

Bridge Alert Management

Supporting document for mariners

1. Introduction

One of the first things mariners do when joining a (new) ship is to familiarize themselves with the various systems installed, including those on the bridge. Such systems may differ with respect to functionality, principle, manufacturer, version, integration level and more, such that the transition from one ship to another can be significant, even for the most experienced mariner. Unfortunately, familiarization takes time (which is not always available when joining a ship), in particular when there have been changes to functionality that is taken for granted or to functionality that is seldom used in full. This equally applies to alert management, to which changes have been made to a wide range of equipment as a result of the introduction of regulations on Bridge Alert Management. The purpose of this document is to prepare mariners for these changes to Bridge Alert Management.

The International Maritime Organization (IMO) has recognized scenarios where inadequate alert management could lead to human error and determined that the risk to the safe operation of a ship and its systems can be reduced by providing standardized requirements for Bridge Alert Management. As a result, resolution MSC.302(87) on Bridge Alert Management (BAM) was adopted by IMO to provide harmonization of alerts with respect to the priority, classification, handling, distribution and presentation of alerts generated by equipment on the bridge of a ship, and in general required that the usefulness of alerts should be improved. IMO defined the following goals for BAM:

"To enable the bridge team to devote full attention to the safe operation of the ship", "to immediately identify any alert situation requiring action to maintain the safe operation of the ship" and, for the Central Alert Management (CAM) system, "to support the bridge team in the immediate identification of any abnormal situations, of the source and reason for the abnormal situation and in its decisions for the necessary actions to be taken". The philosophy to achieve this is "to avoid unnecessary distraction of the bridge team by redundant and superfluous audible and visual alarm announcements", "to reduce the cognitive load on the operator by minimizing the information presented to which is necessary to assess the situation" and "to provide the means for the bridge team and pilot to assess the urgency of different alert situations in cases where more than one alert situation has to be handled".

Subsequent to IMO's adoption of MSC.302(87), the test standards IEC 62923-1/2 were published specifying how equipment should realize this harmonization. This guidance document describes the changes caused by the introduction of BAM from the mariner's perspective. It discusses: the harmonization of alerts (chapter 2) and the operational differences with respect to the pre-BAM era (chapter 3).

2. Harmonization

2.1 Alert priority

For many years, mariners on the bridge of a ship have been presented with 'alarms' from a variety of equipment using a wide variety of sounds and messages that frequently had insufficient relation to the actual importance of the alarm, which often only became apparent after the alarm had been assessed. BAM changes this by introducing four distinct alert (not alarm) priorities to distinguish the level of importance and urgency of the alert, as described in Table 1:

Alert priority	Relative level	Description
Emergency Alarm	highest priority	An immediate threat to human life or the ship and its machinery.
Alarm	high priority	An imminent threat to the safe navigation and safe operation of the ship, for which immediate action needs to be taken.
Warning	medium priority	A situation that requires immediate attention for precautionary reasons, but for which action is only required 'in due course' when the mariner has the time to do so given other pressing matters. As a warning situation can subsequently develop into a dangerous situation, an unacknowledged warning can be escalated into an alarm when the time frame of the danger associated with the alert goes from 'in due course' to 'immediate'.
Caution	lowest priority	Provides awareness of a condition that is out of the ordinary, but does not warrant an alarm or warning. The indicated situation can be dealt with in due course.

Table 1 Alert priorities

The visual and audible functionality of alerts has been harmonized for each priority in terms of colour, symbols and display order and sound signal pattern, repeat interval and location. The rules allow optional speech output of alerts. Other sound properties such as pitch, timbre (sound colour), volume and even the duration of 'short' signals may be used to facilitate identification of the equipment producing the alert, or to distinguish specific alerts.

The priority of an alert is indicated by text, colour, sound and/or symbols, as shown in Table 2.

Priority	Colour	Symbol ^a	Sound
Emergency alarm	Red		Sound will be provided as usual for e.g. fire/abandon ship, etc. (see IMO resolution A.1021(26)). A CAM system (see 2.5) will not provide sound.
Alarm	Red		Three short signals, repeated every 7-10 s. ^b
Warning	Orange		Two short signals, repeated every 15 s to 5 min. ^b
Caution	Yellow		No sound provided. The mariner will have to check the equipment regularly as usual.
Sound will stop when the alert is acknowledged, temporarily silenced, or when the alert condition ceases to exist.			
^a Valid for active (unacknowledged) alert.			
^b The sound will only be provided at locations where the alert can be acknowledged.			

