# Analysis of Ship Radio Frequency Coverage Failure

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***Abstract*—MF/HF Radio communication equipment is a communication device that uses a medium or high frequency system that is intended for maritime purposes. The device is equipped with a maritime mobile service identity, which has the ability to transmit, receive and monitor distress signals. The device also can be used for normal communication between ship-to-ship and ship-to-land. In this article, we conducted direct monthly testing of MF/HF Radio when sending distress signals. We monitored the problems caused by delays in the process of sending and receiving distress signals when the ship was sailing. The delays occurred due to the Single Side Band MF antenna. To analyze the problem, we propose a qualitative descriptive approach, which describes and analyzes the problems found. We use four categories to analyze the problem which are number of incidents, primary causes of failure, time of incidents and average duration of failure. The experimental results show the results of each category. The frequency of coverage failure incidents is eight times incidents. The biggest cause of failure was caused by weather interference with 35 % failure. The time of incident was at night time. It was 30 % of incidents. And the average duration failure was in two hours with 40%. Using this data, we can prevent and improve the MF/HF radio communication when sending and receiving distress signal optimally. Therefore, in shipping activities, especially when carrying out communication activities and facing emergencies, distress signals can be sent and received quickly and accurately.**

**Keywords: Medium/High Frequency, Maritime Communication Radio Communication**

## I. INTRODUCTION

THE Harbormaster and Port Authority Office is a government agency under the auspices of the Ministry of Transportation which has the task of carrying out supervision and law enforcement in the field of port security and patrols, coordinating government activities at ports as well as regulating, controlling and supervising port activities at ports operated commercially [1]. Carrying out port security management inspections and patrols by carrying out port security supervision using patrol boats and checking ships related to welding activities on board ships, bollard pull tests, tank cleaning, and salvage or underwater work.

There are some works related to the analysis of ship radio frequency failure in the past. The use of medium-frequency radio infrastructure to support a maritime terrestrial navigation system has been studied and analyzed in [2]. They analyzed the potential service that could be provided by the Ranging Mode communication. They found that the Ranging Mode could support 20% to 40% of all ships with position. Another study to identify the probability of a ship in distress to have a failure to certain radio equipment has been proposed in [3]. Their method has determined a criterion in the risk factors of identifying a ship with radio communication failures. The safety assessment to radio hazard for marine ship transmitter has been investigated [4]. They have investigated the electric filed levels from seven radio transmitters including VHF, MF/HF, satellite communication (Sat-Com C), AISnavigation, radar X-band and radar S-band. Habibi analyzed the cause of marine transportation failure in his past study. He measured the relation between safety and security with the marine transportation failure. The article was a descriptive analysis which analyzes a secondary data such as regulation and literature study [5]. Sarinten et.al., have evaluated the implementation of standard marine communication [6]. Their approach was descriptive qualitative which is done by collecting data using observation, interview and communication. They obtained the use of standard marine communication phrases inconsistently. Another approach has been implemented to monitor the navigation and communication system of fishery activities. The lack of equipment caused the limitation dan overlapping information among fisheries. The condition also gave an effect to the lack of efficiency and optimization in the excavation of fishery resources [7]. The failure is not only caused by the equipment but also by humans because of a wrong management or unskillful person. The important role of ship management and communication skill to improve safety and security of ship was studied by Supangat [8]. The article found that was a strong relation between ship management and communication skills with the safety and security of ship. The article recommended to do a training to improve communication and hands on people and invest in some equipment to support technological development. In terms of ship communication, some studies also have been done in the past. Modem development for wireless communication system has been developed using ad hoc on demand distance vector algorithm [9]. They can overcome the lack of communication which can cause limitation in excavation of marine resources. A failure of marine communication system can cause many accidents of the ships. In order to reduce and prevent accidents, marine communication has to be improved. This challenge has been overcome, one of them using automatic identification system as proposed in [10]. On other hand, ship navigation system to support autopilot using GPRS GSM system has been developed in [11].

According to previous studies, there are still many challenges for researchers to overcome the problem in Maritim communication especially using radio communication. This article aims to analyze the failure of ship radio frequency coverage. We use four categories to analyze the problem which are number of incidents, primary causes of failure, time of incidents and average duration of failure. The purpose of the study is to prevent and improve the MF/HF radio communication when sending and receiving distress signal optimally. Therefore, in shipping activities, especially when carrying out communication activities and facing emergencies, distress signals can be sent and received quickly and accurately.

## II. METHOD

The design method is divided into three steps such as data collection, data validation and ship radio testing.

