboard to enable active planning of the route.

The weather routing systems are and most probably will be further upgraded with fuel consumption modules in relation to the demand for practical guidance to reduce fuel consumption in waves. This also could lead to the reduction of the emissions of CO2, NOX and SOX [5].

The *BonVoyage System* provides the most recent weather and ocean data to the ship by broadband or email communications in a compressed format in order to minimize communications costs. The captain can view and interpret the information due to the fact that the data are presented under the form of maps and graphics. The system also includes an algorithm that allows the delivery of estimates of fuel cost and time en-route [7].

The forecasts are of higher confidence for voyages of over 10 days due to the high-resolution of wind and wave data. These data provide better simulation and allow ship captains to take advantage of small variations in wind and wave to make safer route plans. Ship safety is improved due to the wave forecasts (72 hours) of the areas where a freak wave is most likely to occur.

BonVoyage (BVS) is a helpful tool due to the prediction of speed loss (issued from its model on climatological ship resistance) and specific vessel consumption.

In May 2012 the *BonVoyage System* was integrated with Transas' Electronic Chart Display Navigation System (ECDIS) to help captains fully optimize their voyage planning. This allows now the data transfer from BVS to Transas Navi-Sailor ECDIS and vice-versa. In December 2013 *BonVoyage System* has been integrated with UKHO's Admiralty e-Navigator and ChartCo's Passage manager and has therefore the capability to interchange track waypoints with the above mentioned systems. The combination between the *BonVoyage System* and the Ship route advisory Services allows the transfer of route data between ship and shore, a graphical depiction of weather, routes and currents through *BVS*, detailed current data with tidal streams, 16 day forecast 4 times a day etc. [10].

The *Vessel Optimization and Safety System (VOSS)* from Ocean Systems Inc. and Oceanweather Inc. is another provider of weather and oceanographic conditions forecast; global wind and wave models are generated for 10 days of forecast 365 days a year (fig. 2). The twice daily forecast is available on 1.25 x 2.5 degree Lon/Lat global grid with update of global circulation currents. Data include tropical cyclone tracks, 500 hPa heights, surface pressure, wind speed and direction and 3 wave trains. Accuracy of the forecast is enhanced by real-time ingestion of satellite altimeter/ scatterometer wind and wave measurements (fig. 1), ocean buoys and ship observations, as well as by experienced meteorologists [12].

The *VOSS* system also provides customized ship response predictions with user specified loading conditions. The ship motion program takes into account voluntary speed reduction based on vessel motions propeller/engine limitations, allows user to simulate multiple routes for comparison. It also predicts roll and pitch motion, accelerations, slamming, bending moment, shear force, speed, power and RPM using forecast or user input sea and swell conditions. Another algorithm is offered within this system for minimum time and minimum cost routes over a range of arrival times without exceeding the Safe Operating Envelope (SOE).

The *Vessel and Voyage Optimization Solution (VVOS)* from Jeppesen Marine Inc. a Boeing company is another weather routing system which automatically generates a full range of optimized routes for balancing trade-offs between ETA and fuel consumption; it also optimizes to minimum fuel speed plan for required arrival time and also realizes a comparison of *VVOS* optimal speed management to traditional strategies such as constant speed or "sprint and loiter" [9]. The simulation tools facilitate the analysis of any route using high-resolution forecast weather to weigh trade-offs among ETA, fuel consumption, ship motions, hull stresses, and weather and sea conditions. The high resolution forecasts of wind, wave and ocean current are for 15 days.

The most efficient routes are identified due to the fact that the system utilizes a just-in time operating strategy that avoids wasting fuel with sprint and loiter alternatives. The routing support from experienced ship masters is available 24/7/365. The system also ensures a route import/export in 20 different ECDIS formats, improving workflow and reducing mistakes.

The *Vessel and Voyage Optimization Solution* includes a guidance system that recommends speed and heading changes to manage ship motions and help minimize heavy weather damage; this is due to the use of hydrodynamic modelling, optimization algorithms and high-resolution ocean forecasts. *VVOS* includes a detailed, ship-specific model of user's ship motion, engine and propeller characteristics. This ship model computes the speed made good under forecast wind, wave and ocean current conditions at a given engine power and propeller RPM, as well as ship motion limitations uniquely defined for each ship. The system also delivers accurate ETA predictions. At sea, ships download the latest ocean area forecasts via satellite communication. Masters can update and re-optimize passage plans as new forecasts become available or operational requirements change during a passage [9].

3.1. Waves forecast

Route selection and surveillance depend on all of the environmental factors but wind and wave's optimization effect is the most important process in obtaining an optimum routing.

Waves forecast improved due to the refinement of short term numerical weather prediction forecast systems and their extension into the medium range and to the development of global spectral wave prediction models. Over most of the global oceans there are few wave measurement sites available for model verification. Therefore, satellite radar altimeter estimates of significant wave heights* are used (fig. 1).

** The significant wave height (H_s) is defined traditionally as the mean wave height (trough to crest) of the highest third of the waves ($H_{1/3}$). The term is historical as this value appeared to be well correlated with visual estimates of wave heights from experienced observers.*

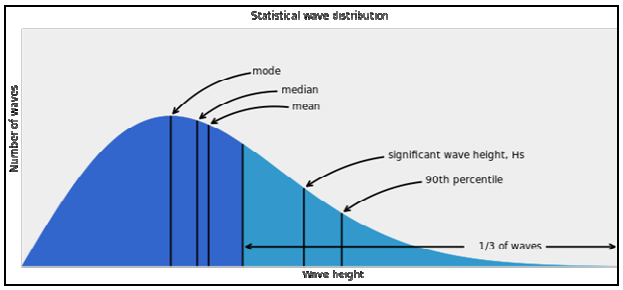

Figure 1. Significant wave height Hs [13]

Most measuring devices estimate the significant wave height from a wave spectrum; satellite radar altimeters are unique in measuring directly the significant wave height thanks to the different time of return from wave crests and troughs within the area illuminated by the radar (figs. 2, 3).

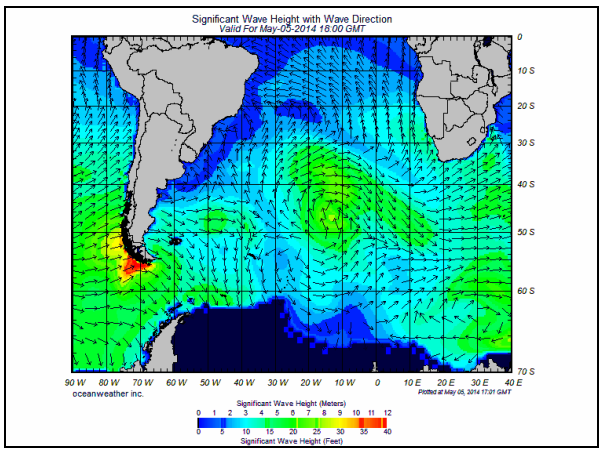

Figure 2. Significant wave height and direction, Oceanweather Inc. [15]

Modern ocean wave prediction systems can also estimate freak (rogue) wave events. This waves' height is at least 2 times higher than the significant waves (fig. 3).

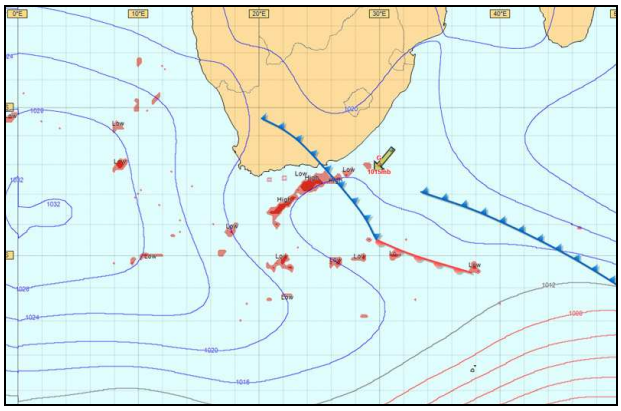

Figure 3. Rogue waves, *BonVoyage System* [7]

3.2. New characteristics: avoidance of the Emission Control Areas (ECAs)

The latest version of the *BonVoyage System* allows the management of the voyage track by displaying ECA zones and making them "no-go" areas. Captains can see their voyage track outside and inside the ECA zones. Simply moving waypoints in *BVS* allows them to visualize the impact of time in the ECA zone and compare it to the overall effect of time en route. With *BVS*'s ECA zone calculation tools, informed decisions can be adopted about how much time to sail inside or outside these zones. The goal is therefore to give captains and ship operators the data they need to manage voyage costs while complying with IMO regulations.

On August 1, 2012, North America Emissions Control Area (ECA) zones become enforceable. The regulation is part of Annex VI to the MARPOL Convention titled "Regulations for the Prevention of Air Pollution from Ships". The regulation dictates that the ECA Zones extend up to 200 nautical miles from coasts of the United States and Canada, including a portion of the Hawaiian Islands. In the ECA Zones, ships are required to burn fuel with sulphur content not exceeding 1.00%. Notable exceptions to this area are the Aleutian Islands and Arctic waters of North America [11].

4. CONCLUSIONS

The ship-board weather routing systems intend to enhance the ship's and crew safety at sea and to gain operational benefits by reducing repair times, reduced fuel expenses and less cargo claims.

The more advanced ship-board weather systems process weather data comprising wind and seaway information to continuously compute the ship's response during the voyage. The technology still undergoes extensive development. Besides wind and wave forecasts, voyage optimization should also take into account sea surface currents since they can significantly impact ship speed and fuel consumption. High resolution global circulation models enhanced by satellite

measurements can now produce accurate depictions of major currents and eddies daily [3].

Further advancements in meteorology are expected, especially in the forecast computer models, which will extend the time range and accuracy of the dynamic and statistical forecasts. Response models for sea-keeping and resistance in waves will be customised to individual ships and routes, which will be achieved by utilizing real-time and historical data with self-learning algorithms [14].

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THE INFLUENCE OF A WAKE EQUALIZING DUCT OVER THE CAVITATION OF A MARITIME SHIP PROPELLER

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ABSTRACT

Marine propellers are the most common propulsion systems owing to the high efficiency supplied by them; nevertheless, it is possible to improve its propulsive performance using additional auxiliary propulsion devices (unconventional propulsions). During the last three decades considerable research and development activities have taken into place within this context. Most of these devices are used to improve propulsive efficiency, but some of them aim to improve other performance characteristics, such as cavitations, vibration, noise, manoeuvrability, etc. The wake equalizing duct (WED) is one of the most commonly used energy saving devices for improving the propulsion performance of a ship; and reducing the propeller-excited vibrations and viscous resistance forces. In this paperwork two versions of an existing ship in normal version and retrofitted with WED device were analyzed in order to demonstrate the influence on the WED device on the propeller cavitations (if any). It was demonstrated that the maximum values for the pressure coefficient is 1.98 for WED free version and 2.029 for WED retrofitted version. The difference is so small that without chances of being wrong, the obvious conclusion is that WED device has no influence over the cavitations of the propeller. To decrease the cavitations we have other choices including a sound design of the propeller biased to improve the propeller behaviour in cavitations. WED is clearly not a choice.

Keywords: *Wake Equalizing Duct; Propeller Cavitations; Maritime Ships; Finite Volume Analysis*

1. INTRODUCTION

Marine propellers are the most common propulsion systems owing to the high efficiency supplied by them; nevertheless, it is possible to improve its propulsive performance using additional auxiliary propulsion devices (unconventional propulsions). During the last three decades considerable research and development activities have taken into place within this context. Most of these devices are used to improve propulsive efficiency, but some of them aims to improve other performance characteristics, such as cavitations, vibration, noise, manoeuvrability, etc. It can be found more review studies about various unconventional

Propulsions in Glover (1987), ITTC (1990), Blaurock (1990), Patience (1991), Breslin and Andersen (1994), and Carlton (1994).

One of the energy saving devices used widely in ships is the wake equalizing duct (WED) (Schneekluth's duct). It consists of two aerofoil sectioned half-ring ducts integrated to the hull in front of upper region of the propeller. Some important parameters for the effectiveness the WED are the angles of duct axis to ship's centre line plane, longitudinal positions, inner diameters, profile section shapes, angles of section to duct axis and lengths of the half-ring ducts. It is assumed that the WED accelerates the inflow of the upper region of the propeller where the flow is slow relative to the lower region of the propeller; and it improves the uniformity of the wake over the propeller disc, so the propeller efficiency is increased. In addition, a well-designed WED reduces the amount of flow separation at the after body, generates an additional thrust as in the accelerating type of duct, reduces the propeller excited vibrations due to the uniform wake, and improves the steering qualities because of the more straightened flow coming to the rudder. If the WED is installed to an existing ship, constructional changes and medications in propeller design are not needed. A WED can also be used in combination with other energy saving devices such as vane wheel and asymmetric stern (Schneekluth, 1986).

Schneekluth (1986) reports that the effectiveness of a WED is most evident if the ship speed is between 12 and 18 knots and its block coefficient is higher than 0.6.
By now, most of the studies related to the estimation of the effect of the WED on propulsion characteristics of a ship have been carried out based on model tests. But it is difficult to extrapolate the powering performance from model tests (especially for very large ships) due to the Reynolds number effects (scale effects) stated in ITTC (1999). At higher Reynolds numbers the scale effects occurs more evidently, in such cases it is recommended that self propulsion tests should be performed to reduce these effects (ITTC, 1999). In addition, numerical flow computations as an alternative of the model tests can also be used to estimate the effectiveness of the WED.
One of the issues of intense debate is whether or not the WED device is having any influence over the cavitations conditions that appear when the propeller of a maritime ship is rotating. In the following paper we'll try to shed some light over this issue.

2. CAD AND FINITE VOLUME ANALISYS (FVA) MODEL OF THE SHIP

The goal of this paper is to calculate via software Ansys 13™ the influence of placement of a WED to an existing ship over the propeller behaviour in terms of cavitations.

The model has as departure point a real port container as seen below, with the following parameters:

- Length *L*- [m]- 173
- Breadth *B*- [m]- 25
- Draught *T* -[m] -9.50
- Diameter *D*- [m]- 5
- Number of blades *Z* - 6
- Propeller RPM-120
- Average Speed-16 knots (7 m/s)
- document.

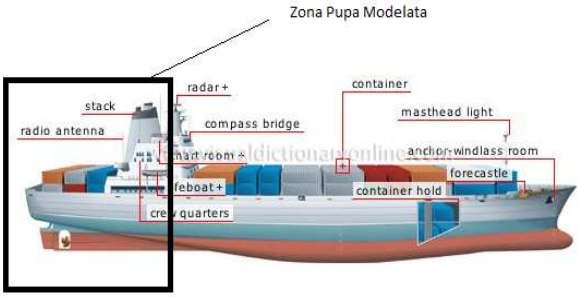
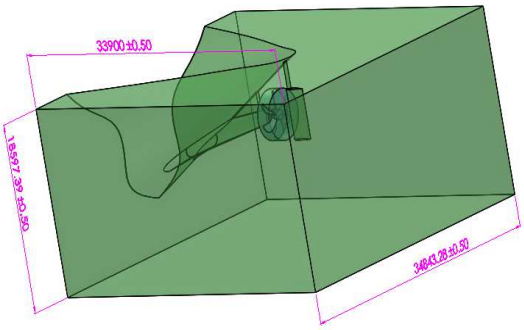
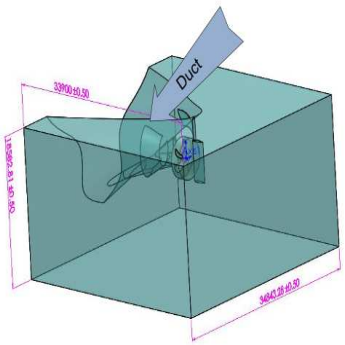


Fig. 1 Port-Container

In order to have a starting point for the simulation, first of all the after body was firstly CAD generated without the WED device, and all the parameters for fluid flow were calculated accordingly. Secondly to the CAD ship after body was attached the WED device and using the same boundary parameters for this second simulation, made possible to compare the results and pull the proper conclusions. The two CAD geometries are shown below:



a.



b.

Fig. 2 CAD geometries a-without WED, b-with WED

In order to provide more details on the geometry of WED device, the below figure is shown, with dimensions in [mm].

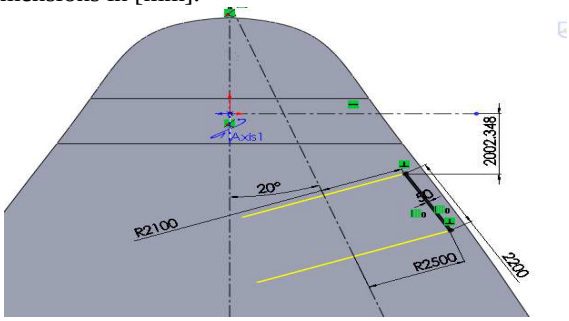


Fig.3-WED device geometry

The fluid domain was divided in two: the fluid domain which is surrounding the after body having the relative velocity on Oz axis of 7 m/s and the Propeller fluid domain with CFX option of "frozen Rotor" where the fluid is moving circularly around OZ axis with 120 RPM. In between these two domains interfaces were established. The other boundary conditions were inlet, outlet and openings as shown below:

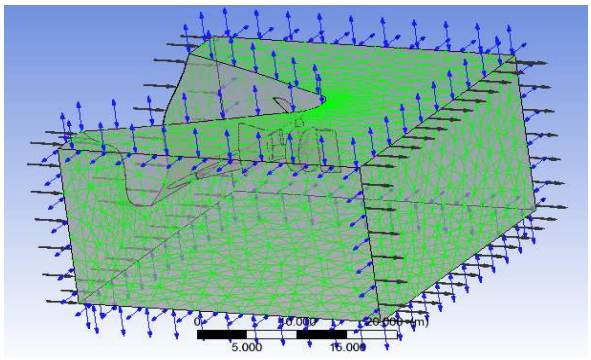


Fig. 4 Boudary Conditions

In order to make clear some important surfaces, three control planes were defined as follows:

- Control plane number 1 (P1) placed at 1200 mm above the propeller axis and coplanar with the two WED devices axis;
- Control plane number 2 (P2) which is including the propeller axis;
- Control plane number 3 (P3) placed at 1500 mm away from the propeller domain;
- Target Plane which is in fact one of the propeller domain interfaces as below.

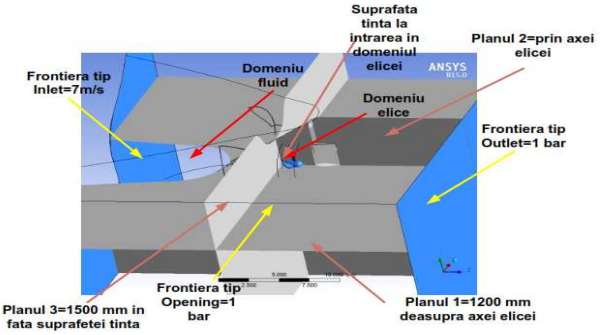


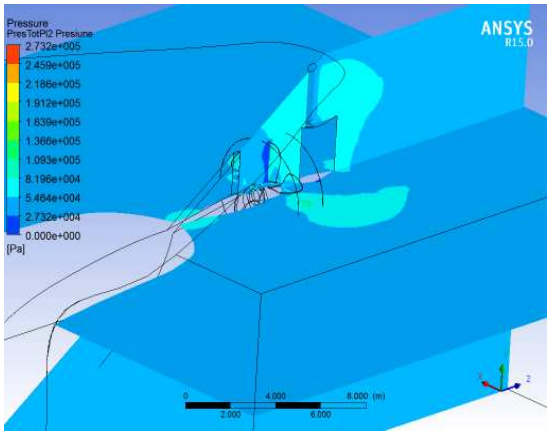
Fig. 5 Control Planes

Cavitations are that phenomenon that appears in low pressure zones of a rotating propeller where fluid vapours are prone to develop. Cavitations is a harming phenomenon tending to destroy the integrity of the propeller surfaces by the implosion of the vapours near the surface leading to the pitting of those surfaces. To simulate this phenomenon in FVA a homogenous multiphase flow of the fluid will be considered. For this the absolute saturation pressure is 3574 Pa.

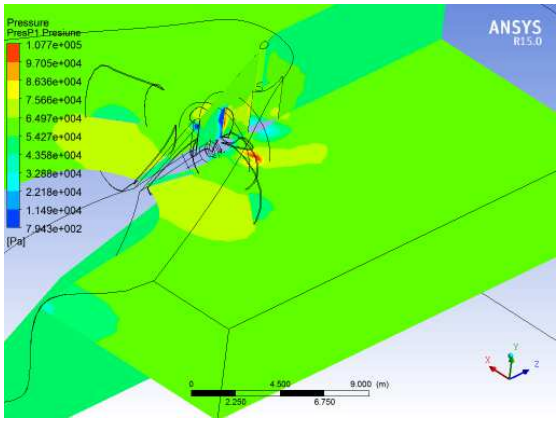
3. FVA SIMULATION AND RESULTS

After reaching the convergence of the given models, some important results were calculated. In the followings the two models are presented simultaneously in order to ease the comparison.

- **Pressures in control planes P1 and P2**



a.

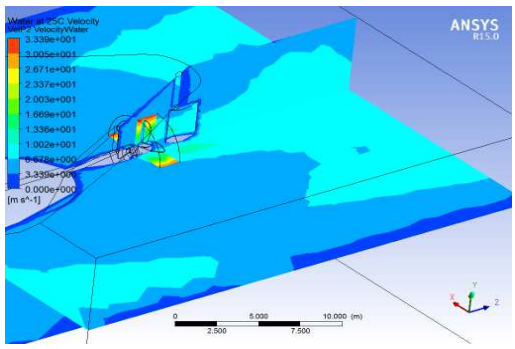


b.

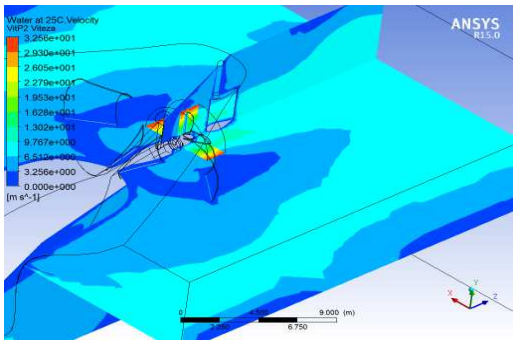
Fig. 6 Pressure fields for P1and P2
a-without WED; b-with WED

By comparing the above figures, the maximum of pressures for WED free version is 2,72e5 Pa whereas the WED retrofitted version is 1,077e5 Pa.
In the same time the shape of pressure fields is different for the two versions, the inner zone of the WED has bigger pressure fields.

- **Fluid velocities on control planes P1 and P2**



a.

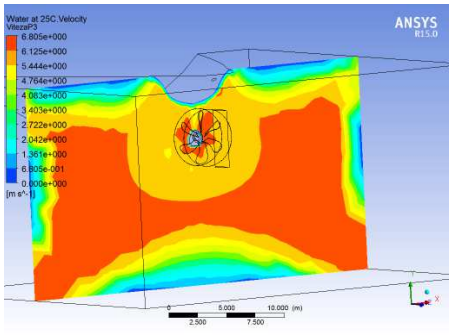


b.

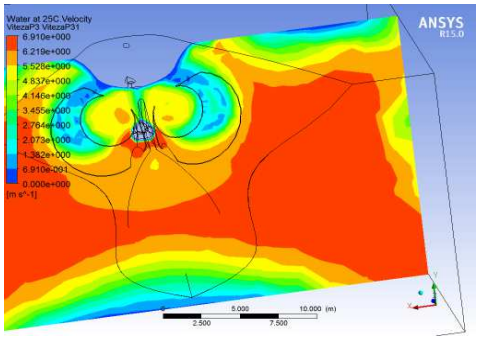
Fig. 7 Velocity fields for P1 and P2
a-without WED; b-with WED

The maximum velocities are bigger for the after body with WED (33.56 m/s). Near and after the WED devices the fluid velocities are smaller indicating a "screening effect".

- **Velocities for P3 control plane**



a.



b

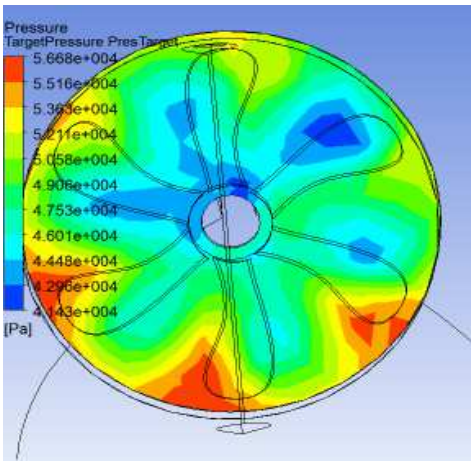
Fig. 8 Velocity fields for P3
a-without WED; b-with WED

This P3 plane is near to the Target Plane (1200 mm away) so that the influence of the propeller rotation motion is not so obvious here. As seen above the maximum velocity in both cases is the same (6.8.6.9 m/s) but field distribution is altered, the WED devices concentrating the mass flux toward their centres and, implicitly, toward the Target plane. In plane words, the WED is "stealing" streamlines of fluid from the besides of the body and is concentrating them over the Target Plane at the upper part of the propeller.

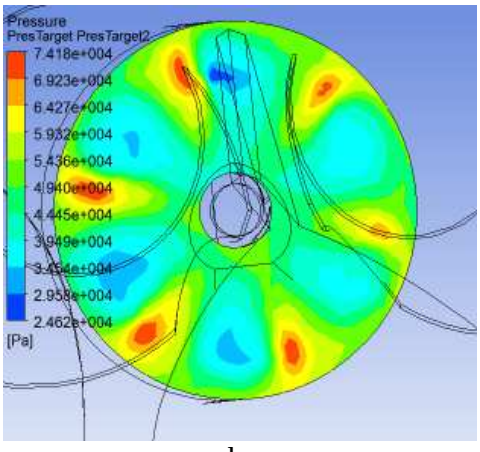
- **Pressure Fields over the Target Plane**

The target plane as mentioned is positioned exactly on the entering zone of the propeller fluid domain where no doubt, the influence of propeller motion is the most pregnant. In order to quantify the variation of pressure induced by WED, a new variable is defined to calculate the average fluid pressure on the target Plane:

Area Ave (Pressure)@Target



a.



b.

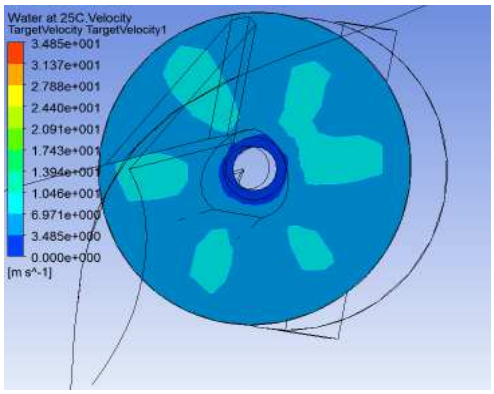
Fig. 9 Pressure fields for target Plane
a-without WED; b-with WED

The average pressure calculated is 48,213 Pa for the WED free version and 49,823 Pa for the WED version meaning that is 103%.

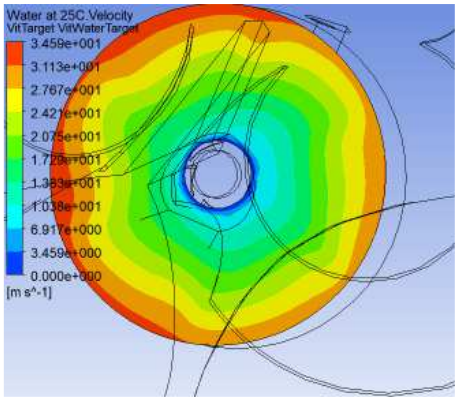
- **Velocity Fields over the Target Plane**

For the velocity fields the situation is quite reversed as compared to the above results. Introducing again a new variable to enable us to calculate the average velocities for the target plane:

areaAve(Velocity)@Target



a.

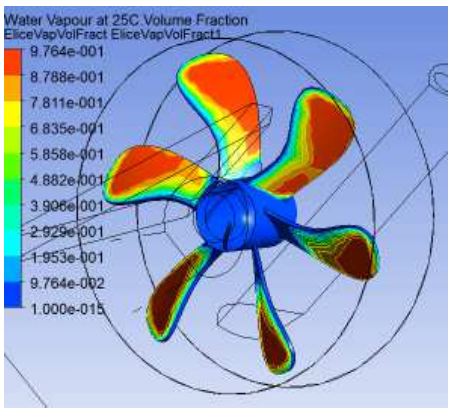


b.

Fig. 10 Velocities fields for target Plane
a-without WED; b-with WED

The WED free version is giving an average of 6.25 m/s whereas the WED version is giving 23.2 2m/s average velocity, meaning that the WED version is increasing with 363.2 % the mass flux over the target plane.

- **The vapour volume fraction for propeller blades**



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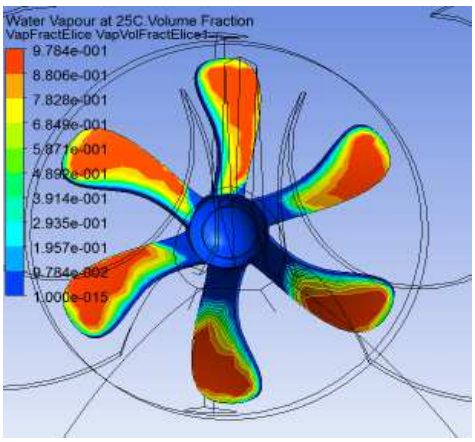
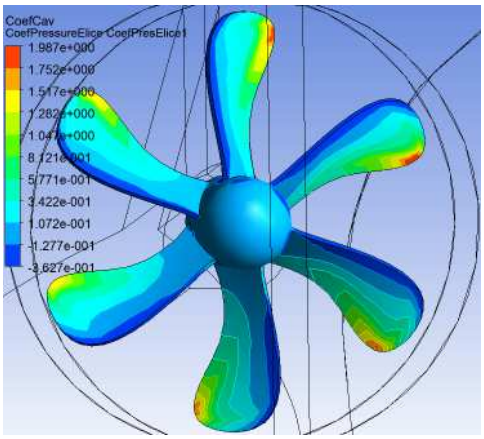


b.

Fig. 11 The volume of vapour fraction over the propeller
a-without WED; b-with WED

The vapour volume fraction is the first and almost the best indicator of the cavitations appearing in that propeller zones. Whether the conditions for vapour development are good then the formation of those vapours and their subsequent implosion is almost certain. By analyzing the above figures is becoming obvious that on the back of the blades (the blade's sides toward the ship) the vapour fraction has a maximum of 97.7 % for both cases and then at the first sight there is no positive influence of WED over the cavitations conditions of the propeller. In order to quantify this we'll need a new variable as below.



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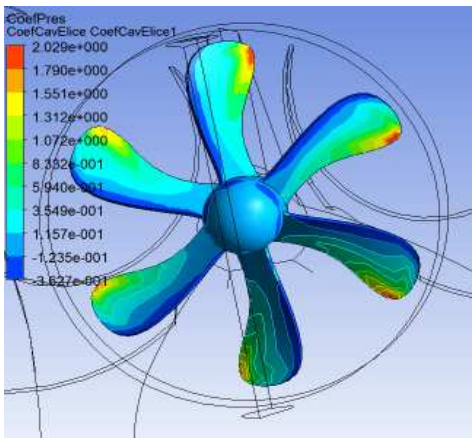

b.

Fig. 12 The pressure coefficient over the propeller
a-without WED; b-with WED

- **The average pressure coefficient on the blade surfaces**

To have a certain picture over the average pressure coefficient causing the cavitations, a new variable is introduced as follows:

Coef Pres=(Pressure-51957[Pa])/(0.5*1002[kg m^-3]*16.91[m s^-1]^2)

where "Pressure" is extracting the pressure calculated for each and every cell of the propeller blade, 5195 Pa is the relative pressure, 1002[kg m^-3] is the sea water density and 16.91[m s^-1]^2 is the average velocity of the propeller.

The above formula is as per the equation :

$$C_{p\min} = \frac{p_{\min} - p_{\infty}}{\frac{1}{2}\rho V^2} \qquad (1)$$

Where p_{min} is the minimum pressure belonging to the propeller.

The maximum values for this coefficient is 1.98 for WED free version and 2.029 for WED retrofitted version. The difference is so small that without chances of being wrong, the obvious conclusion is that WED device has no influence over the cavitations of the propeller. To decrease the cavitations we have other choices including a sound design of the propeller biased to improve the propeller behaviour in cavitations. WED is clearly not a choice

4. CONCLUSIONS

The wake equalizing duct (WED) is one of the most commonly used energy saving devices for improving the propulsion performance of a ship; and reducing the propeller-excited vibrations and viscous resistance forces.

In this paperwork two versions of an existing ship in normal version and retrofitted with WED device were analyzed in order to demonstrate the influence on the WED device on the propeller cavitations (if any). It was demonstrated that the maximum values for the pressure coefficient is 1.98 for WED free version and 2.029 for WED retrofitted version. The difference is so small that without chances of being wrong, the obvious conclusion is that WED device has no influence over the cavitations of the propeller. To decrease the cavitations we have other choices including a sound design of the propeller biased to improve the propeller behaviour in cavitations. WED is clearly not a choice.

5. REFERENCES

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"*Investigation of Scale Effects on Ships with a Wake Equalizing Duct or with Vortex Generator Fins*", Second International Symposium on Marine Propulsions, Hamburg, Germany, 2011.
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THE INFLUENCE OF A WAKE EQUALIZING DUCT OVER THE FLUID FLOW AROUND THE AFTER BODY OF A PORT CONTAINER AND PROPELLER EFFICIENCY

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ABSTRACT

To get a more uniform wake, placing several flow control devices in front of the propeller location may be a good choice. Most of these devices are used to improve propulsive efficiency, but some of them aim at improving other hydrodynamic characteristics, such as the cavitation behavior, vibration level, maneuverability, and so on. The most commonly used control devices are the wake equalizing ducts (WED hereafter), Grothues spoilers, stator fins, or different combinations of them. The goal of this paper is to calculate via software Ansys 13^{TM} the influence of placement of a WED to an existing ship over the propeller efficiency in terms of propulsion. The wake equalizing duct (WED) is one of the most commonly used energy saving devices for improving the propulsion performance of a ship; and reducing the propeller-excited vibrations and viscous resistance forces. In this paperwork two versions of an existing ship in normal version and retrofitted with WED device were analyzed in order to demonstrate the influence on the WED device on the propeller efficiency. It was demonstrated that the propulsion is increased with 4.64% which is very well in line with the results of other researchers which are crediting the WED influence somewhere in between 5 to 10%. Moreover it became obvious that the WED device is transferring some of the streamlines which in the WED free after body would simply pass beside the propeller, to the propeller fluid domain improving by this the overall efficiency of the propeller. This is demonstrating beyond any reasonable doubt that WED device is improving the performance of the propeller and the choice of retrofitting a ship with such a device may trigger fuel savings along with a less environment impact.

Keywords: *Wake Equalizing Duct; Propeller Efficiency; Maritime Ships; Finite Volume Analysis.*

1. INTRODUCTION

Extensive studies proved that the propeller represents the main source of vibration and noise aboard ships.

Lowering the vibration level can be done in two ways: either by improving the propeller design or by optimizing the wake field behind the ship hull. Because the first method requires validation in the cavitation tunnel which is rather expensive and time consuming, the attention focused towards improving the ship wake. A more uniform wake can be regarded as a mean for reduction the risk of cavitation and for lowering the level of propeller-transmitted excitations. Aside of that, sometimes a uniform wake may determine a significant increase of the propeller efficiency. To get a more uniform wake, placing several flow control devices in front of the propeller location may be a good choice. Most of these devices are used to improve propulsive efficiency, but some of them aim at improving other hydrodynamic characteristics, such as the cavitation behavior, vibration level, maneuverability, and so on. The most commonly used control devices are the wake equalizing ducts (WED hereafter), Grothues spoilers, stator fins, or different combinations of them.

WED was firstly proposed by Schneekluth (1986) and consists of two-nozzle shaped half ring ducts which are installed on both sides of the stern ahead of the propeller plane. A WED accelerates the inflow into the upper region of the propeller where the axial velocity is small relative to the corresponding lower region and in doing so, it improves the uniformity of the wake over the entire propeller disk. Moreover, a well-designed WED reduces the amount of flow separation at the stern, generates additional thrust, reduces propeller-induced vibrations and improves the steering characteristics because of the increased incoming axial speed. Despite their advantages, previous studies proved that extrapolating the WED performances from model test results to full scale is rather difficult because of the associated viscous effects:

- Separation which occurs at the model may not occur at full scale;
- Boundary layer thickness is smaller at full scale than that at the corresponding model scale;
- Over prediction of the friction on the duct at model scale (ITTC, 1999).

To investigate the scale effects, extensive experimental tests were performed by Friesch et al. (1994) for a high block coefficient hull with and without WED. The experimental work has proven that the wake equalizing ducts may result in energy saving at full scale, but it was difficult to prove a similar effect at model scale tests. This drawback is attributable to the fact that ship resistance experimental data are transposed from the model scale to the full scale based on the Froude criterion of similarity, whereas the viscous associated effects should be transposed via Reynolds. Experiments based on both criteria are hard to do unless they are performed in depressurized towing tanks. Under such circumstances, it remains that one of the few choices at hand are the measurements performed at full scale, see

Korkut (2005), Celik (2007) and Heinke et al. (2011), in spite of their prohibitive associated costs.

However, in the past years the CFD community approached the subject and some encouraging achievements have been reported.

2. CAD AND FINITE VOLUME ANALISYS (FVA) MODEL OF THE SHIP

The goal of this paper is to calculate via software Ansys 13™ the influence of placement of a WED to an existing ship over the propeller efficiency in terms of propulsion.

The model has as departure point a real port container as seen below, with the following parameters:

- Length *L*- [m]- 173
- Breadth *B*- [m]- 25
- Draught *T* -[m] -9.50
- Diameter *D*- [m]- 5
- Number of blades *Z* - 6
- Propeller RPM-120
- Average Speed-16 knots (7 m/s)

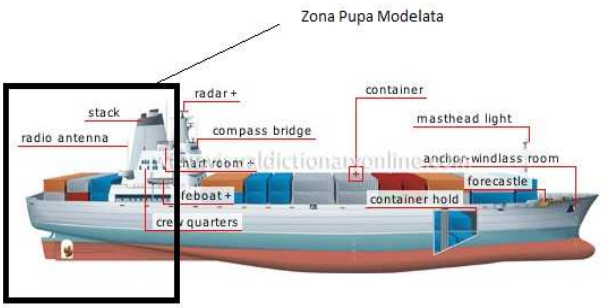
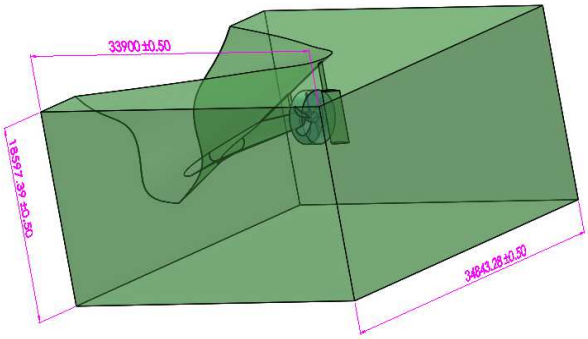


Fig.1-Port-Container

In order to have a starting point for the simulation, first of all the after body was firstly CAD generated without the WED device, and all the parameters for fluid flow were calculated accordingly. Secondly to the CAD ship after body was attached the WED device and using the same boundary parameters for this second simulation, made possible to compare the results and pull the proper conclusions. The two CAD geometries are shown below.



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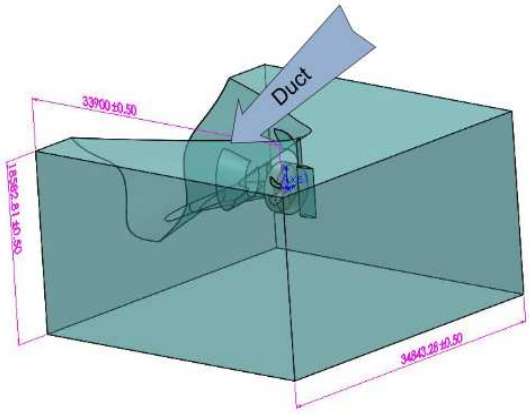


b.

Fig.2-CAD geometries a-without WED, b-with WED

In order to provide more details on the geometry of WED device, the below figure is shown, with dimensions in [mm]:

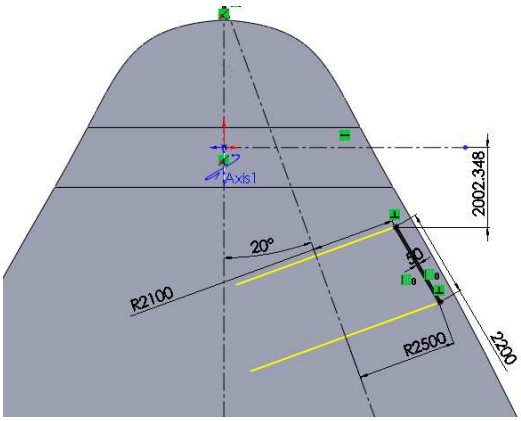


Fig.3-WED device geometry

The fluid domain was divided in two: the fluid domain which is surrounding the after body having the relative velocity on Oz axis of 7 m/s and the Propeller fluid domain with CFX option of "frozen Rotor" where the fluid is moving circularly around OZ axis with 120 RPM. In between these two domains interfaces were established. The other boundary conditions were inlet, outlet and openings as shown below:

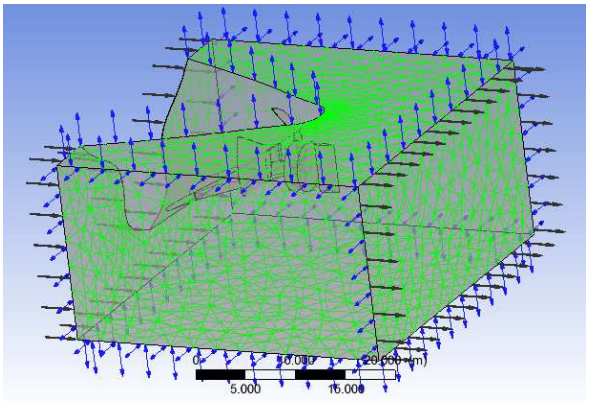


Fig.4-Boudary Conditions

In order to make clear some important surfaces, three control planes were defined as follows:

- Control plane number 1 (P1) placed at 1200 mm above the propeller axis and coplanar with the two WED devices axis;
- Control plane number 2 (P2) which is including the propeller axis;
- Control plane number 3 (P3) placed at 1500 mm away from the propeller domain;
- Target Plane which is in fact one of the propeller domain interfaces as below.

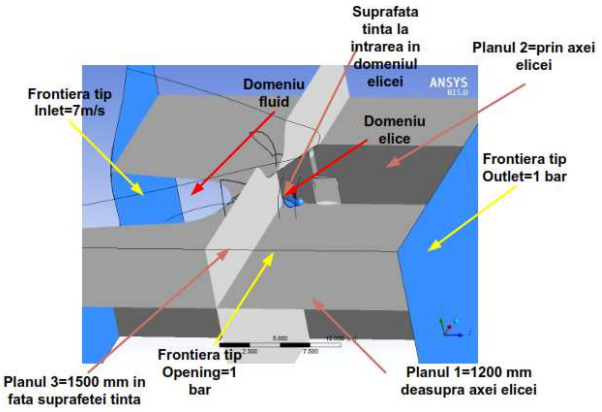
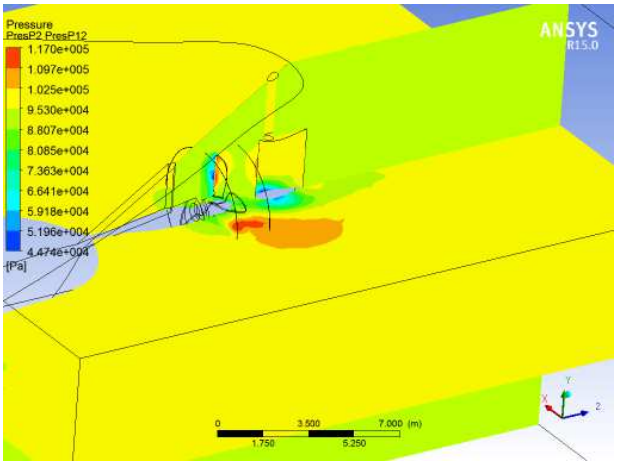


Fig.5-Control Planes

3. FVA SIMULATION AND RESULT

After reaching the convergence of the given models, some important results were calculated. In the followings the two models are presented simultaneously in order to ease the comparison.

3.1 Pressures in control planes P1 and P2



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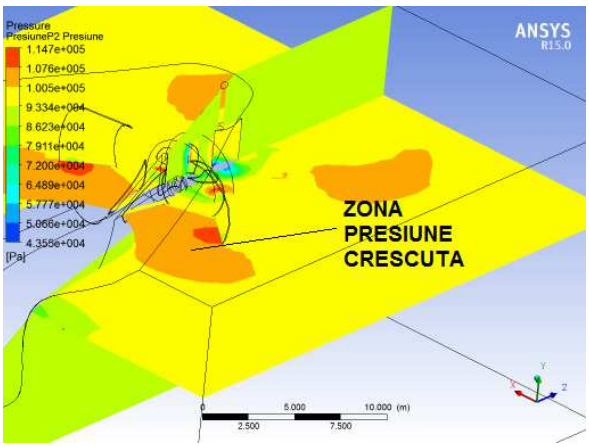
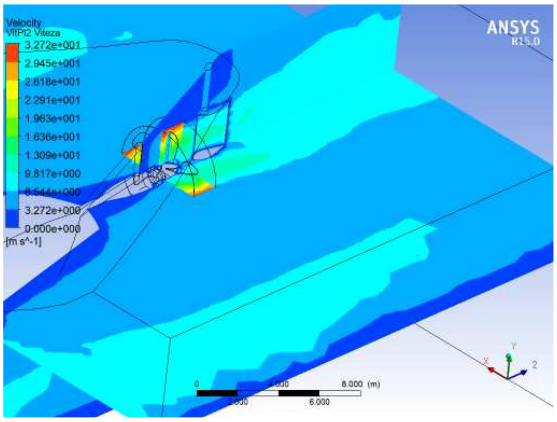


b.

Fig.6-Pressure fields for P1and P2, a-without WED; b-with WED

comparing the above figures, the maximum of pressures is equal in both cases (1.14e05 Pa) but the disposal is somehow different, since a zone of high pressure is detected to the inside of the WED devices.

3.2 Fluid velocities on control planes P1 and P2



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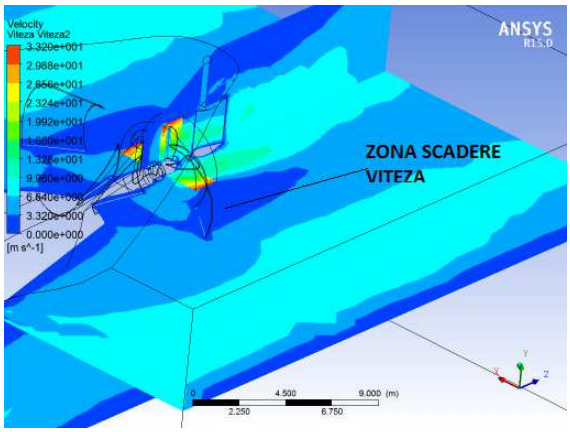
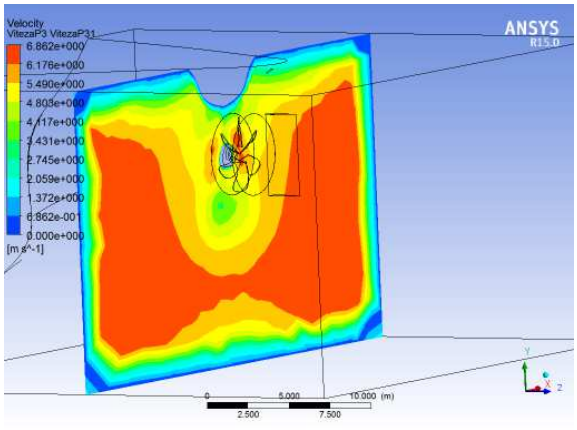


b.

Fig.7-Velocity fields for P1 and P2 a-without WED; b-with WED

The maximum velocities are bigger for the after body with WED (33.2 m/s). Near and after the WED devices the fluid velocities are smaller indicating a "screening effect".

3.3 Velocities for P3 control plane



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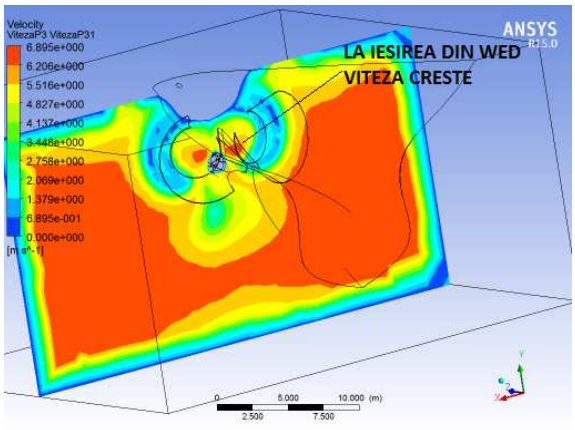


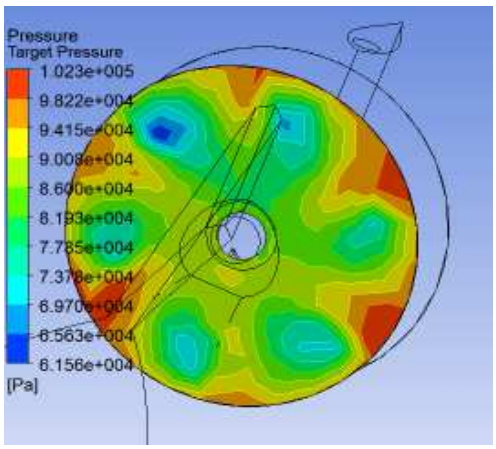
b.

Fig.8-Velocity fields for P3
a-without WED; b-with WED

This P3 plane is near to the Target Plane (1200 mm away) so that the influence of the propeller rotation motion is not so obvious here. As seen above the maximum velocity in both cases is the same (6.8 m/s) but field distribution is altered, the WED devices concentrating the mass flux toward their centers and , implicitly, toward the Target plane. In plane words, the WED is "stealing" streamlines of fluid from the besides of the body and is concentrating them over the Target Plane at the upper part of the propeller.

3.4 Pressure Fields over the Target Plane

The target plane as mentioned is positioned exactly on the entering zone of the propeller fluid domain where no doubt, the influence of propeller motion is the most pregnant. In order to quantify the variation of pressure induced by WED, a new variable is defined to calculate the average fluid pressure on the target Plane:



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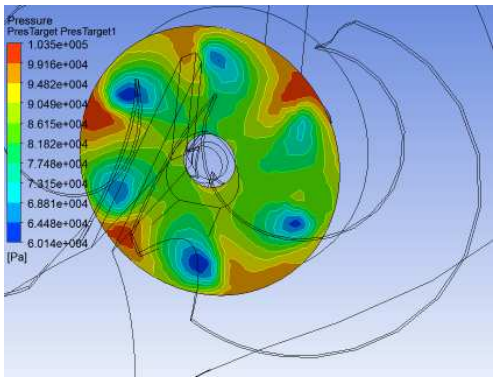


b.

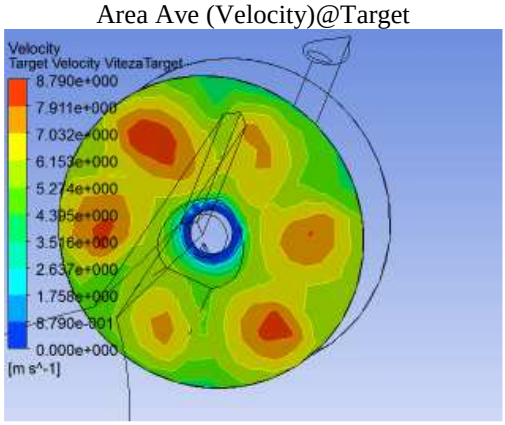
Fig.9-Pressure fields for target Plane
a-without WED; b-with WED

The average pressure calculated is 88,116 Pa for the WED free version and 84,876 Pa for the WED version meaning that is 97.3%.

3.5 Velocity Fields over the Target Plane

For the velocity fields the situation is quite reversed as compared to the above results. Introducing again a new variable to enable us to calculate the average velocities for the target plane:

Area Ave (Velocity)@Target



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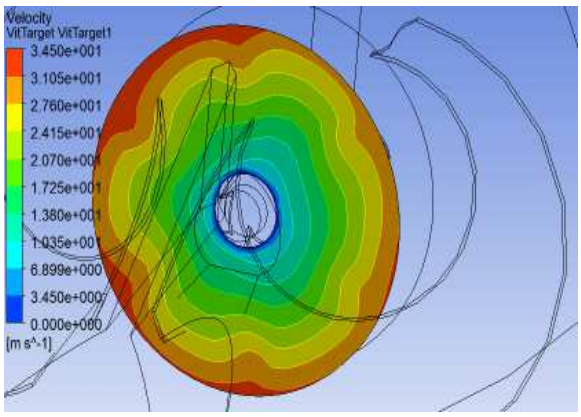


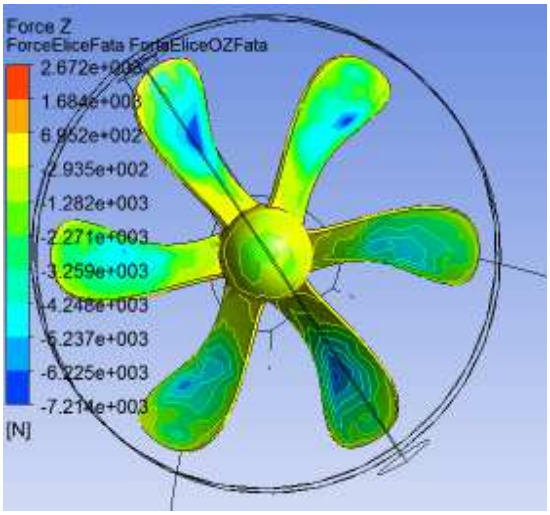
b.

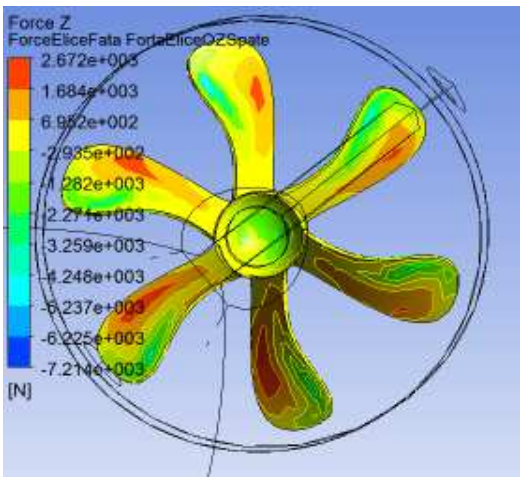
Fig.10-Velocities fields for target Plane
a-without WED; b-with WED

The WED free version is giving an average of 6.03 m/s whereas the WED version is giving 23.27 m/s average velocity, meaning that the WED version is increasing with 385.9 % the mass flux over the target plane.

3.6 The Oz interaction force component between fluid and propeller

The increased velocity of fluid at the inlet area of the propeller is expected to have a certain influence over the propeller efficiency. This can be quantified via calculating the average Oz force component of interaction between propeller and the fluid (Oz is the axis of the propeller). Since the direction of the ship motion is opposed to Oz positive direction a new variable is introduced to quantify the average force on the propeller blades:
Area Ave (Force Z)@Elice





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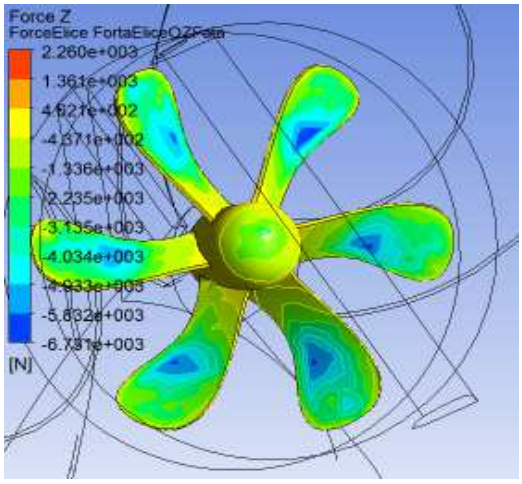
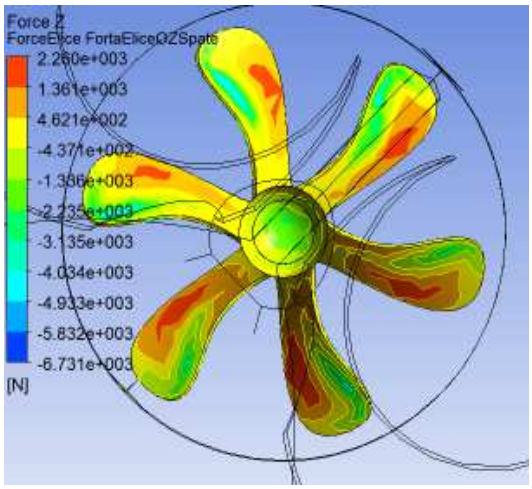


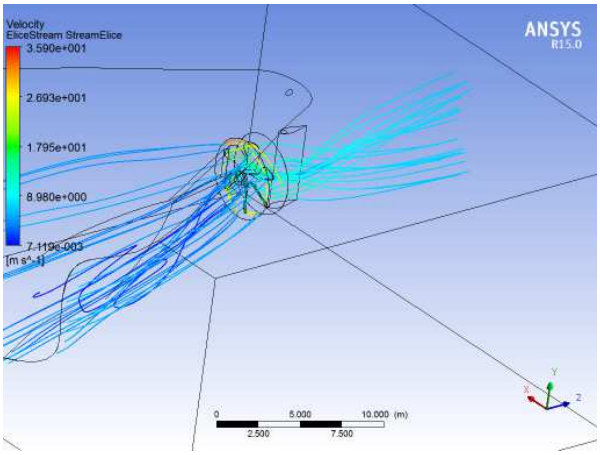


b.

Fig.11-Oz force component on both sides of the propeller; a-Without WED; b-with WED

The WED free version is giving -913.22 N and the WED version is giving -955.63 N. The efficiency is therefore increasing by 4.64 %, result which is very well in line with the results of other researchers which are crediting the WED influence somewhere in between 5 to 10%.

3.7 The WED influence over the streamlines



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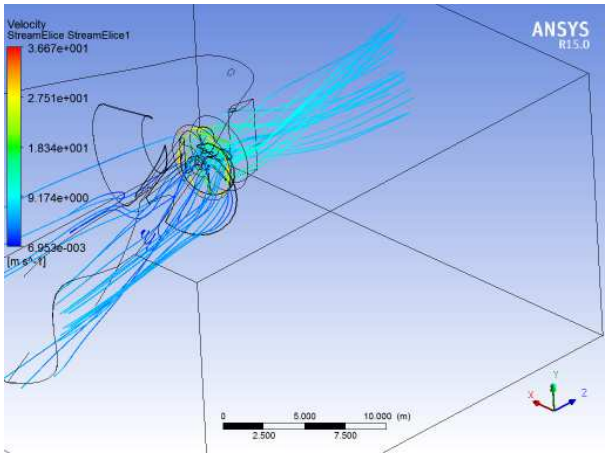

b.

Fig.12-Streamlines originated in the propeller; a-Without WED; b-with WED

By analyzing the fluid streamlines which are passing through the propeller the first conclusion should by that the bulk of them are coming from the bottom of the ship, and the second conclusion is that indeed the WED device is transferring some of the streamlines which in the WED free after body would simply pass beside the propeller, to the propeller fluid domain improving by this the overall efficiency of the propeller.

4. CONCLUSIONS

The wake equalizing duct (WED) is one of the most commonly used energy saving devices for improving the propulsion performance of a ship; and reducing the propeller-excited vibrations and viscous resistance forces.

In this paperwork two versions of an existing ship in normal version and retrofitted with WED device were analyzed in order to demonstrate the influence on the WED device on the propeller efficiency. It was demonstrated that the propulsion is increased with 4.64 % which is very well in line with the results of other researcher which is crediting the WED influence somewhere in between 5 to 10%. Moreover it became obvious that the WED device is transferring some of the streamlines which in the WED free after body would simply pass beside the propeller, to the propeller fluid domain improving by this the overall efficiency of the propeller.

This is demonstrating beyond any reasonable doubt that WED device is improving the performance of the propeller and the choice of retrofitting a ship with such a device may trigger fuel savings along with a less environment impact.

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ON A RISK THAT MAY OCCUR DURING THE OPERATION OF PLATE ROLLS WITH C-TYPE DEVICES

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ABSTRACT

The paper aims to analyze the behavior and operating principles of C-type devices in cargo handling operations such as loading, carriage and discharging of plate rolls. It highlights the economic advantages of using C-type devices during plate rolls handling operations, as well as the risks and hazards associated with it. The papers also provides a numerical example related to the use of a C-type device for roll handling designed by SC Butan Grup SA Galati.

Keywords: *C-type devices, plate rolls, cargo handling operations*

1. INTRODUCTION

Plate rolls are single solid cargo, which, in terms of transport, are part of those whose handling (loading / carriage / discharge) is based on *placement*. **C**-type devices are commonly used for loading / discharging of plate rolls and similar products on/from the vessel. Unlike other devices used for similar products (Figure 1 a, b, c), those of type **C** (see Figure 1, *d*) offer the advantage of high productivity. However, their use may pose hazards caused by the misunderstanding of their operating principle and the failure to strictly comply with their operating instructions. Therefore, slippage of rolls from their device may occur - with serious consequences that may result in material loss and even human life loss.

a)

b)

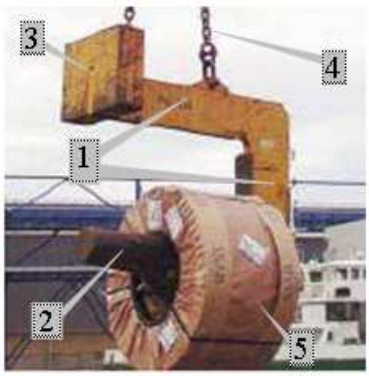
c)

d)

Figure 1 Lifting devices for:
a) steel bars and tubes (horizontal position); *b*) steel tubes; *c*) plate coils (upright position); *d*) plate rolls (horizontal position)

Figure 2, *a* shows (front and profile) a device for the operation of **C**-type rolls, designed by SC Butan Grup SA Galați [[1] and Figure 2, *b*, a devices produced in the UK – offered by Kinetech Distribuitor SRL [[2].

a)



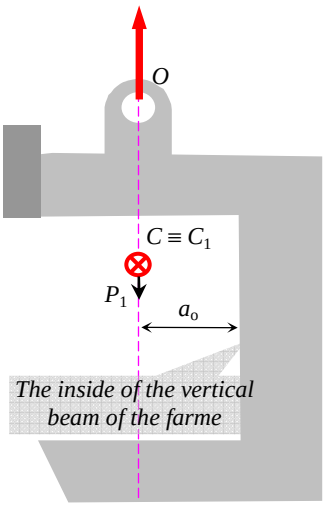
b)

Figure 2
1 - Metal frame, 2 - Horizontal beam that supports a plate roll (for other products, a platform is also provided) 3 - counterweight, 4 - Cable or chain, 5 – plate roll

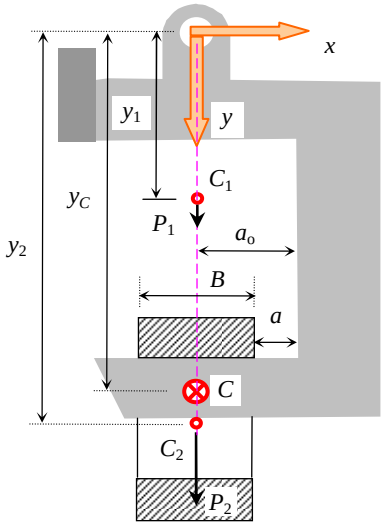
2. MODELING THE BEHAVIOR OF A C-TYPE DEVICE DURING PLATE ROLL HANDLING

In a simple form, a c-type device is shown Figure 3, *a*. Together with a counterweight, it has its own mass m_1 and is designed so that, in a free state, load free, the placement beam is horizontal. Its center of gravity C1 is in the same vertical line as that of the suspension point, *O*, and in the load-free condition. The distance from the inside of the vertical beam of the frame to the vertical line passing through the point of suspension *O* is marked a_o, and to the nearest edge of the plate roll it is marked *a*

(Figure 3, *b*). For safe operation it is necessary that the width of the roll satisfy the relation $B/2 \le a_o$.



a)



b)

Figure 3

a) Figure 3, *b* shows the device with a plate roll of mass m_2, positioned in such a manner so that its mass point (C_2) is located on the vertical line passing through *O* and C_1. In this case, mass point (*C*) of the assembly shall be located on the same vertical line and the placing beam (platform) shall remain in horizontal position. Distance *a* has a particular value in this case, namely

$$\tilde{a} = a_o - \frac{B}{2} . \quad (1)$$

In the reference system with the origin at point *O* (considered immovable):

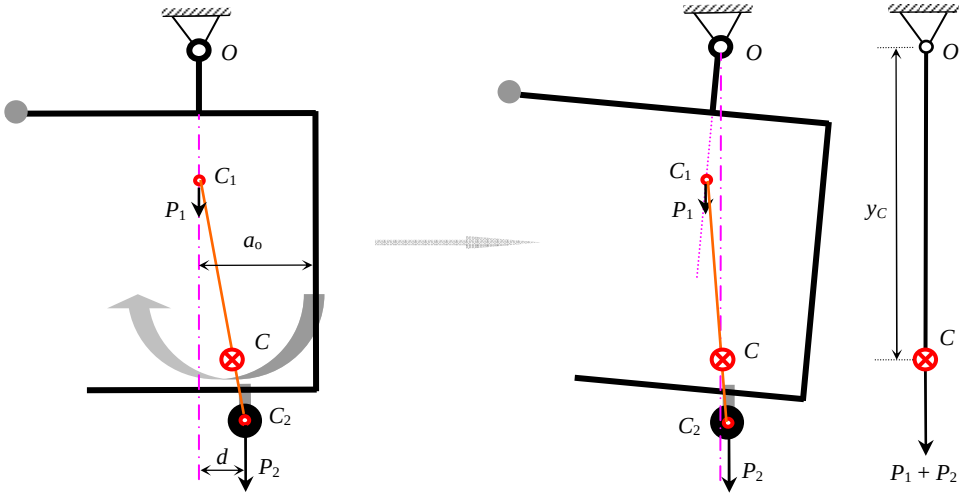
$$x_C = x_1 = x_2 = 0 ; \quad (2)$$

$$y_C = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2} . \quad (3)$$

b) If, initially, the plate roll is positioned eccentrically to the right, at distance d to the position mentioned at point a, so that its mass point is no longer on the vertical line of point O (Figure 4, *a*), there is a point *P2 d* which rotates the assembly clockwise. This rotation triggers the repositioning of the mass point of the assembly (Figure 4, *b*), since the position of stable equilibrium is that where C lies on the vertical line of the support cable (see the mathematical pendulum to which the physical pendulum made of device and roll can be assimilated (Figure 4, *c*). An initial positioning of the load as shown in Figure 4, a is safe, since, by the rotation in a clockwise direction, the distance

$$a < \tilde{a} = a_o - \frac{B}{2} \quad (4)$$

tends to zero, the device having a behavior that is similar to that of a normal hook.



a) *b*) *c*)

Figure 4

c) If the roll is initially positioned to the left (Figure 5, *a*) at distance d from the position referred to at point a, P2 d moment which occurs rotates the assembly through an angle in the counter-clockwise direction (Figure 5, *b*). In such a case, which occurs when

$$a > \tilde{a} = a_o - \frac{B}{2} , \qquad (5)$$

it is possible that, at a certain angle φ, the roll slide to the left, causing an increase in the angle of inclination, and finally the fall of the plate roll from the C–type device.

The dependence between angle φ and distance d is determined from the condition that point C is on the vertical line of the support cable, i.e., the abscissa of the mass point of the assembly is zero (Figure 5, *b*):

$$x_C = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = 0 \rightarrow m_1 x_1 + m_2 x_2 = 0 \qquad (6)$$

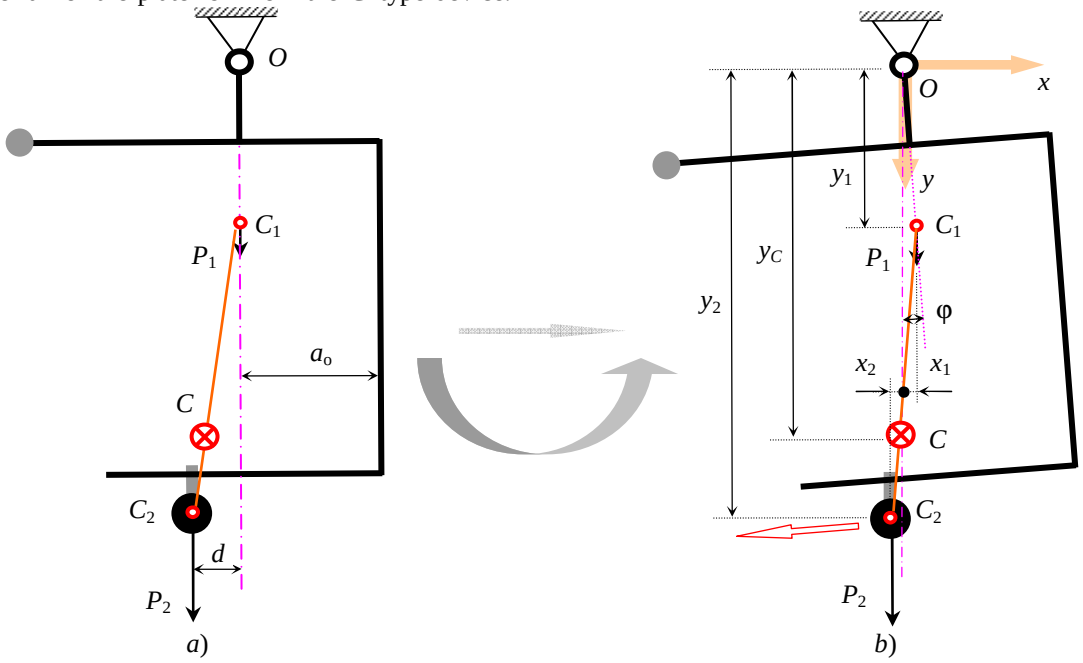


Figure 5

After rotating the device by angle φ and setting the balance, the abscissas of the mass points of the device and plate roll are given by the following relationships:

$$x_1 = y_1 \sin\varphi , \qquad (7)$$

$$x_2 = -d + y_2 \sin\varphi , \qquad (8)$$

By replacing these expressions in $(6)_2$, it results that:

$$\varphi = \arcsin \frac{d}{y_2 + \frac{m_1}{m_2} y_1} . \qquad (9)$$

After rotating the device caused by the eccentric positioning of the roll towards the vertical line of the support point of the device, the roll is on an inclined plane. Component T of P1 weight depends (see Figure 6) on angle φ, hence on eccentricity d, according to the relations

$$T = P_1 \sin\varphi = P_1 \frac{d}{y_2 + \frac{m_1}{m_2} y_1} \qquad (10)$$

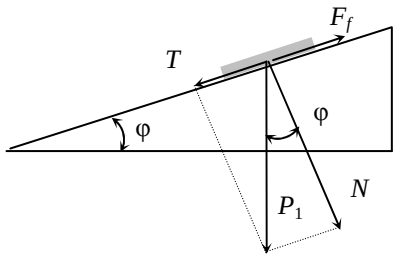


Figure 6

The maximum friction force that can occur between the roll and the device is

$$F_{f\max} = \mu N = \mu P_1 \cos\varphi , \qquad (11)$$

where μ is the friction coefficient between the roll and the placement beam.

The condition that slippage does not occur is given by the following inequality

$$T < F_{f\max} \quad \rightarrow \quad \tan\varphi < \mu . \qquad (12)$$

If friction angle φ_o is introduced ($\tan\varphi_o = \mu$), the result is the well-known condition

$$\varphi < \varphi_o . \qquad (13)$$

i.e.

$$\arcsin\frac{d}{y_2+\frac{P_1}{P_2}y_1}<\varphi_o \Leftrightarrow d<\left(y_2+\frac{P_1}{P_2}y_1\right)\sin\varphi_o \quad (14)$$

3. NUMERICAL EXAMPLE

Below are presented the numerical results obtained on a **c**-type device for roll handling designed by SC Butan Grup SA Galati, with mass

$m_1 = 1300\ Kg$.

The position of the mass point of the device was determined by the lead line method (Figure 7).

Lead line

Centre of gravity

Figure 7

The result obtained by measurement is

$y_1 = 0{,}92\ m$.

For the mentioned device, with a roll of

$m_2 = 19435\ Kg$,

$y_2 = 2{,}05\ m$,

the result is $y_C = 1{,}948\ m$.

From all these data, we have:

$$d\,[m]<\left(2{,}05+\frac{1.300}{19.435}0{,}92\right)\sin\varphi_o = 2{,}11\sin\varphi_o \quad (15)$$

For values of the dry friction coefficient (steel on steel) included in $\mu = 0{,}18 \div 0{,}25$ ($\varphi_o = 0{,}168 \div 0{,}245$ rad), the result is

$$d < 0{,}45...0{,}5\ [m] \quad (16)$$

4. CONCLUSIONS

C–type devices have a high degree of safety if operated correctly, according to operating instructions that take account of the specific device and plate rolls to be handled.

For the avoidance of the roll sliding in the device, it is strictly necessary that the condition

$$B < 2a_o\,. \quad (157)$$

be observed, as well as condition **(4)**. Due to vibration and shock inherently occurring during the operation of lifting and transporting equipment, and the possible presence of oil stains, distance *a*, where slippage of plate rolls can occur, may correspond to an inclination less than 10°. Taking into account possible operations in low-light conditions (bad weather or night time), in order to avoid accidents, condition

$$a = 0\ , \quad (168)$$

is required, i.e. the complete insertion of the roll into the device.

It is also necessary to provide information and transmission marks (documents), as well as handling marks (symbols such as  to clearly indicate the position of the center of gravity - in particular if this position is not central). In some situations roll stowage equipment may be used, such as straps, slings, wire. It is necessary to provide responsible preparation for the staff and to maintain discipline in the workplace. The projects of such devices can be improved in order to avoid accidents.

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COASTAL IMPACT SIMULATION OF A WAVE DRAGON FARM OPERATING IN THE NEARSHORE OF MANGALIA

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ABSTRACT

The objective of the current work is to simulate the influence of a Wave Dragon farm operating in the vicinity of the Romanian nearshore, more precisely in the Mangalia sector. As a first step, the SWAN model was initially used to identify the wave conditions from the vicinity of the target area in order to highlight the main wave characteristics for a ten-year time interval (between 1999 and 2008). Some relevant wave patterns were identified based on this data, which were further used to determine the influence of the Wave Dragon systems on the local wave heights distribution. The physical implementation of the wave farm in the geographical space was possible by considering the obstacle command, which is included in the SWAN model. The shielding effect induced by the wave farm is more significant in the case of the average and extreme scenarios, which suggest that beside the production of electricity such projects, could be considered also suitable for the coastal protection on a local level.

Keywords: *Romanian nearshore, SWAN, Wave Dragon, renewable energy, coastal dynamics.*

1. INTRODUCTION

The global energy market relies mainly on the fossil fuels deposits which are limited and can eventually run out. In contrast, the renewable energy sources are being provided by the sun (directly or indirectly) and present the advantage that they can be replaced by the natural processes at a rate similar to their use.

From the marine environment can be mentioned the wave energy which is the energy transferred from the wind to the air-sea interface. Waves represent an efficient way to transport energy over large water surfaces and although the most energetic regions are being located on the ocean regions (between 30º and 60º latitudes) recent studies revealed the potential of some other areas, like the Mediterranean or the Black Sea [1, 2].

Most of the wave energy converter (WEC) systems are in the research & development stage although over 1000 conversion techniques are been reported in Japan, North America and Europe and the first patent was reported during the oil crisis from 1970 [3]. The immaturity of this market results from the multiple opportunities to harness the wave power (location, methods, etc) which led to the development of a large number of systems, compared to the wind industry where the Danish wind turbine model (three blades) is considered as a reference. Nevertheless several WEC systems are starting to emerge and can be successfully implemented in the near future, such as: LIMPET, Pelamis, AquaBuOY, Wave Dragon or Oyster [4].

The Romanian Black Sea coast is characterised by a linear configuration which is locally modified by the presence of the major harbours (Mangalia, Constanta and Midia) and several coastal protection structures such as breakwaters. The Danube River is the main source of alluvial sediments for the beach areas, the circulation process being mainly influenced by the joint action of the waves and coastal currents [5].

Two geomorphologic units define the littoral: the northern units defined by the Danube Delta and the southern unit which is located between the Mamaia Bay and the border with Bulgaria. The Midia Harbour jetties can be considered an important element for the sediment transport between the two units since remove a large amount of alluvia (to the sea) from the littoral circulation [6]. Since the coastal areas are dynamic environments where the erosion and accretion processes are constantly shifting, the lack of sediments and the abrasive action of the waves can lead to severe changes in the configuration of the shoreline.

In this context the purpose of the present work is to identify the impact of a Wave Dragon farm on the local wave conditions from the vicinity of the Mangalia sector in order to provide a better understanding of how similar projects can be used for the coastal protection.

2. METHODS AND MATERIALS

In the present work, the SWAN (Simulating Waves Nearshore) modelling system was used in order to simulate the wave condition from the target area. This is considered to be a state of the art wave model which determines the spectral energy balance equation in time, spectral and geographical spaces [7]. This is based on the action density spectrum (N) since in the presence of the currents the action density it is conserved, while the energy density (E) is not. Also, it can be mentioned that the spectral action balance equation is equal to the energy density divided by the relative frequency (σ).

