



GUIDANCE NOTES ON

**SAFETY CULTURE AND LEADING INDICATORS OF
SAFETY**

JANUARY 2012 (Updated February 2014 – see next page)

**American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862**

**© 2012 American Bureau of Shipping. All rights reserved.
1701 City Plaza Drive
Spring, TX 77389 USA**

Updates

February 2014 consolidation includes:

- January 2012 version plus Corrigenda/Editorials

Foreword

The mission of ABS is to serve the public interest, as well as the needs of its clients, by promoting the security of life, property, and the natural environment.

The importance of the development of a positive safety culture has been recognized for some time, particularly in large-scale systems where the consequences of losses can be severe.

In safety-critical systems, the use of leading indicators has been proposed to identify areas of weakness in advance of adverse events, affording the possibility of taking action to avoid losses. This is in contrast to lagging indicators, such as numbers of accidents or incidents, which give indications of past performance.

Based on work with ABS clients, these Guidance Notes provide guidance on the self-assessment of a marine organization's Safety Culture, and the development of a Leading Indicators Program.

These Guidance Notes are applicable to all cargo-carrying commercial vessels. Guidance is provided in the form of questionnaires, datasheets, techniques of analysis, and worked examples.

These Guidance Notes become effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of these Guidance Notes is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

Terms of Use

The information presented herein is intended solely to assist the reader in the methodologies and/or techniques discussed. These Guidance Notes do not and cannot replace the analysis and/or advice of a qualified professional. It is the responsibility of the reader to perform their own assessment and obtain professional advice. Information contained herein is considered to be pertinent at the time of publication, but may be invalidated as a result of subsequent legislations, regulations, standards, methods, and/or more updated information and the reader assumes full responsibility for compliance. This publication may not be copied or redistributed in part or in whole without prior written consent from ABS.



GUIDANCE NOTES ON

SAFETY CULTURE AND LEADING INDICATORS OF SAFETY

CONTENTS

CHAPTER 1	Introduction	1
	Section 1 General	2
CHAPTER 2	Safety Culture	8
	Section 1 Safety Factors	10
	Section 2 Administering the Survey	12
	Section 3 Analyzing the Responses	15
CHAPTER 3	Leading Indicators of Safety	22
	Section 1 The Leading Indicators Program	24
	Section 2 Safety Metrics	26
	Section 3 Safety Performance Data.....	30
	Section 4 Identifying Objective Leading Indicators	32
	Section 5 Identifying Subjective Leading Indicators	40
CHAPTER 4	Next Step.....	43
	Section 1 Interpreting the Results.....	45
	Section 2 Presenting the Findings	47
	Section 3 Utilizing the Findings.....	50
APPENDIX 1	Shipboard Safety Culture Questionnaire	57
APPENDIX 2	Shoreside Safety Culture Questionnaire.....	60
APPENDIX 3	Questionnaires and Safety Factors	63
APPENDIX 4	Safety Performance Datasheets.....	68
APPENDIX 5	Electronic Distribution	73
APPENDIX 6	References	75



CHAPTER 1 Introduction

CONTENTS

SECTION 1	General	2
1	Purpose.....	2
2	Background.....	2
2.1	Safety Performance.....	2
2.2	Safety Culture.....	2
2.3	Lagging Indicators of Safety.....	3
2.4	Leading Indicators of Safety.....	3
2.5	Key Performance Indicators.....	3
3	The ABS Safety Culture and Leading Indicators Model.....	3
4	Scope of the Guidance Notes.....	4
5	Contents of the Guidance Notes.....	5
6	Definitions.....	5
	FIGURE 1 The ABS Safety Culture and Leading Indicators Model.....	4



CHAPTER 1 Introduction

SECTION 1 General

1 Purpose

This document has been developed with the objective of improving safety performance in the management and operation of cargo-carrying commercial vessels. ABS provides this guidance in recognition of the beneficial effect that a positive safety culture can have on safety performance, and the part played by leading indicators in guiding action to improve safety performance. This document provides:

- i) Guidance to maritime organizations on the survey and assessment of their organizational safety culture, both onshore and at sea.
- ii) A process for identifying an organization's leading indicators of safety performance. Leading indicators are safety metrics associated with safety performance. Tracking and improving these metrics may help to maintain and improve safety performance.

The results from the survey, and/or any leading indicators, can be incorporated into the organization's ongoing continual improvement program.

2 Background

2.1 Safety Performance

The goal of the International Safety Management (ISM) Code, and of Safety Management Systems (SMSs) is the attainment of peak safety performance (i.e., no operational incidents, no personal injuries, and no harm to the environment), but the maritime industry is still some way from achieving this goal. Tools such as the ISM Code and SMSs undoubtedly aid compliance with regulation, but they do not necessarily improve safety culture.

There is a general recognition in the industry that encouraging safe working practices does not require more rules, regulations, and procedures. Instead, the industry needs a better understanding of the social and organizational factors that foster professionalism in the seafarer in routine and emergency situations.

2.2 Safety Culture

Original attempts to improve workplace safety, or to minimize risks, focused on the technical and engineering aspects of a system. The focus widened as the role of human error became clear and broadened even further with the publication of the report into the Chernobyl disaster (UNSCEAR, 1988). This report identified the absence of a safety culture as the major contributor to the disaster, and defined safety culture as "That assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, [nuclear plant] safety issues receive the attention warranted by their significance".

Subsequent reports into other major disasters produced similar findings. They too recognized the impact of safety culture on the outcome of safety performance, noting that most operational incidents are not solely the result of human error, technical failures, or environmental factors. Often there are more systemic organizational or managerial flaws (e.g., a fatal combination of failure of management, employees not performing their duties, and a breakdown in documented systems).

In all hazardous industries, it is now accepted good practice to have in place an SMS and to institutionalize safe working practices and attitudes through the development of a positive safety culture. There is a close relationship between an organization's safety culture and an SMS. An effective SMS has to take into account all factors that impact safety including the human and organizational; and conversely, the safety culture influences the way in which the SMS is implemented. Consequently, the assessment of safety culture and the SMS are complementary.

2.3 Lagging Indicators of Safety

Safety performance has traditionally been measured by 'after the loss' type of measurements such as accident and injury rates, incidents, and dollar costs. Lagging indicators characteristically:

- Identify trends in past performance
- Assess outcomes and occurrences
- Have a long history of use, and so are an accepted standard
- Are easy to calculate

In the aftermath of catastrophes, it is common to find prior indicators, missed signals, and dismissed alerts which, if they have been appropriately managed at the time, may have averted the disaster.

2.4 Leading Indicators of Safety

Over the past couple of decades, improved safety performance has been associated with a number of measurable activities in various industries, opening up the possibility that some of these metrics may be leading indicators for safety performance. Examples of metrics for these activities are size of safety budget, safety audit scores, number of safety inspections, number of safety meetings involving management, etc.

Leading indicators are safety culture metrics that are associated with, and precede, an undesirable/unexpected consequence such as an operational incident, near miss or personal injury. They can:

- Reveal areas of weakness in advance of adverse events
- Be associated with proactive activities that identify hazards
- Aid risk assessment and management

Leading Indicators are the most important safety culture metrics for the organization as they correlate with the organization's safety performance. ABS has developed a method for identifying potential leading indicators for improving safety performance.

2.5 Key Performance Indicators

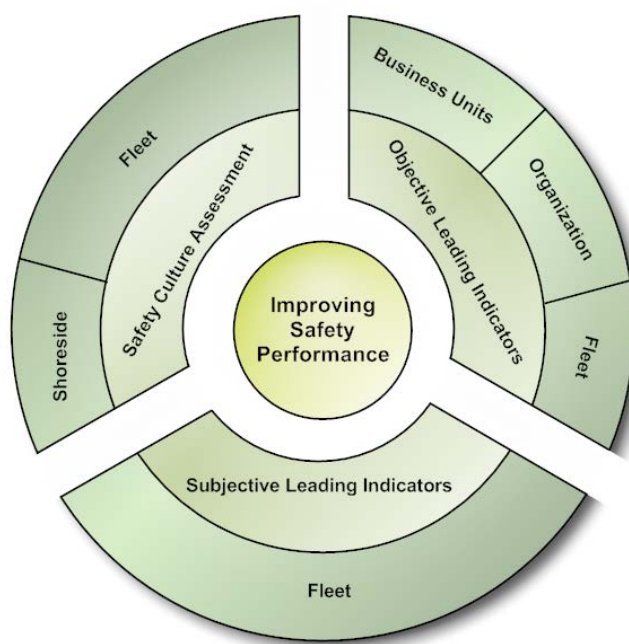
Leading indicators are frequently confused with key performance indicators (KPIs). KPIs are strongly associated with organizational peak performance which may, or may not, be safety-related. Examples of KPIs are: budgetary control per vessel, dry-docking planning performance, and vessel availability (Sleire, 1982). KPIs may be leading or lagging indicators. In contrast, leading indicators are always associated with safety.

3 The ABS Safety Culture and Leading Indicators Model

The central premise of the ABS Model, shown in 1-1/Figure 1, "The ABS Safety Culture and Leading Indicators Model", is that improvements in organizational safety culture can lead to enhanced safety performance. The first step is an assessment of the existing safety culture to identify areas of strength, weaknesses of defenses, and opportunities for improvement against operational incidents, personal injuries, etc.

This can be done using the ABS safety culture questionnaires supplied in these Guidance Notes in Appendices 1 and 2. Details of how to administer the survey and conduct the analysis are supplied in Chapter 2. The findings may reveal strengths which can be built upon, and any weaknesses that need rectifying. Chapter 4, Section 3 provides suggestions for utilizing the results in the organization's continual improvement program.

FIGURE 1
The ABS Safety Culture and Leading Indicators Model



The ABS Model also incorporates a process for identifying an organization’s potential leading indicators of safety. There are two ways of conducting this process:

- i) By the identification of *objective* leading indicators. This is done by correlating safety culture metrics with safety performance data. This is the preferred approach because of its objectivity; because it utilizes metrics that the organization has collected; and it does not require a survey of the workforce, which can be time-consuming. This can be done at three levels:
 - At the Organizational level
 - Across Business Units
 - Across the Fleet
- ii) By the identification of *subjective* leading indicators from a safety culture survey. These indicators are based on the values, attitudes, and observations of employees. This method may identify potentially beneficial safety culture metrics not yet tracked by the organization. This approach may be used when the organization lacks sufficient metrics to use the *objective* leading indicators process.

There are a number of criteria for undertaking a Leading Indicators Program, and for each type of assessment. For example, to undertake the organizational level analysis, the organization must have been collecting safety metrics for at least five years. The criteria are discussed fully in the appropriate sections.

4 Scope of the Guidance Notes

The focus of these Guidance Notes is on the self-assessment of an organization’s safety culture and the identification of that organization’s potential leading indicators of safety (i.e., a set of safety metrics that are correlated with safety performance in that organization.) Guidance is also provided on utilizing the findings as part of an organization’s ongoing continual improvement program.

5 Contents of the Guidance Notes

These Guidance Notes are organized as follows:

Chapter 2: Safety Culture

- *Section 1 Safety Factors* defines the safety factors (aspects of safety culture) such as communication and mutual trust, used in the assessment of safety culture in the ABS survey.
- *Section 2 Administering the Survey* outlines the planning and preparation to be undertaken.
- *Section 3 Analyzing the Responses* describes the data analysis to be done, with a worked example.

Chapter 3: Leading Indicators of Safety

- *Section 1 The Leading Indicators Program* provides background information about leading indicator of safety assessments.
- *Section 2 Safety Metrics* describes and categorizes the metrics used in the Leading Indicators Program.
- *Section 3 Safety Performance Data* describes and categorizes the safety performance data used in the Leading Indicators Program.
- *Section 4 Identifying Objective Leading Indicators*, presents the data analysis (correlation of safety metrics with safety performance data), with worked examples.
- *Section 5 Identifying Subjective Leading Indicators*, presents the data analysis (correlation of survey results with safety performance data), with a worked example.

Chapter 4: Next Step

- *Section 1 Interpreting the Results* discusses how to interpret the results obtained from the safety culture survey and from the leading indicators exercises.
- *Section 2 Presenting the Findings* presents basic information about presentation formats.
- *Section 3 Utilizing the Findings* provides guidance on interpreting the results and including them in a continual improvement program.

Appendices

- *Appendix 1* Presents the shipboard safety culture questionnaire.
- *Appendix 2* Presents the shoreside safety culture questionnaire.
- *Appendix 3* Presents the questionnaires categorized by safety factors, and the questions per safety factor.
- *Appendix 4* Presents the safety performance datasheets used the in Leading Indicators assessments.
- *Appendix 5* Provides summary guidance on how to distribute the safety culture survey electronically.

