

# Mariner Near Misses influencing Design?

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**Abstract** - In an on-going research effort by ABS, Lamar University, and vessel operators, over 18,000 near-miss reports have been collected. The focus of this paper is on near-miss reports that included a recommended “design” change on or to the vessel and any related quality or safety management system.

Limited consistency in the definition of a near miss and the type of near-miss data being collected was found. Interestingly, it was noted that most of the near miss reports for this study contained some form of recommendation or corrective action. This review also noted apparent differences in vessel operator safety program maturity among the companies providing near miss data.

As a result, this investigation focused on the recommended corrective actions and associated hazard control processes. Additionally, based on the findings of limited consistency, this paper will discuss core components for near miss reporting and for an effective near miss management system.

## Keywords

Near miss, corrective actions, design changes, near miss management.

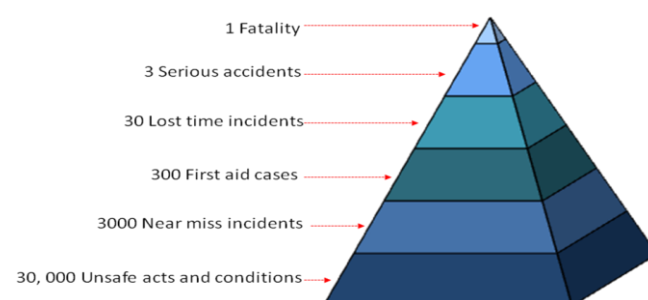
## INTRODUCTION

The contribution of human error to accidents has been a much-discussed topic for decades. Industry specific analysis reveals that at least 80 percent of marine accidents involve human error. In about 45 percent of accidents human error is the precipitating cause; in about 35 percent of accidents human error is a contributing cause (where a situation, such as weather, likely would not have resulted in an accident or loss if the human acted without error). This also suggests that less than 20 percent of marine accidents are not directly attributable to human error (ABS, 2004).

Near misses are another matter, and it is only

recently that the notion of analyzing “accidents that almost happened” has been receiving wider attention and interest. After all, often only a small change in circumstances will convert a near-miss into an accident. The same precipitating conditions can occur again –potentially leading to an actual loss.

Many safety researchers and practitioners assign a ratio of near misses to accidents at about 300:1 and some studies and opinions suggest ratios as high as 1000:1, per F. E. Bird’s Accident Triangle (Figure 1). Regardless of the actual ratio, there is a general consensus that there are a substantial number of near misses to accidents and many of these instances can be used to identify opportunities for design improvements for an organization’s assets and/or safety management system.



**Figure 1: F E Bird's Accident Triangle**

(Source: National Maritime Occupational Health and Safety Committee)

In an effort to find a way to utilize near miss data to benefit the maritime industry at large, ABS and Lamar University (LU) initiated a research effort to collect and analyze near miss data for the purpose of identifying common safety issues and sharing this information with the maritime industry.

This research effort has, to date, partnered with ten ship operating companies to gain access to their near miss files. Combining these sources, 18,000 near miss reports have been gathered, covering a fleet of well over 500 vessels and shipboard operations involving humans. The data has been sanitized and a database created to support analysis of the data.

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This paper discusses an initial public use of the database by exploring what has been proposed in terms of design changes in response to near misses.

### PILOT STUDY USING THE ABS/LAMAR DATABASE

To explore the potential uses of the database this study focused on exploring near miss reports that mentioned a “design” change to the vessel or related management system (e.g., quality or safety). This search reduced the data set from ~18,000 to 754 (~ 4 percent of the records in the database).

Once the search results were reviewed and sorted 407 near misses were directly relevant to the initial scope of this study. After the thorough review of the remaining records, with strong consideration given to the limited consistency of the data, it was decided to investigate these near misses by nature of corrective action (e.g., hazard control technique) and by the type of change that was proposed. This process enabled a better review of the data and the opportunities for improvement that were identified by the ship’s crew and company management.

### HAZARD CONTROL TECHNIQUES

From a safety/engineering perspective there are different levels of controls for hazards. Implementing changes before the hazard becomes a near miss is preferred. However, sometimes these hazardous conditions go unnoticed or it takes a near miss report to bring attention to the issue. These cases require corrective actions and sometimes physical post-design activities to mitigate the hazard to an acceptable level to minimize future occurrences.