Finally, the spectral action balance equation can be expressed as:

$$\frac{\partial N}{\partial t}+\nabla[(\vec{c}_g+\vec{U})N]+\frac{\partial}{\partial\sigma}c_\sigma N+\frac{\partial}{\partial\theta}c_\theta N=\frac{S}{\sigma} \quad (1)$$

Where θ is the wave direction and $\vec{U}$ the velocity of the ambient current which is considered uniform with respect to the vertical coordinate. The propagation velocities of the wave energy are the group velocity $\vec{c}_g$ in the physical space $\left(\vec{c}_g=\partial\sigma/\partial\vec{k}\right)$ with *k* the wave number associated with the relative frequency, $c_\sigma=\dot{\sigma}$ and $c_\theta=\dot{\theta}$ in the spectral space. In shallow water, additional phenomena like bottom friction, depth induced wave breaking and triad nonlinear wave-wave interactions induced by the finite depth effects should be also considered.

The computational domain considered in the present work is defined by a rectangular area with a length of 5km in x-direction (cross shore) and 6km in y-direction (long shore), more information regarding the target area is provided in Figure 1. Regarding the Wave Dragon farm, this consists of 5 WEC systems which are aligned parallel to the coastline on a two lines configuration. Each system presents two wave reflectors which cover a length of 300m (similar to the real device), while for the numerical simulations carried out with the SWAN model a distance of 25m was considered between each system (from a single line). The distance between the two lines was set to 190m while for the transmission coefficient a value of 0.68 was considered, similar to the one used in Diaconu 2013[8].

In the absence of in situ wave measurements for this particular area, the SWAN model was used to simulate the wave conditions on a coastal resolution. As an input was considered the wind data provided by the NCEP-CFSR (United States National Centers for Environmental Prediction, Climate Forecast System Reanalysis), which is characterised by a spatial resolution of 0.312º x 0.312º and a time step of 3 hours.

The numerical simulations are focused on the time interval January 1999 - December 2008 and for the Mangalia sector some relevant wave parameters were indicated for the point S (28º84'E/43º90'N) which is located in the vicinity of the target area.

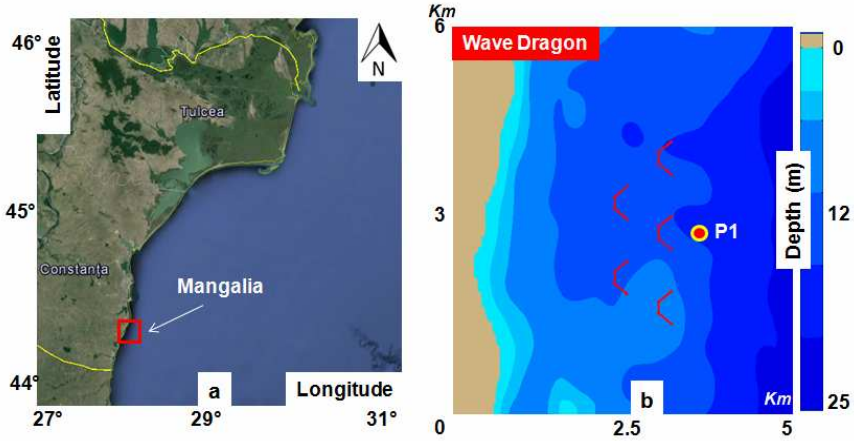

Figure 1 A general overview of the target area, where: a) Romanian Black Sea coast; b) general characteristics of the computational domain, where in the background is presented the bathymetry of the target area while in the foreground the location of the Wave Dragon farm (5 systems)

3. RESULTS

In Figure 2 is presented the evolution of the wave parameters for the point S: significant wave heights (*Hs*) and the mean wave period (*Tm*), respectively. The monthly variations of those characteristics is indicated in Figure 2a and 2b in terms of the mean, 95th percentile (indicated by 95%) and extreme values. Regarding the *Hs* parameter can be noticed that much higher values are being reported during the winter time (between October and March) with a maximum value of 5.7m in January and a 5.2m in November, while for the 95 percentile the wave height do not exceed 3m. Compared to this during the summer time much lower values can be observed in June (2.15m) and August (2.5m). In terms of the wave period can be mentioned a peak value of 10s during March, while the mean and 95 percentile report values below 4s and 6s, respectively.

Considering the histogram distribution (during the total and winter time) can be noticed a significant distribution of the *Hs* values in the range of 0.5-1.5m while the *Tm* parameter indicates a maximum peak for the 2-3s classes.

Based on the wave roses illustrated in Figure 2e and 2f can be observed that the waves coming from the north, north-east and south sector tend to be more dominant, while in terms of the wave height more significant values (from the interval 3-4m) are being reported from the north-east sector during the winter season.

Considering the previous results the following case studies were identified:

- CS1: *Hs*=0.9m; *Tm*=3.2s - average conditions;
- CS2: *Hs*=2.3m; *Tm*=5.4s - energetic conditions;
- CS3: *Hs*=5.7m; *Tm*=10s - extreme situation.

Since the wave direction can vary from north to the east sector and the shoreline is located on the east sector, the following directions were considered for the simulations: a) north-east (30º); b) east (90º) and c) south-east (150º).

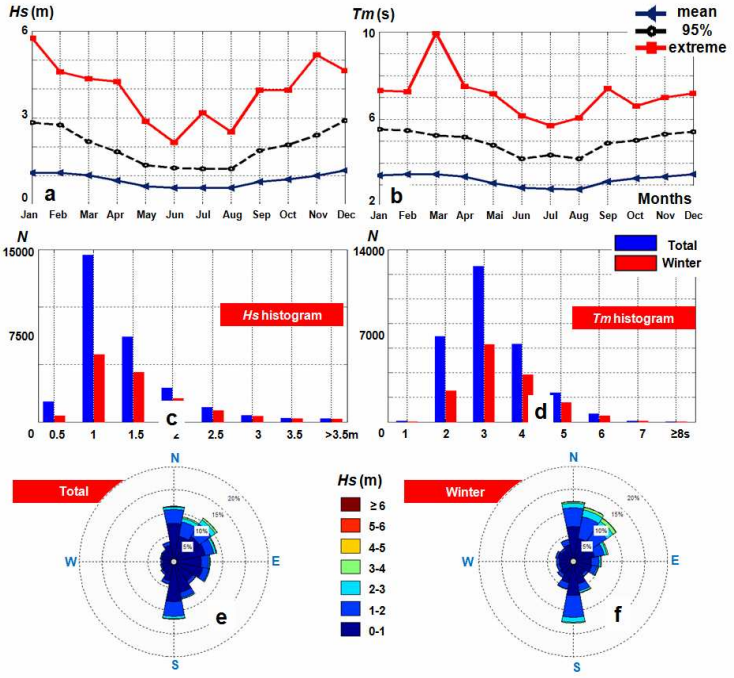

Figure 2 Wave statistics in the point S (28°84'E/43°90'N) for the time interval January 1999 - December 2008. Evolution of the parameter *Hs* (m) and *Tm* (s), where: a, b) monthly variation; c, d) histograms for the total and winter season; e, f) wave roses reported for the total and winter season

Figure 3 illustrate the nearshore transformation of the local wave field for the case study CS1. In the absence of the wave farm the target area is defined mainly by the presence of a single wave field which report a maximum of 0.9m in the offshore region and a minimum of 0.5m in the vicinity of the shoreline. When the waves are coming from the north-east sector can be noticed that the shielding effect of the Wave Dragon farm generate an extension of the narrow wave field located from the shoreline (depth<4m) while behind each WEC system can be reported wave heights of 0.4m. In the case of the east waves the second line of the WEC systems show a more significant impact on the incoming waves indicating in the vicinity of the systems values of 0.45m. The influence of the wave farm in the geographical space in the case of the south-east waves is similar to the one reported for the north-east waves, with the mention that this time much higher variations are being reported in the upper part of the target area.

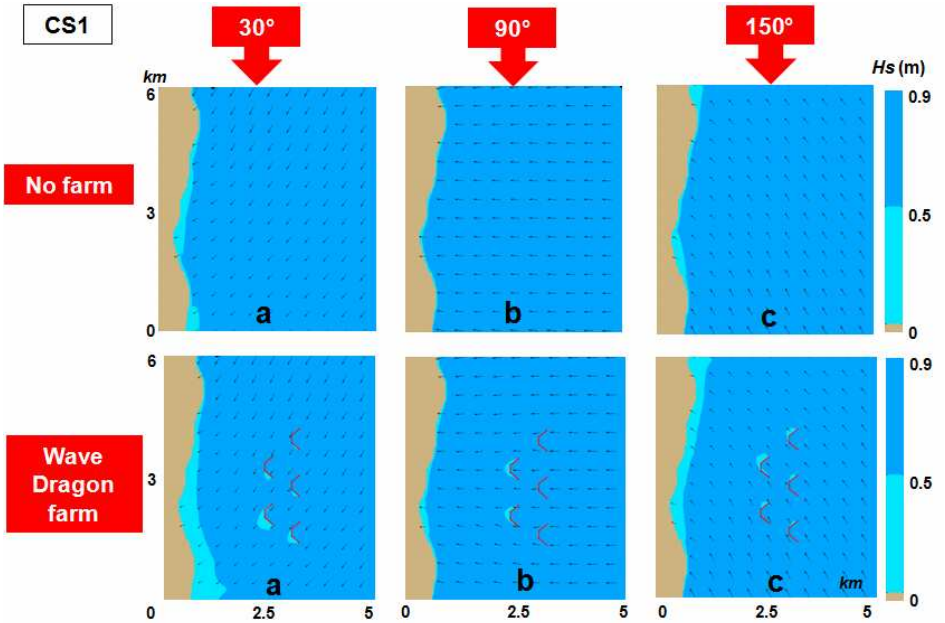

Figure 3 Evaluation in the geographical space of the influence of the Wave Dragon wave farm considering the case studies CS1, for: a) north-east waves (30°); b) east waves (90°); c) south-east waves (150°)

In Figure 4 is presented the evolution of the incoming waves which is reported along a line which start from the point P1 (located in front of the farm - Figure 1), cross the middle of the wave farm and finally ends on the shoreline. In the absence of the WEC systems can be noticed that incoming waves are gradually decreasing (from offshore to the nearshore) from 0.72m to 0.5m (north-east and south-east waves) and from 0.78m to 0.61 in the case of the east waves.

For the north-east waves the presence of the Wave Dragon systems can reduce the wave heights to 0.55m, the profile highlighting the influence of the second line of the WEC system and a local regeneration of the wave heights. In the case of the east waves, the *Hs* parameter can report a minimum value of 0.5m on the contact with the first line of wave farm.

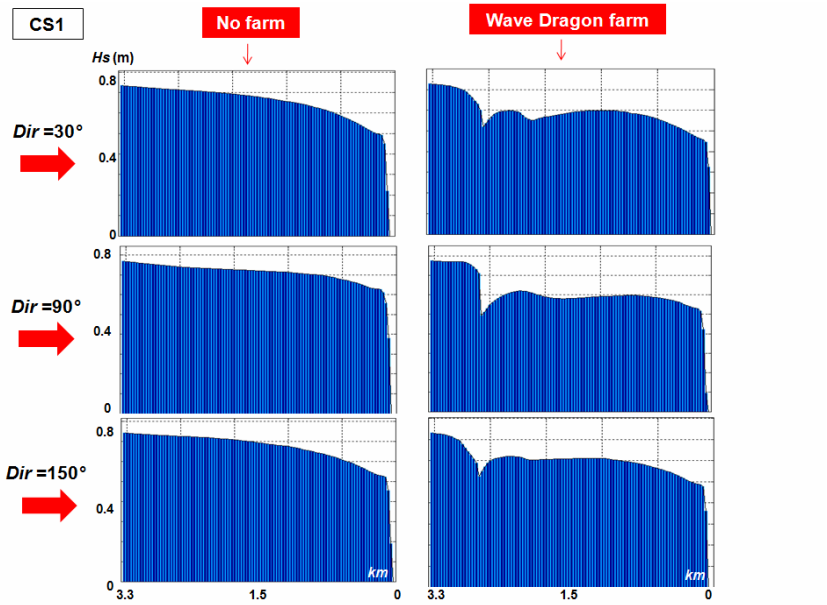

Figure 4 Variation of the *Hs* parameter for the case studies CS1 along a line defined by the point P1- shoreline (passing through the middle of the Wave Dragon farm)

The influence of the wave farm in the geographical space is presented in Figure 5. In the target area can be observed the presence of the two distinct wave fields which reveals values of 2-2.3m (for the offshore one) and wave heights in the range of 1.56-1.97m close to the shoreline, while for the east waves in the lower part of this area it is noticed the occurrence of wave heights close to 2m. For these wave conditions the influence of the WEC systems is more severe than on the first case studies, which mean that the shielding effect generated by the wave farm can lead to an expansion of the shoreline wave field until they reach the second line (from the shore) of the Wave Dragon farm. In this case behind the first line of WEC systems the *Hs* parameter can reach values of 1.4m.

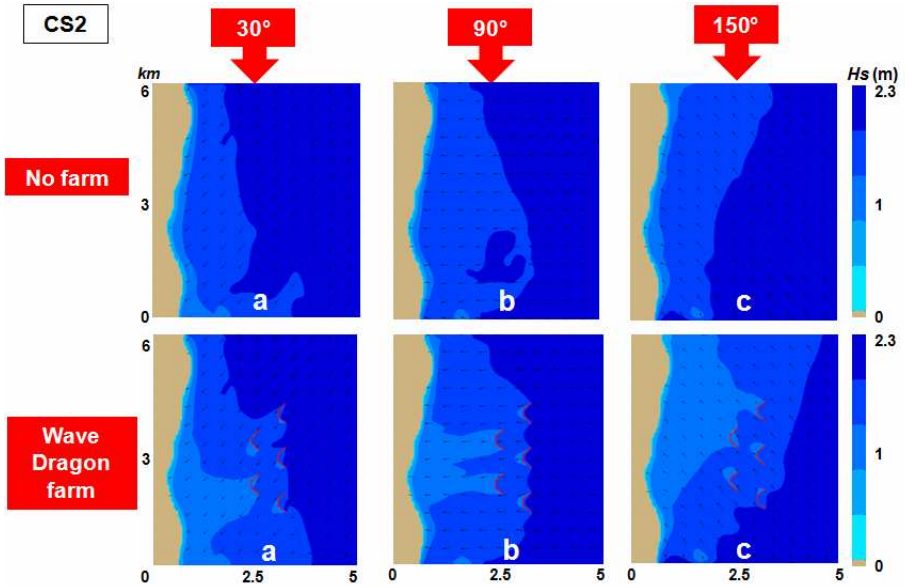

Figure 5 Evaluation in the geographical space of the influence of the Wave Dragon wave farm considering the case studies CS2, for: a) north-east waves (30°); b) east waves (90°); c) south-east waves (150°)

A more detailed investigation of the wave transformation along the reference line defined by the point P1 for the case studies CS2 is presented in Figure 6, where can be noticed that in the offshore area the wave heights are almost 3x higher than the one reported for the CS1.

When the waves are coming from north-east the Wave Dragon farm can initially reduce the wave heights to a 1.5m on the contact with the first and second line, with the mention that between these two lines the *Hs* can reach a maximum of 1.7m. In the case of the east waves can be expected that WEC systems to reduce the initial wave heights to a value of 0.9m which remain constant until the vicinity of the shoreline when the incoming waves will collapse.

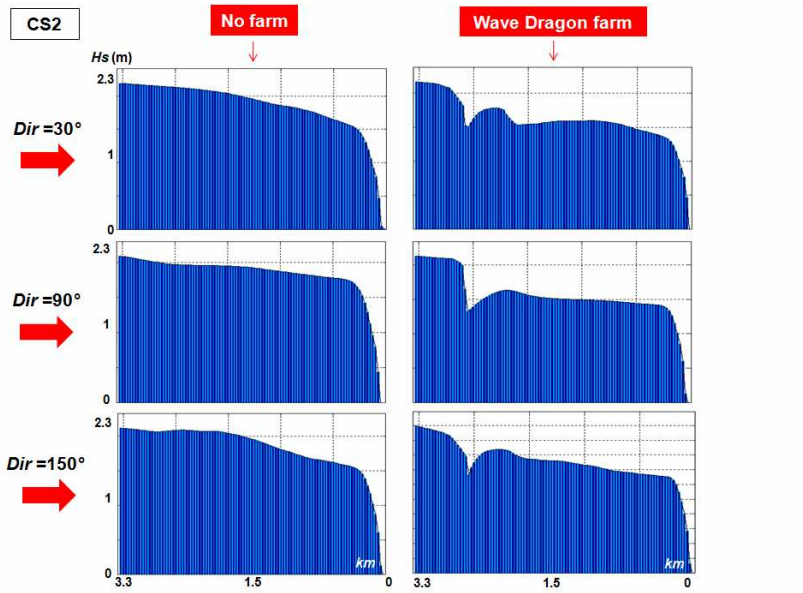

Figure 6 Variation of the *Hs* parameter for the case studies CS2 along a line defined by the point P1- shoreline (passing through the middle of the Wave Dragon farm)

In Figure 7 is presented the distribution of the wave heights which correspond to the case studies CS3. Can be noticed that for the north-east waves, the presence of the wave farm generate in the upper part of the target area a wave field with values in the range of 3.6-3.8m, while in the central region the wave heights of 3.2m are more dominant. In the lower part is possible to occurs *Hs* values of 2.6-2.9m which can expand from the shoreline area to the second line of the WEC systems (from the shore), while locally behind each Wave Dragon system much lower values can be reported (between 2.3m and 2.5m).

When the waves are coming from east in the upper part of the wave farm can be observed wave heights of 3.7m, compared to the central area where behind the second WEC line is reported a value of 3.2m. In the case of the south-east waves between the wave farm and the shoreline are reported three distinct wave fields: 3-3.3m (close to the wave farm); 2.5-2.8m (central area); 2.2-2.5m (close to shoreline - lower part).

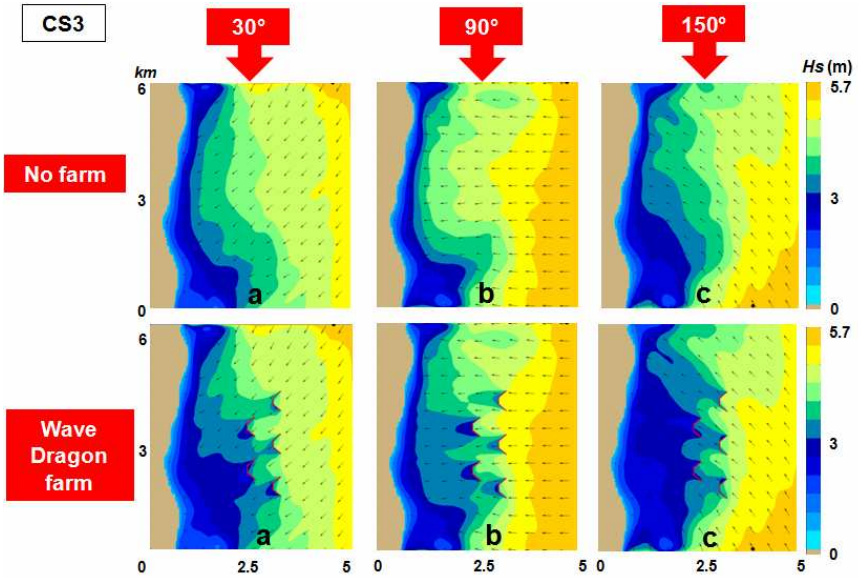

Figure 7 Evaluation in the geographical space of the influence of the Wave Dragon wave farm considering the case studies CS3, for: a) north-east waves (30°); b) east waves (90°); c) south-east waves (150°)

Figure 8 presents the variation of the *Hs* parameter along the reference line defined by the point P1. In the offshore area it is observed a wave height of 5m, which reported to the wave directions, presents a much higher variation for the south-east waves. The presence of the Wave Dragon is more significant for the east waves where a sharp variation it is noticed on the contact with the first WEC systems (from 4.5m to 3m).

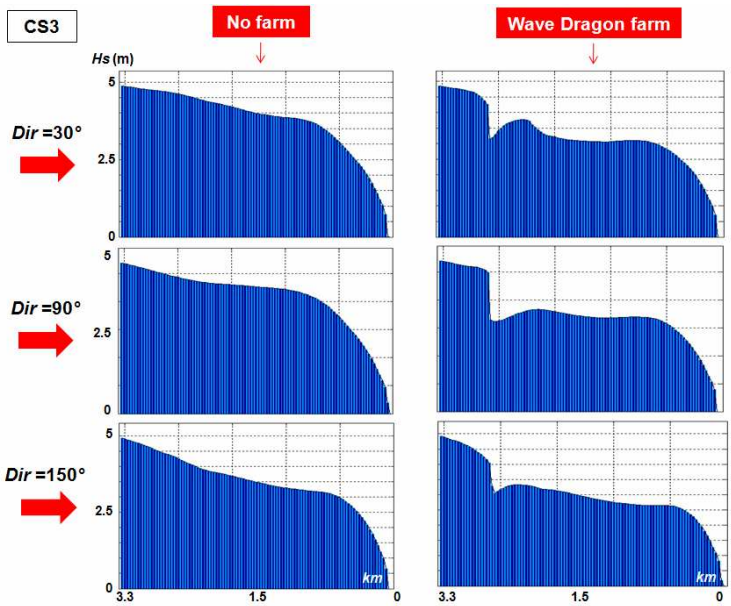

Figure 8 Variation of the *Hs* parameter for the case studies CS3 along a line defined by the point P1- shoreline (passing through the middle of the Wave Dragon farm)

4. CONCLUSIONS

A general assessment of the impact of a Wave Dragon farm operating in the Mangalia sector was performed in this work based on the numerical simulations carried out with the SWAN model. Since no in situ measurements were available for this study, the local wave characteristics were identified for a ten-year interval (January 1999 - December 2008) an extensive SWAN simulation was carried out based on the NCEP-CFSR wind data fields. As a next step several case studies were considered in order to evaluate the influence of a Wave Dragon farm on to the local wave field characteristics.

In general can be noticed that the magnitude of the shielding effect generated by the Wave Dragon farm is related to the magnitude of the wave conditions, while regarding the distribution in the geographical space this is linked more to the direction of the incoming waves rather than the general orientation of the bathymetric isolines. On the contact with the first WEC system the wave heights are significantly attenuated with almost 33%, as follows: 35% (CS1/east waves); 34% (CS2/north-east waves) and 33% (CS3/east waves).

Based on these results can be concluded that a wave farm project could be considered suitable for the protection of the Romanian coastal area, especially during the extreme conditions when the erosion processes are more severe.

5. ACKNOWLEDGMENT

The second and third author acknowledge the receipt of a postdoctoral fellowship in the framework of the project EXCELDOC (ID 132397).

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EXPERIMENTAL RESULTS TO EVALUATE THE WAVE AND CURRENTS CONDITIONS IN THE ROMANIAN NEARSHORE

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ABSTRACT

The objective of the present work is to provide a general overview of the wave and coastal currents from the Romanian Black Sea coast. The measurements sessions were carried out in three coastal sectors (Saint George, Cap Tuzla and Vama Veche) by using the system Midas 808-400, which is capable to monitor various parameters from the marine environment. The results are reported for the time interval June-August 2011 being indicated for several reference points located on water depths of 11-45m. Much higher wave heights are in general noticed in the sector Saint George (which can reach 2.4m), while in terms of the coastal currents was highlighted that the longhsore currents are oriented from north to south and in general present similar or more significant values than the rip currents.

Keywords: *Black Sea, Romanian nearshore, in situ measurements, waves, coastal currents.*

1. INTRODUCTION

The Black Sea is a semi-enclosed basin with a surface of 432000km^2 and a water volume of 538124km^2 which is usually called in the scientific literature as a "small scale ocean model" or "unicum hidrobiologicum" if we consider the hydrological characteristics of the aquatory. In general the structural and dynamical characteristics of the water masses are on a complex interaction with the atmospheric processes which mean constant substance and energy exchange at the interface of the two systems. This basin is connected to a hydrographic network which summarize a volume of 198km^3 from which the Black Sea River share almost 33.4% [1, 2].

For the Romanian Black Sea area the costal currents are under the influence of the maritime currents which are coming from north to east, which are characterised by significant instabilities regarding the direction and the speed if we consider the influence of the local winds, the bathymetry and also by the coastal structures (ex: harbours or breakwaters) [3, 4]. Regarding the surface currents they can report average velocity located between 20cm/s and 40cm/s while in extreme cases can be reached values of 100cm/s. In general the numerical simulations implemented for this area show a good agreement with the in situ measurements, the main difference occurring on the transition between the main seasons [5].

Beside the influence of the local wind conditions [6, 7] the Romanian coastal currents are also generated by the flow discharge of the river Danube [8 - 10]. In this case, the surface currents tend to increase their speeds according to the hydric regime of this river from the north sector which is also influenced by the action of the Rim current (from north to south) and the transversal stratification of the water masses.

According to the meteorological conditions and considering the coastal structures, was noticed that the currents coming from south can report values located in the range of 3cm/s and 50cm/s while for the extreme conditions a maximum of 80cm/s was registered [11].

The coastal current from the Romania nearshore are more present more significant values during the winter time when the energy from this environment significantly increases. As a result, the sediments particles from the shoreline are being on a constant action of the kinetic and potential energy intensifying in this way the longshore and nearshore transport of the sediments along the coastline and to offshore areas [12-14].

In this context, the objective of the present work is to identify some relevant wave and coastal currents features in order to provide an overview of the Romanian coastal environment by using in situ measurements.

2. METHODS AND MATERIALS

In Figure 1 is presented the Romanian shoreline area where was highlighted the location of the three target areas considered for measurements. The Saint George sector is located on the northern part of the shoreline in the proximity of the Danube Delta, while the two other target areas are being situated on the southern unit close to the Cap Tuzla and Vama Veche - 2 Mai beach sector.

The measurements sessions were conducted in four reference points (for each area) and more details regarding their characteristics are being provided in Table 1. In Figure 2 are presented some details regarding the measurement campaigns where in Figure 2b can be observed the system Midas 808-400 used for the present studies. This is a fixed electromagnetic station produced by the Valeport Company, designed to measure the coastal currents for a time interval of 1s for a velocity interval 0.05-5 m/s. The accuracy of the systems is close to ± 5mm/s if we consider a 0.001m/s resolution [15].
The direction is provided by an internal electromagnetic compass which is defined by an accuracy of ± 1%, a resolution of 0.01^o. Regarding the horizon depth, this is determined by a pressure sensor which has a precision of ± 0.1%, considering a pressure measurements resolution of 0.00% and a continuous interval measurement.

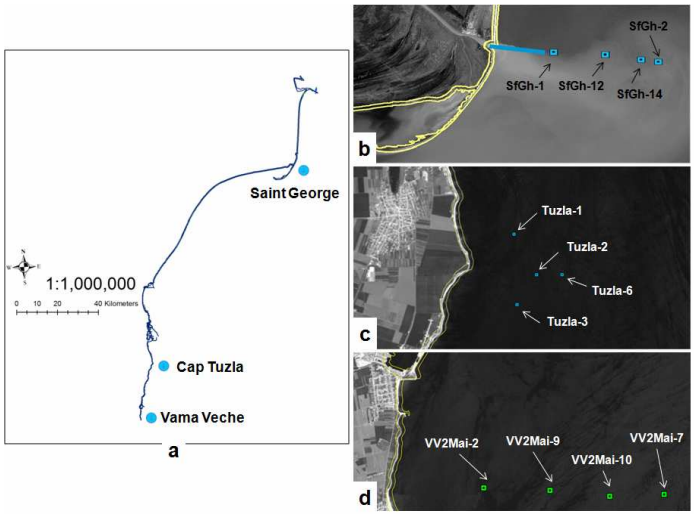

Figure 1 General characteristics of the target areas, where: a) overview of the Romanian shoreline; b) Saint George sector; b) Tuzla sector; c) Vama Veche - 2 Mai sector

Figure 2 Images capture from the measurements campaigns, where: a) preparations of the instruments and measurements; b) overview of the system Midas 808-400

Table 1. The positions and the main features of the points considered for measurements

Point	Time interval	Latitude (^{o})	Longitude (^{o})	Water depth (m)
Saint George				
SfGh-1	09.08.2011	44^o 50’980’’	29^o 40’401’’	27
SfGh-2	09.08.2011	44^o 51’043’’	29^o 50’354’’	39.2
SfGh-12	16.08.2011	44^o 52’934’’	29^o 45’041’’	37.4
SfGh-14	16.08.2011	44^o 5’137’’	29^o 46’197’’	39.7
Tuzla				
Tuzla-1	29.06.2011	43^o 58’177’’	28^o 41’090’’	22.4
Tuzla-2	29.06.2011	43^o 59’141’’	28^o 42’991’’	33
Tuzla-3	2.07.2011	44^o 00’457’’	28^o 41’255’’	30
Tuzla-6	16.07.2011	44^o 00’240’’	28^o 42’839’’	31
Vama Veche – 2 Mai				
VV2Mai-2	07.07.2011	43^o 47’289’’	28^o 37’902’’	21
VV2Mai-7	11.07.2011	43^o 45’847’’	28^o 43’659’’	44
VV2Mai-9	12.07.2011	43^o 45’021’’	28^o 43’571’’	45
VV2Mai-10	15.07.2011	43^o 47’309’’	28^o 36’102’’	11

3. RESULTS

In Figure 3 is illustrated the variation of the wave heights based on the in situ measurements provided by the system Midas 808-400 for the Saint George sector (in four reference points). From the analysis of these measurements it can be mentioned that the point SfGh-14 presents much higher values compared to: SfGh-1 → 1.01m/1.52m/1.65m (minim/average/maxim); SfGh-2 → 1.17m/1.37m/1.57m; SfGh →12-0.77m/1.37m/1.65m; SfGh-14→1.01m/1.75m/2.13m.

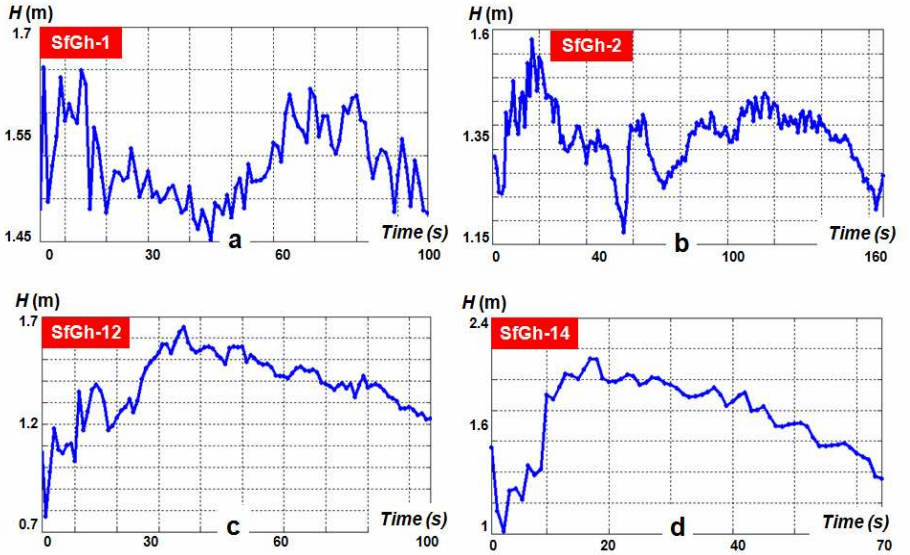

Figure 3 Evolution of the wave heights in four reference points located in the sector Saint George

The evolution of the coastal currents from this sector is presented in Figure 4. The rip (*Cvx* component) and the longshore currents (*Cvy* component) are being considered for analysis, with the mention that in the case of the negative values the corresponding currents are not oriented on the positive *x* or *y* axis of each target area. In this case can be mentioned that the longshore currents present much higher values which suggest that for this sector the sediment transport along the shoreline can be considered dominant, this fact being reflected by the formation of the Sahalin island.

For the rip currents a maximum value of 0.4m/s is being reported by the point SfGh-14 on a water depth of 30m, for the point SfGh-12 a value of 0.3m/s is reported for the water depth 25-60m while a similar value can be observed for the point SfGh-2 especially near the sea bottom.

When the longshore currents are oriented from north to south the following maximum values are being noticed: SfGh-1 →0.43m/s (on a 10m depth); SfGh-2→0.27m/s (10m depth); SfGh-12→ 0.37m/s (between 30m and 50m); SfGh-14→0.61m/s (between 15m and 25m). Analysing the longshore currents from the south sector can be highlighted the following maximum values: SfGh-1→ 0.46m/s (sea level); SfGh-2 → 0.27m/s (40m depth); SfGh-12→ 0.27m/s (0-20m depth); SfGh-14 → 0.33m/s (10m depth).

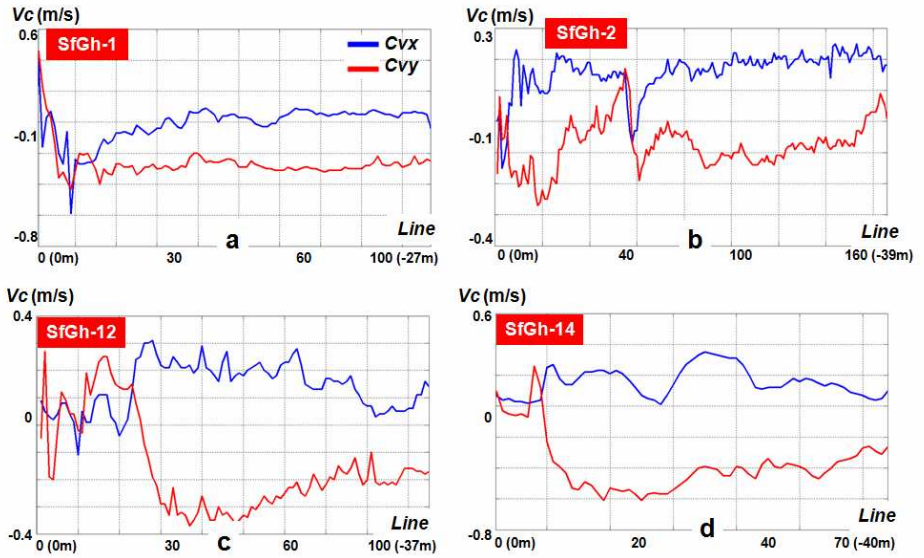

Figure 4 In situ measurements of the rip (*Cvx*) and longshore currents (*Cvy*) reported for the sector Saint George

Going to the Tuzla sector in Figure 5 is presented the variation of the wave heights, from which the following average values can be mentioned: Tuzla-1 (1.07m); Tuzla-2 (1.30m); Tuzla-3 (1.26m); Tuzla-6 (1.29m). The reference points Tuzla-2 and Tuzla-3 (located on a water depth of 30m) reveal maximum values which can reach 1.5-1.6m, while for the Tuzla-1 a maximum of 1.28m is reported.

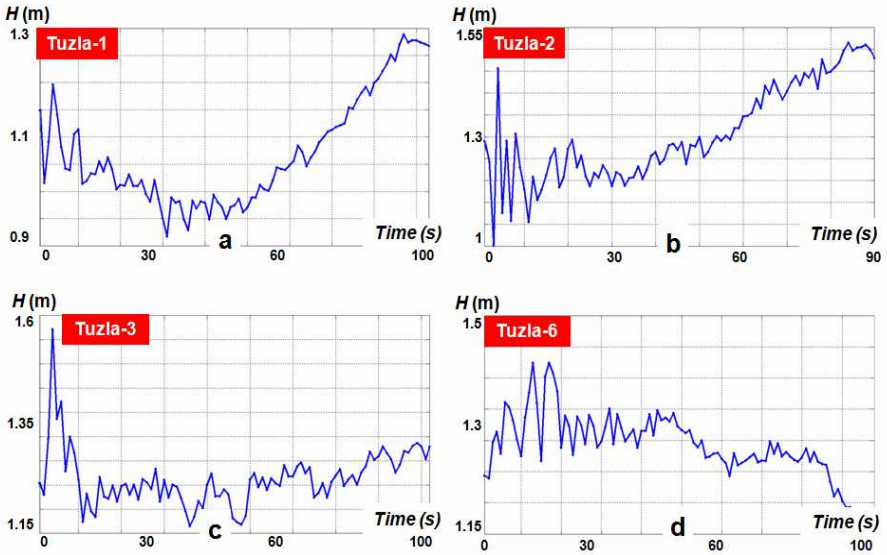

Figure 5 Evolution of the wave heights in four reference points located in the sector Tuzla

Regarding the longshore currents (presented in Figure 6) from the Tuzla sector, the reference points indicate a variation of the values between: -0.29m/s and 0.07m/s (Tuzla-1); -0.36m/s and 0.08m/s (Tuzla-2); -0.39m/s and 0.19m/s (Tuzla-3); -0.32m/s and -0.04m/s (Tuzla-6). The rip currents reveals positive values which are located around a mean value of: 0.25m/s for the points Tuzla-1 and Tuzla-6, while a value of 0.3m/s can be considered more representative for the points Tuzla-2 and Tuzla-3 for the entire water depth.

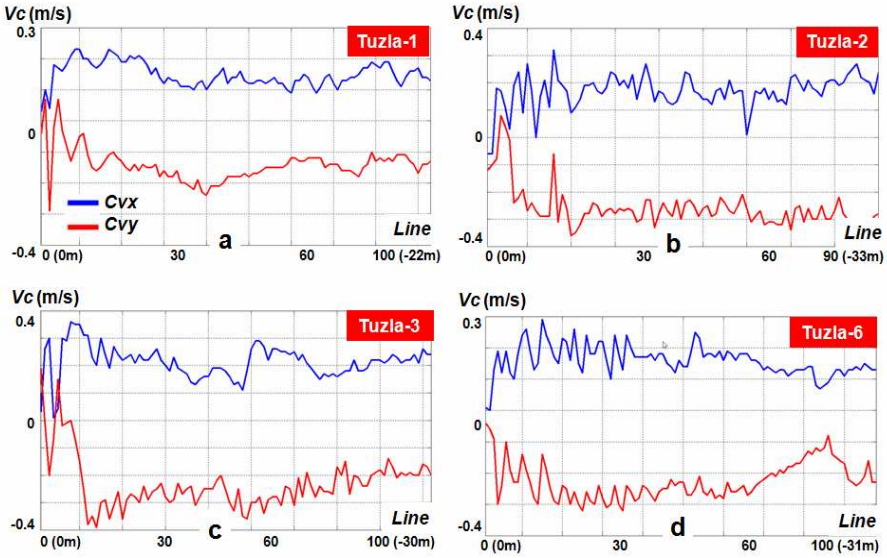

Figure 6 In situ measurements of the rip (*Cvx*) and longshore currents (*Cvy*) reported for the sector Tuzla

The results of the in situ measurements of the wave and nearshore currents from the sector Vama Veche is presented in Figure 7 and Figure 8. For this campaign of experiments the local wave conditions were reported in the range of: 0.99-1.47m (VV2Mai-2); 0.99-1.69m (VV2Mai-7); 0.85-1.61m (VV2Mai-9); 0.52-1.24m (VV2Mai-10). In terms of the longshore currents can be noticed the following variation on the water depth: -0.44m/s and 0.34m/s (VV2Mai-2); -0.37m/s and 0.32m/s (VV2Mai-7); -0.44m/s and 0.66m/s (VV2Mai-9); -0.36m/s and 0.39m/s (VV2Mai-10), with the mention that the point VV2Mai-7 presents much higher values in the vicinity of the sea bottom.

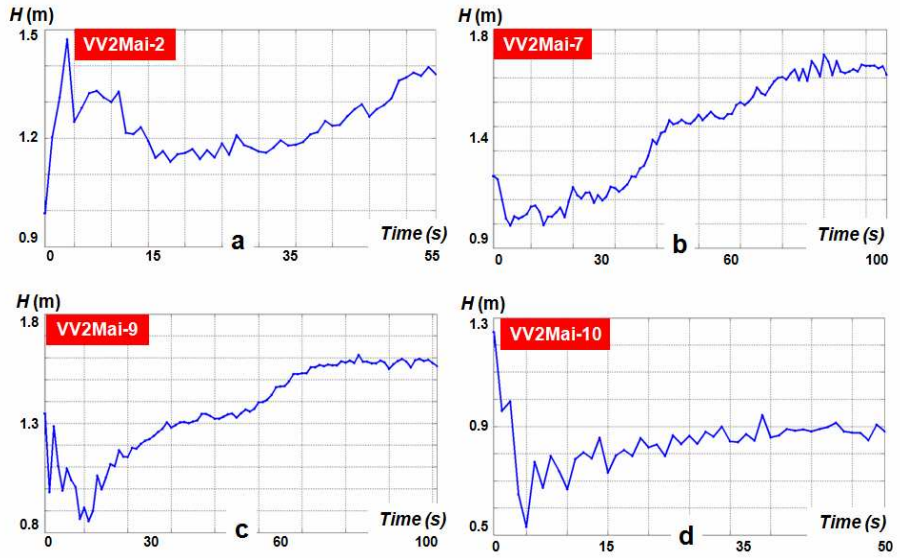

Figure 7 Evolution of the wave heights in four reference points located in the sector Vama Veche - 2 Mai

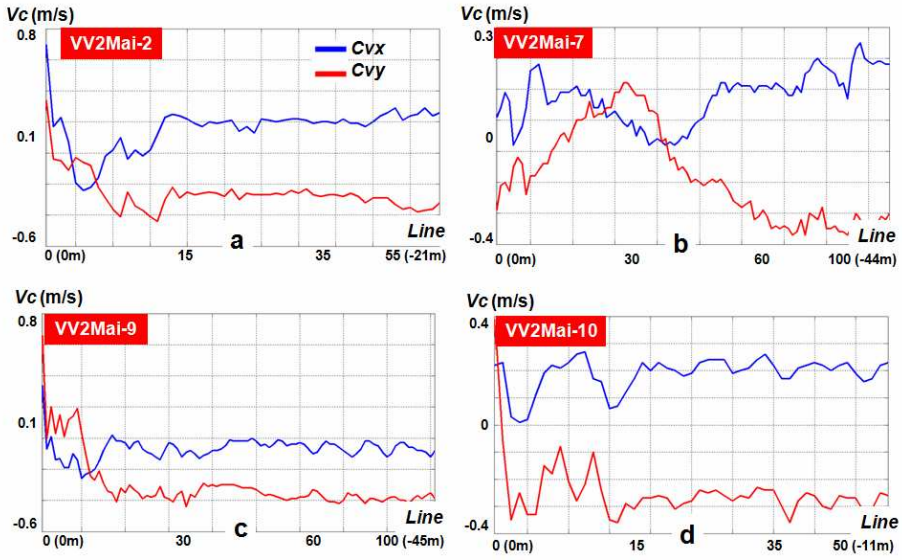

Figure 8 In situ measurements of the rip (*Cvx*) and longshore currents (*Cvy*) reported for the sector Vama Veche - 2 Mai

4. CONCLUSIONS

The objective of the present work was to provide a general overview of the waves and coastal currents conditions from the Romanian Black Sea coast. Three target areas were considered for the measurements campaigns based on the fact that they are distributed along the entire shoreline (both in the north and south unit), as follows: a) Danube mouths - Saint George; b) Tuzla; c) Vama Veche - 2 Mai. The marine parameters were determined by using the system Midas 808-400 (fixed floating station) during the months June, July and August from 2011, for various point which are located on water depths which varies from 11m to 45m.

In general these results reveal that the Romanian coastal area is a highly dynamical environment where the wave conditions can easily reach values of 1.7m (Saint George), 1.3m (Tuzla and Vama Veche) with the mention that in the sector Saint George was also noticed the occurrences of the wave heights higher than 2.1m. Although the wave conditions were monitored for a short period of time (between 50 and 170 seconds) they provide a short inside of marine conditions during the summer time (for various locations and water depths) based on which could be deducted the conditions from the winter time, which usually are 2x higher than the summer values.

Regarding the coastal currents can be observed that the longhsore currents present much higher values than the transversal one (rip currents) and also was highlighted the fact that they can easily exceed 15cm/s when they can dislocate the sediment particles, which is the first phase of the erosion processes. Also can be mentioned the variability of the currents directions, which for the longshore currents can be quantified in a sediment drift along various beach sectors while for the rip currents a positive value of the currents means that they will remove sediments (to the offshore area) from the coastal circuit.

Finally, can be concluded that the present studies provide a brief insight of the local marine characteristics which can be further used to evaluate the erosion rate

from the target areas, and also to determine the amount of electricity produced by various wave farms operating in the Romanian nearshore.

5. ACKNOWLEDGMENT

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SECTION II
MECHANICAL ENGINEERING AND ENVIRONMENT

COLD START AND WARM UP PHASE EMISSIONS FROM DIESEL ENGINES

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ABSTRACT

This paper is a result of experimental study of "Cold start and warm up phase emissions from diesel engines" that carried out at Constanta Maritime University. Diesel engines shows a significant increase in CO, CO2 and HC emissions during cold start and warm up period, studying the emissions during this phase or period takes a lot of attention because of the increase in concentration worldwide about gas emissions from diesel engines, and many systems were invented for reducing these emissions during this phase.

Keywords: *cold start, warm up, emissions, diesel engines.*

1. INTRODUCTION

We mean by cold start and warm up phase, the period of time that the engine takes in order to reach the normal operating temperature.

This phase depends on many factors such as engine displacement, compression ratio, starter, battery size and charge status, and cold start systems such as glow plugs, and Intake air preheating

2. THE COMBSTION INSTABILITY DURING COLD START AND WARM UP PHASE

Combustion development and progression during diesel engine cold start comprise a very challenging operating condition, mainly in terms of complete the process successfully Due to the low combustion chamber wall temperature during cold start, the air-charge in the cylinder may not reach the temperatures which will be capable of vaporizing the injected fuel. Consequently, formation of mixture inside combustion chamber may be prohibited, ultimately leading to complete combustion failure, but more likely to combustion instability with the engine compression ratio and starting aid playing a primary role. A key parameter is also the low injection pressure encountered at the low cranking speed that leads to poor spray penetration, atomization and fuel evaporation.

During the compression stroke and after fuel injection, heat is transferred from the air-charge to the liquid fuel spray, supplying its sensible heat and latent heat of evaporation. This process causes a drop in the local air temperature further enhanced by heat losses to the cold cylinder walls and by the blow-by losses.

The mixture inside the combustion chamber of air and fuel vapour undergoes then pre-ignition chemical reactions. If these processes take place during the compression stroke when heat is added to the system, their rate is favoured.

On the other hand, if some of these processes take place during expansion stroke, where energy is taken away from the mixture, then their rate decreases. In fact, there is an argue that the criterion for ignition to occur in a diesel engine is that compression temperature and pressure should be high enough to reduce ignition delay to the time available between injection and some point prior to TDC. Even if part of the mixture is finally vaporized, the auto-ignition process is still subject to failure as will be discussed in the next paragraph. In any case, during cold starting, ignition delay is prolonged, leading to harder premixed combustion phase and higher combustion noise.

In the case of the increased ignition delay duration in ms does not necessarily correspond to longer ignition delay in degrees crank angle when it compared with normal operation, and this is because of the very low rotational speeds encountered during cold starting. Hence, it has been argued that it may be advantageous to retard signal-stage fuel injection during starting compared with warmed-up operation, in order to promote mixture preparation in a more favourable air environment.

The Figure 1 Summarizes the previous discussion, and illustrates the primary mechanisms that are responsible for combustion failure during cold start of a diesel engine.

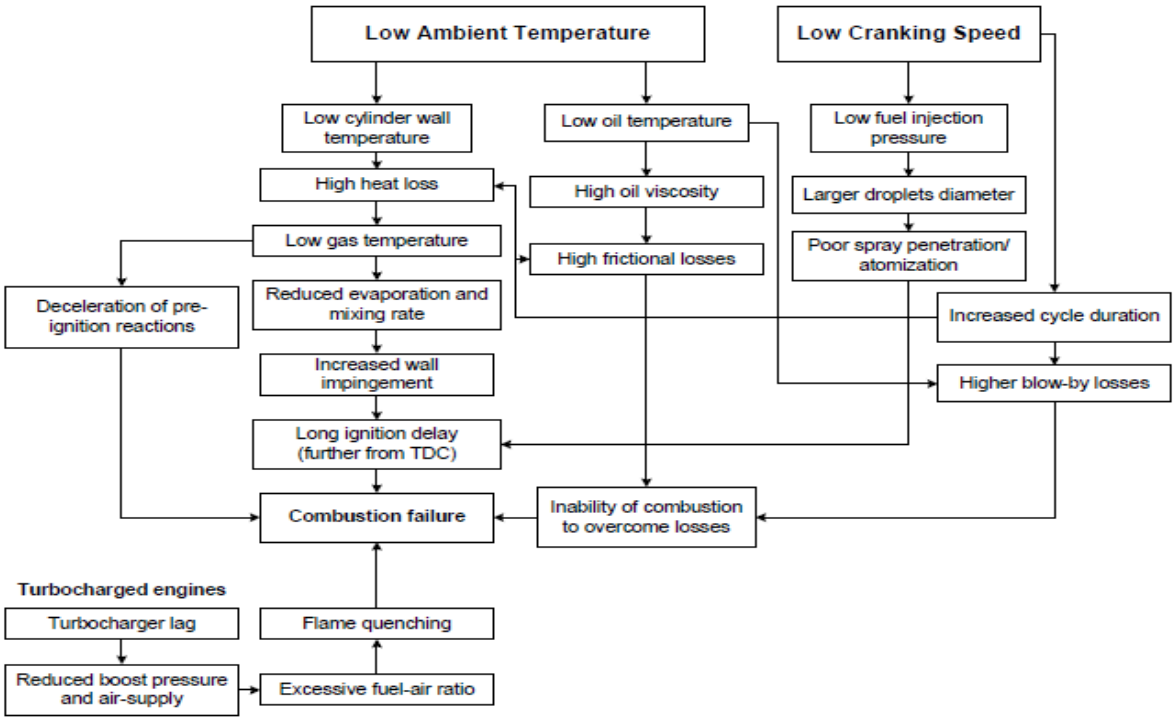

Figure 1 Combustion failure mechanisms during diesel engine cold starting

3. THE EFFECTS OF COMBUSTION AT COLD START AND WARM UP PHASE ON THE FORMATION OF THE ENGINE EMISSIONS

There are two particular aspects that influence strongly diesel engine cold start and warm up phase performance and emissions.

The first aspect is low coolant temperature, hence cylinder wall temperature that increases heat transfer rate to the cylinder walls, and the second aspect is low engine rotational speed that allows more time for losses in the heat to occur.

The formation of emissions is dependent on the combustion parameters, and these parameters are different in warm up phase from normal operating phase. So at cold start phase the temperature of compressed air at the end of compression stroke maybe couldn't reach the temperature capable of complete fuel combustion, leading to even longer ignition delay periods, hence, harsher combustion and higher emissions.

So, cold diesel engines produce higher HC,CO, and soot because their fuel burns incompletely. Smoke (exhaust gas opacity) makes this visible.

4. EXHAUST EMISSIONS IN COLD START AND WARM UP PHASE

Cold starting exhausts are strongly influenced by the low cylinder wall and coolant temperatures that prolong ignition delay and lead to incomplete combustion "as mentioned before", in the case of turbocharged diesel engines turbocharger lag causes high fuel–air equivalence ratios causing increasing in several types of gaseous or particulate components with different chemical compounds and optical properties.

The popular indicator of combustion process during cold start in diesel engines at cold days is the opacity of the gases that emitted from the engine.

The increasing of the opacity of diesel engine is due to Low temperature of the air that supplied to the engine, and to the low temperature of the combustion chamber wall, these conditions will cause lowering the compression ratio, and this is will be responsible for increasing exhaust gas opacity in cold idle significantly.

As shown in Figure 2 the effect of coolant temperature on the smoke opacity.

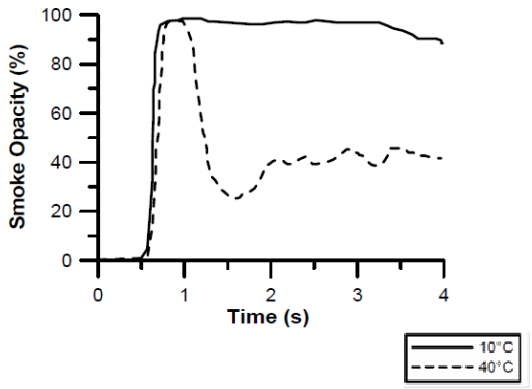

Figure 2 Smoke opacity during engine cold starting for two different coolant temperatures for diesel engine four-stroke, six-cylinder, 8.2 L

The amount of the gases HC and CO which emitted in the cold start phase is higher than that emitted during the similar hot phase of the Cycle and this what we see in the next section .

5. THE EXPERIMENT

The Experimental study of the diesel engine emissions during cold start and warm up phase, that carried out at laboratory of Constanta Maritime University.

The next photo is for engine(T650 Brasov) test cell , the measures were taken while the engine was working at idle speed 793 RPM .

Figure 3 Engine test cell

6. THE EXPERIMENT RESULTS

These results were taken at ambient temperature 24 C, and the atmospheric pressure 1.006 Bar, at different coolant temperature.

Firstly, the measures of gas emissions were taken at the coolant temperature 30 C, then at 50 C

Table 1 the results of the experiment

Cooling Water Temperature	30 c	50 c
RPM	793	793
NOx ppm	690	900
O2%	18.66	19.11
HC ppm	23,00	21
CO%	0.06	0.05
CO2%	1.4%	1.3%

7. THE RESULTS DISCUSSION

In this section we will discuss the results of the experiment for each gas individually with the help of the charts for each gas as well.

CO2 emission, by calculation the percentage of the CO2 emission at the different temperature we find that CO2 emission at 30 C is higher than its value at 50 C by 7.8%

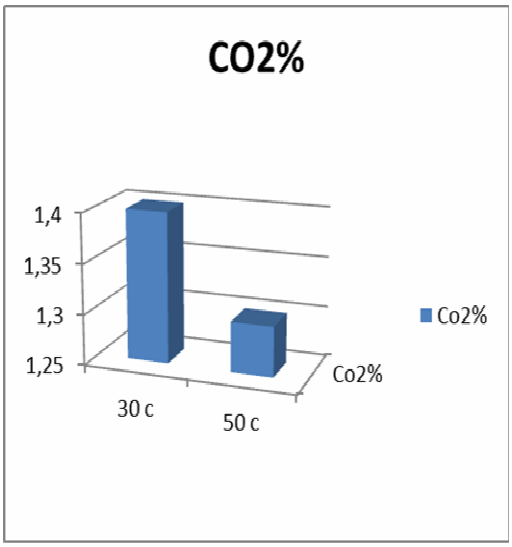

Figure 4. The result of CO2 emissions

Also by calculation the percentage of HC emissions at different coolant temperature the result is at coolant temperature 30 C HC emissions are higher than HC emissions at 50 C by 9.52%

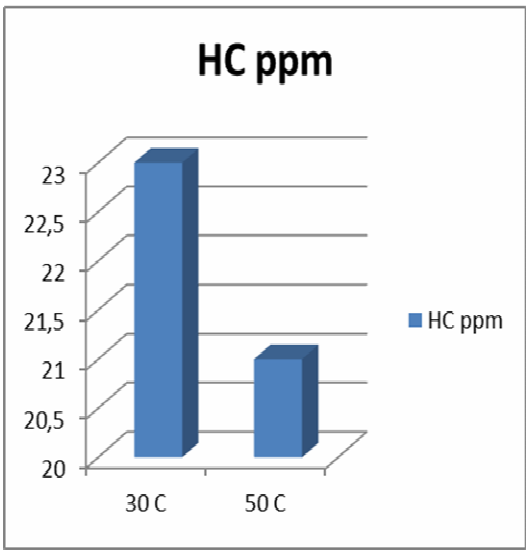

Figure 5 The result of HC emissions

CO emissions at coolant temperature 30 C as figure 6 shows are higher than CO emissions at 50 C and by calculation the percentage between emissions values at the different coolant temperature the CO emissions at 30 C are higher by 20% .

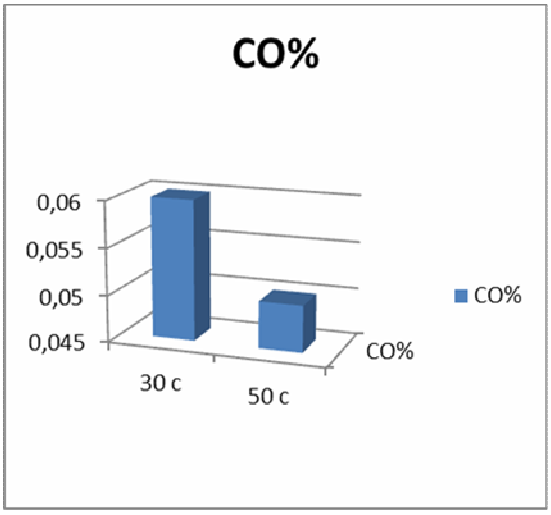

Figure 6. The result of CO emissions

On the contrary of the previous gases, NOx emissions at coolant temperature 30 C are less than NOx emissions at coolant temperature 50 C and the percentage value between them is 23,3%

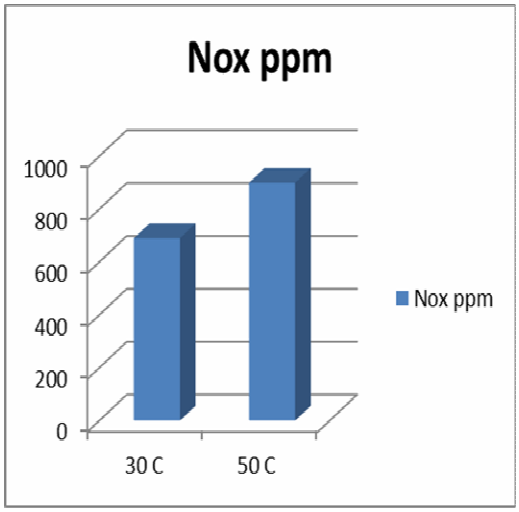

Figure 7 The result of NOx emissions

8. CONCLUSIONS

As the experiment shows at lower temperature the CO, HC, CO2 emissions are higher due to the low wall temperature during cold starting and warm up phase, the air-charge in the cylinder may not reach temperatures capable of vaporizing the injected fuel. Leading to longer ignition delay period.

On the other hand the experiment shows that NOx emissions at lower temperature are lower, because the formation of NOx emissions is related to the temperature inside the combustion chamber, so increasing the compression ratio will cause increasing in the gases temperature inside the combustion chamber resulting in this increase in NOx emissions

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PM-NOx TRADE OFF IN THE DIESEL ENGINES

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ABSTRACT

This paper discusses the relation between PM and NOx emissions and the conditions that affect the formation of PM and NOx emissions, where temperature and the fuel air ratio considered the most influencing factors that affect the formation of both of them, the real challenge in reducing pollutants from diesel engines involves a trade-off between NOx and PM emissions. There is a tendency when decreasing NOx emissions to increase PM. Conversely, reducing PM tend to increase the formation of NOx, also this paper discusses the solutions for PM-NOx trade off and how we can reduce both of them and avoiding the trade-off.

Keywords: *NOx, PM, Particulatr matte, Emissions,Trade off, Diesel Engines.*

1. INTRODUCTION

Diesel combustion process comes by igniting the mixture of hot air and injected diesel, unlike gasoline engines the mixture inside combustion chamber is inhomogeneous because the available time for mixing air with injected diesel in order to form a homogeneous mixture is respectively short. Therefore the air-fuel ratio varies inside the combustion chamber, or what so-called "deficiency" (<< 1) inside regions around the injection sprays. There is an excess of air (>> 1) between injection sprays and on the combustion chamber wall. This deficiency effects emission formation in diesel engines.

2. THE INFLUENCIG FACTORS FOR PM-NOX FORMATION

There are many factors affect or have an influence on the formation of PM and NOx emissions during combustion process, the formation to both of them depends in general on the engine load conditions" low loads or high loads", engine transient operation" Load Increase (Acceptance) or Speed Increase" (Acceleration). The most important factors that affect the formation of PM and NOx inside the combustion chamber are:

2.1. Air fuel ratio

Particulate matter is a significant pollutant of diesel engine and the formation of particulate matter occurs when diesel burns in air deficit zones. Particulate matter forms as a result of thermal cracking of fuel molecules under air deficiency. From the other hand NOx emissions occurs in lean mixture zones since oxygen and nitrogen are present, and the temperature is another condition to form NOx which will be discussed next.

2.2. Temperature

Temperture is a significant factor for formation PM and NOx, PM and NOx form in different regions according to the temperature inside the combustion chamber PM forms in regions at temperature above 1600 K. . While NOx form at temperature above 2000 K

Hence PM forms in rich regions at temperature above 1600 K, and NOx form in lean regions at temperature above 2000 K.

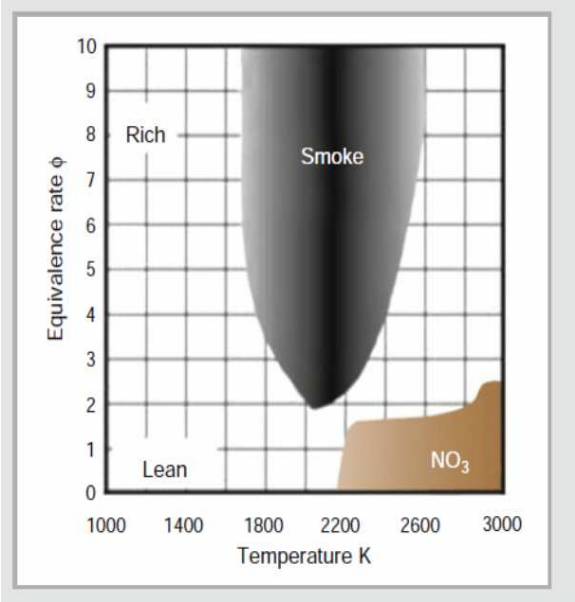

Figure 1 Air/fuel ratio and temperature ranges of NOx and soot formation. $\phi = 1/\lambda$

3. CHEMICAL THERMODYNAMICS

The crucial task for lowering diesel emissions is to improve particulate and NOx emissions simultaneously, and this is considered as a difficult task, as there is usually a trade-off between these two emissions PM and NOx.

To determine if this task is at all possible, basic fundamentals of chemical thermodynamics must be explored. Figure 2 shows a typical mixture distribution in a diesel injection spray just prior to ignition, ranging from rich in the spray core to lean in the spray edge. The diagram on the left shows the temperature history of the zones with different relative air-fuel ratios , proceeding

from the curve of mixture temperature before combustion up to the curve of burned gases after combustion.

The diagram also shows the zones of soot and NOx formation, the darker shadowed zones indicating higher formation rates.

It can be seen that in an indicated target λ-range, combustion is possible without soot formation and only very low NOx formation. Thus, in principle, smokeless, low-NOx diesel combustion should be possible.

If the mixture formation could be narrowed to the required mixture ratio. This may not be possible with the combustion of typical sprays.

However, even if soot formation cannot be completely avoided, there is a possibility of burning the soot, during the high-temperature combustion process as shown in the diagram on the right side of the figure.

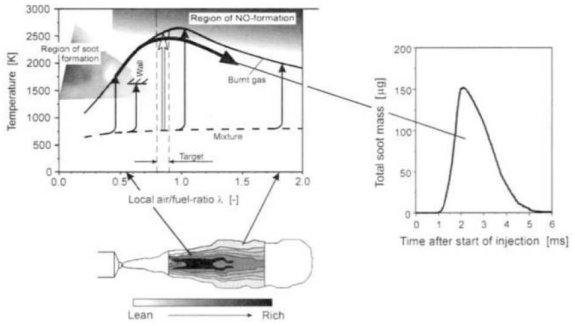

Figure 2 PM formation and nitrogen oxide formation in a diesel fuel spray and its dependence on stoichiometric air-fuel ratio

This of course, requires intensive mixing at the beginning of the expansion process while the temperatures are still on a high level, although not too high because of NOx formation. In this way the soot generated can be burned nearly completely during the process.

It can be concluded that a careful mixing strategy is the key to low-emission diesel combustion. Since mixing is controlled by fuel injection as well as by air motion in the combustion chamber, both processes must be developed concurrently.

Future diesel combustion development approaches follow these guidelines.

4. EGR ENGINE COMPONENT WEAR AND NOX-PM TRADE OFF

During the expansion stroke carbon soot is exposed to the lubricant oil in the cylinder. The effects of engine speed, load, air–fuel ratio, EGR rate and blow-by all affect oil soot loading. Oil aging refers to an increase in the soot level, an increase in oil viscosity and a decrease in the total base number (TBN) of the oil. The viscosity increase may be due to the insoluble and the soot.

The increase in viscosity due to the soot may negate the fuel economy gains from the light-weight oil. The percentage of soot in the oil increases almost linearly with engine operating hours (or vehicle mileage) and is affected by the soot flow rate and the driving cycle. At very high mileage the engine oil may have a ‘gel-like’ appearance when the soot percentage in the oil is high. Previous theory in the literature indicated that at low load conditions or mixed cycles, EGR has no effect on oil aging and engine wear; but EGR may increase component wear at high-load conditions. Engine soot flow rate usually increases with engine speed and load. At high speeds and high loads, higher EGR rate generally tends to increase the soot flow rate.

Based on the NOx–PM trade-off in diesel engines, one may think that the retarded fuel injection timing and increased EGR rate used for NOx control result in an increase in PM emission, and the PM is transported into the lubricant oil to accelerate oil aging.

So there is a relation between oil aging, EGR, soot and NOx emissions However, such a trade-off may not hold true when more advanced high-pressure fuel systems and air handling systems are applied. In other words, modern high-EGR diesel engines may achieve low engine-out soot level with high EGR rate via higher-pressure fuel systems and advanced air systems without much degradation in oil soot loading and wear.

Engine-out PM control is an important system design topic for engine and EGR wear durability. If it is difficult to reduce the engine-out PM level at increased EGR rate, larger oil sump volume, reduced oil change service interval and better oil film thickness in tribological design can be considered in order to accommodate the increased PM level in the oil.

Some chemically treated oil filters can keep soot from agglomerating in the oil for soot dispersion so that a long oil drain interval can be maintained. Enhanced oil filters may also help total base number retention.

If proper design measures are not taken to reduce, control, or accommodate. Soot emission, increasing EGR usually increases the rate of oil aging and hence increase engine wear on the tribological components to a certain extent.

5. INJECTION PARAMETERS AND PM-NOX TRADE OFF

The engine design involves the injection system as well as the piston ring pack design. The injection system can be used to control the carbon (soot) fraction of the particulates and to control the SOF(soluble organic fraction) fraction through the HC condensation.

The ring-pack design controls mainly the SOF fractions of the lube-oil contribution, since only a minor fraction of the lube oil will participate in the combustion.

Soot formation is caused primarily by insufficient fuel-air mixing, which can be improved through fuel-pump and nozzle design by optimizing the injection rate versus the air swirl (high fuel pressure, small nozzle holes, spray directions), as shown in Figure 3 The upper plot in Figure 3 shows total PM versus load and the lower plot shows the trade-off between PM and NOx from a special injection study on low-sulfur diesel oil. NOx increased for increasing injection pressure (except for one test condition) as expected, whereas the influence on PM varied at different loads.

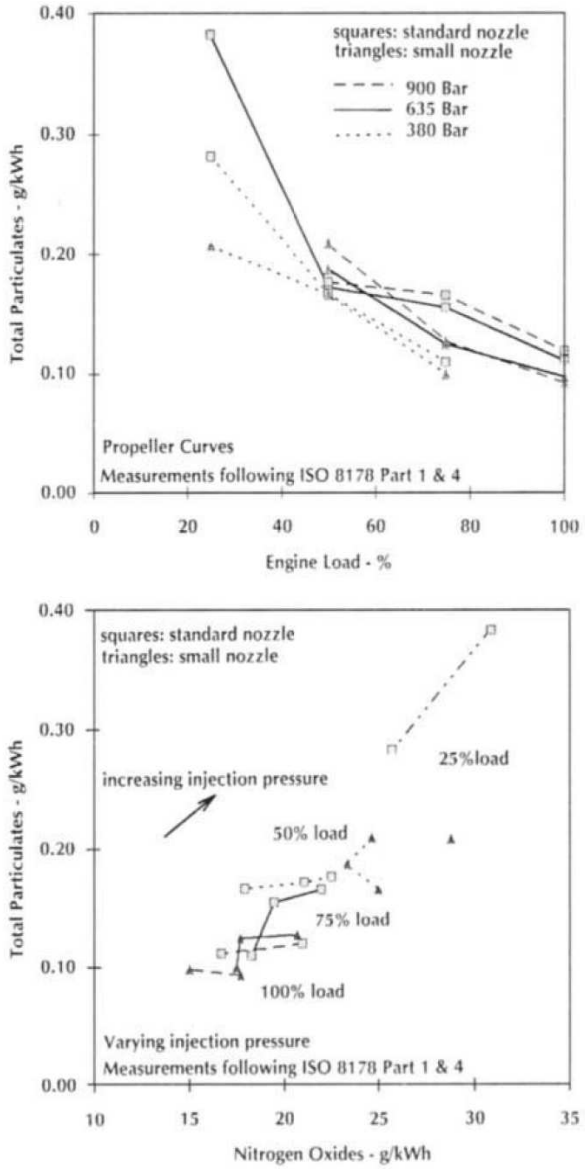

Figure 3 Influence of injecton pressure and nozzle specification on total PM versus engine load (upper plot) and on PM versus NOx (lower plot)

The smaller nozzle improved (reduced) both NOx and PM (except at 50 present load). Therefore, both PM and NOx emission need to be part of the optimization. A conceptual path for high-temperature combustion to reduce particulates (soot) without increasing NOx is proposed.

6. SOLUTIONS FOR PM-NOX TRADE OFF

6.1. Homogeneous combustion

In order to hinder as much as possible the production of the pollutant component nitric oxide NOx and soot, which are dominant in diesel engine combustion, a new combustion process, so-called homogeneous charge compression ignition (HCCI), is being developed.

The NOX -formation generally occurs at temperatures above 2,000 K, soot formation, on the other hand, in rich area of the mixture with $\lambda < 0.8$ and at temperatures above 1,400 K. In the HCCI method, these areas are avoided, see Figure 4.

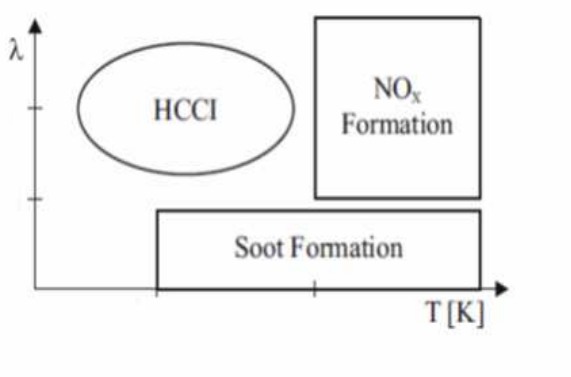

Figure 4 λ , T range of the HCCI method

In homogeneous diesel combustion, the fuel is already injected very early into the combustion chambers as opposed to the conventional diesel process, so that a relatively large amount of time is available for mixture formation.

This very lean mixture ideally ignite simultaneously at many locations in the combustion chamber space ignition) and therefore burns through very quickly. Because of the lean mixture, no local temperature peaks appear, and thus is the thermal formation of NO impeded; also, in largely homogeneous mixtures, no local rich regions are found and thus practically no soot is produced.

Figure 5 shows the injection and heat release rates dependent upon the crank angle for the conventional and HCCI methods. In the HCCI method, the injection takes place via a sequence of single injection impulses (split injections), the heat release takes place very quickly in the TDC area. Split injections can be represented quite straightforwardly by a common rail injection system.

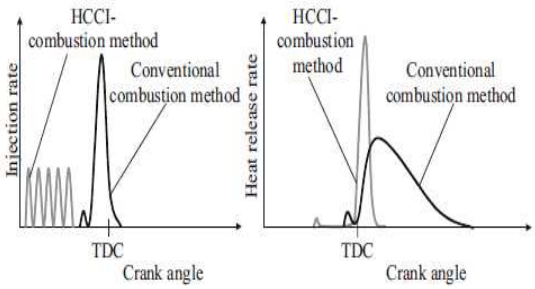

Figure 5 Injection and heat release rates for the conventional and the HCCI method

For the control of the HCCI process, it is sensible to use the exhaust gas recirculation rate. As a result of the high level of charge dilution and very low combustion temperatures, there is a clear increase in CO and HC emissions. Both of these pollutant components must, if necessary, be reduced with the help of an exhaust gas after treatment by means of a catalytic converter.

6.2. Using after treatment systems

In order to meet the diesel emission standard legislation limits, a diesel engine can be optimized by internal means to give low particulate emissions and lower fuel consumption. These modifications of the engine lead inevitably to higher NOx emissions due to the NOx-PM trade off. An efficient Urea SCR after-treatment system is then able to reduce the higher NOx emission to below legislation limit.

7. CONCLUSIONS

As we have seen NOx and PM emissions form in different regions inside the combostion chamber, NOx emissions form in lean regions at temperature above 2000 K, soot emissions form in rich regions at temperature above 1600 K, so because of the complexity of the mixture formation inside the combustion chamber, and the comlexity of the combustion process in the diesel engines, we can not avoid PM-NOx trade off completely, but by improving engine design such as improving the design of engine fuel systems and improving the design of the injectors we can improve the mixture formation causing to improve combustion process and reducing PM and NOx emissions, or by using after treatment systems we can reach satisfied results.

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A POINT OF VIEW ABOUT CONNECTION BETWEEN NATIONAL SYSTEM AND OPERATIVE COMMANDMENT FOR MARINE DEPOLLUTION

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ABSTRACT

The present paper reffers to the Operative Commandment for Marine Depollution (OCMD), the national planning, coordination and ruling of the activities in case of marine pollution by hydrocarbons and other harmful substances structure, which is part of the national system. The OCMD componence, its attribution as well as those of the OCMD members's authorities, the training programme, the specialized personnel, trained and certified in the field of intervention, the specialized equpiment, as well as a national intervention strategy are the factors contributing to the efficient functioning of the national system of action against the marine pollution.

Key-Words: *National System, Operative Commandment for Marine Depollution, marine pollution,operations, division, atribution, responsabilities.*

1. INTRODUCTION

1.1 General

The Black Sea is a continental sea located between south-eastern Europe and Asia Minor, which bathes the shores of Romania on a length of 245 km., as well as Ukraine, Russian Federation, Georgia, Turkey and Bulgaria. Through the Bosphorus-Dardanelles straits system, it communicates with the Mediterranean Sea, and through the Kerch Strait it communicates with the Sea of Azov - which is actually an annex to the Black Sea (Figure 1).

Figure 1 Black Sea boundaries [1]

The Black Sea covers an area of 423,488 km², that is almost twice as large as the whole Romania.

Romania has four seaports: Constanta South, North Constanta, Mangalia and Midia.

Maritime traffic average is 44 million tons.

Length landscaped tourist beaches is 35 km.

Area Maritime Romania has about 20,000 km^2, consisting of: inland marine waters, 753 km^2, territorial sea, 4,487 Mm^2, contiguous, 4,460 Mm^2; exclusive economic zone, 10,300 km^2.

The Black Sea is an important waterway linking the coastal regions with the Mediterranean sea, and thereby the oceans.

The Black Sea is an enclosed sea, requiring greater attention in terms of protection against pollution.

Pollution by oil products and their spread is recognized as one of the major threats to the marine environment of the Black Sea.

Risk associated with heavy traffic requires coordination of all resources in case of national or regional emergency.

So it is noted that the Black Sea should be managed through close cooperation between riparian countries for protection against pollution.

1.2. Legislation

As a coastal state with responsibilities for the safety of navigation, pollution and efficient intervention in crisis situations in the area of jurisdiction, Romania ratified the Convention on the Protection of the Black Sea Against Pollution, signed in Bucharest on April 21, 1992 by the Black Sea countries (Romania, Bulgaria, Georgia, Turkey, Russian Federation and Ukraine) by nr.98/1992 Law.

On this basis has been drawn the Regional Contingency Plan to the Black Sea approved by the Commission of protection of the Black Sea against pollution from 21.11.2006 and signed by Romania on the same date.

By Law no. 6/1993, Romania joined the 1973 International Convention for the Prevention of Pollution from Ships modified by the Protocol of 1978 MARPOL 73/78.

Also by Law no. 160/2000 regarding the approval of Government Ordinance nr.14/2000 Romania accede to the International Convention on preparedness, response and cooperation in the case of oil pollution, adopted in London on 30 November 1990.

Its applicability materialized in Romanian legislation by adopting two normative acts that govern the marine pollution activities, namely:

1. Government Decision no. 893/2006, amending Government Decision nr.1593/2002, approving the National Plan of preparedness, response and cooperation in marine pollution by hydrocarbons;
2. Common Order of the Ministry of Environment and Water, Ministry of Transport, Constructions and Tourism, Ministry of Interior nr.1/217/182 for approval of Regulation for the organization and functioning of the Operative Commandment for Marine Depollution (OCMD).

2. THE NATIONAL SYSTEM OF ACTION AGAINST THE MARINE POLLUTION

In order to apply art. 6's precaution from The International Convention regarding the preparation, response and cooperation in case of hydrocarbons pollution, adopted in London on the 30th of November 1990, which Romania joined through the Government's ordonance number 14/2000, a national system of action against the marine pollution has been established, hereinafter the national system.

2.1 Functioning of national system

The efficient functioning of the national system of action against the marine pollution is based on the existence of four major components: 1) a national structure for planning, coordination and management; 2) specialised personnel instructed and attested in intervention; 3) the specialized equipment, reliable, with a high level of competence in requirements of the polluted area; 4) a national contingency plan, a strategy for action.

Present paper refers to the national structure for planning, coordination and management of activities in marine pollution by oil and other harmful substances.

2.2 The organization of the national system

The national system represents the ensemble of all the preparations, response and cooperation measures in case of hydrocarbons pollution and other harmful substances.

Within this national system have been designated national responsible authorities:

- in order to coordinate activities related to the functioning of the national system, the Ministry of Environment and Water Climate Changes, by its speciality, as national contact point with the international authorities in the domain.
- for organising the intervention actions: on land, the Ministry of Internal Business, through the General Inspectorate for Emergencies, while for the maritime operations, the Ministry of Transports, through the Romanian Naval Authority
- for the safety of navigations, in accordance with the prevention and control of ship pollution rules , the Ministry of Transports, through the Romanian Naval Authority
- for the conduction of the intervention of its own forces, the Ministry of National Defense, thorough the Major State of the Naval Forces.

Also in this national system have been designated as national operational contact points, defined as NOCP, responsible with the recieving and transmiting reports regarding the marine pollution by hydrocarbons and other harmful substances:

- Romanian Naval Authority, defined as ANR, for ship pollutions;
- National Administrations „Romanian Water" – „Dobrogea Litoral"River Basin Administration for coastal pollutions events.

Responsible for applying The National Intervention Plan in case of marine pollution by hydrocarbons and other harmful substances will be the Constanta County Inspectorate for Emergency Situation, which assures the Permanent Secretary of the Operative Commandment for Marine Depollution.