### A. *Data Collection*

This research uses a qualitative descriptive approach for collecting data such as using an interview technique, conducting an observation in the field and analyzing the problems found from the documents. Table I shows the instrument for conducting data collection as well as results of the observation.

TABLE I
INSTRUMENTS FOR CONDUCTING RESEARCH AND DATA COLLECTION

| No | Instrument | Observation Result |
|---|---|---|
| 1. | Check the cause of engine failure on the ship's radio equipment | Regular monthly inspections and maintenance of radio equipment's were conducted. |
| 2. | Check the ship's radio documents before the ship is allowed to sail | Each ship was required to update and check the completeness of radio documents before departure. |
| 3. | Analyze the causes of failure from observations | In-depth analysis of incidents was conducted at the end of each month. |
| 4. | Ensure and check that the power supply on the ship is stable | Power monitoring systems were installed on all ships. |
| 5. | Determine the ship's radio frequency and signal so that failure does not occur when in use | Frequency testing equipment was used to ensure the frequencies were free from interference. |

### B. *Data Validation*

The validity of the data needs to be tested to avoid errors in the data to be analyzed. We do the data validation in several ways such as continuous data collection on the same research subject, triangulation on other sources that can be accounted for, and if necessary, checking by the research subject.

### C. *Ship Radio Testing*

There are several stages before operating the ship's radio equipment when the process of testing a ship's radio to avoid failures in the ship's radio frequency and signal. The ship's radio testing is shown in Fig 1.

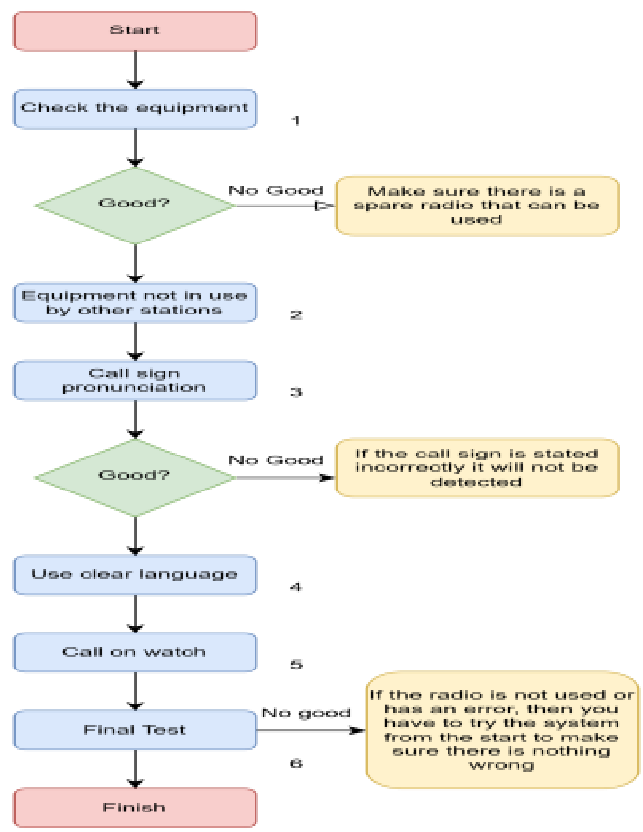


Fig. 1. Flowchart of ship radio testing process

First off, all equipment must be checked to make sure the radio equipment to be used is suitable for its intended purpose. And then, the radio should be ensured that is not being used by another station. It should be ensured that the equipment is not in use by others station. The next step is calling sign pronunciation that uses the correct station name or call sign. If it is good, we use clear language to make sure speaking clearly and use standard maritime phrases. It is better because it avoids double or ambiguous meanings. The step calls on watch is done when sailing the ship is on watch to calls and answers are permitted. The final test was to determine everything is used properly. And the last step is finished which is finished using the radio communication.

## III. RESULTS AND DISCUSSION

We performed the experiment to analyze the problem using four categories which are number of incidents, primary causes of failure, time of incidents and average duration of failure. The experiment was performed for six months between January till June. The experimental results show the result of each category. The experimental results are shown in Table II – V and also in Fig 2 – 5.

