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The use of near misses in maritime safety management

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THE USE OF NEAR MISSES IN MARITIME SAFETY MANAGEMENT

By

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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Title: **The Use of Near Miss in Maritime Safety Management**

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Abstract:

Heinrich's (1931) pyramid revealed that behind a major accident there are 300 minor accidents or near-misses. A Near-miss is an unplanned and unforeseen event which does not cause injury or damage but which could result in injury or loss under different circumstances. It is argued that the only difference between near-miss and actual accident is luck. Considering Murphy's Law "if it can happen, it will happen." (Shcrŏ der, 2005), if the contributing factors of near misses continue to exit, sooner or later, the accident will happen in certain circumstances. Near-misses are valuable opportunities affording early detection of possible system weaknesses and provide an early chance for correction before an accident occurs. The use of near miss in the high risk industries, such as in Aviation and Nuclear Power, has been proved to be successful in safety improvement, without necessarily experiencing actual accidents, as Jones, Kirchsteiger and Bjerke (1999) noted.

By reviewing literature and experiences from existing program, this paper will identify the value of near misses comparing with actual accidents in accident control, as well as the barriers for near-miss reporting. In the end this paper will develop a pro-active, systematic approach through which to manage near misses in maritime industry, following the process: identification, data collecting, filtering and classification, cause analyzing, solutions developing, dissemination, follow-up.

Key words: near-miss, barriers, Heinrich's pyramid, Murphy's Law, pro-active, system

Human element

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Abbreviations

ABS American Bureau of Shipping

AIMS Australian Incident Management Scheme

AMA American Medical Association

ASRS U.S. aviation safety reporting system

ATSB Transport Safety Bureau

BTS U.K. Bureau of Transportation Statistics

CAIR Confidential Aviation Incident Reporting

CHIRP U.K. Confidential Human Factors Incident Reporting Program

CHPCS Center for Human Performance in Complex Systems

CMRS Australian Confidential Marine Reporting Scheme

DTSB Dutch Transport Safety Board

FAA	U.S. Federal Aviation Administration
FSA	Formal Safety Assessment
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
INSAG	the International Nuclear Safety Advisory Group
ISM	International Safety Management
MEPC	Marine Environment Protection Committee（IMO）
MCA	Maritime and Coastguard Agency UK
NA	U.S. National Academy
NASA	U.S. National Aeronautics and Space Administration
NHS	U.K. National Healthcare System
OSHA	U.S. Occupational Safety and Health Administration
NPSA	U.S. National Patient Safety Agency
VDR	Voyage Data Recorder
VTS	Vessel Traffic System

Chapter I: Introduction

1.1 The importance of the study

Shipping might be said to be a rather safe industry for the decreasing frequency of major accidents, considering the billions of tons of material shipped on the high seas every year. However, Iarossi (2003) notes that the magnitude of damage inflicted by a major shipping accident increases the public attention paid to those accidents, and negatively influences the perceived safety of shipping. American Bureau of Shipping (ABS) (2004, p. 7) reviewed that In the past several decades, accidents such as the Erica, Exxon Valdez, Prestige, Amoco Cadiz, Braer, and Sea Empress have increased the public and political pressure to improve the safety and have sparked the writing of new laws or amendments to existing laws and international conventions in a reactive manner.

As shown in Figure 1, Heinrich's (1931) well-known safety pyramid reveals that behind a major accident there are 300 minor accidents or near-misses with limited loss or damage. A Near-miss is an unplanned and unforeseen event which does not cause injury or damage but which could result in injury or loss under different circumstances, Borbidge (2004) noted. It is argued that the only difference between near-miss and actual accident is luck. Considering Murphy's Law: "if it can happen, it will happen." (Shcrŏder, 2005), if the contributing factors to near misses continue to exit, sooner or later, the accident will happen in certain circumstances. We can't control luck, but we can prevent accidents by paying attention to the 'early warnings'.

Maritime industry has been criticized as being limited and reactive by solving yesterday's problems. Generally people focus on collecting data only on events that meet the threshold of a reportable accident, and often with the objective of identifying liability and culpability. As a result, tremendous near misses remain uncovered. Recognizing signals before an accident clearly offers the potential of improving safety, and many industries have attempted to develop programs to identify and benefit from near-misses reporting programs. Borbidge (2004) addresses that the success of the FAA/NASA's Aviation Safety Reporting System (ASRS) and of the independent Confidential Human Factors Incident Reporting Programme (CHIRP) has led to the development of similar schemes throughout the world.

The maritime industry has realized the importance of near-miss information which can be used in risk management through a pro-active approach. On the world maritime day in 2002, IMO (2002) stated that:

> *But, going beyond this, near-miss incidents are reported and investigated with similar vigilance and effort as actual accidents, according to the company. It asserts that, by having a safety culture which encourages near-miss reporting, improvements in risk awareness, revisions in policy, and installation of additional controls has resulted in the prevention of further near-misses and actual accidents. Near-miss reporting trends are measured for each ship team and the results used to improve continually its safety management system and to help determine proactive safety programs. Hence having a positive near-miss reporting trend is indicative of an effective safety culture* (IMO, 2002).

However, there are only few near-miss reporting programs launched in maritime sector within last four years, and they are suffering from low reporting level for reasons such as prevailing blame-culture, hindsight bias, practical matters, etc. That means people still can not take full advantages of near misses as valuable opportunities to find weaknesses

and remedy them before accidents happen. U.K. Bureau of Transportation Statistics (BTS) (2005) noted that the large majority of near-misses from which we could capture useful data on accident precursors or on effective prevention strategies remain unexposed. So it is meaningful to launch a systematic, pro-active near miss program to identify contributing factors to accidents without having to experiencing accidents.

1.2 The objective of the study

This paper will identify barriers of reporting marine-related near-misses by briefly summarizing the literature and exiting near miss reporting systems on possible reasons for failing to report in general, and develop countermeasures. This paper aims to promote a pro-active, systematic approach through which, identifying, reporting, analyzing near misses in maritime industry, and developing, disseminating solutions in wide scope, in order to reach the goal of accident reduction, and to create a safer and more efficient shipping transportation system and mariner work environment.

The program will focus on identifying system failures, instead of blaming someone who is supposed to be responsible for an adverse event, because blame does little help to find the true causes. So it does not matter who did it, only why. When managed effectively such an approach helps identify structural weaknesses in processes, and hence, not only reduces the accident rate and intensity but also provides guidance for overall system improvement.

1.3 Scope and methodology

Early into the project, the concept of "near miss" appeared in the lecture handouts of Professor Shcrŏder Jens-uwe (WMU) helped to identify topic areas of greatest interest.

Emphasis in this research paper has been to collect information through a review of literature. The combined Science Direct database and Google searching engine was

used most frequently. Science Direct database contains a great number of journals and research papers. Key words used during searches were: near miss, safety culture, accident investigation, incident reporting, near miss reporting, reporting barrier, and accident prevention. The key word searches used the words individually or in combinations. Over 300 books or articles were selected for review and possible inclusion as references in this paper. Most of the materials are from other industries, such as Aviation, Nuclear, Healthcare, Railway, Chemical, etc.

In addition to the literature survey, Professor HONG BIGUANG, Captain, have given great support by providing ideas and instructions. He is expert on maritime accidents investigation.

Chapter II: the value of Near-misses

2.1 What is near miss?

'Near miss' is a widely used term in the safety industry. Some individuals call a near miss a close call, near hit, incident, or good catch. Near miss is defined in a variety of ways by different authors. Some of them are rather narrow while others are more inclusive. A near miss, as defined by Van der Schaaf (2000), is an event in which the unwanted consequences were prevented because there was a recovery by identification and correction of the failure, either planned or unplanned. While some definitions are very focused and based on the extent of the potential negative consequences, such as: 'Near-Miss is an undesired event or sequence of events with potential to cause serious damage'. However, Tamuz (2003) prefers a broader definition which focuses not only on the negative side of near-misses but also on considering their positive contribution to safety management. He views near misses as 'improvement opportunities' and includes all operational disturbances, some of which have the potential to cause serious damage while others are inconveniences that mainly cause inefficiencies. Broader definitions increase the probability of identifying potential problems at their earliest stages, Muermann and Oktem, (2002) noted.

2.2 The value of near-miss comparing with accidents

First let us review an example:

One sailor is painting the ship's hull on a platform overboard in anchorage station, suddenly, the rope hanging the board gets broken:

- He falls down, but is saved by life belt, no injury.
- He falls down into water without the protection of life belt; or he falls down into water, although life belt has been used, it is not proper used or get broken because of bad quality.
- After falling into water, he easily stays on the water surface waiting for help, because he has taken life-jacket before working.
- He falls into water without life-jacket; the watchman throws a life-buoy with line to him and saves him.
- He falls into water without life-jacket, nobody notices, he gets drowned.

This example is somewhat contrived, but it illustrates the point: the same initiating event can result in several different outcomes, and the magnitude or severity of these outcomes are dependent entirely upon the state of the system. Only in the last circumstance the major accident happens. Other events can be called near-misses. They reveal both strength and weakness of the system. It represents sources of information that could be applied to the prevention of accidents if they were properly reported, analyzed, and disseminated. The US Coast Guard (2000) argues that these 'non-accidents' or 'problem events' provide an untapped source of data. They can be used as indicators

of safety-levels in the maritime community and provide the information necessary to prevent accidents before they happen.