6 Definitions

These definitions were used in the development and piloting of the safety culture survey and Leading Indicators Program described in these Guidance Notes.

Accidents: Undesired events that result in personal injury.

Conditions of Class: The number of deficiencies identified, or recommendations made, by the classification society's surveyor on a vessel.

Conditions of Class (Frequencies): The total number of conditions of class multiplied by 100, divided by the number of port calls of that vessel in the last year.

Data Sub-Setting: The reduction of large datasets to subsets that are more manageable and/or contain only the data that an analyst needs to perform a particular analysis.

First Aid Case (FAC): Minor work-related injuries only requiring simple first aid treatment.

First Aid Case Frequency (FACF): The total first aid injury cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Kruskal-Wallis Test: This is an extension of the Mann–Whitney U Test to three or more groups. It is used as an alternative to one-way analysis of variance when the data is not normally distributed.

Lagging Indicators: Measures of a system taken after events to assess outcomes and occurrences, such as accident and injury rates, operational incidents, and dollar costs.

Leading Indicators: The National Academy of Engineering defines leading indicators as conditions, events, and sequences that precede and lead up to accidents (NAE, 2004). In essence, leading indicators are defined as conditions, events or measures that precede an undesirable event, and have some value in predicting the arrival of the event, whether it is an accident, incident, near miss, or undesirable safety state (Toellner, 2001).

Likert: The most widely used scale in survey research. Respondents indicate their level of agreement with a statement, usually on a five-point scale.

Lost Time Incident of 24 Hours or More (LTI \geq 24 hrs): Any work-related injury other than a fatal injury that results in a person being unfit for work for a period of 24 continuous hours immediately after the occurrence of the incident.

Lost Time Incident Frequency (LTIF): The total Lost Time Incidents multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Mann-Whitney U Test: This is a non-parametric test to determine whether two samples of data could have come from the same population. The Mann-Whitney U test determines the number of times a score from one of the samples is ranked higher than a score from the other sample.

Medical Treatment Case (MTC): Work-related injuries that are not severe enough to be reported as fatalities, Lost Time Incident, or Restricted Work Accident cases but are more severe than requiring simple first aid treatment; however the injured person is able to carry out all his duties after treatment.

Medical Treatment Case Frequency (MTCF): The total medical treatment cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Metrics: A set of measurements that quantify or qualify aspects of a system (here, organizational safety performance).

Near Miss (NM): An event, or a chain of events, that under slightly different circumstances could have resulted in an accident, injury, damage, or loss of personnel, equipment, or the vessel.

Near Miss Frequency (NMF): The total number of near miss cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Non-parametric Test: A non-parametric statistical test that does not require scores on the outcome variable to be normally distributed.

Operational Incidents: Events that include steering failures, propulsion failures, navigational equipment failures, collisions, groundings, or other navigational or equipment failures.

Operational Incidents (Frequency): The total number of operational incidents multiplied by 100, divided by the number of port calls in the last year.

Port State Deficiencies: The number of deficiencies on a vessel identified by Port State Control.

Port State Deficiencies (Frequency): The total number of port state deficiencies multiplied by 100, divided by the number of port calls of that vessel in the last year.

Principal Components Analysis (PCA): A statistical technique used to reduce the number of variables to a subset that retains most of the substantive information in the original set.

Restricted Work Accident (RWA): Any work-related injury (other than a fatality or lost time incident) that results in a person being unfit to perform all of his/her regular job after the accident.

Restricted Work Accident Frequency (RWF): The total restricted work accident cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Safety Culture: 1. That assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, [nuclear plant] safety issues receive the attention warranted by their significance. (UNSCEAR, 1988). 2. The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management. (ACSNI, 1991).

Safety Climate: A snapshot of the organization taken at a certain point in time, usually obtained by a safety culture survey. Safety climate sometimes refers to local (group) subculture.

Spearman Rank Correlation: The Spearman's rank correlation coefficient, or Spearman's rho, is designed to measure the relationship between two ordered sets of ranks. It is similar to Pearson's Correlation, except Pearson's uses values instead of ranks.

Total Recordable Cases (TRC): The sum of all work-related fatalities, lost time incidents, restricted work accidents and medical treatment cases. $TRCs = LTIs + RWAs + MTCs$.

Total Recordable Case Frequency (TRCF): The total recordable cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Within Groups Analysis: An analysis of a subset of the study participants. For example, an analysis of the differences in job position of one nationality.



CHAPTER 2 Safety Culture

CONTENTS

SECTION 1	Safety Factors.....	10
1	Introduction	10
2	Safety Factor Descriptions.....	10
2.1	Communication.....	10
2.2	Empowerment	10
2.3	Feedback.....	10
2.4	Mutual Trust.....	11
2.5	Problem Identification	11
2.6	Promotion of Safety	11
2.7	Responsiveness	11
2.8	Safety Awareness.....	11
3	Safety Factor Codes	11
	TABLE 1 Safety Factors and Their Codes	11
SECTION 2	Administering the Survey	12
1	Introduction	12
2	Planning	12
2.1	Costs and Benefits.....	12
2.2	Distribution Issues	12
3	Preparation.....	13
3.1	Prepare Employees	13
3.2	Prepare the Questionnaires	13
3.3	Distribute the Questionnaires	14
3.4	Collect Completed Questionnaires	14
SECTION 3	Analyzing the Responses	15
1	Introduction	15
2	Analyses.....	15
2.1	Demographic Analysis	15
2.2	Shipboard versus Shoreside Analysis	15
2.3	Within Groups Analysis.....	15
2.4	Qualitative Analysis of the Free Text Questions	16
3	Preparation.....	16
4	Statistical Testing.....	16
4.1	Outline of Method	16
4.2	The Mann Whitney U Test.....	17

5	Worked Example.....	18
TABLE 1	The Mann Whitney U Test	17
TABLE 2	Critical Values for Larger <i>n</i>	21



CHAPTER 2 Safety Culture

SECTION 1 Safety Factors

1 Introduction

Safety factors are important dimensions of a safety culture, such as effective communications or safety awareness. There is no agreed way to segment safety culture and so no definitive set of safety factors exists. Many sets have been developed; all unique in some way, but broadly similar. Examples include: Ryan (1991); The International Civil Aviation Organization (1993); Dufort & Infante-Rivard, (1998); Zimolong & Elke, (2006).

The set of eight safety factors used in the ABS Safety Culture Survey and the Leading Indicators Program described in these Guidance Notes was derived during ABS-funded research conducted with leading clients in the maritime industry.

The ABS safety culture questionnaire contains forty statements; five statements about each safety factor which participants are asked to rate. The responses are analyzed for differences (or agreement) by job position, age, length of service, shoreside staff versus shipboard crews, etc. Suggestions for improving aspects of safety culture (safety factors) are presented in Chapter 4, Section 3, “Utilizing the Findings”.

2 Safety Factor Descriptions

The different safety factors used in ABS’ research are listed below along with descriptions of the intent of each safety factor.

2.1 Communication

Communications are open and effective: Healthy communication channels exist vertically and horizontally within the organization. Managers and masters are prepared to listen as well as speak. Everyone has, and understands, all the information required for safe operations. Communication channels are monitored for their effectiveness.

2.2 Empowerment

Individuals feel empowered to successfully fulfill their safety responsibilities: The organization provides clear delegation of, and accountability for, safety-related responsibilities. Each member of the workforce is provided the authority and resources to allow success in his/her assigned roles. Each member of the workforce accepts and fulfills his/her individual safety responsibilities. Management expects and encourages the sharing of safety concerns by everyone in the organization.

2.3 Feedback

Management responses to safety issues and concerns are timely: Priority is placed on the timely communication of, and response to, outcomes of incident investigations, audits etc., to the workforce. Mismatches between practices and procedures (or standards) are resolved in a timely manner to prevent normalization of deviance. The workforce is encouraged to raise safety concerns, which are resolved in a timely manner.

2.4 Mutual Trust

Relationships are characterized by mutual trust: Members of the workforce trust managers to “do the right thing” in support of safety, and are expected to shoulder their share of responsibility for performance, and to report potential problems and concerns. Employees trust the motivations and behaviors of peers. There is confidence that a just system exists where honest errors can be reported without fear of reprisals.

2.5 Problem Identification

Potential problems are readily identified: Each member of the workforce has experience, and/or training, in how to recognize unsafe acts and conditions, and how to take steps to avoid or mitigate them.

2.6 Promotion of Safety

Managers promote safety as a core value: Managers lead in promoting safety as a core value in the organization. Visible, active, and consistent support for safety programs and objectives exists at all levels of management within the organization. Managers are seen to be committed to doing what is right, demonstrating their values through their communications, actions, priorities, and provision of resources. This value cascades down through all levels of the organization.

2.7 Responsiveness

Crew members are responsive to the demands of the job, including unexpected events and emergencies: Crew members are encouraged to get adequate rest between shifts to maximize their alertness and readiness to respond during their work periods. All crew members are provided with emergency preparedness training and full personal protection equipment (PPE).

2.8 Safety Awareness

A strong sense of safety awareness pervades the organization: Each member of the workforce has an awareness of his/her responsibilities with regard to safety to self, co-workers, the organization, and to the environment. All employees feel accountable for their own actions, and collectively for the actions of their colleagues/crew. There is a strong individual and group intolerance for violations of established safety performance norms.

3 Safety Factor Codes

The codes for each safety factor are shown in 2-1/Table 1, “Safety Factors and Their Codes”.

TABLE 1
Safety Factors and Their Codes

<i>Safety Factor</i>	<i>Codes</i>
Communication	COM
Empowerment	EMP
Feedback	FDB
Mutual Trust	MTR
Problem identification	PID
Promotion of safety	POS
Responsiveness	RSP
Safety awareness	SAW

In Appendix 3, “Questionnaires and Safety Factors”, the statements are presented with their corresponding safety factor codes; and shown in their safety factor groupings.



CHAPTER 2 Safety Culture

SECTION 2 Administering the Survey

1 Introduction

This Section of these Guidance Notes details the planning and preparation required for successful administration of the safety culture survey to crew on board vessels, and to employees who are shoreside.

2 Planning

These are the issues that should be considered during the decision-making process of determining whether or not to proceed with a safety culture survey.

2.1 Costs and Benefits

Undertaking a survey can be costly, so the costs and benefits should be carefully appraised before proceeding.

2.1.1 Costs

This is a labor-intensive exercise, which requires a particular skill-set, including:

- Good organizational and administrative skills to supervise the process
- Purchase of software tools and statistics packages (if required)
- Knowledge of social science statistics, especially the Mann-Whitney U Test
- Experience of using statistics packages and/or spreadsheets
- Cost of employees' time completing the survey

2.1.2 Benefits

- The identification of areas of excellence
- The identification of areas where there are opportunities for improvement
- Foundation for a program to address areas where there are opportunities for improvement
- Public demonstration of management commitment to safety

2.2 Distribution Issues

Once the decision has been made to carry out a survey, the distribution format needs to be determined. The choices are paper-based, electronic, or a mixture of both (e.g., a web-based electronic distribution for shoreside staff and paper-based for vessels). Appendix 5, "Electronic Distribution" discusses the issues of electronic distribution. The considerations for paper-based distribution include:

- Decide when to run the survey. It is inadvisable to launch a safety culture survey when the organization is in a state of flux (e.g., during company acquisitions or mergers, as the culture will be affected), or in the aftermath of fatalities or serious injuries. The survey should be allowed to run for at least four weeks.
- Determine who will be taking the survey, and which ships and offices to include. The Shoreside Safety Culture Questionnaire should be answered by staff who work on the Operations Desks, or in the Fleet Management Department, or who are knowledgeable about fleet management.

- iii)* Determine the purpose of the survey. Aim to include as many employees as possible, including crew on shore-leave. However, note that where the survey responses are used for a Subjective Leading Indicators Program, only crew responses from vessels are used. Responses from crew on shore-leave, and shoreside employees are NOT included as the correlations for leading indicators are done by the vessel, not by individuals.
- iv)* Estimate the number of copies required; and where and when they are to be printed.
- v)* Decide who is to be responsible for the distribution.
- vi)* Determine how the questionnaires will be distributed to the ships and offices, and how they will be collected.
- vii)* Consider confidentiality issues such as the provision of envelopes for sealed responses, and who will have access to the responses, etc.

3 Preparation

Once a decision has been made to proceed, detailed preparations are required to facilitate a smooth process.