Coordonation at national level of activities related to applying the intervention at the Black Sea plan is made by the Ministry of Internal Business, in co-operation with the Ministry of Transports, The Ministry of Environment and Climat Changes and the Ministry of National Defense, who all have responsibilities regarding the coordination of the preparation, co-operation and response actions, through their specialities and the subordinate units designated in the plan.

2.3 Operative Commandment for Marine Depollution

Following the adoption of H.G., no 893/2006, was founded the Operative commandment for marine depollution, planning, coordinating and ruling of activities in case of marine hydrocarbons pollution and other harmful substances organ.

For coordonation of the intervention and timely transmission of the statements in the event of a marine hydrocarbons pollution for the responsibility area of Constanta county, the Permanent Secretariat of OCMD of the Emergency Inspectorate "Dobrogea" has been established, and for the responsibility area of Tulcea a response cell of the Emergency Inspectorate "Delta" of Tulcea county has been established.

2.3.1 Organizing Operative Commandment for Marine Depollution

The organizing and functioning regulation of OCMD was approved through the Common order of the ministers, no 1/217/182 from the 1st of April 2004.

The Operative Commandment for Marine Depollution (OCMD) represents the planning and coordination of the response in case of marine

hydrocarbons pollutions organ and is subordinated to Constanta county's prefect, as general coordinator. OCMD is made from designated representants of the following institutions: Ministry of Environment and Climate changes; Ministry of Transports, Constructions and Tourism; Ministry of internal business; Ministry of National Defence; Constanta County Council; Ministry of Health; National Sanitary Veterinary and Safety of Viands Authority.

OCMD's subordinates, in case of response, are the following structures: *Marine operations division*, which are intervention forces who act on the sea, and is run by the Romanian Naval Authority representant, as coordinator of marine operations of OCMD; *Terrain operations division*, which are intervention forces who act on land and is run by the head of the Constanta County Inspectorate for Emergency Situation, as co-ordinator of terrain operations.

2.3.2 Composition MOD and TOD

Marine operations division is composed by: Romanian Naval Authority; Romanian Agency for Saving the Human Life on the Sea; National Naval Radiocommunication company "Radionav"-Constanta;Coastal Guard Constanta; Naval Forces Major State; C.S. OMV Petrom SA E&P Production Zone X Petromar; Clinical Hospital Railways Constanta; Constanta County Public Health Direction; Basinal Water Administration "Dobrogea Litoral"; C.S. "Oil Terminal"- A.S. Constanta; National Company "Administrația Canalelor Navigabile"-S.A.; non-governmental organisations, volunteers; The Administration of the Biosphere's Reservation "Delta Dunării"; National Institute of Research and Marine Development "Grigore Antipa" Constanta; C.S. "Rompetrol Rafinare"-S.A.; Environmental Protection Agencies from Constanta and Tulcea; National Environment Guard- Constanta and Tulcea Counties Commissariats; C.S. Regional Air Services S.R.L.; Maritime Tow Company "Coremar". A.S.; other commercial societies, including naval sites.

The terrain operations division has the following components: Constanta County Inspectorate for Emergency Situation; Tulcea County Inspectorate for Emergency Situation; Basinal Water Administration "Dobrogea Litoral"; Naval Territorial Authority Constanta/Tulcea and dock captains;Constanta and Tulcea county councils; Environment Protection Agencies from Constanta and Tulcea; National Environment Guard- Constanta and Tulcea County Commissariats; Naval Forces Major State; National Company "Administratia Porturilor Maritime Constanta"-S.A.; C.S. "Oil Terminal"-A.S. Constanta; Coastal Guard Constanta; Constanta and Tulcea County Police Inspectorates; Constanta and Tulcea County Gendarmes Inspectorates; non-governmental organisations; Romanian Agency for Saving the Human Life on the Sea; Constanta County Public Health Direction; Constanta and Tulcea Counties prefectures, municipalities; Regional Meteorological Centre; National Institute of Research and Marine Development "Grigore Antipa" Constanta; decontamination specialized companies; other economical agents;

Organization and functioning scheme OCMD is shown in the Figure 2.

2.4. Duties and responsibilities
2.4.1 Duties OCMD

OCMD performs the following main tasks:

During routine: elaborates and updates the organization and functioning regulation; elaborates risk scenarios; coordinates the preparation of the national system; creates a data base including maps of the risk zones, sensitive zones and areas which need to be protected, statistic information regarding marine currents and hidrometeorological parameters and copies of local action plans; identifies, elaborates and updates the list of intervention forces with response and communication equipment which belong to the units that are part of the national system; participates with forces and means of intervention at the request of other states, in case of marine hydrocarbons pollution and other harmful substances, within regional co-operation; elaborates the endowment framework necessary for proper functioning; establishes international cooperation projects; draws up the regular exercises schedule; identifies and sets the regular training courses of the national system units personnel; ensures the development of meteorological guides of precaution and response; ensures the development the regulation of organization and functioning of the Consultative Committee for Marine Depollution.

During intervention: evaluates the effects of the major marine hydrocarbons pollutions and other harmful substances incident; elaborates and updates the intervention decision, the decision flow chart and the actions when receiving a report regarding marine hydrocarbons pollutions and other harmful substances; coordinates the response; ensures the informational and communications flow; proposes for international participations; it's responsible with the making of the documents necessary for recovering damages from the polluter which produced the marine hydrocarbons pollution and other harmful substances in the coastal zone; ensures the notification of the authorities of neighbour states, in case of major marine pollution by hydrocarbons and other harmful substances, with trans-boundary character; establishes the necessary material and financial resources for applying the present plan and their use; ensures the informing of international and national authorities, and the informing of the public.

2.4.2 Duties of the general coordinator

The main responsibilities of the general coordinator consist of managing the operations in case of major marine pollution (tier 3), managing the problems related

to fighting hydrocarbons discharge, organizing the intervention and the demanding, through the Ministry of External Business, in the name of the Romanian state, of assistance from and to other states, on the strength of the proposal submitted by OCMD

Through H.G. no 893/2006, for modifying the Governmental Decision no. 1593/2002, regarding the approving of the National preparation, response and co-operation in case of marine pollution by hydrocarbons plan, the Constanta county's prefect and the units nominated in the plan, at the request of OCMD, benefits of speciality indications offered by the Consultative Committee for Marine Depollution, constituted as a consultative organ with non-permanent activity, from nominated specialists from the ministries, institutions, economic operators, agencies, research institutes and other units of competence in the field.

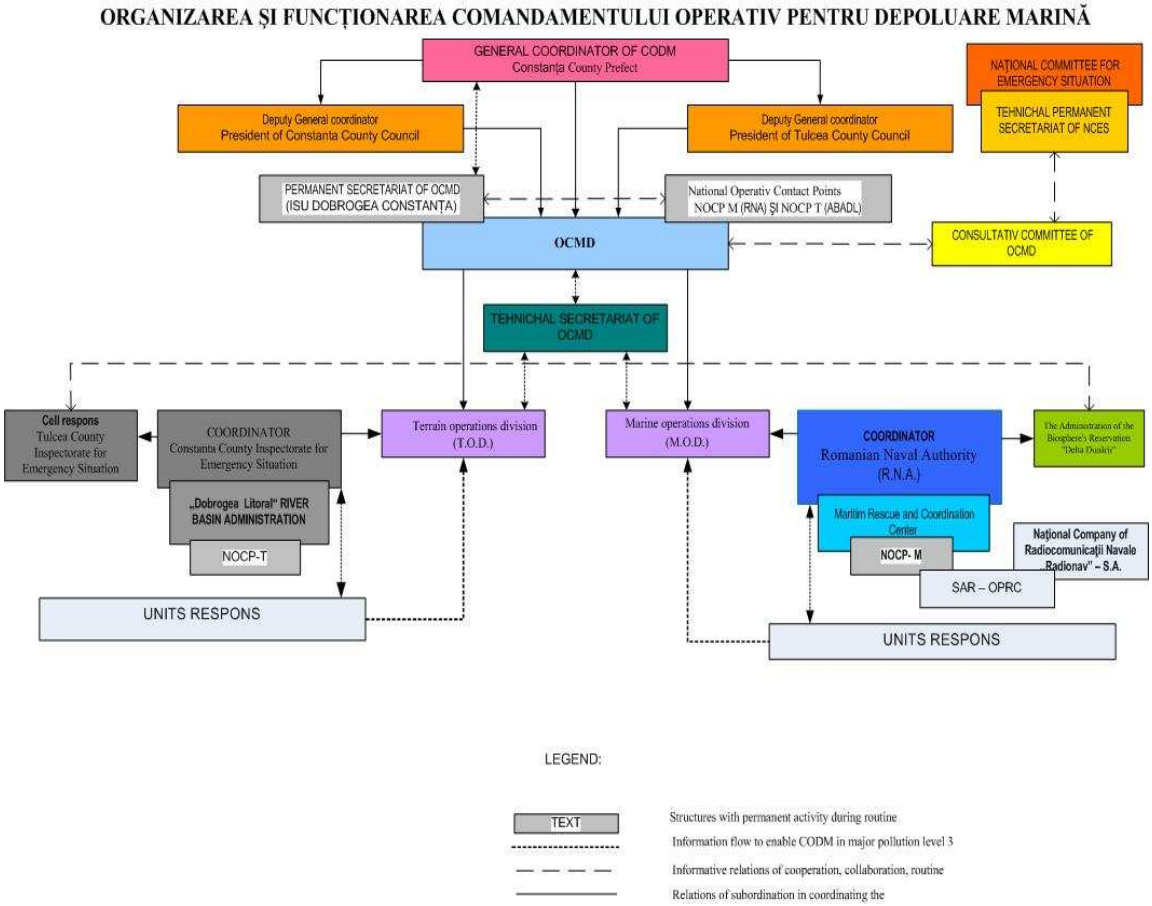

Figure 2 Organization and functioning scheme OCMD

2.4.3 MOD's and TOD's responsibilities

The main responsibilities of the coordinators of the divisions for marine and, respectively, terrestrial operations are: assuring coordination between the forces designated for intervention specific to those two divisions in the area of responsibility of each; assuring the periodic transmission of reports and informations regarding the situation to OCMD; decide the manner of using the material base and the intervention forces; coordinating all the operative activities regarding the intervention; liaises with the national operative contact points; prepare the final report regarding the whole; operation, including recommendations for modifying the operational procedures, possible revisions, feedback regarding the performance of the equipment, suggestions for additional equipment and proposals for improving the training programmes and the local intervention plans;

Within the Operative Commandment for Marine Depollution, Constanta County Inspectorate for Emergency Situation, in its capacity of coordinator and head of terrestrial operations, has the following main attributes: ensures the Permanent Secretariat of OCMD; coordinates and follows the implementation of the decisions of OCMD; ensures the solving of current problems of OCMD and the functioning of decisional-informational flow with the other institutions in the response actions; creates and manages the data base necessary for prevention, limiting and removal of the effects generated by marine pollution by hydrocarbons and other harmful substances; coordinates the

elaboration of organizing and functioning regulations of OCMD and the Consultative Committee for marine depollution and presents them for approval to the prefect; ensures the planning of simulation exercises and leads the training activities on ground directly.

2.4.4 Tasks of the Permanent Secretariat

The main tasks of the Permanent secretariat of the Operative Commandment for Marine Depollution, ensured by the Emergency Inspectorate "Dobrogea" of Constanta county are:

- alarming the component forces within the plan (according to the scheme informational flow - marine remediation decision-Romanian seaside shown below);
- elaborating summaries and reports for the general coordinator;
- providing means of communication between the forces taking part in the interventions;
- coordinating the intervention within the two divisions.

Together with the national operative contact points (NOCP M and T), the Permanent secretariat of OCMD:

- obtains information regarding the features of the polluting material;
- forecasts the movement of the discharged polluting material;
- determines which zones should be prioritarily protected;
- selects the techniques which are to be used during the operations;
- quantifies the damage done due to pollution by hydrocarbons, for obtaining compensations from romanian authorities;
- inventories the equipment and its means of transport.

FLOW INFORMATIONAL - DECISIONAL OF MARINE DEPOLLUTION ROMANIAN SEASIDE

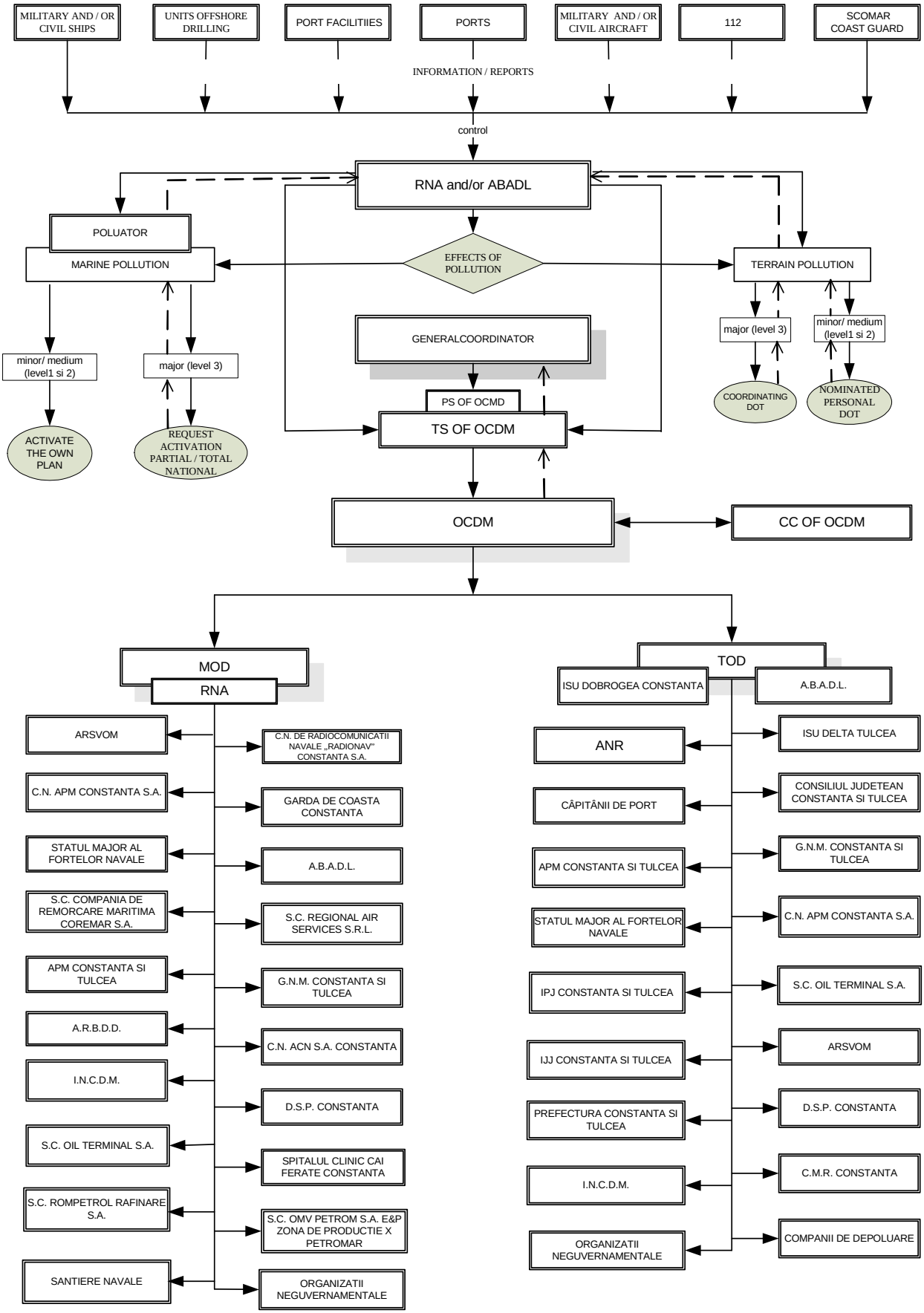

Figure 3 Flow informational-decision

2.5 OCMD's activity

OCMD's activity during routine takes place under a action plan and planning of training activity approved by the general coordinator, prepared in accordance with the provisions methodology for implementation of the National Plan (Decision no. 893/2006).

OCMD's activity follows the applying of OPRC Convention's provisions on the Romanian seaside, territorial sea and in Romania's exclusive economic zone.

The action plan provided for routine activities such as: update databases; updating the laws and regulations of operation; update maps of the areas of environmental sensitivity and vulnerability index; the conclusion of cooperation agreements; establishing procedures; organization of conferences, seminars, congresses.

The main project started by the Operative Commandment for Marine Depollution Action Plan by 2013 and which will continue this year, is updating no.1/217/182 Order of 01.04.2004 for approval of the organization and functioning of the OCMD.

The training activity of the personnel within the Operative Commandment for Marine Depollution consists of periodic organization of forming courses and/or common exercises.

A good coordinated simulation programme exercise includes different grades of interaction and complexity activities:

- the quarterly type communication exercises BRAVO testing the viability means connecting and testing procedures for alerting set;
- "Table-top" exercises(for retaining knowledge) of ALPHA type;
- Intervention crew exercises of type CHARLIE aim testing the co-operation between the intervention units within the Maritime and Terrestrial Operations Divisions, both in terms of equipment and of communication.
- Maganement exercises in the case of an incident(operational) of type DELTA, are organized aiming to test the alarm procedures, the intervention capacity, to measure the time elapsed by DOM and DOT units, to test and train the MDOC structures and the co-operation between the pollution fighting units.

The last national exercise sea rescue and pollution 'SAR - POL "was held in 2012 according to the Co-operation regarding unitary intervention plan, in an emergency situation, for searching and saving the human life on the coastal zone and on the sea, concluded between the Ministry of National Defence, Ministry of Administration of Interior and the Ministry of Transports and Infrastructure.

The purpose of the activities of preparation / training is the organization of a prompt intervention and rapid major oil spill which affects or may affect the the area of responsibility and to facilitate cooperation in the preparation for and response to oil pollution.

3. MARINE POLLUTION INCIDENTS

Pollution off the north pier that arose following the cracking of the fuel tank of shipwreck PARIS, submerged in january 1995, asessed as a minor pollution, with a tendency of becoming a medium pollution, is considered one of the most significant pollutions which took place in the last 10 (ten) years in Constanta's dock.

Pollution danger is represented by the existent fuel in the fuel tanks of ships PARIS (under Malta pavilion)-236 tones of naphtha and 11 tones of diesel and YOU XIU (under HongKong pavilion)-437 tones of naphtha, 40 tones of oil and 17 tones of diesel, sumberged in the evening of 04.01.1995, due to the failure of the north dam of Constanta's dock.

Pollution is notified by the Romanian Naval Authority on 04.10.2009, iridescences stretch on a distance of cca 10 km.

The measures taken were: establishing in extraordinary session, of tasks for each institution within OCMD; assessment of costs based on bids submitted by specialized companies; looking for financial resources to cover the costs incurred by pollution; creation of predictions on the evolution of oil spill; the inventory of all equipment and tools available to state institutions; monitoring the emergency situation and limit the effects of pollution on an area as small; identifying establishments for the installation of reservoirs / tanks with the role of temporary storage of hydrocarbons recovered; choosing the optimal solution with cost-benefit ratio based on the best offers received from specialized companies (the cracks were sealed by cementing divers belonging ARSVOM).

4. CONCLUSIONS

Romania has established, by appropriate legislation, a national action against marine pollution, which are all measures of preparedness, response and cooperation in such situations.

This system is known and appreciated regionally and internationally but unfortunately arouses too little interest in local and national authorities involved in emergency management.

5. ABBREVIATIONS

OG – Government Ordinance
HG – Government Decision
MMGA – Ministry of Environment and Water
MTCT – Ministry of Transport, Constructions are Tourism
MAI – Ministry of Interior
OCMD - *Operative Commendment for Marine Depollution*
NOCP M – National Operativ Maritime Contact Point
NOCP T - National Operative Terrain Contact Points
MOD – Marine operations division
TOD – Terrain operations division
PS – Permanent Secretary of the OCMD
RNA – Romanian Naval Authority;

6. REFERENCES

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ROTARY INTERNAL COMBUSTION ENGINES

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ABSTRACT

This paper aims to make contributions to the study of one of the oldest aspirations of mankind, that of overcoming its limitations of movement: moving faster and with more load than what it is possible through man's own power.

The study of internal combustion engines is a study intrinsically linked to our knowledge of the environment that surrounds us, but especially about matter as an energy carrier, about combustion as a fundamental process of releasing the energy contained in matter, and about mechanical devices that can retrieve and convert to movement the energy released from combustion.

Nowadays in propulsion systems the research efforts are concentrated on alternative fuels in classical engines or on methods not involving combustion at all (i.e. electrical propulsion systems). The rotary engines occupy a niche segment of research that has only seen mass production in automotive application developed by the Mazda Company with Wankel-type Renesis engines.

This paper summarizes the research in Wankel engines and other ongoing efforts in the development of rotary internal combustion engines with application in land, maritime or air propulsion, giving some details about their performances, advantages and disadvantages when compared to classical piston engines, things that contribute to larger topics like efficiency of power systems on-board mobile platforms.

Keywords: *Rotary Engine, ICE, Wankel, Wave Disk Engine, Toroidal Engine, Tesla Turbines*

1. INTRODUCTION

The need for simplicity and robustness stands most often in the design of internal combustion engines, in inverse proportion to the need for efficiency. This fact combined with the discovery of stoichiometric mixtures and thermodynamic cycles led to the current configurations of the four and two strokes piston engines.

Although of some complexity, classic internal combustion engines are built using simple principles that increase the efficiency of the combustion process by maintaining the working fluid parameters at optimal and predictable values while in the same time obeying the laws of thermodynamics cycles.

The detailed design of the components of an internal combustion engine is driven by the need for motion uniformity, balancing the forces and moments resulted from movement and selection of component's materials in such ways as to reduce energy losses and increase the efficiency of operation at various loads or speeds.

The rotary engine is an engine without reciprocating internal pistons as they are used in the traditional ways, but it involves one or more rotors performing the same basic functions. Their history is closely linked to the development starting in the eighteenth century of steam engines and hydraulic pumps, but the stage of patent and prototype has been overcome only by a few models that will be worth mentioning in this paper.

The geometry of rotary engines varies considerably due to their dependence of the constructive solutions chosen by inventors, but most of their shapes can be described as cylindrical with top and bottom ends parallel and perpendicular to the main axis of the cylinder. Because of the defining characteristics of three-dimensional appearance, the design of a rotary engine begins with the design of a two-dimensional transverse section perpendicular to the axis of rotation of the engine.

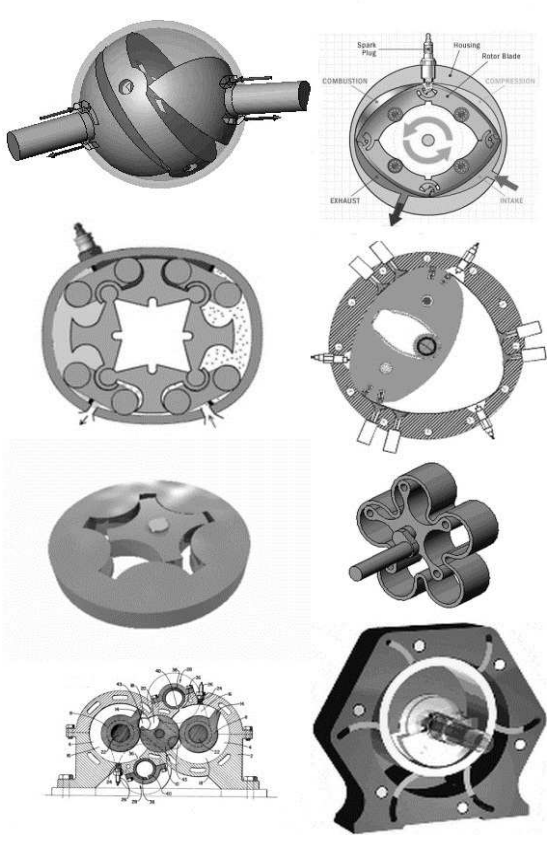

Figure 1 Various rotary engines concepts [18]

2. THE WANKEL ENGINE

The rotary engine designed by Felix Wankel starting in 1929 is the best known and most developed rotary engine. The Wankel engine has been licensed between 1958 and 1973 to a total of 26 world class manufacturers, especially in the U.S., Japan and Germany, but was best adopted and refined by the Mazda Company with the latest Renesis engine equipping vehicles series RX-7, RX-8 and RX-8 Hydrogen. Versions of this engine have even been converted for marine propulsion by companies such as Atkins Rotary Marine.

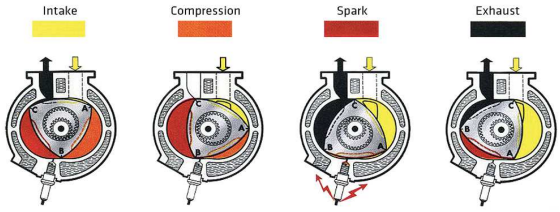

Figure 2 Wankel engine functioning cycle [19]

Throughout its development the Wankel engine has faced a number of problems:
- the rotor sealing was poor due to large temperature differences between sections of the combustion chamber;
- the combustion process was slow and bulky due to the combustion chamber being in motion, causing a thin stream and preventing the flame in the combustion chamber in reaching the outer rims;
- high fuel consumption at frequent changes of RPM, and high emissions of pollutants;
- low torque due to the high rate of repetition of the Otto cycle;

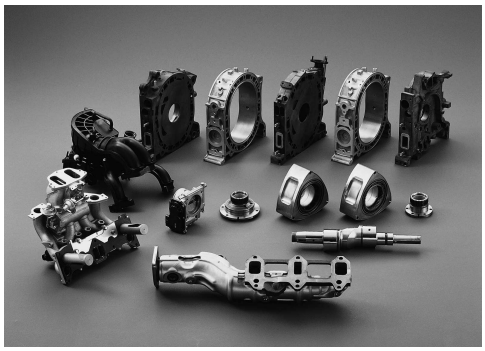

Figure 3 Renesis engine main components [20]

Although these deficiencies have been partially or totally overcome, the Wankel engine has a number of advantages over the classic piston configurations that can tip the balance in applications where volume and weight are very important on the overall performance of the vehicle and when the prevailing parameters of the design are the manufacturing and operating cost.

Some of the advantages of the Wankel engine [2] are:
- higher power to weight ratio than a piston engine;
- there are no reciprocating moving parts;
- it is running with almost no vibration;
- far fewer parts than a piston engine;
- cheaper to mass-produce because it contains fewer parts;
- the filling of the combustion chamber is made at 270 degrees of the main shaft compared to 180 degrees in a piston engine;
- it produces torque for about two-thirds of the combustion cycle, compared to a quarter in a piston engine;
- the wide range of speeds provides greater adaptability;
- it can use various octane fuels;
- does not suffer from the "scale effect" in limiting its size;
- has about a third the size of a piston engine of equivalent power;
- the crankcase oil remains uncontaminated by the combustion process and thus it requires no oil changes;
- the main crankshaft oil is completely sealed from the combustion process.

The classical approach of designing the geometry of a Wankel rotary engine involves generating the inner case using a trochoid curve followed by the design of the inner rotor using an equilateral triangle that stays in permanent contact at its tips with the case shell.

The trochoid is a curve described by the following equations in a Cartesian *x*-*y* planar system:

$$x = e\cos(3\alpha) + R\cos(\alpha) \tag{1}$$

$$y = e\sin(3\alpha) + R\sin(\alpha) \tag{2}$$

In the mathematical expressions above, e is called the rotor eccentricity, R is the absolute length of the apex position vector, and α is the angle vector position of the apex.

The constant of the trochoid K is the ratio between the generating radius R and the eccentricity e which can provide a typical index for a trochoid to indicate its geometric configuration.

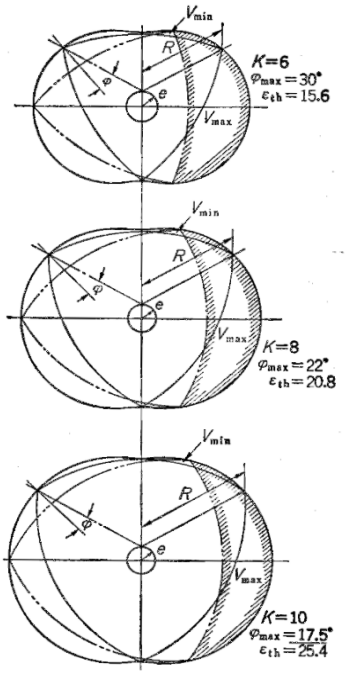

Figure 4 Various trochoid configurations [17]

The envelope of a peritrochoid is a pattern drawn by the peritrochoid fixed on a circle when it rolls along the inner surface of a stationary circle as inscribed. The inner line of this pattern is called the inner envelope.

The inner envelope of the trochoid is a basic curve forming the contour of the rotor. As shown in Figure 4 its three apexes are always in contact with the peritrochoid.

Therefore, the equation of the envelope can be expressed, as:

$$X = R\cos 2v + \frac{3e^2}{2R}(\cos 8v - \cos 4v) + e(1 - \frac{9e^2}{R^2}\sin^2 3v)^{1/2}(\cos 5v + \cos v) \quad (3)$$

$$Y = R\sin 2v + \frac{3e^2}{2R}(\sin 8v + \sin 4v) + e(1 - \frac{9e^2}{R^2}\sin^2 3v)^{1/2}(\sin 5v - \sin v) \quad (3)$$

These functions are cyclic functions with the period of 2π. The inner envelope corresponds to v varying in the intervals $\pi/6 \sim \pi/2$, $5\pi/6 \sim 7\pi/6$, $3\pi/2 \sim 11\pi/6$.

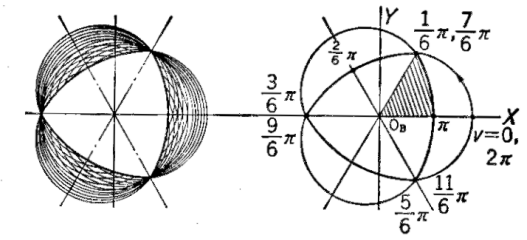

Figure 5 Wankel engine rotor design [17]

The change in the volume of the working chamber is one of the fundamental requirements for the rotary engine to be regarded as an internal combustion engine.

The volume of the working chamber of the rotary engine is defined as the product of the area (side area) enclosed by a side of the rotor contour and the inner surface of the peritrochoid, and the width of the rotor housing.

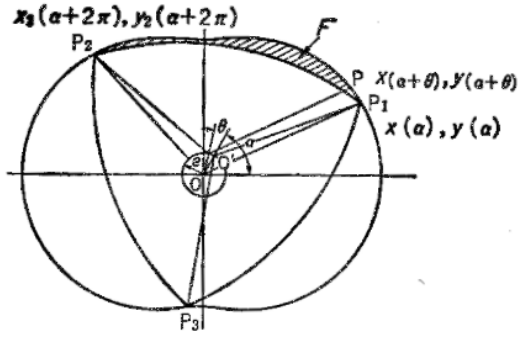

Figure 6 Wankel engine working chamber [17]

The side area F of the working chamber shown in Figure 6 is expressed as:

$$F = F_1 - F_2 - F_3 - F_4 \quad (4)$$

where:

F_1: area enclosed by the peritrochoid and lines OP_1 and OP_2

F_2: area of $\Delta OP_1O'$

F_3: area of $\Delta OP_2O'$

F_4: area enclosed by $O'P_1P_2$ (1/3 of the rotor side area)

The coordinates (x, y) of any point P between P_1 and P_2 on the trochoid are:

$$x = e\cos(\alpha + \theta) + R\cos(\frac{\alpha + \theta}{3}) \quad (5)$$

$$y = e\sin(\alpha + \theta) + R\sin(\frac{\alpha + \theta}{3}) \quad (6)$$

From this,

$$F_1 = \frac{1}{2}\int_0^{2\pi}(x\frac{dy}{d\theta} - y\frac{dx}{d\theta})d\theta = (e^2 + \frac{R^2}{3})\pi - \sqrt{3}eR\sin(\frac{2}{3}\alpha + \frac{\pi}{6}) \quad (7)$$

From the formula of the triangle area,

$$F_2 = \frac{1}{2}eR\sin\frac{2}{3}\alpha \quad (8)$$

$$F_3 = eR\sin(\frac{2}{3}\alpha + \frac{\pi}{3}) \quad (10)$$

$$F_4 = \frac{\pi}{3}(R^2 + 2e^2) - 2eR\cos\varphi_{\max} - (\frac{2}{9}R^2 + 4e^2)\varphi_{\max} \quad (11)$$

The side area of the working chamber is:

$$F = \frac{\pi}{3}e^2 + eR\{2\cos\varphi_{\max} - \frac{3\sqrt{3}}{2}\sin(\frac{2}{3}\alpha + \frac{\pi}{6})\} + (\frac{2}{9}R^2 + 4e^2)\varphi_{\max} \quad (12)$$

where φ_{max} is the maximum angle of oscillation given by α, the value of which can be obtained by applying the condition $d\varphi/d\alpha = 0$, meaning $\varphi_{max} = \arcsin(3/K)$.

With the width of the rotor housing taken as b, the volume of the working chamber is expressed, as:

$$V = b \cdot F = V_{min} + \frac{3\sqrt{3}}{3}eRb\{1 - \sin(\frac{2}{3}\alpha + \frac{\pi}{6})\} \quad (9)$$

where

$$V_{min} = \{\frac{\pi}{3}e^2 + 2eR\cos\varphi_{\max} + (\frac{2}{9}R^2 + 4e^2)\varphi_{\max} - \frac{3\sqrt{3}}{2}eR\}b \quad (10)$$

This indicates that the volume of the working chamber of the rotary engine changes in sine curve.

On the other hand, the volumetric change of the reciprocating engine is expressed, as:

$$V = V_{min} + \gamma \cdot s\{(1 - \sin\alpha) + \frac{1}{4\lambda}(1 + \cos 2\alpha)\} \quad (15)$$

Where γ is the radius of crank, s is the area of cylinder, α is the angle of rotation of crank, and λ is the radius of crank.

The volumetric change of the working chamber of the rotary engine corresponds to that of the reciprocating engine taken as $\lambda \to \infty$. Also, the period of the volumetric change is 1.5 times that of the reciprocating engine, showing a smoother change.

The stroke volume is given by the difference between the maximum and minimum values of the volume of the working chamber.

The stroke volume V_H is:

$$V_H = 3\sqrt{3}eRb \tag{11}$$

With the major and minor axes of the peritrochoid taken as A and B, respectively, the following relations will be established:

$$A = 2(R + e); B = 2(R - e) \tag{12}$$

Using these relations, also

$$V_H = \frac{3\sqrt{3}}{16}(A^2 - B^2)b \tag{13}$$

It is impossible for the rotary engine due to its mechanism to obtain a higher compression ratio than the theoretical compression ratio that is expressed by the ratio of the maximum to minimum values of the volume of the working chamber as obtained above.

This is one of the major problems in designing a diesel rotary engine.

The theoretical compression ratio ε_{th} is given by:

$$\epsilon_{th} = \frac{V_{\max}}{V_{\min}} = \frac{2eR\cos\varphi_{\max} + (\frac{2}{9}R^2 + 4e^2)\varphi_{\max} + \frac{\pi}{3}e^2 + \frac{3\sqrt{3}}{2}eR}{2eR\cos\varphi_{\max} + (\frac{2}{9}R^2 + 4e^2)\varphi_{\max} + \frac{\pi}{3}e^2 - \frac{3\sqrt{3}}{2}eR} = \frac{2K\cos\varphi_{\max} + (\frac{2}{9}K + 4)\varphi_{\max} + \frac{\pi}{3}K + \frac{3\sqrt{3}}{2}K}{2R\cos\varphi_{\max} + (\frac{2}{9}K^2 + 4)\varphi_{\max} + \frac{\pi}{3}K - \frac{3\sqrt{3}}{2}K} \tag{14}$$

As it can be clearly seen from the above calculation, the theoretical compression ratio ε_{th} is determined only by the trochoid constant K. This indicates that, as the trochoid constant increases, the theoretical compression ratio also increases. If the trochoid constant is taken between $K=6\sim10$, the theoretical compression ratio will become $15\sim25$.

The compression ratio of the real rotary engine is inferior to than the theoretical compression ratio because of the effects of the parallel movements of the peritrochoid and its internal envelope, the volume of the recess for the combustion chamber present in the rotor surface, the volume of the ignition plug opening, etc.

Taking the theoretical minimum volume of the working chamber and the stroke volume as V'_{min} and V'_H, respectively, when the parallel movement is considered, and the sum of the volume of the combustion chamber recess, and the volume of the spark plug hole is V_r, the compression ratio ε of the actual rotary engine can be obtained by:

$$\epsilon = \frac{V'_{min} + V_r + V'_H}{V'_{min} + V_r} \tag{15}$$

3. ROTAY ENGINES RESEARCH TRENDS

In recent times rotary engines research is undergoing some steady growth. In this chapter other types of rotary machines/engines are presented as trends worth mentioning due to their increasing popularity and available research funding.

3.1 Wave Disk Engines

The first engine to be presented in this chapter is the Wave Disk Engine which is a non-steady flow device that employs shock waves in order to increase the pressure of fluids by transferring energy from a high-pressure flow to a low-pressure flow inside some narrow channels.

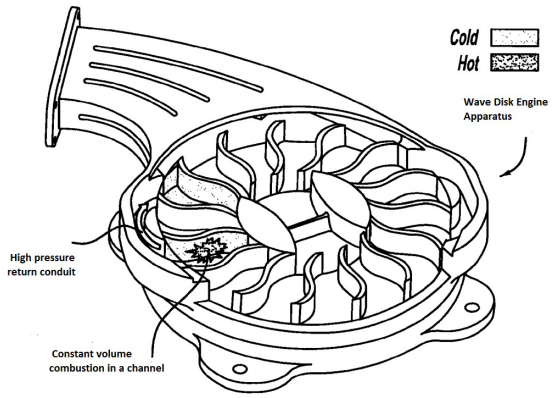

Figure 7 Wave Disk Engine [15]

Inside the gas powered wave disc engine the wave rotor uses high-temperature, high-pressure exhaust gas from a combustion chamber to create a shock wave that compresses the low-temperature, lower-pressure air received from an external compressor. This results in an boost in both temperature and pressure of the air incoming to the combustion chamber; permitting for a higher overall pressure ratio for the complete cycle for a fixed turbine inlet temperature. This kind of a pressure exchange wave rotor efficiently merges a steady-state turbo mechanism with unsteady, compressible gas flow principles, to accomplish superior cycle efficiencies.

Each port of the wave rotor assemblage is designed to expose the channels to running fluids at a specific shaft angle and for a specific amount of time. Shock and expansion waves are started within the channels by pressure differences; because of the port opening and closing. Since the channels are opened to both high temperature and low temperature gases; the wave rotor is obviously self-cooled. Furthermore, because of the pre-expansion of the burned gases of the wave rotor; the combustor can function at superior temperatures with no raising of the turbine inlet temperature. This is

particularly beneficial in applications where the temperature is restricted by material limitations.

Additionally the wave disc engine employs a combustion engine cycle inclusive of compression; combustion, expansion with extraction of positive work, followed by heat elimination to ambience, using the slim, radially set and bent channels. Compression work is usually provided through work produced throughout expansion. Furthermore, the usage of shock waves that travel with sonic speed decreases inertia of the fluid and ensures a rapid reaction. With the expansion at sonic speed directly after combustion; the resonance time at high temperature is very small; which usefully results in very low NO_x emissions. In addition; the significant heat transfer time and areas are exceptionally minute; consequently severely reducing heat losses.

3.2 Swing Piston Engines

Another type of rotary engine currently undergoing research and prototyping is the Swing Piston Engine (also known as Oscillating or Toroidal engine).

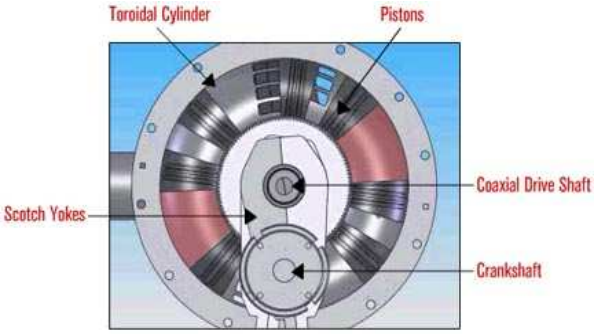

Figure 8 Toroidal engine section [21]

This rotary engine consists of a number of connected units. Each unit consists of a right circular cylinder (with appropriate ignition, intake and exhaust ports), partitioned by a pair of vanes (rotary pistons) into four compact sectors. The vanes rotate on independent concentric shafts aligned along the axis of the cylinder.

Each vane occupies an angular sector of the cross-section of the cylinder. Each shaft is connected to a flywheel via a gear mechanism. The geometry of the gear mechanism that links the torque produced by each unit to the fly-wheel is largely responsible for the nature of its vibrational torque characteristics induced by the impulsive torques from the combustion cycles. The structure of the cross-section across a single combustion unit is shown schematically.

One of the theoretical benefits of the design is a dramatic increase in power-to-weight ratio compared to a conventional reciprocating piston engine. The Rotoblock engine fires 16 times on one revolution of the crankshaft, compared to a V-8's four times per crankshaft revolution, for example.

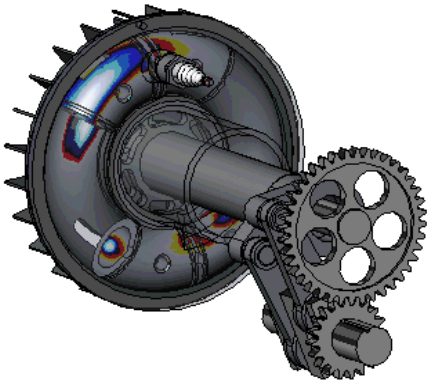

Figure 9 Toroidal engine 3D view [1]

3.3 Tesla turbines

The Tesla disc turbine is a kind of turbo-machinery in which the rotor is constructed by a series of co-axial, parallel flat discs rather than blades. This bladeless turbine was invented by the famous scientist Nikola Tesla.

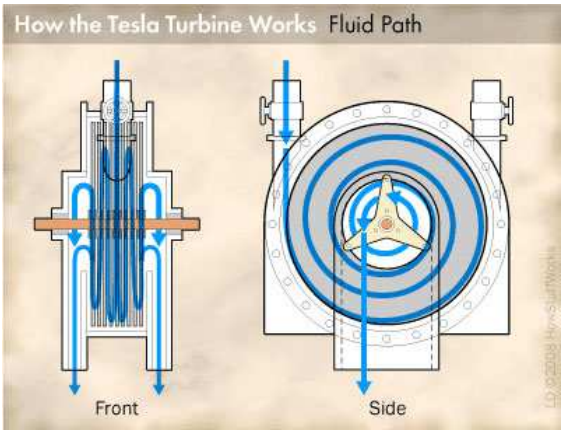

Figure 10 Tesla turbine fluid path [4]

The discs are arranged such that a small gap is maintained between any two successive discs, and they are attached to a central shaft. The combination of discs and shaft is placed inside a cylindrical casing with a small radial and axial clearance.

One or more nozzles are used to guide the working fluid to enter nearly tangentially from the periphery of the discs. There are exit ports near the shaft at the center of each disc. As the fluid passes through the narrow gaps between the discs, it approaches in a spiral path (usually, but there are new findings regarding complex non-spiral relative path-lines).

The working fluid travels from the inlet up to the central exit due the difference of pressure between the periphery and the central exit, and the component of inward radial velocity. The radial velocity gradually increases towards the central exit due to the gradual decrease of flow area. On the other hand, from inlet to exit, the tangential velocity may increase or decrease, depending on the local balance of various components of forces.

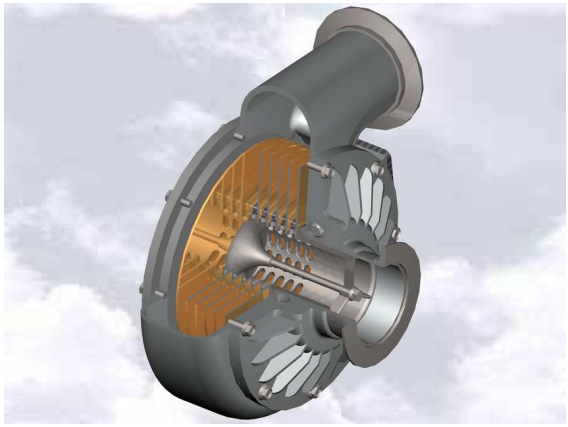

Figure 11 Tesla turbine 3D section view [3]

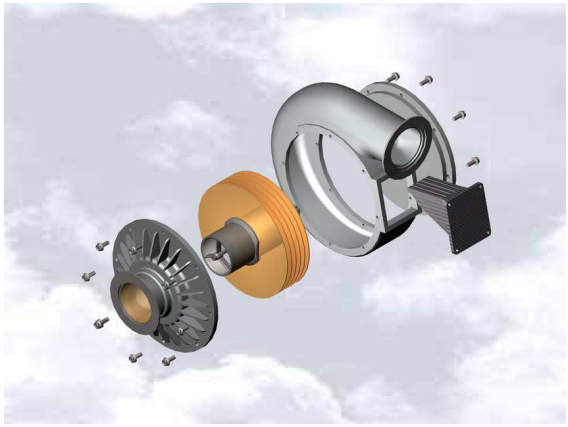

Figure 12 Tesla turbine main components [3]

4. CONCLUSIONS

The subject of propulsion for all kinds of transportation activities atracts a lot of research interest due to improvements that can be made in storage and usage of energy carriyng materials on mobile platforms.

Internal combustion engines are the most mature propulsion technology to date meaning that there is a solid background for studies regarding their performances that could be applied to novel ideas such as the rotary engines.

The rotary engines summarised in this paper gather some major cost advantages over classical piston configuration but they are also challanged by some technical difficulties like sealings and low efficiencies at low values of the rotation speed.

Rotary ICE are also more suitable for high power alternative fuels like hydrogen due to their greater range of functioning speeds.

The rotary internal combustion engines are more likely candidates in mixt electrical configurations or in some applications where high r.p.m. are required as long as the materials and technologies that can assure better sealings would be in place.

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REGRESSION AND ANOVA FOR A SET OF DATA

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ABSTRACT

The paper concerns utilization of linear regression and ANOVA for a set of data. The set of data regards the nonconformant housings of electric motors for different diameters of housings. Using the linear regression theory one can assess if there is a relationship between the types of defects. On the other hand, using analysis of variance for the set of data one can draw the conclusion regarding the fact that the defects have the same mean or not.

Keywords: *Housing of electric motor, linear regression, analysis of variance (ANOVA), non-conformity, defect*

1. INTRODUCTION

In the past it was a clear distinction between regression, analysis of variance (ANOVA) and analysis of covariance (ANCOVA). So, the statistic textbooks spoke of them as they were different entities designed for different types of problems. Nowadays all three procedures are regarded as being subsumed under what is called the general linear model (GLM).

Modern statistical software still contains separate procedures for regression and analysis of variance (ANOVA). These differences should be seen in terms of convenience in use of one procedure compared to the other, that is for certain types of data the problem of fitting a general linear model can be solved more convenient using an ANOVA procedure than a regression procedure.

Fitting a general linear model means to predict one or more dependent variables as a linear combination of independent variables. The dependent variables are also called response variables, while the independent variables are called predictor or explanatory variables and the coefficients of the linear combination are called weights or partial regression coefficients.

Regarding the notation the dependent variables are denoted with y, the independent variables are denoted with x. The weights or coefficients are denoted with β_i where i is the corresponding independent variable.

The two other features of the linear model are the intercept and the prediction error. The intercept is denoted by α and represents a constant. The prediction error, also called residual is the difference between the observation and the predicted value. The prediction error is denoted by e, while the prediction (predicted value) is denoted by y^.

The assumptions underlying the general linear model are the following four: linearity, normality of the residuals, equality of residual variances and fixed independent variables measured without error.

In our case the data to be analyzed are in the table comprising defect housings corresponding to four main defects for different eight diameters of the housings of electric motors. In order to analyze the data we check two assumptions using the regression analysis and the analysis of variance.

First assumption to be tested is that between the data in the table, there is a linear relationship that is to say that the nonconformant housings (defects) are related. This fact has the meaning that there is a systematic error in the production process or the means of production used are not reliable any more, the result being in errors in products (defects).

If the first assumption fails, the second assumption to be tested is that the defects come from the same population and the assumption of equal means is to be checked using the analysis of variance (ANOVA).

2. THEORETICAL ASPECTS ON THE LINEAR REGRESSION AND ANOVA

2.1 Theoretical aspects on linear regression:

Regression analysis allows one to make predictions about the numerical dependent variable based on one or more numerical independent variables.

There are two possible outcomes: if such a relation is found, it is consistent with the hypothesis of a causal influence between the dependent and independent variables, if instead no relation is found then the result suggests that there is no causal influence between the dependent and independent variables. However, in both cases the presence or the absence of the causal influence is not proved.

In the regression analysis one has to check whether there is a linear relationship between the output and input, or between the dependent and independent variable or between the response and explanatory.
The regression model has the form:

$$y = \beta_0 + \beta_1 x + e \quad (1)$$

where β_1 is called the regression coefficient or the slope of the line and e is the error term.
The parameters β_0 and β_1 need to be estimated and their estimations will be denoted as b_0 and b_1 and hence the equation is

$$\hat{y} = b_0 + b_1 x \quad (2)$$

b_0 and b_1 are to be calculated by minimizing the sum of square errors

$$SSE=\sum_1^n e_i^2=\sum_1^n (y_i - y^\wedge_i)^2= \sum_1^n (y_i - b_0 - b_1 x_i)^2 \quad (3)$$

Now, in order to test whether there is a linear relationship between two vectors, one must partition the total variation:

$$y_i - mean(y) = (y_i^\wedge - mean(y)) + (y_i - y_i^\wedge) \quad (4)$$

for i=1,2...n

By squaring the above relationship and summing from i=1 to n it follows:

$$\sum_{i=1}^n (y_i - mean(y))^2 = \sum_{i=1}^n (y_i^\wedge - mean(y))^2 + + \sum_{i=1}^n (y_i - y_i^\wedge)^2 \quad (5)$$

or in an equivalent form:

$$SS_{total} = SS_{regression} + SS_{residuals}$$

Which tells us that the total variation can be explained by the variation due to regression and the variation due to the fact that the observation do not lie on the regression line.

The alternatives to be tested in the case of linear regression are following:

(H_0): $\beta_1=0$ against (H_1): $\beta_1 \neq 0$

The calculated test statistic is

$$f = MS_{regression}/MS_{residuals}$$

Where,

$$MS_{regression} = SS_{regression}/1,$$

(1 being the degree of freedom for regression)

$$MS_{residuals} = SS_{residuals}/(n-2),$$

(n-2 being the degree of freedom for residuals, where n is the number of observations)

The test statistic has Fisher's F distribution with 1 respectively (n-2) degrees of freedom and depending on its value, one can conclude whether there is a linear relationship between y and x, or not.

If the value of calculated f statistic is greater than the value of the quantile (inverse of CDF) at x=0.99 the null hypothesis must be rejected and the alternative hypothesis accepted.

2.2 Theoretical aspects on ANOVA:

In the analysis of variance (ANOVA), the goal is to check whether the groups have the same mean under the assumption that the groups come from the same normal population.

In order to achieve that goal the total sum of squares is partitioned in the sum of squares between the groups and the sum of squares within the groups:

Thus:

$$SS_{total} = SS_{between\ groups} + SS_{within\ groups}$$

Taking into account of degrees of freedom the mean squares are calculated:

$$MS_{between} = SS_{between}/(k-1)$$

where k is the number of groups

$$MS_{within} = SS_{within}/(n-k)$$

where n is total amount of data

The concept of degrees of freedom is summarized by two points. First, the degree of freedom associated with a term equals the number of independent values of that term. Second, the degree of freedom is used as correction factor for the sum of squares (SS) associated with that term. The sum of squares divided by the degrees of freedom gives the value of the mean squares (MS) and the MS is corrected in the sense that is an average amount of variation for each of the estimated independent parameters.

The f statistic is calculated as:

$$f = MS_{between}/MS_{within}$$

The f statistic is also known under the name of f ratio or f observed.

By comparing the obtained f statistic with the value coming from Fisher's F distribution with (k-1) and (n-k) degrees of freedom for a certain significance level one can conclude about the rejecting or not-rejecting of the null hypothesis (groups have the same mean).

If the value of f statistic is large, the null hypothesis can be rejected and concluded that there are more than chance differences between the means of the groups analysed.

How large must be the value of f statistic in order to reject the null hypothesis depends of the significance level chosen in order to perform the test. One must compare the value of the f observed with the value of f critical for a certain significance level. If f observed is greater than f critical the null hypothesis (means of the groups are equal) can be rejected in favour of the alternative hypothesis (means of the groups are not equal).

3. PERFORMING THE ANALYSIS FOR THE SET OF DATA

The following table summarizes the defect housings of electric motors, taking into account the type of defect and the diameter of the housing. The number of defects for each cell in the table corresponds to the same number of the housings of motors observed. Thus the each cell number comes from a samples of same number of observed housings.

Table 1. Defects of four types, per diameter, for a population of housings of electric motors

Diameter	Defect1	Defect2	Defect3	Defect4
112	151	153	145	156
132	157	156	147	152
160	149	147	154	158
180	167	163	157	149
200	145	147	146	160
225	163	150	160	153
250	164	161	162	157
315	150	155	155	163

The first assumption to be verified is that the four types of defects are somehow dependent, fact that can lead to the conclusion that a systematic error lies in the production process or the means of production used are not reliable any more.

In order to check whether there is linear dependency between the types of defects, one checks whether between each column vectors corresponding to Defect2, Defect3 and Defect4 and column vector corresponding to Deffect1 exists such a relationship.

For the first check (of linear dependency between Deffect2 and Deffect1), following results are obtained:

Calculated regression line: y=x*0.54565+69.015

SS tot=250

SS reg=138.60

SS res=111.40

Correlation coefficient between y and x: corr(x,y) = sqrt(SS reg/SS tot) = 0.74457

Value of calculated f statistic is f=7.4644

Value of the 0.99 quantile for the Fisher's F distribution with 1 and n-2=6 degrees of freedom is 13.745

Since 7.4644<13.745 the null hypothesis must not be rejected. Therefore at 0.99 significance level there is no linear relationship between y and x.

For the second check (of linear dependency between Defect3 and Defect1), following results are obtained:

Calculated regression line: y=x*0.55317+67.094

SS tot=299.50

SS reg=142.44

SS res=157.06

Correlation coefficient between y and x: corr(x,y)=sqrt(SS reg/SS tot)=0.68963

Value of calculated f statistic is f=5.4416

Value of the 0.99 quantile for the Fisher's F distribution with 1 and n-2=6 degrees of freedom is 13.745

Since 5.4416<13.745 the null hypothesis must not be rejected. Therefore at 0.99 significance level there is no linear relationship between y and x.

For the third check (of linear dependency between Defect4 and Deffect1), following results are obtained:

Calculated regression line: y=x*(-0.41676)+220.91

SS tot=144

SS reg=80.851

SS res=63.149

Correlation coefficient between y and x: corr(x,y)=sqrt(SS reg/SS tot)= -0.74931

Value of calculated f statistic is f=7.6819

Value of the 0.99 quantile for the Fisher's F distribution with 1 and n-2=6 degrees of freedom is 13.745

Since 7.6819<13.745 the null hypothesis must not be rejected. Therefore at 0.99 significance level there is no linear relationship between y and x.

Performing analysis of variance for the data in the table we obtain following results:

SS between groups=43 at 4-1=3 degrees of freedom

SS within groups=1159 at 32-4=28 degrees of freedom

MS between groups=43/3=14.3333

MS within groups=1159/28=41.3929

The calculated value of the f statistic is f=0.3463

Since f is smaller than the value of the 0.99 quantile of Fisher's F distribution with 3 and 28 degrees of freedom which is 4.5681, the null hypothesis must not be rejected.

Therefore at a significance level of 0.99 the four defects have the same mean.

4. CONCLUSIONS

Both tests used in this paper, as well the test for regression and as well the test for equal means are subsumed to the general linear model.

The similarities of both tests are obvious and they regard on one hand the using of the F test and on the other hand the concept of partitioning the sum of squares.

Although the F test is used to assess different hypothesis the test is used in the same sense, that is to say the null hypothesis is rejected when the value of f statistic (f ratio or f observed) is greater than the value of the f critical corresponding to the Fisher's F distribution with the corresponding degrees of freedom in both cases.

The concept of partitioning is the main idea behind the both – checking of regression and checking of equal means). The term partitioning is used with the meaning of "breaking into components". By breaking into components the total sum of squares (SS tot) in the both cases and using those components by dividing them by the corresponding degrees of freedom the values of f statistic are obtained.

Using the results of the analysis one can conclude about the fact that there is no linear dependency between the defects at the significance level of 0.99.

Performing of the ANOVA on the same set of data it results that the four types of defects are very probable to come from groups with the same mean.

5. ACKNOWLEDGMENTS

I would like to express my deep gratitude to my Professor Mihai Octavian Popescu who is guiding me permanently, for his support and encouragement throughout my study and preparation for the doctoral thesis. My grateful thanks are also extended to my Professor in Statistics, Constantin Tarcolea for his help when I was in difficulty with the work. I would like to express my deep gratitude to Professor Emil Oanta for his willingness to help me on every occasion, for the useful suggestions he gave me, for all the useful time I had the honour to be in his company, time which has helped me and encouraged me to be better and also for the help he offered to me regarding the knowledge and use of the Octave software, the main tool I used in the calculations made.

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PLANNING OF A STRAIN GAGE EXPERIMENT FOR A LARGE CRANE

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ABSTRACT

Complex experimental projects and hybrid models in engineering are long run research concerns of the authors, the current subject being a subsequent result. The paper presents the basic stages regarding the planning of an experimental mechanics project required by a private company. The goal of the experimental project is to measure the strains in a set of points located on a rail mounted quay crane, the location of the points being chosen by the customer company. The paper presents the ideas employed to analyze the demand of the customer company vs. the real conditions and practical capabilities. The analysis takes into account various aspects: scientific, technical, economical and legal, in the planning of an experimental mechanics projects being required a special kind of know-how based on an extensive experience and on an overview level in several fields. The main stages are: initial analysis, on-site documentation, thorough analysis taking into account various aspects, results and conclusions to be included in the planning of the experiment.

Keywords: *plan of the experiment, strain gage technology, maximum data relevancy, minimum costs.*

1. INTRODUCTION

One of Benjamin Franklin's ideas was: "If you fail to plan, you are planning to fail!". Planning is a basic component of all the successful projects, being far more important for experimental projects.

Planning includes the following components:

- verification is the problem is properly formulated;
- analysis of the problem, resources and constraints;
- material resources: available equipment, consumables and backup;
- human resources;
- time resources;
- various other constraints;
- aspects regarding the safeness of the field experiment.

For complex projects we can consider Dwight D. Eisenhower's assertion "In preparing for battle I have always found that plans are useless, but planning is indispensable.". It means that beside the high degree of uncertainty of any project, a thorough planning offers the background for an effective decision making process.

Project management offers the grounds for the planning of any project, but we'll present our approach in terms of engineering, especially experimental mechanics aspects. The first stage to be completed is the analysis of the problem to be solved.

2. PROBLEM TO BE SOLVED

Generally, the approach of some customer companies who order experimental studies, companies with no technical culture regarding the experiments, is: results must be accurate, costless and the deadline is yesterday. In this case, the designer of the customer company had a professional approach and offered us the plan of the structure together with:

- the locations of the point where the strain transducers must be installed;
- the stresses resulted from theoretical studies;
- the load cases considered for the theoretical studies;
- the direction on which the strain gages must be installed and the point where three gages rosettes must be bonded.

Figure 1 presents the structure to be experimentally studied. The crane is supported on four legs fitted with rail wheels. The slewing platform is supported on a large hollow tower and it is fitted with: the engine house, operator's cabin, latticed boom and the mast. The manufacturing company has an extensive experience in manufacturing complex mechanical equipment, including large cranes.

Some of the requests of the customer are:

- the time dedicated to the experiment should be as short as possible;
- the structure should be experimentally weighted;
- the results must be accurate;
- the cost of the experiment should be minimal.

From the beginning we have presented to the customer company a list of other universities in Romania who own data acquisition equipment compatible with the research topic. In this way the customer company can properly choose the best solution in terms of professional approach and financial quotation of the experimental research services which might be provided by us and by other parties.

3. ON-SITE DOCUMENTATION STAGE

The on-site documentation explores the possibility to accept the proposal of the manufacturing company.

The first stage was to evaluate our capabilities regarding the resources: expertise, equipment, consumables, availability of the resources we do not have yet.

The next stage was to prepare the visit to the shipyard where the crane is an ongoing installation process. In order to have accurate information about the problem to be solved there were conceived a list of questions, a list of locations to be photographed and a set of scenarios regarding the effective progress of the experiment.

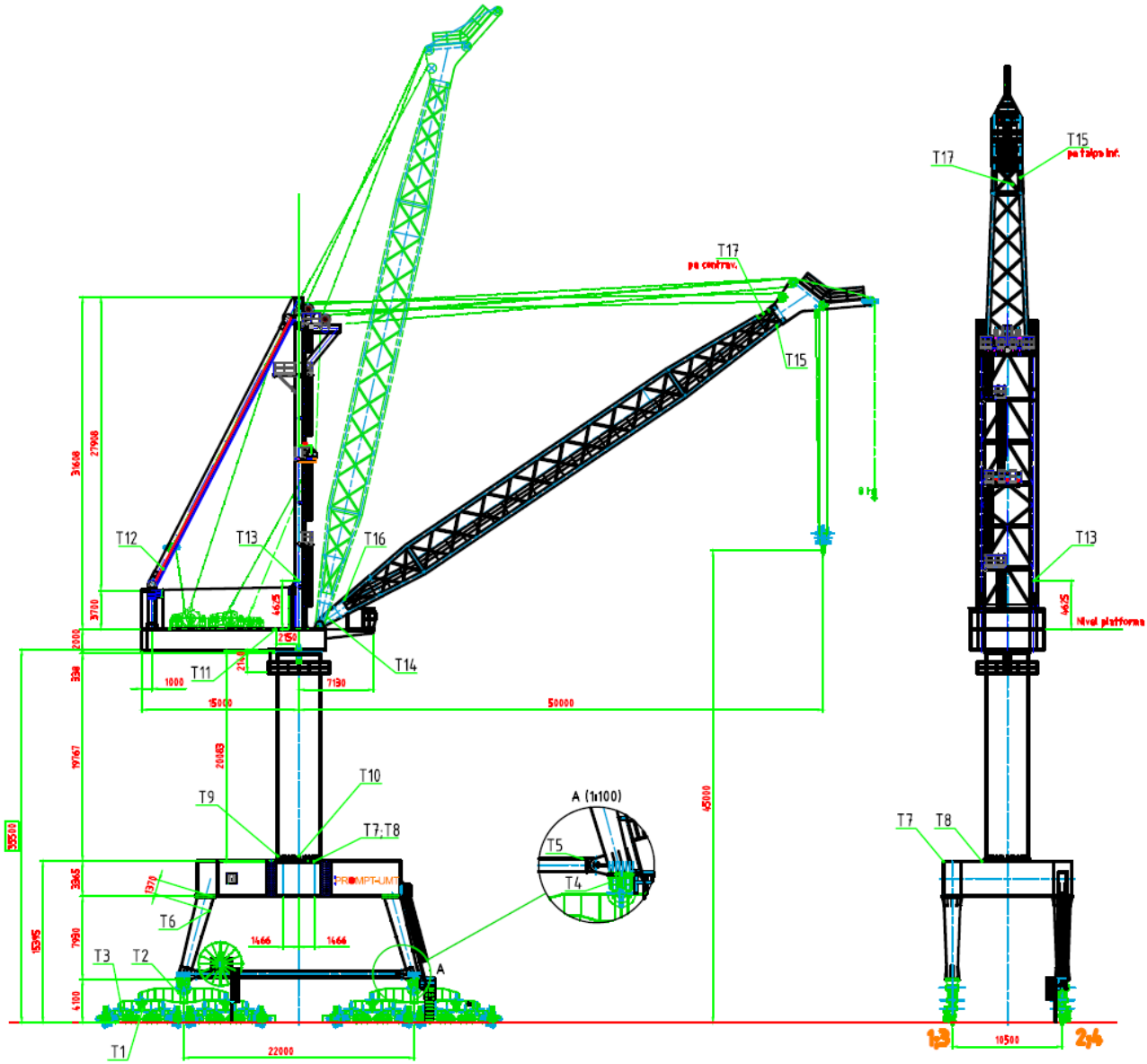

Figure 1 Locations of the points where the strain transducers must be installed

According to the answers of the customer, there were drawn the following conclusions:

- the overall mass of the crane and load is around 1000 tonnes;
- there is a constraint regarding the equally distributed mass of 33 tonnes per meter for the quay where the crane will be operated, the fulfilment of this condition being questionable;
- the customer cannot provide appropriate experimental conditions for the weighting of the structure, though we presented several scenarios and options;
- the customer can provide a cherry picker mobile lift platform which can be used to bond the strain transducers on the external side of the main tower at heights of more than 15.5 meters;
- there are some sources of electric power which will be used to solder the leadwires to the strain transducers;
- in the evaluation of the design and manufacturing cost of the crane there were not planned expenses for experimental studies;
- during the installation process there were noticed some mismatches between the initial design and the effective conditions and some minor redistributions of the on-board equipment was done.

There were taken 567 photographs and videos, the overall size being of more than 1250 MB. All the important aspects were documented:

- possible locations of the measurement points and of the command centre, denoted CC, where the data acquisition equipment will be installed;
- supports of the crane;
- access points inside the crane and to the locations of the measurement points;
- path of the leadwires between the possible locations of the measurement points and the CC;
- hazard work conditions: height, wind and some other weather conditions.

Figure 2 Lattice boom, view from the slewing platform to the top of the arm

Figure 3 Lattice boom, view from the top to the slewing platform of the crane

Figure 4 Mast of the crane, view from the top end of the truss arm

Figure 5 Lattice boom of the crane, view from the top end of the mast

Some other aspects were also noticed:

- temperature and possible temperature variation during the ongoing experiment;
- time required to go from the command centre to the possible locations of the measurement points in order to inspect, maintain or repair the connections.

4. TECHNICAL AND ECONOMICAL ASPECTS

4.1 Technical details

The customer company specified the following locations of the measurement points:

- T01, T03, strain gages, located on the middle beam belonging to the crane motion system, figure 6;
- T03, strain gage, located on the topmost beam belonging to the crane motion system, figure 6;
- T04, strain gage rosette, located on the connecting element between the crane and the motion system;
- T05, strain gage rosette, located on foot no. 2 of the crane, next to the tensioner bracing rod;
- T06, strain gage, located on the tensioner bracing rod which connects the feet on one side of the crane;
- T07, strain gage, located on the outer side of the fixed platform;
- T08, strain gage, located on the transverse beam of the fixed platform which supports the tower;
- T09, strain gage, located on the tower, between feet 1 and 2, next to the transverse beam of the fixed platform; a cherry picker mobile lift platform is necessary to have access to this location;
- T10, strain gage, located on the tower, between feet 2 and 4, next to the transverse beam of the fixed platform;
- T11, strain gage, located on the slewing platform, between the mast and the engine room;
- T12, strain gage, located on the in-tension beam which connects the end of the slewing platform to the top of the mast, over the engine room;
- T13, strain gage, located on the mast of the crane, over the engine room;

Figure 6 Motion system of the crane, leg no. 3

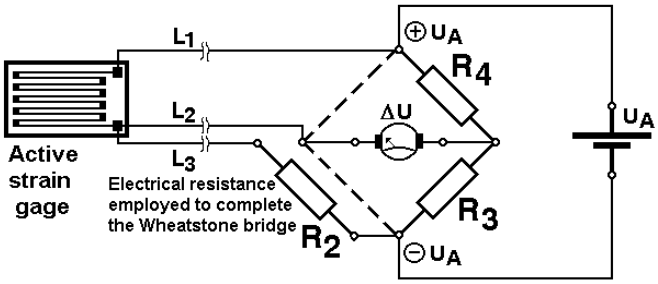

Figure 7 Three wires connection system

- T14, strain gage rosette, located on the lattice boom pinned connection, on the slewing platform, behind the operators cab;
- T15, strain gage, located on the outer end of the lattice boom, on the bottom side;
- T16, strain gage, located on the first beam of the lattice boom, next to the pinned support, on the topmost surface;
- T17, strain gage, located on the last diagonal beam, to the outer end of the lattice boom.

The area where points T15 and T17 are located may be seen in figures 2 and 5. Also, in figure 3 may be noticed the area where points T14 and T16 are located.

The elements of the crane are manufactured of high strength steel for structural purposes.

4.2 Economical aspects

It is well known that all the experimental research studies are expensive in comparison to the theoretical computer based studies.

The consumables consist of strain transducers, chemical substances employed to prepare the surface on which the strain transducers will be bonded, adhesives, protective substances, leadwires, soldering materials and others. All these materials are expensive, for instance a meter of shielded cable with 4 wires costs more than 3 euros and it is delivered in coils of 10 or 100 meters.

Moreover, the delivery period for strain transducers is very long, especially when the European branches of the manufacturing company, VISHAY Measurements, are out of stock because the season for industrial experiments has started.

The constraint regarding the time frame dedicated to the experiment requires several operators working simultaneously, who must install the strain transducers and the leadwires. The cumulated time to install the strain transducers is the same, but the training of the operators in order to update their knowledge and skills according to the strain transducers to be used for this particular experiment leads to an additional cost.

4.3 Legal aspects

The customer company claims that the accuracy of the acquired data must be in the class of precision recognition by the State Inspection for Control of Boilers, Pressure Vessels and Hoisting. System 6000 has a more accurate class of precision, so this requirement is fulfilled.

The team which will carry out the experiment will work at height, this kind of work remaining one of the biggest causes of fatalities and major injuries. To avoid accidents, the team will be legally instructed regarding the safety of the working at heights.

Another aspect regards the copyright of the experimental data acquired.

Acquirement of the necessary materials for the experiment will be done by respecting the actual legal procedures.

5. RESULTS

5.1 The technical solution regarding the design of the experiment

The equipment employed to acquire experimental data consists of: System 6000 with 16 cards/channels, CDS20 cable-extension displacement sensor, P3500 strain indicator (Wheatstone bridge), SB-10 switch and balance unit, MAK tool case for the installation of the strain gages. System 6000 is fitted with 15 strain gage cards model 6010 and one high-level card model 6030. All the equipment was manufactured by Vishay Measurements Group.

There are several strategies to be followed regarding the errors and the parasitic effects in an experiment which uses strain gages, [1]. Some of them are: to eliminate the source of errors, to actively compensate the parasitic effect, to self-compensate the parasitic effect and to correct using calculi the possible errors. It must be reminded that one of the most important parasitic effects is the temperature variation during the experiment, in some cases being very important to measure the temperature in each location of a strain transducer [2].

The experiment will be carried out in open spaces, not in laboratory conditions, so it is certain that the temperature will have a variation during the on-going data acquisition. Figure 7 presents the three wires connection system will be used to wire each strain gage to a card/channel of the data acquisition system. In this way, this parasitic effect of the temperature variation in the leadwires can be self-compensated and the acquired data will have a proper accuracy. The connecting system requires additional wires, so it is important to minimise the path of the cables. Minimisation of the length of the

cable is the first criterion in the selection of the location of the command centres, criterion designated C1.

Another criterion, C2, regards the length of the wires which must use a minimum number of 'standard' coils of 10 or 100 meters length, this means to minimise the costs.

The third criterion, C3, must take into account the constraint regarding the 15 cards dedicated to acquire data from strain gages in the above mentioned System 6000. The request of the customer company presented in the previous section must deal with 23 channels, so at least two command centres must be chosen.

The fourth criterion, C4, must take into account the verification of the data acquired, being mandatory to apply the principle "check, double-check and over check the experimental data". In this way, the data from some measurement points must be acquired from all the command centres in order to verify the repeatability of the measurements, hence of the phenomenon.

The fifth criterion, C5, regards some other aspects, such as the possibility to directly communicate with the crane operator and with the employee of the customer company who is in charge with the management of the experiment. This criterion is important in emergency situations in order to stop the current loading operation or to rapidly discharge the crane.

The order between the aforementioned criteria is "C4.Pr.C3.Pr.C1.Pr.C2.Pr.C5", where the ".Pr." operator is the symbol of the "simple preference" option in the multi-criteria matrix method employed in the decision making process.

Several scenarios were analysed in order to have an optimum accuracy / cost ratio. The best scenario considers two locations of the command centre.

The first command centre, CC1, is located on the ground and it is employed to acquire data from the following measurement points: T01, T02, T03, T04, T05, T06, T07, T08, T09 and T10. The overall number of channels/cards employed for this stage of the experiment is 14 out of a total of 15 cards for strain gages available in the System 6000 previously presented. It is important to remark that one channel / card is free, being possible to measure the vertical displacement of the lattice boom, using the CDS20 cable-extension displacement sensor. There must be reminded an important detail: CDS20 uses 350 Ω strain gages while the current strain gages have 120 Ω. This means that cards may be properly prepared for two electrical resistances, by setting accordingly the proper switches.

The second command centre, CC2, is located on the slewing platform, the experimental data being acquired from points T09, T10, T11, T12, T14, T15, T16 and T17. For this stage of the experiment 10 channels are used out of 15 available channels.

There must be noticed that points T09 and T10 are connected to both CC1 and CC2. In this way there may be evaluated the repeatability of the phenomenon.

Moreover, the SB-10 switch and balance unit together with the P3500 strain indicator may be used in parallel with the data acquisition process from either CC1, or CC2. The results presented by the P3500+SB10 data acquisition chain may be considered for static conditions only. However, the results can validate at least the order of the values acquired dynamically using the System 6000 measurement chain.

It is important to load and unload the crane several times before the data acquisition starts in order to test if the strain transducers are properly bonded and connected to System 6000 or to the P3500+SB10 data acquisition chain. Moreover, after several load and unload cycles the strain transducers are properly extended and they are ready to work smooth together with the structure on which they are bonded.

Being a time sensitive experiment, the installation of the strain gages must be done quickly. To fulfil this requirement there should be done the following operations in advance:

- creation of a code of colours for the wires, to be used as a rule to perform the connections;
- soldering the leadwires to the connectors which will be plugged into the cards belonging to System 6000, in laboratory conditions;
- soldering of the wires which will be used for the P3500+SB10 data acquisition chain into the connectors to be used for the System 6000, in laboratory conditions;
- labelling of the connectors, in laboratory conditions;
- labelling of each wire, using detailed information, in laboratory conditions;
- creation of the plan of the connecting network using the rule previously defined;
- creation of accurate drawings of each strain transducer to be bonded: position, direction, colours of the wires employed for the soldering process;
- creation of a list with all the additional materials needed: extension cable for the electric power supply in each group of locations of the measurement points, small polishing devices, equipment needed for the working at heights.

All the measurement points where the strain gages are bonded must be documented using photos and videos which will present the position on the crane (the context), details regarding the position and the direction of each strain gage, colours of the connecting wires. Visual documentation should also be used for the evaluation of the length of the wires.

Electrical resistance of the wires must be measured in order to correct by calculus the acquired data (for P3500+SB10 acquisition system) and to input them in the System 6000 data acquisition software. Moreover, the non-interruption of all the wires must be tested.

The electric power during the experiment will be supplied by batteries in order to avoid the parasitic effects due to the variation of the parameters of the electric power supplied in the shipyard where many other electrical equipment is used for the cranes and for the manufacturing process, such as for the welding process.

It is also advisable to take into account the mathematical relations, the methods and the algorithms employed to process the experimental data, in order to imagine simple relations to quickly calculate relevant information during the ongoing experiment, as well as for the development of a dedicated software for the experimental data reduction, [3].

Last but not least, it is important to create some emergency situations plans in several malfunction hypotheses: some of the 6010 strain gage cards are not working properly, identification of the possible sources of errors, interruptions or malfunctions, plans to redesign the wire network, plans to evacuate if the structure is overloaded and it might collapse.

5.2 Financial aspects

The overall cost of the experiment was calculated in several hypotheses regarding the position of the command centre. The aim was to minimise the costs and, in the same time, to assure the quality of the experiment, this means the accuracy of the experimental data acquired.

Generally, experiments are costly, and this project keeps all the expenses as low as possible. In this way, according to our calculi, the cost of the experiment is under 2% of the total cost of the crane. However, this cost was not foreseen in the costs estimations of the manufacturing process.

Finally, it should be noticed that all the delays in the elaboration of a decision regarding the date when the experiment must be started will lead to an increased overall cost.

6. CONCLUSION

Planning of an experimental mechanics project for industry is very important and various classes of aspects must be taken into consideration: technical, economical and legal. In order to have an overview and to check if the problem to be experimentally solved is well posed there is necessary an on-site documentation period and several discussions with the technical representatives of the customer company. Mastering the details is important and computer based approaches are needed in order to evaluate all the variants of action. Experimental data should be checked, double-checked and over-checked, in order to have a high degree of confidence. Beside the technical aspects there should be conceived backup plans for different scenarios.

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Ideas regarding the hybrid modeling and the interdisciplinary studies based on the strength of materials theory are the result of the models developed in the framework of the MIEC2010 bilateral Ro-Md research project, Oanta, E., Panait, C., Lepadatu, L., Tamas, R., Constantinescu, M., Odagescu, I., Tamas, I., Batrinca, G., Nistor, C., Marina, V., Iliadi, G., Sontea, V., Marina, V., Balan, V. (2010-2012), "Mathematical Models for Inter-Domain Approaches with Applications in Engineering and Economy", MIEC2010 - Bilateral Romania-Moldavia Scientific Research Project, [5], under the supervision of the National Authority for Scientific Research (ANCS), Romania, that is the follow-up of the ID1223 scientific research project: Oanta, E., Panait, C., Nicolescu, B., Dinu, S., Pescaru, A., Nita, A., Gavrila, G., (2007-2010), "Computer Aided Advanced Studies in Applied Elasticity from an Interdisciplinary Perspective", [4], under the supervision of the National University Research Council (CNCSIS), Romania.

Ideas regarding the analytical models and the automatic calculus in structural studies are the result of the models developed in the framework of the scientific research study 'Development of computer assisted marine structures', Emil Oanta, Cornel Panait, Ghiorghe Batrinca, Alexandru Pescaru, Alexandra Nita, Feiza Memet, which is a component of the RoNoMar project, [6], 2012.

