A Close Scrutiny of Global Maritime Distress System in Maritime Environment

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Received: December 2011 Accepted: July 2011
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Abstract
Global Maritime Distress Safety System (GMDSS) is one of the best and most efficient systems for emergency. The systems have been developed to provide mariners global communications and locating network. This system includes land stations for all INMARSAT services to reporting at sea, and so far using this communication system, in marine emergency situations has helped rescue thousands of lives. All INMARSAT information and COSPAS-SARSAT services are able to receive emergency position indicating radio beacon (EPIRB) data and coast stations. In this Paper, an approach towards improving the GMDSS systems is presented. After identifying the weak points of the current systems, following were discussed:
• Analyzing and inspecting the level and amount of false signals received by the system
• Identifying and inspecting the reasons behind reception of false emergency signals in the system
• Analyzing the costs incurred after reception of false signals in GMDSS systems

Keywords: Maritime Distress, GMDSS, Human Element, EPIRB, SAR, DSC

1. Introduction
The concept of GMDSS arose as an idea by the International Maritime Organization (IMO) in 1973 and entered into force in February 1999 (Hydrographic Office 2008). The requirements of ships to comply with GMDSS are prescribed by the Convention for Safety of Life at Sea (SOLAS), Chapter IV; this system is applicable to all passenger vessels and all cargo vessels over 300 GT, when they are sailing in international voyages. The GMDSS communications between ships and rescue co-ordination centers are carried out using satellite or terrestrial radio sub-systems. This system includes land stations for all INMARSAT services to receive all INMARSAT information and COSPAS-SARSAT services to receive emergency position indicating radio beacon (EPIRB) data and coast stations.

The automatic calling system is known as Digital Selective Calling (DSC) and its main consideration,
when shipboard communications are not in progress, is requesting (warning) the radio operator to check that: a) the equipment is switched on and b) it is correctly installed to perform the nine GMDSS functions required by SOLAS Convention.

The aim of this paper, firstly, is to clarify the importance of sympathy among people who are taking part in emergencies and distress situations towards each other. Secondly, to elaborate on GMDSS systems currently used for helping people in emergency situations at sea, as a tool for reporting and sending SOS signals when a life is threatened.

In the present investigation, the GMDSS pack from 20 ships in Iranian port of Shahid Rajaee is studied and the percentage of GMDSS false alerts were determined. Then, the results are compared with data from different stations with the same conditions in countries such as Germany, Hong Kong, and Iran (COSPAS-SARSAT, 2008). In the end, some useful methods through reducing GMDSS false alerts were suggested according to the collected information.

2. Methodology

In order to improve the GMDSS systems, we need to study the system accurately from the perspective of its weak points. Regarding the wide range of using GMDSS systems all over the world and considering the number of ships on which these systems are being applied, systems of three countries of Germany, Iran and China (Hong Kong) were chosen to be studied. Germany was selected for its main role in covering marine traffic in the European regions, Iran for covering marine traffic in the Middle-Eastern waterways, and Hong Kong for covering marine traffic in Asian eastern waters.

To evaluate the number of false emergency signals, spending lots of time was necessary in regard to the number of systems which were common in each country. Germany is using three types of emergency beacons of DSC, Epirb and INMARSAT for transmitting distress signals. Analysis on the available emergency signals took 6 years to be completed. In Iran, DSC system was the only available system; therefore, analysis was performed exclusively on these types of signals. Also, in Hong Kong, since there were two types of beacons (DSC and Epirb) available, the analysis was performed only on these signals.

It should be noticed that, based on the international standards, the priority for taking and enterprising rescue actions is given regularly to Epirb, DSC and INMARSAT signals, respectively. However, INMARSAT signals are rarely transmitted in emergency situations.

2.1. Procedure of Study

In this study, the procedure of analyzing and inspecting the emergency signals in GMDSS systems was as follows:

1- All received distress signals during 6 years in the three countries were collected and then false signals were identified and the percentage of false signals was calculated.

2- The next step was to inspect the reasons behind the transmission of false distress signals. Based on all inspections, these errors were categorized into three types (human errors, errors due to the malfunctioning of equipments and errors arising from the environmental effects).