3.1 Prepare Employees

- i)* Employees should be given at least four weeks' advance notice of the safety culture survey and encouraged to participate. This applies to crew on board vessels as well as shoreside.
- ii)* Ideally, the announcement should come from senior management, and the importance of participation should be reinforced via other communications. For example, place an interview with senior management in the company newsletter.
- iii)* It is important that the masters understand the importance of the survey, as it will be their responsibility to announce, explain, and encourage participation in the survey.
- iv)* The workforce should be told that the reason for the survey is to find out where the organization should focus on making improvements to its safety culture.
- v)* Let the workforce know that the survey can be completed in fifteen minutes.
- vi)* Let the workforce know what to expect (e.g., that it covers safety culture on board vessels, health and safety, and job characteristics, plus some demographic questions necessary for conducting the analysis).
- vii)* Employees should be told that participation in the survey is voluntary and it will be undertaken during working time at the organization's expense.
- viii)* Let employees know that their replies are anonymous and treated confidentially.

3.2 Prepare the Questionnaires

The survey is undertaken using the questionnaires shown in Appendix 1, "Shipboard Safety Culture Questionnaire" and Appendix 2, "Shoreside Safety Culture Questionnaire".

- i)* Determine that the terminology in the questionnaires is familiar to the workforce. The definitions of terms used in the questionnaires are provided in Section 1, "Introduction". It may be beneficial to provide definitions and examples with the questionnaire to prevent any misunderstanding.
- ii)* Provide a list of departments, job positions etc. to standardize choice.
- iii)* Each ship will need a unique identifier for Section D Question 6 (Shipboard Safety Culture Questionnaire). This could be ship name or ship email address.
- iv)* Crew who are on shore leave should be told to answer Section D Question 6 with "SL" indicating they are currently ashore.
- v)* Print sufficient numbers of copies of each questionnaire.

- vi)* Prepare a covering letter for the survey. This letter should include instructions such as the need to answer ALL questions; direction to choose the “Don’t Know” response where a question is unclear or inapplicable, and the end date for the survey. Emphasize that the questionnaire can be answered in fifteen minutes.
- vii)* Provide a large self-sealing envelope for the return of each questionnaire.

3.3 Distribute the Questionnaires

- i)* Include the covering letter with the instructions.
- ii)* There are two questionnaires in the survey, which are complementary. The questions cover the same ground but are framed differently. The questionnaires are shown in Appendix 1, “Shipboard Safety Culture Questionnaire” and Appendix 2, “Shoreside Safety Culture Questionnaire”.
- iii)* Allow one month for responses.
- iv)* Ten days before the end of the survey, send a reminder.
- v)* Be prepared to extend the deadline, if more time is needed.

3.4 Collect Completed Questionnaires

- i)* Somebody in each office should be given responsibility for the collection of the sealed envelopes shoreside and for sending them to the analyst.
- ii)* Provide clear instructions to the ships as to where to send the responses.



CHAPTER 2 Safety Culture

SECTION 3 Analyzing the Responses

1 Introduction

This Section describes the analysis methodology step-by-step. Worked examples are included to aid understanding of principles but it is recommended that a statistics package, or other computer support, is utilized as undertaking statistics by hand can be very laborious.

2 Analyses

There are two questionnaires, one for the shoreside staff and one for crew members. Each questionnaire contains forty statements that are identical, or equivalent. Respondents indicate their level of agreement to a statement on a five-point scale, known as a Likert scale.

2.1 Demographic Analysis

This analysis is performed to determine any difference in responses on the basis of:

- Age
- Gender
- Nationality
- Job position
- Experience with this organization
- Experience in the maritime industry
- Experience in your current position

2.2 Shipboard versus Shoreside Analysis

This analysis is performed to determine any perceived safety culture difference (i.e., difference in responses to the forty Likert statements) between crew on vessels and shoreside staff.

2.3 Within Groups Analysis

This analysis is performed to determine any difference in responses within each demographic group identified in 2-3/2.1, “Demographic Analysis”. For example, statistical analysis may indicate safety culture differences between crewmembers based on nationality. However, further analysis may need to be performed to determine if this difference is a function of nationality per se or some other factor such as job position. Within group analyses include:

- Job position within nationality
- Job position within experience level
- Job position within age group
- Job position within gender
- Nationality within experience level

- Nationality within age group
- Nationality within gender
- Age group within experience level
- Age group within gender
- Gender within experience level

2.4 Qualitative Analysis of the Free Text Questions

The questionnaires conclude with four questions asking for suggestions to improve safety culture. As the responses are free text, statistical analysis cannot be done. The responses should be carefully collated in terms of recurring themes, good ideas, etc. These findings should be presented to senior management together with the main findings from the statistical analysis.

3 Preparation

The following list contains actions which should be included in preparation for data analysis.

- i) After receiving raw data, develop a plan to format data based on spreadsheet (or statistical package) requirements for analyses.
- ii) Import the response data into spreadsheet software.
- iii) Keep original raw dataset intact and use a copy for sanitization, (i.e., removing any identifying information).
- iv) Sanitize the copy to remove any reference to vessel name, office, and individual employee or crew member.
- v) Keep sanitized dataset intact, and use another copy for analysis.
- vi) Have as few analysts as possible handling the data to reduce error and promote consistent methods and analyses.
- vii) Keep number of dataset files to a minimum, use proper and standardized folder/file names, and have dates on all files.
- viii) Assign one individual to keep all files ('central storage').
- ix) Do not assign one analysis to more than one individual.

4 Statistical Testing

4.1 Outline of Method

A Mann-Whitney U Test is performed for *each* comparison of the demographic factors: age, gender, nationality, job position, and length of time in the organization, in the maritime industry, in the current job, and two groups of workers (shipboard and shoreside). An extension of the Mann-Whitney U Test, called a Kruskal-Wallis Test, can be used for the Within Groups Analysis.

The example described here is for two groups of workers (shipboard and shoreside) and the sixth Likert statement. The steps are repeated for each of the remaining thirty-nine Likert statements. When all responses to the forty Likert statements have been analyzed in terms of shipboard and shoreside workers, the responses to the Likert statements are analyzed in terms of another demographic factor (e.g., nationality).

- i) Establish the hypothesis for the test. The null hypothesis is that there is no difference in shipboard and shoreside response to the statement: "This company has excellent maintenance standards".
- ii) Subset the data in spreadsheet or statistical package of choice. Data sub-setting reduces large datasets to subsets that are more manageable or contain only the set of data that an analyst needs to perform a particular analysis.

- iii) Assign indicator variable (e.g., ‘1’ for shipboard and ‘2’ for shoreside).
- iv) Perform Mann-Whitney U Test (see 2-3/4.2).
- v) Find the average of the responses to show which group (shipboard or shoreside) answered more positively or more negatively.
- vi) Create graphs and output in spreadsheet or statistical package of choice. See Chapter 4, Section 2 “Presenting the Findings”.
- vii) Treat missing data as a “don’t know” response providing this occurs in <5% of the responses. If it occurs in >5% of the responses, exclude this data from the analysis.

4.2 The Mann Whitney U Test

2-3/Table 1, “The Mann Whitney U Test” presents the instructions for running the Mann Whitney U Test where the sample size > 20. A different formula is used for smaller sample sizes – not included here because the sample size (number of people surveyed) will be more than twenty.

TABLE 1
The Mann Whitney U Test

<i>Step</i>	<i>Instructions</i>
1	Assign an unique identifier to the data from each sample, (e.g., use color coding, different fonts, or place identifiers in the adjacent columns).
2	Combine the scores for the two sets of data and sort in ascending order.
3	Assign a rank to each score (i.e., assign “1” to lowest score; “2” to the next lowest score, and so on).
4	Average those ranks that appear more than once. For example, if two scores are equal and would have been ranked in first and second place, the two positions are added together (1 + 2 = 3) and divided by the number of scores (2) to give a ranking of “1.5” for both scores.
5	Sum the average ranks of the smaller sample. If the samples are different sized, assign the indicator n_1 to the smaller sample and n_2 to the larger sample. If they are the same size, it does not matter how they are identified.
6	The Mann-Whitney U statistic is calculated by the following formula, where n_1 represents the smaller sample and n_2 the larger sample: $U = (n_1 \times n_2) + \frac{n_1 \times (n_1 + 1)}{2} - \text{summed rank of } n_1$
7	Calculate the U value for the second sample using the following formula: $U \text{ of second sample} = (n_1 \times n_2) - U \text{ for first sample}$ <p>Note that the two U values combined equal the product of the number of cases in the two samples.</p>

TABLE 1 (continued)
The Mann Whitney U Test

Step	Instructions
8	<p>Use this step when samples sizes are large and there are no ties ($n_1 > 20$ or $n_2 > 20$). U approaches a normal distribution, so the U value can be transformed into a Z value by using the following formula:</p> $Z = \frac{U - (n_1 \times n_2) / 2}{\sqrt{[(n_1 \times n_2)(n_1 + n_2 + 1)] / 12}}$ <p>Where U is the smaller of the two values.</p>
9	<p>Use this step when there are many ties of ranks in the two samples. Z should include the correction factor:</p> $\sum T = \sum \frac{t_i^3 - t_i}{12}$ <p>where t is the number of scores for a given rank.</p> <p>If, for example, there are two scores of rank 4, three scores of rank 2, and four scores of rank 1, then $t_i = 2, 3,$ and 4. This correction factor is incorporated into the equation for the Z transformation.</p> $Z = \frac{U - \frac{n_1 \times n_2}{2}}{\sqrt{\left(\frac{n_1 \times n_2}{(n_1 + n_2)^2 - (n_1 + n_2)} \right) \left(\frac{(n_1 + n_2)^3 - (n_1 + n_2)}{12} - \sum T \right)}}$ <p>The correction factor raises the value of Z by a small amount, which may be important when the sample statistic is near a critical value.</p>
10	<p>Because the test statistic U is the smaller U of the two samples, the null hypothesis is rejected when the specific value of z is smaller than the critical value in the left tail of the Z distribution ($< -z_\alpha$ for a one-tailed test or $z^* < -z_{\alpha/2}$ or $z^* > z_{\alpha/2}$ for a two tailed test) where z^* stands for the calculated value and z_α is the tabulated value. Normal distribution table can be used for comparison.</p>

5 Worked Example

A safety culture survey is undertaken in a marine organization. Two groups of workers (shipboard and shoreside) participate in this survey. Responses to the statement, “This company has excellent maintenance standards” are tabulated on a five-point Likert scale as:

<i>Disagree</i>	<i>Slightly Disagree</i>	<i>Neutral</i>	<i>Slightly Agree</i>	<i>Agree</i>	<i>Don't Know</i>
1	2	3	4	5	0

There are 21 responses from the ships and 6 responses from the shoreside:

<i>Shipboard</i>	<i>Shoreside</i>
5	3
3	2
3	4
4	1
2	5
1	4
2	
3	
5	
4	
5	
4	
3	
2	
3	
1	
5	
5	
3	
2	
4	

The objective is to test if there is a difference in the shoreside and shipboard responses (at a 95% confidence level) that cannot be attributed to chance.

Steps 1, 2, 3: Rank the scores of both the samples together, using rank 1 for the lowest score, rank 2 for the next lowest score and so on.

Step 4: Average the ranks where the same value occurs more than once.

For example, in the table below, there are three scores of 1, corresponding to ranks 1, 2, and 3. The sum of 1, 2, and 3, is 6. Since there are three scores, divide 6 by 3, resulting in 2. Assign a new “averaged” score (for the purpose of statistical computation) of 2 to each of these (raw score = 1).

Similarly, for raw scores of 2, add the corresponding ranks (4 through 8) to get a sum of 30, divide this by 5 (since there are 5 scores of 2). Each raw score has a corresponding “averaged” score of 6.

<i>Raw Score</i>	<i>Rank</i>	<i>Averaged</i>
1	1	2
1	2	2
1	3	2
2	4	6
2	5	6
2	6	6
2	7	6
2	8	6
3	9	14
3	10	14
3	11	14
3	12	14
3	13	14
3	14	14
3	15	14
4	16	18.5
4	17	18.5
4	18	18.5
4	19	18.5
4	20	18.5
4	21	18.5
5	22	24.5
5	23	24.5
5	24	24.5
5	25	24.5
5	26	24.5
5	27	24.5

Step 5: Sum the ranks for the smaller sample (shoreside).