Commonly used mitigation strategies for hazards and hazardous conditions included:

1. Eliminate - Eliminating the hazard by modifying designs. For example the elimination of manual materials handling activities to eliminate lifting related injuries, such as back injuries.
2. Attenuate - Attenuating the hazards by the addition of safety guards, such as a barrier between the crew and rotating machinery. The hazard, rotating machinery is still present, but crew access to the hazard is restricted/limited.
3. Administrative Controls - Administrative controls include controls such as policies and procedures, warnings, labels, and crew training.
4. Personal Protective Equipment (PPE) – PPE should be used only after reasonable efforts have been taken with the previously mentioned hazard controls.

This study’s analysis focused on these four (4) different hazard mitigation strategies. The corrective actions identified in the near miss reports were categorized according to these control techniques.

Table 1 presents the frequency of each hazard control technique. While eliminating hazards through engineering practices is preferred, the data represents administrative controls and hazard attenuation efforts as the more common response to a proposed change in design.

Control Technique	Frequency	Percentage
Eliminate	60	15%
Attenuate	158	39%
Administrative	179	44%
Personal Protective Equipment	9	2%

**Table 1. Hazard Control Techniques in response to near misses**

### Hazard Control Actions Proposed in Response to Near Misses

#### *Hazard Elimination*

Typically from a safety and engineering perspective the highest priority in hazard control is to eliminate or avoid the hazard. This approach was the recommended corrective action in approximately 15 percent of the near misses.

The following list identifies some of the hazard elimination corrective actions proposed in this study:

- Re-design a vertical ladder to include ladder linking platforms
- Re-design of the workplace by installing appropriate crew member working platform
- After making alterations to the vessel’s engine work platform, working with the engine manufacturer to correct this design deficiency
- Increasing the height of a guardrail to enhance crew member safety
- Fabrication and installation of a step to reduce the distance from one piece of structure to another.

#### *Hazard Attenuation*

If a hazard cannot be eliminated, the next preferred corrective action is to reduce the potential consequence or probability of the hazard. This can often be accomplished by diminishing the overall risk to the crew by reducing the potential degree of severity and probability of occurrence.

Often, immediate on-sight hazard attenuation is a corrective action until a permanent hazard control

can be put into place. This approach was the second most common recommended corrective action by the crew. Hazard attenuation controls were recommended as remediation in response to 39 percent of the near misses.

The following list identifies some of the hazard attenuation corrective actions proposed in this study:

- Installing a temporary hold back latch for a door
- The application of anti-skid to any areas of the deck near a leaking pipe
- Installing a safety chain to a broken guardrail
- Installing padding on head-knockers and other objects protruding into the walkway
- Temporarily reinforce equipment to compensate for design weakness
- The installation of additional lighting in dark areas to help prevent slips, trips or falls
- Placement of high visibility tape on trip hazards
- Secure hatch cover by safer means.

*Administrative Controls*

Administrative controls often include hazard warnings, procedures and additional training. While administrative controls do not remove or eliminate the hazard, they try to control the hazard by directing the crew’s actions. This approach was the most commonly recommended corrective action by the crew. Administrative controls were recommended in response to 44 percent of the near misses.

The following list identifies some of the administrative corrective actions proposed in this study:

- Address the near miss at a safety meeting. Improper use of requisite PPE was frequently identified as a near miss.
- Adding the near miss to inspection and safety audit checklists
- Creation of a new procedure for the task
- Revising an existing procedure to more accurately describe the task/process
- Perform and document a Job Safety Analysis
- Develop new labels and warning signs
- Proper placement of warning signs
- Improve crew member situational awareness
- Remove from use and alert other vessels in the fleet
- Translate the directions into English.

- Notify the manufacturer about the defect.

*Personal Protective Equipment*

Personal protective equipment (PPE) is commonly used onboard ships (e.g., safety glasses, hearing protection, safety shoes, etc.). However PPE should not be considered as the primary hazard control measure because its use, similar to administrative controls, depends on the behavior of the crew.

PPE near misses were frequently mentioned in association with administrative controls such as new or revised procedures, safety audit checklists, and additional training requirements for the crew.

The following list identifies some of the PPE corrective actions proposed in this study:

- Requirement for additional PPE (fall protection)
- Equipment disrepair has necessitated the need for hearing protection.
- PPE precludes the need for engineering changes/intervention. (This corrective action goes against safety engineering principles and demonstrates a less mature safety culture.)