2.2.1 Heinrich's pyramid

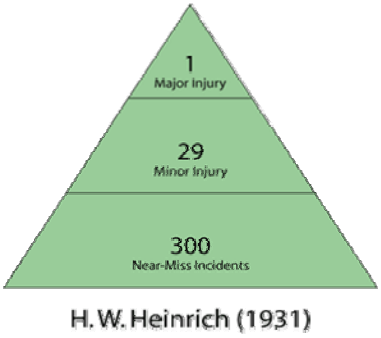

Figure 1: Heinrich's Pyramid

Source: Heinrich (1931)

The pyramidal structure of incidents, known as the "Safety Pyramid" is now widely accepted. Near misses represent the lower portion of the pyramid. Heinrich reported the following ratio for three different types of incidents: Major injury/ minor injury/ near-miss incidents = 1:29:300 (Heinrich, 1931).

It is intended to illustrate the fact that prevention need not wait until an accident occurred, and that prevention should not only be aimed at the most severe consequences, but also to events at the lower levels of triangle. Van der Schaaf (2000) likened studying near misses to an iceberg in which much important data can remain hidden from management view, unless it is brought to its attention. Not understanding near-misses can keep both managers and researchers in the dark about how to prevent accidents, since near-misses are the precursors of accidents," van der Schaaf (2000) emphasized. Hence, investigating near-miss is an effective and proactive means of identifying and correcting hazards. The ratio triangles or icebergs are used profusely in

industry today.

2.2.2 The Murphy's Law

Murphy, a U.S. Air Force officer at Edwards Air Force Base in California, was quoted in the 1950's as saying: "If something can go wrong, it will." The near-misses share many causes and characteristics of actual events. Essentially, a near-miss is an accident that almost happened. The only thing that stands between a near miss and an accident is luck, as Gordon (1997) noted. And luck can't be counted on. The underlying causes for incidents are usually the same regardless of which part of the pyramid the incident falls in. In other words, an incident that causes no injury and is classified in the lower part the pyramid could easily have been classified in the top part of the pyramid. By eliminating or controlling the cause(s) of the minor injury or a "near miss", you can often prevent a more serious injury from occurring in the future.

Marsh and Kendrick (2000) make a survey to assess whether near-miss and minor injury information can be used to plan and evaluate injury prevention program. After analyzing causes of 350 near-misses and minor injuries of children between 3 and 12 months and comparing with actual medically attended injuries happened on 252 randomly selected children, that information was provided by the Home Accident Surveillance System, they draw the conclusion: although some differences were found in the causal factors surrounding non-injury and injury producing events, overall, similar patterns in the circumstances surrounding the incidents were demonstrated.

If the conditions which gave rise to the near-miss are not addressed, the risk will continue unabated; and sooner or later a full-blown accident will occur, with all its attendant consequences. For this reason, a near-miss should be investigated with the same diligence as an accident. Indeed, in reviewing catastrophes, precursor events that had occurred on previous occasions but did not lead to accidents are often discovered. An example represented by Vaughn (1997) that, prior to the Challenger explosion (in

1986 when the Space Shuttle Challenger exploded) engineers had identified and reported degraded O-ring seals dating back to 1982.

2.2.3 Rich in number

Bird and Germain (1996) noted that, one of the most attractive aspects of near-miss analysis is the abundance events compared to actual accidents. Decision making about investing in safety improvements is usually based upon the relative importance of root causes in accidents and failures. Near-misses occur 3 to 300 times more frequently, enabling quantitative analysis, Barach (2000) said. They represent a rich source of information that can be used to project extreme events, determine risk exposure, and assess risk mitigation measures. Reason (1997) addressed that, it is valuable especially for high reliability industries where actual accidents are so infrequent that "lessons" from relatively minor accidents is essential for avoidance of major accidents.

2.2.4 Contains more information

The U.S. National Academy (NA, 2003) mentioned that, after an accident, it may be difficult to determine what actually occurred for a variety of reasons: damage can be so severe that accident reconstruction may be inaccurate; legal and financial concerns may create disincentives that affect the investigation; and witnesses may be unavailable. Occasions arise when there is nobody alive to tell the tale and the process of reconstruction becomes even more difficult. For instance, ships sink, sometimes without trace, or the damage can be so severe that accident reconstruction may be inaccurate. Such as, Derbyshire, the biggest bulk carrier in U.K. at that time, sank with the loss of all on board in 1980, but it was more than a decade before the wreck was located and a comprehensive underwater survey carried out in an attempt to find out why the ship had sunk (IMO, 1999, p.1). It is almost impossible to find the true causes of that accident. The lengths to which it has proved necessary to establish the cause of loss, and the costs of so doing have been and are continuing to be extensive.

After an accident, individuals or organizations may be unwilling to disclose information that could increase their liability, or they may share information selectively. However, as Eqbal (2005) argued, near-misses are far more common than actual accidents, there is far less guilt hangs over the discussion of a near-miss. In this way, hindsight bias is more effectively reduced. More safety information is likely to be revealed.

In addition, near misses can also reveal the strengths in the system. The example (in first paragraph of 2.2) reveals that the one of the following barriers may have prevented the death of the sailor:

- Pre-checking the line to be used, to ensure it is in good order and quality;
- Wearing life-jackets;
- Arranging watchman during overboard working time, etc.

Analyzing near-miss can also help to identify the barriers that prevent adverse situations from developing into a major accident. They can yield significant insights because they tell us about potential protection mechanisms that might be used in similar circumstances. Barach (2000) emphasized that successful recovery information, which offers learning opportunity, can also be captured, studied, and used for improvement.

2.2.5 Low cost

Collecting and analyzing near misses provides an opportunity to learn about system's latent weaknesses, without having to experience painful consequences arising from an actual accident. Although the cost of maintain an incident reporting schemes is high. However, it is much lower than that of from some major accidents. Accidents can have a number of direct costs, such as medical expenses, costs associated with employee convalescence, and equipment damage, property loss, etc. In contrast, U.S. National Academy (2003) noted that near misses may have minimal if any direct costs.

Accidents also have a number of indirect costs that may far outweigh the direct costs. For example, In March 1989, the oil tanker Exxon Valdez ran aground in Alaska's spilling more than 230,000 barrels of oil. The oil washed up on more than 1,300 miles of ecologically rich coastline. Exxon bore about $2 billion in clean-up costs, and another billion in damages and penalties. More than a decade later, harmful effects on the ecosystem and the fishing industry still linger. Furthermore, Mouat (2003) addressed, by operating such system, the safety awareness in the whole industry will be increased. It is quite valuable in a long run.

2.2.6 Be pro-active

Traditionally shipping take reactive approach to prevent the recurrence of accidents. For example, Maritime Environmental Protection Committee (MEPC) was established following Torrey Canyon oil spill, ISM code originated from Herald of Free Enterprise. Maritime accident investigation has been criticized as being limited and reactive by solving yesterday's problems. In response, U.K. Maritime and Coastguard Agency (MCA) developed "Formal Safety Assessment" (FSA) for the International Maritime Organization. As Peachey (2001) reviewed, FSA is a decision support tool for maritime regulators, based on risk and cost-benefit assessments. Paralleling with that, the approach through which capturing, analyzing near-misses, and disseminate safety information to related organization or individuals becomes proactive and predictive. Near-miss events afford early detection of possible system weaknesses and provide an early chance at correction. Hence the near-misses at the base of the accident triangle are often referred to as "preventative opportunities". Therefore, near-miss management perfectly fits into the category of proactive measures, Oktem (2002) argued.

Chapter III: Learn from existing programs

Because of the inherent value of using near-misses to mitigate the risk of accidents, catastrophes, and other extreme events, a number of industries have developed analytical techniques and management approaches to detecting, modeling, and acting on precursor signals. Especially in high-reliability industries, for instance aviation, nuclear power plants. The characteristic of such of kind of industries is that, the number of major accidents is few, there is not so much experience can be learned from these major accidents, however, once a major accidents happened, it will be catastrophic. Recently near miss program has been introduced in other industries, such as railways, healthcare, maritime, etc.

3.1 Aviation

The airline industry has led in the advancement of incident, near-miss, and safety reporting systems to capture potential precursor information. Most frequently used as an example is the United States Aviation Safety Reporting System (ASRS), a well-established national near miss database, which was established in the middle 70's in response to outcry over a particularly serious aviation disaster. ASRS aims to collect, analyze, and respond to voluntarily submitted reports of unsafe aviation situations in order to lessen the likelihood of aviation accidents. Key features of this program are its anonymity provision, its administration by a neutral party (the U.S. National Aeronautics and Space Administration –NASA), worker/management support, and regular feedback

given to the reporting population (through a newsletter and alert bulletins). It is highly successful in its mission of disaster prevention on.

Another example, as Tait and O'Neil (2003) reviewed that, U.K. Confidential Human Factors Incident Reporting Program (CHIRP) was founded in the early 1980s to serve the aviation industry. CHIRP reports are handled on a strictly confidential basis, no personal details are retained from reports received.

Beaubien (2002) introduced that the Australian Confidential Aviation Incident Reporting (CAIR) System is Australia's analog to ASRS and CHIRP. Like its counterparts, CAIR is a voluntary, confidential, and non-punitive incident reporting system that was established to proactively identify safety-related deficiencies and to suggest appropriate remedies.

3.2 Nuclear

The International Nuclear Safety Advisory Group (INSAG, 2002) addresses that, because of its high reliability, Nuclear industry gets few opportunities to learn from actual accidents. The nuclear power industry has adopted a similar approach to gathering safety information to complement its traditional data-collection methods. Every time a precursor event is observed during the operation of a nuclear power plant, the event is analyzed to reassess the measures being used to mitigate against future risk exposure. Tamuz (2004) addressed, in this way, the nuclear industry has been able to improve continuously the safety of plant operations based on empirical data from precursors without experiencing any catastrophic events.