<i>Shoreside Scores</i>	<i>Averaged Ranks</i>
3	14
2	6
4	18.5
1	2
5	24.5
4	18.5
Sum of ranks = 83.5	

Step 6: The Mann-Whitney U statistic is calculated by the following formula where n_1 represents the smaller sample size and n_2 the larger sample size:

$$U = (n_1 \times n_2) + \frac{n_1 \times (n_1 + 1)}{2} - \text{summed rank of } n_1$$

For this example:

$$U = (6 \times 21) + \frac{6 \times (7)}{2} - 83.5$$

$$U = 63.5$$

Step 7: Calculate the U value for the second sample using the following formula:

$$U \text{ of second sample} = (n_1 \times n_2) - U \text{ for first sample}$$

$$U \text{ of second sample} = (6 \times 21) - 63.5 \text{ for first sample} = 62.5$$

Step 8: This step is not necessary because there are many ties.

Step 9: Calculate the Z -statistic using formula given in step 9. In this example, $\sum T = 75$ results in:

$$Z = \frac{62.5 - \frac{6 \times 21}{2}}{\sqrt{\left(\frac{6 \times 21}{(6 + 21)^2 - (6 + 21)} \right) \left(\frac{(6 + 21)^3 - (6 + 21)}{12} - 75 \right)}}$$

$$= -0.02985$$

Step 10: Consider a two-tailed test with a 95% confidence level $z_{\alpha/2} = 1.96$ (see 2-3/Table 2). Since the obtained z (-0.02985) is larger than the value of z in the normal distribution table, it can be concluded that there is insufficient evidence to reject the null hypothesis. Therefore, a statistically significant difference has not been found between the shoreside and the shipboard staff in their perception that the company has excellent maintenance standards.

TABLE 2
Critical Values for Larger n

<i>Level of Confidence</i>	<i>$z_{\alpha/2}$</i>
0.80	1.28
0.85	1.44
0.90	1.645
0.95	1.96
0.98	2.33
0.99	2.575

Chapter 4, Section 1 will help in interpreting the results of this analysis.



CHAPTER 3 Leading Indicators of Safety

CONTENTS

SECTION 1	The Leading Indicators Program.....	24
1	Introduction	24
2	Criteria for Undertaking a Leading Indicators Program	24
3	Costs and Benefits.....	24
3.1	Costs	24
3.2	Benefits.....	25
4	Types of Leading Indicators.....	25
4.1	Objective Indicators	25
4.2	Subjective Indicators.....	25
TABLE 1	Advantages and Disadvantages of Objective Leading Indicators.....	25
TABLE 2	Advantages and Disadvantages of Subjective Leading Indicators.....	25
SECTION 2	Safety Metrics	26
1	Introduction	26
2	Types of Safety Metrics	26
2.1	Baseline Metrics	26
2.2	Subsidiary Metrics	26
2.3	Core Metrics	26
TABLE 1	Safety Factors and Baseline Metrics	27
TABLE 2	Safety Factors and Subsidiary Metrics	28
TABLE 3	Safety Factors and Core Metrics	28
FIGURE 1	The Metrics Hierarchy	26
SECTION 3	Safety Performance Data	30
1	Introduction	30
2	Organizational Level Safety Performance Data.....	30
3	Business Unit Safety Performance Data	30
4	Vessel Safety Performance Data.....	31
TABLE 1	Safety Performance Data for the Organization.....	30
TABLE 2	Safety Performance Data for the Business Units (BUs)	31
TABLE 3	Safety Performance Data for Each Vessel	31
TABLE 4	Normalizing Safety Performance Data.....	31

SECTION 4	Identifying Objective Leading Indicators	32
1	Introduction	32
2	General Approach	32
2.1	Safety Metrics	32
2.2	Safety Performance Data	32
2.3	Correlating Safety Metrics with Safety Performance Data	33
2.4	Assessing Significance	33
2.5	Delayed Effect Variations	34
3	Worked Examples	34
3.1	Organizational Analysis Over Time	34
3.2	Across Business Units	37
3.3	Across the Fleet	38
TABLE 1	Instructions for Spearman's Rho Correlation	33
TABLE 2	Critical Values of Spearman's Rho (Two-Tailed)	34
TABLE 3	Correlation at the Organizational Level ($n = 10$, no ties)	35
TABLE 4	Correlation at the Organization Level	36
TABLE 5	Critical Values for Larger n (Spearman Rho Coefficient)	37
TABLE 6	Correlation Across Business Units	38
TABLE 7	Correlation Across the Fleet	39
SECTION 5	Identifying Subjective Leading Indicators	40
1	Introduction	40
2	Method	40
2.1	Average the Responses for Each Vessel	40
2.2	Prepare the Safety Performance Data	40
2.3	Correlate the Responses and Safety Performance Data	40
3	Worked Example	40
3.1	Average the Responses for Each Vessel	41
TABLE 1	Likert Scale	41
TABLE 2	Subjective Leading Indicators Example	42



CHAPTER 3 Leading Indicators of Safety

SECTION 1 The Leading Indicators Program

1 Introduction

The purpose of a Leading Indicators Program is to identify which safety metrics are most strongly associated with safety performance in a particular organization. This information can be used to guide actions to improve future safety performance. This Section introduces the basic concepts and principles of a Leading Indicators Program.

2 Criteria for Undertaking a Leading Indicators Program

The Leading Indicators approach to improving safety performance is likely to be most effective when the technical aspects of safety are performing adequately and the majority of operational incidents and accidents appear to be due to human error or organizational factors. The Leading Indicators approach is therefore only open to organizations that fulfill a number of specific criteria:

- The organization is compliant with all relevant regulations.
- Human error or organizational factors are causing the majority of operational incidents or personal injuries.
- The organization has a genuine desire to prevent operational incidents and personal injuries and is not solely driven by the avoidance of prosecution.
- The organization is relatively stable, not in the middle of mergers, acquisitions or significant reorganizations.

If an organization does not meet these criteria, then it is not ready for a Leading Indicators Program. In addition, the organization must also meet one of the following criteria, depending on which leading indicators assessment is to be undertaken:

- An objective leading indicators assessment of the organization requires that safety metrics must have been collected for some time: at least five years for an organizational level analysis, and at least one year for the business unit level, or across the fleet.
- A subjective leading indicators assessment requires that a safety culture survey is performed and the results utilized.

3 Costs and Benefits

As with the safety culture survey, a Leading Indicators Program also needs adequate resources. Some of the associated costs and benefits are discussed below.

3.1 Costs

- Resources to retrieve the safety metrics and safety performance data
- Employees' time
- Knowledge of Spearman's rho statistics test
- Extensive experience of using statistics packages or spreadsheets
- Purchase of statistics package, if necessary

3.2 Benefits

- Helps to identify what actions have been, or could be, successful in improving safety
- Can improve understanding of whether or not goals are being met
- Provides a tool for prioritization and a basis for improving effectiveness of safety-related expenditure and allocation of resources
- Raises employee awareness of safety-related issues
- Can identify areas of strength and weakness

4 Types of Leading Indicators

Leading indicators are safety metrics that correlate with safety performance for a given organization. They can be objective or subjective measures.

4.1 Objective Indicators

These are safety metrics that are objective measures, numbers, frequencies, etc. 3-1/Table 1, “Advantages and Disadvantages of Objective Leading Indicators” shows the advantages and disadvantages of this approach.

TABLE 1
Advantages and Disadvantages of Objective Leading Indicators

<i>Advantages</i>	<i>Disadvantages</i>
Utilizes metrics that have been collected by the organization	Does not identify new metrics for collection
Analysis is relatively straightforward	May not be suitable to capture the quality of the safety system in place

At the organizational level analysis, at least five years of data is required. Analysis can also be undertaken at the business unit level, and the fleet level with only one year’s data.

4.2 Subjective Indicators

These are crew values, attitudes, and opinions correlated with safety performance across the fleet. 3-1/Table 2, “Advantages and Disadvantages of Subjective Leading Indicators” shows the advantages and disadvantages of this approach.

TABLE 2
Advantages and Disadvantages of Subjective Leading Indicators

<i>Advantages</i>	<i>Disadvantages</i>
May give rise to new metrics that were not previously collected.	Requires a safety culture assessment as it utilizes the responses.
Can be identified even though the organization has not collected any metrics.	The responses require conversion to metrics suitable for inclusion in a Continual Improvement Program
	They are subjective which makes them difficult to quantify



CHAPTER 3 Leading Indicators of Safety

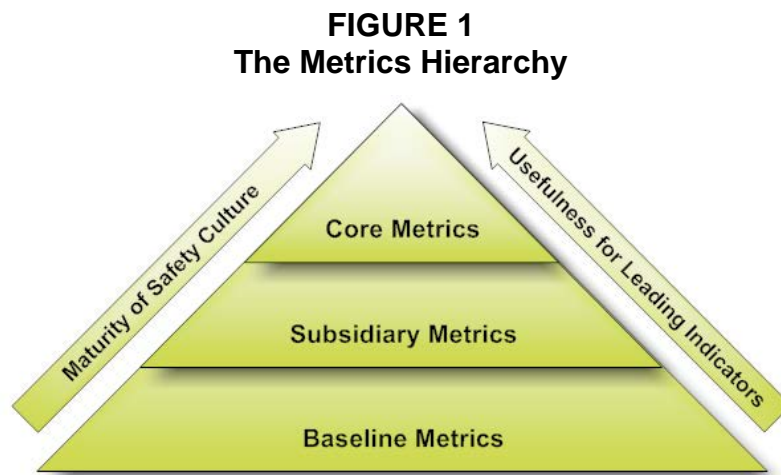
SECTION 2 Safety Metrics

1 Introduction

Objective leading indicators are identified by correlating safety metrics with safety performance data. The process is detailed in Chapter 3, Section 4, “Identifying Objective Leading Indicators”. This Section introduces different types of safety metrics.

2 Types of Safety Metrics

ABS research has identified three types of metrics that have different levels of usefulness for inclusion in a leading indicators program. These are shown in 3-2/Figure 1, “The Metrics Hierarchy”.



2.1 Baseline Metrics

Baseline metrics form the backbone of a safety culture and should be collected. However, because they are expressed as absolutes – the presence or absence of an activity (and not as ratios, frequencies, etc.), they are unsuitable for inclusion in a Leading Indicators Program. They are shown in 3-2/Table 1, “Safety Factors and Baseline Metrics”.

2.2 Subsidiary Metrics

Subsidiary metrics, shown in 3-2/Table 2, “Safety Factors and Subsidiary Metrics”, are useful in a leading indicators program until they peak, which they may do as the safety culture takes root. For example, once “Percentage of crew who have PPE” consistently attains 100%, it is no longer useful as a metric for correlating with safety performance.

2.3 Core Metrics

The core set of metrics, shown in 3-2/Table 3, “Safety Factors and Core Metrics”, are eminently suitable for inclusion in a Leading Indicators Program by all organizations ready to initiate such a program.

