

AIS-ASM Standardised Communication Message Development Based on Users' Communication Needs at Sea

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사용자 요구 기반의 AIS-ASM 표준통신메시지 개발에 관한 연구

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Abstract : Application Specific Messages (ASM) have been introduced by a number of international bodies, such as the International Maritime Organization (IMO), the International Telecommunication Union (ITU) and the International Association of Lighthouse Authorities (IALA), for the purpose of resolving AIS overloading issues caused by an increasing number of ships using AIS systems. ASM communication will transmit a large amount of safety-related information at sea, including meteorological information, accident reporting, and navigational warnings. Specifically, this message transaction system is expected to be actively used for communication among ships and for ship-to-shore (4S), where VHF communication through voice was standard. In order to design a user-oriented service through standardised AIS-ASM messaging in the future, the need for analysis of this seems to be quite critical. In order to reflect users' AIS-ASM communication needs, therefore, frequently-occurring marine communication messages were analysed through a questionnaire survey conducted on 57 marine officers and 50 VTS operators. Based on the survey results, a list of key standardised messages was suggested as a reference for future AIS message development.

Key Words : Automatic Identification System, Application Specific Messages, VHF communication, Standardised communication messages, User needs

요약 : Application Specific Messages(ASM)은 다수 선박들의 AIS사용으로 인한 통신 과부하 문제를 해결하기 위해 IMO, ITU, IALA와 같은 국제기구들에 의해 해상에서의 적용이 결정되었다. ASM을 이용한 통신은 기상 정보, 사고보고 및 항해 경고를 포함하여 해양에서 많은 양의 안전 관련 정보를 전송할 수 있다. 특히 ASM통신 시스템은 음성을 통한 선박 간, 선박과 육상 간(4S) VHF통신의 일부를 메시지로 전달이 가능할 것으로 기대된다. 해상의 4S통신에서 중요도가 높은 문장을 표준통신메시지로 선정하여 ASM통신에 이용한다면, 정확하고 신속한 메시지의 송수신이 가능할 것이다. 표준통신메시지의 결정은 사용자의 의견이 적극적으로 반영되어야 하며, 이를 위해 본 연구에서는 57명의 항해사와 50명의 Vessel Traffic Service(VTS) 관제사를 대상으로 설문을 실시하였다. 설문 결과 분석하여 해상통신에서 사용빈도가 높은 53개의 표준통신메시지를 제시하였다. 제시된 표준통신메시지는 해상에서 사용되는 주요 문장들에 대한 실제적인 정보이며, ASM을 이용한 통신장비 및 인터페이스 개발을 위한 참고 자료로 이용될 수 있을 것이다.

핵심용어 : Automatic Identification System(AIS), Application Specific Message(ASM), VHF통신, 표준통신메시지, 사용자 요구

1. Introduction

The introduction of AIS-Application Specific Messages (hereinafter, AIS-ASM) is expected to enable mass data transmission with regard to the safer operation of ships (Ahn et al.,

2015). The scope of the messages will be quite varied, including navigational warnings, ship-to-ship routine communications, weather information and pilotage (IALA, 2013). In order for users to use this message system in an instant and more convenient manner while navigating ships as responsible officers and managing traffic as VTS operators, it is quite necessary to conduct systematic analysis of the message components and structures and further establish a user-friendly platform for messages (Trenkner and Sevchenko, 2017). Additionally, considering that it is recommended

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to establish the design of ASM messages in IMO Standard Marine Communication Phrases (IMO, 2010), the research on frequently used phrases seems to be very critical at the moment. In this paper, therefore, with an aim of suggesting AIS-ASM messages on the basis of international guidelines and domestic users' needs, an extensive survey of marine communication phrase data was first conducted. Following this, the collected data and relevant marine communication phrases were reviewed by specialist panels through a series of workshops and meetings to narrow the target phrases to a manageable number for the questionnaire survey. Next, the questionnaire survey targeting 57 deck officers and 50 VTS operations was conducted in order to encompass the diverse views of different parties. Finally, the data was analysed and suggestions for future AIS-ASM messages were made.