Table 2 Colour, symbol and sound of alert priorities

This harmonization of sound enables the mariner to recognize the alert priority immediately after the alert is raised.

Note that the sound only indicates the highest priority of unacknowledged alert; when equipment has both an alarm and a warning active and unacknowledged at the same time, the alert sound will be that of an alarm.

IMPORTANT: Compared to the pre-BAM era, the sound of a BAM alarm or warning may be less prominent. During the transition to BAM-compliant equipment both BAM and pre-BAM alerts may be present on a bridge. It is important for mariners to realize that a BAM alert with less prominent sound may actually be more important than a more prominent pre-BAM alarm.

2.2 Alert states

Alert state	Meaning of the state	Alert priority			
		Emergency Alarm	Alarm	Warning	Caution
Active	The alert condition is present.				
Active – Unacknowledged	The alert condition is present and the mariner has not confirmed awareness of the situation.				
Active – Temporarily silenced ^{1, 3}	All current alerts have been temporarily silenced by the mariner but new alerts will sound and alerts still need acknowledgement.				
Active – Acknowledged	The mariner has confirmed awareness of the situation by acknowledging the alert.				
Rectified – Unacknowledged ²	The alert condition is no longer present, but the mariner has not confirmed awareness of the past situation.				
Active – Responsibility transferred	Equipment with more information has taken over responsibility for the alert, and has provided an alert in its place that better takes into account the context of the situation (probably with a lower alert priority).				

¹ Depending on equipment specific regulations, temporary silencing may not be available for specific alerts.

² For some alerts this state is skipped when the alert condition is no longer present, for example the 'CPA/TCPA' alert in RADAR.

³ Alerts within the responsibility of the officer of the watch are silenced for 30 s. Other alerts are silenced for 5 minutes.

Table 3 Alert states, meaning and symbols

BAM has standardized all states of an alert:

- An emergency alarm and a caution don't have to be acknowledged (although e.g. fire bells can be silenced as usual). Alerts of these priorities are either active or not shown.
- For alarms and warnings there are multiple states. For each state a corresponding symbol has been designed, using colour to indicate the alert priority (see Table 3).

2.3 Sorting of alerts

BAM-compliant equipment shows the most important alerts at the top of the alert list. Unacknowledged alerts are shown before the acknowledged alerts. Cautions are shown at the end.

The priority, state and time of alerts are all taken into account when determining the order of the alerts in the alert list. Alert resorting happens when new alerts occur and when alerts are acknowledged or rectified.

2.4 Special presentation

It is possible that multiple alerts are presented under a header, like a folder structure presentation.

This can be done by the equipment when alerts are very similar (referred to as 'aggregation') or when different alerts relate to each other (referred to as 'functional grouping'). Headers can be switched off to show a 'flat' list. Examples of alerts presented under a header are given in Table 4.

Aggregation	Functional grouping
+  Aggregated header alert  Aggregation member alert 1  Aggregation member alert 2  Aggregation member alert 3  Aggregation member alert 4	+  Functional group header alert  Functional group member alert 1  Functional group member alert 2  Functional group member alert 3  Functional group member alert 4

Table 4 Example of aggregation and functional grouping

Aggregated and functional group headers cannot be acknowledged; alerts shown under a header have to be acknowledged individually. When aggregation or functional group headers are shown collapsed (headers only), viewing and/or acknowledging the individual member alerts requires an extra step.

2.5 Central alert management system (CAM system)

In addition to an alert source being able to present all its alerts, IMO specified that each alert source has to provide an interface to communicate alerts to other equipment. The most important example of equipment that receives alerts from an alert source is the Central Alert Management system (CAM system). This is optional equipment that can be fitted on board to be connected to all alert sources in the area.

As a minimum the CAM system has the following functions:

- Combined list of all alerts of the connected systems and the alerts of the CAM system itself. The CAM system will show which equipment raised the alert and displays the alert title together with any guidance for decision making made available by the alert source.
- Operator function to temporarily silence all current audible alerts (newly appearing alerts will still be immediately announced audibly).
- Acknowledgement of alerts for which acknowledgement at the CAM system is allowed.
- Logging alerts and displaying the alert history.