3.3 Health Care

U.S. National Patient Safety Agency (NPSA, 2003) reviewed that NPSA is a special health authority formed in 2001 for learning from adverse events and near misses

improve patient safety by promoting an open and fair culture in the National Healthcare System (NHS). During the period September 2001 to June 2002, 28998 reports were submitted to NPSA electronically. The outcome was categorized in 27,162 of the reports. Of these, 25,660(94%) had a minor outcome or no outcome at all. A similar approach is adopted in U.K. in 2004. It is the biggest healthcare information system of its type in the world (www.npsa.nhs.uk).

3.4 Maritime

Japan (2001) had conducted an investigation into near miss incidents relating to operations on ships' navigation bridge by questionnaire and interviews with seafarers (captains, officers and pilots) of Japanese flag vessels in 1997 and submitted the report to the Committee (MSC 69/INF.16, MSC 71/INF.8, MSC 72/INF.9). By analyzing over 2,000 answers to the questionnaire they draw the conclusion that about 70% of near-misses are caused by or related to human errors.

In 2003 the Department for Transport U.K. extended its CHIRP program to the Maritime industry, carrying out research on the causes of maritime near misses and accidents through a confidential reporting system for the collection of Human Factors-related safety issues. In the first year there are 70 reports in the database. Of those 70, 42 have been forwarded to other related organizations for evaluation. Powell (2004) revealed that many of the reports have resulted in positive action being taken and all have raised awareness of particular issues or perspectives. Reports are published in CHIRP's Maritime Feedback, a quarterly newsletter. It has also a hard copy circulation of 130,000 and is also widely circulated by e-mail.

The Australian Confidential Marine Reporting Scheme (CMRS), founded in 2004, aiming to improve safety in Australian waters by enabling the Transport Safety Bureau (ATSB) to receive, assess and act on confidential reports to prevent, or reduce, the risks of marine accidents (CMRS, 2004).

Confidential, independent outsourcing of report collection and analysis, voluntary, rapid meaningful feedback, and ease of reporting are the common characteristics of above mentioned program. That will offer lessons applicable to the design of safety reporting systems in maritime industry.

Chapter IV: Barriers for reporting

The indicator of the success of near miss program is largely based on the reporting level, in other words, the reporting rate. Heinrich (2001) noted that under-reporting continues to be a major limitation of most incident reporting systems.

Harper and Helmreich (2005), both are affiliated with the Human Factors Research Project at the University of Texas at Austin. Their studies have shown that many physicians are reluctant to participate in programs to report medical errors, and that underreporting of adverse events may be as high as 96 percent. Findings from this survey clearly point to reporter protection as being among the most critical elements influencing the use of a reporting system. Powell (2004) also points out that the CHIRP maritime program in U.K. only received 70 reports in the first year. In a survey of reporting in 53 US hospital blood banks and transfusion services, Schreiber (2001) found that 91% of respondents always reported events with harm, but only 8% consistently reported near-misses that they corrected themselves, and in fact, 73% never reported such near-misses.

The low level of reporting reveal there are significant yet identifiable barriers for implementing a successful reporting system. Webb (1989, p.117) pointed out that the attribution of responsibility and blame as a filtering factor in reporting. O'Leary (1995, p.124) mentioned that there is a high pressure from society to allocate blame and punish someone. From operational aspect, van der Schaaf (2004, p.60) noted lack of time, the

complexity of reporting forms, and lack of training and awareness have all been cited as barriers to reporting. Others have cited additional barriers to reporting, including lack of confidence that a report will result in safety improvements and lack of time to complete the report and still complete other tasks. Bridges (2000) pointed out that extra work, scepticism, lack of trust, fear of reprisals are also powerful disincentives to reporting.

The factors influencing incident reporting can be grouped into following categories:

4.1 Be afraid of being punished

The major reason is that they are afraid of being punished for the prevalent blame culture in the world. The blame culture has been part of human culture ever since Adam blamed Eve for eating the forbidden fruit. The Council of Europe (2005, p.8) addressed that, traditionally thinking, if people try hard enough, they will not make any errors; if we punish people when they make errors, they will make fewer of them; that remedial and disciplinary action will lead to improvement by channeling or increasing motivation.

However, in the vast majority of situations this is either ineffective or even counter-productive, Dunn (2004) pointed out. It's human nature to cover things up for fear of criticism and reprisal. In addition, he noted that, the statement referring to near miss providers' concern that their report would not be truly anonymous was stated as follows: "Despite not having to give my name, I would still worry that I could be identified by a report I submit to an anonymous reporting system." Individuals may fear that they would loose their jobs, fear that their career prospects would be jeopardized, and fear that they would face civil or even criminal prosecutions. Besides, people don't want to get someone else in trouble, so they are reluctant to report incidents done by others. Unfortunately, most reporting systems lack the funding and the necessary managerial support to provide this level of assurance.

In addition, North of England P&I (January, 2005) pointed out, the criminalization of mariners is nothing new. If an accident occurs there will be possibly severe punishment, perhaps without any reference to fault or liability. So it is then a matter of keeping quiet. With luck, things can be kept hidden not just when it comes to near-misses but also when accidents do happen, and a promised bonus for an unblemished accident record can then be paid out.

4.2 Work overload

Through research, Andersen (2002) found that respondents feel reporting entails increased workload. For practical reason, a near-miss reporting form may be time consuming and inconvenient to fill out. Crew on board have always suffered from excessive paperwork. Vander der Schaaf and Kanse (2004) addressed that provider who is already burdened by long work days will be reluctant to take the time out of a busy schedule to report a mistake.

4.3 Safety bias

Van der Schaaf (2004, p.60) observed that people soon find incident reporting useless when no one ever reads and uses the reports. If near miss reports are collected and the information is not evaluated and disseminated and no action taken, workers will become discouraged and stop sharing. Residents might be reluctant to report and discuss near misses because they feel powerless to effect change, said Michael Couturie, MD, a second-year resident at Temple University Hospital in Philadelphia (Iqbal, 2005). Leveson (1995) points out operators often intervene to 'cover up' a potential failure by taking immediate action to restore a nominal state. In many instances, individuals may not even be aware that such necessary intervention should be reported as a focus for potential safety improvements.

Arise from lack of safety awareness, even that the staff from the management level does

not realize the benefit from learning near-misses. Van der Schaaf (2004, p.60) found that incidents might be seen as 'part of the job', and people may think near-misses can not be prevented. Because of their less dramatic end states, near misses may seem less salient as lessons learned than accidents. For example, March (1991, p.5) noted corrective actions developed in response to near misses may be less persuasive and more open to question than corrective actions based on actual accidents. The U.S. National Academy (U.S. NA, 2003) addressed that decision makers may pay less attention to precursors than to accidents, and it may be difficult to persuade them to make changes in technical or organizational designs based on observations of precursors. Furthermore, Christopher (2003) argued that this barrier is typically related to the fact that people never truly know how many accidents have been prevented by improved near-miss reporting.

4.4 Lack of resources

Hong & FU (2003, p.15) pointed out that, ideally all minor incidents should be investigated, but it is impossible for lack of resources. Similarly, U.S. National Academy (2003) addressed, because near misses are likely to be numerous, resource limitations may make it impractical to investigate all of them to the level of detail that would normally be used in an accident investigation. It can be expensive both to set up and to maintain the near miss reporting system. In order to get these reported date well managed and analyzed, skilled staff is indispensable. The process of managing and analyzing near misses is also time-consuming. There are often insufficient resources to perform a detailed study of the context in which an incident occurred.

4.5 Difficult to submit the report

As the main source of near-miss reporting, seafarers spent most of time on board, about 6 to 10 months every year. Some ships may seldom or never call their flag states or registered ports. It is hard to get reporting forms and send them to right place. No

internet, telephone, or mail is available on board.

4.6 Business pressure

The difficulty for the seafarer, particularly the master at times, is maintaining the safety first approach in the face of pressures outside of the ship and company, for instance, the pressures from port authorities, pilots, stevedores, agents and others with an investment in the ship and its cargo but not necessarily an interest in the safety of the crew.

A concern is that reporting potential problems to government regulatory agencies may result in the information becoming accessible to the public, including the media, which could be embarrassing, bad for business, or worse, Christopher (2003) noted. It is nature for the employee and managers to be afraid of being identified and publicized after the near-misses happened to them are reported. If there are many near misses in a ship are reported, it will give others the impression that the ship is not safe, and there is no need to do business with them.

Although, the values of near misses have been reviewed above, we can't ignore the fact that, no matter to what extent the safety awareness of participants will improve, near miss can never be treated exactly equally as actual accidents, during the process of reporting, evaluating, decision-making, etc.

Chapter V: the characteristics of an effective near miss program

Reason (1997) listed five important factors for 'engineering a reporting culture': indemnity against disciplinary proceedings, confidentiality or de-identification, independent from the regulatory authority, as well as rapid, useful, accessible and intelligible feedback to the reporting community, and finally, the ease of making the report. In addition, Lucas (1991) suggested that the use of information in the database (feedback, statistics, and error reduction strategies) and the nature of the organization of the scheme (centralized or local, mandatory or voluntary) contribute significantly to a reporting scheme's success or failure. Wald (2004) describes the characteristics of incident reporting systems: focus on near-misses, provide incentives for voluntary reporting, confidentiality, and emphasize systems approaches to error analysis.