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CONCEPTS REGARDING THE USE OF THE EXPERIMENTAL METHODS FOR THE WEIGHTING OF THE RAIL MOUNTED STRUCTURES

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ABSTRACT

Certain projects require the weighting of a particular structure, any industrial instrument being incompatible with the problem to be solved. In these cases new measuring instruments must be conceived. The paper presents some basic concepts regarding the development of such instruments. The study is dedicated to the weighting of the rail mounted structures. Experiments may be conducted in static or dynamic conditions. Basically, the strain gage technology offers the means to develop customized weighting instruments. The weighting operation implies the insertion of a sensor between the mass and the ground. Several solutions were studied, being presented a first method which uses strain gages and another solution based on displacement sensors. Both solutions are thoroughly analysed, by taking into account various parasitic effects. Finding the criteria to automatically process the experimental data for a load in motion along the measuring beam was an important target of the study. Numerical data were used to verify the range of the strains, of the stresses and of the deflections. Variations of the strains and displacements were graphically presented in order to have a higher degree of relevancy which leads to a more explicit interpretation and comparison of the solutions. The concepts presented in the paper may be used for rail wagons, rail mounted cranes and other rail mounted structures.

Keywords: *concepts, strain gages, displacement sensors, optimal solution.*

1. INTRODUCTION

Particular projects use models which require information regarding the loads, in this class of input data being also included the weights. In these cases the accuracy of the theoretical models, analytical or numerical, depends on the precise evaluation of the weights. Apart from the weighting instruments which can be found on the market, there are certain projects which have several specific constraints, being necessary special weighting instruments.

Several principles and methods may be applied to measure the weights, but one the most precise technique is based on the use of the strain gages. Some of the strengths of this method are: accuracy, availability of instruments and software which can be used for the data acquisition, wide range of mechanical parameters which can be measured and flexibility of this technology.

In the next sections there will be presented concepts regarding particular weighting techniques, based on experimental mechanics methods.

2. CONCEPTS REGARDING THE USE OF THE STRAIN GAGES INSTALLED ON A RAIL TRACK

On a rail track the strain gages may be installed on either the longitudinal surface, or under the rail, between the cross ties. The second arrangement of the measurement points may be also used for the weighting platforms.

In order to install the gages on the side surfaces of the rail track, first there must be solved the problem of the principal directions, principal strains and principal stresses. The principal directions may be calculated using the relation:

$$\alpha = \frac{1}{2} arctg\left(\frac{2\cdot\tau}{\sigma_X - \sigma_Y}\right), \tag{1}$$

where

$$\text{if } (\sigma_X - \sigma_Y) \geq 0 \Rightarrow \alpha = \alpha_1, \tag{2, a}$$

$$\text{if } (\sigma_X - \sigma_Y) < 0 \Rightarrow \alpha = \alpha_2. \tag{2, b}$$

The principal stresses are calculated using the expression:

$$\sigma_{1,2} = \frac{\sigma_X + \sigma_Y}{2} \pm \frac{1}{2}\sqrt{(\sigma_X - \sigma_Y)^2 + 4\cdot\tau^2}\ . \tag{3}$$

If the strain gages are installed next to the centroid of the section, figure 1, the according stresses are:

$$\begin{cases} \sigma_G = 0 \\ \tau_G = \tau_{\max}^{T_Z} \end{cases}. \tag{4}$$

It results that the principal directions are:

$$\begin{cases} \alpha_1^{(G)} = \dfrac{3\pi}{4} \\ \alpha_2^{(G)} = \dfrac{\pi}{4} \end{cases}. \tag{5}$$

and the principal stresses are:

$$\begin{cases} \sigma_1^{(G)} = +\tau_{\max}^{T_Z} \\ \sigma_1^{(G)} = -\tau_{\max}^{T_Z} \end{cases}. \tag{6}$$

The strains are calculated using Hooke's law for the plane stress state

$$\begin{cases} \varepsilon_1 = \dfrac{1}{E}(\sigma_1 - \nu\cdot\sigma_2) \\ \varepsilon_2 = \dfrac{1}{E}(-\nu\cdot\sigma_1 + \sigma_2) \end{cases}. \tag{7}$$

where E is Young's modulus and ν is Poisson's coefficient.

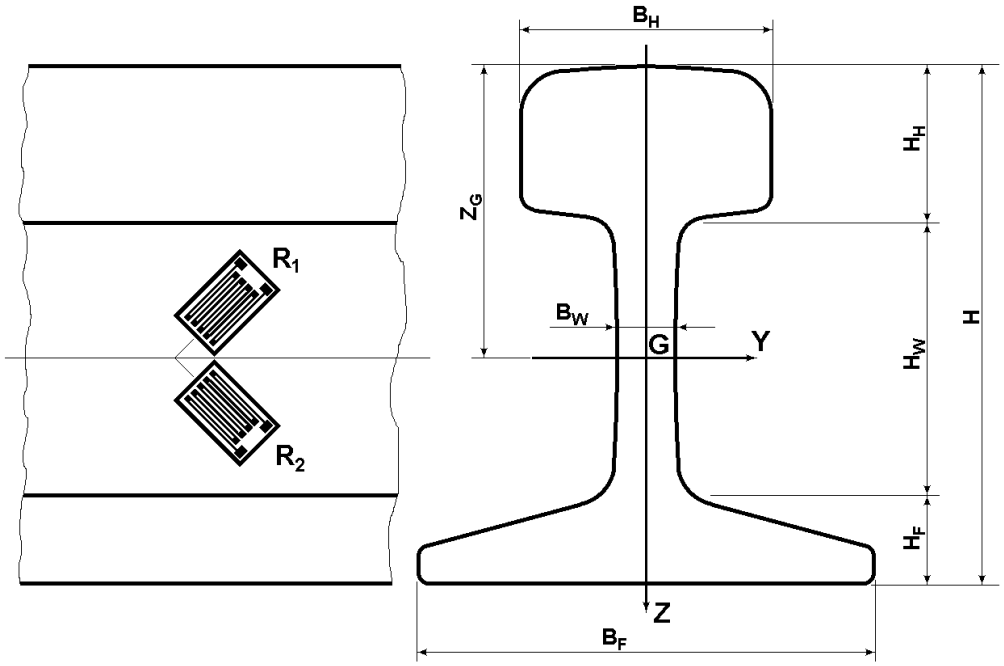

Figure 1 Strain gages on a flat bottom rail track

By replacing the principal stresses in Hooke's law, it results

$$\begin{cases} \varepsilon_1 = \frac{1}{E}\left[\left(+\tau_{\max}^{T_Z}\right) - \nu\cdot\left(-\tau_{\max}^{T_Z}\right)\right] = +\frac{1+\nu}{E}\tau_{\max}^{T_Z} \\ \varepsilon_2 = \frac{1}{E}\left[\left(-\tau_{\max}^{T_Z}\right) - \nu\cdot\left(+\tau_{\max}^{T_Z}\right)\right] = -\frac{1+\nu}{E}\tau_{\max}^{T_Z} \end{cases}.$$

Taking into account that $\frac{1+\nu}{E} = \frac{1}{2\cdot G}$, where G is the shear modulus, it results

$$\begin{cases} \varepsilon_1^{(G)} = +\frac{1}{2}\cdot\frac{\tau_{\max}^{T_Z}}{G} \\ \varepsilon_2^{(G)} = -\frac{1}{2}\cdot\frac{\tau_{\max}^{T_Z}}{G} \end{cases}. \quad (8)$$

Both strain gages measure the strain produced by the mechanical load, $\varepsilon_{1,2}^{(G)}$, as well as the apparent strain produced by the temperature variation during the experiment, designated as $\varepsilon_{\Delta T}$. The strain gages are installed in adjacent arms of the Wheatstone bridge, so the strain indicator outputs the difference between the signals produced by these strain transducers:

$$\begin{array}{ll} \oplus & \varepsilon_{R_1} = \varepsilon_1^{(G)} + \varepsilon_{\Delta T} \\ \ominus & \varepsilon_{R_2} = \varepsilon_2^{(G)} + \varepsilon_{\Delta T} \\ \hline \varepsilon_{R_1R_2} = & \varepsilon_{R_1} - \varepsilon_{R_2} = \varepsilon_1^{(G)} - \varepsilon_2^{(G)} \end{array}$$

As it can be noticed, the parasitic effect of the temperature variation is self-compensated using the half-bridge arrangement of the strain gages in the Wheatstone bridge, [1], 136-140. By replacing the principal strains in the previous relation it results

$$\varepsilon_{R_1R_2} = \varepsilon_1^{(G)} - \varepsilon_2^{(G)} = \frac{1}{2}\cdot\frac{\tau_{\max}^{T_Z}}{G} - \left(-\frac{1}{2}\cdot\frac{\tau_{\max}^{T_Z}}{G}\right) =$$

$$= \frac{1}{G}\cdot\tau_{\max}^{T_Z}$$

and, moreover,

$$\varepsilon_{R_1R_2} = \frac{1}{G}\cdot\frac{F}{I_Y}\cdot\frac{S_Y}{b_Y}.$$

The force which loads the beam is

$$F = \left(\frac{G\cdot I_Y\cdot b_Y}{S_Y}\right)\cdot\varepsilon_{R_1R_2}. \quad (9)$$

Let us consider that on a rail track, the weight is applied according to figure 2. This model is based on the hypothesis that the rail track is built-in on the cross-ties. The built-in hypothesis is accurate if a part of the rail track is replaced by a small beam having the same geometrical and mechanical characteristics, the beam being fitted with some measurement points. This beam is designated as a rail track coupon.

The force measured using the strain gages is actually the shear force, the variation being presented in the figure above. The forces in the two build-in ends of the rail track coupon are:

$$V_1 = F\frac{b^2\cdot(3\cdot a+b)}{(a+b)^3}, \quad (10)$$

$$V_3 = F\frac{a^2\cdot(a+3\cdot b)}{(a+b)^3}. \quad (11).$$

The shear forces diagram in the figure above has a sudden variation in section 2. As it can be noticed,

$$F = \left|T_{Z\,12}\right| + \left|T_{Z\,23}\right|. \quad (12)$$

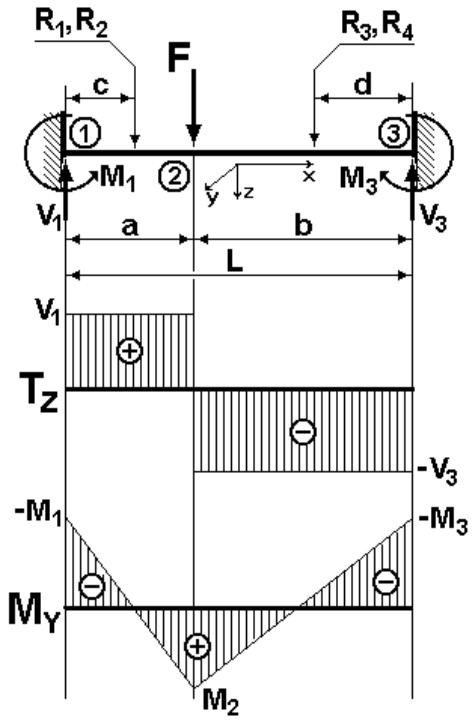

Figure 2 Calculus scheme: weight applied on a rail track, between two cross ties

This means that both of the forces $T_{Z\,12}$ and $T_{Z\,23}$ must be experimentally measured in order to evaluate the weight which loads the beam. This means that two measurement points must be used, being measured the forces

$$F_{R_1R_2} = \left(\frac{G \cdot I_Y \cdot b_Y}{S_Y} \right) \cdot \varepsilon_{R_1R_2} \qquad (13)$$

and

$$F_{R_3R_4} = \left(\frac{G \cdot I_Y \cdot b_Y}{S_Y} \right) \cdot \varepsilon_{R_3R_4} . \qquad (14)$$

The weight applied on the beam is

$$F = \left| F_{R_1R_2} \right| + \left| F_{R_3R_4} \right| , \text{ if } F_{R_1R_2} \cdot F_{R_3R_4} < 0 . \qquad (15)$$

Condition $F_{R_1R_2} \cdot F_{R_3R_4} < 0$ means that the unknown force, F, is located between the locations of the measurement points. This condition is necessary because the unknown force, F, is in motion along the rail track coupon. In order to have accurate results the speed of the F force should be constant and the rail track should have a straight path in the area where the measurement points are installed. In this way, there are no inertia forces and no centrifugal forces, so the only force which loads the beam is the weight force.

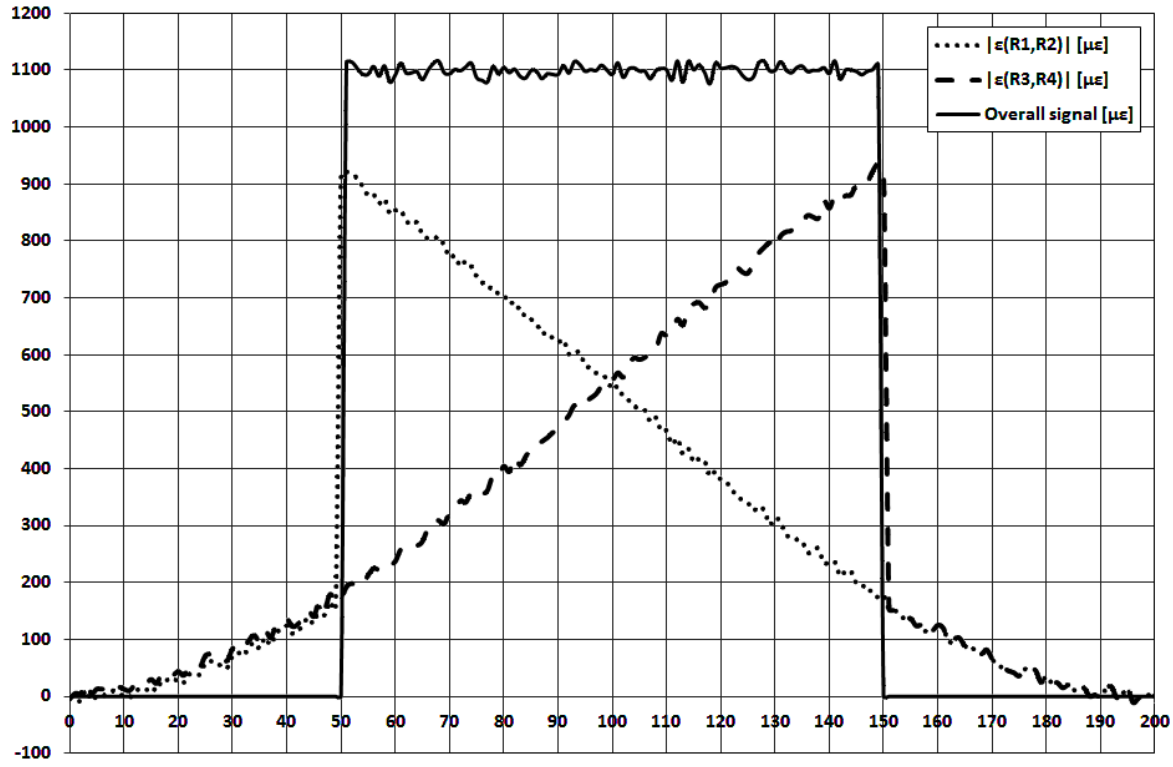

Figure 3 Variation of the strains according to the current position of force F along the beam

It is important to be noticed that there are no constraints regarding the accuracy of the location of the measurement points along the beam. However, there are two contradictory conditions to be taken into account:

- the distance between the locations of the measurement points should be large enough in order to fulfil the condition $F_{R_1R_2} \cdot F_{R_3R_4} < 0$ for long

time, in order to have a significant amount of accurate data acquired;
- the distance between the locations of the measurement points and the built-in end of the coupon should be large enough to prevent the apparition of the parasitic effects due to the stress concentrators.

However, it is important that the strain gages must be bonded along the principal directions, which means 45° with respect to the direction of the rail track. If this condition is not respected, the measurements will have a certain inaccuracy. In this case it would be appropriate the use of three gages rosettes. Moreover, it would be interesting to evaluate the sensitivity of the accuracy of the results, that is the weight force F, with respect to the misalignment errors.

The design of the rail track coupon, especially the length of the coupon, must take into consideration the following aspects:
- the maximum bending moments must not lead to large stresses over the linear elastic range of the stress-strain curve of the material;
- the measured strains must have significant values for the given range of loads, this means an appropriate sensitivity of the coupon.

It is necessary to evaluate the overall range of values of the strains which will be measured in real conditions, so we consider a rail track type 40, figure 1, currently used in Romania, with the following dimensions of the foot, web and head:
- $H_F = 16\ mm$, $B_F = 115\ mm$, $Z_{GF} = 122\ mm$;
- $H_W = 78\ mm$, $B_W = 15\ mm$, $Z_{GW} = 76\ mm$;
- $H_H = 36\ mm$, $B_H = 54\ mm$, $Z_{GH} = 18\ mm$.

Using these values, the geometrical characteristics of the cross section are: $Z_G = 70.325\ mm$, $I_Y = 11115\,926.8\ mm^4$, $I_Z = 2\,522\,162.8\ mm^4$, $W_Y = 158\,064.2\ mm^3$, $W_Z = 43\,863.7\ mm^3$, $S_{Y\max} = 110\,557.3\ mm^3$, $b_Y = 15\ mm$.

Regarding the geometry and the locations of the measurement points, according to figure 2, we set the following values: $L = a + b = 200\ mm$, $c = 50\ mm$, $d = 50\ mm$.

Being an evaluation study, we consider the following material constants: $E = 2.1 \cdot 10^5\ MPa$, $\nu = 0.3$.

In the evaluation of the maximum load, we consider a maximum weight-per-axle (axle load) of 20 tonnes, value allowed for car wagons. However, there are locomotives with 27 tonnes per axle, so we consider a mass of $m = 13\,500\ kg$ as the load which produces the force F, figure 2. Working with an over-dimensioned load is useful in the calculus of the stresses, the computed values being over the current values in practical conditions, so we can verify if the linear-elastic hypothesis is respected.

According to figure 2, there must be noticed the following cases:
- If $c > a \Rightarrow F_{R_1R_2} = F_{R_3R_4} = -V_3$;
- If $c < a < L - d \Rightarrow F_{R_1R_2} = V_1,\ F_{R_3R_4} = -V_3$;
- If $a > L - d \Rightarrow F_{R_1R_2} = F_{R_3R_4} = V_1$.

As mentioned before, the interval where the unknown force F may be measured, is $c < a < L - d$. In order to check this condition, there should be installed some motion sensors, but it is far more easier to replace the above mentioned condition with the condition

$$\varepsilon_{R_1R_2} \cdot \varepsilon_{R_3R_4} < 0, \tag{16}$$

which is similar to the condition given by (15).

In this way the signals $\varepsilon_{R_1R_2}$ and $\varepsilon_{R_3R_4}$ may be added only if condition (16) is respected, leading to:

$$F = \left(\frac{G \cdot I_Y \cdot b_Y}{S_Y} \right) \cdot \left(\left| \varepsilon_{R_1R_2} \right| + \left| \varepsilon_{R_3R_4} \right| \right). \tag{17}$$

Figure 3 presents the variation of the $\left|\varepsilon_{R_1R_2}\right|$, $\left|\varepsilon_{R_3R_4}\right|$ strains with respect to the current position of force F along the beam. Moreover, it is also presented the overall strain

$$\varepsilon_{R_1R_2R_3R_4} = \left|\varepsilon_{R_1R_2}\right| + \left|\varepsilon_{R_3R_4}\right| \tag{18}$$

which is calculated only when condition (16) is fulfilled. In this way, the non-zero values of the $\varepsilon_{R_1R_2R_3R_4}$ signal can be easily identified, even for smaller values of the unknown weight force, F.

Regarding the stresses, the maxim values are:

$$\sigma_{\max}^{M_Y} = 24.825\ MPa, \tag{19, a}$$

$$\tau_{\max}^{T_Z} = 87.812\ MPa. \tag{19, b}$$

The maximum shear stress was calculated by considering $T_{Z\max} = F$, situation which appears in the area next to the built-in ends of the bar.

As it can be noticed, the values are under the values of the allowable stress, but they might become important for the fatigue of the material. However, the maximum load considered is with 35% higher than the maximum loads recommended in the standards, the real stresses being smaller.

3. CASE STUDY: A RAIL MOUNTED CRANE

Beside the car wagons and locomotives, there are other structures supported on rail tracks. Figure 4 presents a rail mounted quay crane. As it can be noticed, each of the four legs of the crane is supported on 16 wheels made of steel which roll along a rail track. The rail track is supported on a concrete plate, not on a set of cross-ties as the railroads.

The problem to measure the weight of the structure is difficult but not impossible. Together with the company which builds the crane there were evaluated several concepts regarding the weighting of the structure.

An initial idea was to use strain gages to measure the force which loads the rail track, method previously presented. The distribution of the masses inside the crane is not symmetrical, so the wheels of each leg of the crane should be considered. This means that two or four coupons must be manufactured and inserted in the rail track. The experiment consists of the measurement of weight force of each wheel. This implies that the crane should be moved along the rail tracks in order to make each wheel pass over its coupon.

Several problems were posed: the modification of the rail track which must be severed, the modification of the concrete plate in order to install the coupon which must have the same level as the entire rail track and which must be properly embedded in order to have built-in ends of the measuring beam, restoration of all the modifications. There were also evaluated methods to calibrate the measurement method. Moreover, there are certain areas where the rail track is embedded in concrete, being difficult to modify the rail and to insert a measuring coupon.

Finally, the representatives of the manufacturing company decided that is too complicated to insert some coupons, being necessary the approvals of the shipyard management and the method would produce later hazards.

Figure 4 Rail mounted quay crane

Another idea was to use a set of hydraulic jacks which can lift each leg or each set of 2 or 4 wheels of the crane. Several problems were posed: coordination of the pistons' motions of all hydraulic jacks, calibration of the measurement method, points on the structure where the hydraulic jacks could be installed.

Finally the representatives of the manufacturing company also relinquished to this measurement method of the weight.

4. CONCEPTS REGARDING THE USE OF THE DISPLACEMENT SENSORS INSTALLED ON A RAIL TRACK

Let us consider the same calculus scheme presented in figure 2. Instead of the measurements points located at distances c and d we consider that we employ displacement sensors, installed under the rail track.

The function of the displacement along the beam is:

$$(E \cdot I_Y) \cdot u_Z(x) = M_{Y1} \cdot \frac{x^2}{2} \cdot H(x) - \\ -V_{Y1} \cdot \frac{x^3}{6} \cdot H(x) + F \cdot \frac{(x-a)^3}{6} \cdot H(x-a) \quad (20),$$

where

$$H(x-x_0) = \begin{cases} 0, & if \quad x < x_0 \\ \frac{1}{2}, & if \quad x = x_0 \\ 1, & if \quad x > x_0 \end{cases} \quad (21)$$

is the Heaviside step function.

The M_{Y1} bending moment is:

$$M_{Y1} = F \cdot a \cdot \left(\frac{b}{a+b} \right)^2, \quad (22)$$

Equation (20) also uses V_{Y1}, which is given by relation (10).

The problem consists in the appropriate assessment of the position of the F force, in motion along the beam, position defined by the a parameter. The previous method used two measurement points and the condition (16) which is fulfilled for the interval where the data may be used to calculate the F force, using the relation (17). In comparison with the previous method where the problem is solved, with respect to the current value of a, the term $F \cdot \frac{(x-a)^3}{6} \cdot H(x-a)$ may be either considered in (20), or it may be zero, so the position of the F force must be accurately estimated.

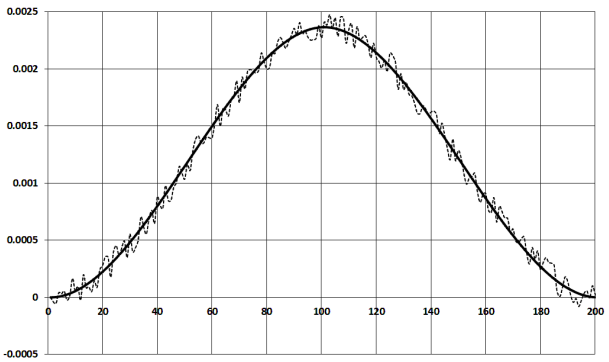

Figure 5 Theoretical and possible variation of the displacement in the $x = 0.5 \cdot L$ section, with respect to a, location of force F

Let us consider that one displacement sensor is installed in the middle section of the measuring beam. In this case the maximum displacement is $u_{Z\max}(x = 0.5 \cdot L) = 0.02364\ mm$, for $a = 0.5 \cdot L$. In order to measure the weight force in motion along the measuring beam there must be noticed that the displacement $u_{Z\max}(x = 0.5 \cdot L)$ is increasing until the F force passes through the section $a = 0.5 \cdot L$ and then decreases, figure 5. Variation of $u_{Z\max}(x = 0.5 \cdot L)$ is hard to be automatically evaluated because of the small variations, but it can be retained the maximum value of the displacement during the motion of the wheel on the measuring beam. However, as it can be noticed in figure 5, the maximum value may be influenced by the small variations.

It is important to notice that the displacement sensor must be precisely installed in the middle section of the measuring beam. Moreover, the sensor must be supported on a platform built-in in the adjacent cross-ties in order to measure only the displacements of the rail track, not the composite effects of the cross-ties, possible elastic supports and other parasitic effects.

5. CONCLUSIONS

By comparing figure 3 and figure 5, one can notice that the values of the overall signal defined by relation (18), may be acquired for an entire interval for which condition (16) is fulfilled. Moreover, the values may be averaged in order to decrease the influence of the small variation. Once the condition (16) is not fulfilled anymore, the acquired data are processed and stored and the system is ready for a new cycle of measurements, this means a new wheel passing on the rail track coupon.

In comparison with this method, the displacement sensors cannot be used to accurately estimate the position of the moving weight force along the beam, so we conclude that the first solution based on strain gages is the optimal solution.

Other weighting methods were also studied along the time, the weight force experimentally measured being useful to estimate the accuracy of the theoretical models, [5], [6].

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Ideas regarding the analytical models and the automatic calculus in structural studies are the result of the models developed in the framework of the scientific research study ‘Development of computer assisted marine structures’, Emil Oanta, Cornel Panait, Ghiorghe Batrinca, Alexandru Pescaru, Alexandra Nita, Feiza Memet, which is a component of the RoNoMar project, [4], 2012.

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STOCHASTIC METHOD FOR MODELING FUEL SPRAY IN DIESEL ENGINES

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ABSTRACT

In this paper, we are interested in problems, such as high-pressure fuel injection in an internal combustion engine, in which the spray carries sufficient momentum to entrain and set into motion the surrounding gas. In turn, the motion of the gas in the vicinity of the particles reduces the resistance to their motion and allows the spray to penetrate much further than would otherwise be the case. It is important, therefore, to account for the interaction between the particles and the gas. This interaction is of course always present, but it is particularly significant whenever the total mass and momentum of the particles is comparable to that of the gas, and when the size of the particles is sufficiently small so that the coupling of a particle to the gas is strong.

Keywords: *spray, interaction, particle, momentum cells, probabilistic.*

1. INTRODUCTION

That paper presents a model for atomized non-evaporating liquid spray injected in diesel engine. The method consists of a fully interacting combination of Eulerian fluid and Lagrangian particle calculation.

The procedure is to represent the spray by discrete particles, rather than by continuous distributions. This amounts to a statistical (Monte Carlo) formulation of the problem, since the finite number of particles used represents a sample of the total population of particles. Each computational particle is considered to represent a group of particles possessing the same characteristics such as size, composition, etc. The use of discrete particles eliminates the problems of numerical diffusion and of resolution in the vicinity of the injector.

The method to be described in this paper differs from these previous [1], [2] and [3] attempts in many details, but principally in eliminating iteration for the particle-gas momentum exchange and in accounting for particle volume displacement effects. It also differs by stressing a statistical, rather than a deterministic, approach to the modeling of sprays. The technique is presently limited to particles whose size does not change (i.e., non-evaporating and nonburning sprays). This is not an inherent limitation of the method but it has been adopted to focus attention on the primary, hydrodynamic features of the method.

2. BASIC EQUATIONS

It will be assumed that no particle coalescence or particle breakup occurs. This implies that the particles are sufficiently dispersed that particle collisions are infrequent. The initial breakup of liquid sprays or jets is not considered It is assumed that initial conditions for the particles are known. That is, the initial particle size distributions, positions, and velocities are independently specified.

This leads to two sets of equations, one set for the gas and the other for the particles. These equations will be coupled primarily by two mechanisms, the displacement of gas by the volume occupied by the particles and momentum interchange between particles and the gas. Because the particles are nonevaporating and nonburning, there is no mass exchange. Further, we assume that the gas or fluid containing the particles is compressible [4].

Spary equations:

$$\frac{\partial f}{\partial t}+\nabla_x\left(fu_p\right)+\nabla_{u_p}\left(fF_p\right)+\frac{\partial}{\partial r_p}\left(fR_p\right)+\frac{\partial}{\partial T_p}\left(f\dot{T}_p\right)=\dot{Q} \quad (1)$$

where u_p, F_p, R_p and T_p is the velocity, force, rate of radius variation and the temperature of an arbitrary droplet in the spray at x position. $fdr_p dv_p dxdT_p$ is the probably number of droplets at x position, in the space dx, with u_p, F_p, R_p and $\dot{Q}$ is f rate of change, made by collision, and coalescention.

Continuity equation for the gas:

$$\frac{\partial \theta}{\partial t}+\nabla\cdot\theta u_g=0\,, \quad (2)$$

where θ is the void fraction, or the fraction of the volume occupied by the gas, and u_g is the gas velocity. The presence of the void fraction in this equation accounts for the displacement effect of the particles.

Momentum equation:

$$\frac{\partial}{\partial t}\theta u_g+\nabla\cdot\theta u_g u_g=\theta g-\frac{\theta}{\rho_g}\nabla p+\nabla\cdot\theta\mu_g\nabla u_g+\frac{1}{\rho_g}M_p\,, \quad (3)$$

where g is the acceleration of gravity, p is the pressure, μ_g is the kinematic viscosity (or eddy viscosity if the flow is turbulent), and M_p is the term defining momentum exchange with the particles, per unit volume. An alternative form of this equation can be obtained by subtracting out the continuity equation:

$$\frac{\partial}{\partial t}u_g+u_g\cdot\nabla u_g=g-\frac{1}{\rho_g}\nabla p+\frac{1}{\theta}\nabla\cdot\theta\mu_g\nabla u_g+\frac{1}{\theta\rho_g}M_p\,, \quad (4)$$

This is the form of the equation used. The terms containing M_p, will be defined later.

In a turbulent flow, the gas equations of the previous section are written in terms of the mean velocity u_g. For particles, gas turbulence is important as a mechanism for diffusion; and it is convenient to write the instantaneous, rather than averaged, equations for the particles. To do this, we define the instantaneous gas velocity, $U_g = u_g + u_g'$, where u_g', is the turbulent component of the gas velocity.

Each particle, individually labeled by subscript *k*, is assumed to obey the following equations:

Particle velocity:

$$u_{pk} = dx_{pk} / dt \tag{5}$$

Particle momentum equation:

$$m_k \frac{d}{dt} u_{pk} = m_k g - \frac{m_k}{\rho_k} \nabla p + D_k[U_g](U_g - u_{pk}); \tag{6}$$

where x_{pk} is the particle position, u_{pk} is its velocity, m_k is its mass, and ρ_k is its density. The notation $D_k[U_g]$ is used to denote the drag function, evaluated using the velocity U_g, which is the coefficient in the force acting on the particle due to its motion through the gas. It will be convenient to abbreviate the notation to D_k when referring to the drag function evaluated at the mean gas velocity u_g ($D_k \equiv D_k[ug]$).

It is sometimes more convenient to consider the effect of turbulence on the particles to be due to a force f_{pk}, in which case the momentum equation is written:

$$f_{pk} = D_k[U_g](U_g - u_{pk}) - D_k(u_g - u_{pk}), \tag{7}$$

$$\Rightarrow m_k \frac{d}{dt} u_{pk} = m_k g - \frac{m_k}{\rho_k} \nabla p + D_k(u_g - u_{pk}) + f_{pk}; \tag{8}$$

The terms in the gas equations (eqs. 2 - 4) dependent on the particles have not yet been defined. Taking ensemble averages, we can write:

$$\theta = 1 - \sum_k \overline{4/3\pi r_k^3 \delta(x - x_{pk})}, \tag{9}$$

$$M_p = -\sum_k \overline{D_k(U_g)(U_g - u_{pk})\delta(x - x_{pk})}. \tag{10}$$

3. NUMERICAL TECHNIQUE

Velocities are defined in the middle of cell faces. Thus, there are two staggered meshes associated with the respective velocity components, and the corresponding cells, called momentum cells, are indicated by dashed lines in Figure 1 [4].

These computational cells act as control volumes for the dependent variables associated with the basic equations. The regular cells are the control volumes for the mass continuity equation. Variables associated with them are the pressure and the void fraction. The momentum cells are the control volumes for the momentum equations, and the associated variables are ug_{ij} and vg_{ij} and the components of the pressure

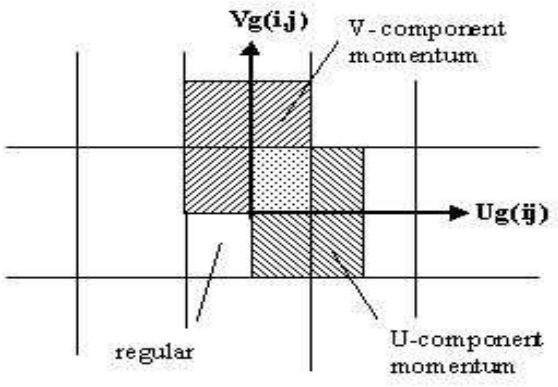

Figure 1. Typical cells

gradient Δp. To a first approximation, these variables are assumed to be constant within their respective cells.

We shall also use a time-splitting procedure employing intermediate time levels denoted by superscripts such that [5]:

$$t^n < t^T < t^{2T} < t^{3T} < t^{n+1} \tag{11}$$

For modeling purposes, it is not possible to deal with the large number of droplets, so that a sampling tehnique be employed in which each single particle represents a characteristic group of particles. This is equivqlent to the following distributions function:

$$f(r,x,u_p,t) = \sum_k N_{pk}\delta(r - r_k)\delta(x - x_k)\delta(u_p - u_{pk}) \cong \frac{\Delta N}{\Delta r \Delta x \Delta u_p} \tag{12}$$

where N_{pk} is the number of identical particle by particle *k*, ΔN is the number of particles in the volume $\Delta r \Delta x \Delta u_p$.

The droplet size distribution is:

$$f_r(r) = \frac{6}{D_{32}} \exp\left(\frac{-6r}{D_{32}}\right) \tag{13}$$

where D_{32} is Sauter mean diameter which is consider to varying very little.

Eddy viscosity was estimated using a value appropriate to a turbulent gaseous jet:

$$\mu_g = 0.0161\sqrt{0.25\pi d^2 V^2}, \tag{14}$$

where *d* is the orifice diameter and *V* is the droplet injection velocity.

No attempt was made to calculate particle diffusion accurately. Particle turbulence was modeled using the assumption, that the fluid turbulence is isotropic and has a Gaussian distribution in velocity. Given the turbulent kinetic energy *k*, is $k = 0.1 u_g u_g$, and turbulent velocity is:

$$u_g^{'} = k^{0.5}\,\mathrm{sgn}(X)\cdot erf^{-1}(|X|), \qquad (15)$$

where, as before, *X* and *Y* are random variables selected for a uniform distribution in the range *-1 < X, Y < 1*. To complete the discription, the relevant turbulence time scale τ is required. The velocity $u_g^{'}$ is assumed to act for a time equal to $\tau = \Delta t$. An elementary analysis suggests that the produces particle diffusion corresponding to [1]:

$$D_T \approx 0.66\left(\frac{D_k}{m_k}\right)^2 q\tau^3. \qquad (16)$$

The resulting particle concentration, which is Gaussian, forms a distribution function for the location of the particle. Particle positions are randomly selected from within this distribution, such that on each time step the diffusional increment in particle position is

$$\Delta x_{pk} = (4D_T\Delta t)^{0.5}\,\mathrm{sgn}(X)erf^{-1}(|X|), \qquad (17)$$

This is equivalent to selecting the following random particle force on each time step

$$f_{pk} = m_k\frac{\Delta x_{pk}}{\Delta t^2}. \qquad (18)$$

Each particle injected or entering the mesh must be assigned a velocity u_{pk}, a radius r_k, and the number of particles in the group N_{pk}. Let the number of computational particles injected per cell per time step be *K*. The radius of each particle is then chosen from a uniform random distribution that verified the relation.

$$\sum_{k=1}^{K} N_{pk}m_k = Q\Delta t. \qquad (19)$$

If the pressure drop across the nozzle is known, then

$$V = C\left(\frac{2\Delta p}{\rho_p}\right)^{0.5}, \qquad (20)$$

The transverse velocity is derived in terms of the initial spray angle using the relationship $0 < (u_{pk})_t \le Max(u_{pk})_t$ where:

$$Max(u_{pk})_t = V\tan(\alpha/2), \qquad (21)$$

$$\tan(\alpha/2) = C(\rho_g/\rho_p)^{1/2}. \qquad (22)$$

Knowing the position of each particle at time t^{n+1} the void fraction is calculated using Eq. 9 where the summation is over all particles in regular cell *(ij)* and V_{ij} is the volume of that cell. The void fraction is assumed to be centered in the cell; values at cell faces are obtained by linear interpolation. For each regular cell the void fraction is:

$$\theta_{ij}^{n+1} = 1 - \frac{4\pi}{3V_{ij}}\sum_k N_{pk}r_k^3, \qquad (23)$$

the continuity equation

$$\frac{\theta^{n+1}-\theta^n}{\Delta t} + \nabla\cdot\theta^{n+1}u_g^{n+1} = 0. \qquad (24)$$

The equations that have to be solved next, simultaneously, are the gas and particle momentum equations over the momentum cell

$$\frac{u_g^{n+1}-u_g^n}{\Delta t} + F^n = g - \frac{1}{\rho_g}\frac{\partial p^{n+1}}{\partial x} + \left(g - \frac{1}{\rho_p}\frac{\partial p^{n+1}}{\partial x}\right)\Delta t S^{2T} - u_g^{n+1}S^{2T} + R^{2T}. \qquad (25)$$

We shall employ a splitting procedure, which, while preserving the original equations, will solve them in a number of stages [6].

$$R^{2T} = \frac{1}{\rho_g\theta^{n+1}V_{mcel}}\sum_k \frac{N_{pk}D_k^{2T}}{1+\Delta t\frac{D_k^{2T}}{m_k}}\left(u_{pk}^n - u_g^{'}\right),$$

$$S^{2T} = \frac{1}{\rho_g\theta^{n+1}V_{mcel}}\sum_k \frac{N_{pk}D_k^{2T}}{1+\Delta t\frac{D_k^{2T}}{m_k}}, \qquad (26)$$

$$F^n = u_g^n\cdot\nabla u_g^n - \frac{1}{\theta^{n+1}}\nabla\cdot\theta^{n+1}\mu_g\nabla u_g^n.$$

We first calculate intermediate gas and particle velocities, accounting explicitly for all forces, except for particle interactions and turbulence, using the following equations:

$$\frac{u_{pk}^{n+1}-u_{pk}^n}{\Delta t} = g - \frac{1}{\rho_p}\frac{\partial p^{n+1}}{\partial x} + \frac{D_k^{2T}(U_g)}{m_k}\left(U_g^{n+1} - u_{pk}^{n+1}\right), \qquad (27)$$

4. NUMERICAL RESULTS

Application of the present technique has been the modeling of fuel injection sprays. It would be desirable to compute sprays for which experimental data are available so that a direct comparison could be made. The experiments of Hiroyasu and Kadota [1] come closest to providing such data and were therefore chosen to provide the basis for the following computations.

The penetration curves is presented in Fig. 2

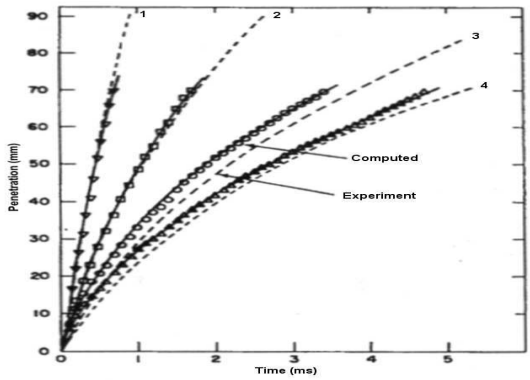

Figure 2. Comparison of computed spray penetration whit experimental data

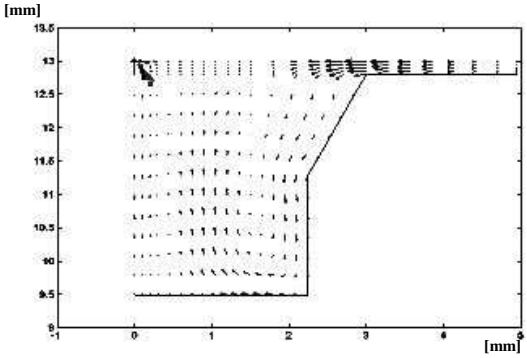

Figure 3. Velocity and particle fields at 354.4 deg.

In order to illustrate the fuel jet evolutions în combustion chamber the geometrical and technical characteristic of T650 Diesel engine made by Tractoru Brasov is used. The fuel spray parameter data had to be estimated, and in some cases drastic approximations had to be made. The calculations are made whit fuel oil with density $\rho_p = 840 kg/m^3$ injected in air, injector whit *5* orifice $d = 0.25\,mm$ and open pressure $P_{in} = 215\ bar$.

The cod is written in Compaq Visul Fortran 6.6 programs.

The quadrilater generalized mesh used, was found necessary to refine near the spray axis because of the large velocity gradients. The model have 2D spatial resolution and consider the injector in the middle of a chamfered bowl combustion chamber.

The Figure 1 - 3 plots the velocity fields and particle motion computation for any representative crank angle in the cycle.

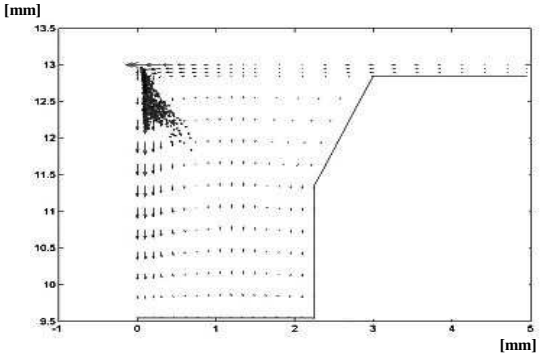

Figure 4. Velocity and particle fields at 358.6 deg.

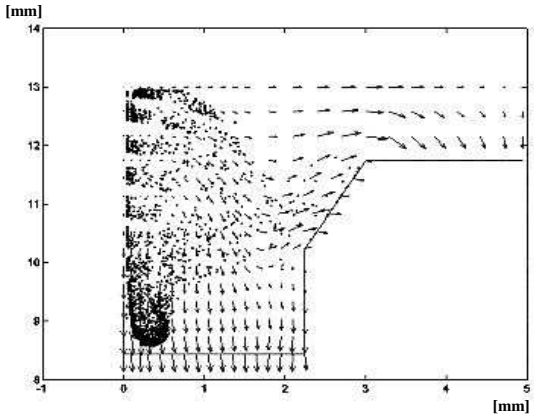

Figure 5. Velocity and particle fields at 369.2 deg

5. CONCLUSIONS

1. The penetration curves of Fig. 2 suggest that good practical results can be obtained with the present technique.
2. The numerical technique described has generally been well-behaved except under conditions when particles cluster locally so that the void fraction becomes negative in that cell. This is strictly unphysical
3. There are a number of possibilities for modifying the technique to prevent particles from packing closer together than the close-packed limit, for example.
4. The development of the technique is based on the assumption of noninteracting droplets. While this assumption is bound to fail in the vicinity of the injector.
5. Clearly, many other approximations are involved, such as the assumption of spherical droplets, as well as the numerical inaccuracies associated with a finite mesh.
6. Much better experimental data than currently available will be necessary to resolve these questions.

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FLOW MODELLING FOR A PANAMAX TANKER

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ABSTRACT

The present study is devoted to the computation of a PANAMAX tanker in head wave. A RANS solver using finite-volume discretization and free-surface capturing approach is employed for the computation. The expected results may be different when using various turbulence models approaches. The main target is to identify the most convenient approach for the adopted turbulence model with regard to the near-wall treatment.

Keywords: *tanker, hull, drag, force, turbulence, model*

1. INTRODUCTION

As most cargo worldwide today is transported via ship, it is very important to design the ship hull forms such that they operate economically. To propel a ship, its engine has to provide enough power to overcome the hydrodynamic drag due to viscosity and wave generation. It is necessary to understand the complicated flow characteristics to design the hull forms with lower drag and higher propulsive efficiency. For better understanding of the flow around a modern commercial ship, it is of primary importance to produce reliable experiment data of practical hull forms.

The experiment data describing the local flow details are also invaluable in the field of computational fluid dynamics (CFD) for the validation of the developed physical and numerical modelling.

There have been some experimental data for the flows around ship models. The International Towing Tank Conference (hereafter, ITTC) summarized available benchmark database for CFD validation for the drag force and propulsion of a ship (ITTC 1999; Longo and Stern 1996; Stern et al. 1998). For the cargo-container ship, Series 60 (Fry and Kim 1985) and Hamburg Test Case Bertram et al. 1994; Gietz and Kux 1995) are given. DTMB model 5415 is recommended for a combatant model (Fry and Kim 1985). For the full-form tanker, HSVA/Dyne tanker models (Knaack 1992) and Ryuko-Maru (Suzuki et al. 1998) are given.

Previously, two workshops (Larsson et al. 1991; Kodama 1994) were arranged for the computational analysis of flow around a ship, and HSVA/Dyne tanker models and a Series 60 model were chosen for the test cases. However, those data are often partial and not enough to understand the complicated flow phenomena.

The hull forms used in those experiments are old-fashioned and quite different from the modern hull forms of ships today.

2. SOLVER

Computation has been performed with the ANSYS CFX solver. Turbulent flow is simulated by solving the incompressible Reynolds - averaged Navier - Stokes equations (RANS). The flow solver is based on finite volume method to build the spatial discretization of the transport equations. The velocity field is obtained from the momentum conservation equations and the pressure field is extracted from the mass conservation constraint, or continuity equation, transformed into a pressure-equation. In the case of turbulent flows, additional transport equations for modelled variables are discretized and solved using the same principles. The gradients are computed with an approach based on Gauss's theorem. Non-orthogonal correction is applied to ensure a formal first order accuracy. Second order accurate result can be obtained on a nearly symmetric stencil. Inviscid flux is computed with a piecewise linear reconstruction associated with an upwinding stabilizing procedure which ensures a second order formal accuracy when flux limiter is not applied. Viscous flux are computed with a central difference scheme which guarantee a first order formal accuracy. We have to rely on mesh quality to obtain a second order discretization for the viscous term. Free-surface flow is simulated with a multi-phase flow approach. Incompressible and non-miscible flow phases are modelled through the use of conservation equations for each volume fraction of phase/fluid. Implicit scheme is applied for time discretization. Second order three-level time scheme is employed for time-accurate unsteady computation.

Velocity-pressure coupling is handled with a SIMPLE like approach. Ship free motion can be simulated with a 6 DOF module. Some degree of freedom can be fixed as well. An analytical weighting mesh deformation approach is employed when free-body motion is simulated. Several turbulence models ranging from one-equation model to Reynolds stress transport model are implemented in Ansys CFX. Most of the classical linear eddy-viscosity based closures like the Spalart-Allmaras one-equation model, the two-equation k-ω, SST model by Menter [5], for instance are implemented. Wall function is implemented for two-equation turbulence model.

3. TURBULECE MODELS

Nowadays, the RANS methods are the ones most commonly used for practical calculations of viscous turbulent flows in marine CFD. The RANS approach is based on complete averaging of Navier-Stokes equations and representation of flow properties as a sum of averaged and fluctuating parts. The presence of turbulent

fluctuations results in additional turbulence stresses, which are to be modeled by one or another turbulence model, either empirical or semi-empirical using experimental and statistical data.

Compared to LES, RANS methods resolve only eddies of largest scale comparable with the size of flow domain, while the rest of turbulence is accounted for through the turbulence model. Recently, some of the turbulence models have been extended to handle low Reynolds number flows and even laminar/turbulent transition. The turbulence associated with eddies of large and medium scale is anisotropic, especially in the domains of intensive vorticity generation, rollup and separation. The velocity and pressure fields are not predicted very accurately in such domains by RANS:

The resulting functions often appear to be much smoother than in real flow, which is the direct consequence of averaging and turbulence modelling.

Different types of turbulence models are developed depending on numerical implementation and what physical effects one or another model is supposed to incorporate. We will only consider the types of turbulence models most widely used in commercial CFD codes.

This model allowed us to arrive at the universal model describing the structure of the boundary layer flow in terms of mean flow velocity. This type of models is called “zero equation” because it does not require additional equations to describe turbulent stresses.

Instead, the turbulent stresses are related to the mean flow characteristics by simple algebraic identities.

The k-ε turbulence model opens the class of two-equation turbulence models which represent today’s main tool for practical engineering simulations by RANS. In these models the turbulent velocity scale and length scale are independently determined. Hence one has to formulate the two equations for their computation. The k-ε model is probably the one that has been most popular at the earlier stages of CFD development due to its high grades based on the combined evaluation criterion “robustness-economy-accuracy application range”. Even today this model is widely (and efficiently) used in many problems of CFD including maritime field. The most common variants of the k-ε model found in commercially available CFD codes include the standard k-ε model (Launder and Spalding, 1972), RNG k-ε model (Choudhury, 1993) and realizable k-ε model (Shih et al,)

The k-ω turbulence models represent a group of two-equation turbulence models in which the transport equation are solved for the turbulent kinetic energy k and its specific dissipation rate ω. The specific dissipation rate, which is used instead of, is understood as the dissipation rate per unit turbulent kinetic energy and which is, thus, proportional to ε k. It has the dimension [1/s]. The k-ω formulation have been put forward and developed in the works by Wilcox (Wilcox, 1998) as an alternative to the k-ε approach with the aim to incorporate the effects of low – Reynolds - number flows, compressibility and shear flow spreading in an entire, consistent way, and to build the model equally suitable to wall-bounded flows and free shear flows.

At present, the most popular versions of the k-ω turbulence models are represented by the standard k-ω model, (Wilcox, 1998) and shear-stress transport (SST) k-ω model (Menter, 1994), (Menter et al, 2003). Both models are available in the commercial CFD codes.

4. DESCRIPTION OF THE TEST CASE

The test case chosen for the present study is based on an older simulation carried on a TRANSAS LCHS simulator, where for this type of vessel, were determined the loading conditions in several ballast situations. The present case is characterized by a stern draft of 7,56 meters and bow draft of 3,03 meters, as shown in the following table:

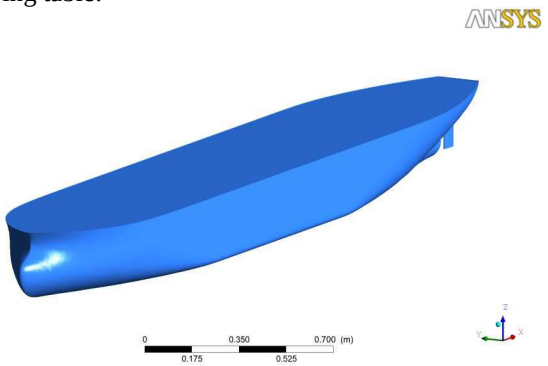


Figure 1 The tanker geometry

Table 1. Parameters for the simulation

Determined value	Load case				
	I	II	III	IV	V
Medium draft [m]	2,96	3,29	4,31	4,77	5,29
Stern draft [m]	5,57	5,22	6,40	6,32	7,56
Displacement [t]	16500	19692	24875,3	27896,4	30958
Wet surface [m2]	5748,4	5874,9	6025	6128,9	6163,4
Block coefficient	0,750	0,764	0,776	0,7871	0,7876

For the considered case, there were used the three turbulence models, with the same settings and initial conditions.

Table 2. The simulations settings

Buoyancy Model	Buoyant	Buoyant	Buoyant
X Gravity	0 [m/s^2]	0 [m/s^2]	0 [m/s^2]
Y Gravity	0 [m/s^2]	0 [m/s^2]	0 [m/s^2]
Z Gravity	-g	-g	-g
Domain Motion	Stationary	Stationary	Stationary
Reference Pressure	1 [atm]	1 [atm]	1 [atm]
Fluid Temperature	25 [°C]	25 [°C]	25 [°C]
Homogeneous Model	True	True	True
Turbulence Model	k epsilon	k omega	SST
Turbulent Wall Functions	Scalable	Automatic	Automatic

All calculations described in this paper were conducted for the unappended hull form.

5. COMPUTATIONAL DOMAIN

The computational domain was defined for the full scale model, with boundaries at $4 \cdot L_{pp}$ at the stern and aside, and with the inlet boundary at $0.5 \cdot L_{pp}$.

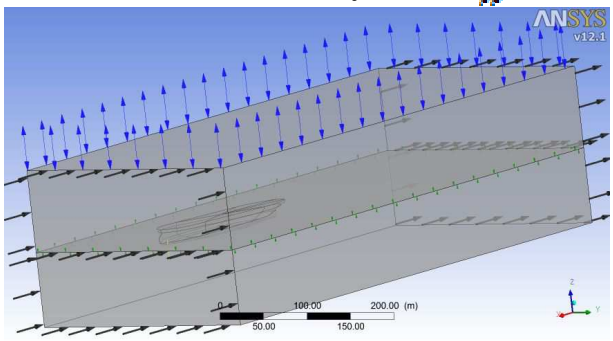


Figure 2 The computational domain

The results presented in this paper were all obtained on a mapped, structured grid with H-O topology and some extra grid clustering close to the ship hull.

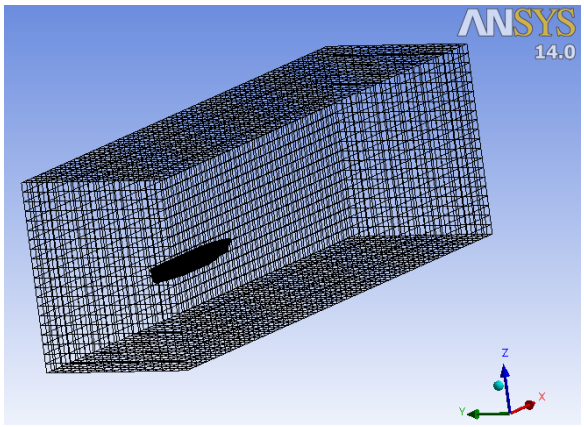


Figure 3 Mesh structure

Table 2. Mesh information

Domain	Nodes	Elements
	248919	325597

At the ship surface the no-slip condition is applied directly and the normal pressure derivative is assumed to be zero. The undamped eddy viscosity, the variable in Menter's one-equation model, vanishes at a no-slip wall. With the present formulation of the turbulence models (Kok and Spekreijse, 2000), all the turbulent quantities are zero at a solid wall.

6. NUMERICAL CONVERGENCE

In the present calculations we have adopted as convergence criterion the reduction of the maximum difference between consecutive iterations of the three velocity components and of the pressure to 10^{-4}.

6. RESULTS

The post processing stage showed the VOF and the velocities in the longitudinal plane in order to analyse the obtained values.

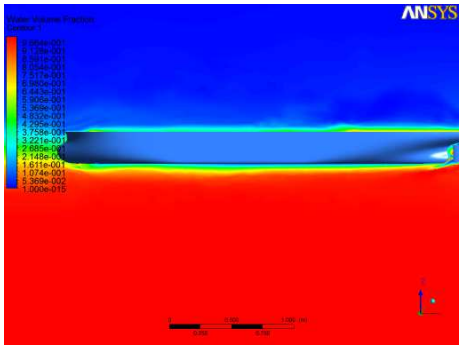


Figure 4 VOF plot for the k-ε turbulence model

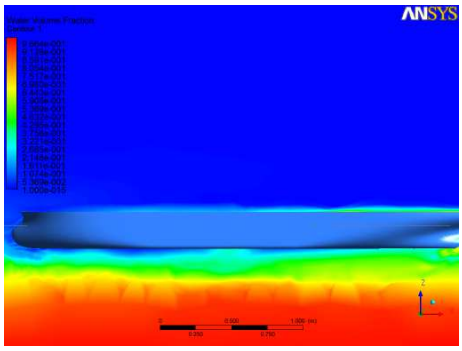


Figure 5 VOF plot for the k-ω turbulence model

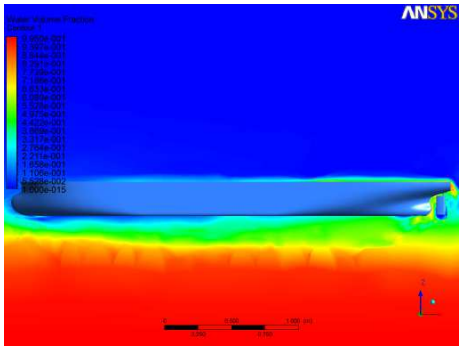


Figure 6 VOF plot for the SST turbulence model

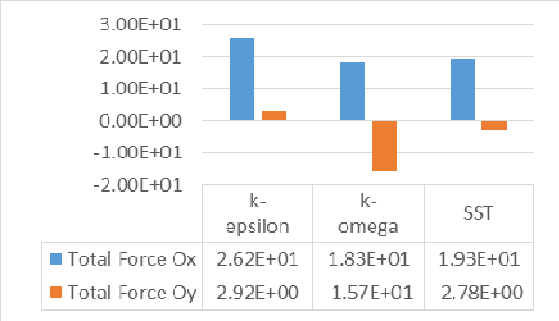
There can be seen certain differences between the free surface development for the three turbulence models. Due to the turbulence models sensitivity, the results established in the near-wall are different for each situation.

One of the main problems in turbulence modelling is the accurate prediction of flow separation from a smooth surface. Standard two-equation turbulence models often fail to predict the onset and the amount of flow separation under adverse pressure gradient conditions. Generally, turbulence models based on the ε-equation predict the onset of separation too late and under-predict the amount of separation later on. This is problematic, as this behavior gives an overly optimistic

performance characteristic for an airfoil. The prediction is therefore not on the conservative side from an engineering stand-point. The models developed to solve this problem have shown a significantly more accurate prediction of separation in a number of test cases and in industrial applications.

Separation prediction is important in many technical applications both for internal and external flows.

When referring to the established drag and drift force, we can also see major differences between the obtained values:



	k-epsilon	k-omega	SST
Total Force Ox	2.62E+01	1.83E+01	1.93E+01
Total Force Oy	2.92E+00	1.57E+01	2.78E+00

Figure 7 The value deviation for the drag force (Ox direction) and drift force (Oy direction) with the considered turbulence models

7. CONCLUSIONS

As stated before, there was determined high differences between the obtained results for the drag and drift forces, calculated in the same initial conditions and for the same geometry.

When considering the statements presented in sections 3 and 6, we can conclude that the SST model is recommended for high accuracy boundary layer simulations. To benefit from this model, a resolution of the boundary layer of more than 10 points is required. The SST model was developed to overcome deficiencies in the k-ε, k-ω and BSL k-ω models. Therefore, using the SST model over these models is recommended.

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SECTION III
ELECTRONICS, ELECTRONICAL ENGINEERING AND COMPUTER SCIENCE

MONITORING OF POWER FACTOR

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ABSTRACT

Monitoring of Power factor is of particular interest for the electricity producer and for the carrier, distributor, supplier and end user because it influences the performance characteristics of all operators on the electricity market, electricity supply costs and available capacity to transfer energy equipment.

Economic impacts caused by operation with low power factor must be taken into account in determining energy electricity tariff aiming to compensate for energy losses that this mode has caused. Given that reducing the power factor is due to phenomena (causes) local technical and financial measures taken to increase its, relate, especially at the node in the power system where is connected user who produce its reduction.

Although the consumer who determines this mode is penalized by price for energy losses in the power system which is determined by the energy transfer to low power factor, the reduction of system performance characteristics and the need to increase the produced power to cover these losses' corresponding harmful effects on the environment make this energy consumption mode not supported.

Keywords: *single-phase circuits, three-phase circuits, power factor, electricity supply, energy losses.*

1. INTRODUCTION

Economic impacts caused by operation with low power factor must be taken into account in determining energy electricity tariff aiming to compensate for energy losses that this mode is causing.

Although the consumer who determines this mode is penalized by price for energy losses in the power system witch is determined by the energy transfer to low power factor, the reduction of system performance characteristics and the need to increase the produced power to cover these losses' corresponding harmful effects on the environment make this energy consumption mode not supported.

2. SINGLE-PHASE CIRCUITS

Power factor P. F. defined as the ratio between active power P and apparent power S is a variable size in time, as the two powers that it defines.

$$P.F. = \frac{P}{S} \tag{1}$$

Assessment of the relations depending on the operating mode, sinusoidal or non-sinusoidal, single-phase or three-phase, symmetrical or asymmetrical, lead to different interpretations and values, which involves different effects on the power system and different ways of approaching problems for the adoption of measures to increase the value of power factor. Generally the power factor is a measure of incomplete capacity utilization of transfer in power system elements given that electrical installations are designed for the apparent power transfer (electric current) but the consumer receives lower active power (power output) if the power factor is low.

In the simplest case of a consumer phase, in the sinusoidal regime, power factor P.F. defines the presence of reactive power Q.

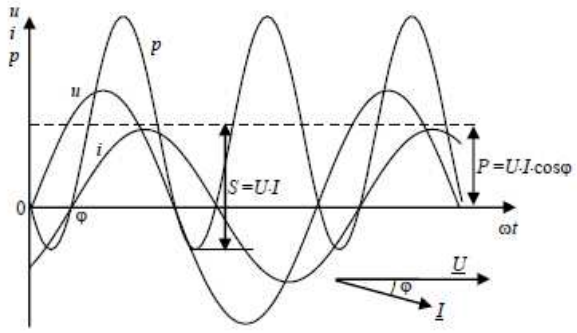

Figure 1 Define power factor single-phase and linear circuits

In the general case of non-sinusoidal regimes the relation (1) has several interpretations:

- The ratio of active power P and total apparent power S

$$P.F. = \frac{P}{S} = \frac{\sum_{h=1}^{\infty} U_h I_h \cos\varphi_h}{UI} \tag{2}$$

where h is the harmonic ranking, U_h and I_h are the effective values of voltage harmonic components, respectively, of electric current, U and I are the effective values of the voltage curves, respectively, for electric current; φ_h- phase angle between the voltage and current curves of harmonics by rank h;

- the ratio of active power P and apparent power partial S ':

$$P.F.' = \frac{P}{S'} = \frac{\sum_{h=1}^{\infty} U_h I_h \cos\varphi_h}{\sqrt{P^2 + Q^2}} \tag{3}$$

Where the reactive power Q is determined from the relation

$$Q = \sum_{h=1}^{\infty} U_h I_h \sin \varphi_h \quad (4)$$

- as the ratio between the active power P_1 and apparent power S_1 corresponding to the fundamental harmonic (h = 1)

$$P.F. = \frac{P_1}{S_1} = \frac{\sum_{h=1}^{\infty} U_1 I_1 \cos \varphi_1}{U_1 I_1} = \cos \varphi_1 \quad (5)$$

For the case of an asynchronous motor supplied through a frequency converter, the harmonic electric current is practically in phase with the fundamental harmonic voltage (inductive phase angle 4 degrees).

Using the value of P.F. different by the 1, for sizing the capacitor, used to improve power factor, it is not indicated, because it leads to significant disruptions in the supply network, (produced by the operation of receiver in capacitive regime and intensification of non-sinusoidal regime which has the effect of reducing the power factor P.F.). Therefore the dimensioning of the capacitor can only be based on power factor PF = DPF (Displacement power factor) = 1,0.

3. THE POWER FACTOR IN THREE-PHASE CIRCUITS

Analysis of the power factor in three-phase circuits may be achieved per phase. This type of analysis is justified, in particular, for the users, given the different characteristics of load on the three phases. The values used by three-phase power factor $P.F._{three\text{-}phase}$, that mean over the three phases, may provide useful information only when the characteristics of the three-phase load are the same.

$$P.F. = \frac{P_{three-phase}}{S_{three-phase}} \quad (6)$$

The value for three-phase active power results as the algebraic sum of active power P_A, P_B and P_C transmitted on the three phases of the electrical network:

$$P_{three-phase} = P_A + P_B + P_C \quad (7)$$

Can be defined two three-phase apparent power:

a) algebraic three-phase apparent power S^A;

$$S^A = |\underline{S}_A| + |\underline{S}_B| + |\underline{S}_C|$$

b) geometric three-phase apparent power S^G:

$$S^G = |\underline{S}_A + \underline{S}_B + \underline{S}_C|$$

It is obvious that the geometric three-phase apparent power S^G is less than algebraic three-phase apparent power S^A , making the algebraic three-phase power factor $P.F._{three\text{-}phase}^{A}$ is less than geometric three-phase power factor $P.F._{thfree\text{-}phase}^{G}$ ($P.F._{three\text{-}phase}^{A} < P.F._{three\text{-}phase}^{G}$).

In alternating voltage electrical installations characterized, electrically, through a scheme with active elements (resistors) and reactive components (coils, capacitors), in the absence of nonlinear elements, there is an active power transfer from source to receiver, correlated with consumer requirements, and with reactive power transfer Q. If receivers from use installation have an inductive character, the electric current curve is out-of-phase (figure 2) and receivers are considered reactive power consuming and the reactive power is considered positive (Q>0). In the case of load current curve is leading voltage curve respective receivers are considered, conventionally, as sources of reactive power and reactive power is considered negative (Q<0).

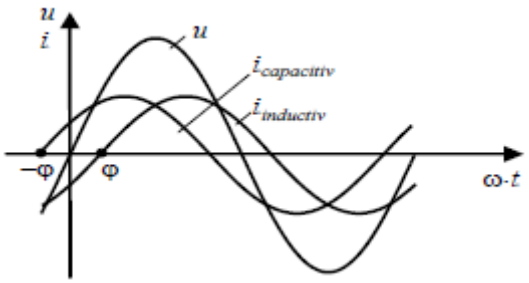

Figure 2 The outphasing of inductive electric current curve and capacitive electric current curve

The main receivers that consume reactive power are: Induction motors, under excited synchronous machines, transformers, electromagnetic induction ovens, coils, lamps with gas discharge and metal vapor. Elements that produce reactive power are overexcited synchronous machines, static capacitors, high voltage overhead power lines or power lines in the cable. Induction motors are the most important consumer of reactive power.

4. THE TECHNIQUE USING A STANDARD MICROCONTROLLER WHICH MEETS EMERGING STANDARD

The digital technique illustrated, allows the current waveform drawn from the mains to be synthesized and to adapt its amplitude to particular requirements.

A voltage pre-regulator is used to boost topology to generate 400 V DC voltage. This DC voltage is regulated by an ST9 microcontroller. The microcontroller also manages the harmonic reduction and other safety features.

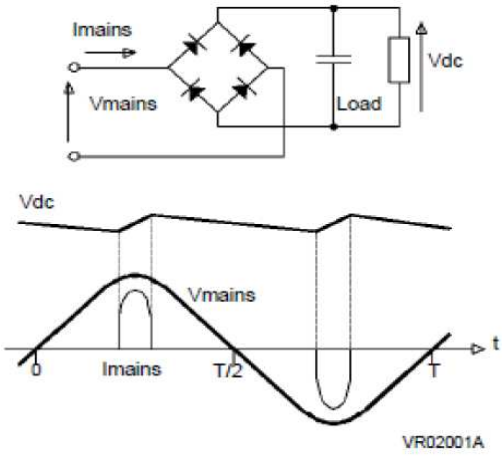

Figure 3 Full wave bridge rectifier generates pulsed current inducing multiple harmonics currents

The current drawn from the mains is pulsed at each peak of the line voltage. This pulsed current generates multiple harmonic currents and gives a poor power factor, between 0.5 and 0.7. This power factor does not comply with the permissible amplitudes of the various harmonic constituents defined by the present of future standard. It is possible to put the harmonics levels under the standard limits and to draw from the mains a non-sinewave current.

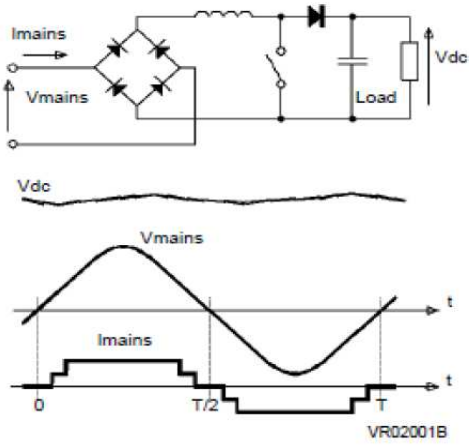

Figure 4 Pre regulator power factor corrector drawing from the mains a non-sinewave current

If one should consider to study the voltage regulation principle and the simplified diagram shown in fig. 5, the output capacitor value C_{out} at 220µF then the power varies from 0 to 400 Watts under a fixed output voltage of 400 V. The current generator supplying the output current I_{out} is a boost stage regulated in current mode. The reference voltage V_{ref} results from the filtered PWM duty cycle generated by the microcontroller multifunction Timer.

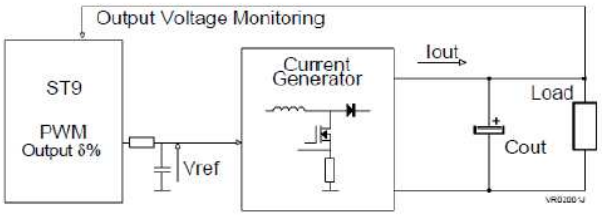

Figure 5 Principle of a pre-regulator controlled by a microcontroller supplying a load with a regulated voltage

The duty cycle variation Δδ is

$\Delta\delta = 50 \times \Delta I_{out(A)}$ and $V_{line} = 220V$,

$C = 220\mu F$ and $V_{out} = 400V$;

The new PWM duty cycle will be

$$\delta_{\%} = \delta_{n-1(\%)} + \Delta\delta \,. \tag{8}$$

The voltage error $\varepsilon_n = V_{out} - V_{tgt}$ and the current change (ΔI_{out}) necessary to complete the capacitor charge during a fixed time (Δt) is:

$$\Delta I_{out} = -C\frac{\varepsilon_n}{\Delta T}; \tag{9}$$

The duty cycle variation necessary to compensate the voltage error

$$\Delta\delta_{(\%)} = -50C\frac{\varepsilon_n}{\Delta T} = S \times \varepsilon_n \tag{10}$$

If we consider $C = 220\mu F$, $\Delta T = 50ms$ we get the relation

$$\Delta\delta_{(\%)} = -50\frac{220 \cdot 10^{-6} \cdot \varepsilon_n}{50 \cdot 10^{-3}} = -0.2\varepsilon_n \tag{11}$$

5. CONCLUSIONS

Software security functions can be easily implemented due to the periodic output voltage measurement. This measurement is automatically performed every millisecond through the microcontroller A/D converter.

A low power factor leads to a number of problems such as, the number of receivers that can be connected to the same central is directly proportional to the power factor. Loss of voltage ΔU , loss of power ΔP and also of energy ΔW are active loss power and they are even higher as the power factor and the voltage is lower.

Consumers who have large induction coils (some electrical machines, transformers, etc.) product out of phase for the absorbing current. They demand a significant reactive power, thereby causing decrease of the source power factor supplying network.

The problem of improving the power factor of the installation electric energy is one of the most important economic technical problems.

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THE INFLUENCE OF PROPULSION FACTORS ON THE FUNCTIONING REGIMES OF A NAVAL POWER PLANT

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ABSTRACT

This paper presents determining the factors propelling a marine power plants.

The ship must carry the parameters for which it was designed and built, thus satisfying all the technical and economic aspects.

For the successful design of a thermal plant, it is required to estimate the major costs involved, to consider the various assumptions, make predictions about the economic, technological, legislative aspects and to use techniques of engineering economics.

The operating regimes of propulsion engine depends on: the type of ship, sailing under construction hull, propeller type and mode of transmitting power from the engine to the propeller.

Keywords: *ship's speed , deadweight, ballast, engine, propeller*

1. INTRODUCTION

A naval power device consists in propulsion installation, electricity works of the ship and the installation of auxiliary ship boilers (steam boiler).

The propulsion engines operating in different exploitation conditions determined by the technical condition of the ship and the propulsion plant and external factors that have an influence on the operation.

Power plant with internal combustion engine is a heat power plant mainly processes the chemical energy of fuel used, and transformed into heat energy from combustion processes and mechanical work necessary technical then its consumers.

In general for an energy plant with internal combustion engines are subsystems [3,4]:
- internal combustion engine;
- consumer (consumers);
- mechanisms and installation auxiliary of the energy internal combustion engines.

2. CASE STUDY

The tanker is equipped with a single propeller, the propulsion of the vessel being provided by a diesel engine, MAN B & W with 6-cylinder.

The manufacturer is running a trial race at full load, ship ballast water is high, the draft of 10.50 [m].

Propulsion of the ship is provided by a fixed pitch propeller that allows modification propulsion performance by adjusting a single parameter function speed propeller.

Particulars of ship
-length overall: 179.96[m],
-beam of ship: 32.20 [m],
-height: 16.50 [m],
-speed of service: 15 [Nd],
-D_W - deadweight-ul = 37000 [t]
-engine power: 9480 [KW], 127 [rpm],
-deadweight in the sea water is 37000tdw

The ship is equipped with three Diesel generators, each with many 6 cylinder in-line power of 960 kW, speed 900 (rpm) [5,6].

The power of towing of the ship:

$$P_{rem} = R_t \cdot v \ [kW] \qquad (1)$$

P_{rem} - the power of towing of the vessel
R_t [kN] - the resistance to progress of the ship
v [m/s] - vessel speed.

Figure 1 shows the resistance to progress of the ship depending on the ship's speed v[Nd] - ship's speed; R_t [kN] - the resistance to progress of the ship (ballast and full load).

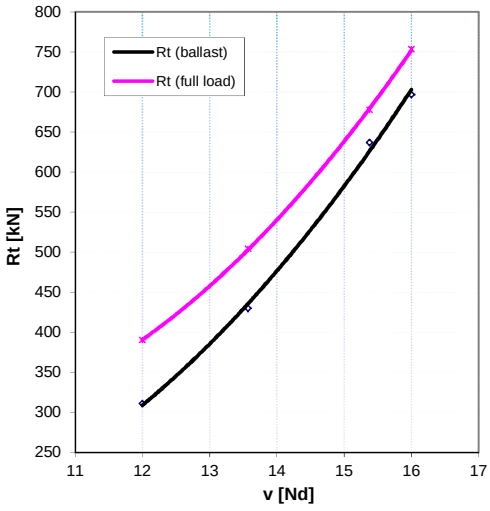

Figure 1. The resistance to progress of the ship

The main engine of a ship is the main consumer of fuel and major energy manufacturer on board.

The expression efficiency propulsion:

$$\eta_{pr} = \frac{P_{rem}}{P_{el}} \quad (2)$$

P_{el} - power needed to drive the propeller

$$P_{el} = M_{el} \cdot \omega = M_{el} \cdot \frac{\pi \cdot n}{30} \quad (3)$$

- M_{el} [kNm] - the effective moment of rotation of the propeller
- n [rot/min] - engine speed,

The engine propulsion is coupled directly to the shafts thus the transmission ratio i_{tr} = 1 and therefore n_{el} = n_{mot}= n

$$\eta_{pr} = \frac{R_t \cdot v}{M_{el} \cdot \frac{\pi \cdot n}{30}} \quad (4)$$

$$\frac{1-t}{1-w} = \eta_H \quad (5)$$

t – coefficient of suction [1];
w – the coefficient of slipstream.

The power needed to drive the propeller will be:

$$P_{el} = \frac{P_{rem}}{\eta_{pr}} = \frac{R_t \cdot v}{\eta_0 \cdot \eta_H \cdot \eta_R} \quad (6)$$

η_H - the influence coefficient of the hull

η_R - the coefficient relative of rotation

The engine power at line of shafts is [7]:

$$P_m = \frac{P_{el}}{\eta_{la}} = \frac{P_{rem}}{\eta_{pr} \cdot \eta_{la}} = \frac{R_t \cdot v}{\eta_0 \cdot \eta_H \cdot \eta_R \cdot \eta_{la}} \quad (7)$$

$\eta_{l.a.}$ =0,98 - the efficiency of the naval propulsion plant line of shafts;

Notations: v_b - the vessel speed (ballast); n_b - engine speed (ballast); v_m – vessel speed (full load); n_m - engine speed (full load).

Figure 2 shows the resistance to progress of the ship, the power engine and the resistance to progress of the ship (full load).

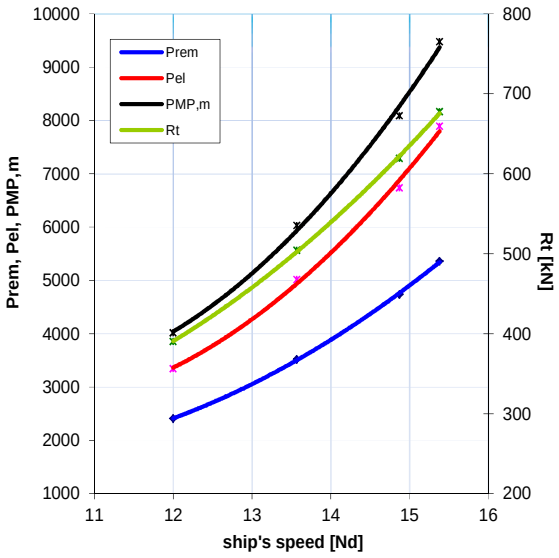

Figure 2. The dependence of power of towing of the ship, the power required to drive the propeller, engine power propulsion and the resistance to progress of the ship (full load)

The functioning regimes for naval propulsion plants are determined by the mechanic characteristics of the functioning of internal combustion engine, power transmission and the ship.

Figure 3 shows the resistance to progress of the ship, the power engine and the resistance to progress of the ship (ballast) [2].

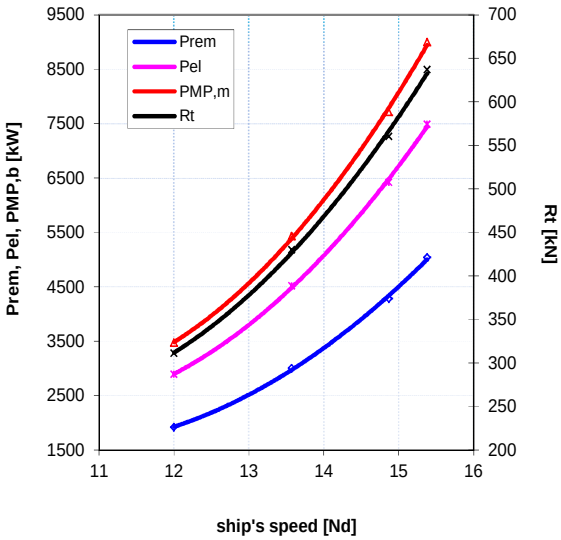

Figure 3. The dependence of power of towing of the ship, the power required to drive the propeller, engine power propulsion and the resistance to progress of the ship (ballast)

The ship must carry the parameters for which it was designed and built, thus satisfying all the technical and economic aspects.