2. Research Methods

2.1 The Overview of the Research Process

A user survey was conducted in order to establish a list of standard phrases according to users' needs. Prior to the survey, the immense volume of marine communication phrases suggested by international guidelines, including IMO SMCP, ITU and International Code of Signals, were collected and condensed enough to make the survey practical (Ahn et al., 2016). The final questionnaire was completed in a total of five stages (Fig. 1) of meetings of and consultations with VHF communication experts.

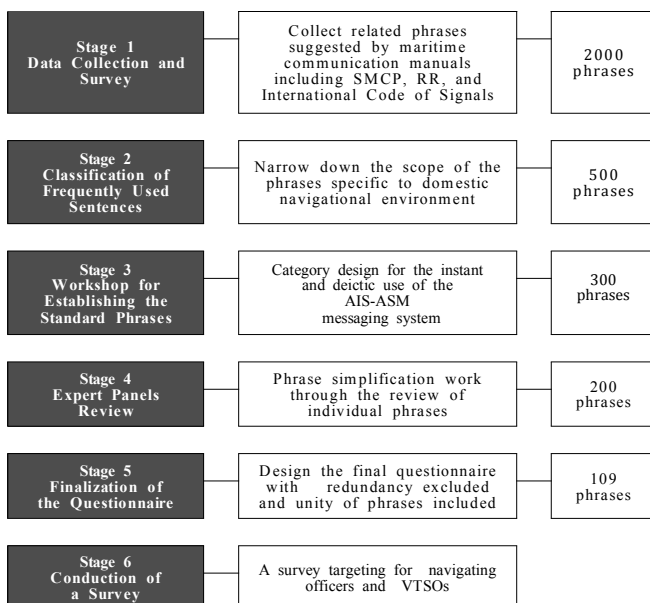


Fig. 1. The outline of the research process.

2.2 Research Process

2.2.1 Data Collection and Phrase Research

The communication database has been established through the collection of the marine communication phrases presented in a variety of international manuals, such as the International Code of Signals (IMO, 2005) and SMCP (IMO, 2002), and reorganising them by category. The total number of the phrases collected is 2,000. This database includes all external communication phrases (e.g., ship-to-ship/ship-to-shore) but excludes internal ones.

2.2.2 Expert Meeting for Classifying the Frequently-Used VHF Communication Phrases

Expert panels, including VTS operators, navigators and linguistic specialists initially attempted the simplification of the data to select phrases out of the whole database that are far less likely to be used in the domestic navigational environment (e.g., related to pirates and polar sea navigation etc.). Through this simplification work, 500 communication phrases were secured.

2.2.3 Workshop on Establishing the Standard Phrases for AIS-ASM Service

A workshop for establishing the standard phrases was held. Four navigators, three VTS supervisors, and two language specialists conducted a meeting to design a questionnaire based on their actual VHF communication experiences. In this meeting, the category of the entire database was redesigned in such a way that users can instinctively find what they want, when they need, either on navigations or VTS, and transmit this information rapidly to other interlocutors. Since it focuses more on user-friendliness, the category is different from the one established in SMCP. The redesigned categories at this stage are as follows: General Communication; Ship-to-Ship Communication; Anchoring Communication; Meteorological and Tide Information; Navigational Safety Information; Distress Communication; Shore Assistance and Pilotage.

In addition, detailed discussions on the 500 updated phrases were made in order to judge their suitability as an AIS-ASM message. Expert panels made the following suggestions: additional phrases for passage between ships are required; navigation safety information regarding special types of ships such as a tugboat or a deep draught vessel should be added; messages indicating the AIS malfunction should be added; transmitting information on pilotage should be detailed; and phrases expressing urgency and emergency during navigation should be excluded.

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Last but not least, the language design minimizing ambiguity in words and creating listener-friendly message structures were discussed to ensure that the receiver could immediately understand the selected phrases; this was reflected on the questionnaire. Through the redesign of the phrases, 300 key messages were selected within a total of seven categories.

2.2.4 Phrase Simplification through the review of individual phrases

Based on the 300 phrases reorganized through the workshop, the collection of expert opinions and research were once again conducted to finalize the phrases to be included in the questionnaire. The final appropriateness in the AIS-ASM message design was judged by thoroughly checking each of the selected example sentences. Each of the evaluators rated each appropriate phrase '1' and each inappropriate phrase '0'. The applicable phrase was included only if more than three of the evaluators judged it appropriate. This was done because, considering the characteristics of AIS-ASM messages, there is a physical limitation in transmitting and receiving all the necessary communications in an environment where navigational situations change constantly, and a wide range of message selections may reduce efficiency in operations. Therefore, the design of AIS-ASM messages should be made such in a way that information among 4S can be more easily transmitted by precisely identifying the most repetitive VHF messages patterns between real users.