**ADDITIONAL SELECTED FINDINGS**

Due to the length restrictions of this paper, there were many additional findings related to this study that could not be adequately reported upon. However, one specific category is briefly discussed below.

**Crew Member Activities**

Understanding the crew member activities that were being performed when the near miss occurred can provide important insight into potential improvements. Table 2 lists the different crew activities that were being performed in the near miss reports as well as the actual number and related percentage of near misses.

Activity Categories	# of Near Misses	% of Near Misses
Maintenance/repair	71	21%
Inspection/Audit	56	17%
Safety drill	52	16%
Berthing/mooring	26	8%
Walking in area	23	7%
Cargo operations	21	6%
Navigation	12	4%
Crane operations	8	2%
No report of activity	75	-
Other	63	19%

**Table 2. Crew Member Activities**

Maintenance/repair and inspection comprised ~40 percent of the total, which is not surprising considering the amount of these types of activities that commonly occur onboard a vessel. What was unexpected is that 16 percent of the near misses were identified during safety drills. Of these “safety drill” related near misses, ~77 percent were related to lifeboats, in particular lifeboat hooks or inoperative/missing lifeboat equipment.

A more comprehensive review of maintenance and repair activities could yield valuable information related to crew tasks, potential hazards, additional corrective actions, and lessons to be learned and shared. As an example, further investigation of these could yield answers to the following questions:

- 1) Is adequate space provided to perform activity (e.g., work envelope) which includes special tools, anthropometrics, and any requisite PPE?
- 2) Are adequate access aids provided (e.g., work platforms)?
- 3) Are appropriate tools provided (e.g., equipment hoists or dollies)?
- 4) Are appropriate labels/instructions provided (e.g., comprehensive, and comprehensible)?
- 5) Is the equipment/workplace designed such that adequate safety protection is afforded the maintainer (e.g., guardrails, toe boards on elevated walkways/platforms above maintenance areas)?
- 6) Are there adequate procedures in place such as lock-out/tag-out, confined space entry, safe work permits, etc.?

This list of questions suggests only a small sample of the important **ergonomic** and **safety** opportunities that could be implemented and reduce the occurrences of the near misses.

## DISCUSSION

The goal of any Safety Management System is to improve overall vessel and crew safety performance with the ultimate goal of no operational incidents, no personal injuries, and no harm to the environment. One way to help achieve this is by thoroughly understanding and learning from those near misses which could potentially result in a safety incident.

The near misses in this study ranged from a small valve leaking oil (potential slip hazard) to a broken guardrail needing replacement (potential fall hazard), to re-equipping Life Saving Apparatus (a lifeboat) with all the requisite equipment (oars).

The near misses in this study came from ten different companies, spanning several years' worth

of data. It was apparent from studying these near miss reports that these companies have different approaches to near miss reporting. Key differences include:

- 1) The different type(s) of information being captured
- 2) The information's comprehensiveness
- 3) A process or system to manage the near miss

These differences could be due to several factors such as crew member training (or lack thereof) with respect to near misses and their reporting, corporate maturity related to near miss reports, or a more (or less) effective (evolved) near miss management system. The authors also suspect that these differences are not just at the organizational level but also at the individual (crew) level because of the high variability (thoroughness) of the near miss data reported such as the potential damage, injury or loss and potential corrective actions. In several instances it appeared that the individual compiling the near miss report was well trained, knowledgeable, and experienced in vessel operations and potential consequences of actual incidents.

What seems to be necessary to further utilize the potential and value of near miss reporting is to improve the consistency of near miss reporting and related management systems. The 2010 International Safety Management (ISM) Code contains requirements that vessel operators investigate “Hazardous Occurrences” such as near-misses. The ISM Code provides some guidance in this respect, such as a high-level definition, basic near miss data reporting requirements and minimal guidance for near miss analysis, investigation, or intervention implementation.

Although it may take time to fully develop, a well-designed near-miss management structure should have the following components:

- 1) There should be a consensus definition of what constitutes a near miss. The ISM Code defines a near miss as “A sequence of events and/or conditions that could have resulted in loss.” This definition could be the corporate definition, or the corporate definition could be expanded to more clearly include instances of the observance of potentially hazardous situations.
- 2) There should also be a core or key set of data that should be recorded for each near miss. The IMO provides a good starting point which includes:
  - Who/what was involved?