3. RESULTS OBTAINED

Table 1. the results obtained for the propulsion factors (full load)

No.crt.	NAME	Notation	Unit.	Speed of the ship [Nd]			
				12.00	13.57	14.87	15.38
1.	The resistance to progress of the ship	R_T	kN	390.400	504.186	619.075	677.525
2.	Ship's speed	v_m	m/s	6.173	6.980	7.649	7.911
3.	The engine speed	n_m	rot/min	94.38	109.42	121.87	126.76
4.	Propeller efficiency	η_0		0.6151	0.6661	0.6856	0.6849
5.	Propulsion efficiency	η_{pr}		0.7205	0.7014	0.7034	0.6795
6.	The power of towing of the vessel	P_{rem}	kW	2409.861	3519.426	4735.383	5360.218
7.	Power necessary to drive the propeller	P_{el}	kW	3344.740	5017.600	6732.600	7889.000
8.	The power to the intermediate shaft	P_B	kW	3413.000	5120.000	6870.000	8050.000
9.	The engine power at coupling flange	$P_{MP.m}$	kW	4019.154	6029.320	8090.123	9479.692

Table 2. the results obtained for the propulsion (ballast)

No.crt.	NAME	Notation	Unit.	Speed of the ship [Nd]				
				12.00	13.57	14.87	15.38	16.00
1.	The resistance to progress of the ship	R_T	kN	310.990	430.000	560.000	637.000	696.440
2.	Ship's speed	v_b	m/s	6.173	6.980	7.649	7.911	8.230
3.	The engine speed	n_b	rot/min	90.553	105.500	118.200	123.300	129.500
4.	Propeller efficiency	η_0		0.5305	0.5574	0.5720	0.5738	0.5705
5.	Propulsion efficiency	η_{pr}		0.6642	0.6644	0.6673	0.6731	0.6547
6.	The power of towing of the vessel	P_{rem}	kW	1919.679	3001.575	4283.512	5039.608	5731.980
7.	Power necessary to drive the propeller	P_{el}	kW	2890.314	4517.800	6419.000	7487.200	8755.222
8.	The power to the intermediate shaft	P_B	kW	2949.300	4610.000	6550.000	7640.00	8933.900
9.	The engine power at coupling flange	$P_{MP.b}$	kW	3473.100	5428.743	7713.290	8996.876	10520.574

4. CONCLUSIONS

With resistance to progress was calculated power required to motor flange, considering yields of propulsion, propeller shafts, bearing in mind that some yields depend on ship speed.

The resistance to progress is one of the most important qualities for navigation, which depends on the power of the propulsion system.

For propulsion plant study appears the need for a method of estimating the required propulsion power.

The operation of the vessel must take into consideration the parameters for which it was designed and built, thus satisfying all the technical and economical aspects, competitiveness included.

During the design, manufacture, repair, there is consumption of raw materials, labour, energy, evaluated by the appropriate cost.

They must be evaluated so that their operation is carried out rationally, with a profit.

Choosing the type of propulsion system must be the result of a technical-economic analysis that takes into consideration all factors that depend on the safety ship and economically operation.

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THEORETICAL INVESTIGATION OF THE ADIABATIC SATURATED TWO – PHASE FLOW – THE SEPARATED FLOW MODEL

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ABSTRACT

Heat exchanges specific to refrigeration are condensers and evaporators; these present a fairly uniform wall temperature.

The aim of this paper is to offer an algorithm for the analysis of the adiabatic saturated two-phase flow, on the basis of saturated flow model.

The importance of such a model results from the lack of attempts in this respect, being found more researches regarding the single phase flow.

Also, the study is about the flow of a pure fluid, in marine refrigeration being met many situations in which the refrigerant is a pure fluid.

The separated flow model considers different properties and velocities for the two phases. Will be given equations involving the first and second laws of thermodynamics, in accordance. Will result a presentation of the entropy generation under this flow condition.

By the help of the entropy generation number it will be possible the performance assessment of heat exchanges with phase change.

Keywords: *heat exchanger, two phase flow, entropy.*

1. INTRODUCTION

Heat exchangers are often used in different industrial sectors, in refrigeration being met heat exchangers with phase change, namely evaporators and condensers.

Heat transfer process is irreversible, for this reason efforts of engineers are directed towards decreasing of these irreversibilities.

Entropy (S) is the measure of the level of disorder of a system. Even if it is difficult to assess the total entropy of a system, it is easy enough to measure changes in entropy.

This change (ΔS) is expressed by:

$$\Delta S = \frac{\Delta Q}{T} \tag{1}$$

where, for a thermodynamic system, ΔQ is the heat transfer at temperature T.

The second law of thermodynamics can be stated in terms of entropy, this law being known also as "law of entropy".

When a reversible process occurs, there is no net change in entropy.

But in an irreversible process, entropy can only increase, resulting always a positive change in entropy (Bejan, 1996).

For irreversible processes occurring in closed systems, entropy generation (production) is the difference between entropy increase and entropy flow:

$$dS_{gen} = dS - \frac{\delta Q}{T} \geq 0 \tag{2}$$

So:

$$dS = dS_{gen} + \frac{\delta Q}{T} \tag{3}$$

Sometimes S_{gen} is also noted as S_i, thus:

$$dS = dS_i + dS_e \tag{4}$$

Above, $dS_i > 0$ is the entropy change due to internal process and $dS_e = \frac{\delta Q}{T}$ is the entropy change due to external flow of entropy through the frontier.

Integrating relation (2), results:

$$S_{gen} = \Delta S - \int \frac{\delta Q}{T} \tag{5}$$

This paper deals with the theoretical analysis of an adiabatic saturated two phase flow, considering the separated flow model.

The separated flow model considers the phases to be artificially segregated with constant but not necessarily equal velocities for the vapour and liquid phases.

This flow model ask for information of either the void fraction or slip effects and friction effects.

Will be found the total pressure gradient in the separated flow and the enthalpy rearrangement between the phases due to the spontaneous flashing effect of the two phase flow.

Will be involved in the analysis the concepts of entropy generation and entropy generation number, which are basis for thermal optimization.

2. FIRST LAW APPLIED TO THE SEPARATED FLOW MODEL

In this model, the two phases are seen to be segregated with different properties and mean velocities. By having different velocities, vapour and liquid phases move on different distances for the same time, dt. In the two-phase flow region, liquid flashes into vapour from the reduction in pressure.

The enthalpy rearrangement between the vapour and liquid phases due to the spontaneous flashing effect will be found after writing bellow formula; it turns to be influential for high pressure drop (Revellin et al, 2009).

For the adiabatic two-phase flow, the quality (mass dryness fraction), x, is calculated as bellow, depending on the mass flow rates of vapour (subscript "v") and liquid (subscript "l"):

$$x = \frac{\dot{m}_v}{\dot{m}_v + \dot{m}_l} \tag{6}$$

Resulting specific enthalpy (h), specific entropy (s) and specific volume of the two-phase (subscript "tp"):

$$h_{tp} = xh_v + (1-x)h_l \tag{7}$$

$$s_{tp} = xs_v + (1-x)s_l \tag{8}$$

$$v_{tp} = xv_v + (1-x)v_l \tag{9}$$

According to the first law of thermodynamics and neglecting the kinetic and gravity terms results:

$$\begin{aligned} &\frac{\delta\dot{Q}}{\dot{m}_m} = h_{lv}dx + [xds_v + (1-x)ds_l]T_{sat} + \\ &+ [xv_v + (1-x)v_l]dp = h_{lv}dx + c_{x,tp}dT_{sat} + v_{tp}dp \end{aligned} \tag{10}$$

Stating that above $\delta\dot{Q}$ is the heat introduced, subscript "m" means total mixture, p is the pressure and T_{sat} is the saturated temperature, bellow it is given the formula for the heat capacity of the two-phase flow when the quality is constant:

$$c_{x,tp} = xc_{x,v} + (1-x)c_{x,l} \tag{11}$$

for which:

$$c_{x,l} = T_{sat}\left(\frac{ds_l}{dT_{sat}}\right)_{x=0} \tag{12}$$

$$c_{x,v} = T_{sat}\left(\frac{ds_v}{dT_{sat}}\right)_{x=1} \tag{13}$$

It is possible to obtain, by using the Clapeyron equation (eq. 14) the following for "dx":

$$\frac{dp}{dT_{sat}} = \frac{h_{lv}}{T_{sat}v_{lv}} \tag{14}$$

$$\begin{aligned} dx = &\frac{\delta\dot{Q}}{\dot{m}_m h_{lv}} - \\ &- \frac{v_{lv}T_{sat}c_{x,tp} + h_{lv}v_{tp}}{h_{lv}^2}dp_{flasing\ effect} \end{aligned} \tag{15}$$

The void fraction (ε) is expressed by the help of the slip ratio ($\Gamma = w_v/w_l$):

$$\varepsilon = \frac{xv_v}{xv_v + \Gamma(1-x)v_l} \tag{16}$$

Because the void fraction is affected by the quality and the pressure, results (Wong and Ooi, 1996):

$$\begin{aligned} \left(\frac{\partial\alpha}{\partial x}\right)_p = &\frac{v_v}{xv_v + \Gamma(1-x)v_l} - \\ &- \frac{(v_v - \Gamma v_l)xv_v}{[xv_v + \Gamma(1-x)v_l]^2} \end{aligned} \tag{17}$$

and:

$$\begin{aligned} &\left(\frac{\partial\alpha}{\partial p}\right)_x = \\ &= \frac{x\frac{dv_v}{dp}xv_v + \Gamma(1-x)v_l - \frac{\left[x\frac{dv_v}{dp} + \Gamma(1-x)\frac{dv_l}{dp}\right]}{xv_v}}{[xv_v + \Gamma(1-x)v_l]} \end{aligned} \tag{18}$$

Noting by letter "z" the axial direction or length, pressure drop along the tube is found involving the pressure drop due to tube wall friction:

$$-\left(\frac{dp}{dz}\right)_T = \frac{-\left(\frac{dp}{dz}\right)_F + F_1}{\frac{dx}{dz}F_2} \tag{19}$$

Where terms F_1 and F_2 include the mass velocity (G):

$$\begin{aligned} F_1 = G^2\Bigg[&\frac{2xv_v}{\alpha} - \frac{2(1-x)v_l}{1-\alpha} - \\ &- \left(\frac{x^2v_v}{\alpha^2} - \frac{(1-x)^2v_l}{(1-\alpha)^2}\right)\left(\frac{\partial\alpha}{\partial x}\right)_p\Bigg] \end{aligned} \tag{20}$$

$$F_2 = 1 + G^2\left[\frac{x^2}{\alpha}\frac{dv_v}{dp} + \frac{(1-x)^2}{1-\alpha}\frac{dv_l}{dp} - \left(\frac{x^2 v_v}{\alpha^2} - \frac{(1-x)^2 v_l}{(1-\alpha)^2}\right)\left(\frac{\partial\alpha}{\partial p}\right)_x\right] \quad (21)$$

3. SECOND LAW APPLIED TO THE SEPARATE FLOW MODEL

Considering the adiabatic flow of the saturated two-phase system and the second law of thermodynamics written for a control volume of dz, can be obtain the entropy generation rate per unit length, in relation with ΔT – the superheat of the wall:

$$d\dot{S}'_{gen} = \frac{\delta\dot{Q}}{dz}\left[\frac{\Delta T}{T_{sat}^2\left(1+\frac{\Delta T}{T_{sat}}\right)}\right] + \frac{\dot{m}_m v_{tp}}{T_{sat}}\left(-\frac{dp}{dz}\right) \quad (22)$$

Because the superheat is less than the saturation temperature and considering a constant perimeter (P) of the tube with respect to z, results that the entropy generation rate is due to the heat transfer contribution and to the pressure drop contribution, as seen in eq. (23):

$$d\dot{S}'_{gen} = \frac{q^2 P}{\alpha T_{sat}^2} + \frac{\dot{m}_m v_{tp}}{T_{sat}}\left(-\frac{dp}{dz}\right) \quad (23)$$

Above, q is the heat flux and α is the heat transfer coefficient at the tube wall.

4. ASPECTS OF IRREVERSIBILITY IN HEAT EXCHANGERS FOR REFRIGERATION

From the second law of thermodynamics, the entropy variation between inlet and outlet ports of the heat exchanger is as bellow (Hermes, 2012):

$$s_0 - s_i = \frac{1}{m}\left(\frac{Q}{T_s} + S_{gen}\right) \quad (24)$$

where T_s is the surface temperature.

The dimensionless rate of the entropy generation, noted as N_s is used to assess the irreversibility loss in heat exchangers; the smaller the entropy generation number, the better the performance of the heat exchanger is expected to be (Bejan, 1977). So:

$$N_s = \frac{\dot{S}_{gen}}{\dot{m} c_p} \quad (25)$$

According to Xu and others (Xu et al, 1996), evaluation of irreversibilities in condensers and evaporators can be made as follows.

The entropy generation rate for the entire condenser is:

$$\dot{S}_{gen} = -(\dot{m} r)_h + (\dot{m} c_p)\ln\left(\frac{T_{co}}{T_{ho}}\right) \quad (26)$$

In eq. (26), r – latent heat and subscripts c, h, o refer to the cold fluid, hot fluid and outlet.

The entropy generation number in this situation is:

$$N_s = \ln\left[1 + \left(\frac{T_{h_i}}{T_{c_i}} - 1\right)\left(1 - e^{-NTU}\right)\right] - \left(1 - \frac{T_{c_i}}{T_{h_i}}\right)\left(1 - e^{-NTU}\right) \quad (27)$$

NTU is the number of heat transfer units and it is calculated with a formula involving the overall heat transfer coefficient (k), the heat transfer surface A_s, the flow rate, $\dot{m}$. Thus:

$$NTU = k\frac{A_s}{\dot{m} c_p} \quad (28)$$

Writing the relation for the total quantity of heat exchanged in the condenser as:

$$Q = (\dot{m} c_p)_c \Delta T_c \quad (29)$$

By using relations (26) and (29), it is possible to obtain the entropy generation per unit amount of heat exchanged:

$$\frac{S_{gen}}{Q} = -\frac{1}{\Delta T_0\left(1 - e^{-NTU}\right)} \cdot \ln\left[1 + \left(\frac{T_h}{T_{c_i}} - 1\right)\left(1 - e^{-NTU}\right)\right] - \frac{1}{T_h} \quad (30)$$

in which:

$$\Delta T_o = T_{h_i} - T_{c_i} \quad (31)$$

Similar equations may be obtained for the evaporator.

From eq. (27) and eq. (30) it might be understood the influence of NTU over N_s and $\dot{S}_{gen}/Q$. Increasing of NTU will be found in the increase of N_s and decrease of $\dot{S}_{gen}/Q$.

5. CONCLUSIONS

It is exposed theory proper for the investigation of the adiabatic saturated two-phase flow, the separated flow. This model asked for data on the void fraction and slip or friction effects.

Entropy generation assessment for such a flow is useful for condenser and evaporator optimal design. Thus, were given relations for writing the entropy generation number and entropy generation per unit amount of heat exchanged.

The number of heat transfer units (NTU) affects the above mentioned: increasing NTU leads to increase of entropy generation number and decrease of entropy generation per unit amount of heat exchanged.

The utility of this statement is reflected by the fact that the smaller the entropy generation number is, the better the performance of the heat exchanger is expected.

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ASSUMPTIONS OF FIRST AND SECOND LAWS OF THERMODYNAMICS DELIVERED TO FUTURE MARINE ENGINEERS IN CMU

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ABSTRACT

From technical point of view and from environmental point of view, and also for a sustainable development of our society are needed tools which enable to analyse the effects of human activities, including maritime transport.

For this reason the education of future marine engineers is in closely connected to environmental protection. With the development of shipping industry appeared also several of undesired and negative effects.

The paper is focus on needed to knowledge and to understanding of the thermodynamics laws, tools which should be at hand of future marine engineers.

These competences should be gained during master education, through a discipline called "THERMODYNAMICS" included in the curricula of the license program entitled "NAVAL ELECTROMECHANIC", developed in Constanta Maritime University.

Keywords: *Thermodynamics, First law, Second law, Kelvin-Planck statement, Clausius statement*

1. INTRODUCTION

Thermodynamics occupies a very important place in the arena of modern science, engineering and technology. It is a basic discipline for engineers, including marine engineers.

Thermodynamics is the science of heat and temperature and, in particular, of the laws governing the conversion of thermal energy into mechanical, electrical, or other forms of energy. It is a central branch of science that has important applications in chemistry, physics, biology, and engineering. It is a completely logical discipline and can be applied without any sophisticated mathematical techniques. The immense practical value of thermodynamics lies in the fact that it systematizes the information obtained from experiments performed on systems and enables us to draw conclusions, without further experimentation, about other aspects of the same systems and about similar aspects of other systems. It allows us to predict whether a certain reaction will proceed and what the maximum yield might be.

Thermodynamics is a macroscopic science concerning such properties as pressure, temperature, and volume. [6]

In Constanta Maritime University (CMU), Thermodynamics is delivered to students enrolled in Naval Electromechanics, during 2 semesters, 140 hours. The thermodynamics objective, according to the Appendix 3 from STW44, IMO Model Course 7.04, is the capacity of translating in practice theory gained during theoretical courses, obtaining solutions to specific engineering problems and the ability of communicating these results. The purpose of this discipline is to demonstrate a knowledge and understanding about: thermodynamic properties, thermodynamic energy, thermodynamic system, energy change, heat transfer, vapours, and theoretical cycles of thermal machines, ideal gases, thermodynamic processes, work transfer, heat exchangers, and moist air.

2. ABOUT THE FIRST LAW OF THERMODYNAMICS

Energy cannot be created or destroyed-this fundamental law of nature, more properly known as conservation of energy, is familiar to anyone who has studied science. Under its more formal name of the First Law of Thermodynamics, it governs all aspects of energy in science and engineering applications.

The first law of thermodynamics states that energy can be converted from one form to another but cannot be created or destroyed. Furthermore, because energy can be changed from one form to another, the energy lost by one system can be gained by another system in a different form. For example, the energy lost by burning oil in a power plant may ultimately turn up in our homes as electrical energy, heat, light, and so on.

Put another way, this law says that the total energy of the universe is a constant. During an interaction between a system and its surroundings, the amount of energy gained by the system must be exactly equal to the amount of energy lost by the surroundings. A rock falling off a cliff, for example, picks up speed as a result of its potential energy being converted to kinetic energy.

The first law deals with macroscopic properties, work, energy, enthalpy, etc.

A way of expressing this law is that any change in the internal energy of a system is given by the sum of the heat Q that flows across its boundaries and the work W done on the system by the surroundings.

$$\Delta U = Q + W \tag{1}$$

This says that there are two kinds of processes, heat and work, that can lead to a change in the internal energy of a system. Since both heat and work can be measured and quantified, this is the same as saying that any change in the energy of a system must result in a corresponding change in the energy of the world outside the system- in other words; energy cannot be created or destroyed.

The first law of thermodynamics, a simple re-statement of the conservation of energy principle for a closed system or control mass, may be expressed as follows:

$$Q - W = \Delta E \tag{2}$$

where:
Q – net heat transfer across system boundaries, $Q = \sum Q_{in} - \sum Q_{out}$;
W – net work done in all forms, $W = \sum W_{out} - \sum W_{in}$;
ΔE - net change in total energy of system, $\Delta E = E_2 - E_1$.

The total energy of a system is considered to be comprised of three parts: internal energy, U, kinetic energy KE, and potential energy PE. The change in total energy ΔE is:

$$\Delta E = \Delta U + \Delta KE + \Delta PE \tag{3}$$

For stationary closed systems, the changes in kinetic and potential energies are negligible, and the first law relation reduces to:

$$Q - W = \Delta U \tag{4}$$

For a cyclic process, the initial and final states are identical $(\Delta E = 0)$. Therefore,

$$Q - W = 0 \Rightarrow Q = W \quad . \tag{5}$$

3. ABOUT THE SECOND LAW OF THERMODYNAMICS

The second law, however, is probably better known and even more profound because it describes the limits of what the universe can do. This law is about inefficiency, degeneration and decay. It tells us all we do is inherently wasteful and that there are irreversible processes in the universe. It gives us an arrow for time and tells us that our universe has an inescapably bleak, desolate fate.

It comes to complete the first law of thermodynamics and it can be expressed in several ways. According with this law, energy is destroyed during process.

In contradiction with the first law, the second law of thermodynamics deals with concepts as entropy and exergy.

There are several ways in which the second law of thermodynamics can be stated. The three statements of second law of thermodynamics are listed below:

1. Kelvin-Planck statement of the second law: No process is possible whose sole result is the absorption of heat from a reservoir and the conversion of this heat into work.

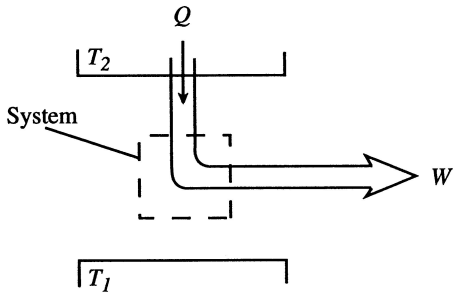

Figure 1 The process is not possible (Kelvin-Planck)

In exceptional cases, if the width of the tables or figures is bigger then the width of a column, the tables or figures can occupy the entire width of the page, with the condition that they do not exceed the limits of the printing area established by the page format.

2. Clausius statement of the second law: No process is possible whose sole result is the transfer of heat from a cooler to a hotter body.

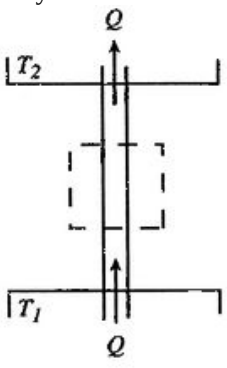

Figure 2 For $T_1 < T_2$, no process is possible (Clausius)

3. There exists for every system in equilibrium a property called entropy, S, which is a thermodynamic property of a system. In loose terms, entropy is a measure of the amount of disorder within a system.

For a reversible process, changes in this property are given by:

$$dS = (dQ_{reversible})/T \tag{6}$$

The entropy change of any system and its surroundings, considered together, is positive and approaches zero for any process which approaches reversibility.

$$dS_{total} \geq 0 \tag{7}$$

For an isolated system, i.e., a system that has no interaction with the surroundings, changes in the system have no effect on the surroundings. In this case, the first and second laws become:

$$\begin{aligned} \Delta E_{system} &= 0, \\ \Delta S_{system} &\geq 0. \end{aligned} \tag{8}$$

For an isolated system the total energy (E = U + Kinetic Energy + Potential Energy +…) is constant. The entropy can only increase or, in the limit of a reversible process, remain constant.

The limit, $S_{total} = const$ or $S_{total} = 0$, represents the best that can be done.

All of these statements are equivalent, but the third statement gives a direct, quantitative measure of the departure from reversibility.

The simplest way to define the second law being that heat will naturally flow from a hotter to a colder body. The entropy of an isolated natural system will always tend to stay the same or increase – in other words, the energy in the universe is gradually moving towards disorder. In a closed system, heat cannot spontaneously flow from a cold object (low entropy) to a hot object (high entropy).

Entropy is not a familiar concept and it may be helpful to provide some additional rationale for its appearance. Looking at the first law,

$$dU = dQ - dW \quad (9)$$

the term on the left is a function of state, while the two terms on the right are not. For a simple compressible substance, however, we can write the work done in a reversible process as $dW = PdV$, so that

$$dU = dQ - PdV \quad (10)$$

The equation (10) represents the first law for a simple compressible substance, reversible process.
The second law tells us that the intensive variable is the temperature, T, and the extensive state variable is the entropy, S. The first law for a simple compressible substance in terms of state variables is thus

$$dU = TdS - PdV \quad (11)$$

Because equation (11) includes the second law, it is referred to as the combined first and second law. Because it is written in terms of state variables, it is true for all processes, not just reversible ones.

The first law of thermodynamics only deals with the magnitude of energy and does not refer to its quality, while the second law of thermodynamics states that energy is featured both by quantity and quality. [2]

Exergy is defined as the maximum work that can be produced by a steam of energy or matter, or from a system, as it is brought into equilibrium with a reference environment. Other definition is that exergy is seen as the quality of energy. This concept is based on both first and second laws of Thermodynamics. [4]

The classical analysis method based on the first law of Thermodynamics consists in writing the equation of energy balance. This practice offers no information regarding the degradation of energy occurring in the process. [5] These limitations are overcome by the exergy method of analysis.

Unlike energy, exergy is consumed due to irreversibilities taking place in all real processes. Thus, the second law of Thermodynamics can be stated as: exergy is always destroyed, partially or totally. [2]

Exergy's application indicates clearly the locations of energy degradation in a process and allows one to quantify the loss of efficiency due to the loss of the quality of the energy, thus indicating where the process can be technically improved. [3]

$$Ex = Ex_{PH} + Ex_{KN} + Ex_{PT} + Ex_{CH} \quad (12)$$

where Ex_{PH} - the physical exergy,
Ex_{KN} - the kinetic exergy,
Ex_{PT} - the potential exergy
Ex_{CH} - the chemical exergy.

4. CONCLUSIONS

In Constanta Maritime University (CMU), Thermodynamics is delivered to students enrolled in Naval Electromechanics, during 2 semesters, 140 hours. Course objectives comply with STW44, IMO Model Course 7.04, and want to demonstrate a knowledge and understanding about: thermodynamic properties, thermodynamic energy, thermodynamic system, energy change, heat transfer, vapours, and theoretical cycles of thermal machines, ideal gases, thermodynamic processes, work transfer, heat exchangers, and moist air.

Process analysis of thermal systems is based on the first and second laws of thermodynamics.

The efficiency of first law (energy efficiency) and of second law (exergy efficiency) may indicate ways to optimize thermal processes. According to the second law of thermodynamics, the performance of a process or system can be expressed in terms of degradation of available energy (irreversibility), $I=T_0 \Delta S_{tot}$, the "0" is standing for the dead state (atmospheric conditions). The second law efficiency (exergy efficiency) is indicating us how much we get out compared to the maximum possible we could obtain, being known the inlet and outlet conditions.

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SECTION IV
MATHEMATICAL SCIENCES AND PHYSICS

COMPARATIVE NUMERICAL ANALYSIS OF LARGEST LYAPUNOV EXPONENT CALCULATION TECHNIQUES

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ABSTRACT

Detecting and qualifying chaos in a dynamical system is an important issue that is solved by computing the largest Lyapunov exponent, which measures the average exponential rate of convergence or divergence of nearby orbits in the phase space of the considered dynamical system. In this article, we consider two approaches for computing the largest Lyapunov exponent: orbit separation method and power method. These techniques are briefly reviewed and applied to two discrete-time dynamical systems, Lorenz map and Gumowski-Mira map, and the results are compared and discussed.

Keywords: *Lyapunov exponents, order and chaos, discrete dynamical systems.*

1. INTRODUCTION

According to Strogatz, chaos is an aperiodic long-term behavior in a deterministic system that exhibits sensitive dependence on initial conditions [1].

In the last decades, due to its applications, the problem of detection and qualifying chaos has become an important issue for the scientists in the field of nonlinear sciences. At present, there are an increasing number of methods employed to detect chaos in dynamical systems, such time series, phase portraits, Poincare maps, power spectrum, bifurcation diagram, Lyapunov exponents or the group of variational indicators (the Fastest Lyapunov Indicator, the Mean Exponential Growth Factor of Nearby Orbits, the Smaller Alignment Index and its generalized version, the Generalized Alignment Index, etc) [2-8].

The Lyapunov exponents, especially the Largest Lyapunov Exponent (LLE), of a dynamical system have been shown to be the most important and most useful for fundamentally characterizing attractors and chaos. These numbers represent the average exponential rate of convergence or divergence of nearby orbits in the phase space of the considered dynamical system. Since nearby orbits correspond to nearly identical states, exponential orbital divergence means that systems whose initial differences we may not be able to resolve will soon behave quite differently as the predictability ability is rapidly lost.

A *N*-dimensional system has *N* Lyapunov exponents. Between them, LLE is the most useful to distinguish various types of orbits of a dynamical system. When the LLE is negative, the orbits attract a stable fixed point or a stable limit cycle. A negative LLE is a characteristic of a dissipative (non-conservative) system. When the LLE is zero, the orbit is a neutrally fixed point. When the LLE is positive, then the orbit is unstable and chaotic.

Generally the calculation of Lyapunov exponents cannot be carried out analytically, and in most cases one must resort to numerical techniques. For systems whose equations of motion are explicitly known the problem of finding Lyapunov exponents was satisfactory solved. One of the most and effective numerical method to calculate the entire Lyapunov spectrum from a set of differential equations was developed independently by Bennedin et al. [9] and by Shimada and Nagashima [10] and is based on Gram-Schmidt orthonormalization procedure. Other methods, based on the group-theoretical representation of orthogonal matrices, were proposed by Rangarajan et al. [11]. Wolf et al. proposed a method to estimate one or two positive exponents from a time series. Sano and Sawada [12] and Eckermann et al. [13] developed similar procedures to determine several exponents, including positive, zero and even negative values. Their techniques require relatively long time series and/or data of high precision, but such series and precisions cannot be obtained in many real-world situations. To avoid these disadvantages, Zeng et al. [14] proposed a procedure by which one can calculate the entire Lyapunov spectrum from relatively small data sets of low precision.

Obviously, all the above-mentioned methods give us the LLE, as the maximum value of the spectrum. Apart from these techniques, there exist methods which can estimate only the LLE. The widespread techniques are the tracked method of Wolf et al., the Rosenstein et al. [15] algorithm for small data set, the space grid method suggested by Friedmann et al., and so on [16-26].

In this article, two different methods of computing LLE for discrete-time dynamical system are numerically investigated and compared. The relative merits and demerits of these methods are pointed out.

The remainder of the paper is organized as follows. Section 2 describes the classical approach for defining LLE. In Section 3, the Lorenz and Gumowski – Mira maps are presented. Section 4 reports the results of applying the orbital separation method and the power method for computing the LLE on these 2-D discrete dynamical systems. Finally, Section 5 provide some concluding remarks.

2. THE LARGEST LYAPUNOV EXPONENT

Let $\mathbf{x_0}(t)$ denote a reference trajectory passing through $\mathbf{x_0}(0)$ at time t = 0 and let $\mathbf{x}_1(t)$ be another trajectory passing through $\mathbf{x}_1(0)$ at time t = 0. The

largest (maximum) Lyapunov exponent $\lambda(\mathbf{x_0})$ is defined with respect to the reference orbit $\mathbf{x_0}$ by

$$\lambda(\mathbf{x_0}) = \lim_{t\to\infty} \lim_{\|\Delta \mathbf{x(0)}\|\to 0} \frac{1}{t} \log \frac{\|\Delta \mathbf{x(t)}\|}{\|\Delta \mathbf{x(0)}\|} \qquad (1)$$

where $\|\Delta \mathbf{x(0)}\| = \|\mathbf{x_1}(0) - \mathbf{x_0}(0)\|$ is the Euclidean distance between the trajectories $\mathbf{x_0}(t)$ and $\mathbf{x}_1(t)$ at time t = 0 and $\|\Delta \mathbf{x}(t)\| = \|\mathbf{x_1}(t) - \mathbf{x_0}(t)\|$ is the Euclidean distance between the same trajectories at an arbitrary time *t*. In (1), $\mathbf{x}_1(t)$ can be any trajectory that is initially infinitesimally close to $\mathbf{x_0}(t)$ at time t = 0.

3. DISCRETE-TIME DYNAMICAL SYSTEMS DESCRIPTION

As models for our numerical study on LLE we consider two typical nonlinear discrete dynamical systems which, depending on parameters, exhibit either regular or chaotic behavior. They are as follows:

(A) LORENZ MAP

The Lorenz discrete-time system is given by the difference equations

$$\begin{cases} x_{n+1} = (1 + a\,b)\,x_n - b\,x_n\,y_n \\ y_{n+1} = (1-b)\,y_n + b\,x_n^2 \end{cases} \qquad (2)$$

with *a* and *b* parameters. Keeping *b* = 0.75 unchanged and varying *a* between 0.5 and 1.25 one obtain the bifurcation diagram in Figure 1. A magnification of this diagram in the range $a \in [0.83, 0.90]$ is realized in Figure 2 for highlighting the complex dynamics of the Lorenz map, not very well illustrated in Figure 1.

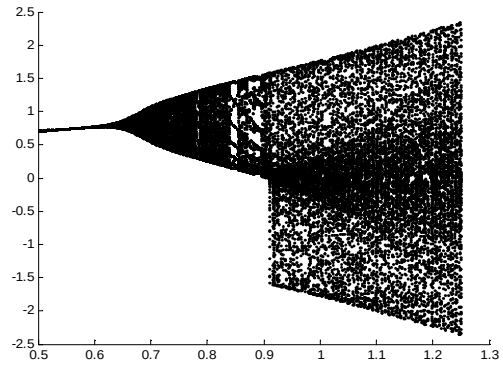

Figure 1 Bifurcation diagram of Lorenz map for *a* between 0.5 and 1.25 and *b* = 0.75

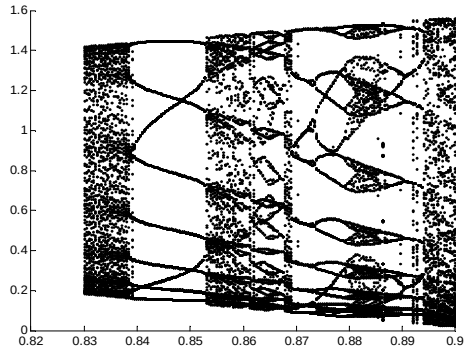

Figure 2 Bifurcation diagram of Lorenz map for $a \in [0.83, 0.90]$ and b = 0.75

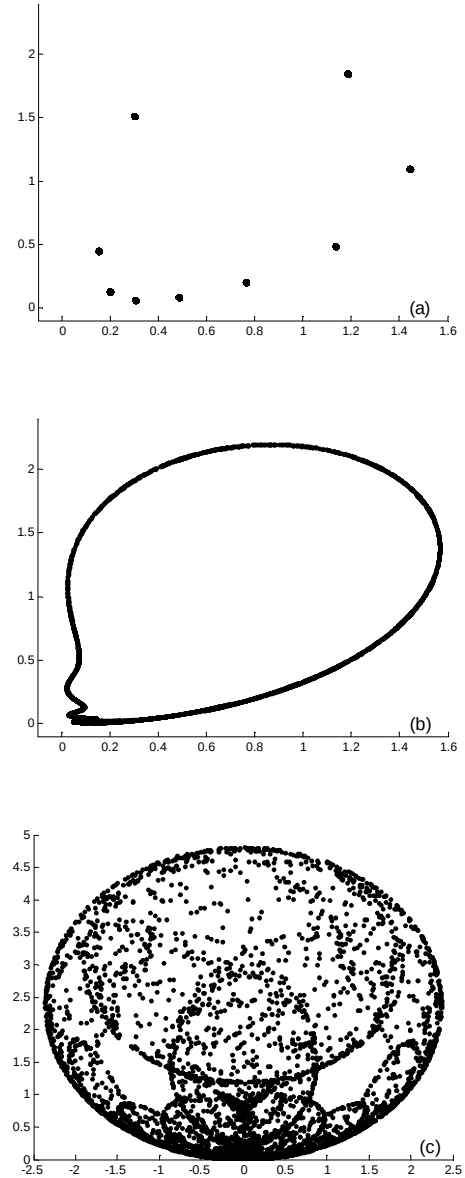

Figure 3 Phase diagrams of Lorenz map: a) 9-period orbit; b) quasi-periodic orbit; c) chaotic orbit

Three typical plots representing chaotic, quasi-periodic and periodic orbits, respectively, are presented

in Figure 3. The initial conditions were $x_1 = 0.1$, $y_1 = 0.2$, and the first 2.000 points on every orbit were ignored.

(B) GUMOWSKI – MIRA MAP

This map has been introduced for modeling and studying accelerated particles trajectories at CERN in 1980. Iterations defined by equations

$$\begin{cases} x_{n+1} = y_n + a\left(1 - b y_n^2\right) y_n + h(x_n) \\ y_{n+1} = -x_n + h(x_{n+1}) \end{cases} \quad (3)$$

where

$$h(x) = \alpha x + \frac{2(1-\alpha)x^2}{1+x^2}, a, b, \alpha \text{ constants} \quad (4)$$

produce different kind of cellular patterns such that depicted in Figure 4.

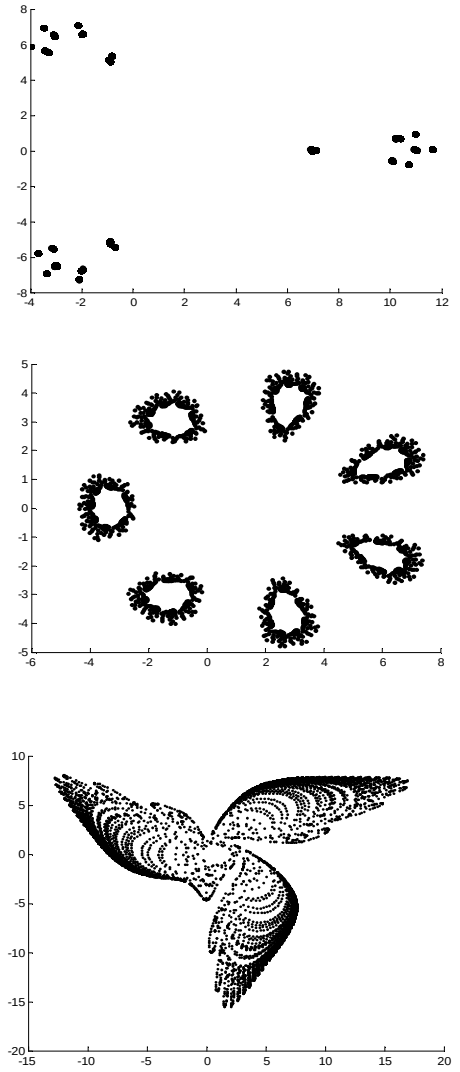

Figure 4: Phase diagrams of Gumowski-Mira map: a) up: $\alpha = -0.5$; b) middle: $\alpha = -0.497$; c) down: $\alpha = -0.492$

Figure 5 presents a bifurcation diagram for $a = 0.008, b = 0.05$, and $\alpha \in [-0.56, -0.49]$. The same initial conditions, $x_1 = y_1 = 0.1$, were considered for all the two hundreds orbits used in Figure 5 and the first 8.000 iterations were discarded.

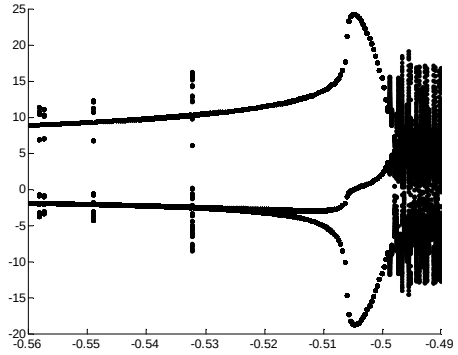

Figure 5: Bifurcation diagram of Gumowski-Mira map for $a = 0.008, b = 0.05$ and $\alpha \in [-0.56, -0.49]$

4. METHODS FOR COMPUTING THE LARGEST LYAPUNOV EXPONENT. DESCRIPTION AND APPLICATIONS TO SOME MAPS

4.1. Orbit separation method (OSM)

4.1.1. Method description

This method calculates sensitive dependence on initial conditions by perturbing an orbit by a small quantity ε and measuring the resulting separation at every time step. The steps of the method are as follows:

Step 1: Start with any initial conditions $\mathbf{x_0}$ in the basin of attraction;

Step 2: Iterate until the orbit is on the attractor. Thus, the first few points of the numerical orbits are not used in order to eliminate data that are not sufficiently close to the attractor. How many points to discard, it depends on the dynamical system.

Step 3: Select another initial condition $\mathbf{x}_0^*$, which is $\mathbf{x_0}$ perturbed by the small constant ε. So, the separation distance between $\mathbf{x_0}$ and $\mathbf{x}_0^*$ is $d_0 = \left\| x_0 - x_0^* \right\| = \varepsilon$.

Step 4: Advance both orbits, $\mathbf{x}$ and $\mathbf{x}^*$, one iteration and calculate the new separation distance $d = \left\| x - x^* \right\|$.

Step 5: Compute $L = \log|d/\varepsilon|$ in any convenient base. Usually, the natural logarithm is used.

Step 6: Change $\mathbf{x}^*$ so that it is again only ε apart from $\mathbf{x}$, but preserving direction. Thus, if $\mathbf{v} = \mathbf{x} - \mathbf{x}^*$, the equation $\mathbf{x}^* = \mathbf{x} + \frac{\varepsilon}{\|\mathbf{v}\|} \cdot \mathbf{v}$ describes the normalization procedure which readjust the orbit $\mathbf{x}^*$ so its separation from $\mathbf{x}$ is ε in the same direction as $\mathbf{v}$.

Step 7: Repeat steps 4-6 many times and calculate the average of step 5. That means the sum of the *L* values over iterations is initiated as zero, $L_S = 0$, and computed every iteration as $L_S = L_S + L$. At the end, the largest Lyapunov exponent for the analyzed orbit is

$$\lambda_{\max} = L_S / n$$

where *n* is the number of iterations after the transient is surpassed. For most dynamical systems few thousands iterates of the map usually suffices to have an accurate estimate to about two significant digits of $\lambda_{\max}$.

4.1.2. Numerical results

(A) LORENZ MAP

We calculated first the LLE of the Lorenz system (2) using 8.000 iterations (first 2.000 iterations were discarded) and initial separation $\varepsilon = 10^{-6}$. The results are shown in Figure 6. We immediately see that the LLE's values are in agreement with the bifurcation diagrams in Figures 1 and 2.

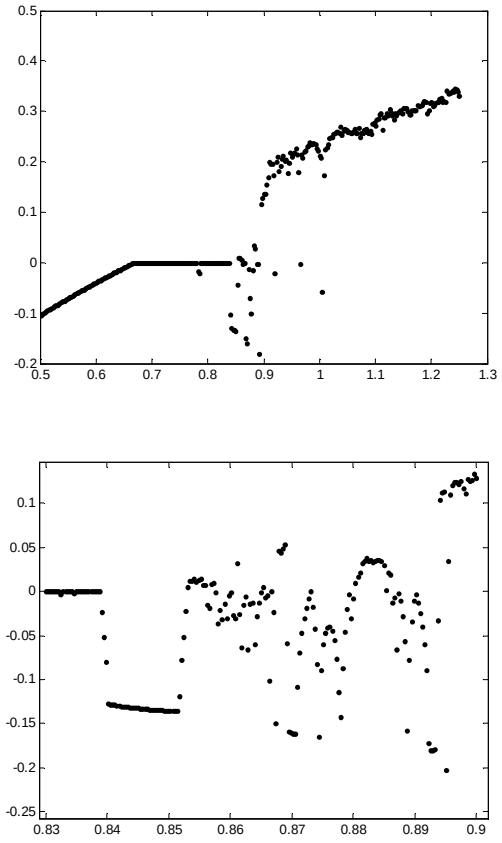

Figure 6 Largest Lyapunov exponent of Lorenz map Up: $\alpha \in [0.5, 1.25]$, b = 0.75; Down: $a \in [0.83, 0.90]$, b = 0.75

The next numerical simulations were focused on the influence of initial separation, ε, and of the maximal number of iterations, N_{end}, on the LLE. Thus, in Figure 7 are depicted the differences obtained in the LLE's computation when $\varepsilon = 10^{-8}$ is replaced by $\varepsilon = 10^{-6}$ and $\varepsilon = 10^{-4}$, respectively. These differences are in the worst case of $O(10^{-4})$, so they do not influence the decision regarding the type of orbit (chaotic or regular).

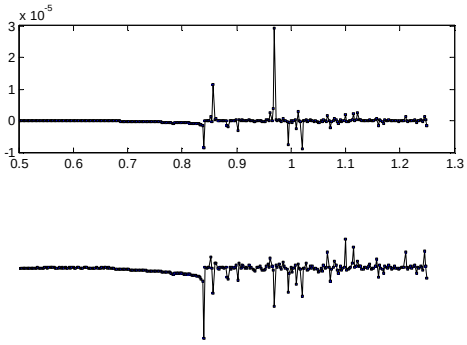

Figure 7: Differences obtained in the LLE's computation for Lorenz map. $\lambda^1_{\max}, \lambda^2_{\max}$, and $\lambda^3_{\max}$ correspond to $\varepsilon = 10^{-8}$, $\varepsilon = 10^{-6}$, and $\varepsilon = 10^{-4}$, respectively.

On the other hand, the errors have increased significantly with decreasing the maximum number of iterations used in computations. So, Figure 8 presents the errors in LLE's evaluation when, instead $N_{end} = 15.000$, the values $N_{end} = 8.000$ and $N_{end} = 4.000$ are considered. With a single exception, $a = 1.19$, changing $N_{end} = 15.000$ with $N_{end} = 8.000$ does not affect considerably the LLE's value. This is not true for $N_{end} = 4.000$, especially for *a* values which correspond to chaotic orbits. Even in this case. When errors are $O(10^{-2})$, the LLE remain positive ($\lambda_{\max} = O(10^{-1})$), so the final conclusion is not distorted.

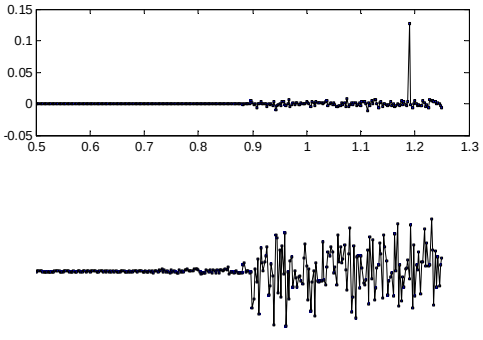

Figure 8 Differences obtained in the LLE's computation for Lorenz map. $\lambda^{(1)}_{\max}, \lambda^{(2)}_{\max}$, and $\lambda^{(3)}_{\max}$ correspond to $N_{end} = 15.000$, $N_{end} = 8.000$, and $N_{end} = 4.000$, respectively.

(B) GUMOWSKI – MIRA MAP

One of the features of this map is the long transition to the attractor. Considering this, we neglect the first 8.000 iterations and use the next 4.000 to build the graph in Figure 9. Comparing Figures 5 and 9, we notice once again the effectiveness of the orbit separation method in distinguishing between regular and chaotic trajectories.

The effect of increasing initial separation of neighboring orbits from $\varepsilon = 10^{-8}$, to $\varepsilon = 10^{-6}$ or $\varepsilon = 10^{-4}$ on LLE is insignificant in this case, too, as just results from Figure 10. Differences greater than 10^{-4} in the LLE's computation are not noticeable.

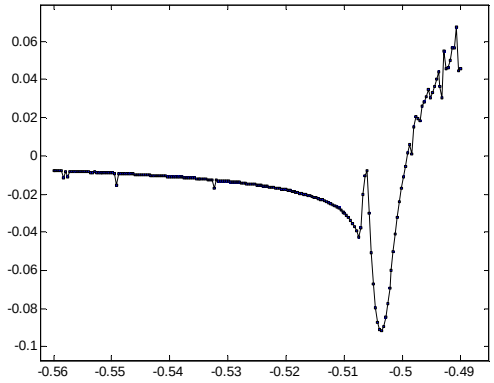

Figure 9 Largest Lyapunov exponent of Gumowski - Mira map: $a = 0.008, b = 0.05$ and $\alpha \in [-0.56, -0.49]$

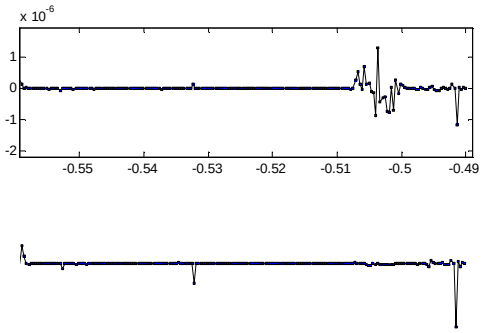

Figure 10: Differences obtained in the LLE's computation for Gumowski - Mira map. $\lambda^{1}_{\max}, \lambda^{2}_{\max}$, and $\lambda^{3}_{\max}$ correspond to $\varepsilon = 10^{-8}$, $\varepsilon = 10^{-6}$, and $\varepsilon = 10^{-4}$, respectively.

On the contrary, considering a shortage of iterations in the LLE's computation, leads to erroneous conclusions on the orbit type, especially for dynamic systems with a slowly transient to the attractor. Thus, Figure 11 presents the differences in LLE's values for $N_{end} \in \{15.000, 8.000, 4.000\}$. There exist some α values in the ordered area of bifurcation diagram for which these differences are unacceptable.

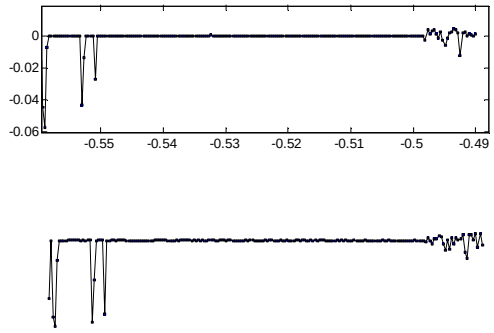

Figure 11 Differences obtained in the LLE computation for Gumowski - Mira map. $\lambda^{(1)}_{\max}, \lambda^{(2)}_{\max}$, and $\lambda^{(3)}_{\max}$ correspond to $N_{end} = 15.000$, $N_{end} = 8.000$, and $N_{end} = 4.000$, respectively.

One of these values is $\alpha = -0.546$, which correspond to a 3-period orbit (see Figure 12, where the first 8.000 iterations are not depicted). The transient ends after approx. 9.300 iterations, so only 12.000 points in $\lambda_{\max}$ computation leads to the wrong value $\lambda_{\max} = 0.03031$, characterizing a chaotic orbit. The increasing of number of iterations to 15.000 produces a right value (as sign) for LLE, namely $\lambda_{\max} = -0.00199$.

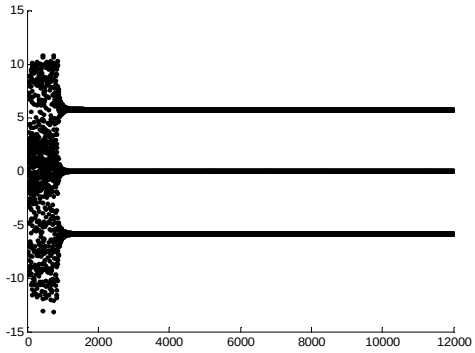

Figure 12 A long transition to a 3-period orbit

4.2. Power method (PM)

4.2.1. Method description

The power method is applied to the Jacobean matrix of the analyzed discrete dynamical system, *J*, to approximate the largest Lyapunov exponent by creating a graph of $\ln(\mathbf{y_n})$ versus *n*, where *n* is the number of iterations of the power method and

$$\mathbf{y_n} = \frac{1}{n} \ln \left| J(\mathbf{x_{n-1}}) \cdot J(\mathbf{x_{n-2}}) \cdot \ldots \cdot J(\mathbf{x_0}) \cdot \mathbf{y_0} \right|$$

The slope of the graph will be an approximation of LLE. The steps of the method are as follows:

Step 1: Start with any initial condition in the basin of attraction;
Step 2: Iterate until the orbit is on the attractor;
Step 3: Assign the starting value $\mathbf{x_0}$ to the last iterate from above and initialize the Jacobean matrix $J(\mathbf{x_0})$; Choose an arbitrary vector $\mathbf{y_0}$ and compute $\mathbf{v_0} = J(\mathbf{x_0}) \cdot \mathbf{y_0}$;
Step 4: Advance the orbit one iteration, from $\mathbf{x}_{k-1}$ to $\mathbf{x}_k$, k = 1, 2, .., N_{end}, and calculate the new Jacobean matrix $J(\mathbf{x}_k)$ and the new vector $\mathbf{v}_k = J(\mathbf{x}_k) \cdot \mathbf{v}_{k-1}$;
Step 5: Store the $\mathbf{y_k} = \ln|\mathbf{v_k}|$ data for graphing;
Step 6: Repeat steps 4-5 many times (k = 1, 2, .., N_{end});
Step 7: Graph the elements of vector $\mathbf{y}_n$ versus *n*. All the slopes will represent the LLE of the discrete system;
Step 8: Use the least square method to compute slopes. Consider the LLE as the average of all slopes.

4.2.2. Numerical results

(A) LORENZ MAP

We start the new series of numerical simulations with a typical example of power method's application. Figure 13 shows the plot of $\mathbf{y}_n$ versus *n* for Lorenz map with $a = 0.5$ and $b = 0.75$ (a fixed point). Practically, this plot is a straight line so the number n should not be too large.

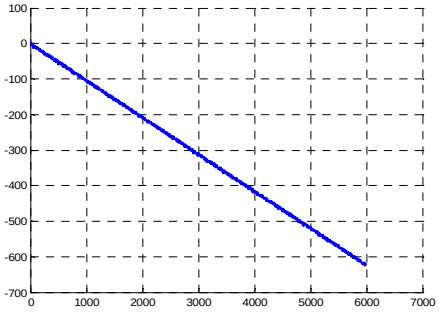

Figure 13 A typical example of power method's application

Figure 14 presents the recorded differences in the LLE's values when the OSM ($N_{end} = 15.000, \varepsilon = 10^{-6}$) and PM ($N_{end} = 2.000$) were used. The first 2.000 iterations were discarded. With a single exception, $a = 1.19$, both method indicate the same behavior of the Lorenz map. Unfortunately, both the value given by OSM, $\lambda_{\max} = 0.19197$, and the value produced by PM, $\lambda_{\max} = 0.32554$, are wrong because we deal with another long transition to a 7-period orbit (see Figure 15). A right value, $\lambda_{\max} = -0.01329$, was obtain by discarding 10.000 iterations and using OSM with $N_{end} = 90.000$.

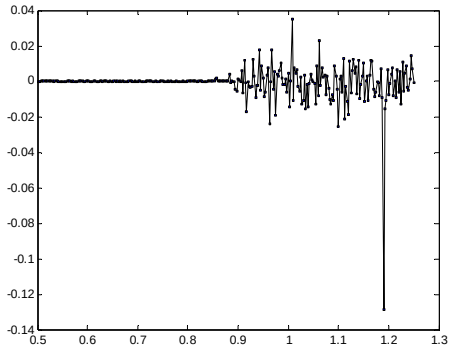

Figure 14 The difference $\lambda_{\max}^{OS} - \lambda_{\max}^{PM}$ versus *a* for the Lorenz map. The first 2.000 iterations were discarded.

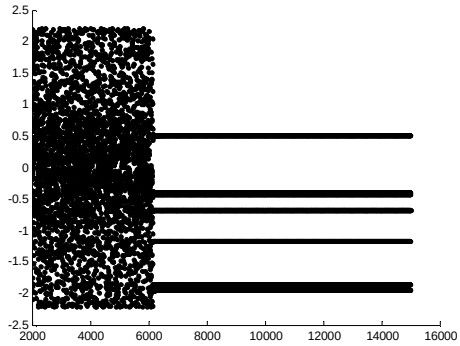

Figure 15: A long transition to a 7-period orbit of Lorenz map ($a = 1.19$, $b = 0.75$)

In fact, we extended our study on the entire range $a \in [0.5, 1.25]$ by ignoring the first 10.000 iterations. The results shown in Figure 16 prove that the both methods give identical conclusions regarding the type of orbit, even for a in the range $a \in [0.9, 1.25]$, where the differences are $O(10^{-2})$.

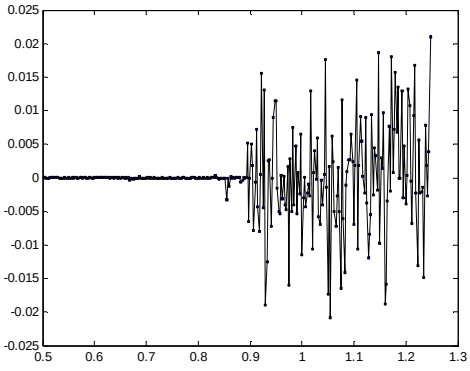

Figure 16 The difference $\lambda_{\max}^{OS} - \lambda_{\max}^{PM}$ versus *a* for the Lorenz map. The first 10.000 iterations were discarded.

The same are valid for Gumowski-Mira map. Figure 17 reports our findings for $\lambda_{\max}^{OS} - \lambda_{\max}^{PM}$ versus α. The

first 8.000 iterations were discarded and the next 7.000 were used for computation. The only notable differences, recorded near $\alpha = -0.49$, do not affect the final conclusion.

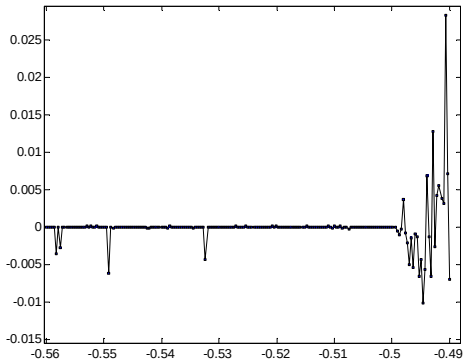

Figure 17 The difference $\lambda_{\max}^{OS} - \lambda_{\max}^{PM}$ versus α for the GM map. The first 8.000 iterations were discarded.

5. CONCLUSIONS

In the paper, we make a detailed numerical comparison of the orbit separation method with the power method, as regards accuracy and efficiency, by computing the largest Lyapunov exponent, over a range of parameters, of two tipical discrete-time dynamical systems with two variables, namely Lorenz map and Gumowski-Mira map. Our main conclusions are as follows:

- there is a reasonable agreement among the two techniques as far as the values of the largest Lyapunov exponent are concerned;
- generally, the small differences recorded in largest Lyapunov exponent's computation does not affect the conclusion regarding the type of orbits (ordered or chaotic);
- the power method seems to score over the orbit separation method as far as efficiency, indicated by CPU time, is concerned. On the other hand, some problems regarding the convergence of power method are recorded;
- the influence of the parameters, the length of initial transient and the maximal number of iterations, is investigated. Thus, to avoid an erroneous conclusion concerning the character of the analyzed orbit, a prior knowledge of the system dynamics is desirable (for example, time series is a necessary additional tool).

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SECTION V
TRANSPORT ECONOMICS

THE ROLE AND OBLIGATIONS OF A MEMBER STATE OF THE INTERNATIONAL MARITIME ORGANIZATION AND EUROPEAN UNION

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ABSTRACT

As a member of the International Maritime Organization, requirements which should be fulfilled by Romania are differentiated on three main directions which are in the same time characteristics of a maritime state: costal state, flag state and port state. Those tree characteristics impose obligations as per mandatory IMO instruments in one hand and as per the European maritime legislation in the other hand. The characteristics deal with safety of navigation requirements implemented to our own ships and also regarding the safety measures for safe navigation in the Romanian jurisdiction waters as well.

The role played by the Administration through Flag state and Recognized Organizations is of the highest importance to fulfil the obligations assumed by the Romanian government when the Conventions and other mandatory IMO instruments were agreed and signed. To delegate the flag state competences to a Recognized Organization is a great responsibility.

The respect for the environment is covered by MARPOL requirements but also by the European directives which should be fully implemented by the Administration.

The SAR convention deals with the salvage of the human life at sea and imposes a series of requirements to be fulfilled as special equipment, well prepared and trained people and designated salvage ships. A special communication system is required as well.

The Port State characteristic should be implemented and well connected to all regional agreements within the world for the global benefit of safety and the environment.

Keywords: *Costal state, New Inspection Regime, Port State.*

1. INTRODUCTION

It is important to understand the role of the administration of a state such as Romania, member of IMO and European Union, between the obligation of respecting minimal provisions of IMO Conventions and high standards imposed by EU in the naval transport field. It is obvious that all norms, requirements and obligations mainly refer to safety of navigation, working and repose conditions on board ships and preventing pollution of the marine environment.

An IMO Convention, once ratified by the Administration of a member state, must take the way of being adapted to the national legislation norms, implemented by creating an institutional basis and then the process of imposing its requirements. Same for EU Rules and Regulations, they must be adapted to the national legislation, implemented and imposed. In this way all compulsory requirements may be implemented and controlled and non-compliance with provisions and regulations may be punished if Romania made a commitment to respect them by ratification, acceptance or signing.

Fulfilment of obligations of an IMO member state is resumed, in a few words, to the fact that signing and ratifying IMO Convention, means that the state's administration makes a commitment to fulfil obligation provided by the conventions' provisions which the state accepted, becoming a signatory part.

What is the role of IMO? What does EMSA represent? These are questions to which we should answer for those who do not know the mechanisms regulating the naval transport sector, to be able to understand how the system, of implementation and control over the way in which signatories respect their obligations, generally works.

Requirements which should be fulfilled in Romania are differentiated on three main directions which are in the same time characteristics of a maritime state: costal state, flag state and port state.

As a member state of IMO and EU, it is needed to prove that what was agreed by signing and ratifying was properly implemented by one's own administration. Otherwise said, the administration needs to prove that the requirement of the compulsory IMO instruments and the provisions of the community legislation in the naval field have been correctly implemented and are functioning efficiently.

2. THE COSTAL STATE CHARACTERISTIC

Costal state it's a characteristic which requires for the administration of the member state to make effort for providing complete safety in navigation without any discrimination, for all ships navigation in the jurisdiction and responsibility area of that particular coastal state. This means that the coastal state must obey relevant international provisions for a series of matters related to safety in navigation and saving human lives at sea.

Buoyage system, navigation maps, nautical publications, notices to mariners, traffic separation schemes, lighthouses, meteorological services and warnings are compulsory elements and requirement which must be provided by the coastal state.

Administrations undertake to encourage the collection of meteorological data by ships at sea and to arrange for their examination, dissemination and exchange in the manner most suitable for the purpose of aiding navigation. Administrations shall encourage the use of meteorological instruments of a high degree of accuracy and shall facilitate the checking of such instruments upon request. Arrangements may be made by appropriate national meteorological services for this checking to be undertaken, free of charge to the ship.
In particular, Administrations undertake to carry out, in cooperation, the following meteorological arrangements:
- to warn ships of gales, storms and tropical cyclones by the issue of information in text and, as far as practicable graphic form, using the appropriate shore-based facilities for terrestrial and space radio communications services.
- to issue, at least twice daily, by terrestrial and space radio communication services, as appropriate, weather information suitable for shipping containing data, analyses, warnings and forecasts of weather, waves and ice. Such information shall be transmitted in text and, as far as practicable, graphic form including meteorological analysis and prognosis charts transmitted by facsimile or in digital form for reconstitution on board the ship's data processing system.
- to prepare and issue such publications as may be necessary for the efficient conduct of meteorological work at sea and to arrange, if practicable, for the publication and making available of daily weather

Administrations undertake to arrange for the collection and compilation of hydrographic data and the publication, dissemination and keeping up to date of all nautical information necessary for safe navigation.

In particular, Administrations undertake to co-operate in carrying out, as far as possible, the following nautical and hydrographic services, in the manner most suitable for the purpose of aiding navigation:
- to ensure that hydrographic surveying is carried out, as far as possible, adequate to the requirements of safe navigation;
- to prepare and issue nautical charts, sailing directions, lists of lights, tide tables and other nautical publications, where applicable, satisfying the needs of safe navigation;
- to promulgate notices to mariners in order that nautical charts and publications are kept, as far as possible, up to date;
- to provide data management arrangements to support these services.
- Administrations undertake to ensure the greatest possible uniformity in charts and nautical publications and to take into account, whenever possible, relevant international resolutions and recommendations.
- Administrations undertake to co-ordinate their activities to the greatest possible degree in order to ensure that hydrographic and nautical information is made available on a world-wide scale as timely, reliably, and unambiguously as possible.

Nautical charts and nautical publications, such as sailing directions, lists of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage, shall be adequate and up to date.

This characteristic includes another obligation for the Coastal state, which is to provide place of refuge in case of force majeure. The Coastal state must provide specially designated places of refuge for ships in difficulty in order to save the crews and ships as well as to mitigate damages resulted from marine or any other kind of pollution.

Salvage activity of human lives at sea is regulated by SAR Convention and imposes to the coastal state to provide proper communication, intervention and salvage means for people in danger at sea. Human life saving at sea is an obligation of the state which is provided freely and without discrimination. The existence of Maritime Coordination Centres represents the provision of proper communication technique, qualified personnel, 24 hours permanent working regime, salvage equipment and ships for intervention. The audit based on volunteers of the International Maritime Organization which was performed in 2008, emphasised the fact that Romania satisfies properly the requirement of SAR Convention to which it is a signatory part.

In general each Administration undertakes to ensure that necessary arrangements are made for distress communication and co-ordination in their area of responsibility and for the rescue of persons in distress at sea around its coasts. These arrangements shall include the establishment, operation and maintenance of such search and rescue facilities as are deemed practicable and necessary, having regard to the density of the seagoing traffic and the navigational dangers and shall, so far as possible, provide adequate means of locating and rescuing such persons.

The Administration undertakes to make available information to the IMO its existing search and rescue facilities and the plans for changes therein, if any.
Administrations undertake to arrange that life-saving signals are used by search and rescue facilities engaged in search and rescue operations when communicating with ships or persons in distress.

The salvage of human lives refers to the International Convention on Maritime Search and Rescue, 1979 and the following resolutions adopted by the Organization: Homing capability of search and rescue (SAR) aircraft (resolution A.225(VII)); Use of radar transponders for search and rescue purposes (resolution A.530(13)); Search and rescue homing capability (resolution A.616(15)); and International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual (resolution A.894(21)).

Vessel traffic services (VTS) contribute to safety of life at sea, safety and efficiency of navigation and protection of the marine environment, adjacent shore areas, work sites and offshore installations from possible adverse effects of maritime traffic.

Administrations undertake to arrange for the establishment of VTS where, in their opinion, the volume of traffic or the degree of risk justifies such services.

The Administrations shall plan and implementing VTS, wherever possible, following the guidelines developed by the International Maritime Organization. The use of VTS may only be made mandatory in sea areas within the territorial seas of a Costal State.

The Administration shall endeavour to secure the participation in, and compliance with, the provisions of vessel traffic services by ships entitled to fly their flag.

All these provisions are referring to Guidelines on Vessel Traffic Services adopted by the IMO by resolution A.857 (20). Each port of the Coastal state must provide cargo and/or passenger ships the status of safe port. This status is provided by offering the optimal depth conditions for entering ports and operating berths, proper embankment for safe operations of ships, pilotage and safe towage as well as supplies, fuel, water and electric energy facilitation.

Providing security of port facilities became also compulsory in every port of the coastal state.

3. THE FLAG STATE CHARACTERISTIC

Flag state represents mainly the characteristic of adapting to national legislation and implementing to one's own ships the provisions of IMO Convention as well as legislation requirements in the field provided by EU. This means institutional constructions and qualified personnel capable to apply and implement conventions and agreements to which the flag state by adherence to these instruments became a signatory part. Mainly, the ships of the flag state which are subjected to IMO Conventions must satisfy all requirements and national and international norms. Applying international requirements to one's own ships and their technical certification is done by using one's own qualified personnel and by delegating competences, by a special mandate, to Recognized Organizations (ROs). Recognized Organizations are Classification Societies originated from those who are members IACS and which, due to their high performances, have been agreed by the European Commission and which are on the list of organizations recognized by all EU member states. In other words, EU member states may delegate the competences of Flag state only to Recognized Organizations (ROs). These competences are different from state to state. Romania delegated such competences by signing Protocols with recognized organizations such as Germanisher Lloyd, Det Norske Veritas, Korean Register of Shipping, Russian Register, Italian Register (RINA) and Lloyd Register. Competences awarded to these ROs are those related to inspection and statutory technical certification (Statutory Convention Certificates). Upon request, the administration may delegate other competences too.

Compliance of one's own ships with international requirement and norms is controlled and imposed through a mechanism called Flag State Control. The body of experienced and highly trained professionally inspectors is composed by naval engineers, naval architects and navigating personnel with management certificates (Masters, Chief Engineers).

This personnel may provide supervision of the ship's construction, inspection of materials used for ships' construction, technical inspections and documentation, repairs plans, revision, construction, modification, etc. Issuance of convention certificates and their renewal (prolonging their validity) respecting international criteria and norms applicable to different categories of ship, also represents an important activity for the flag state.

The right of a member state to inspect ships under a foreign flag to verify if those ships satisfy the compulsory and applicable requirements of IMO Conventions in order to eliminate from operation ships below standard, obliging the specific state to fulfil firstly its obligations applicable to one's own ships.

The member state has the obligation, through the Flag state, to communicate to the International Maritime Organization one's own technical norms corresponding to IMO Conventions to which one adhered but where the administration must issue one's own norms meant to satisfy requirements. The provision of the convention only stipulates, for the satisfaction of the Administration.

The Administration may grant to individual ships exemptions or equivalents of a partial or conditional nature provided that the Administration has taken into account the effect such exemptions and equivalents may have upon the safety of all other ships.

The role of the FSC body of inspectors is to determine how one's own ships fulfil and satisfy technical and operational requirements applicable. An FSC service well organized and aware of the importance of fulfilling the obligations assumed by the flag state by adhering to IMO Conventions and Protocols and EU Requirements, may and must contribute to the accession of the specific flag state, on the white list of the Paris Memorandum. This serves for getting a preferential status of the flag in the worldwide shipping industry with image and also important economic advantages.

Training and certification of the maritime personnel is also an obligation of the flag state which adhered to the STCW95 Convention. All training curricula for future maritime officers in specialized maritime institutions are controlled and certified by the competent authority of the flag state. For Romania, this task belongs to the Romanian Naval Authority (RNA). The training curricula in maritime education must correspond for duration (number of hours) and content with the conventional requirements and Model Courses adopted by the International Maritime Organization.

RNA, representing the Administration, has the duty to inspect and control the manner in which maritime education institutions satisfy all requirements in view of the accreditation. This activity of verification is performed by the auditor's body of RNA through periodical audits and unannounced controls.

The manner in which future maritime officers are trained is very important for the safety of navigation and the training level required must be provided through the mechanism of the flag state.

Certification is the responsibility of the flag state to provide credit (certificates) for the maritime personnel which satisfies from all points of view the conventional requirements and the corresponding health, training and practice level in order to name them as officers or personnel participating in providing safety of navigation.

The Contracting Governments/Administrations undertake for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned.

Every ship to which mandatory requirements applies shall be provided with an appropriate minimum safe manning document or equivalent issued by the Administration as evidence of the minimum safe manning considered necessary to comply with the provisions.

On all ships, to ensure effective crew performance in safety matters, a working language shall be established and recorded in the ship's log-book.

The Company, or the master, as appropriate, shall determine the appropriate working language. Each seafarer shall be required to understand and, where appropriate, give orders and instructions and to report back in that language. If the working language is not an official language of the State whose flag the ship is entitled to fly, all plans and lists required to be posted shall include a translation into the working language.

For EU ships English shall be used on the bridge as the working language for bridge-to-bridge and bridge-to-shore safety communications as well as for communications on board between the pilot and bridge watch keeping personnel, unless those directly involved in the communication speak a common language other than English.

The Principles of Safe Manning adopted by the Organization refers to IMO resolution A.890(21).

4. THE PORT STATE CHARACTERISTIC

Port state signify both a characteristic and an obligation for the member state of IMO and EU to control ships, no matter their flag, which operate in ports or ride at anchor in their roadstead's, with the purpose of evaluating their conformity with provisions of conventions and other relevant instruments. The main purpose of this control (Port State Control) is to eliminate from operation ships below required standards by the provisions of IMO conventions and other relevant instruments.

Eliminating from operation ships below mandatory standards contributes to enhancing safety in navigation and eradicating non loyal competition practiced by some shipowners. They bring on the freight market technically damaged ships, with low freights, to the prejudice of serious ship owners who provide safe and properly maintained ships at the corresponding level of freights.

PSC control system is present worldwide and it is organized by associating IMO member states in agreements and/or regional memoranda such as: Paris MoU, Black Sea MoU, Med MoU, Caribbean MoU, Tokio MoU, Abuja MoU, Vina del Mar Agreement, Riyadh MoU, Indian Ocean MoU.

New Inspection Regime (NIR) is a new concept of tracking and monitoring ships with a special system, having an electronic data basis in which PSC inspections' results are introduced as well as a series of determinant factors. This new system was implemented by Paris MoU through THETYS data basis controlled and administrated by EMSA. Essential factors creating the risk profile of ships are: the age of the ship, the flag of the ship, classification society/ Recognised Organisation, shipping company or operator and ship's history (non conformities and detentions due to PSC inspections). The most important aspect is that the system is processing the risk profile of the ship. This means that a vessel could be evaluated as a high risk, medium risk or a low risk vessel. The priority for PSC inspection could be fixed as priority I or priority II. Depending on the risk profile the modality of the PSC inspection is also determined as initial inspection, detailed inspection or more detailed inspection.

The Port State characteristic is considered as the most important tool of the Administration to fight against substandard foreign flag ships.

5. CONCLUSIONS

To be an IMO and a European Union member means to understand the huge responsibility and obligations concerning safety of navigation and pollution prevention. A shipping company or a vessel should be from all points of view well secured and safety. The environment is one of the most important legacy that oblige all Governments to take appropriate measures of protection including the implementation of technical standards for their ships as required by the IMO conventions and other mandatory instruments. The sea is the source of existence of mankind's economic and it must be protected and guarded for any damage. We must realize that the sea is to be assured of our children's future.

As an obligation, the safety of life at sea is to be ensured by all IMO members providing a climate of peace and security to those aboard vessels working for their families or who are resting after exertion. The protection of human life at sea has to be understood as a principal priority and considerable efforts have to be made by each contracting government. All this may not be possible without appropriate policies of professional education for future navigators, the staff who work at companies or sailing on board ships.

6. REFERENCES

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[2] The Directive 2009/16/CE of the European Parliament and of the Council
[3] Government Decision 50/2001 for Memorandum of Understanding ratification concerning PSC activity in the Black Sea area
[4] The Provisions of the Paris Memorandum of Understanding
[5] The PSC Manual
[6] IMO – FAL.5/Circ.39
[7] Resolution A.225(VII)
[8] Resolution A.530(13)
[9] Resolution A.616(15)
[10] Resolution A.894(21)
[11] Resolution A.890(21)

ROMANIA IS A MEMBER OF PARIS MOU AND BLACK SEA MOU

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ABSTRACT

Today, Paris MoU is recognized for having the highest applicable standards for inspecting ships arriving for operation in ports and areas of jurisdiction of the signatory states.

The manner of performing Port State Control (PSC) is regulated by the provisions of the regional Memorandum of understanding establishing the general frame and obligations of the signatory states and the PSC Manual which details the control activity. Proper character of ships according to provisions of relevant IMO instruments concerning working and repose conditions of crews, safety of navigation and prevention of pollution of marine environment represent the essence of PSC activity. By introducing in 2011 a new inspection regime (NIR) a decisive impact on the results have had obtained. The BGW Lists is the challenging tool to conclude the efforts done by the controlling authorities and by the owners and operators as well. The ROs are the most important actors in eradicating the substandard ships and their place in the rankings is important to be known.

The ship's certificates represented the first impression of the situation of a ship.

Keywords: *New Inspection Regime, Port State Control, Memorandum of understanding.*

1. INTRODUCTION

Romania is a maritime state who is convinced of the maritime safety importance within the region. As a member of both memoranda there are obligations in controlling ships arriving in Romanian ports using the Paris MoU system and the Black Sea MoU system as well. The same determination of all members makes the navigation safety ensuring also a clean marine environment.

The actors involved in the process are the Flag state authority, the Recognised Organisation, and the Company (owner/operator). When those actors will understand the benefit of the maritime safety totally a perfect world with cleaner seas and safer ships it will establish.

One of the stimulating tools as a result of the PSC controlling process for a better maritime safety world is the White, Grey, Black Lists and its mechanism that gives meaning to all efforts.

A certain aspect is clear: does not exist efficiency and economical advantages without ensuring safety first.

2. LEGISLATION RELATED TO PROCESS CONTROL

Do National legislation regulating Romania's membership to the two memoranda of regional understanding concerning port state control (PSC), is represented by the Government Decision no. 811/2010 which refers to Directive 2009/16/CE of the European Parliament and of the Council on 23rd of April 2009 and Government Decision no. 50/2001 for Memorandum's of understanding ratification concerning PSC in the Black Sea area, signed at Istanbul on the 7th of April 2000, approved by Law no. 639/2001.

The manner of performing Port State Control (PSC) is regulated by the provisions of the regional Memorandum of understanding establishing the general frame and obligations of the signatory states and the PSC Manual which details control activity. Proper character of ships according to provisions of relevant IMO instruments concerning working and repose conditions of crews, safety of navigation and prevention of pollution of marine environment represent the essence of PSC activity.

It is important to mention the fact that the Memorandum of understanding from Paris (Paris MoU) joins today 28 states, out of which 26 belong to the European Union, plus Canada and the Russian Federation. The European Maritime Safety Agency (EMSA) occupies a place in the Paris MoU Commitee. The basis of this memorandum were laid at Paris, in 1982, when six developed states of Europe decided to enhance safety of navigation and cleaner environment in their maritime jurisdiction area.

Today, Paris MoU is recognized for having the highest applicable standards for inspecting ships arriving for operation in ports and jurisdiction areas of the signatory states.

3. THE NIR AND THE BGW LISTS

New Inspection Regime (NIR) is a new concept of tracking, controlling and monitoring ships with a special system, having an electronic data basis in which PSC inspections' results are introduced as well as a series of determinant factors. Determinant factors creating the risk profile of ships are: the age of the ship, the flag of the ship, classification society/RO, shipping company or operator and ship's history (nonconformities and detentions due to PSC inspections). In this way the risk profile of a ship generated by the data basis may be: high risk, medium risk and low risk. According to the risk level, the system generates priority for inspection of ships; priority I or priority II as well as the type of PSC inspection (initial inspection, detailed inspection, more detailed inspection). The data basis so called THETYS

of the Paris Memorandum, is located in Lisbon and administrated and controlled by EMSA.

The score electronically calculated by introducing inspection reports in the data basis by PSC inspectors determines finally a hierarchy according to ships' register, shipping companies and flag states' performances of the ship. This way, all these factors involved in increasing safety of navigation and pollution prevention by respecting provision of IMO conventions and relevant instruments are made responsible and part of the performance hierarchy. In this way, Paris MoU introduced the flags' list, White, Grey, Black list, in which Flag States are categorized according to their ships' performances.