2.2.5 Establishing Final Questionnaire

The final questionnaire items were established in accordance with the following standards, which are designed to increase unity among phrases and exclude redundancy within them.

Through the standardization process suggested in the table, a total of 109 phrases were included in the final questionnaire within the seven categories: general communication; ship-to-ship communication; anchoring communication; weather and tide information; navigation safety information; distress communication; and shore assistance and pilotage.

The questionnaire was designed using the Likert Scale, allowing respondents to check the following five-point scales: 'Very High', 'High', 'So so', 'Low', 'Very Low', according to the frequency of the phrases.

2.2.6 Participants

The respondents to the questionnaires are as follows:

- Navigating officers: 57 (with 5.6 years of VHF communication experience)
- VTSOs: 50 (with 11.64 years of VHF communication experience)

The total number of respondents was 107. Among these, 57 were navigating officers, accounting for 53.27 % of total respondents, and 50 were VTSOs, accounting for 46.72 % of respondents. The average marine communication experience of the navigating officers and VTSOs was 5.6 years and 11.64 years, respectively. The VTSOs have more than twice the years of VHF communication experience on average than that of navigation officers. The VHF communication experience of both groups is 8.65 years on average.

3. Analysis

3.1 The Categories of Questionnaire Items

Prior to beginning the questionnaire analysis, the composition of all questionnaire items were looked into based on the seven categories, which were established after five stages of expert meetings, workshops, and consultations. In this process, the 109 final phrases were confirmed out of an original total of 2,000. In this regard, the questionnaire items themselves are expected to be significantly meaningful when designing the future AIS-ASM marine communication. The number and ratio of the phrases included in a total of seven categories are as shown in the Fig. 2.

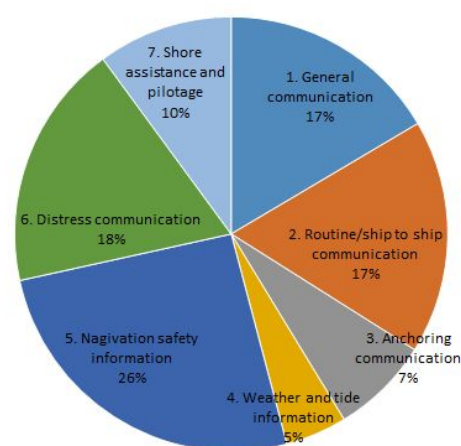


Fig. 2. The distribution of the questionnaire items by category.

As shown in the chart above, the most dominant content of communication phrases in terms of frequency and importance is the 'Navigational Safety Information', which accounts for 26 % of

the total phrases. The phrases on 'Distress Communication', 'General Communication', and 'Ship-to-Ship and Routine Communication' account for 18%, 17%, and 17%. 'Routine Communication' and 'Navigational Safety Information', however, which include overtaking one another, altering course, port of call and destination, and navigational warning, were considered more important. Therefore, the ways of being able to search various phrases on the screen in an instant and instinctive manner must be considered so that the messages regarding ship-to-ship or ship-to-shore communication can be exchanged in an immediate fashion.

3.2 Frequently Used VHF Communication Categories

The average frequency of the 109 total items was 3.02. The phrase showing the highest score was 4.72 (e.g., What is your port of destination?), and the lowest was 1.99 (e.g., Do you have any list?).