TABLE 1
Safety Factors and Baseline Metrics

<i>Safety Factors</i>	<i>Baseline Metrics</i>
Communication	Provision of a communications training program Provision of a company newsletter Provision of bulletins, toolbox talks, or similar regarding lessons learned or alerts regarding incidents that could have fleet-wide application Provision for making safety communications available in native languages Provision of an anonymous reporting system Provision of communications of safe work practices Provision of two-way communication Provision of new hire training EHS policy and goals are communicated with the crew
Empowerment	Presence of clear documented accountabilities for safety Presence of a means for crew involvement in safety improvement Presence of a means for crew influence in safety improvement Presence of an off-the-job safety training program Establishment of a safety committee that includes a vertical slice of the organization
Feedback	Presence of an employee suggestion/feedback program Presence of a crew feedback system concerning near misses and hazard identifications Presence of a feedback system to crew on safety audits, issues and concerns Periodic employee opinion/attitude surveys Presence of a crew feedback system concerning shipboard meetings concerning safety
Mutual Trust	Presence of documented policies that prevent unethical behavior in the organization Establishment of a fair system for incident investigation Presence of an internship training program Presence of a documented hiring policy and procedures Presence of an interviewer training program
Problem Identification	A policy in place mandating safety procedures, instructions, or rules for all jobs A policy and/or procedures for reporting unsafe conditions Update period policy for safety checklists Policy to complete pre-operational checks exist
Promotion of Safety	Presence of safety budget Safety budget is not reduced due to operational budget Presence of safety goals Presence of a procedure that makes all incident investigation findings available to employees Presence of an induction training program that meets the requirements of the STCW code Procedures to identify and impart any training required in support of safety management systems Senior management attend safety meetings Presence of maintenance budget Maintenance budget is not reduced due to operational budget
Responsiveness	Provision of PPE for crew Presence of a training program for emergencies Creation of metrics for resolution of safety concerns Procedures to enable crew to get scheduled rest/time off duty
Safety Awareness	Documented procedures for effective ship and watch hand-overs Provision of a training program for hazard/risk assessment

TABLE 2
Safety Factors and Subsidiary Metrics

<i>Safety Factors</i>	<i>Subsidiary Metrics</i>
Communication	Number of mechanisms for communicating safety to employees (e.g., newsletters, toolbox talks, meetings, training, incident findings) Percentage of safety training in native languages Frequency of safety meetings Frequency of toolbox talks
Empowerment	Number of job procedures that require modification due to safety concerns, per employee Percentage of employees receiving ALL safety training
Feedback	Percentage of safety reports on which feedback was provided Number of mechanisms by which safety is communicated from employees to management (e.g., suggestion boxes) Percentage of safety suggestions on which feedback was provided Percent of employees who have their performance appraised annually
Mutual Trust	Percentage of employees receiving ethics training Percentage of procedures provided in native language of crew, as well as English
Problem Identification	Number of hazard analysis techniques utilized Percentage of jobs that have safety checklists Average update period of safety checklists Average update period of standard operating procedures Number of safety inspections per annum Percentage of jobs requiring pre-operational checks if pre-operational check is required Number of corrective action reports (CARs) originating from audits
Promotion of Safety	Frequency of safety meetings attended by senior management Percentage of crew receiving feedback on safety audits, issues, and concerns Percentage of new hires put through a formal induction process Percentage of time schedules affect crew/vessel safety Percentage of safety meetings attended by senior management Number of safety management meetings
Responsiveness	Percentage of correction action reports (CARs) closed out within 6-9 months Percentage of employees provided with ALL PPE Percentage of safety concerns that are addressed within 3 months
Safety Awareness	Number of safety performance indicators utilized Percentage attendance at safety meetings

TABLE 3
Safety Factors and Core Metrics

<i>Safety Factors</i>	<i>Core Metrics</i>
Communication	Percentage of employees receiving communication training Budget for communicating safety to employees (e.g., newsletters, toolbox talks, meetings, training, incident findings)
Empowerment	Percentage of employees with accident investigation training Percentage of safety training that includes competency testing
Feedback	Percent of performance appraisal based on safety related matters
Mutual Trust	Average turnover rate (%) Average length of stay in organization Average absenteeism Percent increase in crew staffing per vessel

**TABLE 3 (continued)
 Safety Factors and Core Metrics**

<i>Safety Factors</i>	<i>Core Metrics</i>
Problem Identification	Percentage of accidents reported per employee Number of safety audits completed per year Number of safety inspections per year Percentage of incident reports on which causal analysis was undertaken Number of completed safety inspection/monitor/audit/review activities vs. planned in the past year
Promotion of Safety	Percentage increase in annual safety budgets from previous year Percentage of employees receiving onboard or in-service training Percentage of closure for CARs over three months' old Percentage of total operational budget allocated to safety items Number of training hours logged Average number of safety training sessions logged per employee
Responsiveness	Average time to implement action on complaints or suggestions Number of safety audit recommendations closed out in time Percentage of maintenance items completed on time in the past year Percentage of maintenance items that have been postponed in the past year
Safety Awareness	Number of safety suggestions submitted per employee Percentage of incidents reported per employee Number of job hazard analyzes conducted per employee Percentage of time a Job Safety Analysis (JSA), Project Safety and Health Review (PSHR) (or similar) was conducted when there were changes to jobs, tasks, or equipment in the past year Number of near misses reported per employee



CHAPTER 3 Leading Indicators of Safety

SECTION 3 Safety Performance Data

1 Introduction

Objective leading indicators are identified by correlating safety metrics with safety performance data. The process is detailed in Chapter 3, Section 4, “Identifying Objective Leading Indicators”. This Section introduces the safety performance data required. The safety performance datasheets, for collection of the safety performance, are in Appendix 4, “Safety Performance Datasets”.

All of the safety performance data requires normalization before statistical analysis, to enable valid comparisons of vessels on different routes, etc. This is shown in 3-3/Table 4 “Normalizing Safety Performance Data”.

2 Organizational Level Safety Performance Data

The safety performance data for the organizational level covers both operational data and health and safety; this is shown in 3-3/Table 1 “Safety Performance Data for the Organization”. Raw data can be normalized using 3-3/Table 4 “Normalizing Safety Performance Data”.

TABLE 1
Safety Performance Data for the Organization

<i>Operations Data for the Organization</i>	<i>Health and Safety Data for the Organization</i>
Operational Incidents Frequencies	Total Recordable Cases Frequency for the fleet
Near Miss Frequencies	Lost Time Incidents Frequency for the fleet
Conditions of Class Frequencies	Medical Treatment Case Frequency for the fleet
Port State Deficiencies Frequencies	Restricted Work Accident Frequency for the fleet
	First Aid Case Frequency for the fleet

3 Business Unit Safety Performance Data

The safety performance data for the business units covers both operational data and health and safety. This is shown in 3-3/Table 2 “Safety Performance Data for the Business Units (BUs)”. Raw data can be normalized using 3-3/Table 4 “Normalizing Safety Performance Data”.

TABLE 2
Safety Performance Data for the Business Units (BUs)

<i>BU Operations Data</i>	<i>Health and Safety Data for the BU</i>
Operational Incidents Frequencies	Total Recordable Cases Frequency for the BU
Near Miss Frequencies	Lost Time Incidents Frequency for the BU
Conditions of Class Frequencies	Medical Treatment Case Frequency for the BU
Port State Deficiencies Frequencies	Restricted Work Accident Frequency for the BU
	First Aid Case Frequency for the BU

4 Vessel Safety Performance Data

The safety performance data for the vessels covers both operational data and health and safety. This is shown in 3-3/Table 3 “Safety Performance Data for each Vessel”. Raw data can be normalized using 3-3/Table 4 “Normalizing Safety Performance Data”.

TABLE 3
Safety Performance Data for Each Vessel

<i>Vessel Operations Data</i>	<i>Health and Safety Data for the Vessel</i>
Operational Incidents Frequencies	Total Recordable Cases Frequency for the vessel
Near Miss Frequencies	Lost Time Incidents Frequency for the vessel
Conditions of Class Frequencies	Medical Treatment Case Frequency for the vessel
Port State Deficiencies Frequencies	Restricted Work Accident Frequency for the vessel
	First Aid Case Frequency for the vessel

TABLE 4
Normalizing Safety Performance Data

<i>Data Type</i>	<i>Normalizing Factor</i>	<i>Result</i>
Lost Time Incidents (LTI)	The total Lost Time Incidents in the last year multiplied by 1 million, and divided by the number of exposure hours in the last year.	Lost Time Incident Frequency (LTIF)
Restricted Work Accidents (RWA)	The total Restricted Work Accidents in the last year multiplied by 1 million, and divided by the number of exposure hours in the last year.	Restricted Work Accident Frequency (RWAFF)
Total Recordable Cases (TRC)	The total recordable cases in the last year multiplied by 1 million, and divided by the number of exposure hours in the last year.	Total Recordable Case Frequency (TRCF)
Medical Treatment Case (MTC)	The total medical treatment cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.	Medical Treatment Case Frequency (MTCF)
First Aid Case (FAC)	The total first aid injury cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.	First Aid Case Frequency (FACF)
Near misses	The total number of near misses in the last year multiplied by 1 million, and divided by the number of exposure hours in the last year.	Near Miss Frequency (NMF)
Operational incidents	The total number of operational incidents in the last year multiplied by 100, and divided by the number of port calls in the last year.	Operational Incidents Frequency
Port State Deficiencies	The total number of port state deficiencies in the last year multiplied by 100, and divided by the number of port calls in the last year.	Port State Deficiencies Frequency
Conditions of class	The number of conditions of class on a vessel in the last year multiplied by 100, then divided by the number of port calls of that vessel in the last year	Conditions of Class Frequency



CHAPTER 3 Leading Indicators of Safety

SECTION 4 Identifying Objective Leading Indicators

1 Introduction

Objective leading indicators are identified by correlating safety metrics with safety performance data. This approach is the preferred approach because it is objective, and it does not rely on survey responses which are needed for the subjective leading indicators approach described in Chapter 3, Section 5, “Identifying Subjective Leading Indicators”.

The objective leading indicators program can be done at three levels:

- The organization
- The business units (or other appropriate units such as offices, countries, regions)
- The fleet

The methods for each are described below, together with worked examples to aid understanding.

2 General Approach

The organization’s safety metrics are correlated with its safety performance data using the Spearman’s rho test. Significant safety metrics are the organization’s leading indicators. Each safety metric belongs to a safety factor grouping. Suggestions for improving safety factors in the organization are given in Chapter 4, Section 3, “Utilizing the Results”.

2.1 Safety Metrics

- Choose safety metrics from the Core Metrics set and the Subsidiary set in Chapter 3, Section 2, “Safety Metrics”.
- Baseline metrics are not suitable for a leading indicators exercise.
- Other metrics that the organization has collected may also be suitable; as the lists in Chapter 3, Section 2, “Safety Metrics”, are not exhaustive.

2.2 Safety Performance Data

- Collect safety performance data. This is detailed in Chapter 3, Section 3, “Safety Performance Data”.
- The datasheets for data collection are presented in Appendix 4, “Safety Performance Datasheets”.
- Normalize all data as shown in Chapter 3, Section 3, “Safety Performance Data”.
- The safety metrics and safety performance data must cover the same time period.

2.3 Correlating Safety Metrics with Safety Performance Data

The statistical testing is undertaken to ascertain which (if any) of the safety metrics are significantly correlated with the safety performance data. As the data does not come from a normal distribution, the non-parametric measure of statistical dependence between two variables (Spearman’s rank correlation coefficient) is used. The steps of this test are outlined in 3-4/Table 1, “Instructions for Spearman’s Rho Correlation”.

TABLE 1
Instructions for Spearman’s Rho Correlation

<i>Step</i>	<i>Instructions</i>
1	Construct a table with two sets of categories (e.g., number of safety meetings and TRCF), and rank the order of each category in an adjacent column.
2	Subtract the ranks and enter the difference in the next column under d_i (differences)
3	Square the differences (to eliminate negatives) and enter the products (values) in another column under d_i^2 (squared differences)
4	Sum the squared differences (sum column 7)
5	Insert $\sum d_i^2$ (the value obtained from Step 4) and n (numbers of subjects) in the formula provided to compute the coefficient. $\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$
6	To determine if the <i>rho</i> coefficient is statistically significant compare the magnitude of <i>rho</i> versus the value obtained from the look-up table (3-4/Table 2). A worked example is attached for $n = 10$.
7	When the number of pairs (n) is > 30 , the look-up table cannot be used. This formula is used instead: $\rho = \frac{\pm z}{\sqrt{n-1}}$ <p>where the value of z corresponds to the standard normal confidence level. For example, if the confidence level is 95%, z will equal 1.96. If the obtained <i>rho</i> is larger than the critical <i>rho</i> (in 3-4/Table 2), reject the null hypothesis and conclude that there is a significant relationship between the two variables at the 95% confidence level. A worked example is presented for $n = 39$.</p>

2.4 Assessing Significance

Compare the obtained value for *rho* with the value in the appropriate column, taking into account the number of paired scores. When n is not mentioned in the table, use the nearest smaller n (e.g., for 17, use 16).

TABLE 2
Critical Values of Spearman’s Rho (Two-Tailed)

<i>Number of Pairs (n)</i>	<i>95% Confidence Level</i>
5	1
6	0.886
7	0.786
8	0.738
9	0.683
10	0.648
12	0.591
14	0.544
16	0.506
18	0.475
20	0.450
22	0.428
24	0.409
26	0.392
28	0.377
30	0.364

2.5 Delayed Effect Variations

It is possible to try to ascertain if the introduction of an action or activity correlates with a decrease in accidents or operational incidents, etc., in the following year. In this case, the Spearman’s rho rank correlation test should be performed on each year’s safety metrics with the following year’s safety performance data. An even greater delayed effect can be investigated, for example two years’ delay, where the metrics and safety performance data are available.

3 Worked Examples

3.1 Organizational Analysis Over Time

Organizational analysis over time is the primary application of the Objective Leading Indicators Assessment method.

3.1.1 Select Safety Culture Metrics

Safety culture metrics to be analyzed were selected from the Core Metrics and Subsidiary Metrics lists in Chapter 3, Section 2, “Safety Metrics”.