The final purpose is uniformitarian on a worldwide level of all PSC inspection regimes by applying similar procedures and standards applicable for ships.

In order to understand the functioning of the system and the way it acts on ships, flag states, companies and classification societies/ROs, it is important to analyse PSC inspections' results in the region Paris MoU in 2013, from a statistic point of view.

Flags' performances in 2013 on the White, Grey and Black Lists indicate important aspects concerning shipping quality pollution prevention and safety of navigation generally.

This way, last year, Thailand and United States of America, with efforts towards increasing standards of safety navigation, preventing environment' pollution as well as working and repose conditions onboard, entered in the White list and this year Kazakhstan, Saudi Arabia and Switzerland managed to pass from Grey list in White list.

Efforts made by Georgia, Liban, Saint Kitts and Nevis, Libia and Albania are remarcable in the same direction, which courageously and with determination passed from the Black list to the Grey list.

In 2013 the number of states (flags) in the White list was 46, France being on top of this list followed by Norway and Sueden. This proves high implemented standards onboard ships hoisting France, Norway and Sweden flags. This situation of ships is economically reflected by advantages on the insurance market and freight market. The interval between two PSC inspections in Paris MoU region is increased up to 36 months to encourage the good standards ships against 6 months period for low standards ships.

Recognized Organizations (RO) to which Flag States have delegated the statutory inspections are monitored by the same system from performances' point of view. This way, the most performant Recognized Organization within 2011-2013 was Lloyds Register, followed by American Bureau of Shipping and Det Norske Veritas. Korean Register of Shipping decreased in performances, out of the top 5 being replaced by Nippon Kaiji Kyokai.

The weakest register organization (RO) concerning performances' results following PSC inspections is INCLAMAR Classification Society.

By introducing in 2011 a new inspection regime (NIR) a decisive impact on the results have had obtained in 2013. The percentage of detentions of ships increased in 2013 by 3,8% from 2012. Due to multiple detentions, 28 ships were denied the right to operate in the ports of Paris MoU region, representing the highest number of ships denied to access in EU ports from 2005 till now. In 2012 the number of ships rejected from entering in the Paris MoU ports was 15.

We may conclude that in 2013 the number of inspections on ships hoisting flags from the Black list was 1188, resulting in 154 detentions (detained ships) representing a rate of 12,96%. Within 3 years ships hoisting flags of the Republic of Moldavia, Tanzania, Saint Vincent and the Grenadines and Togo, due to multiple detentions, registered the highest number of refusals of access (banning) in the ports of the Paris MoU region.

For ships listed in the Grey list the rate of detentions was 7,64% corresponding to a number of 851 inspections resulting in 65 detentions.

For ships listed in the White list the rate of detentions was 2,82% corresponding to a number of 15551 PSC inspections and 439 detentions.

Out of the statistics, to understand the process which lead to nonconformities, detentions and bannings, and finally to White, Grey and Black List, it is obviously important to come into the practical process of PSC inspection.

Talking about PSC inspection, prior to detain a ship, the control of the ship' certificates is an important issue that raised many disputes.

4. THE SHIP'S CERTIFICATES

The most important step and the first check on the PSC procedure is the verification of the ship's certificates which is not an easy process. How must be kept the ship's certificates on board? Originals or copies? It is a question that I would like to clarify is this article.

Issue of SOLAS certificates to ships is regulated in Ch.I/Reg.12. Ch.I/Reg.16 states that the certificates which have been issued under reg. 12 and reg.13 shall be readily available on board for examination at all times.

For ISM SOLAS Ch.IX Reg.4 states that a Safety Management Certificate (SMC) shall be issued to the ship and a copy of the Document of Compliance (DOC) shall be kept on board. Through Ch.IX reg. 6 it is regulated that the SMC shall be readily available on board for examination at all times.

Issue of MARPOL certificates to ships is regulated in MARPOL I/Reg.7, MARPOL II/Reg.9, IBC-code Ch.1/Reg1.5.4.1, MARPOL IV/Reg.5, MARPOL VI/Reg.6.

MARPOL Protocol Article 5 states that with regards to the certificates issued under the annexes the PSCO shall verify that the valid certificates are on board. For the COF the IBC-code Ch.1 reg 1.5.4.3 states that the certificate shall be on board for examination at all times.

LOAD LINES convention has similar provisions in article 16 and article 21.1, TONNAGE '69 convention in article 7 and article 12.

In STCW95 convention reference to the original certificate required to be on board is made because the STCW certificates are not issued to the ship but to a

person. The provision requires the person to bring his/her certificate to the ship he/she serves on.

A certificate is an official (legal) document issued to the ship by an authority. A copy of a certificate is not a certificate and can therefore not be considered as the certificate (unless it is a certified copy).

The general opinion failure to comply with the regulations where the issuance of a certificate to the ship is regulated, linked with provisions on the control on the availability of the certificate, is a ground for detention.

The procedure PSCOs would follow in case of certificates in copy form only (with reference to the PMoU guidance on detention and action take) is:

- Application of main criteria: the PSCO will assess whether the ship has relevant, valid documentation. If the result of this assessment is negative the ship will be considered for detention.

- Lack of valid certificates is considered to be a detainable deficiency

- The PSCO will exercise professional judgement in determining whether to detain the ship until deficiencies are rectified or to allow ship to sail with certain deficiencies without unreasonable danger to safety, health, or the environment.

Since the certificates are the basis on which PSCOs conduct our inspection, and they cannot judge the reason behind the fact that the originals are not on board, PSCOs will seek clarification from the Flag State on the issue.

A satisfactory response from the Flag State has to be available before the end of the inspection. If there is a satisfactory response PSCOs will record the fact that the certificates are copies as a deficiency with action taken code 55.

If there is no satisfactory response from the flag state before the end of the inspection the PSCO is not able to assess whether the ship has valid documentation. This means that the main criteria will be applied and the vessel will be detained.

PSCOs would not accept just the fact that the surveys have been performed since there might be reasons for the Flag State or RO not to issue the certificate yet which they are not aware of.

PSCOs would not be satisfied with an explanation from the master but they would require an explanation / statement from the Flag State.

If there is a satisfactory explanation from the Flag State, PSCOs would record a deficiency. If there is no satisfactory explanation from the Flag State the vessel would be detained.

5. CONCLUSIONS

I am of the opinion that some guidance with regards to original certificates and PSC can be taken from MSC-MEPC.4/Circ.1, guidance on Port State Control related matters. Here it is stated that retention of the original documents is the primary method of attesting to the ships compliance. Further guidance is given to PSC on how to deal with the “exceptional circumstances” in which original documents are removed from the ship by authorities. Herewith I could conclude that according to IMO certificates on board shall be originals (knowing that this is not a relevant instrument but suggested as one of the possible options to get an idea of the IMO position).

6. REFERENCES

[1] Government Decision 811/2010 regarding PSC
[2] The Directive 2009/16/CE of the European Parliament and of the Council
[3] Government Decision 50/2001 for Memorandum of Understanding ratification concerning PSC activity in the Black Sea area
[4] The Provisions of the Paris Memorandum of Understanding
[5] The PSC Manual
[6] IMO – FAL.5/Circ.39

IMPLEMENTATION OF A HUMAN RESOURCE MANAGEMENT COURSE AT A SHIPPING COMPANY

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ABSTRACT

In the spirit of The 2010 Manila Conference recommendations, concerning amendments to the International Convention on Standards applied of Training, Certification and Watch-keeping the or Seafarers, 1978 and to the Seafarers 'Training, Certification and Watch-keeping Code (STCW Convention and Code), a shipping company deemed necessary to implement an internal course, to be applicable to both those who work on the deck and on the engine room. This was created just for the reason that the amendments to be referred to include common references applicable in both sectors. It is a course called Maritime Team Management, which itself is a human resource management course. Maritime Team Management training program is designed to equip seafarers with an understanding of the human issues that may affect them when dealing with the design, build, maintenance, operation and management of, in particular, safety critical technologies. The purpose of this course is to develop the skills and knowledge of Seafarers, Professional Standards and increasing their enhancing job satisfaction.

Keywords: *STCW Manila, resource management, team skills, training program.*

1. INTRODUCTION

STCW Manila amendments include a number of common provisions applicable to both deck and engine room.

They refer to the knowledge of resource management principles, including: allocation, assignment and prioritization of resources; effective communication; assertiveness and leadership; obtaining and maintaining situational awareness.

In these conditions, a shipping company found useful for his officers to implement a single common course simultaneously, both for those from the deck and for those from engine-room. This is the <<Maritime Team Management training program>>.

2. THE 2010 MANILA CONFERENCE RECOMENDATIONS

<< - Having adopted the Manila amendments to the International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978 and to the Seafarers' Training, Certification and Watch keeping Code, as amended (STCW Convention and Code),

- Noting with concern the reported and anticipated shortage of qualified officers to effectively man and operate ships engaged in international trade,
- Appreciating that the overall effectiveness of selection, training and certification processes can only be evaluated through the skills, abilities and competence exhibited by seafarers during the course of their service on board ship,

Recommends that Administrations make arrangements to ensure that shipping companies:

- establish criteria and processes for the selection of seafarers exhibiting the highest practicable standards of technical knowledge, skills and professionalism;
- monitors the standards exhibited by ships' personnel in the performance of their duties;
- encourages all officers serving on their ships to participate actively in the training of junior personnel;
- monitors carefully and review frequently the progress made by junior personnel in the acquisition of knowledge and skills during their service on board ship;
- provide refresher and updating training at suitable intervals, as may be required and
- takes all appropriate measures to instill pride in the maritime profession and encourage the creation of a safety culture and environmental conscience among all those who serve on their ship. >>

(From the *Resolution 7 - Promotion of technical knowledge, skills and professionalism of seafarers)*

3. MARITIME TEAM MANAGEMENT TRAINING PROGRAM

3.1 Course Description and Aim:

Maritime Team Management training program is designed to equip seafarers with an understanding of the human issues that may affect them when dealing with the design, build, maintenance, operation and management of, in particular, safety critical technologies.

The purpose of this course is to develop the skills and knowledge of Seafarers, Professional Standards and increasing their enhancing job satisfaction.

Also wants to develop non-technical skills and team work Applying Procedures Company. Last but not least, the objective refers to the maximum extreme to collect and share experience and to learn more about personal behavior in a stressful Situation.

3.2 Format of the Course

Taking the model from the aviation industry at this Maritime Team Management Training Course is attending a psychologist as expert on human error and human/machine interface. It is important that different professional knowledge blend together to counteract human error.

Training Team must be composed of one Seafarer per rank:

- Deck: Master / Chef Officer / Deck Officers /
- Engine: Chef Engineer/2nd Engineer/ Engineers / Off Electrician

In addition could attend on temporary basis:

- Cadets (Deck, Engine or Electrical)
- Reefer-man
- Sea trainers
- All other Rating

The course includes a series of Learning Objective:

- Develop individual & collective actions with respect Quality Improvement of safety of operation and protection of environment;
- Apply natural planning work method: proactive methodical, approach to the management systems, Effective communication, review;
- Risk awareness and safety of the team. Human Behavioral factors;
- Prioritization of actions;
- Errors identification chains in various Circumstances (operational, emergency and crisis situation);
- Technical resources management;
- Asses own performance and made Objectives for "Continuing Professional Development" Purposes;
- Briefing / debriefing and guidance Techniques.

The course is both: seminar / group workshop and simulator based and aims to over four days to go through a series of mandatory items.

- System approach / Safety of operations / Environmental issues
- Professional Conduct / Operational Performance
- Situational awareness / Perception/
- Decision-making / Interaction with technologies
- Communication
- Stress
- Team skills / Team competencies / Delegation
- Leadership / Functional leadership
- Management
- Risk Assessment and Risk Management
- Error chain
- Efficient use of available resources / Equipment limitations
- Planning and prioritizing / Contingency planning
- Identification of cause of problem and timely correct response
- Emergency preparedness
- Crisis situations

3.3 Course References

Maritime Team Management is designed in Compliance with international standard regulations

- STCW 1978/ 95 as amended :
  - Section A-II/1;
  - Section A-II/1&2;
  - Section A-III/1;
  - Section A-III/1&2;
  - Section B-VIII/2
  - MRM – Teamwork

- International Convention of Training, Certification and Watch keeping for Seafarers STCW 1978 as amended

- IMO model courses:

- Model course 1.08 Radar Navigation - Management Level
- IMO Model Course 1.22 BTM Bridge Team Management
- Model Course 1.27 Operational use of ECDIS
- Model Course 1.29 Proficiency in Crisis Management
- Model Course 1.30 - On-Board Assessment

- International SOLAS Conventions :

- Chapter II-2 - Fire protection, fire detection and fire extinction
- Chapter IV – Radio communications
- Chapter V - Safety of navigation
- Chapter IX - Management for the Safe Operation of Ships

Maritime Team Management training program is designed by using DNV – Standard for certification No. 3.201 learning programmes (April 2011) and particularly approved by DNV (with class notation Machinery operation simulator ERS 5000 to the Class A Standard for Certification of Maritime Simulators).

4. APPLYING THE RESOURCE MANAGEMENT COURSE

4.1 About Resource management concept

Resource management involves the utilisation of all available human, informational, and equipment resources toward the goal of safe and efficient operations.

The Main Tenets of Resource management are:

- Cooperation – the ability to work effectively in a team
- Leadership and management skills – achieving effective joint task completion within a motivated

fully functioning team through coordination and persuasion.
- Situational awareness – the perception of the elements in the environment within volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.
- Decision-making – the process of reaching a judgement or choosing an option.

All of these are Non-technical Skills.

4.2 Deployment and functionality

Every one of the company officers must achieve and be able:

- to enhance the operational safety of company vessels,
- to reduce the like hood of an incident to a company vessel,
- to reinforce the company's Vision and Mission

These aims to be met in particular by emphasising skills which will increase Shipboard Officers' abilities to act responsibility to environmental concerns; resource management and team building being principle values.

The course aims to demonstrate the importance of:

- Possession of the "whole picture"
- Possession of the facts and essential information
- The leader being an organiser
- Planning, prioritising, and taking advantage of windows of opportunity
- Communications and keeping people informed
- "Being Prepared"
- Teamwork
- The dangers of "tunnel vision"
- That NOBODY knows it all!

The knowledge gained during the course must to provide course participants with the skills necessary to effectively:

- Use resource management skills.
- Identify and analyse risk factors, arriving and decisions which maintain vessel safety.
- Recognise the need to make contingency plans.
- Recognise the development of an error chain and effectively break such a chain

By the end of the course, participants should be able to demonstrate the ability to apply appropriate and effective safety management skills and resource management skills in order to:

- Establish and maintains safe working platform and pollution free safe working environment.
- Provide for safe working practices in ship and machinery space s operation, placing emphasis on preventive actions.
- Identify risks and establish safeguards against them.

Human factor plays an important part in both causing and preventing accidents.

- Technical excellence alone is not sufficient to ensure good performance and that the knowledge and application of non-technical skills is essential.

- Human performance training is designed to equip people with an understanding of the human issues that may affect them when dealing with the design, build, maintenance, operation and management of, in particular, safety critical technologies.

5. CONCLUSIONS

It follows that in the medium term that officers be able to prepare and action emergency plans and procedures, including "maintenance of effective communications" and "preparedness training", for emergencies related to safety of personnel, plant, ship and environment and also, correctly identify, respond to and correct abnormal, hazardous or emergency situations. With respect to reduction of "Human Error" contributions to accidents, this "Medium Term" objectives should be willingly and conscientiously obtain the necessary knowledge and skills to manage, operate and contribute to the improvement of the company's SAFETY MANAGEMENT SYSTEM, in keeping with the "spirit and intent" of the IMO International Safety Management Code (ISM Code) as well as STCW 95 Code Section A-VIII.

The long-term goal is to determine the course participants to devise and adopt the programs of "Continuous Professional Development" in order and action to support the Ideals and Requirements of the ISM Code**.**

Also, long-term it is recommended to encourage others to adopt the objective above mentioned.

Always must remember: Technical excellence alone is not sufficient to ensure good performance and that the knowledge and application of non-technical skills is essential.

6. REFERENCES

[1] IMO model courses: 1.22 BTM Bridge Team Management; 1.27 Operational use of ECDIS; 1.29 Proficiency in Crisis Management; 1.30 - On-Board Assessment; Published by International Maritime Organization (IMO)

[2] STCW 1978/ 95 as amended:

- Section A-II/1;
- Section A-II/1&2;
- Section A-III/1;
- Section A-III/1&2;
- Section B-VIII/2
- MRM – Teamwork

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[4] http://www.steamshipmutual.com
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A BRIEF STATISTICAL ANALYSIS OF THE ROMANIAN FREIGHT TRANSPORT

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ABSTRACT

Transport sector is essential for every country and its society. It connects good and services to markets, it gives access to jobs, education, healthcare; it is the key of economic growth, contributing to the prosperity of a nation. The present article stresses the importance of indicators in measuring all these aspects. As freight transport has the largest share in total transport activity, I have realised a short statistical analysis of freight transport in our country through specific indicators, which have to be considered both generally and in terms of sustainable development, as one of the main priorities of Romania in the field of transport.

Keywords: *statistical analysis, freight transport, Romania, sustainable development indicators, road transport, railway transport, maritime transport, transport infrastructure investment, energy consumption.*

1. INTRODUCTION

Transport is the essence of every country socio-economic development. Transport infrastructure connects people to jobs, education, health services; allow proper development of global trade; permits people to come in the same place, to interact and to exchange knowledge and experience in various fields of activity, boosting the long-term economic growth.

To accomplish these goals, transport has to face many challenges, such as rapid motorization, air pollution, road safety, climate change. That's why it is very important to monitor these issues and to lead to the conception of national strategies and to the creation of an indicators' system, which has to follow the main objectives and the modalities of action for their accomplishment.

Romania has developed a set of indicators structured on the sustainable development national strategy's objectives and this set is a solid base for periodic monitoring of progresses.

2. STATISTICAL CHARACTERIZATION OF FREIGHT TRANSPORT IN ROMANIA DURING 2006-2011

One of the most important statistical indicators for measuring transport activity is the volume of goods transported - an useful indicator in international comparisons, especially when we consider its correlation with Gross Domestic Product (GDP) of a country .

In total transported freight in Romania in the period under study 2006-2011, the volume of goods transported by road has the highest share in each year, even if there is a decrease to half its value in 2011 compared to the reference year 2006 (absolute decrease of 151698 thou tons) (see table 1).

Road transport is followed at great distance by rail, which many years ago holded supremacy in the transport of goods. On the 3rd and 4th ranks shipping and inland waterways, and the last place is for the air freight transport.

Table 1. Transported goods by mode of transport in Romania in the period 2006-2011

-thou tonnes-

Type of transport	2006	2007	2008	2009	2010	2011
Railway transport	68313	68772	66711	50596	52932	60723
Road transport	335327	356669	364605	293409	174551	183629
Inland waterways transport (1)	29304	29425	30295	24743	32088	29396
Maritime transport (2)	46709	48928	50449	36021	38118	38883
Air transport	23	22	27	24	26	27
Transport via petroleum pipelines	12702	12310	12390	8520	6551	6020

(1) Since 2009, transit transport data reported by Regional Harbour Masters and Bulgarian inland waterways transport equivalent to transit transport for Romania included;
(2) According to the Eurostat methodology on approach related to the treatment of "double counting" in national transport.
Source: [2]

Therefore, the highest share in total transported freight holds road transport, the following places in the ranking being allocated to railway transport and maritime transport.

Regarding railway transport structure on the types of goods in 2011, according to NST 2007 code (Standard Goods Classification for Transport Statistics), the top five categories of goods that occupy most of the volume of goods transported by rail are shown in the table below. The smallest share in the volume of goods transported by railway belong to grouped goods (code 18 - Grouped goods: a mixture of types of goods which are transported together – 2 thou tonnes).

Table 2. Railway transport by type of goods in Romania in 2011

NST 2007 Code	Type of goods	Thou tonnes
02	Coal and lignite; crude petroleum and natural gas	28145
07	Coke and refined petroleum products	13754
08	Chemicals, chemical products and man-made fibres, rubber and plastic products, nuclear fuel	4167
10	Basic metals, fabricated metal products, except machinery and equipment	3506
03	Metal ores and other mining and quarrying products; peat, uranium and thorium	2388

Source:[2]

In maritime transport, top five types of goods that have the highest values are shown in Table 3. Romania is a country with agricultural potential and rich reserves of coal, lignite; generally, the goods transported by sea are mainly included in these categories. The last place belongs to the goods in Group 13 - Furniture and other manufactured goods -1 thou tonnes.

Table 3. Maritime transport at ports by type of goods in Romania in 2011

NST 2007 Code	Type of goods	Thou tonnes
01	Products of agriculture, hunting and forestry; fish and other fishing products	9218
02	Coal and lignite; crude petroleum and natural gas	7734
19	Unidentifiable goods	5178
03	Metal ores and other mining and quarrying products; peat, uranium and thorium	4648
07	Coke and refined petroleum products	3457

Source:[2]

The structure of goods transported by road in 2011 is shown in Table 4, the first among top five categories of goods being occupied by "Metal ores and other mining and quarrying products; peat, uranium and thorium". Last place in the ranking of goods transported by road is owned by group 15 - Mail, parcels - 240 thou tonnes.

Table 4. Road transport by type of goods in Romania in 2011

NST 2007 Code	Type of goods	Thou tonnes
03	Metal ores and other mining and quarrying products; peat, uranium and thorium	70679
09	Other non-metallic mineral products	44240
04	Food products, beverages and tobacco	14001
01	Products of agriculture, hunting and forestry; fish and other fishing products	8410
06	Wood and products of wood and cork (except furniture); articles of straw and plaiting materials pulp, paper and paper products; printed matter and recorded media	7849

Source:[2]

3. STATISTICAL ANALYSIS OF SUSTAINABLE DEVELOPMENT INDICATORS FOR ROMANIAN FREIGHT TRANSPORT IN THE PERIOD 2000-2010

The indicators in the database of the National Institute of Statistics of Romania are pursuing the objectives and modalities of action at the horizon years: 2013, 2020, 2030, established by the National Strategy for Sustainable Development. The main function of indicators is to meet the monitoring requirements that the National Strategy for Sustainable Development expresses associated with the time of the targets, which in turn represent political commitments related to the strategic objectives of sustainable development. The set of sustainable development indicators for Romania is structured considering the objectives of the National Strategy for Sustainable Development, the hierarchy being structured on three levels: level 1 -core indicators, level 2 -complementary indicators and level 3 -progress indicators of the National Strategy for Sustainable Development.[4]

Table 5. Volume of freight transport relative to GDP in Romania in the period 2000-2010

Year	Indicator value (%)
2000	100,0
2001	106,3
2002	119,6
2003	127,1
2004	145,1
2005	174,2
2006	171,4
2007	165,6
2008	148,5
2009	113,0
2010	105,8

Source:[2]

The complementary indicator “volume of freight transport relative to GDP” is defined as the volume of domestic freight transport, on road, rail and inland

waterways, relative to GDP. This highlights the trend of goods transport compared to GDP's evolution.

The evolution of this indicator knows a progressive increase in the period 2000-2005, following the continuous decrease since 2006 and reaching a value lower than that recorded in 2001. If in 2005 the volume of freight transport growth from the GDP is 74,2%, in 2010, it is only 5,8%, according to statistics presented in table 5.

Following the structure of the domestic transport of goods in the period 2000-2010, we observe the large share that road transport of goods holds. In almost all the period under study specific weight of this mode of transport in total is over 50%, in 2007 recording the highest value of 71.3% compared with 18.9% at rail transport and 9.8% at inland waterway transport. Figure 1 shows clearly the trends in rail freight transport, road transport and inland waterway transport.

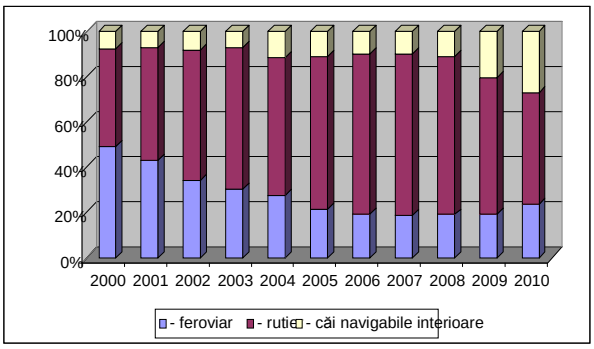

Figure 1 Modal split of freight transport in Romania in the period 2000-2010

One of the critical objectives in achieving sustainable development national strategy is to decouple economic growth from transport growth in order to reduce the negative impact on the environment. This indicator can be used to establish economic and environmental policies that lead to accomplish this goal.

For analysis it is used the core indicator "energy consumption by transport mode". In Figure 2 of the article notes that road transport is the largest consumer of oil, reaching a value almost double in 2011 (4734 thou tonnes of oil equivalent) from the level of 2000 (2697 thou tonnes of oil equivalent). Air transport manifests also a growing trend of energy consumption, but at a much smaller scale than road transport. Transport modes whose consumption fell significantly during 2000-2011 are rail and inland waterways.

Generally, the cost of energy are around 25% of total costs for car users, 5% for bus companies, 5-10% for rail transport and 15-30% in aviation. [1]

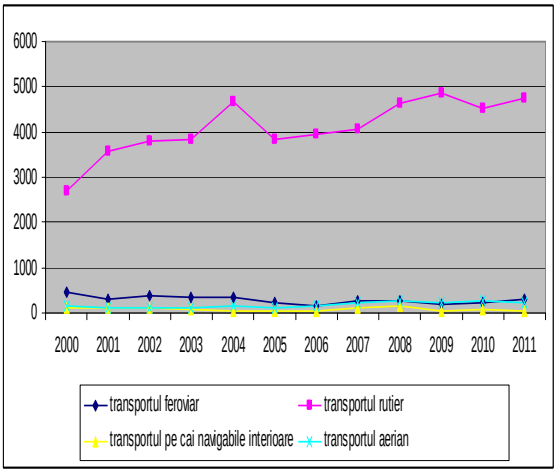

Figure 2 Energy consumption by transport mode in Romania in the period 2000-2011

A brief analysis of investments in transport infrastructure show that road transport ranks first in the absorption of funds for building works necessary to infrastructure development (see table below). Purpose of calculating this progress indicator is the establishment and monitoring of transport infrastructure development policy - another objective of the national strategy for sustainable development.

Table 6. Transport infrastructure investment in Romania in the period 2006-2009

- million RON-

	2006	**2007**	**2008**	**2009**
Total	8229,8	12088,2	20418,5	19541,9
Highways, streets and roads	6875,3	9358,6	14330,1	13165,1
Railways	358,8	1037,2	1165,3	752,1
Runways for airports	53,3	139,6	33,6	26
Bridges, elevated highways, tunnels and underground	191,9	356,2	3084,9	3325,3
Waterway, port construction and other hydraulic structures	750,5	1196,6	1804,6	2273,4

Source:[2]

4. CONCLUSIONS

As the developing world rapidly urbanizes, there is an opportunity to build safer, cleaner and more affordable transport systems that reduce congestion, facilitate access to jobs and lower transport energy consumption. „Energy consumption by transport mode" is an indicator that Romania can use to establish economic and environmental policies that lead to decouple economic growth from transport growth in order to reduce the negative impact on the environment.

Another important indicator analised in the paper is the volume of goods transported and the analysis conclusion is that the highest share in total transported freight holds road transport, the following places in the ranking being allocated to railway transport and maritime transport.

The volume of freight transport relative to GDP highlights the trend of goods transport compared to GDP evolution. In Romania, the evolution of this indicator knows a progressive increase in the period 2000-2005, following a continuous decrease since 2006.

Regarding the structure of the domestic transport of goods in the period 2000-2010, we observe the large share that road transport of goods holds (over 50%).

The supremacy of road transport in total freight transported in Romania is reflected by the investments in transport infrastructure, which are 70-80% absorbed by road.

Overall, freight transport in Romania is constantly developing and it is important that the set of indicators by which we characterize this activity to be monitored and continuously improved in order to achieve the objectives of the national strategy for sustainable development.

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THE IMPACT OF EXTERNAL COSTS IN TRANSPORT.CASE STUDY IN MARITIME TRANSPORT

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ABSTRACT

It is clear that transport costs are an important element which influence the final cost of a product, due to the fact that they represent a more complex area than in many other industries. Beside the internal costs (time and operation), representing costs incurred by individuals or operators for providing services required by the market, the external costs, which were seriously taken in consideration in the last few years, are considered to be a negative impact of transport. Thru this paper we tried to establish the important role of those costs, how they influence the transport activity, especially the maritime transport sector. This article contains a welfare economic analysis of transport's external effects regarding congestion, accidents, noise, air pollution and climate change.

Keywords: *Transport activity, external costs, negative impact.*

1. INTRODUCTION

Transport activity brings lots of benefits to the economy, due to the fact that it increases the production efficiency and it also links the producer and the customer from the logistics system (it also links regions, countries and continents).

Despite the benefits that transport activity brings (it contributes to economic growth and enables a global market), it also raises costs due to its environmental impacts, accidents and congestion, effects that aren't generally produced by the transport users[1]. It needs to be noticed that the benefits of transport are higher than the costs.

The costs associated to these effects are usually denoted as "external costs" or "externalities" (Fridell E., Belhaj M.,Wolf C., 2011). The freight transport network includes internal costs (that are considered to be time and operation) and external costs (like congestion, accidents, air pollution and CO2 emissions) (Marquez L., Cantillo V., 2013).

The most common definition of the "external costs", consider them to be social costs imposed on others, but not paid for by the infrastructure user, like the "internal costs". All forms of transport give rise to bad side effects like: trains and aircrafts contribute to noise, ships to air pollution or road vehicles to congestion (see figure 1). For example accident costs are considered to be equal for all means of transport, while congestion costs are considered to be more significant for road transport (due to the transport in urban areas). According to many authors the road transport activities give rise to a wide range of external costs (Verhoef E., 1994).

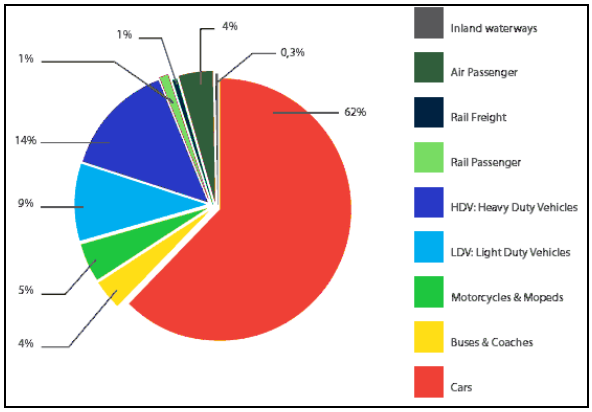

Figure 1 Total external costs of transport by transport mode
Source: International Union of Rails

There are many European studies (The Europe 2020 strategy, the Roadmap for moving to a competitive low carbon economy in 2050, the 2011 White Paper on Transport and the IMPACT study), which make clear that the transport sector faces huge challenges and they try to take into account all the elements that contribute to transport's "externalities", the development of the TEN-T, co-modality and modal shift[2].

One of the leading principles in EU transport policy is represented by the process of internalization of those external costs, an important issue for transport research and policy development for many years in Europe and worldwide. This process is very important because without it the external costs won't be taken into account by the transport users when making a transport decision. The traditional answer of economists to the problem of internalizing external costs of transport is "setting prices right" (Musso A., Rothengatter W., 2013). The internalization suggests that when transport users take a decision regarding the transport activity, the effects of

[1] According to the "Handbook on estimation of external costs in the transport sector- The IMPACT study", M. Maibach, H.P. van Essen, B.H. Boon, R. Smokers, C. Doll, B. Pawlowska, February, 2008.

[2] As said by the European Commission, "An inventory of measures for internalizing external costs in transport", Directorate-General for Mobility and Transport, Belgium, November 2012.

the external cost should take part of the decision making process.

An important study regarding transport's external costs is the IMPACT Handbook on estimation of external costs in the transport sector that covers all environmental, accidents and congestion costs. It tries to recommend a set of methods for estimating external costs, after providing first a comprehensive overview of approaches for this estimation.

Transport's externalities, for which many different methods have been developed and actually applied regarding the costs they cause, are: congestion, accidents, noise, air pollution and climate change[3] (see figure 2).

- Congestion: those external costs are felt by transport users in travel times, operating costs and travel time unreliability;
- Accidents: when referring to this side of the external costs it represents a relatively large part of total external costs (especially for road transport), as a result of traffic accidents (such as cost for material damages, medical costs, production losses, administrative costs and immaterial costs- pain, sorrow);
- Noise: this side of external costs has two important elements: costs of annoyance (undesired social disturbances, resulting in social and economic costs like any restrictions on enjoyment of desired leisure activities, discomfort or inconvenience) and health damages (like hearing damage, the risk of cardiovascular diseases, the increase of blood pressure and hormonal changes) leading to many types of costs like medical costs, costs of productivity loss and the costs of increased mortality;
- Air pollution: this side of externalities leads to different types of external costs, referring to health (cardiovascular and respiratory diseases caused by air pollutants), the impact on ecosystems and biodiversity (the most important ones are considers to be nitrogen oxide (NOx), sulphur dioxide (SO2), volatile organic compounds (VOC) and Ozone (O3) as an indirect pollutant);
- Climate change: according to the European Commission, in Europe, almost 20% of total greenhouse gas (GHG) emissions were caused by transport, emissions that have a significant effect on global warming (with health impacts, ecosystems and biodiversity impacts, an increase in extreme weather effects, agricultural impacts or regarding the rise of the sea level). There are considered to be three important greenhouse gases caused by transport: carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4). It is also important to notice that aircrafts emissions at high altitude also have an impact on global warming.

[3] According to CE Delft, INFRAS, Fraunhofer ISI in "External Costs of Transport in Europe" from November 2011.

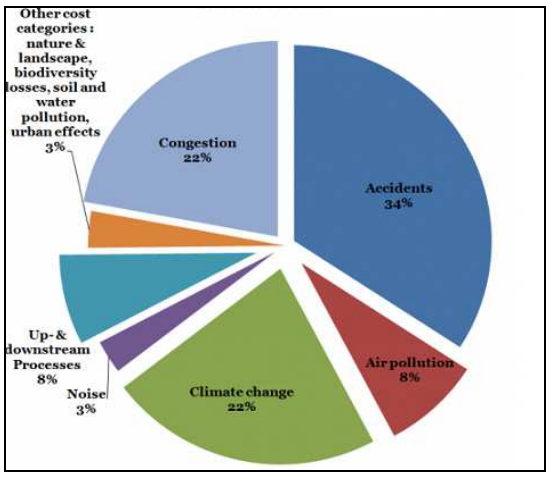

Figure 2 Total external costs per externality in EU 25+ 2 (Norway and Switzerland)
Source: International Union of Rails

2. METHODS FOR ESTIMATING EXTERNAL COSTS

From 1990 many projects and studies have been undertaken, European Union's project- UNITE (Nash, 2003), ExternE (Bickel & R., 2005), NEEDS or national research projects- INFRAS/IWW (Schreyer, 2004), CE Delft et al. (CE Delft; Infras; Fraunhofer ISI, 2011), with the purpose of improving estimations of cost and the methodology used for estimations of external cost. There were also some studies that were conducted in order to estimate the external costs of the European transport sector.

The estimation of external costs is an important process that has to consider several uncertainties, but the best practice for this estimation is based on three elements: speed-flow relations, value of time and demand elasticity.

When referring to the external costs of transport, many authors consider that there are two ways of estimating them: top- down and bottom-up approaches. One of them starts at macro-level and the other one at micro-level. The easier method regarding the way of determination is the top-down approach, which suggests that the external costs of a country can be calculated by the national transport volume, so at macro-level (Bickel and Friedrich, 2005). On the other hand is the bottom-up approach, that is considered to be more precise due to the fact that first are specified in details the basic elements and then they are linked together to form a complete system, at micro-level (Friedrich and Bickel, 2001; Miola, Paccagnan and Turvani, 2008).

3. EXTERNALITIES OF MARITIME TRANSPORT

According to the European Commission ships transport almost 90% of the EU's World trade volume. Usually when trying to quantify the external cost of maritime transport, a bottom-up approach is used (the Impact Pathway), that has several steps like: the division of the fleet into ship categories, calculation of the environmental impact factors and monetary valuation of the external costs.

In the picture below (figure 3) are presented the main environmental impact factors of ships such as:

- greenhouse gases (CO2- associated to the fossil fuel combustion process, as well as the HCFC- losses of refrigerant gases from air conditioning systems and on board freezers);
- atmospheric emissions;
- discharges into the sea (marine pollution- wastewater discharges from bilge separators, accidental oil spills due to operational activities, wastewater discharges from cargo tanks cleaning with seawater-based process, grey (laundries, kitchen, showers) and black (sewage) wastewater discharges, ballast water discharges).

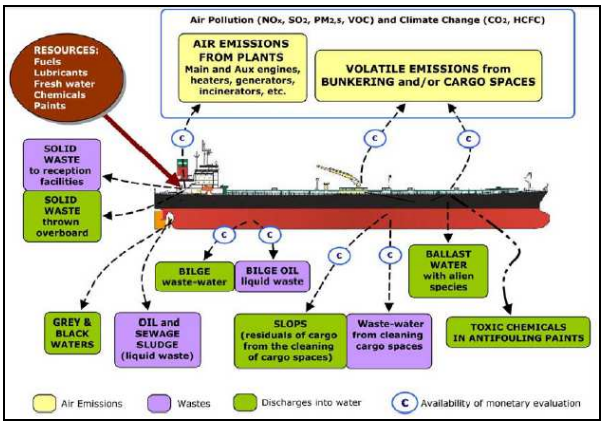

Figure 3 Ship's Resources Consumptions and Environmental Impact Factors

Source: European Parliament, External costs of maritime transport

Even if maritime transport activity is considered to be less harmful to the environment than any other type of transport, it has different environmental impacts during all activities that occur at ship (including the impacts that came from accidental events), in port or during ship construction/maintenance/dismantling. This is why the European Commission (thru Trans-European Transport Networks, TEN-T) tries to shift freight transports from trucks to ships, providing a more efficient, less polluting and more cost effective transport. It will also reduce road congestion on key bottlenecks across Europe and provide better, more reliable connections for peripheral regions.

4. CONCLUSIONS

External costs are an important element that affects both transport operators and transport users and their internalisation is a needful process due to the fact that it is a way to give transport users the right incentives. Those costs should be included in taxes because this will lead to a change in transport user's behaviour, resulting in changing vehicle type, vehicle utilisation, transport mode or even their overall transport volume. Studies have shown that from the total external cost of transport (that can be achieved by summing all types of externalities) in Europe, about 77% of the costs are caused by passenger transport and 23% by freight[4].

The European Commission also approaches this subject in the White Paper "Roadmap to a single European transport area- Towards a competitive and resource- efficient transport system" (COM (2011) which targets the development and deployment of new and sustainable fuels and propulsion systems and the promotion of a more sustainable behaviour.

It is also important to notice that the impacts of the external effects of transport can manifest in both short and long-term ways, so we need to take both of them in consideration if we don't want to face much larger costs in the future.

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EU STRATEGY ON ENVIRONMENTAL ACCOUNTING

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ABSTRACT

Improved environmental accounting is increasingly seen by corporate managers and environmental advocates alike as a necessary complement to improved environmental decision-making within the private sector. This paper develops an economic approach to the evaluation of environmental accounting's benefits and derives the value, and determinants, of improved accounting information in several production and capital budgeting contexts. Using concepts from managerial economics, finance, and organizational theory, the analysis identifies the types of environmental accounting improvement that are most likely to yield significant financial and environmental benefits.

Keywords: *environmental accounting, Economic and Financial Affairs Directorate, Eurostat.*

1. WORKING GROUP MISSIONS

In December 2000 a working group on the European strategy for environmental accounting was founded (ESEA). The group gathers statistical services of different EU member countries (Germany, Denmark, Greece, Finland, France, Italy, Netherlands, United Kingdom and Sweden) including the Economic and Financial Affairs Directorate of Environment and the European Environment Agency. Secretariat is provided by Eurostat.

Environmental Accounting in Europe contributes fully and effectively to the demands of information on environmental issues and sustainable development. In this field, the missions of this group refer to:

- The reviews on policies utilizations, on user needs and it also refers to the identification of the areas where environmental accounting can contribute in an optimum way to the goals achievement on a long-term in Europe.
- The contribution to the harmonization of environmental accounting results at EU level, especially when it comes to creating links with other systems indicators such as environmental accounting harmonization and improvement.
- The international manual revision of SCEE (*Systeme de compatibilite economique et environnementale integre*). SCE 2000 Manual was prepared by the London Group on Environmental and resource accounting. In March 2002, the UN Statistical Commission approved the publication SEEE (in cooperation with Eurostat, IMF, OECD and World Bank).

The answer to these concerns refers to:

- The growing demand for integrated environmental information in economic statistics and other resources, including the overall context and frameworks for sustainable development indicators
- The review after seven years of business accounting environment, given that conceptual phase, tests show that production started regulating in various fields
- The role of environmental accounting is one of a high importance and it answers the need for a systemic approach able to provide integrated assemblies of information on environmental and economic issues.
- ESEA group reunited several times in 2001 and 2002 in order to develop recommendations on environmental accounting and communication by e-mail between meetings. They tried to identify after that the need of users and how to improve links between policy needs and environmental accounting in Europe, in order to effectively use available data in areas where information system shows a competitive advantage.

2. USER NEEDS AND POLITICAL DEMANDS

ESEA Group undertook a comprehensive review of user needs at community and national level. Understanding these needs involves the identification of a long-term political vision on specific information requirements and develop data sets to meet this demand. In practice, the uses are numerous and require specific data availability. Political trends that are interested in environmental accounts information are, as it follows:

- Policy is focused mainly on the problem requiring long-term care in which, of a great importance is the supervision of changes in structure (e.g. use of energy and climate, transport, non-renewable resources)
- policies tend to use indicators on the environment as objectives in certain areas (biodiversity, water quality), hence the need for the integrated data sets that link the economic, environmental pressures, environmental status
- concepts of dissociation, eco efficiency and resource productivity, are subjects of great importance
- New political fields that are oriented on products are evaluating integrated product

policy, international trade and analyzing the impacts of chemicals policy

- Much attention is given to issues concerning the impact of transport, waste management and use of natural resources on the role of economic development and structural changes

Analysis of synthetic results and indicators of data sets allows the evaluation of policies and a better interpretation of the indicators and their potential use. A better informing is needed over structures, especially if we want to understand better the differences concerning levels and trends in all countries. Although primary information are incomplete now, environmental accounting is useful because it provides a framework of evaluation procedures for the missing data, based on other sources. Users give now a greater importance to the analysis and application of environmental accounts when it comes to shaping and determining the forecasts, preparing political projects and implementing them, noticing their impact. Some countries have governmental commissions, advisory or consultative bodies that contribute to the development of environmental accounting, facilitates users exchange and it is a source of official request for environmental accounts. A proactive approach towards users is essential in a context of environmental accounts. User groups shows relatively different needs that need to be taken into account in communication. Therefore, there are required products as in response to the needs of different user groups.

3. PRIORITIES

Development of an integrated economic, environmental and sustainability policy, respectively integrating environmental concerns into other policy areas, explains the increasing demand on indicators for measuring progress. Among EU policy initiatives is the sixth action program, which is an EU sustainable development strategy on a sectorial level -the Cardiff process. The main areas that have an interest in all these documents relate to climate change, sustainable transport, nature and diversity, health and environment, use of natural resources, waste management, etc. User needs may differ slightly from one country to another and correspond to specific national endowments. But the main elements of the standard environmental accounts are similar: a selection of natural resource accounts, expenses, activities and environmental taxes, etc. Priorities for future developments include areas like water, waste, including the environmental chapter" (quality of water, air, soil, ecosystems). Based on a profound analysis of the political demand and on the users need, the work group ESEA identified environmental accounting modules who directly respond to this request.

Environmental accounts recommended for a joint implementation	**Main needs of UE users**
Atmospheric emissions and energy accounts	Climate change, air quality and health, resources and energy efficiency, evaluating trends in emissions, international aspects of sustainability, assessing the direct costs and the costs of planned policies
Water flow accounts (use and supply)	Water framework directive, sustainable use of resources, economic evaluation of projects
The accounting for raw materials flows in the economy	Sustainable use of natural resources, decoupling economic growth and resource use
Spending accounts for environmental protection and environmental industry	Framework Directive on water, waste and resource management, economic policy analysis, environmental assessment activities and employment
Environmental taxes	Climate change, modeling green taxation and fiscal policy, economic instruments and economic evaluation
Environmental forestry and active resources	Ustainable use of natural resources, climate change, nature and diversity

4. THE ADDED VALUE AND LIMITS OF ACCOUNTING

Environmental accounts are tools that offers a good cost-performance report for the following reasons:

- they enable integration and optimal use of dispersed and incomplete primary data and also contributes to the existing data structure, improve coherence and serve as a basis for evaluation;
- are integrated into the data set that correlates environment information with economic agents;
- allow obtaining consistent sets of correlated indicators;

- represents consequently an essential basis for analysis and modeling concerning environment and economy;
- guarantees international comparability of results because of the frames, concepts and common methods;
- play a role in the Systemic informational environment in which accounting staff can help guide and develop environmental information to ensure greater consistency with economic and social information and other uses.

There are considered different types of analysis concerning environmental accounts. A minimum of analytical applications is useful in the process of compiling and disseminating imputation emissions, through some techniques that involve inputs and outputs. Other applications are related to decomposition analyses and estimates on goods and services.

5. LIMITATION OF ENVIRONMENTAL ACCOUNTING

Environmental Accounting suffers from various and serious limitations as it follows:

- There is no standard accounting method.
- Comparison between two firms or countries is not possible if method of accounting is different which is quite obvious.
- Input for EA is not easily available because costs and benefits relevant to the environment are not easily measurable.
- Many business and the Government organizations, even the large and well managed ones, don't adequately track the use of energy and material or the cost of inefficient materials use, waste management and related issue. Many organisations, therefore, significantly
- underestimate the cost of a poor environment performance to their organization.
- It mainly considers the cost internal to the company and excludes cost to society.

6. STATUS QUO

Environmental work in accounting performed by Eurostat and the Member States is quite diverse. The working group's task is to examine the experience of Member States and on an international level, to analyze the definitions and classifications in force concerning primary data in order to evaluate the availabilities and to identify the political needs in this area.

Environmental accounts have evolved from an incipient manner to a business organization form of modules adapted to a developing interest in the relevant accounts. Each module is connected with other modules and one of the tasks of environmental management accounts is to ensure consistency of individual modules in order to allow information to be taken directly from source. It is also important to use the best practices of national accounting for their application in environmental accounting. Activity domains of environmental accounting are as follows:

Environmental accounts recommended for a joint implementation	Main needs of UE users
Atmospheric emissions and energy accounts	Climate change, air quality and health, resources and energy efficiency, evaluating trends in emissions, international aspects of sustainability, assessing the direct costs and the costs of planned policies
Water flow accounts (use and supply)	Water framework directive, sustainable use of resources, economic evaluation of projects
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Environmental taxes	Climate change, modeling green taxation and fiscal policy, economic instruments and economic evaluation
Environmental forestry and active resources	Ustainable use of natural resources, climate change, nature and diversity

We mention the progress in other fields, even though the methods and the results are still in an experimental stage and the primary data aren't available yet. It is about soils, ecosystems, water, waste and specific substances accounts, including recreational and environmental functions of forests. A development of these modules is necessary and it must be planned according to the political requests. Regarding this, we present the new statistic regulation (SBS, NACE REV. 1.1 – concerning waste management statistic).

The environmental accounting modules proposed by SCEE 2000 include natural resource accounts, physical fluxes accounts, monetary accounts, etc.

7. RECOMANDATIONS FOR AN ENVIROMENTAL ACCOUNTING STRATEGY AT AN EU SCALE

By creating an environmental accounting at a community scale, Eurostat began to standardize collecting data on different areas. It was agreed on the capitalization and establishing a working program that can ensure regulated and on time production of some environmental module accounts. The environment is a very complex domain. Providing relevant information involves the use of data sets.

8. ENVIRONMENTAL ACCOUNTS APPLIED AT COMMUNITY LEVEL

The priority areas recommended for establishing harmonized reports are:

- atmospheric emissions and energy accounts
- Water flow accounts (water supply and use)
- material flow accounts of the economy
- environmental taxation
- Forestry accounts (work wood)
- Subsoil asset accounts (Oil and Gas)

The development of these accounts is made on modules, in terms of keeping the integrity of such elements.

Accounts can serve as a framework for obtaining short-term forecasts and indicators on sustainable development.

8.1. Priorities for tracking development

It is essential to follow the development in other areas of environmental accounting. The Member States have proposed three types of experimental accounts concerning: development on a short-term, middle-term and long –term. Considering the political request on information and the estimated costs, it is proposed the following classification:

- Areas for a short term development and for an experimental application in EU states.
  - Waste accounts
  - Soil accounts
  - Water quality accounts
  - Accounts on water emission
  - Accounts concerning the use of feedstock
- Areas for a middle term development and for an experimental application in EU states.
  - Soil accounts
  - accounts of fisheries and fish
  - Water quality accounts
  - resource management expenditure (for water)
  - Economic instruments (grants)
- Areas for a long term development and for an experimental application in EU
  - environmental and recreational functions of forests
  - ecosystems accounts
  - accounts of specific substances
  - Other management expenditure of resources
  - economic instruments
  - expenses related to natural and economic disasters.

9. CONCLUSIONS

Eurostat in conjunction with the working group ”Environmental economic accounts”, usually collects information for other fields also. Considering the high operationality accounts it is necessary to improve the comparability between countries and also improve the harmonization of data series.

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THE IMPORTANCE OF MANAGERIAL ACCOUNTING IN MANAGERIAL ACCOUNTING SYSTEM

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ABSTRACT

In order to determine the role of Managerial Accounting in a company's information system we must start with a systematic approach. According to systematic approach, this system is a structure that produces:

- transformation;
- self-adjusting;
- synergy (the principle of totality).

Therefore, considering the above, the total is higher than the sum of the component parts, when we are referring to plus- value creation.

Keywords: *managerial accounting, role, accounting system.*

1. INTRODUCTION

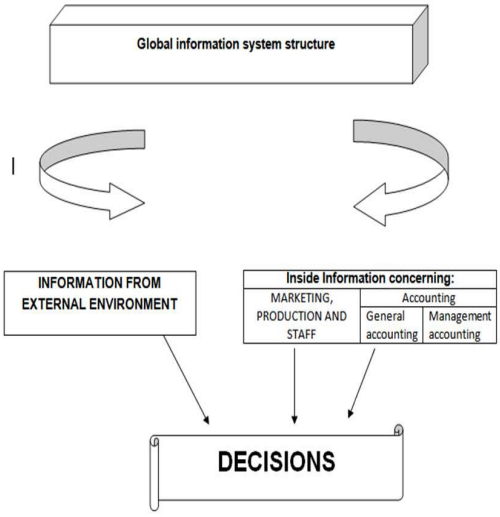
The research of an entity in a systematic vision involves the following phases:

- establishing the system requirements and formalizing the stake in time and space
- the identification, analysis and evaluation of flow constraints
- identification and analysis of subsystems assembly
- ensuring value of the internal dynamics of each subsystem
- interdependence and coherence value of the functional system
- flow analysis results
- system control
- system pilotage

2. THE INFORMATIONAL SYSTEM AND THE ACCOUNTING WITHIN THE SYSTEM

In order to achieve the objectives of each entity, the accounting management is one of the main sources of information and data, presented in a performance report enabling decision making. The use of management accounting is very important for the management act because the external environment contributes to increase the interest in accounting information and data. These conclusions lead to information on resources, on human and material staff usage, market placing, the company place on the market compared to other companies on the competitive system.

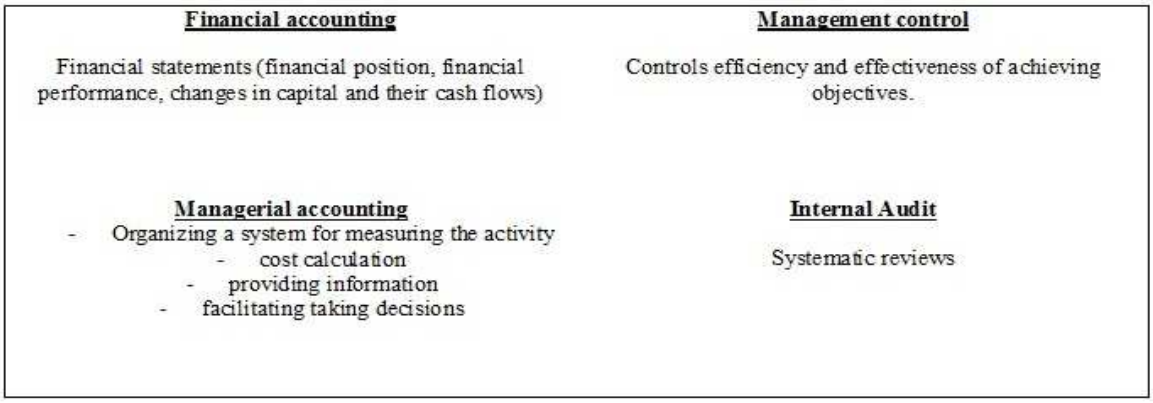
In order to establish market selling prices according to the request and to achieve expected margins, the company has to build and use a knowledge of the cost of their products of their services and their workers.



3. MANAGEMENT ACCOUNTING - DEFINITION

In the specialized vocabulary, management accounting can also be found under the name of analytical accounting, managerial accounting, or internal management accounting. Under this aspect we believe that a diffrence should be made between management accounting and managerial accounting, because the first one is a component of the second. Management accounting should be viewed as a system that includes specific elements of general accounting, managerial accounting, managerial control and internal audit - all of this are pursuing the enterprise objectives and systemic evaluation , improving risk management, control and process management.

In a schematic presentation, the components of managerial accounting system can form the diagram below:



In these conditions, management provides to the manager "those elements strictly necessary to make him understand the phenomena and processes that are occurring in the entity to provide operational information on which to take relevant decisions, to be able to foresee the repercussions of taken decisions, to have the levers for making a permanent and effective control.

4. GENERAL CONSIDERATION ON MANAGERIAL ACCOUNTING

Revolution of 1989 was a milestone in the evolution of Romania as a state from all points of view – economically, socially, and scientifically. The transition period from the communist market economy was extremely complex and it was impossible to be established as a period of time because it is economically and socially dependent on the specifics of each country. Socio- economic difficulties are important and they depend on the measures taken to overcome them.

The distinctive feature of the market economy- that is competition (an element missing entirely from the old social order) are the manifestation of freedom intitiative and the determining factor that makes a company viable on the new market is regulated by supply and demand.

Along with this, through the transformation of the company's organizational scheme, because of enterprise restructuring and elimination of state economic control. Free enterprise could occur and it raised the possibility that informational products provided by the accounting system to meet the requirements of internal and external users according to their interests. By adopting the new accounting law in 1991, major reforms have started , accounting reforms having as a main objective the placement of the accounting component in a higher position, that corresponds to the economic environment.

5. THE CHARACTERISTICS OF MANAGEMENT ACCOUNTING

Management accounting is a process through which a company prepares reports for the top management. The company bases its major executive decisions on these reports. Management accounting facilitates short-term decision-making.

Management accounting is often referred to as "managerial accounting" or "cost accounting". The reports prepared show the cash the company has in hand, the sales amounts, amount of sales returns, the purchases of materials, the purchase returns, the value of the work-in-progress and the payables and receivables. But its characteristics could be summed up by the following:

- Cause and effect analysis: Financial accounting is limited to the preparation of profit and loss account and finding out the ultimate result, i.e., profit or loss management accounting goes a step further. The ‘cause and effect’ relationship is discussed in management accounting. If there is a loss, the reasons for the loss are probed. If there is a profit, the factors different expenditures, current assets, interest payables, share capital, etc. So the study of cause and effect relationship is possible in management accounting.
- Use of Special Techniques and concepts: management accounting uses special techniques and concepts to make accounting data more useful. The techniques usually used include financial planning and analysis, standard costing, budgetary control, marginal costing, project appraisal, control accounting, etc. The type of technique to be used will be determined according to the situation and necessity.
- Taking Important Decisions: Management accounting helps in taking various important decisions. It supplies necessary information to the management which may base its decisions on it. The historical data is studied to see its possible impact on future decisions. The implications of various alternative decisions are also taken into account while taking important decisions.
- Achieving of Objectives: In management accounting, the accounting information is used in such a way that it helps in achieving organizational objectives. Historical data is used for formulating plans and setting up objectives. The recording of actual performance and comparing it with targeted figures will give an idea to the management about the performance of various departments. In case there are deviations between the standards set

and actual performance of various departments corrective measures can be take at one. All this is possible with the help of budgetary control and standard costing.

- Increase in Efficiency: The purpose of using accounting information is to increase efficiency of the concern. The efficiency can be achieved by setting up goals for each department. The performance appraisal will enable the management to pin point efficient and inefficient spots. An effort is made to take corrective measures so that efficiency is improved. The constant review of working will make the staff cost – conscious. Every one will try to control cost on one's own part.
- Supplies Information and not decision: The management accountant supplies information to the management. The decisions are to be taken by the top management. The information is classified in the manner in which it is required by the management. management accountant is only to guide and not to supply decisions. 'How is the data to be utilized' will depend upon the caliber and efficiency of the management.
- Concerned with forecasting: The management accounting is concerned with the future. It helps the management in planning and forecasting. The historical information is used to plan future course of action.

6. A PARALLEL BETWEEN FINANCIAL ACCOUNTING AND MANAGERIAL ACCOUNTING

Analysing the two sides of the accounting system we can establish with a maximum of objectivity both the differences and the common elements of the two sub-branches of Accountancy.

6.1 Differences Between Financial Accounting & Managerial Accounting

Financial and management accounting are both important tools for a business, but serve different purposes. A business uses accounting to determine operational plans in the future, to review past performance and to check current business functions. Management and financial accounting have different audiences, as investors are not usually involved in the day-to-day operations of the business but are concerned about their investment, whereas managers need information quickly to make daily business decisions.

- **Financial Accounting**

Financial accounting is used to present the financial health of an organization to its external stakeholders. Board of directors, stockholders, financial institutions and other investors are the audience for financial accounting reports. Financial accounting presents a specific period of time in the past and enables the audience to see how the company has performed. Financial accounting reports must be filed on an annual basis, and for publically traded companies, the annual report must be made part of the public record.

- **Management Accounting**

Management or managerial accounting is used by managers to make decisions concerning the day-to-day operations of a business. It is based not on past performance, but on current and future trends, which does not allow for exact numbers. Because managers often have to make operation decisions in a short period of time in a fluctuating environment, management accounting relies heavily on forecasting of markets and trends.

- **Differences**

Management accounting is presented internally, whereas financial accounting is meant for external stakeholders. Although financial management is of great importance to current and potential investors, management accounting is necessary for managers to make current and future financial decisions. Financial accounting is precise and must adhere to Generally Accepted Accounting Principles (GAAP), but management accounting is often more of a guess or estimate, since most managers do not have time for exact numbers when a decision needs to be made.

6.2 Similarities Between Management Accounting & Financial Accounting

Accounting is a vital part of every business. Accounting is used to create budgets, keep track of a business' assets and liabilities and provide an overall picture of the business' financial health. There are several types of accounting a company uses, two of which are financial and managerial accounting. Although both serve the same purpose, the audience for each is different.

- **Financial Accounting**

Financial accounting is used to generate reports and statistics to detail a company's financial health to external interests. These external parties include stockholders, silent partners and mortgage holders. It enables those external stakeholders to see how their investment is faring and can help a current stakeholder decide to remain a stakeholder, invest more into the company or remove his assets and invest elsewhere.

- **Managerial Accounting**

Managerial accounting is completed for internal stakeholders, such as the management team. Managerial accounting is used for the day-to-day operations of the business. This information would be used to determine sales prices, employee bonuses, raises for employees and other general operation decisions.

- **Similarities**

Both financial and managerial accounting methods present the general health of a business. Financial accounting reports are more formal and have a strict format for presentation to external stakeholders. Managerial accounting reports are more informal since

they are used in-house. But even with these differences, both methods allow the reader to make a conclusion on the health of the business, allowing them to make financial decisions that must be made.

7. THE NEED TO ESTABLISH NEW GOALS

Economic modelling must take into account the strategic development needs so that the management can identify and provide all the necessary information. The traditional analysis was modified due to the technological program, which sometimes introduces information that is not necessarily about costing operations. Quantitative and physical data play a higher and higher role, and current cost structure is influenced by data that doesn't consider manufacture cost itself. In this context we find reverse relations between costs - indirect costs exceed direct costs and structure costs approaches the material costs.

Changing boundaries of management accounting is influenced by a number's factors:

- Activities decentralization and emergence of a new type of management
- Changing market policies by directing economic power to customer
- the emergence of new methods in production organizing.

8. CONCLUSIONS

Management Accountants have far advanced from their tradition role of preparation of financial and non-financial statements. The Management

Accountants are now a members of management itself which take part in decisions making.

The managerial account information should be relevant, accurate, timely and cost effective.

Managerial accounting should adopt itself to the changing circumstances.

The management accounts re member of cross-functional teams which seeks ways and means for strengthening the position of its company or organization to boldly face the competitive environments and dynamic conditions in the industry.

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MARINE ENVIRONMENT IN THE ROMANIAN LEGISLATION

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ABSTRACT

In the overall context of sustainable development, shipping is a very powerful and positive force, making a major contribution to global trade and prosperity in a way that has only a relatively small negative impact on the global environment. Prevention, reduction and control of marine pollution caused or is linked to the activities of the internal waters, the territorial sea, the exclusive economic zone and the atmosphere above shall be carried out in accordance with the Romanian legislation and Conventions to which Romania is a party.

Keywords: *environment, marine, pollution*

1. INTRODUCTION

By marine pollution means the introduction by any person or entity, directly or indirectly, of substances or energy into the marine environment when it has or may have deleterious effects such as harm to living resources, marine living resources, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality of sea water in terms of its of use and degradation of its recreational values. Competent Romanian authorities set standards and take action to protect and preserve the marine environment and the prevention, reduction and control of marine pollution in relation to maintaining the safety of navigation and protection of the region concerned and ensure compliance and enforcement in ports in internal waters, territorial sea and exclusive economic zone of Romania.

Measures taken to prevent pollution of the marine environment include the following limitation:

a) release of toxic, harmful or noxious substances, especially degraded from land-based sources, from or through the atmosphere or atmosphere by immersion ;

b) pollution from vessels, in particular measures for preventing accidents and to cope with emergencies, ensuring the safety of operations at sea, to prevent spills, whether intentional or not, and to regulate the design, construction, equipment and

operation of ships and composition/structure affected their staff

c) pollution from installations and devices used in exploration or exploitation of natural resources of the seabed and its subsoil, in particular measures for preventing accidents and to cope with emergencies, ensuring the safety of operations at sea and regulating the design, construction, equipment and operation of these facilities and devices and composition/structure affected their staff ;

d) pollution from other installations and devices operating in the marine environment, applying measures to prevent accidents and to cope with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment and operation of such plant and equipment and composition/structure affected their staff.

Measures taken under the provisions of this chapter apply and those measures necessary to protect and preserve rare or fragile ecosystems as well as the living environment of the species and marine organisms whose numbers are declining, threatened or endangered. Is prohibited under the laws in force, pollution of any kind of internal waters, territorial sea and exclusive economic zone and the atmosphere above it, by any manner or means, such as dumping, throwing, sinking or release of the vessel or other floating plants, submerged or fixed on the aircraft and the sources located on the shore of substances or non-degradable waste, toxic, radioactive, oil and other harmful substances harmful or hazardous to human health or to the flora and fauna of the sea, or other residues or materials can cause damage Romanian shore or create barriers to legitimate use of the sea. Where there is evidence that a vessel used for commercial purposes, which lies in the internal waters, territorial sea or exclusive economic zone of Romania or Romanian legislation violated international rules on the prevention, reduction and control pollution of the marine environment by dumping or discharge of wastes or non-degradable substances, toxic, radioactive, oil and other harmful substances harmful or hazardous to human health or the flora and fauna of the sea, which have occurred or may occur, pollution risks and damage to shoreline Romanian or Romanian state interests or any resources of its interior maritime waters, territorial sea or exclusive economic zone, the competent Romanian authorities have the right to legal action in connection with the breach, the under Romanian law, and order, subject to international law and whether the evidence warrants, detention. If a foreign vessel used for commercial purposes is a Romanian port or at an offshore terminal, Romanian competent authorities may initiate legal proceedings in connection with any breach made by the ship and if the ship is in the internal waters, territorial sea, the contiguous zone and the exclusive economic zone of Romania, can be tracked and retained in accordance with the law.

If the internal waters, territorial sea or exclusive economic zone of Romania is a collision of ships, stranding or other maritime emergency and actions related to such an event may have harmful consequences for the environment and marine fauna as well as internal waters, territorial sea, exclusive economic zone or the

Romanian coast, the competent Romanian authorities are entitled to take the necessary steps, corresponding to the actual loss or the threat they represent in order to protect from pollution or threat of pollution, and to ensure that these measures beyond the territorial sea .

The sinking of waste in the territorial sea, exclusive economic zone or continental shelf Romania Romania as defined in art . 76 of the UN Convention on the Law of the Sea, can not take place without the prior express consent of the competent Romanian authorities.

They have the right to authorize, regulate and control the dive, after duly considered the matter with other States for which this can dive due to their geographical situation, to cause, damage by pollution to them and their environment.

2. POLLUTION PREVENTION. METHOD OF IMPLEMENTATION

Prevent, limit and control the negative effects of human activities on the environment have imposed specific development of administrative techniques and classic new ones (special), headed by a system of permits, approvals and authorizations, to determine the extent to which pollution is allowed or prohibited.

This requires the establishment of restrictions, different in nature and content, and to establish conditions for the activities with possible negative impact on the environment, corresponding implications for the exercise of certain fundamental rights, led by property rights, free enterprise or the right to use the common goods (water, air, etc.), on behalf of overriding public interest environmental and basic human right to a healthy environment. States shall take, individually or jointly as appropriate, all measures which are necessary to prevent, reduce and control pollution of the marine environment, whatever its source.

They will use for this purpose, means best adapted for disposal, according to their means, and shall endeavor to harmonize their policies in this connection.

States shall take all measures necessary to ensure that activities under their jurisdiction or under their control to be conducted in such a way as not to cause, damage by pollution to other States and their environment, such as pollution from incidents or activities under their jurisdiction or control do not extend beyond the areas where they exercise sovereign rights in accordance with the Convention.

Action is all sources of marine pollution.

They include, in particular, measures that tend to limit as much as possible:

a) release of toxic, harmful or noxious, especially non-degradable substances originating from land based sources, from or through the atmosphere atmosphere or immersion;

b) pollution from vessels, in particular measures for preventing accidents and to cope with emergencies, ensuring the safety of operations at sea, to prevent spills, whether intentional or not, and regulating the design, construction, equipment and operation of ships and their component affected staff ;

c) pollution from installations and devices used in exploration or exploitation of natural resources of the seabed and subsoil, in particular measures for preventing accidents and to cope with emergencies, ensuring the safety of operations at sea and regulating the design, construction, equipment and operation of these facilities and devices and their component affected staff ;

d) pollution from other installations and devices operating in the marine environment, in particular measures for preventing accidents and to cope with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment and operation of these facilities and devices and their component affected staff.

When taking measures to prevent, reduce and control pollution of the marine environment, States shall refrain from unjustifiable interference with activities carried out by other States in the exercise of their rights and obligations in accordance with the provisions convention.

Measure taken under this part include measures necessary to protect and preserve rare or fragile ecosystems as well as the living environment of declining species and marine organisms, threatened or endangered .

When taking measures to prevent, reduce and control pollution of the marine environment, States shall act so as not to transfer, directly or indirectly, damage or hazards from one area to another and not one type of pollution into another.

States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of techniques within their jurisdiction or under their control, or the introduction, intentionally or accidentally, in a marine area of alien or new species which may cause significant and harmful changes to it. Each Party shall require that ships entitled to fly its flag to possess on board an emergency plan for combating oil pollution, as required and to this end the provisions adopted by the Organization in accordance with them.

A vessel must have on board an emergency plan to combat oil pollution under subparagraph a) is subject, as long as it is in a port or terminal in the sea under the jurisdiction of a Party, control officers duly authorized by that Party for this purpose according to the practices set out in existing international agreements or national law.

Each Party shall require that operators of offshore units under its jurisdiction possess plans for combating oil pollution, to be coordinated with the national system established in accordance with art. 6, and approved in accordance with procedures established by the competent national authority.

Each Party shall require that authorities or operators in the service of these sea ports and oil handling means , within its jurisdiction, as appropriate, to possess plans for combating pollution by oil or similar arrangements, to be coordinated with the national, and approved in accordance with procedures established by the competent national authority.

3. RESPONSIBILITIES OF THE MASTER AND OFFICERS ON BOARD TO PROTECT THE MARINE ENVIRONMENT

According to the Minister of Public Works, Transport and house no. 1730/2001 on the approval of incident reporting in involving ships carrying dangerous goods, substances harmful and/or marine pollutants:

Captains of ships carrying dangerous goods, harmful substances or marine pollutants in packaged form in Bulk or involved in an incident in waters under the jurisdiction of Romania or Romanian ports and masters of ships flying the Romanian flag, involved in a incident outside the waters under the jurisdiction or outside Romania Romanian ports are required to write and report compliance with the requirements of this order.

The reports provided for must be submitted as follows:

1.If an incident occurs in waters under the jurisdiction of Romania, the master involved you must immediately notify the operator of communications service call, danger and rescue by the coast radio station, at least one of the frequencies assigned call communications, danger and rescue of 500 KHz, 2182 KHz or 156.800 MHz.

2. If an incident involving a ship flying the Romanian flag outside waters under Romanian jurisdiction, the report should be made to the nearest coastal State through appropriate coast radio station. If the incident affects the safety of navigation, the report will be preceded by a call of danger, and if the incident affects the safety of the ship or persons, to an emergency call.

3. If the vessel is in the vicinity of coastal radio stations medium frequency (MF) and very high frequency (VHF), the report must be done to the nearest coastal radio station High Frequency (HF) or maritime satellite communications system

4. If the vessel is in or near an area that was established a system for reporting by ships, the report must be sent to the designated body responsible for the operation of that system.

5. Reporting format and reporting procedures must comply with the requirements of section 2 of the "standard reporting format and procedures" of the Annex to this order.

5. Addition to reports made according to item 1, when the incident occurs in the handling of hydrocarbons terminal, the terminal operator also needs to report the incident:

a) as soon as possible and using the most rapid means to the Harbor Master in whose area of activity is terminal;

b) if possible, in accordance with the provisions of section 2 of the Annex to this order.

For communication coastal radio station reports do not charge fees.

The reports should contain specific information included in section 3 "Detailed reporting requirements" Annex to this order. In drawing up reports will use terms and concepts specific requirements of the IMDG Code, IBC Code and IGC Code INF Code.

The provisions of the Annex to this Order shall not apply messages danger referred to in regulation V / 2 of SOLAS.

The details are not immediately available to be sent in a supplementary report.

In the case involving harmful substances and/or marine pollutants, additional report must follow immediately or as soon as possible after the initial report.

The additional report must include information that is essential for the protection of the marine environment, according to the incident. Such information shall include the letter. P, Q, R, S and X, has as provided in section 2 of the Annex to this order.

The probability of a discharge resulting from damage to the ship or its equipment as a reason to make a report.

In order to determine whether there is such a probability, and if it is necessary to report, to be taken into account, among others, the following factors:

1. Nature damage, deterioration or malfunction of ships, installations or equipment;

2. Sea state and weather conditions and traffic density in the area at the time and place of the incident.

The master of the ship shall report at least the following cases:

1. Damaging, deterioration or damage affecting the ship's safe, produced as a result of incidents such as collision, aground, fire, explosion, structural damage, flooding, cargo shifting; and

2. Failure of plant or equipment which results in impaired vessel navigation safety, produced as a result of incidents such as failure of the steering system, propulsion plant, the power generation system (electric generator), naval means essential shipping insurance.

If a vessel is engaged or both are required to be engaged in an operation to provide assistance or rescue of a vessel involved in an incident referred to in art. II, paragraph. 1 lit. a) or b) of Protocol I of MARPOL 73/78, the master shall report without delay saving features action taken or planned.

The report should include letters. A, B , C (and D) , E, F, L, M, N, P, Q, R, S, T, U and X.

Saving master must ensure that the coastal State is informed of the action's rescue. Failure to comply with this order by masters Romanian maritime flag is action indiscipline and sanctioned in accordance with the law.

Failure to comply with this order by masters of ships flying the flag of another State, in the waters under the jurisdiction of Romania, determined by port captains will be notified to the NRA authority that issued patent that command and authority which granted the right to fly its flag ship involved. In particularly serious cases, the competent Romanian authorities may, as a complementary, seizure of ships, installations, gear, apparatus and other items from the offender, in committing the offense used.

Property acquired by committing the offense shall be confiscated. Penalties also apply to legal persons.

No contravention facts provided, if committed in order to ensure safety of navigation or ship or saving life times in order to avoid damage to the ship or cargo.

Offences and penalties shall be established in accordance with the regulations for staff supervision and control of the navigation of the Ministry of Public Works, Transport and Housing, special personnel authorized by the Minister of National Defence, Minister

of Interior, Minister of Water and environmental protection, the Minister of Agriculture, food and Forestry and the Minister of Health and others specifically authorized by law. Fines for offenses not exempt the offender from the obligation to pay compensation for the damage caused by land, internal waters, territorial sea and exclusive economic zone of Romania, according to Romanian law.

Fines imposed on individuals or legal entities shall be paid in convertible currency by converting fines of USD currency at the official exchange rate from the time of committing the offense.

Against the contravention report may be submitted within 15 days of notification, the Department of Marine and river to Court Constanta.

The offenses are applicable Government Ordinance no. 2/2001 on the legal regime of contraventions.

4. CONCLUSIONS

Shipping – which transports 90 per cent of global trade – is, statistically, the least environmentally damaging mode of transport, when its productive value is taken into consideration. The vast quantity of grain required to make the world's daily bread, for example, could not be transported any other way than by ship. Moreover, set against land-based industry, shipping is a comparatively minor contributor, overall, to marine pollution from human activities.

IMO's original mandate was principally concerned with maritime safety. However, as the custodian of the 1954 OILPOL Convention, the Organization, soon after it began functioning in 1959, assumed responsibility for pollution issues and subsequently has, over many years, adopted a wide range of measures to prevent and control pollution caused by ships and to mitigate the effects of any damage that may occur as a result of maritime operations and accidents.

These measures have been shown to be successful in reducing vessel-sourced pollution and illustrate the commitment of the Organization and the shipping industry towards protecting the environment.

Of the 51 treaty instruments IMO has adopted so far, 21 are directly environment-related or 23, if the environmental aspects of the Salvage and Wreck Removal Conventions are included. The Marine Environment Protection Committee (MEPC) is IMO's senior technical body on marine pollution related matters. It is aided in its work by a number of IMO's Sub-Committees. Environmental legal issues are so complex and complicated that hardly will soon find a safe solution, theoretical and practical, in all its aspects.

For this reason, the activities aimed at environmental protection to be successful, must be implemented and scientifically legal institutions related to these activities, including the concept of ecological damage.

Environmental policy based on social support of the majority, there can be no real and thorough assessment of the situation and without knowing the society.

And it even more today as environmental pollution negatively affects the economic and social activity around.

Therefore, it is necessary scientific research and thorough knowledge of each legal institutions, including the concept of ecological damage, which makes accurate and fast compensation of environmental damage caused by pollution.

In the right environment for expressing environmental damage caused by pollution, sometimes uses the phrase "environmental damage" or "environmental damage", which includes both suffered pollution damage to the natural environment, as well as those incurred by the person or property other than the natural environment.

In the event of acts for which Romanian law provides for the arrest or detention of its foreign master, the competent Romanian authorities will immediately notify consular or diplomatic mission of the flag State measures taken.

Detained ship and crew will be released as soon as the appropriate bail, according to the legal regulations in force.

Bail will be set at USD and will be paid in convertible currency by converting the sum of USD currency at the official exchange rate at the time of committing the offense.

Bodies of the Ministry of National Defense and the Ministry of Interior will enforce the law and will assist other State institutions to the application of coercive measures against foreign ships in the territorial sea and the exclusive economic zone of Romania, under the present law.

Environmental goals and improving environmental conditions can only be achieved within the actual process of social and economic development, which needs specific regulatory means based on the discovery of correlations, which can influence the evolution. Environmental policy based on social support of the majority, there can be no real and thorough assessment of the situation and without knowing the society. And it even more today as environmental pollution negatively affects the economic and social activity around.

Therefore, it is necessary scientific research and thorough knowledge of each legal institutions, including the concept of ecological damage, which makes accurate and fast compensation of environmental damage caused by pollution.

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SPECIAL RULES OF PROCEDURE FOR CONDUCTING RESEARCH ON BOARD

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ABSTRACT

1982 Convention requires Member shall cooperate in this area and to exercise freedoms granted taking into consideration the interests of other countries and their rights on the international activities of the submarine areas.
Seas must be used exclusively for peaceful purposes, is prohibited, for example, nuclear testing in the high seas and airspace above it (treaty of 1963) or the placement of nuclear weapons on the seabed (Treaty of 1971). Seas is not, however, demilitarized and nuclear-free neutralized restrictions set partially in character, so that in time of peace on the high seas is allowed there military navies and seas in wartime can be used as a theater of operations military.

Keywords: *rules, procedure, research on board.*

1. INTRODUCTION

Specific offenses naval transport system are provided in special laws, such as Law. 191/2003 on offenses shipping, Government Ordinance no. 42/1997 regarding shipping, Law no. 17 of 7 August 1990, republished, the legal regime of internal waters, territorial sea, contiguous zone and the exclusive economic zone of Romania Government Emergency Ordinance no. 23/2008 on fisheries and aquaculture.

Taking action and conduct research on board a ship flying the flag of a foreign state, the Romanian state concluded agreements which provide consular notification of the State whose flag the vessel is, shall be in accordance with the provisions of this Convention. For works that do not have a criminal or public order interests, port captains will assist foreign skippers on board measures only at the written request of the master or consular officer of the State whose flag.

Criminal Procedure Code regulates the criminal investigation into the safety of navigation is performed by the harbor that particular organ, for crimes against the safety of navigation on the water and against order and discipline on board and service for offenses or related service provided in criminal Code committed by civilian Navy aircrew if the act had or could jeopardize the safety of the ship or ships.

From this point of view, the territorial competence is simplified as in Romania being one sea-river court follows that whatever the place of commission of offenses or acts and domicile or headquarters of the natural or legal disputes are settled by the Court constant sea-river station.