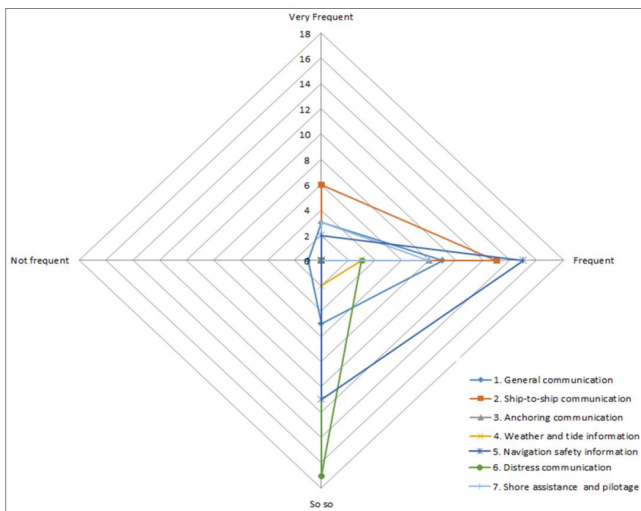


Fig. 3. The different levels of frequency among seven categories.

As shown in the Fig. 3, the most dominant category of all the phrases was 'ship-to-ship communication' with a frequency of 3.75, followed by 'shore assistance and pilotage' (3.71), 'general communication' (3.30), 'weather and tide information' (3.19), 'navigational safety information' (3.16) and 'distress communication' (2.66). In light of the above facts, the message design for routine and safe navigation, such as crossing between ships, communication with VTS centres for berthing and leaving a port must be prioritised. Transmitting and receiving messages for emergency situations does not seem to be suitable for the ones comprising the AIS-ASM messages considering the urgency of

situations and the need for immediate responses to and actions in those situations.

3.3 Frequently Used VHF Communication Phrases

Table 1 shows the results of the most frequent VHF communication phrases that scored higher than 3.5 points.

Table 1. Most frequent VHF communication phrases

| Phrases | Categorizations | Points |
|---|---------------------|--------|
| 1. What is your port of destination? | General | 4.72 |
| 2. What is the name of your vessel and call sign? | General | 4.71 |
| 3. What is your ETA at []? | Shore assistance | 4.47 |
| 4. When will the pilot embark? | Shore assistance | 4.44 |
| 5. What was your last port of call? | General | 4.39 |
| 6. Navigate with caution. | Shore assistance | 4.39 |
| 7. The pilot boat is coming to you. | Ship-to-ship | 4.23 |
| 8. Keep clear of me. | Shore assistance | 4.22 |
| 9. I am keeping course and speed. | Navigational Safety | 4.14 |
| 10. Do not overtake. | Ship-to-ship | 4.12 |
| 11. What is your position? | Ship-to-ship | 4.10 |
| 12. Advise you alter course to starboard/port. | Ship-to-ship | 4.04 |
| 13. I will pass ahead/astern of you. | Ship-to-ship | 4.00 |
| 14. Stop in present position and wait for the pilot. | Shore assistance | 3.99 |
| 15. What is your present course and speed? | Ship-to-ship | 3.94 |
| 16. [] wishes to overtake on your starboard/port side. | Ship-to-ship | 3.93 |
| 17. I am altering my course to starboard/port. | Ship-to-ship | 3.92 |
| 18. You must anchor in a different position. | Anchoring | 3.82 |
| 19. Advise you keep your present course. | Ship-to-ship | 3.81 |
| 20. I wish to overtake []. | Ship-to-ship | 3.81 |
| 21. You may overtake []. | Ship-to-ship | 3.79 |
| 22. What is your cargo? | General | 3.78 |
| 23. Do not cross the fairway. | Navigational Safety | 3.78 |
| 24. What is your flag state? | General | 3.76 |
| 25. I cannot alter course to starboard /port. | Ship-to-ship | 3.75 |
| 26. You must maintain safety speed | Navigational Safety | 3.72 |
| 27. What is visibility in your position? | Weather and tide | 3.69 |
| 28. You must heave up anchor. | Anchoring | 3.68 |
| 29. What is your present maximum draft? | General | 3.67 |
| 30. What is wind direction and force in your position? | Weather and tide | 3.65 |

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Table 2 shows the results of the least frequent VHF communication phrases that scored less than 3 points.