5.1 Legal protect

It is important that the legal framework is in place to run a reporting system. Even the most well meaning management will have problems to build and maintain trust if legal action can still be undertaker against participants. In order to encourage reporting, there need break down legal barriers in existing laws need to be revised. For instance, the Maritime Traffic Safety Law of the People's Republic of China (1984), being accepted as the constitution of maritime law of China, of which article 43 addresses that the competent authorities shall ascertain the cause of the accident and fix the responsibility for it. Almost all maritime laws in china give us a signal that anyone

who is responsible for an incident is subjected to be blamed. The actions include warning, license withdrawing, license suspending, fining, and even criminal accusing. Such as the Provisions of the People's Republic of China on Marine and Maritime Administrative Punishment (2003), of which regulation 36 addresses that even to minor accidetns the the action to the seafarers who is responsible is suspension of license at least 3 months.

A guarantee of reporter protection from legal discoverability or disciplinary action could increase their motivation to use a reporting system. Evidence of the motivating power of this type of guarantee in increasing reporting rates can be found in aviation. For this reason, Helmreich and Harper (2005) address that NASA goes to great lengths to publicize the rules that protect the identity of contributors to the US Aviation Safety Reporting System. The impact of these changes and the power of immunity or a non-punitive process were demonstrated by a large increase in reporting rates that the program experienced over 8 years following enhancements in the immunity policy. Legal impediments such as civil litigation, regulatory sanctions, criminal proceedings and public disclosure are major deterrents to improving aviation safety through enhanced safety information collection and sharing. One example of an effort to encourage collection of the information needed to effectively correct safety deficiencies is Chapter 3 of Annex13 of the Convention on International Civil Aviation (1944) which states "the sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability." In addition, U.S. National Aeronautics and Space Administration (NASA, 1999) reviewed that there was an agreement from the Federal Aviation Administration (FAA) to grant pilots immunity from punishment in return for voluntary submission of reports.

Nørbjerg (2001) describes that, in 2001, a new law was passed by the Danish Parliament, mandating the establishment of a strictly non-punitive and strictly confidential system

for the reporting of aviation incidents. The law would grant freedom from prosecution, even though the reporter had committed an erroneous act or omission that would normally be punishable. Investigators would, by law, be obliged to keep information from the reports undisclosed.

It is obvious that for the scheme to be successful, reporters must have the utmost confidence that the confidentiality will not be breached. The provisions regarding regulating the behavior of investigators should be included, in order to ensure the identity of reporters will not be publicized. Their general duties include an obligation to ensure a full, independent and objective investigation. It is also important to clearly define permissible uses for the data.

Once the investigators or other staff of the program breach the regulation the legal action will be taken against them. The organization should have written policies and procedures on event reporting. Procedures for timely submission of event reports and action to investigate and follow up on events should be established.

There is generally a threshold above which some type of punishment may apply. Tamuz (2001) argued that a regulatory agency must make a critical trade-off between its responsibility to maintain accountability and its responsibility to identify and avert accident precursors. Disciplinary action will only be considered in clearly defined occasions, namely where there has been a breach of law, willful negligence or professional misconduct. That should be clarified in the regulations.

5.2 Management commitment

And also the use of a reporting system is largely dependent on management perception of the value of such a system. At the least a voluntarily reported near miss should never have any negative repercussions for those reporting it. Van der Schaaf (1995, pp.1241-1242) noted that organization leaders must be involved in the development and

implementation of precursor programs and must have a clear understanding of each program's structure, merits, and potential vulnerabilities. Pidgeon (1998), Toft and Reynolds (1997) noted that, management has an important role for shaping an organization's culture. With management commitment, employees will be willing to report safety concerns because they believe it is their responsibility to do so, because they are encouraged by their co-workers, because they know their management will respond to their concerns and because they know they will receive continuing feedback.

Ives (1991) describes nuclear "near miss" reporting systems where an established reporting mechanism was destroyed through a change in management demonstrates the necessity of management understanding and involvement in a reporting system. In his example high numbers of incident reports started to be used as a negative indicator of plant manager performance. The numbers of reports dropped to almost nothing and valuable preventative information was lost.

5.3 Be independent

The concept of independent incident investigation has been widely used around the world in various industries. The program should be independent of any authority with power to punish the reporter or the organization. It should be administered by an impartial third party, system operated by a non-regulatory third-party agency. Independence from the regulatory authorities allows people to talk freely and encourage the full disclosure necessary for improvements to be made by substantially removing the fear of punitive action. Independence can enable the staff in the program to operate it with disinterest, impartiality, and without pressure to compromise any operational decisions they are required to make. Furthermore, Tait and O'Neil (2003) argued that although it may be difficult to avoid, such organizations should not be the source of funding for confidential systems since funding a system will inevitably generate the capacity, real or imagined, to put pressure on the system.

Wu & Fu (August, 1995, 40) suggested that maritime incidents investigation should be carried out independently. Liu (April, 2003, 145-146) noted that both in England and American, the maritime incidents are investigated by independent organizations. CHIRP is also maintained by the CHIRP charitable Trust, an independent, charitable organization.

IMO's Resolution (IMO, 1999) A.849 (20) and A.884 (21) about guidelines of marine accident investigation also recommends separate, not for blame investigations of maritime accidents. U.K. Maritime Accident Investigation Board, U.S. National Transportation Safety Board are both independent investigating organization. In this way, it will facilitate finding true causes of the reported incidents. Powell (2004) noted that this independent assessment of the depersonalized issues helps ensure that the maximum potential safety benefit can be realized. CHIRP for the maritime industry is being funded by the UK Department for Transport. The CHIRP program (2003) revealed that the independent charitable status of CHIRP ensures its impartiality in dealing with all reports received, no matter which organization may become involved in subsequently remedying any reported problems.

Vollenhoven (2004), Chairman of the Dutch Transport Safety Board (DTSB) addressed that:

> *Because independent investigations are the only type of investigation intended to find out the whole truth about what happened. No other investigation serves that purpose, because they pursue other interests. And that includes criminal inquiries and investigations under civil law. The purpose of a criminal inquiry is to find out who was to blame, not to reveal the whole truth. And possible suspects have the right to remain silent. They do not have to incriminate themselves* (Vollenhoven 2004).

Comparing with accident investigation, the near-miss program will be easier to be

performed in independent manner. Because near-misses will attract little attention from public, politician, regulator and other interested parties, for their limited impact.

5.4 Non-punitive, just reporting culture

Many organizations are quick to allocate blame for failures, and then seek to prevent recurrence either through disciplinary or "retraining" actions. However, in the vast majority of situations this is either ineffective, or even counter-productive. In MAIB (Marine Accident Investigation Branch) annual report (2000), it states that 'The dangers of such an approach are that the real, and underlying, causes of whatever happened are either ignored or forgotten with the attendant risk that the same thing will happen all over again.'

It acknowledged that a large proportion of unsafe acts were honest errors'(the kinds of slips, lapses and mistakes that even the best people can make) and were not truly blameworthy. Instead, employees who bring such information to their supervisor's attention should be congratulated, van der Schaaf (2000) emphasizes. The International Safety Management (ISM) Code, which strives to rid the shipping industry of the 'blame culture' and encourage ship operators and seafarers to work together towards loss prevention. The promotion of a 'safety culture' within the shipping industry has been identified by IMO as a key priority.

Pidgeon (1991) provides one encompassing definition: A safety culture is the set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious. Any effective safety information system depends crucially on the willing participation of the workforce, the front line workers who are in direct contact with hazard. The program should focus on problem finding, instead of proportion blame. The reporter should be guaranteed immunity. Trust is the primary lubricants of the reporting system. The trust should be built among

employee, manager, regulator, etc. On this matter, (Borbidge, 2004) states that 'In the words of a great teacher/philosopher: Tell me and I will forget…Show me and I will remember… Involve me and I will understand. And adding our words: Recognize me and I will do it again and again.'

To gather near miss, Madsen (2002, p.161) suggested that an effective reporting culture alongside a healthy safety culture is essential to the organization. Since the prevailing 'safety culture' determines the way safety issues are addressed in an organization. Reason (2000) suggests that establishing a "reporting culture" depends on trust being a key element of the safety culture. He describes a Just Culture as an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety-related information. A Just Culture supports learning from unsafe acts in order to improve the level of safety awareness through the improved recognition of safety situations and helps to develop conscious articulation and sharing of safety information. Employees will be willing to report safety concerns because they believe it is their responsibility to do so.

Disciplinary action will only be considered in clearly defined occasions. However, even in the case of a deliberate violation, it is important to understand why it took place and whether the procedure was workable and correct and whether there were extraneous pressures that may have contributed to the individual act.

5.5 Confidential

The National Healthcare System (NHS, 2004) concluded that a review of incident reporting systems in other industries and other countries illustrates the very high importance they have placed on protecting the confidentiality of incident data to ensure the integrity of their reporting system. Incident reporting systems rely on gathering data from individuals about their mistakes and guaranteeing that their identities will never revealed to a third party, especially to their employer or licensing authority.

Some may argue that since aim to protect reporters, why not use anonymous manner. Anonymous systems enable contributors to entirely hide their identity. However, Heinrich (2001) argued that, confidential systems allow the limited disclosure of identity but only to trusted parties. The important distinction between an anonymous and a confidential reporting system lies in the fact that, with an anonymous reporting system the reporter will submit unidentifiable reports. O'Leary and Chappell (1996, 12) point out, however, that anonymity is not always possible or desirable. An anonymous report offers no possibility to derive further facts in the investigation process. Analysts cannot contact reporters for more information; anonymous reports may be unreliable. Anonymity may also be criticized for its threat to accountability and transparency, both at variance with the ethics of professionalism.