When the alert source has a limited alert display capability, the CAM system may provide more information about the alert than is available at the alert source.

Many alerts can be acknowledged on the CAM system without the need to go to the equipment that raised the alert. However, this capability is restricted to alerts for which sufficient information for situational awareness can be presented at the CAM system. An example where acknowledgement at the CAM system is not allowed is a CPA/TCPA alert. For this type of alert the mariner needs to see the RADAR display with the tracked targets to get a sufficient awareness of the situation. The same applies for anti-grounding alerts from ECDIS, where the chart needs to be seen to understand the danger. Such alerts can only be acknowledged at the equipment raising the alert. The CAM system will not provide sound for such alerts, only the alert source will give sound, thus helping the mariner identify where the alert can be handled.

When acknowledgement at the CAM system is not allowed, this is always indicated. This can be done in various ways. When symbols are used, the symbols in Table 5 will be used.

Alarm	Warning	Meaning
		Acknowledging not allowed on the CAM system.

Table 5 'Acknowledging not allowed' symbols

Another type of alerts that cannot be acknowledged on the CAM system are the alerts that come to the officer of the watch from a different domain than is his responsibility, such as to the bridge from the engine room (for example a slowdown alert). Such alerts cannot be acknowledged on the bridge at all, because the situation is the responsibility of a different watchkeeper (for example the engineer of the watch). In such a case the CAM system on the bridge shows the alert for information, and the alert will silence when acknowledged in the domain of origin.

3. Operational changes

3.1 Generic

When compared to the pre-BAM era, BAM introduces a variety of changes for the mariner. This does not only concern the harmonization as described in Chapter 2. The changes to the operational concept are even more important.

3.2 Functional alerts

The main difference lies in the philosophy of the alerts. In the pre-BAM era, many alerts indicated symptoms of a possible problem (e.g. a measurement value is abnormal). It was up to the mariner to evaluate the possible causes, to confirm that a problem actually exists, to consider the possible solutions and finally to determine the action to take. This requires ship specific and equipment specific technical knowledge. IMO indicated that this process led to a high cognitive load and resolved that the alert messages should improve. In the pre-BAM era other alerts were often provided to assist rectification of the cause of an alert (repair the fault, which is not always possible in an operational situation), instead of helping the mariner to deal with the consequences of the situation.

IMO now requires equipment to apply a more user-centric approach towards provision of alert information. This implies that manufacturers have to apply operational knowledge in order to give sufficient guidance to the user. Alerts applying BAM principles inform the mariner about the consequences of the detected problem on the operation of the vessel and, where practicable, provide advice on how to deal with these consequences given the current operational situation.

3.3 Reduction of high priority alerts for a quiet bridge

Over decades, mariners have become familiar with many alarm sounds and messages from various sources competing for their attention in addition to the task(s) at hand. Alarms were announced, presented and

handled in different ways. In general there was insufficient distinction of the urgency of alerts available to the mariner. In practice, mariners risked determining the priority of an alarm by how intrusive the sound was, rather than the seriousness of the situation. As a consequence, mariners have become used to the presence of, what they may regard as, spurious alerts, with the consequential risk of an important alert being missed.

BAM provides clear definitions of alert priorities, resulting in the reduction of the priority and consequential alert sounds of many pre-BAM alarms. The sound pattern of a BAM alert (see Table 2) provides an appropriate indication of the urgency with which the attention of the mariner is required (immediate, imminent or in due course).

BAM will substantially reduce the frequency of alert sound occurrence and the disturbance level of audible alerts on the bridge. For BAM alerts the following is therefore valid:

If there is an **alert sound**, the mariner should never ignore it as an alert sound always means **immediate (alarm) or imminent (warning) danger**.

It should however be noted that the frequency of occurrence of some alerts is influenced by mariner settings (for example CPA/TCPA and look-ahead) given the prevailing operational situation.

3.4 Reliance on good seamanship

In practice, many of the alerts provided by bridge equipment do not indicate an immediate or imminent threat to ship or life and will therefore be of priority caution. This implies that there is not always sound to attract the mariner's attention to alerts that occurred – for cautions there is only a steady visual indication in the alert list. BAM compliant systems rely on the mariner to identify these alerts during regular system checks and to have them addressed in due course.