Table 2. The least frequent VHF communication phrases

| Phrases | Categorizations | Points |
|--|---------------------|--------|
| 1. Do you have any list? | General | 1.99 |
| 2. Proceed with your voyage. | General | 2.14 |
| 3. I will/cannot beach in present position. | Distress | 2.18 |
| 4. I cannot control flooding. | Distress | 2.38 |
| 5. I require pumps/divers. | Distress | 2.41 |
| 6. Aground forward/amidships/aft/full length. | Distress | 2.43 |
| 7. I am in danger of capsizing. | Distress | 2.43 |
| 8. I am flooding below water line. | Distress | 2.43 |
| 9. I am proceeding to your assistance. | Distress | 2.46 |
| 10. You must close up on the vessel ahead of you. | Navigational Safety | 2.48 |
| 11. I am sinking after collision/grounding/flooding/explosion. | Distress | 2.52 |
| 12. What is the latest tropical storm warning? | Weather and tide | 2.54 |
| 13. Risk of grounding at low water. | Navigational Safety | 2.55 |
| 14. Traffic clearance is required before entering port area. | General | 2.58 |
| 15. I am on fire after explosion. | Distress | 2.65 |
| 16. I have collided with []. | Distress | 2.66 |
| 17. I can proceed without assistance. | Distress | 2.67 |
| 18. You have permission to enter the traffic lane/route - traffic clearance granted. | General | 2.68 |
| 19. I must abandon vessel. | Distress | 2.68 |
| 20. What is your freeboard? | General | 2.75 |
| 21. You may overtake []. | Ship-to-ship | 2.75 |
| 22. I am in critical condition. | Distress | 2.76 |
| 23. I require fire-fighting assistance. | Distress | 2.76 |
| 24. Spell the name of your vessel. | General | 2.79 |
| 25. What is the latest gale/storm warning? | Weather and tide | 2.84 |
| 26. You are proceeding at a dangerous speed. | Navigational Safety | 2.87 |
| 27. I require medical assistance. | Distress | 2.87 |
| 28. I will take shelter in safe place of outer port. | Navigational Safety | 2.91 |
| 29. Keep clear of the fairway approach - Large vessel is leaving the fairway. | Navigational Safety | 2.91 |
| 30. You are obstructing the vessel ahead of you. | Navigational Safety | 2.93 |

As discussed in a previous section, it is quite evident that the general communication for routine navigational situations including 'ship-to-ship communication' and 'shore assistance' are more

frequent patterns of marine communications than any others. Of course, in terms of importance (not frequency), the 'distress communication' and 'warnings for safe navigation' have great value. It could, however, be quite challenging for the speakers or listeners (navigating officers and/or VTSOs) to deal with abnormal situations by using a messaging system displayed on screen, rather than evaluating various possible situations in an instant manner by exchanging voice communication with different parties involved to take necessary actions. This has been also pointed out several times in the consultation meetings with experts, who have expressed concerns that the officers or operators could be very disorganised when communicating with multiple stations simultaneously through messengers rather than having one-to-one communication through VHF receivers. In this regard, it might not be appropriate to include the messages for distress situations in the AIS-ASM messaging system.

3.4 Suggestions for AIS-ASM Messages

Based on the research results of the user perceptions discussed above, the major phrases for AIS-ASM messages are designed as follows (Table 3). The total number of phrases is 53 and those scoring a frequency higher than 3 points were included in the final list.

Table 3. Most frequent VHF communication phrases

| Categorizations | No. | Phrases | Points |
|----------------------------|-----------------------|--|--------|
| Ship to ship communication | 1 | I wish to overtake []. | 3.81 |
| | 2 | You may overtake []. | 3.79 |
| | 3 | I cannot alter course to starboard/port. | 3.75 |
| | 4 | Do not pass ahead/astern of me. | 3.62 |
| | 5 | Do not pass on my starboard/port side. | 3.58 |
| | 6 | [] agrees/does not agree to be overtaken. | 3.34 |
| | 7 | I am going astern. | 3.12 |
| | 8 | Wait for [] to cross ahead of you. | 3.07 |
| Anchoring communication | 9 | From what direction are you approaching? I am approaching from []. | 3.00 |
| | 1 | You must heave up anchor. | 3.68 |
| | 2 | It is dangerous to anchor in your present position. | 3.63 |
| | 3 | Anchoring is prohibited. | 3.47 |
| | 4 | You are at anchor in a wrong position. | 3.46 |
| | 5 | Are you dragging/dredging anchor? Yes, I am dragging/dredging anchor. No, I am not dragging/dredging anchor. | 3.43 |
| | 6 | You must anchor clear of fairway. | 3.39 |
| 7 | Do not dredge anchor. | 3.11 | |