3.1.2 Collect Organizational Safety Performance Data

Safety performance data for the organization was collected using the organizational safety performance datasheet provided in Appendix 4, “Safety Performance Datasheets”. The data was normalized using 3-3/Table 4, “Normalizing Safety Performance Data”. The metrics and safety performance data covered the same timeframe.

3.1.3 Correlate Metrics with Safety Performance Data

Step 1: Populate column 2 with the first metric: Number of safety management meetings; and ranks in column 3.

Populate column 4 with the first safety performance data (3-3/Table 4): Total Recordable Case Frequency (TRCF) and ranks in column 5.

Step 2: Subtract the ranks (column 5 from column 3) and enter the difference in column 6 under d_i (differences).

Step 3: Square the differences (to eliminate negatives) and enter the products in column 7.

Step 4: Sum the squared differences (in column 7). Sum $d_i^2 = 328$

TABLE 3
Correlation at the Organizational Level ($n = 10$, no ties)

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Date (i)	No. of meetings	Rank	TRCF	Rank	d_i	d_i^2
2009	52	10	5.3	2	8	64
2008	50	9	5.2	1	8	64
2007	44	7	6.1	4	3	9
2006	47	8	6.0	3	5	25
2005	32	4	7.2	7	-3	9
2004	36	5	7.0	6	-1	1
2003	38	6	6.6	5	1	1
2002	25	2	7.7	9	-7	49
2001	26	3	7.4	8	-5	25
2000	22	1	7.8	10	-9	81
Total						328

Step 5: Insert the values for d_i^2 (328) and n (10) in the formula provided to compute the coefficient.

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} = 1 - \frac{6 \times 328}{10(10^2 - 1)}$$

The resulting coefficient is -0.9879

Step 6: With a sample of size 10, the critical value (in 3-4/Table 2, “Critical Values of Spearman’s Rho”) for rejecting the null hypothesis at the 0.05 level is 0.648. The obtained value for the Spearman rho is -0.9879. Ignore the sign and compare absolute values only. As $\rho(0.9879) > \rho(0.648)$ reject the null hypothesis. That is, a significant (inverse) relationship exists between these two variables; as one variable increases the other decreases.

Using the same safety metric, the statistical analysis is repeated with the rest of the safety performance data. Once all of the safety performance data has been correlated with the first safety metric, the second safety metric is used, until all safety metrics have been tested with all safety performance data.

3.1.4 Worked Example ($n > 30$)

As stated in Step 7 of 3-4/Table 1, “Instructions for Spearman Rho Correlation”, when $n > 30$, a formula is used to compute the critical value to assess the statistical significance of the rho coefficient. In this example, there are ties in the data, and $n = 39$.

Follow Steps 1 to 5 in the instructions in 3-4/Table 1, “Instructions for Spearman Rho Coefficient”. Using the formula $\sum d_i^2 = 11254$, the resulting coefficient = -0.13907.

Skip Step 6 and instead use the formula provided in Step 7 to compute the critical rho value.

For instance, for a level of confidence of 95%, z will = 1.96 and $\rho = \frac{1.96}{\sqrt{39-1}} = 0.31$.

Since (calculated) < (critical value in 3-4/Table 2) the null hypothesis must be accepted. This means that the two variables are not significantly related.

For additional critical values of level of confidence, please refer to 3-4/Table 5, “Critical Values for Larger n (Spearman Rho Coefficient)”.

TABLE 4
Correlation at the Organization Level

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
<i>Date (i)</i>	<i>No. of meetings</i>	<i>Rank</i>	<i>TRCF</i>	<i>Rank</i>	<i>d_i</i>	<i>d_i²</i>
2009	52	39	5.3	2	37	1369
2008	50	38	5.2	1	37	1369
2007	44	36	6.1	5.5	30.5	930.25
2006	47	37	6	3.5	33.5	1122.25
2005	32	26.5	7.2	17.5	9	81
2004	36	33.5	7	13	20.5	420.25
2003	38	35	6.6	9.5	25.5	650.25
2002	25	14	7.7	22	-8	64
2001	26	16.5	7.4	20.5	-4	16
2000	22	7	7.8	23	-16	256
1999	22	7	6	3.5	3.5	12.25
1998	21	4	6.1	5.5	-1.5	2.25
1997	20	2	6.2	7	-5	25
1996	18	1	6.4	8	-7	49
1995	23	10	6.6	9.5	0.5	0.25
1994	21	4	6.8	11	-7	49
1993	25	14	7	13	1	1
1992	30	21.5	7.1	15.5	6	36
1991	32	26.5	7.4	20.5	6	36
1990	31	23.5	7.3	19	4.5	20.25
1989	32	26.5	7.2	17.5	9	81
1988	33	29.5	7.1	15.5	14	196
1987	34	31	7	13	18	324
1986	35	32	8	24.5	7.5	56.25
1985	36	33.5	8.1	26	7.5	56.25
1984	21	4	8.2	27.5	-23.5	552.25
1983	22	7	8.3	29.5	-22.5	506.25
1982	23	10	8.4	31.5	-21.5	462.25
1981	23	10	8.5	33.5	-23.5	552.25
1980	24	12	8.6	35	-23	529
1979	25	14	8.7	36	-22	484
1978	26	16.5	8	24.5	-8	64
1977	27	18	8.2	27.5	-9.5	90.25
1976	28	19	8.3	29.5	-10.5	110.25
1975	29	20	8.4	31.5	-11.5	132.25
1974	30	21.5	8.5	33.5	-12	144
1973	31	23.5	9	37	-13.5	182.25
1972	32	26.5	9.1	38	-11.5	132.25
1971	33	29.5	9.2	39	-9.5	90.25
Total						11254

TABLE 5
Critical Values for Larger n (Spearman Rho Coefficient)

<i>Level of Confidence</i>	$z_{\alpha/2}$
0.80	1.28
0.85	1.44
0.90	1.645
0.95	1.96
0.98	2.33
0.99	2.575

3.2 Across Business Units

This analysis requires that there are at least five business units that can be compared.

3.2.1 Select Safety Culture Metrics

Select safety culture metrics to be analyzed from the Core Metrics and Subsidiary Metrics lists in Chapter 3, Section 2, “Safety Culture Metrics”.

3.2.2 Collect Organizational Safety Performance Data

Collect safety performance data for the organization using the Business Unit safety performance datasheet provided in Appendix 4, “Safety Performance Datasheets”. Normalize the data using 3-3/Table 4, “Normalizing Safety Performance Data”. The metrics and safety performance data must cover the last available, consecutive, 12 months.

3.2.3 Correlate Metrics with Safety Performance Data

Step 1: Populate column 2 with the first metric: Number of safety management meetings; and record their ranks in column 3.

Populate column 4 with the first safety performance data: TRCF, and the ranks in column 5.

Step 2: Subtract the ranks (column 5 from column 3) and enter the difference in column 6 under d_i (differences).

Step 3: Square the differences (to eliminate negatives) and enter the products in column 7.

Step 4: Sum the squared differences (in column 7). Sum $d_i^2 = 66$

Step 5: Insert $d_i^2 = 66$ and n (numbers of subjects) (6) in the formula provided to compute the coefficient.

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} = 1 - \frac{6 \times 66}{6(6^2 - 1)}$$

The resulting coefficient is -0.8857

TABLE 6
Correlation Across Business Units

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
<i>BU (i)</i>	<i>No. of meetings</i>	<i>Rank</i>	<i>TRCF</i>	<i>Rank</i>	<i>d_i</i>	<i>d_i²</i>
BU 1	50	5	5.1	2	3	9
BU 2	45	4	5.7	4	0	0
BU 3	38	2	6.0	6	-4	16
BU 4	30	1	5.8	5	-4	16
BU 5	52	6	5.0	1	5	25
BU 6	40	3	5.2	3	0	0
Total						66

With a sample size of 6 (number of pairs), the critical value (3-4/Table 2) for rejecting the null hypothesis at the 0.05 level is 0.886. The obtained value for the Spearman rho is (-)0.8857 (only compare the magnitude not the direction of the resulting coefficient). Since $\rho(0.8857) < \rho(0.886)$ do not reject the null hypothesis and conclude that there is no significant relationship between the two variables. Even though the correlation appears to be strong, the sample size ($n = 6$) is too small to be sure that the two variables are significantly related.

Using the same safety culture metric, the statistical analysis is repeated with the rest of the safety performance data. Once all of the safety performance data has been correlated with the first safety culture metric, the second safety culture metric is used, until all safety culture metrics have been tested with all safety performance data.

3.3 Across the Fleet

This analysis can be undertaken where the metrics for each ship are retained separately.

3.3.1 Select Safety Culture Metrics

Select safety culture metrics to be analyzed from the Core Metrics and Subsidiary Metrics lists in Section 5: Safety Culture Metrics.

3.3.2 Collect Organizational Safety Performance Data

Collect safety performance data for the organization using the vessel safety performance datasheet provided in Appendix 4, “Safety Performance Datasheets”. Normalize the data using 3-3/Table 4, “Normalizing Safety Performance Data”. The metrics and safety performance data must cover the last available, consecutive, 12 months.

3.3.3 Correlate Metrics with Safety Performance Data

Step 1: In this worked example the fleet has 14 vessels, numbered 1–14.

Populate column 2 with the first safety culture metrics for each vessel (number of safety management meetings); and records their ranks in column 3.

Populate column 4 with the first safety performance data (TRCF) and their ranks in column 5.

Rank the 14 scores, and insert in Column 3.

Step 2: Subtract the ranks (column 5 from column 3) and enter the difference in the column 6 under d_i (differences).

Step 3: Square the differences (to eliminate negatives) and enter the products in column 7.

Step 4: Sum the squared differences (in column 7). Sum $d_i^2 = 888$

Sum $d_i^2 = 888$. Insert 888 into the formula below and n (number of vessels) = 14.

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} = 1 - \frac{6 \times 888}{14(14^2 - 1)}$$

The resulting coefficient is -0.9516.

TABLE 7
Correlation Across the Fleet

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
<i>Vessel No. (i)</i>	<i>No. of meetings</i>	<i>Rank</i>	<i>TRCF</i>	<i>Rank</i>	<i>d_i</i>	<i>d_i²</i>
1	21	3	5.0	11	-8	64
2	38	14	1.0	3	11	121
3	35	12	0.75	2	10	100
4	20	2	6.5	14	-12	144
5	36	13	0.5	1	12	144
6	18	1	6.0	13	-12	144
7	29	8	4.0	9	-1	1
8	32	10	1.5	4	6	36
9	22	4	5.5	12	-8	64
10	28	7	3.0	7	0	0
11	25	5	3.5	8	-3	9
12	33	11	2.0	5	6	36
13	26	6	4.5	10	-4	16
14	31	9	2.5	6	3	9
Total						888

3-4/ Table 2 shows that the critical value for rejecting the null hypothesis for a sample size of 14 is 0.544. The obtained value for the Spearman rho is (-)0.9516. Ignore the minus sign as it is the magnitude not the direction that is of interest here. As $0.9516 > 0.544$, reject the null hypothesis. This means that a significant relationship exists between these two variables. The minus sign means that the relationship is inverse, so as the number of safety meetings increases, the number of TRCF decreases.

Using the same safety metric, the statistical analysis is repeated with the rest of the safety performance data. Once all of the safety performance data has been correlated with the first safety metric, the second safety culture metric is used, until all safety metrics have been tested with all safety performance data.



CHAPTER 3 Leading Indicators of Safety

SECTION 5 Identifying Subjective Leading Indicators

1 Introduction

Subjective leading indicators are identified by correlating survey responses with safety performance data for the last twelve months. This Section details the method and a worked example to aid comprehension.

This method can be undertaken if the organization does not have sufficient safety metrics to look for objective leading indicators. The identification of objective leading indicators is the preferred approach. The subjective leading indicators approach is more speculative and so should only be undertaken following a survey, with the responses readily available. This approach does offer the possibility of identifying new metrics for the organization to collect.

2 Method

2.1 Average the Responses for Each Vessel

Find the arithmetic mean for the responses to the statements. Do this for all of the forty statements, for each and every vessel. Treat missing responses as “don’t know” for up to 5% of the total responses. Where missing responses comprise more than 5% of the responses, exclude that individual’s response for that question from the analysis.

2.2 Prepare the Safety Performance Data

At the same time, collect the safety performance data. One year’s data is required. This should be the most recent data available, preferably for the last twelve months, averaged to yield a single annual figure. Use the safety performance datasheet for Vessels. The safety performance sheet is in Appendix 4, “Safety Performance Datasheets”. All data should be normalized as shown in 3-3/Table 4, “Safety Performance Data”.