Iran because of its location in the oil-rich zone of the Persian Gulf experiences the highest traffic of tanker ships and as such, was designated as the reference country for the study. Receiving emergency signals in this zone is of vital importance and inaccuracies might lead to significant damage to the environment, ships and people.

An Iranian port (Shahid Rajaee Port, SRP) was selected as the sample port. Port State Control Officers working in SRP have documented about 50 incidents on ships as a result of personnel errors and GMDSS systems errors. Personnel errors in some ships had arisen both from staff and technical
sectors. In addition, through the assessment of reasons behind transmission of false signals from ships to the beacons, the cost-related data for distress signal checking process were collected. In this paper, only costs relating to fuel and communications were subjected to analysis, and costs relating to the risk of the personnel’s lives participating in rescue operations or costs of accessing database of distressed ships transmitting false signals were overlooked.

3- A questionnaire on reasons of sending GMDSS false alerts was prepared and the feedback from all the SOLAS Conventional ships such as cargo ships, container ships and Ro-Ro ships was obtained. The emphasis of the questionnaire on GMDSS false alert concentrated on human element, technical problem, and environmental effects. In addition, another questionnaire was prepared to investigate, all root causes which might have affected human error on 50 ships.

4- Analyzing of the costs was performed using following equation:

\[ C = Y + X \]

\( C \) = the total costs incurred after receiving a false signal
\( X \) = the fuel cost of ship and helicopter used for the operation \( \times \) the number of operations performed after receiving false signals
\( Y \) = telephone costs for each pulse \( \times \) call duration \( \times \) the number of telephone contacts

3. Results and Discussion

The research team investigated and evaluated the GMDSS pack for 50 ships in SRP to detect the main factors that might influence the sending of GMDSS false alert, and determined the percentage of GMDSS false alerts from ships for all related stations in Germany, Hong Kong and Iran for the period of 2001-2007 (COSPAS-SARSAT, 2006).

Percentages of false alerts in INMARSAT-C and DSC received by all stations in Germany’s coast and INMARSAT stations are shown in Figures. 1 and 2 (COSPAS-SARSAT, 2008).

![Fig. 1: INMARSAT-C (percentage of false alert) of Germany 2001-2007 (Bertoria, Ch., 2007)](image1)

![Fig. 2: DSC (percentage of false alert) of Germany 2001-2007 (Bertoria, Ch., 2007)](image2)

The percentage of false alerts in DSC and Epirb received by all stations in Hong Kong, Iran and Germany were calculated (Figures 3, 4, 5 and 6).

![Fig. 3: DSC (percentage of false alert) of Hong Kong 2001-2007 (Bertoria, Ch., 2007)](image3)
Results obtained through the questionnaire are summarized in Table 1.

Percentage of main factors that caused sending GMDSS false alert is shown in Figure 7.

Table 1. Questionnaires for GMDSS false alert (Bertoria, Ch., 2007), (COSPAS-SARSAT, 2008)

<table>
<thead>
<tr>
<th>False Alert</th>
<th>Human Element</th>
<th>Technical Problem</th>
<th>Environment Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF DSC ( )</td>
<td>YES [ ] NO [ ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MF DSC ( )</td>
<td>YES [ ] NO [ ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HF DSC ( )</td>
<td>YES [ ] NO [ ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPIRB ( )</td>
<td>YES [ ] NO [ ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INMARSAT SYSTEM ( )</td>
<td>YES [ ] NO [ ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please choose one of below reasons you may think exist in this vessel and cause sending GMDSS false alert

**HUMAN ELEMENT:**
- UN FAMILIAR PERSON WITH GMDSS OPERATION: (below equipment (please fill attach form in related to human element fault)
  - VHF DSC ( )
  - MF DSC ( )
  - HF DSC ( )
  - EPIRB ( )
  - INMARSAT SYSTEM ( )

**TECHNICAL PROBLEM:**
- The equipment may be destroyed by environment effect such as corrosion and other thing, if vessel has this problem choice the equipment.
  - VHF DSC ( )
  - MF DSC ( )
  - HF DSC ( )
  - EPIRB ( )
  - INMARSAT SYSTEM ( )

**ENVIRONMENT EFFECT:**
- May be this vessel have essential problem in GMDSS software or hardware and this problem cause send FALSE ALERT:
  - VHF DSC ( )
  - MF DSC ( )
  - HF DSC ( )
  - EPIRB ( )
  - INMARSAT SYSTEM ( )

Results showed human error was the most important factor in sending false alerts. Results of questionnaire 2 relating to root causes of human errors on 50 ships are shown in Table 2 and shown in Figures 8, 9, 10 and 11.