In the territorial jurisdiction of Romanian courts is established by an authority it has a sea and river section, but it is "limited" because the law of judicial organization by the Minister of Justice such a station was established only in the Constanta Court.

Romanian criminal jurisdiction applies to any offense committed on Romanian territory by persons on board foreign ships used for commercial purposes, and of any offense committed on board such ship, the time when it is in port Romanian or internal waters. Romanian criminal jurisdiction shall not be exercised on board a foreign vessel used for commercial purposes, passing through the territorial sea, of an offense committed on board, unless:

a) the offense was committed by a Romanian citizen or a person without citizenship residing in Romania;

b) the offense is against national interests or against a Romanian citizen or a person resident in Romania;

c) the offense is likely to disturb the public order in the country and order within the territorial sea ;

d) the exercise of jurisdiction is necessary Romanian suppression of illicit traffic in narcotic drugs or psychotropic substances ;

e) assistance Romanian authorities has been requested in writing by the master or by a diplomatic agent or consular officer of the flag ship.

Romanian criminal jurisdiction applies to infringements of the provisions of this Law on the Exclusive Economic Zone of Romania by persons on board foreign ships used for commercial purposes, if the acts are committed in such circumstances that the criminal law are considered offenses.

Criminal jurisdiction on board a ship flying the flag of a state with which Romania has concluded a consular convention or other similar agreement is exercised in compliance with them. In exercising jurisdiction Romanian Romanian competent authorities may provide, in accordance with the legal provisions in force, detention or seizure of foreign vessels used for commercial purposes and will take enforcement action against such vessel is in the territorial sea, the waters interior sea or the contiguous zone of Romania, to ensure fulfillment of obligations incurred or other obligations assumed by the vessel during or in connection with the passage through the territorial sea or internal waters of Romania and other claims arising from events navigation resulted in the damage to the ship or cargo, or resulting from collisions, or rescue assistance, and for damages, costs and the like. In case of violation of the Romanian state sovereign rights of exploration, exploitation, protection, conservation and management of the environment and living resources in the exclusive economic zone, the Romanian authorities will take the necessary steps, in accordance with Romanian law in force and international conventions which Romania is a

party, including inspection or detention of foreign vessels used for commercial purposes.

The ship and its crew detained will be released immediately after filing a bond or other appropriate safeguards. Where there are reasonable grounds to believe that a vessel used for commercial purposes, which lies in the internal waters or the territorial sea or sailing times that passed through the exclusive economic zone of Romania, the Romanian legislation or rules violated international the prevention, reduction and control of marine pollution, the competent Romanian authorities are entitled to require the vessel explanation of the facts complained of, and to inspect the ship, where they refuse to provide an explanation of or if the explanations received does not correspond to the facts, and where the evidence so warrants, institute legal proceedings in connection with the breach, according to the Romanian legislation, and, among other measures necessary to order, subject to international law, detention. Full sovereignty over its territory a maritime state is exercised by the outer limit of the territorial sea beyond the seas start. Security needs of states, or achievement of their own interests and in certain large portions beyond the outer limit of the territorial sea and dedication led to the special areas in which states are entitled to exercise certain attributes of their sovereignty.

These areas are contiguous zone, continental shelf and exclusive economic zone. Contiguous zone is the portion of the sea which extends beyond the outer limit of the territorial sea to a distance of 24 nautical miles from the baselines to sea, the coastal State has certain exclusive rights precisely determined.

In this area the coastal state is entitled to exercise control laws and regulations to prevent abuse of its customs, fiscal, health and border regime.

Coastal State may take any measures to prevent and sanction the violation own under the same conditions as in its national territory, but only in the areas mentioned.

From the historical point of view, the origin of the contiguous zone are areas where certain maritime powers have booked since the eighteenth century some exclusive control rights in customs, and in other areas to better protect their interests, while the territorial sea does not exceed 3 km in width.

In terms of geological continental shelf is an extension of the slope below the sea shore of a coastal State on the steep Mrs. PA. Legal Aspects of the Law of the Sea Convention 1982 defines the continental shelf as soil and underground submarine areas that extend beyond the outer limit of the territorial sea throughout the natural prolongation of the land territory to the outer limit of the continental slope, or until a 200 miles away from the size measured from the baselines of the territorial sea where the outer limit of the continental slope does not reach this distance. Where the continental slope extends over very large distances of several hundred kilometers, the convention establishes that the continental shelf shall not exceed 350 miles from the baseline or 100 km beyond the point where the water depth reaches 2500 m. Delimitation of the continental shelf is within the limits set by the Convention by each riparian state for its area. Between neighboring countries or between countries situated in front of demarcation is done by agreement of the parties under international law, provided that the solution reached is fair. Consecration legal continental shelf appeared and imposed after the Second World War, when the improvement of means of exploitation submarine (flora and fauna, oil and gas deposits or metal) aroused interest in harnessing the developed countries of such resources.

The legal regime of the continental shelf emerged first as a unilateral practice of states, which has become the custom character and then enshrined in the "Convention on the Continental Shelf" signed in Geneva in 1958, where he was taken in the Convention on the law of the Sea in 1982. On the continental shelf of the coastal State exercises sovereign rights of exploration and exploitation of its natural resources.

No other state can acquire rights over the continental shelf without the express consent of the coastal State. However, the coastal State may not impede another state to install and use pipelines and submarine cables in the area of its continental shelf. The route shall be established, however, together with the coastal State.

Rinveran state rights in its continental shelf do not depend on the actual occupation or any express declaration by it. Rights over the continental shelf can not affect its over seas or airspace that remain outside of any right of sovereignty.

Coastal State is keen to exploit its continental shelf without thereby hampering free shipping or to seriously harm marine biological resources.

He can build or implanting artificial islands and other installations for the exploration and exploitation of the area around them and establish security zones up to 500 m, provided they are not located in places that would hinder the normal use of shipping lanes.

Exclusive economic zone concept is recent, he appeared after 1946 when some South American countries interested in protecting their fisheries resources, established certain areas to protect their coastal fishing rights beyond the territorial sea, the varying distances of up to 200 nautical miles from the ocean. Such zones were subsequently established by other countries, especially in Asia and Africa.

Conventional about this right was enshrined in the "Convention on the Law of the Sea" in 1982, as one of the most important innovations of the Convention.

The exclusive economic zone is a portion of the high seas to sea stretching distance of 200 nautical miles from the baselines from which the territorial sea is measured. EEZ is not part of the national territory of the state is subject to the jurisdiction thereof riveran.

Ea only for some economic rights of exploitation.

In the exclusive economic zone the coastal State has sovereign rights for exploration and exploitation, conservation and management of natural resources, biological and non-biological, seas and oceans.

Freedom of navigation and overflight and the laying of submarine cables and pipelines, which have all the world's seas should be respected in this area.

Coastal State in the area can build and use artificial islands, installations and structures in economic purpose and is only right to authorize and regulate the construction and use of such facilities to other states.

He also has the right to conduct marine scientific research in the area and establish marine conservation measures, other states have authorized such activities need to. Coastal State may conduct fishing activities in the area, but other mining and exploration activities in the area for business purposes such as power generation using water, marine currents and wind etc.

In terms of fisheries, the coastal State may establish total catches, catches its own volume and agreements with other countries, their fishing quotas in the area, giving preferential treatment in this regard landlocked countries and the economically disadvantaged, as recommended in the wording of the Convention of 1982.

2. RULES APPLICABLE TO FOREIGN WARSHIPS, SUBMARINES AND OTHER SUBMERSIBLE VEHICLES AND OTHER GOVERNMENT SHIPS USED FOR GOVERNMENT SERVICES

Foreign military ships, submarines and other submersible vehicles and foreign flag vessels used for government services may enter the territorial sea, in ports and shave only with the prior approval of the Romanian Government, except in cases of emergency or storm shelter. Approval is requested at least 30 days before the date on which it was to be passing through the territorial sea or visiting ports or laugh unless between Romania and the flag State agreed otherwise.

Foreign submarines and other underwater vehicles passing through the territorial sea are required to navigate on the surface and fly the national flag.

Those who will be in immersion will be forced to come out. In case, due to a fault may not come out, they are bound to signal, by all means, the situation in which it is located.

If a foreign warship Romania violate laws and regulations in the internal waters or territorial sea and disregards the warning that was given to comply with them will be ordered to immediately leave the territorial sea of Romania.

Liability for any loss or damage caused by a foreign warship or any other ship of state used for government services or commercial purposes and by people who are part of the crew of such vessels, the time when the vessel was in ports, internal waters, territorial sea and exclusive economic zone of Romania returns the state whose flag the vessel.

3. APPLYING THE CRIMINAL JURISDICTION OF ROMANIA ON BOARD

Field research and reconstruction, carried on ships or ports inside the courts or other bodies prosecution than port captains, are only assistant port captain or his representative.

Criminal Procedure Code regulates the criminal investigation into the safety of navigation is performed by the harbor that particular organ, for crimes against the safety of navigation on the water and against order and discipline on board and service for offenses or related service provided in criminal Code committed by civilian Navy aircrew if the act had or could jeopardize the safety of the ship or ships.

LAW NO. 17 of 7 August 19905 on the regime of internal waters, territorial sea, contiguous zone and the exclusive economic zone of Romania Romania governing criminal jurisdiction that apply in respect of any offense committed in the novel by persons on board foreign vessels used for commercial purposes, and of any offense committed on board such ship, the time when it was in Romanian ports or internal waters. In accordance with Art. 49 nr.17/1990 law constitutes a crime punishable by imprisonment from 3 months to 2 years or a fine discharge of pollutants from a ship in:

a) the internal waters or ports aquatory where applicable Marpol 73/78;

b) the territorial sea;

c) the exclusive economic zone or in an equivalent area determined in accordance with international law;

d) the high seas.

To the extent not inconsistent with the provisions of international law, the Romanian criminal jurisdiction applies to the facts mentioned above committed by foreign vessels:

a) the exclusive economic zone of Romania or in an equivalent area determined in accordance with international law;

b) outside Romania and the exclusive economic zone , but have caused or threaten to cause pollution in its territory or in its exclusive economic zone and the ship is voluntarily within a port or offshore terminal of Romania;

c) the high seas, and the ship is voluntarily within a port or offshore terminal of Romania.

In application of art. 230 para. 1 of the UN Convention on the Law of the Sea, signed at Montego Bay (Jamaica) on 10 December 1982, ratified by Law no. 110/1996, the facts set out in art. 49 committed by a foreign vessel outside Romania are punishable by a fine in cases where the criminal jurisdiction of Romania applicable under national or international rule.

Not covered by that Article discharges of polluting substances from ships of war, the auxiliary warships and other vessels belonging to the Romanian state or another state or operated by it and used exclusively for the service when discharged public, noncommercial use.

Also not covered by this article acts committed by the owner, master or crew, if the discharge of pollutants has been produced under the terms of Rule 4.2 of the revised Annex I or Annex II Revised Regulation 3.1.2 of the Marpol 73/78.

If the Romanian Naval Authority finds an offense under this law or is aware of the risk of committing such an offense that causes or may cause imminent pollution , shall inform the other Member States likely to be exposed to such damage as and the European Commission. However, if the Romanian Naval Authority finds an offense under this law or is aware of the risk of committing such an offense, which may be subject to the jurisdiction of another Member State shall immediately inform the Member State thereof. Romanian Naval Authority shall immediately notify the flag State or any other State concerned of measures taken in implementation of this law.

The offenses which attract the jurisdiction of several Member States, Romania, by the central competent authorities shall cooperate with the Member States concerned, in particular the prosecution to establish the conditions and rules on mutual legal assistance.

4. CONCLUSIONS

Seas principle was formulated jurist Hugo Grotius in 1609 by the great, considering that, due to the development of international trade, the old principle of closed sea, specifically taking advantage of the Middle Ages and the naval powers of the era who claimed exclusive rights to increase or portions of the oceans no longer meets their interests with access to all parts of the world. Principle has become customary way then, but his consecration Conventional only occurred in this century by the 1958 Geneva Convention on the High Seas.

Seas convention defined as that part of the sea that did not belong to the territorial sea or internal waters of a State, on which no sovereignty of any State, being open to all nations. Some new details were brought by the Convention of 1982 which states that the legal regime of the high seas applies "to all marine areas that are not part of the exclusive economic zone, the territorial sea or internal waters of a State, or in the archipelagic waters a State - archipelago ".

The legal regime of the high seas is governed by the principle of freedom of the seas, that the world's oceans and seas are open to all States, whether or not landlocked and no State can declare sovereignty over any part free.

The principle of freedom of the sea gives a number of world states tangible seas freedoms: freedom of navigation, freedom of overflight, freedom of fishing, freedom to lay submarine cables and pipelines, freedom to construct artificial islands and other installations permitted under international law and freedom of scientific research.

The first four freedoms belong to classic law being established as such by the Convention of 1958, and the last two are set for the first time in the 1982 Convention, as one of the innovations brought in by it. Freedom of the seas is not, however, absolute. In exercising jurisdiction Romanian Romanian competent authorities may provide, in accordance with the legal provisions in force, detention or seizure of foreign vessels used for commercial purposes and will take enforcement action against such vessel is in the territorial sea, the waters interior sea or the contiguous zone of Romania, to ensure fulfillment of obligations incurred or other obligations assumed by the vessel during or in connection with the passage through the territorial sea or internal waters of Romania and other claims arising from events navigation resulted in the damage to the ship or cargo or resulting from collisions, or rescue assistance, and for damages, costs and the like.

In case of violation of the Romanian state sovereign rights of exploration, exploitation, protection, conservation and management of the environment and living resources in the exclusive economic zone, the Romanian authorities will take the necessary steps, in accordance with Romanian law in force and international conventions which Romania is a party, including inspection or detention of foreign vessels used for commercial purposes. The ship and its crew detained will be released immediately after filing a bond or other appropriate safeguards.

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PERSPECTIVES OF MEMBERSHIP OF THE SUPPLY CHAIN IN SHIPPING

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ABSTRACT

Developments in recent years in the field of maritime transport, inland waterways and port operation required a number of situations of belonging to a supply chain. There were two distinct situations: the strength in employment or to join a chain. Studying the situation of maritime shipping companies, river and port operators observed a direct link between their relationships in a supply chain evolution and involution of their respective companies. Amid the global economic recovery, shipping companies and related are failing to thrive after the economic crisis, having gone through difficult situations. This paper presents the conditions that influence participation in a supply chain, advantages and requirements of this belonging.

Keywords: *logistics, shipping, port supply chain.*

1. INTRODUCTION

A number of logistics professionals now believe "supply chain" is "top" business operations

management, international business and domestic between two or more partners, Balan (2006). As is found in the literature as "the main purpose of the existence of a supply chain is to satisfy customer needs and the company to obtain profit", David et. alt. (2008). Essentially activities in the supply chain starting with the order from the customer, continues with a number of key activities and related ends with a "satisfied customer" who pays for your purchase, transportation and all related services. Continuous observation of the functioning of processes is the basis for performance measurement and cost control. For supply chain management and distribution are considered following important points:

-Develop strategies for supply chain and distribution, including network design.

-Re-design processes and organizational structures, as part of that chain.

-Re-design chain control and optimization of certain influences on performance, among others in the context of capital reduction.

-Lean Management ("supple" management process), which refers to the value added, maintenance, etc, aligning and optimizing the components.

In addition, to optimize certain sub-processes in the supply chain or distribution are also used, Amancei (2009):

-Procurement and supply by establishing a management model suppliers.

-Operations and production by optimizing execution time.

-Distribution by planning and sales operations.

An important problem is that of value added. It is known that not all the supply chain adds value. Companies that invest in tools "supply chain management" to identify such activities can reduce and eliminate those activities that do not add value, achieve what is called "reducing costs to maximize profits", Balan (2008). Such companies can deliver products and services to market faster, cheaper and better quality, gaining a distinct advantage to the less efficient competitors.

2. THE STRATEGY RELATIONS, BASICS IN SUPPLAY CHAIN MANAGEMENT

A firm can obtain a unique and important position rendered different activities from those of competitors or run the same tasks in different ways, with minimal costs, Gattorna et.alt. (2001). If the supply chain may appear more customer-oriented activities, but they are presented as well as major links between dependent activities. For example the production of its products "in house", where attention is focused on lowering the cost of production, with all products derived from long-term suppliers, directly contributes to lower production costs. An important component of the strategy is to create it so that it matches the supply chain activities. "The success of a strategy depends on the execution of the activities well, not just the few and their integration with each other", Porter (1980). A particular strategy is successful only if all the activities are compatible with each other, or more, if the reinforce each other. The highest level of compatibility of these activities, called "optimization effort" is attained only when the information and coordination are used for all activities, in order to remove the excess and minimize effort, Lee et.alt. (2008). Supply chain management has been defined as organizational units integrated into the supply chain and as a coordinator of activities related to flows of material, information and finance. So supply chain management is not a stand alone strategy, however it can and should be an integral part of the strategies that the company and individual strategies regarding business partners. In this supply chain management is generating competitive advantages for the integration and coordination of organizational units flows; compresses specific activities, particularly those relating to carrying the very end of the command, which may be a part of company strategies, using tools suitable to meet the specific level at which it aspires to fit among the strategic activities of the firm. Hence a number of ideas related to basic resources and core market, Martin (2010).

a).A resource may consist of all assets, capabilities, organizational processes, basic attributes, information, knowledge controlled by a firm, but allows the firm to devise and implement strategies that improve efficiency and effectiveness.

b).On basic market principle, it is desirable that it should be developed as an industry usually consists of several markets for businesses to resist best against competitive forces are given industrial competitors, potential new competitors, power of buyers or suppliers, new products or services appearing.

The two views are not antagonistic, but rather complementary and hence should be noted that, Balan (2008).

-Development and implementation of strategies within a single corporation may be a difficult goal to achieve, but it will be more challenging in an inter-organizational supply chain.

-Strategies individual partners to be aligned with those of the entire supply chain.

-Then when formulating business strategies must be taken into account different levels of integration for aspiring and modalities.

-Even if contracts strengthen the partnership with companies, though some companies are vulnerable and the contract is only for a limited time.

-It is wise to consider and carry out emergency plans in case of separation.

These, however, may require:

-Good relationships with alternative suppliers as well as customers who are not part of company, thus allowing them to become part of another company.

-Introduction of flexible capacity (production flexibility) which also can be used in another supply chain.

-Involvement in other supply chain systems for to mitigate the risk.

The debate strategies in the literature are dominated by the principle of pure competition, Bacanu (2006). In the field of supply chain collaboration strategies are the most important. Some difficulties arise in finding a fair compromise for differences that sometimes occur between chain partners. More chain partners need to worry about the centralization of investment decisions that are made for the benefit of the chain as a whole, which may require reductions, incentives or specific guarantees by other supply chain partners. Since the general rules for calculating transfer prices or fair compensation still missing, negotiations are basic. This situation becomes more delicate if chain partners are reluctant to reveal the true cost of the structure and if the power chain partners governing the negotiations that will take place in the future, Timar (2013). It is clear that a strategy chain, always friendly, it must be specific, given the potential chain. Borrow ideas expressed in market research or analysis success factors, it may be a good starting point. Chain strategies can guide servitude as large chain needs.

3. PARTNERSHIP FORMATION IN THE CHANNEL OF DISTRIBUTION

Components distribution channel of maritime transport, inland waterway and port operation are next, figure 1, Iordanoaia (2006):

1. Manufacturer (s) of goods (raw materials, finished products) called the “Charterer”.
2. Exporter (international shipments house) called the “Charterer”.
3. Dry carrier (road, rail, pipeline) or river.
4. Broker Charterer (manufacturer and exporter).
5. Port operator, warehouses or charger.
6. Maritime shipping company (owner), the owner of the ship (7).
8. Ship Suppliers (technical-material supply).
9. Insurers of ships.
10. Unloader port operator, warehouses.
11. Broker Charterer (end user or importer).
12. Broker owner (for “Tramp” shipping companies).
13. Dry carrier (road, rail, pipeline) or river.
14. The importer (international shipments house) called the “Charterer”.
15. The end user (wholesaler, industrial user, retailer end user) called the “Charterer”.

Shipping companies that are strategically oriented recognize that interdependence, not the coercion or conflict is necessary to achieve long-term profitability, Iordanoaia et.alt. (2013). Interdependence involves cooperation and establishing mutually beneficial relationships. Hence arises a question of incentives that can cause a company to abandon opportunism and adopt a cooperative approach in relations of distribution channel. This incentive is provided by the creation of added value, i.e. the process by which a product becomes more valuable as it moves into the channel from supplier to consumer.

Shipping is a service whose value is influenced by the client and the circumstances that appear on the maritime market. This may explain the development of transport of “express” where the customer is prepared to pay extra money for fast and safe transport, Iordanoaia (2011). Improve existing relationships between members of the distribution channel can be achieved by marketing activities carried out between partners in order to gain profit.

The implementation strategy of partnership marketing philosophy consists in the following:

-Determination of the distribution activity by checking it regularly.

-Reviewing agreements within the channel.

-Taking into account the changes that can be made to these agreements.

-Implementation of marketing practices by selecting members of the distribution channel.

Understanding the vision of the other members of the distribution channel is essential to impose a spirit of reciprocity and no one polarity. Through this combination of forces all members of the distribution channel can work effectively having a common purpose to obtain profit.

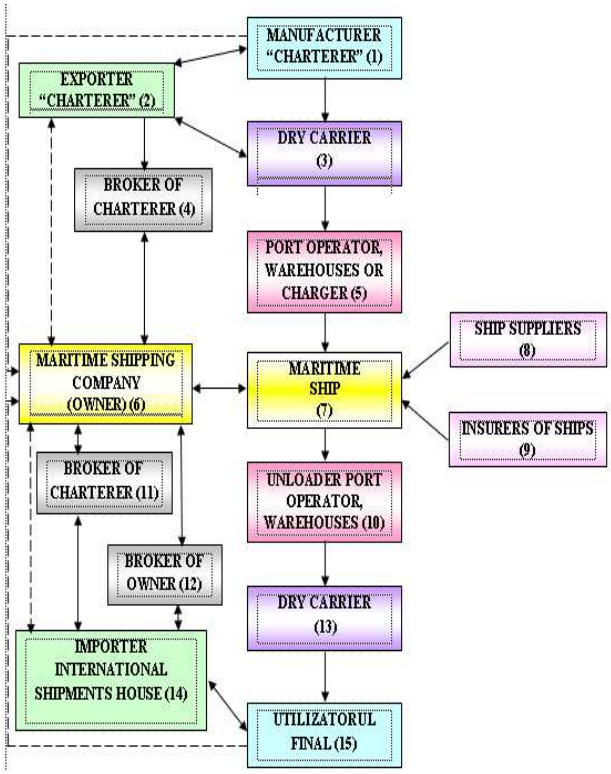

Figure 1 The distribution Channel in the maritime sector

Source: author's study.

4. FORMATION OF THE PARTNERSHIP IN THE CHANNEL DISTRIBUTION

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5. SUPPLY CHAINS LEADERS

For a proper understanding of the situation of belonging to a supply chain, it is necessary to know the companies that are leaders in supply chains. In terms of maritime and river shipping companies, they call them as "Charterers". Classification can be done as follows, Iordanoaia (2012):

a). Economic criteria, Figure 2:

-Producers of raw materials and semi-finished products.

-Manufacturers of finished products.

-Travel Agencies and Tourism (cruises).

-Commerce companies and expeditions (wholesale).

-Individuals.

b). By type of goods transported they are owners, figure 3:

-Solid bulk cargoes: grain, ore, coal.

-Hydrocarbon liquids: petroleum products, chemicals, natural gas.

-Wood and derivatives.

-Living animals.

-Consumer, food and non-food.

-Plant and equipment-specific.

The relations between owners and charterers involved a number of intermediaries in the field of navigation "tramp" take charge of finding goods for transport. For port operators and logistics companies in the areas of maritime or inland port, the same companies "owners" of the goods may contract for the operation of ships, loading-unloading, internal transport inside the port, storage, packing, sorting, packing and other operations technical and commercial. Any of the types of companies listed may be the leader of a supply chain. For the partnership to be effective in the supply chain, relationships between members must be interdependent, not dominance or power. There are many opportunities to develop joint marketing plans, to seek new business partners. The main advantages of a partnership in the sea, river, port and logistics operating close range are, Iordanoaia (2006):

- Establish a unique delivery program.
- Improved communication and electronic data exchange.
- Optimal conditions for conducting trade relations.
- Favorable lending agreements.
- Packing goods type of vessel or inland shipping.
- Logistics such as "just-in-time".
- Liability for damage to goods during transportation.
- Joint - promotion activities.
- Opportunities for negotiation.

In this regard partners have common goals and strategies to achieve them similar and a common means of defense against any intrusive element in this partnership. Through partnership they are allies, not

enemies, they all want long term profit gains rather occasional.

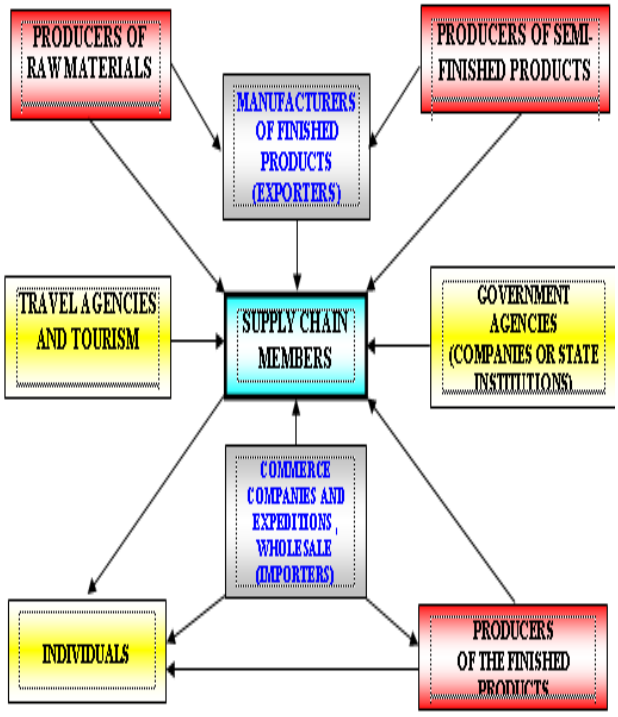

Figure 2 Supply chain leaders.
Source: author's study.
Legend:

-Circuit of orders and information.

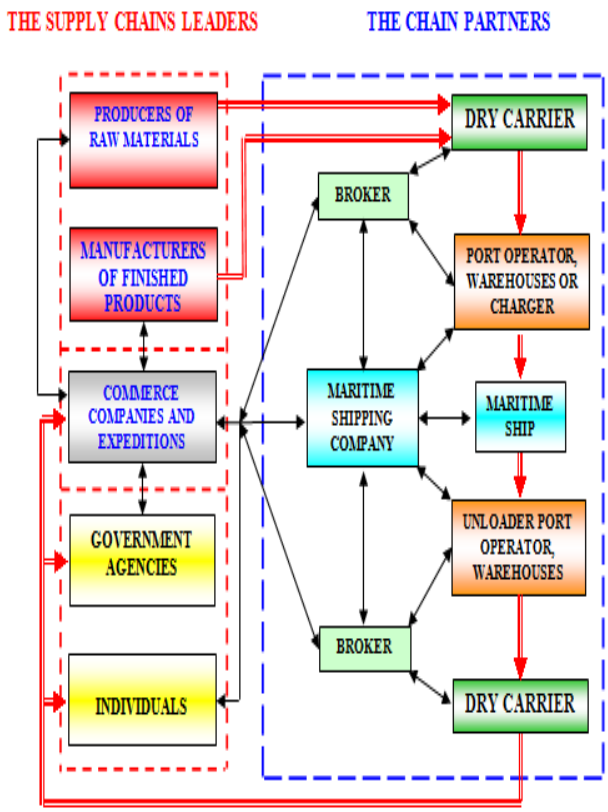

Figure 3 Goods supply chain leaders.
Source: author's study.
Legend:
-Flow of information.

-The circuit of goods.

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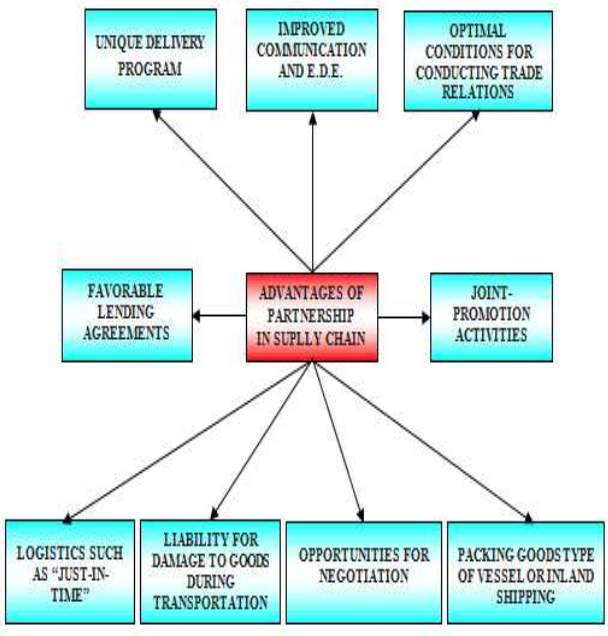

Figure. 4 The advantages of chain.

Source: author's study.

6. CONCLUSIONS

Depending on the subject, a number of researchers have ideas about partnerships and business in this area. Among the beginning to emerge include:

a).The future is linked to globalization logistics customers. The idea is based on the fact that the market is growing logistics. More companies need to transform the warehouse and production facility to outsource the logistics. This is caused by higher fuel, Bleort (2012). Another aspect is the fact that the need for freight is increasingly fragmented, it opens up new retail points of sale and hence changes occur on routes and quantities of goods required.

b).Increasing rents storage space in city centers. This leads to the transfer of large logistics centers outside the cities and in places remote from the classical point of transit, Duica (2013). All logistics firms operating in a dynamic market, often uncertain or difficult market, Ionescu (2012). These situations require special measures, sometimes radical changes.

c).Rethinking operating models and standardizes all the roles, processes and controls associated supply chain. This has a number of benefits estimated as follows, RLA (2013):

-Reduce costs in the supply chain.

-Alignment of operational strategies of selling or marketing objectives to increase market share and competitive positioning chain members.

-Identify and evaluate best strategies for networks of production, distribution, assembly and administrative support globally.

-The development of performance measurement systems in the execution of operational strategies.

-Identify assets which add value and operations could be consolidated or outsourced. Hence an imperative aspect, companies must have a holistic approach to their operating models, Popa (2012). By standardizing operational departments can obtain efficient that companies seeking.

d).Using emerging technologies such RFID in the supply chain technology "Radio Frequency Identification" (Radio Frequency Identification - RFID), ELA (2013). This technology is different from normal only identifies the product labels, RFID tags can retain what kind of product, where stationed, expiration date or other information about the product. RFID technology can provide more information about each product in the supply chain, when and where it was manufactured, picked, packed, shipped, when it will expire. This huge amount of data to be retained transmitted and shared in real time with the lead deposits, inventories, financial departments and other systems within companies. It will have a major impact and another benefit is that RFID tags can be read automatically by electronic readers, which enable the automatic monitoring of shipments in key areas such as ports or major cities without having the shipment be slowed for verification. This can add extra visibility in the supply chain.

e)."Resistance" supply chain. This concept assumes that "the resistance of a supply chain is given by the strength of its weakest link", Mihai (2012). This requires a number of steps you take leading supply chains. Among the most important are:

-Choice financially strong partners with notable previous results that have equipment, facilities and modern equipment and qualified personnel for activities required within the chain.

-Making direct or via the audits to those we aim to draw in, partnership or asked them to collaborate. Both types of audits are very important and they represent a first step in the collaboration within the chain.

-Follow permanent situation of partner companies, the main economic and financial indicators and the development staff and executive management positions.

Membership in a supply chain organization, driven by a large, powerful, multinational company, is a correct solution, viable business that can bring profits for the maritime and river companies or port operators. There isn't only one solution, but one that has the security it provides powerful leader of the supply chain.

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LEADERHIP IN PUBLIC SECTOR.OPTIMIZING RNA'S LOGISTIC SYSTEM

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ABSTRACT

This study develops the concept of integrated leadership in public sector, and particularly in portuar public services. Integrated leadership could be conceived as the combination of five leadership roles that are performed collectively by employees and managers at different levels of hierarchy. This approach tests the hypothesis that integrated leadership has a positive effect on organizational performance in the public services sector.
The paper also discusses issues related to the link between global financial crisis and human resources management, at a general level, focusing on human resources management in port administration, in the management of uncertainty. This paper's literature review regarding recent research on managerial strategy in the public sector has found that aggressive strategies aimed at exploting opportunities in the external environment can be as effective as change-oriented leadership behavior when it comes to improving organizational effectiveness. The paper's research treats some various other aspects that have been linked to organizational effectiveness in the public sector, including goal settting, motivating employees and the shaping organizational culture. The data sources from Naval Romanian Authority and the sample on which the emphirical analysis is based suggest that the findings are generalizable across the national bureaucracy. ***Strategic decisions*** are those that determine the goals of the entire business organization, its purpose and direction. Top management has the big picture of all the elements of a complex business enterprise, and it must be able to integrate all aspects of a business into a coherent whole. The decisions made at this level also determine how the busniess will relate to external environments. Beacause strategic policies affect the entore business, they can best and must be made at the highest level within an organization. These policies and goals are not very specific because they must be applied to all levels and departments in a company. Strategic decisions are usually nonprogrammed in natureThese decisions determine the manner in which operations are conducted-operations designed to accomplish the tactical decisions made by mid-management. These decisions concern the most effective and efficient way to accomplish the goals stated on the operational(day to day) level. The decisions' management is properly applied when the logistic system is operational. The study's objective is optimization of the informational fluxes by implementing a modern informational management instrument, responsible with the improvement of the managerial and operative activities, information and the processes carried out within the pyramidal structure and the RNA's organizational chart. The study's objective is to create the parameters for a management informational system of documents and of the work fluxes, which is functional and can be implemented within the RNA and its 5 subordinated units. We will analyze the parameters of a **Disaster Recovery Data System** and of a **Portal** which will constitute specialized archiving and compression software, in order to assure the reduction of the decision times and generate proper statistics and reports regarding the institution's activity.

Keywords: *public sector leadership, integrated leadership, shared leadership, performance, port services.*

1. INTRODUCTION

Casual observation suggests that individuals who start their own organizations are somehow different from those that work in large organizations. Entrepreneurs have been described as risk-takers and rugged individualist (Begley and Boyd 1987; Mc Grath et al 1992), as engaging in deviate social behavior (Shapero, 1975), and as being "breed apart"(Ginsberg and Buchholtz 1989). In contrast with these entrepreneurial leadership characteristics, managers in large organizations have been described as being risk averse, and more predictable in their decision making. The research literature has some empirically efforts in describing differneces between entrepreneurs and managers in large organizations (Low and Mac Millan, 1988; Busenitz and Barney, 1997). Our purpose in this study is to examine differences in the decision making processes used by entrepreneurs and managers in large organization. The well practice example of Naval Romanian Authority established that public managers could also be implicate in improving logistic system, in order to enlarge efficiency in managing decisions. Literature review showed up that entrepreneurs use biases and heuristics more extensively in their strategic decision making than do managers in large organizations. We examine differences between entrepreneurs and managers in large organizations with the respect to two biases and heuristics: overconfidence and represntativeness (Tversky and Kahneman 1974; Hoghart 1987; Bazerman, 1990; Busenitz and Barney, 1997). Identifying best practices preoccupation for managers in public sector is some other goal of our research. Best practices have been widely implemented in an organization as a technique, method, process, activity, or mechanism in order to optimize the result of production or management practices are commonly used to describe the most efficient and effective way of accomplishing a task of achieving a goal(Engle, 2008; Yan Xu and Chung-Hsing Yeh, 2011). To address this issue of strategic importance for an organization, we present some integrated evaluation and planning approach, supposed to be developed in a large organization, such Naval Romanian Authority. The

approach integrates a system: Multiattribute decision making theory, a new evaluation model developing for measure the relationship between lower-level objectives and higher level goals, and to give each practice a relative priority scale. How to effectively prioritize a given set of best practices and strategically plan their implementation for achieving the global strategic goals of the organization remains an open issue. The present approach studied this issue and found it complicated by the fact that the best practices are performed at the corresponding business units essentially for achieving their own local operational objectives, while being evaluated in terms of their contribution to the higher level global strategic goals of the organization. "To ensure effective implementation of best practices at individual business units for achieving the organization's global strategic goals, it is desirable to plan their implementation in a phased manner from the perspectives of both the organization and individual business units."

2. MANAGERIAL DECISIONS MAKING. A COMPARATIVE APPROACH PUBLIC/PRIVATE SECTOR

Under conditions of certainty all decision variables and the results of each potential course of action or solution are known in advance. A manager can approach the decision-making secure in the knowledge that there will be no unanticipated results. In the sense, decisions made under condition of certainty are programmed decisions (Montana and Charnov, 2008). Since all results are known before making a decision, many managers prefer to make decisions under conditions of certainty. This is possible only in the most simple situations. There are rarely knowledge of all possible results, and management usually encounters a degree of risk. Risk is defined as a condition in which the results of any decision or course of action are nor definitely known but will probably fall within a known range. Risk could be described in the terms of probability; the probability of a specific outcome is a fraction between 0 and 1, and if the probability of a specific outcome is 1, it is completely known; if the probability is 0, it is completely unknown. Since under conditions of risk the probability is neither completely known nor completely unknown, it is described as a fraction between two extremes. When a manager cannot predict the outcome of a managerial decision, or if the outcome can be predicted but the probability of the outcome actually happening cannot be predicted, a condition of uncertainty exists. The inability to predict outcome or assign probability may be due the following factors:

- Too many variables in the situation
- Few variables in the situation but not enough knowledge about the variables
- Both too many variables and not enough knowledge about them.

The assignment of probability becomes impossible under these conditions. The first step in the managerial

decision making process is an examination of the current situation to determine if a problem actually exists. This is the accomplished by performing a *situational analysis.* In managing organizations, once a statement of goals is determined, alternatives are considered and evaluated, performance standards set, and such as pilot testing could begin. Situational analysis is a form of examination of available data, is the "what is". There are managers who have a stake in the status quo and will resist to change. These managers may not see the current situation in an unbiased manner, and their perceptions cannot be relied upon to determine an accurate analysis of "what is". One of the ways in which management can accomplish an accurate analysis of the current situation is to make use of an external consultant. Since outside experts theoretically have no stake in the status quo, they should be able to give an accurate appraisal of the current company situation.

Managers often find it useful, in executing a situational analysis, to focus on the internal organization conditions, the external factors that bear upon the business and the relationship between the two. The internal analysis, called an organizational audit, consists of listing the organization's strengths and weakness. The strengths, what the business does well, are referred to as its "core competencies".

On average, the level of uncertainty facing entrepreneurs in making decision is greater than the level of uncertainty facing managers in large organization in making decisions (Hambrick and Crozier 1985; Covin and Slevin 1989; Busenitz and Barney 1997). "At the very least, managers in large organizations usually have access to historical trends, past performance, and other information that reduce the level of uncertainty and help taking best strategically decisions (Mintzberg, 1973). Managers in large organizations can appreciate the rational ideal in their decision-making.

Large organizations develop elaborate policies and procedures to aid managers in their decision-making. Nelson and Winter (1982) call these decision making practices routines and emphasize the ability of routines to simplify the decision-making-complexity facing managers."In addition to these routines, large organizations adopt elaborate organizational charts that define area of decision-making responsibility. Here it is the effect of reducing the complexity of the decision making context facing a private firm, thus enable managers form large public companies not to rely on biases and heuristic as much. As literature reviewed suggested, a large number of biases and heuristics have been studied (within the non rational decision making literature). One of this paper's purposes is to analyze the differences between the two sets of individuals with references to two biases and heuristics: overconfidence and representativeness. "Overconfidence was chosen

because is considered somewhat characteristic of a number of these biases and heuristics identified in the literature reviewed (Kahnen et. al 1982).
Representativeness is one of more widely used heuristics (Pitz and Sachs 1984; Barnes, 1984; Katz, 1992) and an important indicator which generalize from a single or limited number of past experiences in taking decisions.

3. OVERCONFIDENCE AND REPRESENTATIVENESS IN TAKING STRATEGIC DECISIONS

Overconfidence has been shown to exist in a wide variety of settings (Bazerman, 1990, Busenitz and Barney, 1997). "Overconfidence exists when decision-makers are overly optimistic in their initial assessment of a situation and then are slow to incorporate additional information about a situation into their assessment because of their initial overconfidence"(idem; Alpert and Raiffa, 1982). Managers in large organization do not have to rely on their personal confidence in making decisions to as great an extent. Rather, these managers can rely on decision-making tools and historical performance patterns to convince executive management that their projects should have priority because are much important to the stakeholders' needs. Most research on non-rational decision making suggests that most decision makers manifest various biases and heuristics including overconfidence to some extent. We don't have clearly dates which could confirm the hypothesis that entrepreneurs will manifest more overconfidence than will managers on the executive level of large organization.

Representativeness is the most common decision making by heuristics and biases. Decision-makers manifest their heuristic when they are willing to generalize about a person or a phenomenon based only a few attributes of that persona or only a few observation of a specified phenomenon. Decision-makers ignore fundamental base rate information and underestimate the error and unreliability inherent in a small samples of data (Busenitz and Barney, op.cit; Payne et al.1992).

4. MANAGEMENT INFORMATION SYSTEM

The latter half of the 21-st century may well be regarded by future historians as the age of information. The invention of the computer and the creation of new communication technologies have made it possible for managers to acquire, manipulate, and evaluate more information than ever before in human history. As with so many other mechanical discoveries, it was preceded by the emergence of a new philosophy of information.
Most business decisions are of the routine nature. They are distinguished not only because they recur with regularity but also because the decision making parameters are well understood. Because they are well understood, these kinds of decision are often called structured decisions. Because the decisions are well understood, the information needed to make these decisions is also well understood. This information fits into a predetermined format that is used in the regular reporting process. The specific part of the corporate MIS that generates this information is called the management reporting system. This makes use of computer processed information generate the standard reports that are employed by managers to make routine and recurring decisions.
The design and execution of a successful MRS is a slow and deliberate developmental process that is focused on the derivation of information in a useful format to aid managers in decision making, and is always subject to evaluation and improvement. Indeed, as information needs change in response to the challenges of managerial decision-making in often fact-changing business environments, the management reporting system must also change. Managers who fail to evaluate their information systems periodically risk obsolescence, not only for the system but also of their entire business. The rapid pace of contemporary business demands constant attention. To fall behind is to court failure, and making critical decisions based on bad data almost ensure poor performance in a marketplace that is totally unforgiving of such performance.
The second type of decisions made by management, are those cases that are nonrecurring and non-routine. They may be even one-time decisions characterized by their uniqueness. These problems and their decisions are referred to as unstructured, and their information requirements are not well understood. Since the kinds and amount information needed to make a managerial decision in an unstructured situation are not readily apparent, it is difficult to design a system to provide the information, but it is not impossible. The most important key to designing a successful decision support system is flexibility. That is the reason why bureaucratic public organizations, which are resistant to change, are suffering in implementing a good decision support. An example of unstructured decision is hiring of a new manager. To a large extent, each hiring decision is unique, and in each case different information is considered important. The interviewer of a personnel department has the ability to request needed information in each case, and when additional information is deemed necessary to the hiring decision, it can also be requested.

5. BEST PRACTICES MODEL, A FRAMEWORK FOR IMPLEMENTING STRATEGIC DECISION IN NAVAL ROMANIAN AUTHORITY

Best practices are distinguished from good practice by their repeatability and universality. "Only those practices that have been widely recognized over time as excellent approaches for many organizations and recommended by a large number of practitioners or experts to adopt for successful results are regarded as best practices"(Xu and Yeh, 2012).

Sources where best practices could be learned are: industrial experiences (practitioners, company hand books), consulting experiences, advanced information

systems and knowledge base (literature review, research studies, volume of the conferences). Best practices could be described as process-oriented and outcome oriented. In order to achieve operational objectives of the organization, the process-oriented or outcome-oriented functionality could be diverse set of best practices implemented in large organization, and we propose this best practice model for implementing in Naval Romanian Authority.

To address this issue, we will use this model, called BSC framework to organize best practices in alignment with the strategic goals of the organization and the operational objectives of its organizational units. In the measurement tool and performance of the organization, BSC is used for articulate and communicate the correct strategy of the organization and for implementing a proper decisional process. The BSC model is oriented on satisfaction of the stakeholders, within four strategic perspectives:

- Learning and growth, which is focused on the knowledge organizations: the organization's ability to change and improve for achieving its version;
- Internal process-focus on business process that an organization must excel in order to satisfy the needs of its stakeholders: inclusive clients and beneficiary of the public services;
- A strategic management in order to create values for customers and beneficiary of the public services;
- Financial, which focus the strategy for satisfying the stakeholders;
- Maintains a well balance between long-term strategies and short-term activities
- Maintains a well balance between long-term goals and short-term objectives;
- Maintains a well balance between financial and non-financial measures;
- Create a framework for grouping the criteria and measures for evaluating a set of alternatives in various decision such as IT investments;
- Creation of a management information system and a documents' workflow implemented under the NRA and the five captains subordinated
- Creation of asystem of electronic signature
- Creation of a Business Inteligence Solution that provides any level of management support and a real time decision making;
- Creating a system of labeling, classification of documents and electronic messages so as to ensure archiving and data security;
- Un Disaster Recovery Data System, a specialized archive and compression software that ensures data center protection against any informational attack;
- Creation of a Portal needs to provide information, communication and amangement of decisions within the organization, and also with the external stakeholders of the NRA(crew human resources, crewing companies and ship owners).

In this paper we propose for the NRA's logistic system improvement a new evaluation of managerial decision process system, called MADM algorithm, decribed in the paper *An integrated approach to evaluation and planning of best practices (*Xu and Yeh, 2012). MADM alghorytm measures the relationship between the global strategic goals and decisions in large organization and the local objectives of its units. Ecquipped with the MADM algorithm unde the BSC framework, "the evaluation model can prioritize a given set of best practices by their relative importance and achievability from the aspects of whole organization" Satisfaction of the stakeholders could be achieved by implementing of this evaluation of managerial decision making process model.

5. CONCLUSIONS

The central goal of this study is to improve RNA's logistic system. We intended to measure the use of biases and heuristics as a part of the decision making style of managers in large organization (and public ones) comparative to the style of entrepreneurs. The proposed applied models were Best Practice Evaluation (within the BSC-based framework and MADM Evaluation). Managers from large organizations were defined as individuals who have responsibility for at least two functional areas (such as management of human resources, statistics, marketing, finance, research's department) and work for a public organization with more than 2000 employees. Referenced authors in this paper suspect that without biases and heuristics, many important decisions in organization would never be made. To face logistics problems in organizations from a strict econometric approach would not postpone decisions but would in all likelihood make them overwhelming (Russo and Schoemaker, op.cit.). A fundamental decision in a large organization could be correctly taken if the organization tends to be characterized by more methodical decision making, such environments can be very styling for more comfortable with biased and heuristic reasons. Large organization should be populated with managers who are able to take their contributions in taking decisions on large term (strategic decisions). In public sector, there is a tendency for a long term objectives to be variable and difficult to forecast. It is one of the dysfunction of bureaucracy. Multiatribute value theory (MAVT) developed by Keeney and Raiffa (1976) will generate a cardinal preference or ranking of the decision alternatives, for each of which a relative score is obtained. This is the fundamental methodology on which the evaluation model (Best practice and MADM) developed in the

named authors' papers and suggested for application in RNA's logistic system, is based. Global strategic goals in the public large organization will be a constant priority if we apply this evaluation model. Based on the merits of MAVT in dealing with weights, the simple weighted sum method used in MADM is used to determine the relative importance (weight) of each local strategic objective with the respect to the organization stakeholders' goals. "The aggregation method is also used to give best practice a relative importance value in terms of its contribution to the organization's global strategic goals"(Xu&Yeh, 2012).

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TRIP DISTRIBUTION AND TRAFFIC ASSIGNMENT FLOW OF ROADS NETWORK IN URBAN AREA IN VLORA, WITH TRANSCAD

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ABSTRACT

During the performance in planning process of the traffic flows in an urban area, the case of Vlora City, a very important stage is the distribution trip phase or the build of the matrix of tripping O-D. For the build of this matrix is important the balanced table of trip, generated and extruded. Method that have to be used for the distribution trip, is gravitational method. Build of tripping matrix is the base for the loading in the roads network of the urban zone. This is accomplished next phase that is the traffic assignment phase (assignment). Assignment of traffic flow over the road network will be based in method "all or nothing". Both phases have to be worked in TRANSCAD program. On the base results, we will draw the relevant conclusions, which will be issuing the part of network less loaded and the issuing parts with more heavily loaded.

Keywords: *distribution, trip, flow, assignment, method.*

1. INTRODUCTION

City of Vlora is an urban zone, which in recent years has begun to feel the effect of a huge traffic flow. From year to year, the number of vehicles have been increased. By being a touristic town, in summer and winter time, is demonstrated the flow of increase vehicles. Vlora have a great potential of development, in terms of truism as well as in commercial and industrial fields. This refers to the position as a seaside town and with the port connected on it, and being one the connected gate between Albania and Italy, and with other countries. After '90, in town has a huge increase of rural population toward the city, which is still continue till now.

This has make the traffic flow over the roads network in city to be feels more, not only in the certain periods of the year, but also in the peak hours. This situation has led to an urgent needed plan and a better distribution of traffic flow over the roads network. In this time we don't have an engineering using method for the planning of traffic flow over the roads network in city, below I will present a method how it can be done.

For the realizing this, first of all is necessary to build the tripping table generated and extruded, in which for our study we will take it from a previous work. Table has come from the calculation of tripping regression, relying on on-line data extracted from the relevant institution relating on number of population, the assets, activities and the measurements of traffic flow which are measured in certain points of roads network of urban zone.

Balanced trip table in one column contains generating trip and in the other column are the diverted trip. This table, with TRANSCAD program, by using gravitational method, will be spread for every pair O-D, by taking in the end the trip matrix. This matrix contains traffic flow that will be done for every pair O-D.

On the base of tripping matrix for every pair O-D we will pass the traffic assignment fluxes over the road network in the urban zone. For the traffic assignment fluxes will be used the method "all or nothing". After we assign the matrix over the road network, we see also the other part of network that is less loaded and also those more heavily loaded.

The importance of this work, is based in the fact of base of outcoming result can be make a better organization of traffic flow, by diverting it from the other part of network assignment in that less assignment. At the same time can be serve also like a base for planning investment for possible intervention in infrastructure or the building of new infrastructure. Graphic of traffic flow over the road network can be served also as a base for urban development, by keep the acceptable reports between house living and the number of available vehicles. Also, another intervention for traffic flux reduce, can be the alternative of planning urban transport.

2. MATERIAL AND METHODS

For the realization of this work, we will focus on the classic model of transport. Classic model is split in four phases. In the first phase gather the social – economic data and those for the territory. Also made measure of traffic flow over the road network in urban zone, which will become the tripping plan. Second phase is the generated phase and the trip attraction, with such factors as, population, activates, number of vehicles etc. During this phase, also is effecting prediction for the future by using. If we will have to anticipate a later period for example year 2030, we chose the technique of growing factor. Basic equation is:

$$T_i = F_i \cdot t_i \qquad (1)$$

where T_i and t_i are respectively prediction for the future and actual trip in zone i, and F_i is the growing factor. The only problem of this method is the estimating of F_i, other part is useless. Factor is connected with variables like population (P), incomings (I) and the number of ownership vehicles in a function below:

$$F_i = \frac{f(P_i^d, I_i^d, C_i^d)}{f(P_i^c, I_i^c, C_i^c)} \quad (2)$$

where ***f*** can be a function without parameters, and service *d* and *c* describe the current year and the incoming year too. Over the base of founded formula from the regresion, recalculating once more the generating attracting trip. After recalculating, we make the balanced table, so number of generated attracted trips must be the same.

Third phase is the distributing tripping phase or builded phase of tripping matrix O-D. Every cell of trip matrix in every row *i*, contain the origin of trips in a zone and every respective cell of column *j*, destination in the other area that it corresponds. Main diagonal corresponds travel within the area. T_{ij} is the number of trips between origin *i*and destination *j*. All the traveling group is marked with $\{T_{ij}\}$ or T. O_i is the total number of tripping that it has the origin in zone *i*, and D_j is total number of tripping that has the destination in zone *j*.

Building of this matrix is based in the model of gravitational distribution, in analogy with gravitational model of Newton. The simple formulation of gravity model is expressed as follow:

$$T_{ij} = \frac{\alpha P_i P_j}{d_{ij}^2} \quad (3)$$

where P_i and P_j are population origin and the destination, d_{ij} is distance between *i* and *j*, while α is the factor of probability (with unit of distance – trip^2 / population^2).

Using of method with analogy with law of gravity, instead of total population, use of total trip (O_i and D_j) and a parameter *n*, for calibrating like power for d_{ij}.

Fourth and final phase is the traffic assignment phase. Through this phase is made the matrix assignment of trip over the road network which is in review. Too many methods are used for the assignment traffic flow over the road network, but we will use technique "all or nothing assignment" which is also more simple method. This method assumes that there are no traffic jams and drivers have the same attributes in the selection of the road and they perceive in the same way method. This means that every driver for going from *i*to *j* will chose the same road, and no other driver has chosen another road to go from *i* to *j*. Algorithm of traffic assignment is a procedure which it attract matrix T for tree of shortest path and produce fluxes $V_{A,B}$ in connection (between nodes A and B). All the algorithmic of attraction started with beginner phase, in this case, making all $V_{A,B} = 0$ and then apply one of the two classic methods: method pair to pair and between approximations.

Method pair by pair: in this case we start from an origine and we take destination take on. In the beggining we start with $V_{A,B} = 0$. Then we continue for every pair (*i*,*j*).

Walking through: this method is known as method "cascade" and it assignment the accumulated fluxes from the nodes to connections by follow the minimal cost tree from a origin *i*.

2. RESULTS AND DISCUSSION

Continuing the above reason, as the beginning we present the unbalanced table. This table is built by connecting statistically through mathematical regression, generated and attracted trips with other factors, which are the population, number of ownership vehicles, number of activities, etc. With "Origin" we mark the centroid codes, which are the center zones, and ID are numbers of identification zones.

Table 1. Unbalanced table of generated and attracted trips for years 2012 – 2030

Origin	ID	Gen_'12	Attr_'12	Gen_'30	Attr_'30
123	1	450	703	1517	812
142	2	1223	1408	1606	2286
124	3	971	818	1713	1288
146	4	246	1103	1001	745
134	5	495	447	1789	920
143	6	360	796	1167	1730
131	7	754	433	1909	579
156	8	612	987	374	1644
140	9	369	456	1335	808
147	10	423	116	951	406
151	11	488	475	475	1034
150	12	746	628	895	1392
144	13	400	470	380	922
148	14	879	433	400	1094
127	15	15	36	487	506
126	16	919	383	181	1462
152	17	2127	1755	4255	4698
128	18	1001	829	754	1512
154	19	475	666	1487	1216
129	20	33	7	225	178
122	21	948	584	1455	1722
176	22	19	22	79	123
136	23	905	1410	1487	2836
138	24	669	545	1499	657
132	25	780	1073	548	1984
Total		16304	16584	27969	32554

This table doesn't guarantee that number of generated trips from zone O_i, to be equal with attracted trips from zone D_j, according to equation below:

$$\sum_i O_i = \sum_j D_j \quad (4)$$

For this reason, normal practice, is that all destinations D_j to be multiplied from a factor f, which is given like below:

$$f = T \Big/ \Sigma_j D_j \quad (5)$$

As a conclusion, by doing the procedure of balanced trips with TRANSCAD, we can give the final balanced table for all generated attracted trips from each zones, for both years we took in consideration.

Table 2. Balanced table of generated and attracted trips for years 2012 – 2030

Origin	ID	Gen_'12	Attr_'12	Gen_'30	Attr_'30
123	1	450	691	1517	697
142	2	1223	1384	1606	1964
124	3	971	804	1713	1106
146	4	246	1084	1001	640
134	5	495	439	1789	790
143	6	360	782	1167	1486
131	7	754	426	1909	497
156	8	612	970	374	1412
140	9	369	449	1335	694
147	10	423	114	951	349
151	11	488	467	475	889
150	12	746	618	895	1196
144	13	400	462	380	792
148	14	879	426	400	940
127	15	15	36	487	435
126	16	919	376	181	1256
152	17	2127	1725	4255	4036
128	18	1001	815	754	1299
154	19	475	654	1487	1045
129	20	33	7	225	153
122	21	948	574	1455	1479
176	22	19	22	79	106
136	23	905	1386	1487	2436
138	24	669	536	1499	565
132	25	780	1055	548	1705
Total		16304	16304	27969	27969

After having the balanced table above, of generated and attracted trips, we can continue through TRANSCAD the procedure of distributing trips, which is based in the gravitational model of distribution.

For the year 2012, distributed matrix will be reflected as in the table above. In rows are reflected origin fluxes for each zone, while in columns are fluxes for each zone as a destination. In diagonal of trip matrix are trips that can take place inside each area and who consider as zero.

Same procedure will be make with TRANSCAD also for year 2030, table that reflect trip matrix with the same data as the table of 2012, is given below. After we build trip matrix, we start the last phase, which is the phase of assignment fluxes of traffic over the road network, of urban space of Vlora. Also this phase will be realized with TRANSCAD.

As we mentioned above, we will use the method "all or nothing assignment". Graphical presentation of traffic over the road network with method "all or nothing assignment" also realized with TRANSCAD program, is presented below.

In this graphic are presented traffic fluxes over the road network in city of Vlora with method "all or nothing", realized with TRANSCAD, for year 2012 and 2030. For each part of network are presented also fluxes value. We can easily see each part of network more assignment and those less assignment. Over the base of this presentation we will do also the analyses and conclusions.

Figure 1 Introduction of traffic fluxes over the road network of urban space in city of Vlora with method "all or nothing", realized with TRANSCAD for year 2012

Figure 2 Introduction of traffic fluxes over the road network of urban space in city of Vlora with method "all or nothing", realized with TRANSCAD for year 2030

Table 3. Distributed matrix of trips with gravitational model for year 2012

2012	Des																									
Orig.	122	123	124	126	127	128	129	131	132	134	136	138	140	142	143	144	146	147	148	150	151	152	154	156	176	Tot.
122		58	55	24	2	48	0	26	61	26	82	29	27	91	40	25	78	6	23	34	26	103	34	48	1	948
123	24		27	11	1	22	0	12	29	13	39	14	13	45	19	12	39	3	11	17	13	48	16	23	1	450
124	41	48		24	2	49	0	28	66	29	88	31	29	101	43	27	77	7	24	36	27	106	35	51	1	971
126	35	39	47		2	53	0	25	61	25	84	30	24	81	43	25	60	6	23	33	24	111	37	50	1	919
127	1	1	1	0		1	0	0	1	0	1	0	0	1	1	0	1	0	0	1	0	2	1	1	0	15
128	37	41	51	27	2		0	27	68	27	93	35	27	89	51	28	64	7	27	38	28	130	43	59	1	1001
129	1	1	1	1	0	2		1	2	1	3	1	1	3	2	1	2	0	1	1	1	5	1	2	0	33
131	28	32	41	18	2	39	0		53	22	71	25	21	72	34	21	51	5	19	28	21	83	28	40	1	754
132	29	34	42	19	2	42	0	23		23	77	28	23	75	38	24	53	6	21	31	23	92	31	44	1	780
134	19	22	27	12	1	25	0	15	35		45	16	14	48	22	14	34	3	12	18	14	54	18	26	1	495
136	35	40	50	24	2	52	0	28	69	27		33	27	88	45	27	63	7	25	36	27	111	37	52	1	905
138	23	26	33	16	1	36	0	18	46	18	60		18	58	35	20	41	5	19	26	19	83	28	40	1	669
140	14	17	20	8	1	18	0	10	25	11	32	12		37	16	11	26	3	9	14	11	40	13	20	0	369
142	51	60	76	30	3	65	0	37	89	38	116	42	40		58	37	95	9	33	49	37	141	47	68	2	1223
143	12	14	17	9	1	20	0	9	24	9	32	13	9	31		11	22	3	11	15	11	49	16	23	0	360
144	14	16	20	9	1	20	0	11	27	11	35	14	11	36	19		25	3	11	17	12	47	15	23	1	400
146	12	14	15	6	1	13	0	7	17	7	22	8	8	26	11	7		2	6	9	7	27	9	13	0	246
147	15	17	21	9	1	20	0	11	28	11	36	14	12	38	19	13	27		12	18	13	48	16	24	1	423
148	29	34	41	20	2	44	0	22	57	22	74	31	23	74	45	26	52	6		38	27	114	37	58	1	879
150	25	30	37	17	1	37	0	19	49	20	64	26	21	66	37	23	47	6	23		26	93	30	48	1	746
151	17	20	24	11	1	24	0	13	32	13	41	16	14	44	23	15	31	4	14	23		58	19	30	1	488
152	77	86	107	56	5	128	1	58	147	58	197	80	58	190	123	65	135	16	68	92	67		117	194	3	2127
154	16	18	22	11	1	26	0	12	30	12	41	16	12	39	25	13	28	3	13	18	13	72		32	1	475
156	20	23	28	14	1	32	0	15	38	15	51	21	16	50	32	18	35	4	19	26	19	106	29		1	612
176	1	1	1	0	0	1	0	0	1	0	2	1	0	2	1	1	1	0	1	1	1	2	1	1		19
Total	574	691	804	376	36	815	7	426	1055	439	1386	536	449	1384	782	462	1084	114	426	618	467	###	654	970	22	16304

Table 4. Distributed matrix of trips with gravitational model for year 2030

2030	Des																								
Orig.	122	123	124	126	127	128	129	131	132	134	136	138	140	142	143	144	146	147	148	150	151	152	154	156	176	Tot.
122		56	70	70	25	69	8	28	89	45	134	29	39	116	73	40	43	18	45	60	45	236	51	62	5	1455
123	119		71	66	24	66	7	28	89	46	133	29	41	119	73	40	45	19	46	62	47	229	50	63	5	1517
124	106	51		77	29	78	8	34	106	55	158	34	47	142	86	47	47	22	53	72	53	269	59	74	6	1713
126	10	5	7		3	9	1	3	11	5	17	4	4	13	10	5	4	2	6	7	5	32	7	8	1	181
127	28	13	21	23		23	2	9	30	15	45	10	12	36	25	13	12	6	15	19	14	78	17	21	2	487
128	40	18	30	37	12		4	14	46	22	70	16	18	52	43	21	16	9	25	31	22	138	31	36	3	754
129	11	5	8	10	3	11		4	12	6	19	4	5	14	12	6	4	2	7	9	6	46	9	11	1	225
131	103	48	81	84	31	87	9		121	61	181	39	49	144	97	53	44	24	59	78	57	302	67	82	7	1909
132	30	14	23	25	9	26	3	11		17	55	12	15	42	30	16	13	7	18	24	18	93	20	25	2	548
134	98	47	78	79	29	81	9	37	114		168	37	48	141	91	50	43	23	56	75	55	284	63	78	6	1789
136	84	39	65	72	26	76	8	31	103	48		34	40	116	84	44	36	20	51	66	48	262	58	71	6	1487
138	73	34	57	64	22	71	8	27	91	42	135		36	102	86	43	31	19	51	65	46	262	58	72	5	1499
140	74	36	59	56	21	59	6	26	83	42	120	27		108	68	38	33	18	43	58	44	210	46	59	5	1335
142	97	47	78	73	27	75	8	33	105	54	154	34	48		85	47	43	22	53	71	53	263	58	73	6	1606
143	57	27	44	51	17	57	7	21	70	33	104	27	28	79		34	24	15	43	52	37	227	50	62	4	1167
144	19	9	15	16	6	17	2	7	23	11	34	8	10	27	21		8	5	13	18	13	64	14	18	1	380
146	67	33	48	44	16	44	5	19	60	31	89	19	27	80	49	27		12	30	41	31	152	33	42	3	1001
147	48	23	38	38	14	41	5	17	57	28	83	20	25	69	50	29	21		32	44	33	155	34	44	4	951
148	19	9	15	16	6	18	2	7	23	11	34	9	10	27	23	12	8	5		19	14	74	16	21	2	400
150	45	22	35	36	13	40	4	16	54	25	78	19	23	63	50	27	20	12	34		34	160	34	47	4	895
151	24	12	19	19	7	21	2	8	28	14	41	10	12	34	26	14	11	7	17	25		82	17	24	2	475
152	238	108	178	217	70	240	32	84	280	131	421	105	112	318	294	135	98	59	177	217	154		234	335	19	4255
154	70	32	53	64	21	72	9	25	84	39	126	31	33	94	88	40	29	17	51	62	44	316		81	5	1487
156	17	8	13	15	5	17	2	6	20	10	30	8	8	23	21	10	7	4	14	17	12	89	16		2	374
176	4	2	3	3	1	3	0	1	4	2	6	2	2	5	4	2	2	1	3	4	3	14	3	4		79
Total	1479	697	1106	1256	435	1299	153	497	1705	790	2436	565	694	1964	1486	792	640	349	940	1196	889	4036	1045	1412	106	27969

3. CONCLUSIONS

Judging by the appearance of traffic flows on the road network of the city of Vlora, we can say that it is completely possible to use engineering planning modeling traffic flows.

To realize this, it is necessary to gather all information from institutions as civil offices for number of population, registration vehicles office, tax offices for the number of businesses, the road network and administrative division planning offices in municipalities, etc.

From graphic presentation we see that traffic flow will be increased on road network, compare year 2012 with year 2030. This comparison is made by considering that the road network of the urban area is the same. For year 2030 is considering also the build of Vlora city by-pass, which will reduce the traffic flow in entrance, from highway, in northern part.

Noted that the part of road network along the seaside is less assignment and it has to be found a solution for the part of fluxes who are passing by. This can be realized by the local authorities, who can invest in the improvement of the road, both in quality and in the expansions.

Another intervention that can be realized, is also the better organization of traffic, especially in the heavy assignment parts.

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SOME FORMS OF POLITICAL UNITY IN EUROPE BEFORE THE ADVENT OF THE EUROPEAN UNION

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ABSTRACT

Due to its geographical location and its culture and economy, Europe has never been a closed or isolated area from the rest of the world. Since antiquity, the first forms of government in Europe have proven economic, cultural and spiritual openness. The openness is partially the result of the geographical and cultural specificity of Europe. This openness led to the appearance and development of major trade routes of antiquity. The development of the trade routes resulted in the development of economy and has strengthened the economic and cultural relations among the European nations. To the closeness of the European states contributed the diversity of natural resources, soil fertility and the deepening social division of labour. The first attempts of association and alliance of European states are lost in the mists of time. A first step in the development of legal rules related to public international law was the occurrence of the first interstate military alliance. Concluding alliances using international treaties or agreements proved necessary to resolve international disputes. Countries in Europe have been associates and "friends" in one way or another in order to avoid wars. Leaders of European countries and thinkers of the time conceived the idea of "building" a federation of states or a large European country to avoid any war.

Keywords: *Europe, history of Europe, the European Union, European unity.*

1. INTRODUCTION

Since ancient times, the leaders of the Greek sought to maintain permanent political dialogue and alliances. Alliances were made especially by concluding marriages between different royal families. The first royal marriages were made for political purposes between Greek city-states. Ancient Greece "invented" the first social and political rules, rules of law on private property and freedom of the citizen. Along with technical progress, city-states emerged (*polis* in Greek). A fortress - state was virtually an administrative-territorial entity with its own territory, population, legal and religious rules. Legal marriages between different families led to the first forms of "union between countries." Among the great thinkers of antiquity, Plato first supported the idea of peace by establishing a confederation of Greek states. A confederation should to be based on religious institutions and existing political institutions. Direct negotiation or arbitration must be ways of resolving disputes between Greek states [1]. Subsequently, for the first time in history, countries of Europe were united under the sceptre of Rome. The redoubtable military force of the "eternal city" managed to bring European countries under the same administration rules for the first time. Unfortunately, the brutal way in which this association was made and the lack of diplomacy in dealing with people made this "union" exist only formally. The Roman administration didn't serve to develop the generous ideas of unity but to satisfy economic and financial interests of the aristocracy and the Roman emperors. Because of these reasons, the collapse of the Roman Empire meant the ending of the so called "union of states" under Roman domination. Anyway, the importance of Roman domination results, as well, from the fact that, for the first time in history, the countries of the Mediterranean basin were under the same administration and the same rules [2].

2. IDEAS ABOUT THE EUROPEAN POLITICAL UNION DURING THE MIDDLE AGES

Some thinkers believe that the Carolingian state laid the foundation of the first European unification, taking as its starting point the Christian ideology. Charlemagne was King of the Franks and master of Rome, whose patron he is considered to be, in tandem with the Pope. By his key position, Charlemagne appears as an undisputed leader and master of the West European Christianity [3]. At that time, he just missed a title by which to be recognized as the heir of the Roman emperors. In December 25, 800 in St. Peter's Basilica in Rome, Charlemagne was proclaimed emperor of the Romans, and crowned by the Pope. This imperial coronation marked the existence of an empire with a single chief having the mission to propagate the Christian faith, given that Byzantium was in full decline at that time, having serious economic and social problems. The period during which Charlemagne was a king meant a real renaissance of culture and arts. This revival was supported by the legal provisions issued by the imperial chancellor, the financial support and also because of the tax exemptions of the monasteries. Also, at that time the royal palace school and major network Benedictine monasteries were famous where priests were great literati and poets of the time. Meanwhile, the priests were charged with supporting and popularizing values of the Christian church, so they became teachers for the future "Christian teachers". Episcopal parishes and schools were established gradually throughout the empire and actively promoting social, political and cultural heritage of Western Christianity [4]. The main political and philosophical ideas about society and the

state in the late Middle Ages belong to common models. These models were developed by the Christian Church of the time, which was all-powerful. Based on unbounded power in society, the church adopted a set of moral reform, promoting the so-called *"pax Cristiana"* (Christian peace). The church strengthened the role and place of the family in society, promoting the Christian religious type marriage. Gradually, throughout the Western Christian church schools and universities were established, which were attended by young people from all over Europe. The network of universities in the Middle Ages developed, especially three university centres: Bologna, Oxford and Paris. Thanks to legal provisions issued by the Pope, three subjects were considered fundamental at that time - theology, Roman law and medicine. Teachers in universities at that time were considered "masters" and in order to teach those subjects, they had the obligation to be holders of so called "licenses". Teachers who came into possession of "licenses" had the right to teach at several universities in Europe, through the so-called academic wanderings. Among the "masters" of those times we could mention Thomas Aquinas or Roger Bacon. These developments led to a sharp growth of the society, which began for the first time in history to embrace the idea of European unity based on religious unity imposed by the strong Catholic Christian church. The idea of European unity was imposed due to repeated peacekeeping attempts dating back to antiquity. The first theories were based on religious dogmas of the Christian church. A practical way of achieving this goal would be war against infidels who occupied the "holy land of Jerusalem." This large European republic should be led by the sovereign Pontiff. Major legal issues that would have arisen from the state level should be solved by "apostolic council" formed by several bishops who ought to have its headquarters in the Vatican. Beyond the common bond created by Christianity, Europe underwent a series of important steps in the economic and commercial. Trade was a real "engine" of rapprochement between different European countries. Continuous attempts to remove customs "barriers" of the free movement of goods led to the removal of obstacles to the circulation of ideas and people [5]. In an attempt to develop trade in Europe, the countries of the Middle Ages built a vast trans-European road network. Creating this network of roads has boosted trade between states but gave an unexpected cultural exchanges boost. In the Middle Ages are developed communications and sciences grace to appearance of the major European roads - along the Danube, the Rhine, the Atlantic Ocean, the Black Sea, the North Sea, the Mediterranean and the Baltic Sea.

3. THE PRESENTATION OF THE EUROPEAN UNIONISTS IN MODERN TIMES

In the modern era, between theories supporting the idea of the European unity, there stood the German thinker Immanuel Kant. Kant elaborated a comprehensive study according to which the common political will of the European countries can establish permanent peace. To achieve this, it was necessary to create a confederation of states at the European level. This international organization should develop its own constitution. The Constitution ought to govern the relations and mechanisms of good cohabitation between these states. This European fundamental law should be assumed by all Member States freely. Permanent peace was necessary for the settlement of disputes between states to use some principles of public international law:

• renunciation of force in settling disputes between states.

• non-interference in the internal affairs of member states.

• using the negotiation and the diplomatic solutions.

Immanuel Kant advanced for the first time in history the idea of abolition of the permanent military service. He wanted to use a body of civil servants specialized in this field. Another way of achieving the much-needed eternal peace was identified by the philosophical school of the abbey of Saint-Pierre. This philosophical school believes that the use of public international law in solving disputes between states would have led to the accomplishment of the objective. According to representatives of the abbey, in order to eliminate the war, a system of international treaties of peace has to be established. These treaties should include all European countries and a set of legal rules should be stipulated, aimed to:

• keep the balance of forces among European countries.

• ensure borders of the European countries.

• promote interstate agreements especially in the economic and financial area [6].

• establish a permanent senate, made up of representatives of each European country. Important decisions should be laid in the hands of the Senate, referred to the territorial reconfiguration or change of the power relations. Any war between European states and a third country should be subject to the prior approval of the Senate. In cases in which a State shall not accept the decision of the Senate, it could be subject to sanctions. One of the harshest penalties could be related to removal of the right to have its own army. Senate decisions were to be adopted by a vote of at least two thirds of the Senators present. Another way to achieve eternal peace is presented in the nineteenth century by Prince Adam Czartoriski. Conclusion and adoption of an European code of international law could meet the European dream of eternal peace. That code shall govern political and diplomatic relations between the European countries. Guarantee the observance and enforcement of this code of international law could be made by the British Empire and the Russian Empire, which were the major European powers of the time. In the early nineteenth century, for the first time in history, the idea of a Society of Nations appeared [7]. The idea belonged to the politician and philosopher Joseph de Maestre, who wrote the famous book -"Soirees of St. Petersburg". In this book he established the idea of a society of states that have some common political and economic goals. Achieving these goals would lead necessarily and maintain a state of permanent peace. These ideas were quickly embraced by thinkers of that time and they actively progressed. The famous 1849 speech of the great writer Victor Hugo at the Paris Peace Conference. Addressing those present Hugo said: "the day will come when the weapons will be

forgotten and will be replaced by the free word and universal voting rights for all the peoples of Europe". This phrase made history and proved him as a true prophet. Another idea was a Swiss Johann Kaspar who in 1878 developed a theory stating that the judicious use of public international law would remove the threat of war. Establishment of a European confederation of states ruled by a European Council and the European Senate is the right way to bring peace. The Council and the Senate would be composed of representatives of all Member States. These national representatives should be elected by the population using the direct vote. The two institutions were tasked as executive (the Council) and legislative tasks (the Senate).

4. EUROPEAN THEORIES ABOUT UNITY AFTER THE SECOND WORLD WAR

After completion of the Second World War, Europe was devastated by the damage suffered and was in a critical financial and economic situation. Political institutions of the European countries were close to collapse and the two world superpowers had already started their first European disputes concerning the supremacy over the continent. United States openly expressed their desire to maintain their political and military influence, especially in the western European continent. Another stated goal was to stop the rise of communism system in the world. Union of Soviet Socialist Republics (U.S.S.R.) has started the expansion of its sphere of political influence by setting up many communist totalitarian regimes in "the old continent". Existing political and diplomatic situation caused major political and economic changes in Europe. Also, there were a series of significant changes in diplomatic and legal system. The existing situation determined the majority of the European countries to conclude successively several treaties, agreements and international multilateral understandings. Political and diplomatic relations between the United States of America and U.S.S.R. increasingly deteriorates during 1947 – 1950 period, amid the struggle for the world and European supremacy.

United States of America's President Henry Truman believed that democratic European states in Western Europe had to stand united and face together the communist danger. President Truman decided that only substantial economic aid would be able to limit the Soviet expansion. The historical conditions determined Western Europe countries to conclude a vast coalition to face domination and pressure from the Soviet Union manifested mainly in Eastern Europe, where "the Soviet boot" was being experienced very acute.

During this difficult context, the ideas of federalization of Europe were gaining more and more followers and adepts. In 1947, the British Prime Minister Winston Churchill showed publicly the generous idea to create a "World Peace Temple" which had to be built on "four pillars": U.S.A., U.S.S.R., "United States of Europe" and "the British Empire"[8]. According to the British politician, this vision of the "United States of Europe" did not include the United Kingdom, who was a guarantor of the constitution of the federal structure, but did not have to be part of this European structure. On the background of the "cold war" between the communist Eastern team and the Western Europe, General George Marshall, Secretary of State, founded in 1947 a team of specialists in the field of economy and finance, a team led by one of his leading advisors, George Kennan. The central aim of the specialist team was to design an economic and political strategy for economic and financial support to help out Europe, devastated by World War II. The American team had contact with the French Foreign Minister, Jean Monnet. Finally, after a laborious work, the team advisor George Kennan drafted and presented to the public "The recovery program for Europe", well-known in the specialist literature as the "Marshall Plan."

"The recovery program for Europe" was launched in the summer of 1947, after intense media coverage. To popularize the Marshall Plan media from the United States of America and Western Europe were used. The Marshall Plan was implemented in order to restore the economy of "the old continent" seriously affected by the Second World War. Restoration and reconstruction of Europe wanted to be achieved by providing economic and financial aid to all European countries. Although the "Marshall Plan" was addressed to all European countries, the aid was not accepted by all countries of Europe. The economic and financial plan was accepted only by Western European countries. For purely political reasons, under Soviet pressure, six European countries refused the American aid - Albania, Czechoslovakia, Finland, Yugoslavia, Poland and Romania, despite the fact their national economies were destroyed by the Second World War.

Once enacted, the plan provided assistance to European countries. U.S. transferred five billion U.S. dollars each year. Prerequisite for countries to benefit from this aid, is to establish a social order based on respect for democratic principles widely recognized. To manage issues related to the implementation of the Marshall Plan, the Americans decided to set up a structure called the Organization for European Economic Cooperation [9].

European Economic Cooperation Organization has been operating, bearing in mind the achievement of two very important economic and financial objectives:

- the first objective was to avoid economic collapse caused by the destruction of war. The first goal was achieved in 1952, after the United States of America completed grant of U.S. $ 17,000 billion in Western Europe countries.
- the second objective, aimed at strengthening European economic cooperation is permanent. "The Marshall Plan" sought to intensify economic cooperation, especially by reducing taxes and tariffs and by reducing unemployment (by creating new jobs). Decreasing of the inflation was another important objective of the plan. The end of the Marshall Plan led to the intensification of cooperation in western European countries. The completion of the American plan stabilized the prices of raw materials and fuel and last but not least, established a sharp political and economic stability, which removed Soviet influence in the Western European countries. It is interesting to note that even after the end of the

"Marshall Plan" in 1952, the organization continued to exist as a space to promote free trade among the member countries. Over time, this organization received new members and other developed economically countries. It eventually became, in 1961 the Organization for Economic Cooperation and Development (OECD), well known in the economical European area and not only in this space.