- What happened, where, when and in what sequence?
- What were the potential losses and their severity?
- What was the likelihood of a loss being realized?
- What is the likelihood of a recurrence of the chain of events and/or conditions that led to the near miss?

Additional data items that could also be recorded include, but should not be limited to:

- What were the weather conditions?
- When in the work shift did the near miss occur (when first coming on watch, right after or before a meal, or right before being relieved)?
- When in the course of crew rotation did the near miss occur (when the crew member just rotated on the vessel or getting ready to leave)?
- What is the proposed corrective action or resolution?
- Is this near miss vessel specific or could it be applicable to other vessels in the fleet? Or if the near miss is significant, should it be shared with vessel designers, equipment manufacturers, or even regulatory authorities?
- Are there any lessons to be learned?

3) There should also be a near miss management program. Listed in the following table are high-level program components.

	<b>Component</b>	<b>Description</b>
1	Awareness	Begins with management support, training of employees in the identification of hazards, near-misses, and recognition of improvement opportunities
2	Reporting	Implemented and management supported system for reporting hazards and near-incidents, preferably electronic.
3	Investigation	Determination of the priority level, high, medium or low depending on the potential outcome if the near-miss becomes an accident. Based on the identified need and associated risk, investigation is carried out to the extent deemed necessary.

	<b>Component</b>	<b>Description</b>
4	Root Cause Identification	The incident is analyzed and causes are evaluated until a detailed cause that can be discovered is reached.
5	ID corrective actions and recommendations	Using previous experience, research, knowledge of the situation, brain storming, acceptable corrective action(s) and recommendations can be made.
6	Dissemination	All near misses should be shared with the immediate crew, and within the organization. If deemed valuable, the near miss investigation and outcomes should be shared with industry to raise awareness about the hazard.

4) There should also be a comprehensive training program for the crew. The training program should include, but not necessarily be limited to:

- What is a near miss and how can they be identified?
- The role of near misses in crew and vessel safety
- Corporate and individual responsibilities related to near miss reporting and management
- The near miss management team members?
- How the company's near miss process works
- Root cause identification

After performing this study and reviewing near miss management schemes in other industries (e.g., land based), it is encouraging to know that near miss reporting in the maritime industry has adopted some of the more commonly accepted principles and practices, such as using a 5-why or modified fault-tree in root cause identification. However, the authors found that the practice of effective dissemination of information was generally absent beyond the vessel initiating the near miss. This means that potential lessons learned on one vessel were not effectively transferred to other vessels in the fleet. This is a very important shortcoming if the near miss is related to equipment or systems that are common among the fleet.

While there can be hundreds of near misses for one serious accident, without corporate or individual learning from near-misses the value of the information gathered from a near miss may be lost. It is understood that sometimes near miss data collection, investigation, analysis and corrective

action implementation can be an arduous process, but as evidenced by some of the near miss reports analyzed for this study, some companies appear well equipped to do so efficiently and effectively. It also appears that several of the ship operators have a higher level of safety awareness and thus safety culture within their organizations as demonstrated by the more comprehensive near miss reports, analysis, investigation and associated corrective actions related to near misses.

What is still unclear and is currently being researched by ABS and LU is analysis techniques for near miss data and clarification on how the near miss information being used and/or disseminated within the organization. It is foreseen that appropriate analyses of near miss data will help direct corporate safety initiatives and projects and safety auditing efforts; identify new training areas (e.g., toolbox talks); generate a database of potential corrective actions; assist in the generation of Job Safety/Hazard Analyses, etc.

As part of many corporate cultures, continuous improvement is a key objective, especially when talking about safety performance. Commonly used statistics are 'after the loss' type of metrics such as accident and injury rates, incidents and monetary costs. These are more commonly known as lagging indicators. These are both necessary and useful but what we should really be looking for are things such as prior (leading) indicators, precursors or missed signals (e.g., near misses) which, if they have been appropriately managed (e.g., analyzed and data disseminated) at the time, may have helped to avert the unwanted event.

Near misses are not just related to personnel injury. For example, a near miss can be related to a potential equipment failure which could have resulted in a vessel black-out condition which could have resulted in a grounding or collision. These leading indicators (e.g., near miss analysis and associated corrective actions) in essence can become additional leading indicators, supplementing more traditional leading indicators such as the size of the safety budget, safety audit scores, number of safety inspections, number of safety meetings involving management, etc., which may impact overall system and personnel safety performance.

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