Table 2. Questionnaires to analyses human error (Bertoria, Ch., 2007), (COSPAS-SARSAT, 2008)

A) Human element
1. Have a daily weekly test on DSC’s?
   YES [ ] NO [ ]
2. Familiar about how undesigned distress alert is sent on VHF, MF/HF DSC’s
   YES [ ] NO [ ]
3. Familiar about how designated distress alert is sent on VHF, MF/HF DSC’s
   YES [ ] NO [ ]
4. Familiar about how you will cancel a false distress alert sent on VHF DSC, including channel and Message
   YES [ ] NO [ ]
5. Familiar about how you will cancel a false distress alert sent on MF/HF DSC, including frequency and message
   YES [ ] NO [ ]
6. Familiar about how you will send an undesigned distress alert using the INMARSAT terminal
   YES [ ] NO [ ]
7. Familiar about what action you will take to cancel a false distress alert on INMARSAT C
   YES [ ] NO [ ]
8. Familiar about how you will send a designated distress alert on INMARSAT C
   YES [ ] NO [ ]
9. familiar about how the EPIRB activates automatically and precautions to be taken to prevent false alerts
   YES [ ] NO [ ]
10. Familiar about how to manually activate the EPIRB
    YES [ ] NO [ ]
11. Familiar about procedure to cancel false alert sent on EPIRB
    YES [ ] NO [ ]
12. Familiar about routine checks & tests to be carried out on EPIRB
    YES [ ] NO [ ]
13. Familiar about the daily weekly & monthly tests/checks to be carried out as per GMDSS Regulations
    YES [ ] NO [ ]
14. Familiar about how the GMDSS Radio Log is to be maintained
    YES [ ] NO [ ]
Fig. 8: Human factor – concerning the unfamiliar personnel to work with a GMDSS equipment, test & canceling

Fig. 9: Human factor – concerning the unfamiliar personnel to work with a GMDSS equipment, test & canceling

Fig. 10: Human factor – concerning the unfamiliar personnel to work with a GMDSS equipment, test & canceling

Fig. 11: Human factor – concerning the unfamiliar personnel to work with a GMDSS log & test

It must be noted that according to GMDSS instructors, it is the responsibility of the operator on board to evaluate how much one person is familiar with the use of instruments to be able to detect the root causes of human error reliably (Table 2).

It could be noted that approximately in every 10 distress messages from Epirbs, only 1 message is true and 9 messages are false. If there were 1.4 million beacons in 2015, then, almost 90% of these beacons would be false, based on SAR false alert rate in the world. If we expand this factor (growth of false alerts) to all means of GMDSS such as DSC and INMARSAT distress alert, then, there will be a critical point in time endangering maritime safety, and hence, there is the need resolving this problem.

Unfamiliarity with the procedure for cancelling false alert was the most important problem in SRP (Figures 8, 9, 10 and 11). Therefore, it is clear that the false alert must be cancelled immediately by using GMDSS system to inform the appropriate authorities (COSPAS-SARSAT, 2008) appropriately.

In Table 3, operational procedure is explained for cancelling false distress alerts in the Global Maritime Distress and Safety System - Resolution 349 (WRC-97). The work was carried out only to clear sending GMDSS false alert and to find a method to reduce the root causes (IMO, 2008).

2.3 Analyzing the Cost of Operations Fulfilled after Receiving False Signals

There is not much information available about the percentage of alerts, only for EPIRBs’ false alerts. In
In many occasions, especially on receiving EPIRB emergency signals, the center sends rescue team to the location which incurs heavy costs. It is noted that, search and rescue services, according to SAR convention, are given by the governments at no cost. Therefore, on receiving a distress signal, while there is no proof on the emergency situation of the distressed ship and the risk for its crew, the coordination centers proceed to send search and rescue teams and if the signal was a false one a heavy cost would be incurred to the center. In this paper, the research team worked on evaluating heavy costs of fuel and telecommunication using SRP search and rescue center of Iran as an example. Costs relating to the risk of losing personnel lives or costs of accessing database of the distressed ships are not considered in calculations.