In other words: **a system that remains quiet may still have alerts requiring the mariner's attention.**

When installed, a CAM system (or an INS with embedded CAM system) will make this task easier by presenting all alerts, including all cautions, in a single list.

3.5 Conditional alerts

An important aspect of the BAM concept is that an alert should provide proper guidance to the mariner regarding the decisions and actions to be taken. Equipment is required to provide alerts with functional information about a detected problem, i.e. the operational consequences of the situation and advice on what to do mitigate the situation. This implies that the provision of alerts may depend on operational conditions such as whether the equipment is in use, in standby, or switched off; whether there are standby facilities/alternatives; or whether there is other equipment with more knowledge regarding the (consequences of) the situation. It is even possible that, in certain conditions, no alert will be provided for a situation.

Time can also be a factor, as some problems may initially cause a warning but in due course may be escalated to an alarm to reflect that a situation has become more urgent.

The type of alert presented, and whether an alert is to be raised in the first place, can depend on the operational conditions. In some cases another system may have more information about the operational

condition than the alert source alone and may use that information to raise a more appropriate alert (usually of a lower priority). This results in the original alert being shown in the 'Active – Responsibility transferred' state (see Table 3).

In general, compared to pre-BAM equipment, mariners may sometimes have the feeling of 'missing' audible alerts and, depending on the situation, may experience only a single audible alert where more were expected, a caution alert with no audible sound, or even no alerts at all.

3.6 Introduction of BAM compliant systems

Although the IMO performance standards for BAM entered into force in 2014, for some time many ships, especially those being retrofitted, will have a mix of BAM-compliant and pre-BAM systems on board, and different levels of application of the BAM principles. Therefore the bridge team should familiarize themselves with the alert capabilities of the bridge equipment installed and be aware that the older systems can cause 'alarms' that seem to be more urgent than the alerts of the newer systems, in which case the opposite will be true.

When ships are fitted with a CAM system, it may be that pre-BAM equipment does not have the possibility to be connected to the CAM system. In such cases the mariner should be aware that a CAM system is not able to show the alerts of all equipment.

Part of the BAM concept is that alert management can be organized in various areas of responsibility (clusters). The alerts in each cluster are intended to be handled by the responsible mariner.

The 'Bridge' alert management concept has been primarily introduced for the bridge of a ship. However, the same concept is expected to appear in other locations, particularly the engine room automation, as other standards are picking up the same concept.

4. Conclusions

The fitting of equipment applying IMO's Bridge Alert Management principles results in a more harmonized and improved presentation and handling of alerts in bridge equipment.

The mariner will benefit from this as:

- unnecessary distraction by spurious alert sounds will be minimized - the mariner will be able to rely on alert sound being a true indication of the importance of the reported problem;
- information and guidance provided by alerts will be improved to decrease the cognitive load. Systems won't cause technical alerts that first need to be interpreted before mariners can consider the appropriate response; rather systems will provide functional alerts with information about operational consequences as well as guidance on how best to respond, thereby reducing the risk of human error; and
- a CAM system can be fitted to provide an overview of all alerts on the bridge, including guidance for decision making, to assist in the selection of which alert, or other task at hand, to attend to first and what to do. A CAM system also allows all current alerts to be temporarily silenced and enables most alerts to be acknowledged from a single location, thereby further reducing disturbance of the mariner.

However, mariners have to be aware of some implications, in particular on ships that have a mix of pre-BAM and BAM-compliant equipment:

- If BAM-compliant equipment reports an alarm or a warning, it should be addressed immediately (alarm) or as soon as possible (warning).

- An audible alert from BAM-compliant equipment may be more important than an alarm from pre-BAM equipment.
- Even when BAM-compliant equipment is silent, regular attention is still required to ensure the mariner is aware of problems that have been detected that, in due course, need attention or may lead to a situation with alerts of a higher priority.
- Compared to pre-BAM equipment mariners may sometimes have the feeling of 'missing' audible alerts.
- Mariner settings (for example CPA/TCPA and look-ahead) continue to influence the number of alerts given the prevailing operational situation.

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