It may, Barach (2000) suggested that, however, be important to provide anonymity early in the evolution of an incident reporting system, at least until trust is built and reporters see practical results. However, with a confidential system the reporter will submit their name, and can thus be contacted during the investigation process for further clarification and feedback purposes. This can be achieved by de-identifying individuals in reports, guaranteeing protection from disciplinary action. The report form is then returned to the employee and no copies are made. Thereafter it is impossible to link a particular report to a particular employee. For example, Tamuz (2003) reviews that ASRS uses de-identification of both individuals and airlines to ensure that reports are not used as a basis for regulatory enforcement, disciplinary action, or litigation. After return of personal details, CHIRP is unable subsequently to contact the reporter. However, it was also argued that in the longer term the culture of the industry would be such as to make confidential reporting unnecessary.

5.6 Feedback

Reporting needs to be encouraged and responded to constructively. Once near-miss

reports are submitted, it is important to respond to them. Reporting can be encouraged by acknowledgement and recognition. Giving feedback timely let reporters know that they are not doing something useless. Feedback keeps staff 'in the loop'. The investigating staff can issue a receipt of a report and confirm that it is being investigated. In a well-run system, they can see that their concerns are treated seriously and are acted upon by the organization. Providing feedback to staff about reportable events is an important step in the quality improvement process. U.K. National Healthcare System (NHS, 2003) addressed formal recognition that reporting incidents results in visible or tangible system improvements supports and fosters a safety culture.

Johnson (2000) noted, research into the effectiveness of incident reporting systems in other domains has stressed the importance of providing the individuals who contribute to an incident reporting scheme with direct feedback about the effect of their contributions on fundamental and long running concerns.

5.7 Voluntary

Since the object of any confidential reporting scheme is to gather data on incidents that generally are not made visible to third parties, there is no function in attempting to make such a scheme mandatory since it will inevitably be up to the individual concerned whether to make a report or not. For instance, U.K. Bureau of Transportation Statistics (BTS, 2005) reviews that, in addition to the mandatory requirements of major accident reporting, an explicit recommendation to report near misses to MARS is operated on a voluntary basis. Within the United States, voluntary reports have been the prevalent source of information concerning unsafe acts.

The American Medical Association (AMA) and the American Hospital Association (AHA) oppose mandatory reporting and believe that any reporting that is tied to punitive action or public disclosure will encourage making the reporting system a "numbers game" and drive reporting underground by perpetuating a culture of blame.

However, the public feels that mandatory reporting improves accountability. Clearly, both voluntary and mandatory approaches are required, each with their own benefits and limitations. For instance, because of pressure from public, relatives of victims and politicians, the accidents with great damage both to environment and property, injuries or death, need to be mandatory reported and thoroughly investigated.

5.8 Operate in wide scope

The level of a reporting system is used to distinguish between local, national and international initiatives. In this paper, a national level reporting system is recommended.

The scope of a system defines the groups who are expected to participate in the scheme. There are important differences between national and regional reporting systems. For example, it can be easier to guarantee anonymity in national systems. Reports that are submitted to local systems often contain sufficient details for others to infer the identity of individuals who are involved in an adverse event. Barach (2000) argued that, national systems are more likely to be protected by legal guarantees of confidentiality. Beyond this, National systems have correspondingly greater coverage of the whole industry, which facilitates recommendations to be widely shared. Furthermore, more reports may be received and better statistical data can be derived from them.

Section 9 of the ISM Code requires reporting not only accidents but also hazardous occurrences, near-misses and non-conformities, Anderson (2001) noted. However, Captain, Beedel (2002) argued: 'This is all very commendable but, even if the reports are published within the company, they are kept 'in-house' and nobody else benefits from them.'

In addition, U.K. National Healthcare System (NHS, 2004) addressed that research has shown that some staff welcomes a national system because they feel it will give greater

weight to local reporting and that incidents will be taken more seriously at management and board level.

Mariners who move around the service and spend most of their time on the sea have to become familiar with different systems in different local organizations. There is often a lack of clarity about what issues to report, how to report them and to whom. Dislike other industries, such as aviation, nuclear, healthcare sectors in which people live and work in a relative fixed place. It is not practicable or convenient to use a local reporting system in maritime industry. Operating near-miss reporting system in national level will be a better choice. Ideally, in a long run, if it is possible, operating in international level will facilitate wide information sharing.

5.9 Simple in form, easy to report

Since most seafarers have being suffering overloaded paperwork, under the requirements both by convention (or regulation) and by company, it is important to prevent reporters from feeling reporting is a burden. Oktem (2002) notes that, the procedure for reporting and collecting incidents must be simple, straightforward and easily understood by all staff to encourage everyone who observes or experiences a problem to fill-out a report without spending much time and effort. Also, various ways to submit the reports should be available.

A simply, user-friendly standardized format for reporting (on paper or e-form) should be available to all participants of this program. A report that requires selection from lists of possible events assists with ease of reporting because check-off boxes reduce the time involved in completing the report. Each reporting form can contain a series of pre-defined fields that describe the relevant conditions that immediately preceded the incident. Space is also provided for a text-based narrative so that the reporter can provide additional details, such as causal/contributing factors, the chain of events, and suggestions for preventing the event's reoccurrence.

It is important to capture as many near-misses as possible even though not all of them will have the same importance. By keeping reporting simple and narrative, and by allowing workers to use their own words to describe a situation, employees are more likely to share. The key is to learn what types of near-misses are occurring, not necessarily all the details involved in the occurrence.

Chapter VI: the process of near-miss management

Although there are so many barriers, successful near-miss programs are attainable. Near-miss management systems have been developed and are implemented across a range of industries. Near-miss management can be systematized and managed to provide an important reinforcing element of accident prevention and preparedness at hazardous facilities. To do so, it requires a well designed infrastructure for identifying, reporting, analyzing and disseminating the results of near misses. In addition, the system needs to be periodically evaluated and audited to maintain its effectiveness. In this chapter, this paper will identify key processes of a systematic near-miss management program in maritime industry, as shown in Figure 2.

Identification	Reporting	Classification	Analyzing	Recommendation & dissemination	Follow-up

Figure 2: the process of near miss management

6.1 Identification:

To successfully identify a near miss, individuals must recognize an incident or a condition, with potential for serious consequence. If not identified, disclosed and properly managed the incident may be forgotten and the latent potential for damage remains. Different reporting systems have different definitions of what should and what should not be reported. The range of near-misses reported depends on how they

are defined. Participants should know what types of events to report and they could recognize them when they occur. Even highly knowledgeable individuals can have different views of the meaning of accident precursors, which can substantially affect the range of incidents reported. To harvest value from a near-miss it must be clearly identified.

6.2.1 Clear definition

Definitions vary from highly specific criteria (such as exceeding a specific quantitative threshold) to broad definitions that encompass a wide range of events and circumstances. Oktem (2002) noted that setting the threshold for reporting too high or defining reportable precursors too precisely may mean that risk-significant events may not be reported, valuable information could be lost. However, U.S. National Academy (NA, 2003) argued that too low a reporting threshold can lead to a perception that the reporting system is of little value.

Broader definitions can increase the probability of identifying potential problems at their earliest stages. Tamuz (1994) emphasizes that the use of broad ambiguous definitions of potential dangers aids discovery of risks that escape existing definitions. To have an effective near miss system there is an overwhelming need for an encompassing and helpful near-miss definition. The definition has two-folds:

- Firstly, it should address the importance of near miss as valuable opportunity to find the weakness and strength of the system. If the underling hazard is timely identified and remedied, the likelihood of the incident recurring is greatly reduced or eliminated. If not identified, disclosed and properly managed the incident may be forgotten and the latent potential for damage remains.

- Secondly, it should include these incidents below the threshold of existing accidents reporting scheme.

For this reason, Phimister, Oktem, Kleindorfer and Kunreuther (2000) define near-miss as: 'An opportunity to improve environmental, health and safety practice based on a condition, or an incident with potential for more serious consequence.' It is based on the elements depicted in Figure 3:

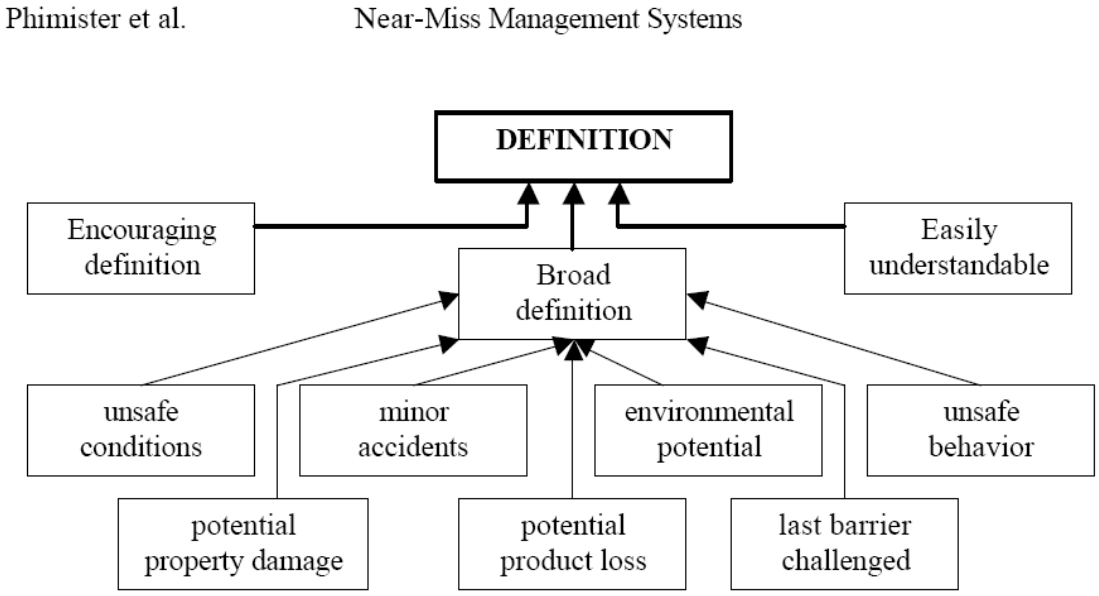

Figure 3: Broad definition of near miss

Source: Phimister (2000).