SRP search and rescue center is located between geographical latitude of 53 degrees to 58 degrees, and the main center consists of 6 sub search and rescue centers. This center possesses two types of 20 meter long fast ships called Naji 1 and 2. Each ship carries 4 agents, and their fuel capacities are 5000 and 4700 liters, respectively. In average, 7500 liters fuel is consumed monthly for rescue operations and considering the low price of fuel in Iran, an average of USD 2625 per month is spent due to false distress signals. In addition, MRCC Bandar Abbas is equipped with one helicopter with an average of USD 20,000 monthly operation cost due to false distress signals. Cost for a total of 6 years adds up to USD 1,442,625. Also, according to our surveys, the duration of telephone calls made for analyzing the validity of the signals and coordinating the operations was about 90 minutes in average, and considering the 0.5 dollars per minute cost for telephone calls in Iran, cost of USD 3240 is incurred for the six years. Thus, a sum of USD 1,445,865 is incurred during 6 years for only one search and rescue center in Iran on checking, analyzing the signals and performing rescue operations on receiving false emergency signals.

Although this amount might seem negligible in the first look, but two important points are to be noted; the cost of fuel and telephone charges in Iran is very low, compared with other countries and there are 705 search and rescue centers in the world. Thus, taking into account the costs incurred per center and via extension to the number of centers in the world, overall cost would be huge (COSPAS-SARSAT, 2008).

Based on findings of this study on false distress signals received in three sample countries, Germany, Iran and China (Hong Kong), it was found that the number of false signals was very high and in many
cases, it led to the lack of motivation by rescue center staffs in taking immediate action for performing rescue operations.

According to the inquiries made in Iranian ports as a sample country in a strategic region, we found that of three possible causes for transmitting false signals, human errors ranked the highest.

Considering all the previous discussions, we come to this conclusion that GMDSS system is an advantageous system on its own but it needs fundamental changes. Hence, the research team proposes two models for improving GMDSS system. The basic of these propositions is to improve skill of the GMDSS users and also to reduce role of the human on working with package. Therefore, two long term and short term models are proposed as below:

The Short term model: the first part includes a strict educational framework for seafarers to get familiar with GMDSS in general and being able to cancel false alert sent by seafarers in particular. Moreover, the second part is to control the training which has to be exercised in a serious manner. To achieve a successful control and to promote seafarers competence in dealing with GMDSS, port authorities should employ an experienced port and flag State control officer (PSCO) and a training officer as well. Training officer should train seafarers in order to make them familiar with GMDSS in general, and canceling false alert in particular, while the PSCO should start inspection of all vessels calling the port during the signal receiving process; PSCO will indicate the vessels having human element based problem (unfamiliar personnel to work with GMDSS). The training officer should then target these vessels and if there were any problem in the vessels due to other factors such as technical problem it should be detained by the PSCO until seaworthy stage has been obtained by vessels.

The Long term model: In this model, fundamental changes should be applied to the hardware and software systems of GMDSS. In this approach, toward reducing the role of human element in sending distress signals and working with the systems, using various sensors and employing advanced technologies would be necessary.

4. Conclusions

The total amount of costs incurred, in checking, analyzing and taking actions for rescue operations on receiving distress signals sent from ships, on search and rescue centers is very high. In average, in a six years period, calculating for 705 centers worldwide, approximately, an estimated amount of USD 296, 402, 325 is spent on false alert calls.

It was realized that the most contributing factor in sending false distress signals was human errors and accounted for 70 percent of the transmitted false signals. After inspections made on this problem, it was found that the most important reason behind human errors was the lack of skilled personnel knowing how to report the falseness of the transmitted signal. Therefore, in order to reduce this type of errors and to save in costs, training courses for operators working with these systems as well as inspecting (checking and analyzing the signals) and upgrading of equipments are proposed.

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