| | | | |
|-------------------------------|------------------------------|--|---|
| Distress communication | 1 | I am not under command. | 3.51 |
| | 2 | I require assistance. | 3.30 |
| | 3 | I am adrift. | 3.18 |
| General communication | 1 | What is your cargo? My cargo is []. | 3.78 |
| | 2 | What is your flag state? My flag state is []. | 3.76 |
| | 3 | What is your present maximum draft? My present maximum draft is []. | 3.67 |
| | 4 | Do you carry any dangerous goods? I do carry dangerous goods. My cargo is []. I do not carry any dangerous goods. | 3.53 |
| | 5 | Are you underway? Yes, I am. / No, I am not. | 3.30 |
| | 6 | What is your draft forward/aft? My draft forward/aft is []. | 3.28 |
| | 7 | I am ready to get underway. | 3.20 |
| | 8 | What is your full speed/full maneuvering speed? My full speed/full maneuvering speed is []. | 3.09 |
| | 9 | Do you have any deficiencies/restrictions? I have deficiencies/restrictions. []. I do not have any deficiencies/restrictions. | 3.08 |
| | 1 | Do not cross the fairway. | 3.78 |
| | 2 | You must maintain safety speed. | 3.72 |
| | 3 | You must proceed by the fairway. | 3.64 |
| | 4 | You must keep clear of this area. | 3.31 |
| | 5 | Do not enter the traffic lane. | 3.20 |
| | 6 | You must avoid this area. | 3.18 |
| Navigation safety Information | 7 | Nets with buoys/without buoys in this area - navigate with caution. | 3.17 |
| | 8 | Your present course is too close to ingoing/outgoing vessel. | 3.16 |
| | 9 | Your present course is too close to the vessel that you are overtaking. | 3.11 |
| | 10 | Stop engines. | 3.11 |
| | 11 | Where will you take shelter? I will take shelter at []. | 3.10 |
| | 12 | Proceed to the emergency anchorage. | 3.05 |
| | 13 | You must stay clear of the fairway. | 3.02 |
| | 14 | You must take shelter in safe place. | 3.02 |
| | 15 | I wish to shelter in safe place due to typhoon/bad weather/dragging by strong wind. | 3.02 |
| | Weather and tide information | 1 | What is visibility in your position? Visibility in my position is []. |
| 2 | | What is wind direction and force in your position? Wind direction and force in my position is []. | 3.65 |
| 3 | | Visibility is increasing / decreasing / variable. | 3.22 |
| Shore assistance and pilotage | 1 | I require tug arrangement. | 3.58 |
| | 2 | You must take a pilot - pilotage is compulsory. | 3.51 |
| | 3 | Must I take a pilot? Yes, you must take a pilot. No, you must not. | 3.41 |
| | 4 | How many tugs do you require? I require [] tugs. | 3.39 |
| | 5 | I am constrained by draft. | 3.35 |
| | 6 | Pilotage at [] has been resumed. | 3.30 |
| | 7 | I can/cannot proceed by myself. | 3.19 |

4. Conclusion

With the aim of establishing AIS-ASM messages, users' perception of the frequency of VHF communication was analysed through a questionnaire survey targeting navigating officers and VTS operators.

Based on the analysis, the following should be taken into account in the consideration of the final set of the phrases for AIS-ASM. First, the most repetitive communicative situations should be reflected in the final version of the messages. Considering that most of such situations relate to routine and navigational safety communication, which requires instant communicative actions from recipients, the user interface should be intuitively designed so that the target messages, such as ship-to-ship or ship-to-shore communication, can be more instantly accessible. On the other hand, regardless of their critical importance in maritime communication, the messages for 'distress communication' and 'warnings for safe navigation' were regarded as inappropriate as part of AIS-ASM messages. This is because speakers dealing with abnormal situations are usually required to communicate with multiple parties simultaneously, and various possible situations should be evaluated and considered by the speakers. In this sense, the message exchanges through AIS-ASM should focus more on general routine communication than emergency situations. Finally, in order to make this list more practical and applicable to real communicative situations at sea, the usability needs to be tested, and its practicality should also be thoroughly reviewed for its ability to enhance both safe and efficient communication at sea.

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