In maritime sector, the author defines near-miss as: Conditions, behaviors, incidents that have potential to cause injury (or life loss), property damage (or loss), environmental damage; or conditions, behaviors, incidents that have caused injury, property damage (or loss), environmental damage, but below the threshold of existing reporting system.

6.2.2 Who should report?

Seafarers, port state control officers, VTS staff, worker in port, maritime administrators, ship company staff, agents, cargo owners and other interested individuals or

organizations should submit near-miss report.

6.2.3 What should be reported?

According the definition, the following events or conditions should be reported:

- . A procedure or practice that would endanger the safety of the ship or a person, such as unsafe navigation;
- . Defective life saving or fire fighting equipment;
- . Extreme corrosion of the hull;
- . Crew schedules resulting in fatigue;
- . Unreported accidents and near-misses and unsafe condition;
- Ineffective regulations;
- The recovery information

Oktem (2002) suggested that the reporting system should extend to security issues. The September 11th attacks followed by the anthrax problems and various other threats increased the awareness of the terrorism risk, not only in the United States but also in countries around the world. There has been a heightened awareness and an increased emphasis on security for all commercial operations, so does in maritime industry. People should look at a problem not only from the safety and environmental perspective but also from the security perspective.

6.2 Training

It is the skills, performance and attitudes of people that will determine success and ensure incidents are handled in a consistent and effective manner. Once the objective

of this program is established, and the definition of near miss is defined, the training of all persons who will be involved is fundamental.

In practice, it would be helpful to develop a list of in-context examples that illustrate what people consider to be near misses. Authority can approve special lists of occurrences that must be reported. Guideline addressing the procedure of reporting should also be available to all participants to inform them which incidents should be reported and how to report. Thomas (2002) suggested that by developing comprehensive training programs, using a variety of different approaches to raise safety awareness and help users clarify definitions and terminology standard templates for reporting procedures, risk assessment frameworks and methodologies is critical to this program. Ensure that all participants understand the importance and value of near-miss reporting for safety improvement and willing to invest the time to investigate near misses, including spending overtime labor if necessary.

6.2.1 Improve awareness

Improve awareness of safety, environment protection, and the value of near miss in risk management in all level of participants, including the operators, managers, politicians, administrators, public and other interested parties related maritime industry. Especially, through training the providers can increase their willingness to report safety information.

6.2.2 Ensure familiar with definitions and procedures

Although near miss is not a new concept, but the definition always confused people. Maybe everyone has their own criteria in mind. For instance, someone only view the incidents with minor damage as near-misses. Generally, on board, only officers or engineers are familiar with the procedure of incident reporting and the way to clear narrate the events. Majority of seamen seldom do this kind of work. Through training, the participants will know what to report, as well as how to submit reports.

The investigators will know how to keep confidentiality when they deal with these collected data. In addition, after being familiar with the procedure, the participants will feel less afraid of being identified and punished based on the information they provided.

6.2.3 Improve skills

There are clear problems in interpreting the evidence provided by an initial report of an incident. The problems of interpreting eye witness statements are not simply related to the difficulty of assessing non-technical accounts of system failures. Individuals may not be able to observe the consequences of the adverse events that they witness. They need be well trained to fill the reporting forms properly, so that complete information will be submitted.

In addition, Heinrich (2001) and Ayeko (2002, p.125) argued that the process of analyzing near misses, developing recommendations is typically a complex and skilled task. In respect of skills, Tamuz (2003) insisted that such an expertise must include the ability to effectively analyze data received ensuring of developing preferred recommendations which are appropriately specific, and therefore easier to implement. They should be familiar with the objective, the procedure, the analyzing methods, the terminologies, and have experience of maritime affairs.

Specially, experts with knowledge of human factors should be included, since human error continues to be the dominant factor in maritime accidents, and it is a great challenge to analyze human factors contributing to incidents. The statistics made by American Bureau of Shipping (ABS, 2004, p.3) revealed that for all accidents over the reporting period, approximately 80 to 85% of the accidents analyzed involved human error. Of these, about 50% of maritime accidents were initiated by human error, and another 30% of were associated with human error. The characteristics of people that lead to unsafe situations cover a wider range, particularly their errors, which are unique to each situation, including the psychological and physical characteristics of people, the

hardware and software with which they interact, and the surrounding physical, social, and organizational environments in which activity takes place. The staff is necessary to fully appreciate the cognitive backgrounds of the human error model, and to ensure an objective and uniform approach in describing, classifying and interpreting the reported events, van der Schaaf (1995) emphasized.

6.3 Collecting reports

To successfully identify a near-miss, individuals must recognize an incident or a condition, with potential for serious consequence. Reporting are vital in providing a core of sound, representative information on which analysis and recommendations can be based. Wiegmann (2002) addressed that an effective and systematic reporting system is the keystone to identifying the weakness and vulnerability of safety management before an accident occurs. Reporting should be made very simple to encourage everyone who observes or experiences a problem to fill-out a report without spending much time and effort. A key objective is to create reporting systems in an open and fair culture so that staff can report freely and in confidence. In this process, various ways can be used to collect as much as possible valuable near misses and make sure such information is accurate and sufficient. The prevention of reporters' identities from be released to public or any other third parties is critical important.

Once receiving reports, the staff should review the contents in the reporting forms, and evaluate the information, if necessary, they can contact with reporters for further information to ensure the reports are complete and accurate. When entering these data into database, the reports shall be de-identified to remove all information mentioning the identities of the reporters, companies, ships, witnesses, etc. This process shall be rechecked by other members of the center.

When determine in which way the seafarers can report near-misses, their unique work environment different from other industry should be taken into consideration. The way

should be easy to access through a variety of reporting methods, including telephone, internet, mail, and automatic recording.

6.3.1 Mail

In order to encourage reporting, the center can distribute post-free envelopes with pre-printed address of reporting center to seafarers and other participants. The mail can also be sent directly to reporting center or be transferred by staff working in medical examination centers where seafarers have to get examined periodically. The precondition is that they can get the reporting forms and envelopes easily.

6.3.2 Telephone

Free hot-lines can be arranged to facilitate reporters who witness or perpetrate near misses report if they want.

6.3.3 E-form

By providing standard and user-friendly e-Forms on the reporting center website, reporters can send near miss information fast through internet. The ease of electronic or online event reporting has been shown to reduce under-reporting, improve timeliness, and contribute to managers' 'real time' knowledge of near misses for early intervention. As Healthcare Risk Control (HRC) System (May, 2003) addressed, some computerized event reporting systems have boasted considerable decreases in event report turnaround times and significant savings in data-entry time.

6.3.4 Automatic recording:

One additional source of information on unsafe situations involves automated methods of data collection. The reporting of incidents takes time, and is dependent on both the ability and willingness of informants to report events accurately. Most witnesses do

their best to remember events but there will be many gaps in the information they can provide. U.K. Bureau of Transportation Statistics (BTS, 2005) suggested that advances in technology offer the opportunity to record events automatically in a way that will allow the nature and origins to be ascertained and verified objectively.

Data recorders are now commonplace in many forms of transport and have made a substantial contribution to the understanding of incident causes and the improvement of safety. Lang & Beer (1999, p.199) suggested that recorded data has enabled accident investigators to reconstruct events to identify precisely what went wrong and to ensure that effective, rather than convenient, recommendations can be made to prevent the same thing happening again. The mandatory fitting of flight deck recorders and cockpit voice recorders in most commercial aircraft has made a major impact to the improvement of safety in the air. As "black box" on vessels the Voyage Data Recorder (VDR) can record and save the data gauging system and personnel performance as well as operating status so that analysis can be made when the ship arrives next port.

6.3.5 Others

Additionally, Lang & Beer (1999, 202) recommended that other sources of recorded data are becoming available including recorded radio channels, vessel traffic system (VTS) shore radars, closed circuit television and privately operated video cameras which are getting widely used around the world. Clarke (1998) also suggested that alternate means of data collection include periodic interviews, questionnaires.

6.4 Preliminary filtering, Classification

Ideally, all near-misses, no matter how minor, should be reported. However, as Vander der Schaaf and Kanse (2004) reviewed, if a large number of reports are submitted, it is impossible to analyze all of them. Resource constraints may make it difficult to have the right focus and to identify the most important problems highlighted in the reported

data. They are subjected to further prioritization and filtering. For example, U.S. National Academy (NA, 2003) noted that, ASRS receives about 2,900 reports a month, only 15 to 20 percent of which are logged because of resource constraints. ASRS analysts first classify reports by their safety significance. It is important to set criteria for prioritization, Oktem (2002) noted. In addition, there must be recognition that the reporting of an event is not necessarily a prejudgment of its risk significance (U.S. NA, 2003).