5. CONCLUSIONS ABOUT EUROPEAN UNIONIST IDEAS

Finally, before the creation of the European Union, all these theories led to the emergence of generous ideas:
• ensuring joint economic development of European countries.
• ensuring higher standards of living for all citizens of the European states.
• ensuring the historical desideratum to avoid any conflagration in Europe.
• ensuring the defence of democratic rights and freedoms in the common European space.
• creation of political and economic preconditions for strengthening cooperation between European countries.
• harmonization and standardization of national laws.
• elimination of customs duties, protectionist obstacles and import-export restrictions.
• developing and adopting common legal rules to ensure free movement of the persons, capital and services.
• development and adoption of legal rules to help coordinate and standardize economic policies and the financial and banking system of the Member States.
The historical importance of these ideas is above any question. However, most of these ideas will be found in the European legal norms of the European Union today. A few figures show up the importance of these ideas today. Operating as a single market with 28 countries, the European Union is one of the largest worlds trading power. European Union economic and financial strategies seek to intensify growth by investing in infrastructure, industry, transport, energy and scientifically research. The European Union today is permanently looking for development minimising the negative impact on the environment. The European Union's economy (taking into account the goods and services it produces – G.D.P.) — is now larger than the United States'. European Union's G.D.P. in 2012 was estimated at 12,000,000 million EURO. The European Union population represents about 7% of the world's population. The European Union's trade with the rest of the world accounts for about 20% of global exports and imports. Around two-thirds of the European Union countries' total trade is done with other European Union countries [10]. The EURO currency is used every day by about 332 million Europeans. This currency is not only regular money but is the most important and concrete proof of cooperation between European Union countries. Its benefits are immediately obvious to investors and banking system [11]. The single currency is encouraging the European cooperation and common policy in the financial and economic area. The European Union today wants to enhance further the democratic ways of cooperation between the Member States. Its policy is aiming to achieve the strengthening and the convergence of Member States economies and to develop the economic and monetary union including extend on European level of its single and stable currency. The Union permanently promotes economic and social progress for population, taking into account the principle of sustainable development and within the context of the accomplishment of the internal market and of reinforced cohesion and environmental protection [12]. The member States agreed to implement policies ensuring advances in the economic integration accompanied by parallel progress in other domain. The European Union implements a common foreign and security policy among Member States including the progressive framing of a common defence policy, reinforcing the European identity and its independence in order to promote peace, security and progress in Europe and in the world [13].

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LISBON TREATY - ORIGINS AND EXPECTATIONS

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ABSTRACT

The establishment of the European Communities in the '80s was one of the first steps in the process of developing the European Union as we know it today. Creation of the European Union marked the beginning of a new phase in European countries that have made efforts to understand the need for the working team. Its fundamental principles were also established - freedom, democracy and human rights, aiming to promote economic and social progress. Through a series of international treaties adopted at European level structures have been established that we call the European Union today. These treaties, known as "modifying treaties" began with the Marshall Plan in 1947 and ended in 2009 with the well-known Lisbon Treaty. U.E. today operates through a system of supranational independent institutions that make decisions through negotiation with Member States. The most important institutions of the European Union are: the European Commission, European Parliament, European Council, European Court of Justice and the European Central Bank. Perhaps the most important achievement of the European Union is the creation of the European single market comprising a unified system of economic and financial laws which apply in all member states. Legal rules imposed by the European Union guarantees the free movement of people, goods, services and capital. European law promotes common policies in the field of justice and home affairs, environment, health, agriculture, commerce and agriculture. There is a clear set of rules within maritime domain, fisheries and regional development. It was also established a monetary union, the so-called "Eurozone" currently consists of 17 states. Union has a combined population of over 500 million, i.e. about 8 % of the world population. The European Union had an annual GDP of about 18 trillion U.S. dollars in 2011. That means it is the first in the world bringing together about 21 % of global GDP.

Keywords: *Lisbon treaty; European treaties; European Union, European institutions.*

1. INTRODUCTION

The beginning of the unification started with six European countries, namely Belgium, France, Germany, Italy, Luxemburg and the Netherlands that, by the Treaty of Paris signed on 18 April 1951, established the European Coal and Steel Community, designed to manage the production of coal and steel under a common market by removing customs barriers. This treaty was considered as the foundation of the eternal peace within Europe after the end of the Second World War. On March 25, 1957, the same signatories decided by a treaty concluded in Rome, creating of the European Economic Community, EEC and the European Atomic Energy Community - Euratom. After changes and improvements in institutional and organizational level the number was increased to nine Member States, respectively by Great Britain, Denmark and Ireland in 1979. In 1981, Greece joined, followed in 1986 by Spain and Portugal [1]. Despite the fact that, in the beginning, initial measures were just economic, they evolved into political cooperation. The phrase "European Community" means a set of international organizations based on economic integration and limiting the sovereignty of Member States. Member States were not asked to give up sovereignty, but to transfer parts of their authority to European level. Early 1980s led to an opinion current on the importance of freedom of movement of persons within the European Community. After numerous discussions, representatives of the same European countries, namely France, Luxemburg, Germany, Belgium and the Netherlands decided to create an area without internal frontiers. The agreement between these countries was signed on June 14, 1985 in the town of Schengen in Luxembourg. On June 19, 1990 the Convention implementing the Schengen Agreement was signed, all such documents consecrating the abolition of controls at internal borders of the signatory states and creating a single external frontier, where checks are carried out according to a strict common set of rules. Also, common rules on visas, migrants, asylum seekers and measures concerning police cooperation, judicial and customs were established. We cannot omit the adoption of the Unique European Act in 1987, which planned a six-year comprehensive program, aimed to resolve issues related to free movement of goods within the EU. Thus, legal rules and standards were established in the area of free movement of goods, services, capital and people across the European Community along with "the single market".

In 1992 the *Maastricht Treaty* was signed establishing the *European Union* consisting of 12 Member States, modifying forever the concept of *European community*. The Treaty provisions sought implementation of a common foreign security policy, while defining a common defence policy, the expansion of economic integration in the monetary and political issues. The treaty established the duties of the European Parliament, the European Council, European Commission, Court of Justice and the Court of Auditors. In 1995, the EU accession process continued with the admission of Austria, Finland and Sweden.

The Treaty of Amsterdam, signed on 2 October 1997 introduced four new large areas: freedom, security

and justice, the Union and its citizens, trying to improve the effectiveness of the foreign policy. By a protocol attached to the Treaty, the officials managed to incorporate the Schengen acquis into the legal and institutional framework of the European Union [2]. The year 2004 brought the admission to the Union for the following countries: Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, the Czech Republic, Slovakia, Slovenia and Hungary, and the second wave took place in 2007 marking the admission of Romania and Bulgaria. Finally, 2013 marked the admission of Croatia among the EU member states. Under these circumstances, the EU currently consists of 28 Member States, five candidate countries (Iceland, Montenegro, Turkey, Serbia, Macedonia) and 2 potential candidates (Albania and Bosnia and Herzegovina).

2. THE TREATY OF MAASTRICHT

It was signed by the European Council on February 7, 1992, and represented the most profound change of the treaties establishing the European Community. The European Union does not replace the old European Communities, but it brings together under a common umbrella a new policy and new forms of collaboration. The initial economic objective, namely the achievement of a common market, was overcome by the adoption of this treaty, expressed political vocation. Marking a new phase in the European integration, the Maastricht Treaty established the three pillars of the Union: the European Communities, the Common Foreign and Security Policy and police and judicial cooperation in criminal matters.

The first pillar consists of the European Community, the former European Coal and Steel Community (ECSC) and the former Euratom and refers to areas where Member States exercise sovereignty jointly by the Community institutions. Under this pillar, the used procedure is the Community method, namely the European Commission elaborates the legislative proposal, the Council and the European Parliament adopt it and the Court guards the application of it. The second pillar defines the Common Foreign and Security Policy (CFSP), referred to in Title V of the Treaty of the European Union. This replaces the provisions of the Single European Act and allows Member States to take joint action in foreign policy [3]. This pillar is subject to an intergovernmental decision-making process used unanimously. The role of the Commission and the Parliament is modest, and the jurisdiction of the Court of Justice on the matter doesn't count. The third pillar is devoted to cooperation in justice and home affairs (JHA) set out in Title VI of the Treaty of the European Union. The union aims to undertake joint actions to provide citizens with a high level of safety within an area of freedom, security and justice. The decision is also intergovernmental and created the European Police Office EUROPOL and other common policies have been achieved through ongoing coordination and harmonization of national objectives. The ultimate goal is to ensure common security of EU member states.

In this context, the Treaty of Maastricht answers five key objectives:

• strengthen the democratic legitimacy of the institutions;
• increasing the efficiency of the institutions;
• implementation of the economic and monetary union;
• community social dimension;
• establishment of a common foreign and security policy;

Community policy introduces eight new areas: trans-European networks, industrial policy, consumer protection, education and vocational training, youth and culture. Particularly important are the provisions on economic and monetary policy, especially those relating to the foundation of the Unique Market as a result of economic and monetary union. To achieve this goal, Member States shall coordinate their economic policies, establishing multilateral control of the coordination and follow certain rules of budgetary and financial discipline. The objective of monetary policy is the introduction of a single currency (Euro) and guaranteeing the stability of the currency, the price stability and the rules of the market economy principles [4]. Another new aspect is the concept of European citizenship, additional to national citizenship and the right of the free movement and residence within the Community, the right to vote and to be elected to the European elections in the residency state, right to diplomatic and consular protection, and the right to petition to the European Parliament and to the Ombudsman.

3. TREATY OF AMSTERDAM

It was signed on October 2, 1997, amended the Treaty of Maastricht and had 4 main objectives: to place employment and citizens' rights in the spotlight of the European Union, to suppress the last obstacles to the free movement of people and enhance security, enabling Europe to strengthen its position globally, and streamline the institutional architecture of the Union's future enlargement. Under the treaty, the employment is a very important chapter. Implementation of policies in this area lies largely in the hands of the signatory states, but the treaty establishes a framework for these policies. Thus, the objective of increased employment level is verified in implementing other common policies. Likewise, the employment situation is examined by the European Council and the Council of Ministers examines in detail the actions of the governments of Member States. Another important issue in the treaty is the general principle of equality (non-discrimination). It shall combat all forms of discrimination, whether based on race, ethnic origin, political beliefs, religion, sex, disability, age or sexual orientation. In this context it is strengthened principle of equality between women and men on the work market. The new treaty provides tools for the gradual establishment of an area of freedom, security and justice throughout the Union, establishing specific measures to create a European common border control, asylum and immigration. In the field of Common Foreign and Security Policy, the Treaty introduces new tools: the joint strategy, High Representative for the CFSP and the new Unit for Planning and Early Warning. Another innovation is the inclusion within CFSP of the humanitarian and crisis management. Institutionally, the Treaty promotes the reform of the European institutions and the enlargement. The Treaty established that the European law will be

adopted in qualified majority in the Council of the European Union in the fields of research and technological development, public health and customs cooperation [5]. Parliament will not have more than 700 members, regardless of the enlargement process and the jurisdiction of the Court of Justice extends to new areas such as immigration, asylum, visas and border crossings. For the first time, the Treaty establishes the principle of subsidiarity, according to which European law decisions should be taken at the level closest to the citizen. Although it contains many provisions which facilitate the progress of institutional reform in the European Union, the Treaty of Amsterdam leaves unresolved many important issues, such as those of social, employment, reducing unemployment, fiscal harmonization [6].

4. TREATY OF LISBON

The Treaty of Lisbon, known as the "Reform Treaty" has been signed by the European Union Member States on December 17, 2007 and entered into force on December 1, 2009. The Treaty amended the Treaty on the European Union (also known as the Maastricht Treaty) and the Treaty establishing the European Economic Community (known as the Treaty of Rome). Due to the Treaty, the European Union integrates the common foreign security policy, defence policy and police and judicial cooperation in criminal matters, in a structure which is intended to be consistent. The reason for the Lisbon Treaty is the fact that Europe is not in the same situation as it was 60 years ago. The world itself has changed and is not the same place as in the past. Europe has been changing since 1959 because of important phenomena: globalisation, demographic increase, security vulnerabilities, climate change, the need for green energy sources and starvation. The countries of the world in this century are facing other challenges as well. Frontiers of the European countries and not only do not count very much in the light of these issues. The European Union countries cannot easily face these threats alone. The unity of the countries means a lot in the European context, because together, the EU countries could stronger respond to the concerns of the public. For this, Europe needs to modernise, especially since in 2013 it expanded from 27 to 28 members, due to the accession of Croatia to the European Union. The modern difficulties need the effective coherent building capacity of the European Union to function properly and respond to the serious threats and vulnerabilities in the present world. That involved redefining some of the important rules of nation cooperation within the European Union. The Lisbon Treaty was signed in Lisbon (Portugal) on 13 December 2007 and established new rules and new criteria within the European club. The provisions of the Lisbon Treaty tried to established new and effective rules, in the political, economic, technical and social domains. These rules aimed to meet the need to live up to the hopes and expectations of the European public. The Treaty of Lisbon is a modern international agreement which established the European Union limits and possibilities. The treaty alters the structure of the European Union's institutions and the working system of those institutions and agencies. As a final outcome, the European Union proved to be more democratic and far more effective in its endeavour to meet its goals.

This treaty is the result of negotiations between EU member countries in an intergovernmental conference, in which the Commission and Parliament were also involved. The treaty was ratified by each of the EU's 28 members. It was up to each country to choose the procedure for ratification, in line with its own national constitution.

The achievements of the Lisbon Treaty can be summarized into four elements:

- a more democratic and transparent Union by increasing the power of the European Parliament (extension of co-decision procedure);
- a more effective Europe due to institutional changes;
- a Europe of rights and values, freedom, solidarity and security (including the Charter of Fundamental Rights into European primary law);
-Europe as a global actor (the establishment of the High Representative of the Union for Foreign Affairs and Security Policy.

It is important to note that the Lisbon Treaty establishes the legal personality of the European Union, stands as an institution of the European Council and the European Central Bank and the President of the European Council is converted into a permanent President of the Union, with a mandate of two and a half years. All that has been achieved so far is the result of a joint effort of nations of Europe. The two major dimensions of European integration are deepening and widening. The processes involved are complex and have many dimensions: economic, political, social, cultural. The essence of the Treaty is that the European Union is required to provide all its citizens an area of freedom, security and justice regardless the internal borders of the Member States. European citizens have guaranteed freedom of movement, being adopted common measures regarding border control, asylum and fighting organized crime. EU works for development of the internal market and creates a platform for the sustainable development of Europe, fostering scientific and technical progress, economic, social and territorial cohesion and solidarity among Member States. Europe as an actor on the global stage will be achieved by bringing together Europe's external policy tools, both when developing and deciding new policies [7]. The Treaty of Lisbon offered the European Union the necessary tools to work more effectively in the relationships with other countries and other international organization. The treaty allows the European Union to promote its values in economic, humanitarian, political and diplomatic domains. The diplomatic force of the European Union has increased by observing the specific interests of the Member States in the world. A new Foreign Affairs tool has been established. The new High Representative for the Union in Foreign Affairs and Security Policy reinforced the importance, the quality and the visibility of the European Union's on international level. The European External Action Service has been established, acting as a Ministry for Foreign Affairs of the European Union. The mentioned service will provide specialized back up and support to the High Representative [8]. Establishing one single institution to represent the European Union abroad

will strengthen the Union's negotiating power. All dialogues between the European Union and other third countries will be more effective on the world stage and more convincing. Progress in European Security and Defence Policy will preserve special decision-making arrangements but also pave the way towards reinforced cooperation amongst a smaller group of Member States [9]. The European institutions are organized and operate in accordance with the procedures and objectives of European law.

The Parliament is made up of representatives of EU citizens directly elected by them through a national election process. MEPs are elected by direct, free and secret ballot for a term of five years, each Member State having a number between 6 and 96 MPs, accordingly to the principle of representativeness and decreasing proportionately. The total number of MEPs is no more than 750.

The European Council is made up of all the Heads of State or Government of the Member States plus the President of the Council and High Representative of the Union for Foreign Affairs and Security Policy. The Council's role is mainly political, setting the general political priorities of the Union and the central objectives of its policy.

The European Commission is the European institution which constantly promotes the general interest of the Union and takes all necessary steps in this regard. So, it has the power to monitor how legal norms of the European treaties are implemented in national law and applied in the Member States. The Commission has legislative initiative in almost all areas of action, and coordinates overall activities unit. Each member of the Commission is selected on the basis of competence and professional reputation for a term of five years, and must carry out its professional work in complete independence, serving the interests of the European Union. Each commissioner represents a state of the European Union.

The Council of Ministers is composed of 28 Ministers representing each Member State. The profile of the Minister is given by the problem analyzed. This is a decision-making body that coordinates the economic policies of the Union, having common legislative and budgetary powers with the European Parliament.

The EU Court of Justice construes EU law to ensure that it is applied in the same way in all EU countries. It also settles legal disputes between EU governments and the European institutions. Individuals, businesses societies or organizations could bring a case before the Court of Justice if it considers that their rights have been violated by a European institution. The Court of Justice shall consist of one judge from each Member State, with a term of six years, and has the support of nine attorneys general.

The European Central Bank is responsible for defining and implementing the Union's economic and monetary policy. However the Central Bank monitories the European currency and prices stability in the Union, with the role of maintaining financial system stability.

The European Court of Auditors shall examine how EU funds are managed; serving to guarantee European citizens that public money is spent effectively. It does not have legal force, if irregularities are detected should inform the European Anti-Fraud Office. Also, this Court submits reports to the European Commission and Member State governments. European Parliament, European Council and European Commission shall be assisted by the Economic and Social Committee and the Committee of the Regions, both being advisory bodies. The Lisbon Treaty explicitly recognizes for the first time, the possibility for a Member State to withdraw from the Union.

5. CONCLUSIONS

As shown, the European structure is based on contemporary European legal rules, which are designed to operate and maintain a complex mechanism. Finally, this mechanism should provide multiple benefits to European citizens. Because they are the ultimate beneficiaries, it is not possible to analyze the European Union without the contribution of citizens, without democratization process of European construction. The Lisbon Treaty is the last Agreement to alter the European law, which established modern institutions and effective working process. The current conditions of financial crisis, serious for some European countries, were the origin of the Eurosceptic current along EU. Therefore, the Lisbon Treaty is especially important for the innovations. Investments in "green technologies", with close European cooperation will lead to an increased quality of life and long-term welfare. All these are the premises on which all European actors will contribute to the maintenance and development of European institutions and mechanisms.

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MARITIME LAW IN ROMANIA

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ABSTRACT

The Romanian maritime law consists of a set of legal rules contained in several acts. Among these are commercial code, ordinary laws, ordinances, government decisions, plus maritime usages. The Romanian maritime law also contains a number of provisions of international conventions ratified by Romania. Romanian maritime law is not a component of the transport law. Maritime law refers not only to transport by sea, but also to the status of property and persons involved in shipping. The study subject of maritime law is much diversified. Maritime law rules describe vessel ownership, maritime rights and transport-related activities. Another object of study refers to the status of seafarers, maritime security, rescue and assistance at sea, crew hiring and obligations, arrest, prosecution and forced sale of the commercial ships. Other topics of study relate to ship owners, shipmasters, charterers etc. Due to the dangers of the sea, maritime risk is found in almost all analyses and works on maritime law. The dangers of the sea transport justify the principle of the limitation of the liability. Because of this principle, the theoretical institutions of joint damage, maritime assistance and collision assistance have been established.

Keywords: *vessels, maritime safety, the European Union, maritime pollution;*

1. INTRODUCTION

According to the Romanian Commercial Code a ship is regarded as the movable goods. According to Art. 490 of the Code "vessels are movable goods". The following are considered vessels: craft vessels, gears, specific tools, weapons, ammunition, supplies and generally all things for the permanent use of the staff, even if the mentioned itms are on the vessel for a specific period of time. According to Romanian legislation, the ship means:

- floating constructions are not normally intended for movement, such as floating docks, floating jetties, wharves, floating hangars for ships, drilling platforms and floating lights;
- floating plants such as dredgers, floating elevators, floating cranes, floating grips and others with or without power;
- maritime vessels and inland navigation vessels of any kind, propelled or non-propelled sailing vessels on the surface or submerged, for the carriage of cargo and/or passengers, fishing, towage or pushing;
- pleasure craft.

Each vessel must be registered in order to distinguish it from other ships. According to the Romanian law [1], there are four elements necessary to identify a ship: name, tonnage, port of registration and nationality. Vessels may be of two types: with or without propulsion. Ships, installations and constructions with propelled floating are distinguished by a name proposed by the owner and approved by the Romanian Naval Authority.

Ships, pleasure craft, floating installations and constructions which have propulsion, are given their own record numbers from Romanian authorities. These vessels could have the name proposed by the owner with the consent of the harbourmasters. The name or number of the ship is registered in the records of the authorities and on the ship's hull. Evidence of ships sailing under the Romanian flag is kept in the Register of the ships and the Central Register of the ships. Accounts of the vessels under construction are kept by the harbourmaster of the whereabouts of the shipyard.

The Romanian flag can be hoisted by [2]:

a) vessels owned or leased by the Romanian citizens or Romanian companies;
b) vessels owned by persons who are citizens of the European Union or companies having headquarters in the European Union;
c) vessels owned by foreign citizens or foreign companies having residency or headquarters in Romania;
d) vessels owned by foreigners, rented for periods no less than one year, by the Romanian citizens or companies.

In any of the above situations, all the vessels registered in Romania must comply with the mandatory technical standards established by the Romanian Naval Authority. After granting the Romanian flag, harbourmasters will register the vessels in the special records and issue the Romanian nationality document. Ships acquiring Romanian nationality cannot sail under the flag of another state. Romanian flag ships have the right to suspend the right to use thereof for a period of two years, if the vessels are leased.

Withdrawal of Romanian flag is done in several circumstances:

- on the request of the ship-owner;
- as a penalty if the conditions to use the Romanian flag are not fulfilled. As well, if the owner-ship or shipmaster are violating the requirements of maritime international conventions;
- if the ship was destroyed as a result of a shipwreck, stranding, fire, sinking;
- the ship was abandoned by the crew;
- the ship was scrapped.

However, after the withdrawal of Romanian flag, the ship is removed from the maritime accounts. The flag importance result from the law applicable to the doings that occur on the ship and establish the territorial sea of

that vessel. Depending on the flag there are a number of legal consequences:
- the real rights and the guarantees of the vessel;
- the rights and the obligations of the shipmaster;
- the form of employment for seafarers;
- the liability of the ship-owner for the doings of shipmaster and crew;
- the issues related to injuries, assistance and salvage at sea.

2. OWNERSHIP OF THE MARITIME VESSELS AND RIVER VESSELS

Ownership of the vessel is acquired in two ways:
- main ways (by construction of the ship or sales and purchase) ;
- derived modes (dissolving company by owner, abandonment, maritime outlet, seizure etc.).

The contract for the construction of a ship is a contract that manufacturer undertakes to build a ship or to provide a service to the beneficiary, in exchange of a certain price. The manufacturer is required to deliver the ship upon a deadline and to ensure that the ship has adequate quality. Delays will attract monetary penalty. Also, if the ship has faults that make the good improperly, the manufacturer will pay damages. The main obligation of the beneficiary is to pay the agreed price. The price must be fixed before between parties and to be serious. The price is paid upon delivery or in multiple rates at the completion of each stage.

Sales and purchase contract of a ship. It is a bilateral contract (concluded between two parties), pecuniary (involves payment of a sum of money), consensual (it is concluded as a result of the will of both parties) and ownership transfer (it transfers the ownership from the seller to the buyer). To be valid, a contract must meet several conditions:
- ability to contract of the parties (legal capacity of exercise);
- valid consent of the parties (except for vitiated consent);
- a specific object to be sold (a ship, a boat, a floating dock, etc.);
- legal cause (contractual refer to lawful cause);
- concluded in written form (to be enforceable against third parties);

Unlike ordinary civil law, in maritime law, if there are more co-owners, the decision of the majority shall apply. I mean, majority decisions (the shareholders who own more than half of the vessel) are required for the other co-owners. This rule applies to the possible sale of the vessel.

3. RULES APPLICABLE TO CREW

Seafarers represent all persons who possess patent or capacity certificate, entitling them to perform functions on board. Evidence of the crew will be kept by the National Romanian Authorities using special registers. Besides seafarers on board every ship may use additional staff (especially administrative staff). All crew members must be adults, have a good health condition and specific training stipulated by law. As we previously mentioned, the specific training is proved by official documents issued by Romanian authorities.

Ship's crew consists generally of the following members:
- Captain (shipmaster);
- Second deck officer;
- Chief engineer;
- Deck officers;
- Officers mechanics;
- Other officers;
- Administrative staff.

Inland waterway vessel crews consist of the following members:
- Captain;
- Helmsman;
- Chief engineer;
- Engineer;
- Other staff.

The legal labour rights of the crew members are set by:
- international agreements and conventions concluded by Romania;
- the national labour law;
- the concluded collective agreements;
- the individual labour contracts.

According to national and international law, each member of a crew has the following rights:
- free accommodation and food on the ship or the daily food allowance. The costs are borne by the employer and are not included in taxable wages;
- the payment of daily allowance in hard currency during the international voyage;
- to redress the damage they suffered during the service or because of a navigation event without guilt;
- the additional compensation for navigation in war zones.

The captain is the one who gives orders on the ship and is vested with authority to all persons and goods on the ship. He performs the duties incumbent in accordance with national law and instructions ship-owner. Captain ensures compliance with international agreements and conventions signed by Romania. He also is the representative of the ship-owner for the authorities. A sea captain (also called a captain or a master or a shipmaster) is a licensed mariner in charge with the command of the vessel. The captain is responsible for its safe and efficient operation, including cargo operations, navigation, and crew management and ensuring that the vessel complies with the flag state policies. All persons on board, including officers and crew, other staff members, passengers, guests, custom officers and pilots, are under the captain's authority.

The master of a ship shall have, by law, three types of privileges available:
- privileges related to navigation;
- commercial privileges;
- privileges of public authority (police officer, notary etc.);

Privileges related to navigation. Ship is the responsibility of the captain who piloted and administrated during the voyage. Navigation-related privileges allow the captain to lead several activities [1]:

- could perform any actions necessary to save the persons on board;
- could act providing protection to the vessel and cargo;
- protects the vessel's documents in different ways;
- provide assistance to any vessel in distress;

According to the rules, the captain is responsible to the ship-owner or carrier for his mistakes in piloting and for any ship management doings.

Commercial privileges. Captain conducts commercial legal acts using the indications of the ship-owner. He is liable to the ship-owner liable for any misconduct. Hague rules of law, establish that the ship-owner and the carrier shall be liable for the acts of the master trade. If he improperly operates loading, stowage and delivery of goods and causes damage, the carrier and the ship-owner has to pay.

Privileges as public authority. In special situations, the captain of a ship shall be entitled to decide on board exceptional measures to ensure public order and peace:

- to isolate a persons on board, if his actions endanger the safety of the vessel, persons and cargo carried by the ship;
- investigating of an offense that was committed on board;
- granting to the accused person the right to defence;
- providing protection to the accused person and its property;
- surrender of the accused person and the papers concluded during the investigation to the competent authorities of the nearest port;

Captain has powers conferred by law as notary:

- in the logbook he records births, marriages and deaths that occur on board;
- certify the will of a person on board;
- may conclude marriages between persons on board.

4. SPECIFIC CONTRACTS FOR MARITIME AND RIVER NAVIGATION

Merchant ships carry out two types of transport activities: irregular navigation (tramp) and regular (freight) navigation. Irregular navigation is called this way because there is no predetermined route transport for the ship voyage. There is no need for the vessel to reach certain ports predetermined. The vessels used for irregular navigation scour the seas and oceans of the world in search of the most convenient freight to transport. Such ships dock in those ports where the master of the harbour provides more favourable conditions for transport. From the action of scouring the seas and oceans of the world follows their name *tramp* (from English language). Every journey of a tramp ship is based on a contract of maritime law. This contract is an prior agreement concluded between the ship-owner and the charterer (person who rented the ship). This type of contract is called *charter party*. The charter party stipulates the conditions of the carriage. Charter contracts may appear in different forms:

- Rental of the ship per voyage (voyage charter- party);
- Rental of the ship per time (time charter party);
- Rental of the ship part (booking notes);
- Rental of the ship according to the transported quantity (affreighment);

Voyage charter-party is a contract whereby the ship-owner undertakes to carry goods for an amount of money called freight. Charterer is renting the ship for an indefinite period of time. If time is determined (there is a period of time firmly stipulated in the contract) the charter contract is classic. If time is not determined and there is only a date in the future we will be dealing with a "charter trip contract". There are also so-called partial charter party (booking notes) that uses the regular and the irregular navigation aimed at filling up the capacity of the ship. In irregular navigation there are often situations when a charterer does not have enough cargo to fill up the ship at full capacity. Therefore, the charterer will collect goods from other persons using charter agreements. The freight carrier often takes goods from many clients to cover the entire capacity of the vessel. The lease depending on quantity (affreighment) is used where the volume of cargo charterer is not enough to make a voyage.

The freight navigation. The so called regular navigation is carried out by moving a ship in a regular and permanent manner on a certain route. The ship has a fixed itinerary, from which it cannot deviate. The ship route is established before, having a movement zone known to all potential clients. The ship will sail only between the ports of dispatch and destination. The freight ships are usually used to transport goods in small quantities. The owner is looking for more and more customers to cover the entire carrying capacity of a ship. In maritime law, this type of contract is called "booking note" (letter of booking a space transport ship) or bill of lading.

5. GENERAL ASPECTS CONCERNING CHARTER-PARTY CONTRACTS

As mentioned above, the sea charter-party contract is an agreement whereby the ship-owner undertakes, for a sum of money called freight, to transport chartered goods by sea and deliver them to a specific port to a certain person.

The Charter- party contract has certain legal characters:

- it is commutative – it is determined by the extent of the obligations of the parties with the conclusion of the contract;
- it is consensual - there is agreement between the parties on the terms and conditions mentioned in the contract.
- it is pecuniary – upon the conclusion of the contract the parties pursue certain goals of material nature;
- it is reciprocal – the ship-owner and the charterer have interdependent and reciprocal obligations. If a party does not fulfil its obligations, the other party may request the termination of the contract;
- successively achieved - contract goals cannot be achieved in a single step.
- substitution possibility - the owner could replace the ship during transportation process;

In practice, standard contracts are used. These forms are developed by international organizations, such as BIMCO. This organization has developed the most common variant of standard contracts, respectively GENCON CHARTER PARTY 1994. BIMCO is a

shipping association providing a wide range of services to its members who have interests in the shipping industry, including ship-owners, operators, managers, brokers and agents. The objective of the organization is to feature the commercial standard developing contracts and operations by standard clauses and providing quality information, advice, and education. BIMCO favours optimal business practices, free trade and open access to markets. BIMCO, as an international organization provides a plenty of services in the maritime domain. The organization is ready to provide assistance and guidance on problems encountered in daily activities, by ship-owner, captain, charterer and shipping companies [2]

Information about companies. This information is very appreciate in the maritime trade area allowing different actors involved in maritime transport to avoid scams and frauds. BIMCO provides trustable information about potential business partners. Among the information there is some information about non-payment of freight, demurrage, commission or other amounts due, for late payment, for not honouring arbitration awards or legal decisions or for otherwise failing to honour contractual commitments.

Costs and taxes related to naval transport. This kind of costs includes port cost estimates, information on freight taxes, verification of requests for advance funds etc. Restrictions, including details of boycotts, embargoes and other restrictions as well as ice conditions (seasonal).

Documentary problems, including interpretation of clauses in charter parties and other contract forms, objective opinions on charter party disputes, recommendations of forms to be used, warnings on objectionable terms etc.

Intervention to collect outstanding amounts. BIMCO may assist at request to collect outstanding freight, demurrage, commission, hire or other amounts due, provided the amount in question is undisputed.

Port information, including specifics on berthing delays, strikes and lock-out warnings, holidays and working hours, availability of cargo handling equipment and other details on ports.

Issues related to security. BIMCO may inform at requests on problems related to drug smuggling, piracy, armed attacks on ships and stowaways and as a security-risk warning centre.

Technical issues, including information on stowage of cargo, hazardous cargo regulations, port state control regulations, pilotage requirements, bunker quality, fumigation, reception facilities, garbage removal, safety and anti-pollution regulations etc. Details of international, regional and national rules and legislation are also available from BIMCO.

BIMCO is a strong advocate for the harmonization and standardization of the shipping activities. BIMCO is a Non-Governmental Organization who actively promotes the application of International Cooperation in the area of maritime commerce. Standardized contract consists of two parts. The first part consists of 26 boxes to be filled. In the second part of the form there are 19 contractual clauses that describe the contract. In this clause, it may be added other clauses required by the contracting parties. If it is wished, the parties may remove certain clauses and may use alternative clauses.

6. CONCLUSIONS

The maritime law is one of the most important branches of the Romanian law. Maritime law subscribes to international law, allowing the settlement of disputes between firms and other foreign and Romanian ships in accordance with the interests of the Romanian state. One of the most important issues in operating a ship or developing a maritime project is the capacity to implement international conventions and legal tools adopted by relevant international organizations. For this reason, all countries of the world need to have appropriate legal maritime system to incorporate the provisions of the adopted international law into national juridical system and to establish procedures for applying and enforcing the legal provisions in all situations. Each state should have the possibility to review and change the maritime legislation of that legislation, according to the international maritime law and the latest developments in marine technology and shipping practices. In this respect, there is a constant need for well-trained legal staff specialized in maritime and shipping law. There is a need, as well, for persons with relevant experience and skills in the drafting, preparation and checking of legislative instruments. The maritime law specialists are not always available and there is a constant need of specialist in this domain. International Maritime Organization has developed, as an important part of its activity issuing of specific programmes, projects for technical advice and assistance in maritime law and legislation [5]. There is not just a need for an efficient maritime legal regime, but also a constant request for specialists available to oversee, permanently, the implementation of existing law. It is necessary to evaluate the legal provisions for an appropriate implementation and to prepare suitable texts to be applied. The maritime law has been used since ancient times by inhabitants of the country to solve problem related to fishing and navigation of commercial vessels but also the sensitive problem of the stationing of the warships. This branch of law will be used to resolve disputes on exploitation of international maritime zone, protecting of the living resources of the sea, marine environmental protection and scientific research of the sea. The freedom of movement at sea, the possibility of the resources exploitation and joint ownership of marine resources are mentioned in Romanian maritime law and has to be reflected in the future.

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COMMUNICATION AND MANAGEMENT IN TECHNOLOGICAL INNOVATION AND ACADEMIC GLOBALIZATION

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ABSTRACT

Globalization and the telecommunications revolution have brought to developments that were largely unanticipated. The first is the reemergence of the importance of regions and geographic proximity as important units of economic activity. That innovative activity has become more important is not surprising. What was perhaps less anticipated is that much of the innovative activity is less associated with footloose multinational corporations and more associated with high-tech innovative regional clusters, such as Silicon Valley, Research Triangle, and Route 128. Only a few years ago the conventional wisdom predicted that globalization would render the demise of the region as a meaningful unit of economic analysis.

Keywords: *Technological collaborations; managerial strategies; emerging challenges; new technologies.*

1. MANAGEMENT COMUNICATIONS

Communications management is the systematic planning, implementing, monitoring, and revision of all the channels of communication within an organization, and between organizations; it also includes the organization and dissemination of new communication directives connected with an organization, network, or communications technology. Aspects of communications management include developing corporate communication strategies, designing internal and external communications directives, and managing the flow of information, including online communication. New technology forces constant innovation on the part of communications managers. Communication plays a fundamental role in the success or failure of managers. On any credible list of the most important skills for managers and business leaders, communication is rated at or near the top. Management Communication involves the study and practice of all aspects of communication between various constituencies in business settings. Managers and executives must be able to think about communication strategies and to select the proper strategy for each situation and each audience. The field of Management Communication includes research on communication behavior, theories of communication strategy and application, and practical skill development for managers in a wide variety of areas. Such skill areas include Strategic Communication, Interpersonal and Corporate Communication, Presentations, Persuasion, Interviewing, Giving and Receiving Feedback, Communicating Technical Information to Non-experts, Communicating in Meetings, Team/Project Communication, Communicating across Cultures, Using New Communication Technologies, Facilitation Skills, and Managerial Writing.

The notion of globalization of innovation, similarly to that of nance, production, culture and information, is now diffuse. Scholars, govern- ments and international organizations have attempted to assess the changes that have occurred in innovative activities due to an ever increasingly globalized society. Globalization is not a single phenomenon, but a catch-all concept to describe a wide range of forces. It has been de ned very differently according to the social science within which it is applied. Paul Streeten (1996) has, half in jest, collected the various definitio the literature. Here, we have applied a rather wide de nition of globalization, which conforms to that provided by Giddens (1990: 64): 'the intensi cation of world-wide social relations which link distant localities in such a way that local happenings are shaped by events occurring many miles away and vice versa'.

2. KNOWLEDGE MANAGEMENT FOR PUBLIC ADMINISTRATION

The roles of knowledge and understanding for organizational performance have become more noticeable nowthen ever before. Knowledge management is a set of tools and processes, which served to improve the performance of publicservant by transforming them to knowledge workers. Major characteristic of managing knowledge in the publicorganizations is the existence of additional information sourcesand transformers of information.

For instance the utmostimportance in the public organizations is the knowledge that is being accumulated, stored and processed within therelationship of the administrative authorities and the politicalactors with whom the public managers are in directdependence. Usually this type of knowledge is highlyunstructured and hard to systemize and automate. The specificof the administrator-policy maker relationship is such that inmost of the cases the knowledge is being created at individual evel, which makes it difficult for codification, standardization nd linkage to other sources and transformers of knowledge inthe public organizations.

3. THE GLOBAL TECHNOLOGICAL COLLABORATIONS

In recent times, a third type of globalization of innovative activities has made a forceful entry on the scene. This, in some ways, is interme- diate to the two

preceding categories. Technological collaborations occur when two (or more) different □rms decide to establish a joint venture with the aim of developing technical knowledge and/or products. Three conditions need to be respected: (1) the joint venture should be something more than an occasional and informal collaboration; (2) □rms preserve their ownership; and (3) the bulk of the collaboration is related to sharing know-how and/or the generation of new products and processes (Mowery, 1992). Such collaborations often take place among □rms of the same country, but in many cases they involve □rms located in two or more count- ries, thus emerging as authentically global. These forms of collaboration for technological advances have promoted a variety of mechanisms for he division of costs and the exploitation of results. In a way, the neces- sity to reduce the costs of innovation – and to cope with its increasing complexity – has created new industrial organization forms and new ownership structures, which today are expanding beyond the simple technological sphere (Dodgson, 1993). However, it was not the private sector that discovered this form of knowledge transmission. The academic world has always had a transnational radius of action: knowledge is traditionally transmitted from one scholar to another and thus disseminated without always requiring pecu- niary compensation.

4. HIGH AND LOW CONTEXT IN COMMUNICATION

Anthropologist Edward T. Hall's theory of high- and low-context culture helps us better understand the powerful effect culture has on communication. A key factor in his theory is context. This relates to the framework, background, and surrounding circumstances in which communication or an event takes place.

4.1 High-context cultures

(Including much of the Middle East, Asia, Africa, and South America) are relational, collectivist, intuitive, and contemplative. This means that people in these cultures emphasize interpersonal relationships. Developing trust is an important first step to any business transaction. According to Hall, these cultures are collectivist, preferring group harmony and consensus to individual achievement. And people in these cultures are less governed by reason than by intuition or feelings. Words are not so important as context, which might include the speaker's tone of voice, facial expression, gestures, posture-and even the person's family history and status. A Japanese manager explained his culture's communication style to an American: "We are a homogeneous people and don't have to speak as much as you do here. When we say one word, we understand ten, but here you have to say ten to understand one." High-context communication tends to be more indirect and more formal. Flowery language, humility, and elaborate apologies are typical.

4.2 Low-context cultures

(Including North America and much of Western Europe) are logical, linear, individualistic, and action-oriented. People from low-context cultures value logic, facts, and directness. Solving a problem means lining up the facts and evaluating one after another. Decisions are based on fact rather than intuition. Discussions end with actions and communicators are expected to be straightforward, concise, and efficient in telling what action is expected. To be absolutely clear, they strive to use precise words and intend them to be taken literally. Explicit contracts conclude negotiations. This is very different from communicators in high-context cultures who depend less on language precision and legal documents. High-context business people may even distrust contracts and be offended by the lack of trust they suggest.

4.3 Reconciling high and low context in communication

Reconciling opposing cultural values is a key skill in crossing cultures and managing diversity. If we merely focus on 'spelling things out' when communicating across cultures, we are likely to end up damaging relationships. On the other hand, if we focus on protecting people's 'face' through a high- context style, we might safeguard relationships but the clarity of the message will suffer. Thus, to reconcile potentially conflicting approaches to communicating meaning in a business context, we need to be able to use a common language (such as English) to make our messages to international partners (or those from other diverse backgrounds) both clear and transparent (the strength of Low Context cultures) as well as sensitive and relationship-orientated (the strength of High Context cultures).

5. THE LESSONS OF GLOBALIZATION: ENERGIZING MANAGERIAL STRATEGIES

Today, globalization impacts customers and the management mindset in profound ways. Unfortunately, the global economy today neither reflects the existence of the political institutions defined as the "nation state" nor the makeover of those very institutions needed to correct the post-1945 imbalances between the "third world" and the first world. Today, a new "Great Game" has arisen, reconstructing the global economy not around a collection of individual nations, but one with global economic institutions, and with membership well beyond the G-7 or G-20 group of countries. The BRIC countries, for example, are a new global force and their influence is felt across a range of sectors, from autos and computers to energy and finance.

Yet there remains a disconnect. For instance, emerging markets and their central bank reserves actually provide the savings for the first world by purchasing foreign governments' treasury bonds. The U.S. is the noted example. Indeed, the financial flows from the emerging countries don't always reflect the rich world's real but critical influences on the capital markets of the rich world. While stock market indexes highly correlate between say New York and Toronto or London, the same is not true between markets in New York and Tokyo in the past or between New York and Shanghai today. The result is that business cycles and savings-investments fluctuations can vary tremendously.

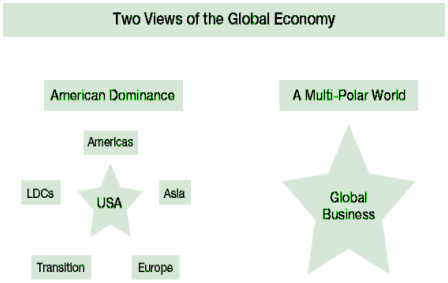

Figure. 1

The unalterable trends of globalization, led by the three main drivers, financial capital, technology and wealth-creating overseas trade, integrate countries and their industries in ways that are unprecedented. Clearly, the impact of China and India on the global business community has no precedent. The two countries account for 40 per cent of the global population. This forces all managers to ask a simple question: Do we have an India or a China strategy? It is a question that must be asked, from the very limited strategic perspective of the nation state, because these two counties impact global competition in direct and indirect ways. The direct ways include the new stock-exchange listings of Indian and Chinese companies that want to be global MNEs. The stereotyping of Indian and Chinese companies – IT and software for India, low-cost labour manufacturing for China – ignores many other sectors, from advanced household appliances to semi-conductors, from medical robots and medical devices to space technologies that are producing best-in-class companies in these two countries. India and China count, not just because of their population and trained labour force, but because they need to import so many technologies, managers and products. This is a great opportunity for Canada, to become part of their supply chains, their research centers and their North American marketing outlets.

China and India also have an indirect impact on other countries, through strategies that range from joint ventures to research alliances, from direct investments abroad to sub-contracting in rich countries. That explains why, in recent years, they have doubled the annual output of engineers, computer scientists and IT specialists with 3- and 4-year degrees, about 600,000, compared to only 225,000 in the United States. These are just some of the reasons why Canada must have a strong presence in these countries. Indian and Chinese prowess is creating real convulsions in the global business environment. Now, two entire continents, South America and Africa, are awakening to globalization. No two continents are so rich in natural resources. No two continents could impact so many industries with sophisticated innovation – from agribusiness to petroleum, minerals to fashion. But South America and Africa need to make their own choices. Some countries want to play the global game, while others do not. Who will be left out? The same issues apply to the Middle East, steeped in ethnic and religious conflicts, and staggering oil wealth. Even a cursory check of developments in place like Dubai or Qatar raises basic questions about managerial biases towards nationalism and even isolationism in North America, where the U.S. Patriot Act makes it difficult for Arabs to travel in the U.S. or to buy U.S. companies. Where does Canada fit, and which Canadian industries and corporations form part of the solutions? For Canadian managers, the basic challenge is to change the mindset, both of how managers and employees see the world, and of how Canadian institutions – universities, banking, manufacturing, government bureaucracies, and national media (including the CBC) – accommodate this new reality. Globalization forces everyone to have a world perspective. As shown in Exhibit 2, best-practice managers focus on a dominant paradigm, value creation for shareholders. Value creation is a result of excellence at all levels, in strategic positioning, in recognizing value from constant innovation, and from exploiting strengths and competences. In this sense, people count, and the best-practices firms go to inordinate lengths to recruit the best people, cultivate a learning environment, and practice a form of kaizen or continuous improvement of the strategic matters that count.

6. EMERGING CHALLENGES

Technologies offer educators and students alike opportunities for creating meaningful learning environments. Technologies enable different types of social interaction, provide ready access to information and can overcome some of the difficulties presented by time and space. Students can create new materials, artefacts and new knowledge with the media tools now available to them.These tools are constantly evolving as individuals and companies create and refine new software. The futurist Alvin Toffler is reputed to have predicted some 30 years ago that '... the illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn'.Including technologies in teaching and learning requires a reconceptualisation of the curriculum and how it can be taught. Using technologies to simply replace blackboards with whiteboards and pens with computers and word processors does not constitute a reconceptualisation of teaching and learning, nor the nature of school education. Such an approach will not support students to 'learn, unlearn, and relearn'. Studies over the past decade have tended to show that using technologies to improve students' learning outcomes is difficult to demonstrate. Indeed, in the United States of America a recent, large-scale study found that, even with good hardware and educational software, little learning benefit for students was identified (Dynarski, Roberto, Heaviside, Novak, Carey, Campuzano, Means, Murphy, Penuel, Javitz, Emery & Sussex, 2007). Furthermore, Cuban (2001) described how the use of computers in classrooms did not result in improved learning opportunities for students. Such studies demonstrate that using technologies to support a pre-existing curriculum is of contested effectiveness. Instead, they point to some of the challenges facing teachers as they shift to student-centred teaching and learning approaches that include technologies. Other studies point to the potential of technologies to address the complex set of challenges facing the world: addressing issues such as climate change and feeding the planet (Puttnam,

2009). Rather than simply trying to slot technologies into the curriculum, however, educators are now afforded an opportunity to rethink the ways in which they carry out their work. This shift calls for more demanding professional pedagogical repertoires than those that have been required in the past (Johansson, 2000).

7. USING NEW TECHNOLOGIES TO FORGE A PATH TO TOMORROW'S INNOVATIONS

One of the essential foundations for creating a successful company over the long term is to identify technological trends from an early stage and to exploit the opportunities that new technologies offer for product innovations. However, factors such as the hugely dynamic nature of technological progress make it increasingly difficult for companies to comprehensively identify technology-related opportunities and to harness them in a goal-oriented manner. A key prerequisite for successful technology development therefore lies in the ability of an organization to rapidly and efficiently align the requirements of the market with the potential offered by new technologies and to integrate the results in its own products and processes. The methods and organizational solutions developed in the Technology and Innovation Management business unit to improve and synchronize research, innovation and technology development processes have been shown to trigger success in the market: companies whose technology development capabilities have been properly organized achieve higher growth, increased profitability and an enhanced competitive edge.

8. THE TECHNOLOGY AND INNOVATION MANAGEMENT BUSINESS UNIT FOCUSES ON THE FOLLOWING KEY TOPICS:

- Developing and implementing innovation and technology strategies
- Increasing organizations' capacity for innovation
- Organizing innovation and research and development (R&D) effectively and efficiently using lean processes
- Identifying, evaluating and exploiting new technologies
- Setting up and supporting technology and innovation networks
- Intellectual property: IP for innovation
- IT support for R&D, technology and innovation management.

9. CONCLUSIONS

Globalization is dependent on communication technology, and communication technology is in turn dependent on globalization. Communication technology is just one of the factors that has played a major role in spreading globalization, and some experts believe that globalization would have never been possible in the absence of communication technology. While the impact of communication technology has been overly positive, it has led to certain challenges. There is a wide disparity when it comes to access to technology between developing and developed nations which can be countered by making further innovations in communication technology.Contemporary globalization is marked by rapidly and dramatically increasing interdependence, which operates both within and among countries. Increasing global interdependence has profound influence on education at all levels, such as how to deal with a world with more permeable boundaries in which people are on the move more frequently (migration) than ever before in human history, and in which urbanization is increasing at an unprecedented rate. This paper proposes a transformational analysis of contemporary globalization and identifies the increasing challenge for education due to the globalization, including the struggle to match the pace of technology change in society, to provide graduates with skills relevant to contemporary society, and to lead education students to an accommodation with persistent and rapid social change. Among the positive consequences of globalization are the widening of peoples' horizons, access to knowledge and the products of science and technology, multiculturalism and intercultural views, an increase in opportunities, personal and social development and possibilities of sharing ideas and joint action towards solutions to common problems. The negative consequences are mainly on social, economic and environmental levels. On one hand, there is increasing poverty in societies, a growing gap between developed and developing countries and between privileged and excluded people, low standards of living, disease, forced migration and human rights violations, exploitation of weak social groups, racism and xenophobia, conflicts, insecurity and growing individualism. On the other hand, there are many environmental repercussions, such as the greenhouse effect, climate change, pollution and the exhaustion of natural resources. Resistance to globalization, from various ideological perspectives, has grown as people have come to recognize its effects on their lives and on the world. Anti-globalization forces are critical of the inequities of global trade, environmental problems, loss of national sovereignty, and cultural imperialism.

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TRANSPORT ECONOMICS AND SEAWORTHINESS OF VESSELS

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ABSTRACT

This article describes the research conducted by the writer concerning the possibilities in enhancing the safety of ships and seaworthiness through risk management and marine insurance connected to new possibilities developed by research results achieved by solutions developed for Bridge Resource Management and Crew Resource Management. The article describes the basic solution in new Nordic Marine Insurance Plan 2013 for encouraging the ship owners to develop safety practices which can be accepted by the insurers as safety regulations in insurance policies to affect the risk management and to create safety practices which in turn increase safety on vessels and create cost efficiency through decreased insurance premiums when risk management on a ship or whole fleet is taken care of by using these modern safety practices which are made possible through effective use of modern technology and use of research models adjusted to practices on vessels. The further research will identify possibilities to develop similar practices to enhance safety culture by developing similar models which can be used as models to decrease transport costs.

Keywords: *Transport economics, Risk management, Seaworthiness, Unseaworthiness, Marine insurance, Crew Resource Management, Ship owner' s liability, Bridge Resource Management*

1. INTRODUCTION TO UNSEAWORTHINESS PROBLEMACY IN GENERAL

All vessels which leave port are made seaworthy as ascertained by the captain before the common perils for ship and cargo will be encountered. Seaworthiness of ships is a basic concept in Maritime law and in Law of Marine Insurance.

The concept of seaworthiness itself is related to a great deal of laws and provisions - given both by private and governmental organisations. The concept is also often used in universal language without specified meaning. In this article unseaworthiness is considered as a term and phenomenon related firstly to maritime transportation and ship owner´s liability and secondly to marine insurance.

Meaning of the seaworthiness concept is relevant when we consider liability issues between ship owners and cargo owners. As the law stands today in most jurisdictions – the vessel has to be seaworthy when the vessel leaves port. If the vessel later will be considered unseaworthy at the time of departure, the ship owner will usually be considered liable in relation to the cargo owners if there will be a causal link between the loss of cargo and the unseaworthiness of the vessel.

In the law of marine insurance, most maritime jurisdictions follow the same pattern using Seaworthiness/unseaworthiness evaluation as a basic rule to protect the insurer. The Nordic countries use safety regulations for the same purpose. Since the beginning of 2013 the unseaworthiness rule has been abolished from the clauses in all Nordic countries. This increases the use and meaning of safety regulations for the insurer, who is able to deny the insurance cover for ships when the owners are in breach of the safety regulations specified in insurance policies.

Seaworthiness/Unseaworthiness is still the core of the insurance conditions and insurance policies in other jurisdictions than in the Nordic jurisdictions. The regulation in Nordic countries can benefit the owners in several respects as the development of new safety practices through technology can be more easily be directly connected to the safety culture of the ship or fleet and benefit the owners through risk evaluation when the premiums are adjusted to meet the real risk evaluation.

The concept of unseaworthiness is usually not defined in the provisions concerning the question. In all jurisdictions seaworthiness seems to be a relative term that must be evaluated according to the circumstances in question; the ship, trading area, time of the year, quality of the cargo etc.

The concept contains usually not only the physical condition of the vessel but also other aspects of the ship, like sufficient manning, skills and certification of the crew, defects in stowage, documentation etc.

Requirements are also different for vessels in port from vessels at sea. In some jurisdictions the concept is used without any qualification at all and in some jurisdictions unseaworthiness –provisions include more detailed guidelines as to what constitutes unseaworthiness.

2. MASTERS LIABILITY FOR SAFETY AND SEAWORTHINESS OF VESSELS

2.1 Introduction

In the world we are living now the primary responsibility of the master is to ensure compliance with various laws that apply to the vessel and crew - Was it national law or international law - both in the country of the vessels flag or the law of the country the vessel is visiting.

At first sight one could imagine that all masters should also have at least a master degree in international law before they accept this demanding post. But they do not, and if some of them have, they will be hired by the London market - as we have seen to happen. The other

important master´s responsibility is to ensure that company policies and procedures are followed.

Modern legislative trends are increasing the responsibilities placed not only on shore side administrators and managers but also shipboard personnel, especially the master. For example environmental laws carry with them not only civil penalties, but the potential for personal criminal liability as well.

The legislative atmosphere surrounding maritime transportation has been affected primarily by a few major accidents during the last decades. The laws affecting maritime activities are enacted largely as a response to catastrophes of one sort or another, or as a reaction to international pressures and trends. The last trends and pressures have especially and unfortunately been seen also as criminalisation of seafarers.

Masters should become familiar with the legal responsibilities of the position. Unlike in earlier days they have new problems like work-hour rules, reduced manning, automatisation, flow of personal documents, additionally required logs and recording documents number of which keeps increasing year by year etc. etc.

All this workload for the masters should be taken into consideration when the safety of ships is guaranteed be the owners. New technical procedures should be made to ensure the safe prosecution of the voyage and to help the masters in ensuring the safety on board.

When a master accepts the command of a vessel, he agrees to act honestly and to do the best of his ability to protect the interests of the company. He looks after the safety of the vessel, cargo, passengers, and crew at all times and he also has a legal and moral duty to protect the environment. The master acts as a direct representative of the company and sometimes also as a representative of the charterer and is responsible for all damage and accidents that happen on board. The master is responsible for all persons on board whether their presence is authorised or not. His work to ensure the safety should be made easier by technological means so that they make the safety procedures easier to be controlled by him.

2.2 Development of Seaworthiness requirement

The concept of seaworthiness was born in 17th century England when insurers and charterer's needed a concept for evaluation of the conditions of the vessel they were going to insure or charter. Shipping registries and classification societies were needed for supervision of the requirements when the ships became larger and more technical entities.

Although seaworthiness was at first the concern of charterers and insurers, many other interests were soon involved and interested in seaworthiness of a ship.

Authorities after all the others, which have been mentioned above, became last interested in the issue.

Seaworthiness has been foremost an issue attached to shipping business before last decades when safety at sea has become increasingly important.

2.3 Technical seaworthiness of a vessel

The requirement of technical seaworthiness means first and foremost vessels hull, machinery and all equipment connected to these and which are closely related to the use of a vessel. Modern vessels are practically loaded with technical instruments, which can be enumerated in under this requirement; steering gear, hatches, pipelines, firefighting systems etc.

Although ship owners are also responsible for keeping the ship seaworthy, it is expressly stated that the master has a duty to ensure that all these technical seaworthiness requirements are fulfilled before the ship sets of on a voyage. Master accepts this responsibility by signing in ships log that vessel has been made seaworthy before the voyage each time the ship leaves port.

2.4 Seaworthiness for a voyage

Ship has to manned and equipped for the intended voyage and master is responsible for taking into account all possible needs for intended voyage plus possible changes of route ordered by ship owner or charterer. Ship has to carry along necessary charts and other navigational aids, medicine, bunkers, provision and documentation.

To compare the two requirements - technical seaworthiness and seaworthiness for a voyage – we could imagine a house with walls, roof and things that are fixed in the house to symbolize the technical seaworthiness of a vessel. Living in the house is not possible without all movable objects which make living in it possible for at least for a certain period of time which in turn symbolises equipping the ship for a certain voyage. The master is responsible for the cleanliness, sanitation, and good condition of the living quarters on the vessel. He has to ensure also that no unauthorized personnel are permitted aboard when the vessel leaves port.

2.5 Cargoworthiness

Ship is expected to arrive at port of destination unharmed with its cargo. The ship has to be considered cargo worthy already before loading to make this possible. Cargo holds must be cleaned after previous cargo in a way that is expected by the new cargo. Master has to be aware of the required measures expected by the new cargo.

On the other hand the charterer will not be willing to pay for unnecessary delay caused by unnecessary cleaning or other measures which were not necessary for his cargo. All cargoes cannot be accepted at the same time and certain cargoes make the ship unseaworthy for transporting the others (for example IMDG –cargo)

3. RESEARCH AND TECHNICAL SOLUTIONS TO ENHANCE THE SAFETY AND SEAWORTHINESS OF VESSELS

3.1 Introduction

Seaworthiness must nowadays be evaluated in very different circumstances than traditionally. In the era of technology a seaworthy ship needs to be technically and

electronically in order before leaving port and equipped and manned in a way that it stays that way also during the voyage. Crew must be able to cope with the situations which might arise at the bridge.

The ship owner must have means to cope with the different requirements which are posed for the crew by the officials which control the seaworthiness of the ship and the skills and certificates /validity of the training of the crew.

The work at the bridge must also be arranged that way that the shall be manoeuvred in way that stays seaworthy and the crew at the bridge doesn't lose concentration because of unnecessary occupancies or routines which make the crew lose concentration at the precise moment when the best endeavours would be needed.

Ship with wrong routines or unnecessary people at bridge can lead to a disaster which could be avoided by strict obedience of safety procedures in critical points of the voyage on a well-planned route. Different scientific models are analysed which can be used in this respect in order to guarantee a seaworthy vessel throughout the voyage.

Another aspect relating to technical possibilities for avoiding classical unseaworthiness problems are development and planning of electronical crew certificate management systems and spare part management systems which efficiently guarantee, if they are well used, that the requirement for safety can be met.

Satakunta University of Applied Sciences has for years encouraged the teachers and researchers into both theoretical studies and research connected with more practical examples to be performed with the students in relation to seaworthiness problems in relating to human behaviour and technical avoidance of such problems.

3.2 Cruise ship safety and cybernetic model for BRM

Research concerning Cruise ship safety has been done for years but the last research project has been well timed as it was started before and finished after the Costa Concordia incident – and the core of the project was to analyse the safety from the ankle of the workload and activities on bridge. The greatest remarks during the study made by Master of Marine Technology student, Master Mariner *Risto Sipilä*, were made on the human behavior.

Sipilä Pointed out that the natural features on human-being are not included to the training of the officers and seldom considered on board.

The implementation of new was found difficult. The attitude and working habits of the captains and the officers were strongly rooted and build, not only during the test use of the Cybernetic tool, an environment, where the alterations, possible improvements and the experimentation of them, or even independent thinking were rejected.

*Sipilä´*s research pointed out that the crucial role of the captain has huge effect on the projects like his study. As the captain is responsible of the safety on board and to implement the bridge team management to meet his criteria, he is usually the only person able to bring new ideas in to force. This was acknowledged by the company as well.

Bridge operation related documents on safety management system state that the captain is responsible to plan and establish proper manning by creating watch plan and giving the required orders to instruct the officers accordingly. The responsibility is clearly noticeable but this kind arrangement creates other difficulties. In the companies where the crew members shift between two or more vessels it is typical that the working methods shift with the persons. This hinders the formation of standards as the colleagues are constantly changing.

The captain as responsible person changes the whole bridge procedures according to his opinion. This creates every time difficulties to the colleagues who have to learn the new way of working in the middle of their contracts.

If the company doesn't create the procedures with the captains, who agrees to implement the procedures on board, in the fleet will be as many bridge management systems as there are captains. Implementing new systems and working procedures, especially when they deal with significant changes, must be introduced and brought into force from the higher level of management to enhance maritime safety - considers *Sipilä* in his research outcome.

Sipilä points out that this kind of implementation of working procedures would as well solve the confusions with the descriptions of required actions. When the company acknowledges the captain to be responsible to implement "proper manning on the bridge" they actually cover their own back and make the captain partly guilty of accidents.

This is remarkable point in the cases when the captain is not fully capable to deal with the resources. After an accident the bridge management will be noted not to be in order, which shows that the captain hadn't fulfilled his duties. This leads to more complex difficulties. The totalitarian system, where the leaders command the underlings without interaction hasn't worked, and will not work on board either.

Sipilä highlights in his research that the safety standards of the work on the bridge during the navigation must be taken into account constantly; also when the idea of the double watch system is considered to be worth implementing, it is not appropriate to wait until it's completed. Beforehand and when implementing big changes, the safety attitudes are the most remarkable factor to improve or hamper the standards.

The attitudes are impossible to transfer – they are everybody's own based on the qualities and knowledge of the person. These own opinions, and the actions based on them, will affect the ones of surrounding people and influence their ideologies. The positive changes are about to increase and create culture, which uses the best possible methods to improve the safety standards: the human beings.

The research to be completed in SAMK is to find out the connections between liabilities of the owners in relation to seaworthiness of the vessels when the owners can be anticipated – or even shown – to accept the unsatisfactory procedures or safety culture on bridge.

The relation of ISM code to new safety practices on maritime safety research shall also be under consideration in near future.

In the future when seaworthiness will be evaluated constantly during the voyage also from the liability point of view - when the Rotterdam Rules will be effected by maritime nations - the question on causality and liability of the owners will be even more interesting. The Rotterdam Rules are expected to enter into force by 2017.

3.3. Resource management and communication in a shipping company – some considerations

Resource management systems are often as many as shipping companies even though some standard systems have been developed. There are electronical systems which are tailored for companies on the basis of some basic solution and there are solutions that are tailored directly for a company on the basis of company´s own needs – and then there are companies which do not have any electronical systems in place at all.

The research which was made at the SAMK by Master of Maritime Management student, Master Mariner *Mona Zilliacus* during the last calendar year pointed out interesting considerations on the needs of such systems especially in relation to companies where demands for changing crews very often between different kinds of vessels.

The side effect of the research was to take into consideration the fact that there is a severe risk in such circumstances that the crew management misses the requirements if there is no proper system in place and the vessels sail with an unseaworthy manning as a consequence of a missing certificate and the crew does not have necessary knowledge on the demands of the vessel.

The outcome of the research was that there is a specific need for a workable and tailored program especially when the mobility between vessels is significant especially in situations with tug owners where only a part of the vessels are continuously manned.

Also this research has been promoting new research project concerning the relations of the procedures created by shipping companies in relation to the owner´s knowledge and liability for safety and seaworthiness of vessels in general.

5. CONCLUSIONS

The continuous research project concerning seaworthiness of vessels and promoting safety at sea aspects to enhancing safety thorough insurance conditions has been conducted in SAMK for years.

The idea of the Finnish educational system is twofold: the basic research should be made at the Universities and the Universities of Applied Sciences take care of the research which applies the results in to practice.

In Master of Maritime Management program this basic idea is used in a way that these two are combined as research projects by Senior Lecturers or research fellows working on their Doctoral thesis and the students (Captains with bachelor degree + minimum of three years working experience at sea) working on their Masters thesis. They both benefit each others.

The Findings that can be made on the basis of the analysis of the two resent Master thesis will be more closely analysed in further work. A new group of master mariners has started work to develop further research on new topics to promote shipping safety related to transport economics and ship safety related to decreasing insurance cost of vessels. One of the issues is to analyse Ship owners and shippers practices concerning seaworthiness and HNS convention relating to container transportation of HNS cargoes. HNS convention will enter into force year 2015 having received enough ratifications 2014.

Especially Nordic Marine insurance conditions (Nordic Marine Insurance Plan 2013) make it possible for the shipping companies to promote better safety cultures in shipping companies and to affect at the same time on the level of their own insurance premiums when the risks though technological solutions connected to ensurance of human behavior are created and put into place - and made safety regulations as detailed insurance conditions in the policy.

The basic idea is simple to sell for the ship owners – The technical solutions and investments on workable models for BRM that promote safety, need investments when they are created and put into place, but the investments can be saved within a year or couple of years when the insurance premiums can be negotiated to take into consideration the new safety culture of the vessel or the hole fleet.

6. ACKNOWLEDGMENTS

In the end of this article if wish to thank all my Master of Maritime Management students who have encouraged the others with their example and especially those who have been working – And are working at the moment - with the thesis connected to the issues of Safety at sea, technological solutions and Seaworthiness.

The companionship between the student colleagues has been remarkable and has also benefited the research significantly as the atmosphere among those conducting the research has been enthusiastic and supporting for both students and the teachers.

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SETTING THE PRODUCTIVITY OF A TYPE 2 CHEMICAL TANKER ON A PARTICULAR ROUTE AND EMPLOYMENT TERMS

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ABSTRACT

Through this paper we do analyze productivity of a chemical tanker – IMO type 2, on a specific route and under specific employment terms. Within the introduction chapter will be shown technical differences between those three IMO types of chemical tankers that impose certain limitations on their use for chartering; further, a short definition will show us that productivity is one of the way of measuring the efficiency of any element, in our case the chemical tankers fleet. Due to the business environment which in changing dynamically in the shipping industry, beside the financial instruments that every shipping companies have to use in order to survive on this market, the type of contract in which the ships are involved are very important in raising the productivity of the entire company. Depending on the ship's employment situations based on two types of contracts, time charter and voyage charter, we tried to determine the productivity of each other, using a voyage in which the vessel was hired to transport a quantity of 35,000 m³ MTBE (methyl tertiary butyl ether). In each case the two participants have different interests, but one of them is common, releasing a satisfactory profit. Striking conclusions were drawn from the calculation of productivity and also cover solutions have been proposed to achieve optimum productivity in this sector.

Keywords: *productivity, voyage charter, time charter, ship-owner, charterer, Certificate of "On-Hire"*

1. INTRODUCTION

In the global economy, an extremely important element is international shipping with the purpose to create connections between areas, regions and countries in terms of business, economic, social and political activities. The importance of this sector is the economic development of the society by creating jobs in shipbuilding, port industry and of course on board.

Shipping also contributed to people migration in order to meet the needs of commercial, economic or social knowledge related to tourism or scientific research, facilitating relationships between maritime transporters and ship owners, suppliers, intermediaries and authorities. This area is largely influenced by political factors, state authorities, who, thru their measures can stimulate this activity and also when necessary may introduce restricting measures.

So shipping took a significant contribution to the evolution of humanity since ancient times, geographical discovery era, modern era and especially the present era. Shipping has an important international role by contributing to world trade; it transports the necessary materials for agriculture, industry, finished products, goods and also people. Shipping increases exchange of goods in terms of quantity and effectiveness, it reduces costs relating to those goods, due to the fact that transport costs are included in the final cost of a product.

Shipping' evolution is very important when referring to the world trade, the performance of shipping companies being a vital component that should be checked thru efficiency and productivity analysis. Given its complexity we can easily say that treating this subject can be constantly a hot topic. Considering the current technical level we can say that ships are the only means of transport that can provide traffic of billions of tons in the annually circuit of goods

So the shipping industry is rather seen as a business, given the large number of stakeholders in achieving these exchanges, including ship-owners, charterers, sea-brokers, ship builders and financiers, working together to achieve almost 4 billion tons of freight per year by maritime transport.

Referring to the types of chemical tankers, there are two Codes that provides details for the construction and equipment of three types of chemical tankers, varying from the ships presenting the greatest overall hazard: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code, ships built after 1986) and the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH Code, for older ships).

Due to MARPOL, Annex II, the three types of IMO Ships are defined as:

- IMO Ship Type 1- a chemical tanker intended for the transportation of products considered to present the greatest overall hazard. The quantity of cargo required to be carried in a Type 1 ship should not exceed 1,250 m3 in any one tank.

- IMO Ship Type 2 - a chemical tanker intended to transport products with appreciably severe environmental and safety hazards which require significant preventive measures to preclude escape of such cargo. The quantity of cargo required to be carried in a Type 2 ship should not exceed 3000 m3 in any one tank.

- IMO Ship Type 3 - a chemical tanker intended to transport products with sufficiently severe environmental and safety hazards. These products require a moderate degree of containment to increase survival capability in a damaged condition. There is no filling restriction for chemicals assigned to Ship Type 3.

In brief, IMO Ship Type 3 doesn't have void space, so in case collision happen, the cargo will leak out directly to sea, while for type I and II, the cargo won't leak out directly to sea, due to the double hull. Nowadays there are some countries, like Singapore, that reject IMO Ship Type 3 to call their port.

Due to the fact that in order to build a IMO Ship Type 1, the owner need to spend a lot of money and due to the fact that our product, MTBE, is perfect to be transported with a IMO Ship Type 2, the best designated IMO type for Chemical Tankers and for this calculation right now is IMO Ship Type 2.

2. PROBLEM FORMULATION

According to David (1994) productivity is concerned with the efficient utilization of resources (inputs) in producing goods and/or services. Shipping is a highly competitive capital-intensive transportation service industry where the ship owners compete by their ability to undercut their competitors and by the record of efficiency and performance as a profit earning reputed carriers or fleets.

Productivity depends upon three main factors:

- Mean Operating Speed, which determines the time a vessel takes on a voyage. The mean operating speed is important because it determines the amount of cargo that can be delivered during a fixed period and hence the revenue is earned. Sometimes it is better to operate the ship at full speed in a high freight rate market whereas in low freight rates a reduced speed may be more economic because the cost of fuel saving may be greater than the loss of revenue.

- Deadweight Utilization, which refers to the extent to which a vessel travels with a full load of cargo. In practice, the deadweight cargo capacity of a ship represents a physical maximum, and it is commercial decision whether this capacity is fully utilized. The ship owner has always the option to accept a part cargo depending on the market condition.

- Loaded Days at Sea which is a vessel's time divided between loaded at sea (steaming days) and the unproductive days (in port, off hire, in ballast etc.).

The existence of different types of ship chartering contracts in the bulk shipping industry provide charterers greater flexibility to secure their sea transportation requirements, while minimizing their costs.

The contracts vary depending on the terms of agreement and the type of service that shipowners agree to provide to charterers. Broadly speaking, chartering contracts can be classified into five different types: Voyage Charter (VC), Consecutive Voyage or Contracts of Affreightment (CoA), Trip Charter (TC), Time or Period Charter (PC), and Bareboat Charter (BC) contracts. The main differences among these contracts are the: duration of the contract, method of freight rate calculation, cost allocations and commercial and operational responsibilities[1].

To determine the productivity of a ship will use two employment situations of the ship on a voyage charterparty and under a time charterparty.

Voyage Charterparty is the contract between shipowner and charterer; the shipowner, in exchange for an amont of money called freight that depends on the quantity of goods, promises to transport it, from one port to another on a vessel, the charterer, that promises to provide goods and pays the freight.

Time Charterparty is the contract between shipowner and charterer, the shipowner, in exchange for a payment called rent, make available to the charterer, for a period of time, the ship and crew services. For this period, charterer will exploit commercially the ship, he chartered ending future contracts and supporting a series of voyages specific costs incurred.

In the first case, hiring the ship on a voyage charterparty, the vessel was hired to transport a quantity of 35,000 m³ MTBE (methyl tertiary butyl ether), during the voyage (TC 04-t), from April 27 year t, profit is divided equally between the owner and the charterer due to their common interest in ship's efficiency through a better coordination of trips, reducing waiting times and travel to the next port of loading. Under this type of contract the charterer is directly interested in voyage's efficiency and a better coordination between the port of unloading and loading. Also known quantities of heavy fuel oil for main engine (HFO) 950 t, diesel, light fuel oil for auxiliary engines (DO) 70 t and freshwater (FW) 120 t, the ship was loaded in Port Shepstone (South Africa), destined Hamriyah (UAE), as figures 1 and 2.

Between the two ports the ship's passage plan was in the southwest Indian Ocean as Figure 1 and 2.

Fig. 1. Passage plan in the southwest Indian Ocean
Source: www.maps.google.ro

[1] Stopford, M. (2009) "*Maritime Economics*" Routledge, London

Fig. 2. Passage plan in the southwest Indian Ocean
Source: www.maps.google.ro

After routing you must perform economic calculation and you can begin with determining the costs as seen in Table 1.

Table 1: Determining costs

Total goods cost:	35.000m³ x 60USD= **2.150.000 USD**
Fuel cost:	**347.100 USD**
- Loading port expenses (duration 24 hours)	5t x 650USD= 3250 USD
- Cost of theoretical march (duration 12 days)	31t x 12days x 650USD= 241.800 USD
- Additional cost due to piracy area (duration 3 days)[2]	33t x 3days x 650USD= 64.350 USD
- Discharging port expenses (duration 24 hours)	28 t x 108 USD = 18.200 USD
- Cost of moving the ship in ballast to the next port of loading (duration 2 days)	2days x 29 t x 650 USD= 37.700 USD
Maneuvering cost:	**34.000 USD**
-Mooring in loading terminal	3.500 USD
-Unmooring from loading terminal	1.900 USD
-Pilotage from loading terminal	8.000 USD
- Mooring in discharging terminal	5.800 USD
- Unmooring from discharging terminal	3.800 USD
- Pilotage from discharging terminal	11.000 USD
The cost of preparing the tanks for the next loading operation (tank cleaning operations)	10t x 650USD= **6.500 USD**
Crew wages[3]	19days x 2.730 USD= **51.870 USD**
Provisions costs	19days x 7USD/day x 23 person= **3.059 USD**
Drinking water cost	8 t/day x 19days x 2 USD= **304 USD**
Ship's maintenance cost	**11.450 USD**

Thus charterer will realize a profit of 687.400 USD (50% x total freight cost - fuel cost – maneuvering cost – tank cleaning operations cost) and Ship-owners profit is U.S. $ 1,008,317 (50% x total freight cost- crew wages- provisions costs- drinking water cost- ship's maintenance cost).

In the second case, hiring the ship under a time charterparty, you will use the same ship, but this time the ship was engaged for a period of 12 months, from January 10 year t, to transport the same amount of MTBE, with the same loading and discharging port. Ship has issued Certificate of "On-Hire" on January 10 year t, and if this type of contract, profit commodity returns in a higher percentage of owner (by contract agreement 60% + the ship's rent 30.000 USD/day 40%), just to compensate (partially) losses due to the so-called downtime.

In this case the charterer will realize a profit of 472.400 USD[4] (40% of total freight cost - fuel cost – maneuvering cost – tank cleaning operations cost) and ship-owner profit of U.S. $ 1,793,317 (60% of total freight cost- crew wages- provisions costs- drinking water cost- ship's maintenance cost).

In order to compare both profits, they were pooled in Figure 3.

[2] Occurs because the additional generator is started to improve transport safety (moving in convoy), leading to increase consumption (2t more fuel than normal consumption of 31 tons)

[3] The crew consists of 23 people, whose total monthly wages reached 81.900 USD, which means a daily cost of 2.730 USD

[4] According to data revealed by Table 1

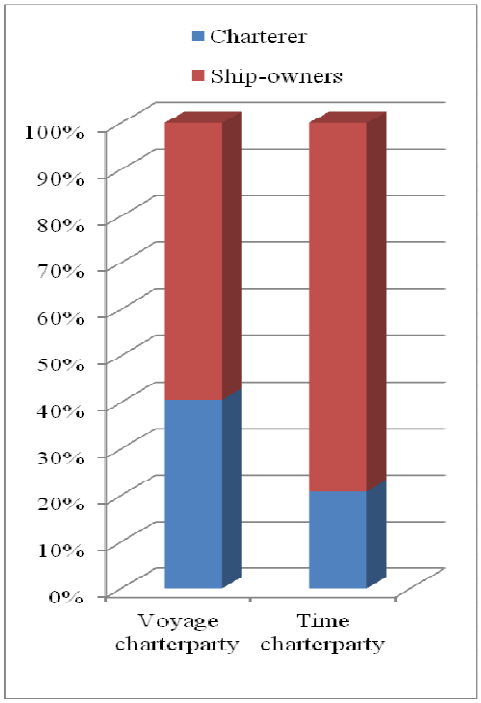

Fig. 3. Shipowners and Charterer profit for both voyage types

The vessel's description is particularly important for the charter on a time charterparty, using the details received from the owner, he estimates the contract's efficiency and establishes a certain rent. Thus data provided to charterers are closely related to the period the vessel is chartered and its intentions regarding the operation. Unlike the case when concluding a voyage charterparty the level of ship's details depends largely on the particular voyage. Thus, the owner has the right to substitute the vessel only if there is no such provision, and it is also necessary to mention if one can just substitute a right or an obligation, and if it can be done once or several times.

3. CONCLUSION

It is clear that shipping has an important role in connecting "time-space" between geographical areas, continents and countries from all over the world, representing numerous services that influenced the evolution of many economic activities, a sector that contributes in increasing the added value of a product or a service. Productivity is a key that differentiate companies' profits, companies that have the same number of ships and the same capabilities. Thus the results obtained in this work can be extrapolated to all shipping works as the core of maximizing efficiency results is given by merchant ships.

The analysis revealed that for the ship-owner, hiring a vessel for a defined period of time is more advantageous than the voyage charter. Generally voyage charterparty is used when transporting small quantity of cargo and on a relatively short distances or when the ship owner is unwilling to assume the risk of bad weather and delay in loading or discharging. Time charterparty is usually used in larger companies, which have a considerable number of ships.

Thus we offer to companies which are interested in maximizing their results to maintain their vessel in time charterparty and also to reduce the number of crew members from a number of 20-21 to a number of 17 or less, without jeopardizing the safety of navigation, complying with standards of the International Maritime Organization; those having an immediately effect in reducing ship's operational costs.

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