2.3 Correlate the Responses and Safety Performance Data

Once all of the safety culture responses and safety performance data are prepared, the statistical analysis can begin. The data does not come from a normal distribution, so the non-parametric test Spearman’s rho for ranked correlations is used. The steps used for the correlation are the same as those shown in 3-4/Table 1, “Instructions for Spearman’s Rho Correlation”.

Spearman correlation analysis should be performed for each averaged vessel safety culture question response with each variable of the collected safety performance data.

3 Worked Example

The crews aboard a fleet of 14 vessels were given the safety culture questionnaire. In principle, this is how the results would be analyzed. In practice, this labor-intensive exercise would be undertaken with the aid of electronic tools.

3.1 Average the Responses for Each Vessel

Step 1: Construct a table as shown in 3-5/Table 2, “Subjective Indicators’ Example”.

Populate column 2 with the average (arithmetic mean) of the responses to the first statement. Let us assume that the results for Vessel No. 13 are returned first. Vessel No. 13 has a crew of 20 (who all completed the survey) so there are 20 responses to Statement No. 1:

“When ship management is told about accidents, incidents or near misses, corrective action is taken promptly.”

These 20 responses are shown on the 5-point Likert Scale in 3-5/Table 1, “Likert Scale”. Note the value of the ratings for each category, shown in brackets in the top row. In this example:

- 1 crew member disagreed with the statement
- 5 crew members slightly disagreed with the statement
- 3 crew members were neutral about the statement
- 7 crew members slightly agreed with the statement
- 4 crew members agreed with the statement, and
- None of the crew chose “don’t know”

**TABLE 1
Likert Scale**

	<i>Disagree (1)</i>	<i>Slightly Disagree (2)</i>	<i>Neutral (3)</i>	<i>Slightly Agree (4)</i>	<i>Agree (5)</i>	<i>Don't Know (0)</i>
Row 1	1	5	3	7	4	0
Row 2	1	10	9	28	20	0

Row 1 shows the ratings given by the 20 crew members.

Row 2 shows those ratings multiplied by the value of their position on the Likert scale (1 × 1; 5 × 2; 3 × 3; 7 × 4; 4 × 5).

The arithmetic mean is found by adding the scores in Row 2 (1 + 10 + 9 + 28 + 20) = 68, and dividing by the number of crew members (20). Mean = 3.4

Insert those results in the 2nd column of the table below, for Vessel No. 13. Find the arithmetic mean for statement No. 1 for the rest of the fleet and finish populating Column 2.

Rank the 14 scores, and insert in Column 3. The ranking used here runs from low to high. Either rankings (low-to-high or high-to-low) can be used, but whichever way is chosen must be applied equally to both variables.

At the same time, collect the safety performance data for the most recent twelve months. Use the safety performance datasheet for Vessels. Average the twelve month’s data to give one annual figure for each entry. Normalize the data using 3-3/Table 4, “Normalizing Safety Performance Data”.

Start the analysis with (normalized) Total Recordable Case Frequency (TRCF) for the previous 12 months. Insert those results in column 4, and their ranks in column 5.

Step 2: Subtract the ranks (column 3 – column 5) and enter the difference in column 6 under d_i (differences).

Step 3: Square the differences (to remove negative numbers) and enter the products in d_i^2 (column 7).

Step 4: Sum the squared differences (in column 7). Sum $d_i^2 = 888$.

TABLE 2
Subjective Leading Indicators Example

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
<i>Vessel No. (i)</i>	<i>1st Statement</i>	<i>Rank</i>	<i>TRCF</i>	<i>Rank</i>	<i>d_i</i>	<i>d_i²</i>
1	3.25	3	5.0	11	-8	64
2	3.90	14	1.0	3	11	121
3	3.70	12	0.75	2	10	100
4	3.20	2	6.5	14	-12	144
5	3.80	13	0.5	1	12	144
6	3.15	1	6.0	13	-12	144
7	3.50	8	4.0	9	-1	1
8	3.60	10	1.5	4	6	36
9	3.30	4	5.5	12	-8	64
10	3.45	7	3.0	7	0	0
11	3.35	5	3.5	8	-3	9
12	3.65	11	2.0	5	6	36
13	3.40	6	4.5	10	-4	16
14	3.55	9	2.5	6	3	9
Total						888

Insert 888 (for d_i^2) and 14 (for n , number of vessels) into the formula below.

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} = 1 - \frac{6 \times 888}{14(14^2 - 1)}$$

The resulting coefficient is -0.9516.

With a sample of size of 14, the critical value for rejecting the null hypothesis at the 0.05 level is 0.544. The obtained value for the Spearman rho is (-)0.9516 (compare only the magnitude not the direction of resulting coefficient). As 0.9516 > 0.544 reject the null hypothesis. That is, a significant (inverse) relationship between these two variables. This means that as the belief that corrective action is taken promptly when ship management is told about accidents, incidents or near misses, increases so the TRCF decreases for those ships.

Staying with Question 1 on the safety culture survey, this exercise is repeated with the next safety performance results (e.g., accidents), (i.e., delete the entries in columns 4-7 and populate the accident data, ranks, differences and sum of differences). Use the formula to find the coefficient.

When all of the safety performance results have been correlated with Question 1 on the safety culture survey, repeat all of this analysis on Statement No. 2 of the safety culture survey. Repeat with the rest of the statements until all forty statements on the safety culture survey have been analyzed. This labor-intensive exercise is greatly facilitated by the use of a statistics package.



CHAPTER 4 Next Step

CONTENTS

SECTION 1	Interpreting the Results	45
1	Introduction	45
2	Interpreting the Safety Culture Results.....	45
3	Interpreting the Leading Indicators Results	45
SECTION 2	Presenting the Findings	47
1	Introduction	47
2	Presentation Formats.....	47
2.1	Pie Charts.....	47
2.2	Bar Charts	48
2.3	Interval Plots.....	48
2.4	Line Graphs.....	49
FIGURE 1	Example of a Pie Chart (Location on Ship).....	47
FIGURE 2	Example of a Bar Chart (Job Position)	48
FIGURE 3	Example of Interval Plots (Shipboard vs. Shoreside Responses).....	48
FIGURE 4	Example of a Line Graph (Showing Leading Indicator Findings)	49
SECTION 3	Utilizing the Findings	50
1	Introduction	50
2	Action Plan.....	50
3	Communication	51
3.1	Desired Activities, Attitudes, and Behaviors	51
3.2	Possible Activities for Improvement.....	51
4	Empowerment.....	52
4.1	Desired Activities, Attitudes, and Behaviors	52
4.2	Possible Activities for Improvement.....	52
5	Feedback	52
5.1	Desired Activities, Attitudes, and Behaviors	52
5.2	Possible Activities for Improvement.....	52
6	Mutual Trust	53
6.1	Desired Activities, Attitudes, and Behaviors	53
6.2	Possible Activities for Improvement.....	53

7	Problem Identification	54
7.1	Desired Activities, Attitudes, and Behaviors	54
7.2	Possible Activities for Improvement	54
8	Promotion of Safety	54
8.1	Desired Activities, Attitudes, and Behaviors	54
8.2	Possible Activities for Improvement	54
9	Responsiveness.....	55
9.1	Desired Activities, Attitudes, and Behaviors	55
9.2	Possible Activities for Improvement	55
10	Safety Awareness	55
10.1	Desired Activities, Attitudes and Behaviors	55
10.2	Possible Activities for Improvement	56



CHAPTER 4 Next Step

SECTION 1 Interpreting the Results

1 Introduction

This Section discusses how to interpret the significance of the results obtained for both the safety culture survey and the leading indicators analysis. Statistical hypothesis testing is stated in terms of the null hypothesis.

The null hypothesis for a test of difference (here the Mann Whitney U Test) is that there is no difference between the two groups being investigated. If the null hypothesis is disproved, then there is a significant difference between the two groups. The groups under investigation are any of the demographic factors listed in 2-3/2.1.

The null hypothesis for a test of correlation (here the Spearman's rho Test) is that the two groups being investigated are not correlated. If the null hypothesis is disproved, then there is a statistically significant correlation between the two groups.

In the case of the Objective Leading Indicators, the two groups are safety metrics and safety performance data.

In the case of the Subjective Leading Indicators, the two groups are responses on the safety culture survey averaged for each vessel, and each vessel's safety performance data for the previous twelve months.

2 Interpreting the Safety Culture Results

In the safety culture survey, the responses of various demographic groups are subjected to statistical analysis to see if they are significantly different. The null hypothesis is that the groups' responses are similar and any differences are due to chance.

Since the data is non-normal, a non-parametric test known as Mann-Whitney test has been used to analyze the safety culture data. Considering a two-tailed test with a 95% confidence level, the obtained value of z has been compared with the tabulated value. The null hypothesis is accepted when the obtained z is larger than the value of z in the normal distribution table, and it is rejected when the obtained value of z is smaller than the tabulated value.

3 Interpreting the Leading Indicators Results

The purpose of a correlation test is to determine if the ordering of the two columns of data (safety metrics or safety culture responses to safety performance data) is significant. The null hypothesis states that there is no significant association of the ordering.

The test used is the Spearman's rho test as the data is non-parametric. The sign of the Spearman correlation indicates the direction of association between X (the independent variable) and Y (the dependent variable). If Y tends to increase when X increases, the Spearman correlation coefficient is positive. If Y tends to decrease when X increases, the Spearman correlation coefficient is inverse.

A Spearman correlation of zero indicates that there is no tendency for Y to either increase or decrease when X increases. The Spearman correlation increases in magnitude as X and Y become closer to being perfectly correlated. When X and Y are perfectly correlated, the Spearman correlation coefficient becomes 1 for a perfect positive correlation and -1 for a perfect inverse correlation.

An inverse correlation is usually meaningful in this analysis as it indicates that the intervention (denoted by the metric) has a beneficial effect on safety performance data (accidents, incidents, etc.) as the intervention increases, so the accidents, incidents, etc., decrease.

A graphic example of this may be found in 4-2/Figure 4, “Example of Line Graph (Showing Leading Indicator Finding)”.

However, occasionally a positive relationship between the two variables may be beneficial. For example, increased near miss reporting may indicate increased safety awareness and increased reporting.

As a rule of thumb, the following guidelines on strength of relationship may be useful for deciding which results warrant attention.

<i>Strength of Relationship</i>	<i>Value of r (positive)</i>	<i>Value of r (inverse)</i>
Strong	1.0 to 0.5	-1.0 to -0.5
Moderate	0.5 to 0.3	-0.5 to -0.3
Weak	0.3 to 0.1	-0.3 to -0.1
None	0.1	-0.1



CHAPTER 4 Next Step

SECTION 2 Presenting the Findings

1 Introduction

Presenting the findings from both the safety culture and the leading indicators analyses can be done in a variety of formats. The report or presentation should include:

- i)* Summary information (outlining what was done, where, number of participants, response ratio, etc.)
- ii)* An overview of the results
- iii)* Statistically significant findings
- iv)* The implications of the results, especially any unexpected or unusual findings.

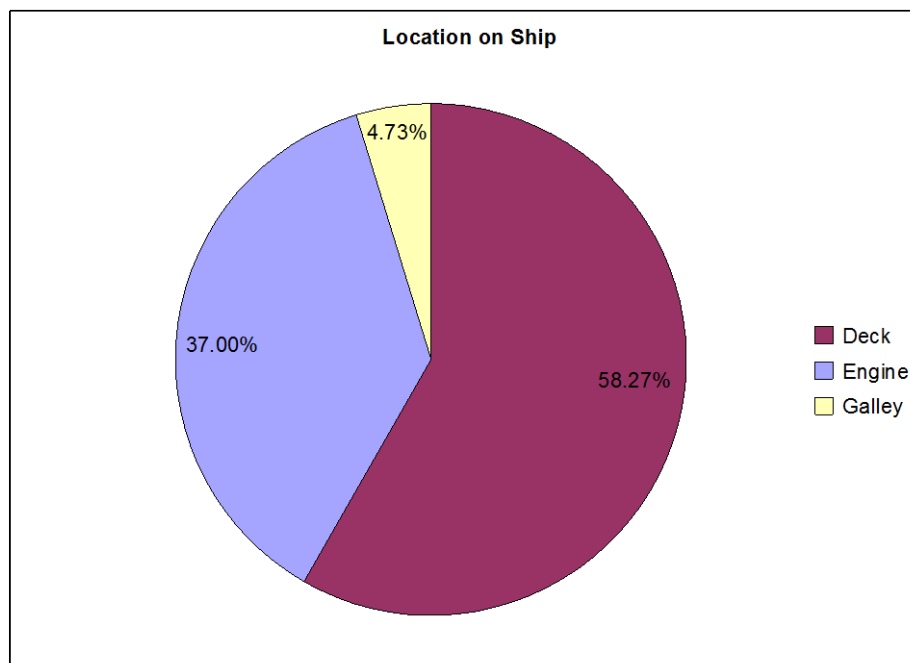
2 Presentation Formats

Detailed results should be shown in a variety of formats (e.g., bar charts, pie charts, tables, interval plots, graphs) to maintain interest and to facilitate the communication of a large volume of data.