Classification schemes provide key terms that can be used to access incident data in large, national databases. "filtering" allows classifying near misses into two categories, high or low priority, by comparing potential damage, loss or injury against a given criteria. Only in the case of more significant or complicated events is additional analysis and detailed investigation necessary. In this way, we can reduce the number of events requiring in-depth analysis to a more manageable figure. However, to determine the potential harm of a reported near miss is much based on creative activities such as brain storming sessions. U.K. Bureau of Transportation Statistics (BTS, 2005) argued that it is particularly challenging for causes arising from the human component.

ASRS analysts first classify reports by their safety significance. If a report has safety potential, it is carefully examined and coded. Tamuz (2000) suggested that potentially significant events are further classified as: (1) urgent situations that require immediate intervention or (2) events that warrant in-depth analysis and coding by ASRS safety analysts. Furthermore, these near misses need to be classified according to kinds of incidents or contributing factors.

A limited number of investigators are responsible for processing these forms. However, all identifying information is removed from the report before it is submitted for further analysis. From this point of view, it is impossible to link a particular report to a particular employee, or organization.

6.5 Causal analysis

A Chinese Proverb says "To get rid of weeds, dig up the root; to stop a pot from boiling, withdraw the fuel." A systematic in-depth analysis of incidents is necessary to identify the root causes. Incidents should be reviewed and investigated fairly, free from hindsight bias. Root cause is defined as the most basic or fundamental reason for an undesirable condition or problem which, if eliminated or corrected, would have prevented recurrence of this and similar occurrences. Root cause analysis requires that both the direct and indirect cause of incidents to be determined. The causes may be technical, human behaviors, organizational culture, process, procedure, equipment, environment, etc. It helps to determine whether the presence or absence of certain factors increases the probability that an incident will occur.

Research has shown that a typical accident is the result of many related and unrelated factors that somehow all come together at the same time, for instance the integration of working practices, working environment, line management and regulatory intervention together support a catalytic or triggering failure, as indicated in Figure 4.

Nation Healthcare System (NHS, 2002) suggested that the analysts should keep asking the questions “How” and “Why” to determine the most probable underlying causes of problems and undesired events within an organization. For instance, "Failure of employee to wear required personal protective equipment" is a common cause, in which case you need to find out why supervisors are not consistently enforcing the wearing of the equipment or are not training employees in what is required.

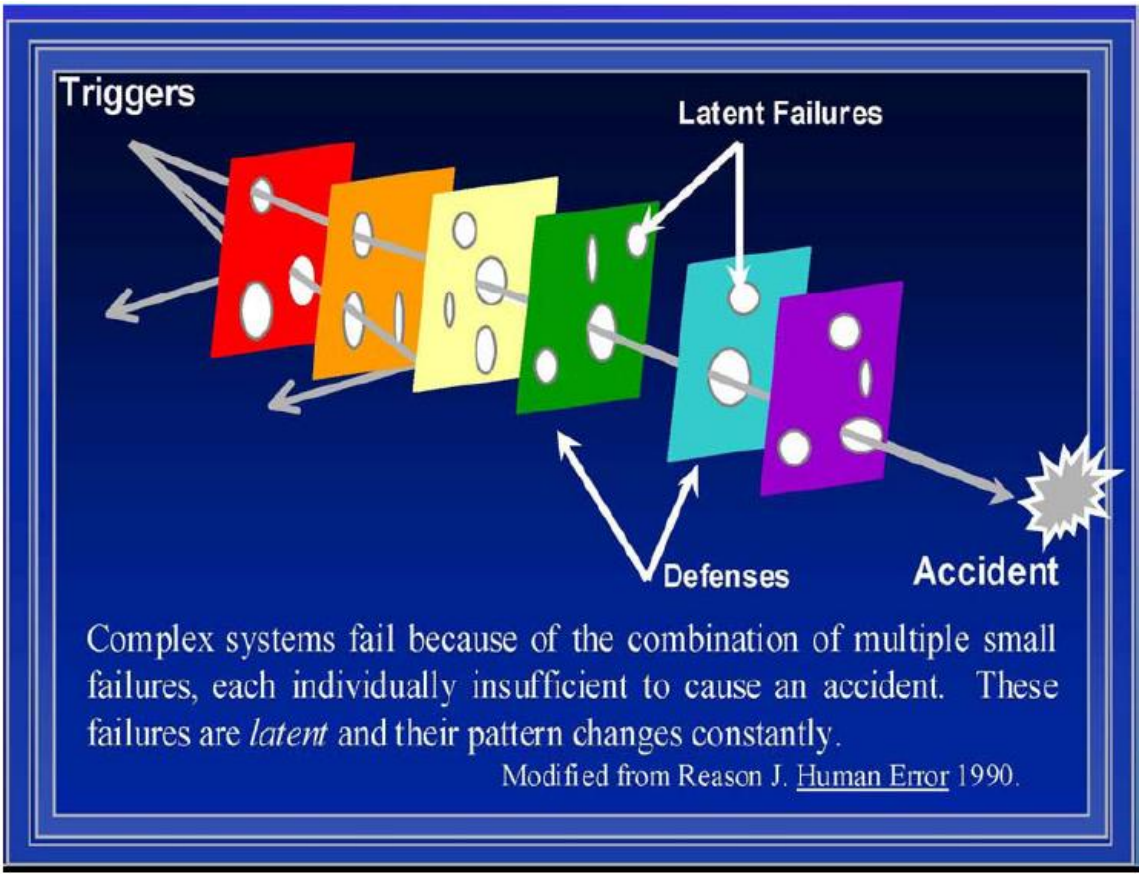

Figure 4: Modified Reason's cheese model

Source: Kirsch (2005)

Because, generally it is impossible to investigate near misses on scene, or directly contact with witnesses. So the process of analyzing near misses includes subjective components, in other words, brain storming sessions. It is important to emphasize that subjective judgments need not be 'a bad thing'. Heinrich (2001) argued that, it reflects the expertise and experience of the investigator.

Other valuable information can be concluded from the near miss analysis are the recovery information and the barriers in the system still working, which can be used for safety improvement in similar circumstances in the future.

5.5.1 Focus on system

Usually when incidents happen, operators are blamed or exhorted to 'try better, next time'. Heinrich (2001) argued that, correspondingly less attention is placed on the organizational, technical and environmental circumstances which contributed to an incident.

Leveson (2003, p.500) pointed out that, this program has contributed to the popularity of systemic theories as an explanation of incident causation. In this view, individual errors rarely create the causes of an adverse event. Instead, Johnson (2004) insisted that we must look at the complex conjunction of managerial, regulatory and even legislative constraints that jeopardized the safety of a more general system. Reason (2000) uses a mosquito-control analogy, suggesting that rather than swat mosquitoes one by one, the better remedies are to create more effective defenses and to drain the swamps in which the mosquitoes breed.

Christopher (2003) and Liu (2002, 27) noted that instead of focusing primarily on the operator (e.g., with more regulation, punishment, or training), it is time that we also focus on the system in which operations are performed. Similarly, Itoh (2002, 144) addressed that it has been observed that organizational problems are frequently latent causal factors that contribute to the occurrence of human errors made by frontline personnel. IMO (2000) addressed that peoples are essentially human system components involved in complex interactions with other system components such as machinery, equipment, procedures, and other humans, in an operating environment, to accomplish a certain mission objective. As behavioral psychologist, through quantitative research Reason and Hobbs (2003, p.96) found that, human error is inevitable for a number of physiological and psychological factors); human error is not intrinsically bad, because Success and failure spring from the same roots. Ayeko (2002, p.116) argued that when a failure occurs and causes are attributed to "human error", the

people on the scene are not always at the root of the problem.

5.5.2 Analysis techniques:

In order to objectively assess events, an adequate structured event investigation methodology has to be applied, which leads to the identification of appropriate root causes by which relevant corrective actions are established, implemented. Many tools are available to aid the analysis phase. However as Jacinto and Aspinwall (2003, p.3) said, so far none has been universally accepted; each single model presents a specific/limited view of the problem. Each has its own strengths and weaknesses and preferred realms of application. Some may focus on human element; some may focus on management failure. Therefore, it is not possible to recommend any single technique. The use of one or a combination of techniques in event analysis should ensure identification of the relevant causes and contributing factors which aid in the development of effective corrective actions.

It also should be noticed that each technique will achieve different results, so the method selected should be appropriate to the specific situation. In addition, costs vary with each technique, so choosing a technique may depend on resources and the perceived severity or plausible, worst-case consequences of the event or condition. Sklet (2004) suggested that, each of the methods has different areas of application and qualities and deficiencies, such that a combination of methods ought to be used in a comprehensive investigation of a complex incident.

The most common root cause analysis methods are: Cause and Effect Analysis, Change analysis, Events and Causal Factors Charting, SHELL model, Barrier Analysis, etc.

5.5.3 Use software

Since there is great number of near-misses needed to be analyzed, the use of

comprehensive toot cause analysis (RCA) software may facilitate a quick analysis and ease the burden of the investigation process and documentation of the results. Dunn (2004) said that, a growing number of Root Cause Analysis processes are being supported by RCA software. The software prompts the user to think about problem causes using some form of hierarchical outline or "pick list" which users use to identify problem causes.

However, it need to be noted that a predefined hierarchy is likely to represent the biases of whoever created the categorization scheme, and this may not reflect, or include, the causes that are relevant to the problem being solved. There are an infinite number (and number of levels) of causes. Experience says that most people will restrict their thinking to those causes that are contained in the software. We need to be careful not to oversell the benefits of software in effective problem solving, Dunn (2004) suggested.