TABLE II
FREQUENCY OF RADIO COVERAGE FAILURE INCIDENTS

| Category | Jan | Feb | March | April | May | June |
|---|---|---|---|---|---|---|
| | (cases) | | | | | |
| Frequency of Radio Coverage Failure Incidents | 5 | 7 | 4 | 6 | 3 | 8 |

TABLE III
PRIMARY CAUSES OF FAILURE

| Category | Jan | Feb | March | April | May | June |
|---|---|---|---|---|---|---|
| | (%) | | | | | |
| Weather Interference | 35 | 35 | 35 | 35 | 35 | 35 |
| Equipment Malfunction | 20 | 25 | 25 | 25 | 25 | 25 |
| External Source Interference | 20 | 20 | 20 | 20 | 20 | 20 |
| Human Error | 10 | 10 | 10 | 10 | 10 | 10 |
| Other Factors | 10 | 10 | 10 | 10 | 10 | 10 |

TABLE IV
TIME OF INCIDENTS

| Category | Jan | Feb | March | April | May | June |
|---|---|---|---|---|---|---|
| | (%) | | | | | |
| Morning | 20 | 20 | 20 | 20 | 20 | 20 |
| Afternoon | 25 | 25 | 25 | 25 | 25 | 25 |
| Evening | 30 | 30 | 30 | 30 | 30 | 30 |
| Night | 25 | 25 | 25 | 25 | 25 | 25 |

TABLE V
AVERAGE DURATION OF FAILURE

| Category | Jan | Feb | March | April | May | June |
|---|---|---|---|---|---|---|
| | (%) | | | | | |
| 2 hours | 40 | 40 | 40 | 40 | 40 | 40 |
| 4 hours | 35 | 35 | 35 | 35 | 35 | 35 |
| 6 hours | 15 | 15 | 15 | 15 | 15 | 15 |
| More than 6 hours | 10 | 10 | 10 | 10 | 10 | 10 |