There are generally many smaller problems that can be solved more or less immediately, simply through the use of software. Nevertheless, using RCA software can save time dramatically. The outcomes can be revised manually if necessary.

6.6 Identifying Solutions

There are some principles to be followed during this process. Johnson (2004) argued that root cause analysis will never yield 'zero incidents' and so questions must be asked about the cost effectiveness both of the recommendations that are produced and of the analysis that is performed to identify those recommendations.

Firstly, for each of the contributing factors and/or causes of the incidents a corrective recommendations should be achievable and reasonable, and in a cost-effective manner. It does not require everything possible to prevent an accident but only what is "reasonably practicable". The potential risk should be compared with the cost of removing or reducing it, in money, time and trouble. When there is a gross

disproportion between them it is not necessary to remove or reduce the risk. This process is based on qualitative analysis, and is quite subjective. When developing corrective actions, safety and environmental considerations must be of paramount importance.

Secondly, the recommendations shall not be too general. If the recommendations that are proposed for dealing with Organizational Causes are too generic in nature, then it becomes more difficult to implement them. Dunn (2004) suggested that the recommendations should be appropriately specific, and therefore easier to implement. For example, if an engineer on board doesn't know how to properly use Oil-water separator. The solution should not be simply defined to enhance training. The barriers to stop an unskilled engineer to work on board need to be identified and remedied.

Corrective actions can be immediate, interim or long term necessitating detailed evaluation. It need to be noted that generating too many actions may overwhelm the intended beneficiary and leave some important ones outstanding for too long. The success of this process is quite based on skill and experiences.

6.7 Dissemination

Participation by multiple parties in information sharing can often amplifies the benefits derived from the information. Oktem (2002) and Heinrich (2001) suggested that the program should broadly disseminate de-identified, applicable, system improvement information to further encourage and promote safety improvements. U.S. National Academy (NA, 2003) addressed that if a member of an industry experiences a problem and fixes it, every other member can benefit from that member's experience without having to encounter the problem. For example, in ASRS program the safety information identified from near miss analysis is distributed to more than 85,000 pilots, air traffic controllers and others in the aviation industry, as Heinrich (2001) noted.

As mentioned in chapter V, through disseminating related safety information to participants, the reporters will be encouraged to submit near miss information, since they feel they are doing something meaningful, not only to others, but to themselves.

One thing is important that, before dissemination any identities of individuals or organizations from the information must be removed, otherwise, the trust which is fundamental to the success of such systems will be destroyed. Klampfer and Grote (1999) addressed that this can lead to a difficult ethical decision in which investigators might choose not to release important information about a potential hazard in order to safeguard the longer term future of the reporting system.

This system must go beyond repeated reminders to be careful if they are to preserve the confidence of those who contribute to them, because immediate remedies to individual incidents will fail to address the root cause of a problem. The ASRS recognize this by issuing two different forms of feedback in response to the reports that they receive. The Callback bulletin describes short-term fixes to immediate problems. In contrast, Heinrich (2001) pointed out that, the DirectLine journal addresses more systemic causes of adverse events and near misses even if it has a more limited audience than its sister publication.

Attention should be paid to the fact that, in the process of implementation, corrective actions developed in response to near miss data may be less persuasive and more open to question than corrective actions based on actual accidents.

6.7.1 The destination of dissemination

- To regulators. They can make new regulations or revise existing ones in relation to safety and environmental protection based on the information.
- To seafarers, stevedores and other operators in the frontlines. They can be kept

reminding their behaviors and operations.

- To administrators. Such information can facilitate them to adjust their managing style, procedure and correct their mistakes.
- Training institution (including maritime colleges). According to the recommendations they can adjust the knowledge structure or methods of training.
- To companies. Dissemination of information about these errors and their root causes to permit marine companies, where appropriate, to redesign their systems, change policies, procedures, equipment, and, if necessary, personnel to prevent future events.
- Others with whom there are agreements.

6.7.2 Ways to dissemination

The information can be shared in a variety of ways within an organization. The way of dissemination can be, through printing feedback (or newsletter) periodically or direct access to web center. For example, in The U.K. Confidential Human Factors Incident Reporting Program periodical publications such as Feedback and Callback, as well as Direct Line, play a critical role in increasing the visibility of these common occurrences (CHIRP, 2000).

Increasingly, electronic information systems are being used to reduce the costs associated with paper-based distribution. Databases can be established to provide the public with access to summary information.

6.7.3 Access to the database

The data compilation activities should be performed under carefully defined confidentiality restrictions. Only de-identified information is available to public.

Besides, the database can also be available to scholars who are interested for second analysis or research, to develop their own opinion.

6.7.4 Internationally sharing

Within the maritime industry there are great benefits to be gained by sharing information and experience internationally. By now, only few states have launched near-miss reporting programs. They set up their own databases, and issue their own reports, and pay great efforts on the programs. However, such valuable outcomes are not getting full used around the whole industry. As a result, someone is still repeating the errors which have been identified and remedied by others.

There is a need to make international standards or guidelines to be followed by all member states of IMO to facilitate international co-ordination among these systems.

6.7.5 Cross-industry information sharing

Although, each industry has unique characteristics comparing with other industries, they can also shamelessly learn from each other. Such as, issues related human elements, management, regulatory, legal are similar to some extend among different industries. Greater cross-industry sharing of safety information could be widely beneficial.

6.8 Follow-up

Johnson (2004) discussed that once solutions are identified and implementers are informed, it is important to track all suggested changes to ensure that they are properly executed. Follow-up includes determining if corrective action has been effective in resolving problems, and the safety information has been widely shared. Whether the recommended resolutions are practicable or effective should also be assessed.

This process can be carried out through questionnaire, interview, or checking

documentary.

6.9 System evaluating and up-dating

An effective near-miss management system can significantly contribute to minimizing the recurrence of accidents. The near miss system need to be periodically checked if it is performing up to the expectations set-forth as part of its design, Oktem (2002) suggested. As Healthcare Risk Control (HRC) System (May, 2003) suggested, the evaluation of reporting system should be undertaken to determine not only how effective it is in capturing information on near misses, but even more so, how effective it is in improving systems and procedures. As U.S. Occupational Safety and Health Administration (OSHA, 1997) addressed, the purpose of this review is to evaluate the overall process effectiveness and to recommend remedial measures to resolve any weaknesses if identified. Relatively low level of reporting may be the indicator of poor management.

U.S. National Academy (NA, 2003) mentioned another reason why the program needs to be evaluated is to share the resulting information with the people expected to participate in the program to encourage them to continue their participation.

The following methods are going to be used:

- Compare the accidents statistics with old date. Through which people can assess the effectiveness of the program.
- Evaluate the weakness and strength of the cause analyzing models being used.
- Evaluate the reporting level and analyze the sources of the reports. To find out the reporting structure, in other words, to identify what kind of participants are willing to or have reported near misses.

- Questionnaire. To find out whether the participants are familiar with the program, the definition, terminology, the procedure, collect their comments and recommendations, and evaluate their willingness to report.

U.S. National Academy (NA, 2003) stressed that experiences of operating and maintaining such a system, the outcomes of near-miss analysis regarding management failure and human elements, categorizing methods, cause analysis techniques, etc, in different industries are valuable for others. In this respect, sharing and advancing approaches for predicting, modeling, managing, and mitigating risk exposure based on precursor information will have cross-industry benefit.

In this way, the weakness of the program can be identified timely, certain solutions based on the evaluation can be developed for improving and up-dating the program.

Chapter VII: Conclusion

Marine incidents have the potential to cause significant loss of life and substantial environmental damage. Yet many incidents are often repeated before lessons are learned and any action is taken. Generally, some major accidents have been carried out in-depth investigation through which to clarify the basic, contributing and immediate causes to such accidents as well as identifying the appropriate measures to prevent the occurrence of similar events in the future, as Roed (2004, p.1) noted. Maritime industry has been criticized as being limited and reactive by solving yesterday's problems. Heinrich's pyramid revealed that behind a major accident there are 300 minor accidents or near-misses. A Near-miss is an unplanned and unforeseen event which does not cause injury or damage but which could result in injury or loss under different circumstances. It is argued that the only difference between near-miss and actual accident is luck. Considering Murphy's Law "if it can happen, it will happen." Near misses represent inexpensive learning opportunities for analyzing the strength and weakness of a system.

However, a number of near-misses were ignored and under-reported for various reasons: Be afraid of being punished, Work overload, safety bias, lack of resources, difficult to submit the report, business pressure, etc.

The near-miss program in maritime industry is intended to identify and neutralize factors could cause accidents or vessel trouble through a proactive, preventive approach. The

program focuses on system weaknesses and finding remedy actions, instead of blaming individual, as Bridges (2000) mentioned. The whole process is done under non-blame, confidential, independent manner, in order to protect reporters and encourage their reporting. It was also argued that in the longer term the culture of the industry would be such as to make confidential reporting unnecessary.

In order to cover more valuable opportunities, the program prefer to use a broad definition of near-miss, aiming to identify any incidents, unsafe behaviors, unsafe procedures, conditions, that have the potential to cause life injury(or loss), property damage(or loss), environmental damage, or that have caused such kinds of damage under the threshold of current reporting scheme. These collected data will be well classified and analyzed by skilled staff to find contributing factors, and recommended remedy actions will be developed and widely disseminated for future accident reduction.

This program can be considered as an important and integral part of a safety management system in maritime risk management, as Jacinto and Aspinwall (2003, p.7) said. It is a win-win strategy for everyone involved.

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