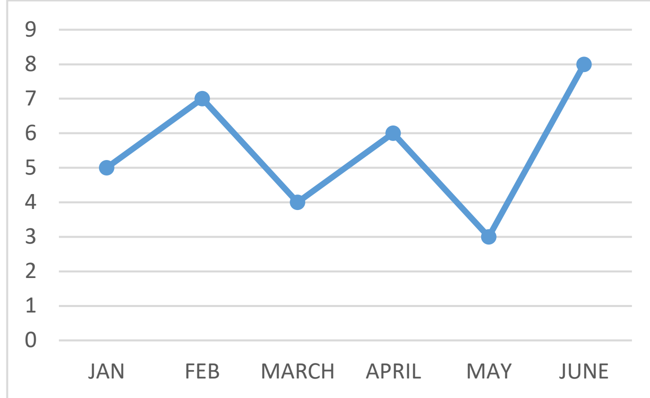


Fig. 2. Frequency of Radio Coverage Failure Incidents

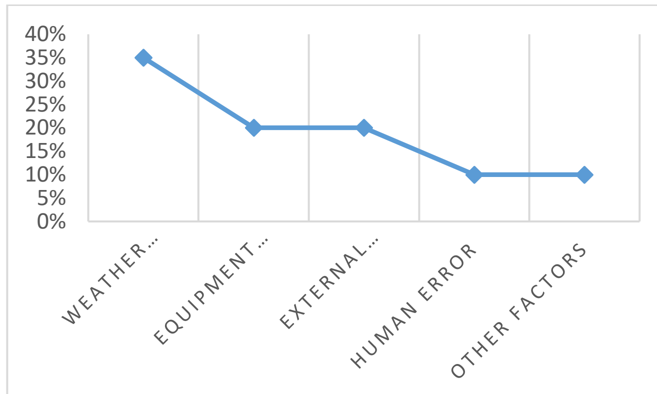


Fig. 3. Primary Causes of Failure

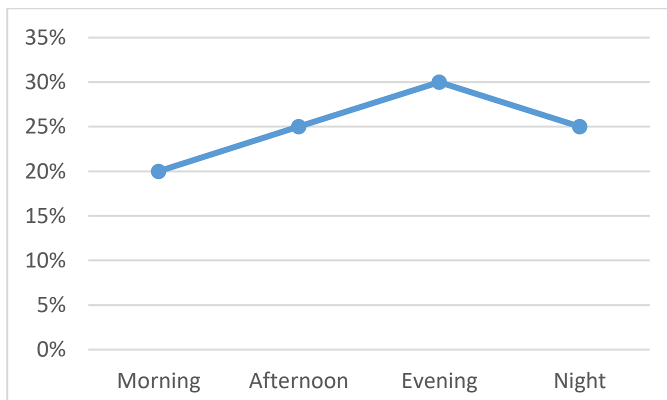


Fig. 4. Time of Incidents

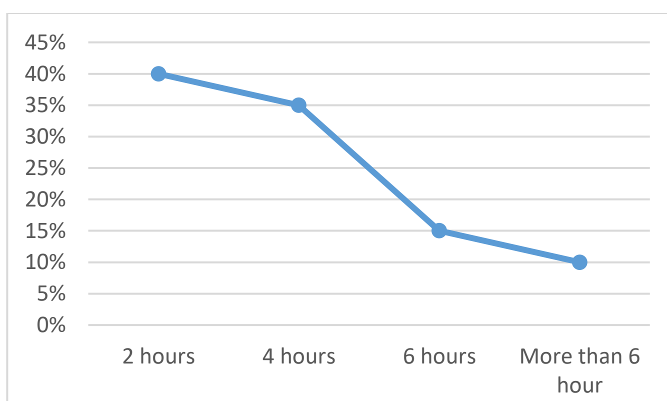


Fig. 5. Average Duration of Failure

During six months of monitoring between January and June, we obtained the incidents of radio frequency coverage failure varied each month and the peak failure occurred in February with 7 cases of incident and June with 8 cases of incident as shown in Table II and Fig. 2. In March, there was decreasing incident become 3 cases. It is because at that time radio equipment inspections were conducted on all ships operating at the Port. It was found that five ships had damaged radio components. These components were immediately replaced or repaired. Consequently, the number of radio frequency failure incidents in March decreased to 4 cases. In April, this inspection identified ships that did not meet standards, delaying their departure until repairs were made. It is a cause the incident increased in April to 6 cases. In June, it was found that two ships used frequencies causing interference. After adjustments were made, frequencies were corrected and aligned with international guidelines. Although the number of incidents remained high (8 cases), this action prepared for reducing in future incidents.

Table III and Fig.3 show the primary cause of failure. It was shown that the primary caused by weather interference becoming the highest which was 35% and the lowest was caused by human error which was 10%. For the time of incident, the highest incident in the evening time 30% and the lowest incident in the morning 10% as shown in Table IV and Fig. 4. For the category average duration of failure of incident, the highest incident occurred in the duration every two hours.

Table IV and Fig. 4 show the monitoring result regarding average duration of failure. We obtained that the average duration failure has the highest duration in 2 hours which is 40% and the lowest duration in more than 6 hours which is 10%.

After we obtained incident data for each, we performed an improvement step to prevent and decrease the number of incidents such as inspecting radio equipment failure monthly, checking ship radio document before departure, analyzing the failure causes with observations, ensuring and checking stable power supply on the ships and determining ship radio frequency and signal to prevent failures during use.

To address the delays in the process of sending and receiving emergency messages on MF/HF Radio we performed some operations such as replacing old SSB MF/HF antennas, repairing the main board of the automatic Tuner, monthly routine testing, training and regular Maintenance.

By conducting regular checks and ensuring that the improvement steps continue to be effectively implemented, it is expected that the delay in the process of sending and receiving emergency messages on MF/HF Radio can be effectively addressed. Table VI shows the result of monitoring received and problematic frequencies from January to June 2024. Problematic frequency refers to frequencies experiencing interference or issues causing instability in ship radio communication, while received frequency refers to frequencies functioning well and being properly received by ships.

Based on the table, it can be observed that each month has different problematic frequencies. Nevertheless, the received frequencies tend to remain stable.

TABLE VI
THE COMPARISON BETWEEN PROBLEMATIC AND RECEIVED FREQUENCY

| Month | Problematic Frequency (MHz) | Received Frequency (MHz) |
|---|---|---|
| January | 3.2 | 4.5 |
| February | 3.6 | 4.3 |
| March | 3.8 | 4.1 |
| April | 3.4 | 4.7 |
| May | 3.5 | 4.6 |
| June | 3.9 | 4.2 |

## IV. CONCLUSION

We have conducted direct monthly testing of MF/HF Radio when sending distress signals and monitored the problems caused by delays in the process of sending and receiving distress signals when the ship was sailing. Four categories to analyze the problem which are number of incidents, primary causes of failure, time of incidents and average duration of failure were used to analyze the communication failure. According to six months monitoring, we found the highest incidents of the frequency coverage failure was eight times incidents. It occurred in June. Where the biggest cause of failure was caused by weather interference with 35 % failure. The time of incident has the highest incident at night time. It was 30 %. And the average duration failure was in two hours with 40%.

Based on the monitoring data, the MF/HF radio communication when sending and receiving distress signal, the failure communication can be prevented and improved. Therefore, in shipping activities, especially when carrying out communication activities and facing emergencies, distress signals can be sent and received quickly and accurately.

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