2.1 Pie Charts

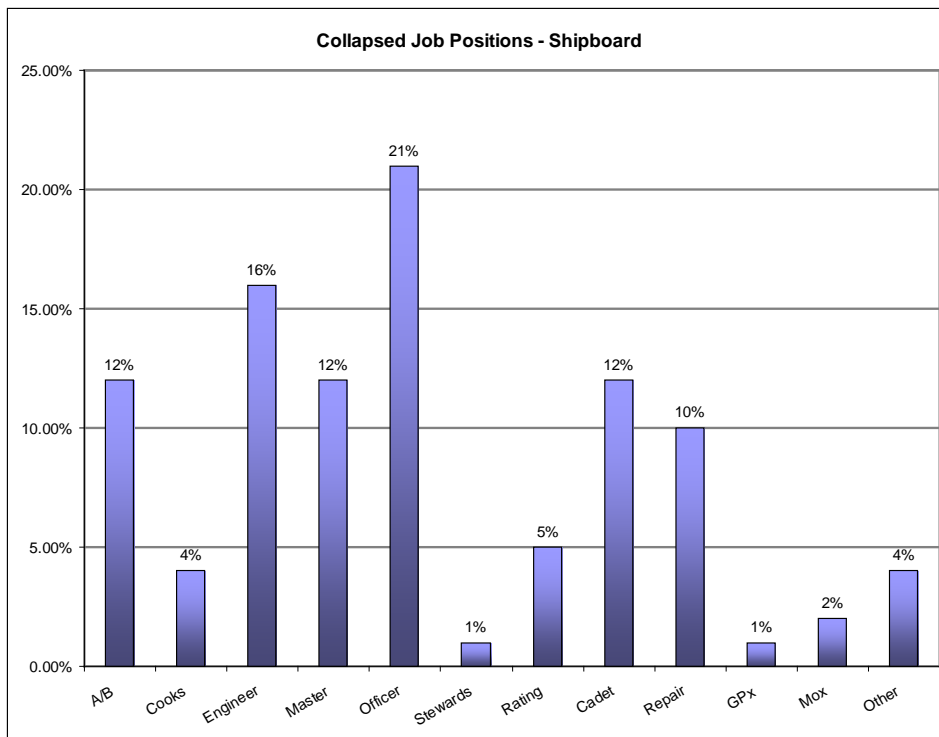
This is a good way to show demographic data where there are a small number of groups.

FIGURE 1
Example of a Pie Chart (Location on Ship)



2.2 Bar Charts

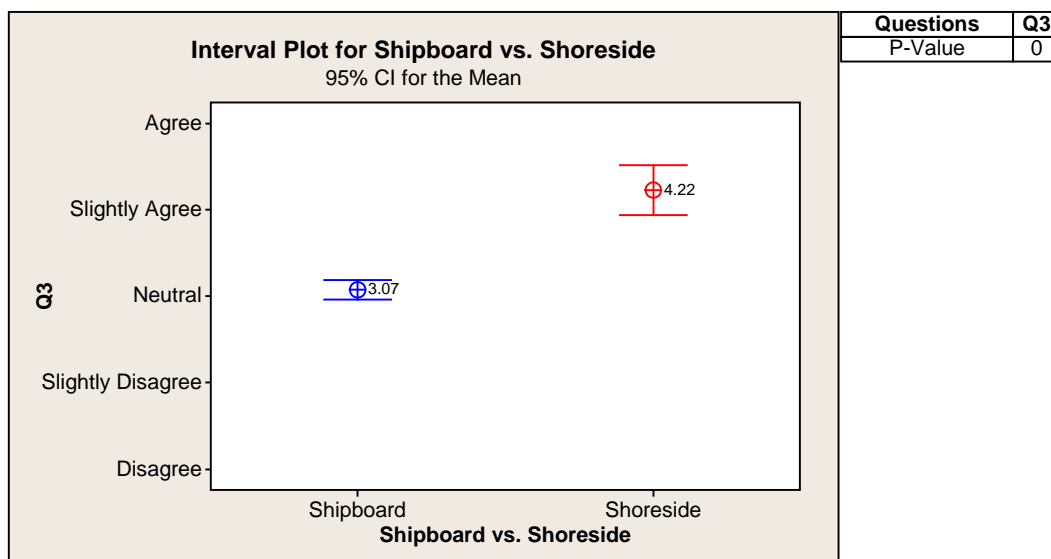
FIGURE 2
Example of a Bar Chart (Job Position)



2.3 Interval Plots

Interval plots are useful for showing the strength of association between two or more variables, and indicating which group responded more positively (or negatively).

FIGURE 3
Example of Interval Plots (Shipboard vs. Shoreside Responses)



Shoreside managers never put schedule or costs above safety (POS)

2.4 Line Graphs

Line graphs are particularly useful for presenting Leading Indicator results (i.e., safety metrics vs. safety performance data). They can show increasing and decreasing trends of safety metrics versus safety performance data on the same graph.

Although line graphs are visually explicit, they can be difficult to read. For example, in Section 4, Figure 4, it is important to associate the line with the square marker (number of safety management meetings) with the y-axis on the left of the graph, and the line with the diamond marker (restricted work accident frequency) with the y-axis on the right of the graph.

FIGURE 4
Example of a Line Graph (Showing Leading Indicator Findings)



The line graph in Section 4, Figure 4 shows that as the number of safety management meetings increased from over 200 in 2003 to over 1,600 in 2008, the restricted work accident frequency dropped from approximately 4.7 in 2003 to approximately 1.7 in 2008.



CHAPTER 4 Next Step

SECTION 3 Utilizing the Findings

1 Introduction

This Section of these Guidance Notes provides guidance on how to use the results of the safety culture survey or the leading indicators assessment. The value of either exercise cannot be fully realized until the results are incorporated into the organization's continual improvement program.

2 Action Plan

The following steps should be taken to benefit from a safety culture survey or leading indicators assessment:

- i)* Study the findings, and note the safety factors (categories of statements or metrics) that need to be addressed. The safety factors for the questionnaire statements are shown in Appendix 3, "Questionnaires and Safety Factors". The safety factors for the metrics are shown in 3-2/Table 2, "Safety Factors and Subsidiary Metrics" and 3-2/Table 3, "Safety Factors and Core Metrics".
- ii)* Look at the appropriate safety factor detailed in this Section which contains desired activities, attitudes, and behaviors as well as possible activities for improvement.
- iii)* Consider if the findings (i.e., significant questions in the safety culture survey, or leading indicators) could relate to a different safety factor, as there is some overlap. In that case, consider the desired activities, attitudes, and behaviors and possible activities for improvement for that safety factor too.
- iv)* Communicate the results to the workforce. Feedback should include strengths as well as areas of weakness. This can be done in a variety of ways (e.g., written reports, team briefings).
- v)* Let the workforce know how weak areas will be addressed and monitored. This feedback is important for buy-in to safety culture improvement.
- vi)* Prioritize the opportunities for improvement. Initially identify three to five key areas to focus on and develop an action plan.
- vii)* Consider how those key areas align with other initiatives/needs. Focus on strategies that may address more than one area or need.
- viii)* Consider if there are areas that are drivers of the safety culture practices in your organization (e.g., leadership, feedback, communication openness, safety awareness, and training).
- ix)* Engage key shipboard personnel (front-line personnel) in the planning and the trialing of process changes. Action plan development and implementation are typically more successful if these personnel are able to be included.
- x)* Keep all personnel informed of next steps and progress. They were asked for their input – let them know what is being done with it, or next time they may not participate or trust that management takes safety culture practices seriously.
- xi)* Celebrate success, and look for continuous input on challenges. Open communication is one of the cornerstones of safety culture. Use your response and actions relating to survey results to model the behavior you are seeking in your personnel.
- xii)* Track changes for continual improvement efforts.

The desired activities, attitudes and behaviors and possible activities for improvement for each safety factor are described in this Section. It should be noted that this is not an exhaustive list, but is presented to help stimulate discussion of ideas.

Once the findings have been presented to senior management, staff and participants, an action plan needs to be developed in line with organization's business plan, vision, and mission. This action plan should include:

- Action items
- Established responsibilities
- Completion dates
- Unambiguous milestones that are attainable

Within three years, a follow-up safety culture assessment should be performed to measure improvement.

3 Communication

3.1 Desired Activities, Attitudes, and Behaviors

- i) Managers and masters listen as well as speak.
- ii) All of the workforce (both crew and shoreside staff) are provided with all necessary information to do their jobs safely.

3.2 Possible Activities for Improvement

- Increase the number of mechanisms for communicating safety to employees (e.g., newsletters, toolbox talks, meetings, training, incident findings).
- Increase safety training (including printed formats) in native languages.
- Provide a mechanism for anonymous input to management so that those fearful of reprisal have an alternate communication pathway.
- Emphasize the importance of, and management's expectations for, timely and effective communication throughout the chain of command.
- Provide positive public reinforcement of communications – even the “bad news”. Do not shoot the messenger.
- Provide communications training to everyone.
- Create newsletters and other modes of management communication.
- Include safety messages in periodic newsletters or other communications.
- Provide access to internet sites that have regulatory activity that affects the organization.
- Disseminate relevant information from Masters' and management reviews which indicate continuance or change of direction in policies and/or procedures.
- Increase safety and/or information meeting frequency and effectiveness.
- Distribute summaries of external incidents and communicate how the lessons learned from them might apply locally.
- Disseminate organizational policies for quality, health, safety, and environment (QHSE).
- Disseminate bulletins throughout the organization regarding lessons learned or alerts regarding incidents that could have fleet-wide application.

4 Empowerment

4.1 Desired Activities, Attitudes, and Behaviors

- i)* Every employee has the authority and responsibility to terminate a task or activity if there are legitimate safety concerns.
- ii)* All crew feel able to voice concerns and to make suggestions to improve safety.
- iii)* Every employee tries to improve safety.

4.2 Possible Activities for Improvement

- Check that all employees know how to voice concerns, whether proactively as an opportunity for improvement or reactively as notice of deficiency.
- Solicit workforce opinions on effective communication means and frequency.
- Check that employees have the resources necessary to satisfy safety responsibilities.
- Clearly define accountability for safety systems.
- Celebrate employee safety decision/action successes.
- Institute an off-the-job safety program.
- Promote highlighting of employee safety concerns through formal and non-traditional means.
- See that employee safety concerns and suggestions are resolved in a credible, timely fashion.
- Establish safety committees that include a vertical slice of the organization.
- Establish clear, documented accountabilities for safety.
- Create an anonymous safety issue reporting system.

5 Feedback

5.1 Desired Activities, Attitudes, and Behaviors

- i)* The workforce is informed of outcomes of incident investigations, audits, etc., in a timely manner.
- ii)* Mismatches between practices and procedures (or standards) are quickly resolved to prevent normalization of deviance.
- iii)* Employee concerns are resolved quickly.

5.2 Possible Activities for Improvement

- Implement an employee suggestion/feedback program.
- Increase the number of mechanisms by which safety is communicated to employees and encourage their usage.
- Increase the percentage of employees who have their performance appraised annually.
- Establish a feedback system to crews on safety audits, issues, and concerns.
- Encourage suggestions from employees for improvements through the corrective/preventative action system, with corresponding follow-up for effectiveness once decisions are made and plans implemented.
- Establish and communicate a policy from the top management to all levels of the organization that it is acceptable and encouraged that people appropriately question safety issues.
- Discuss QHSE policies, objectives, and progress made during QHSE meetings.
- Communicate lessons learned from internal and external audits.

- Provide frequent status updates on lengthy projects that are important to employees, so they are aware of progress.
- Implement periodic employee opinion/attitude surveys to identify any concerns not making their way through normal channels.

6 Mutual Trust

6.1 Desired Activities, Attitudes, and Behaviors

- i) There is a good understanding of individual and crew responsibility for safety.
- ii) Relationships are characterized by respect.
- iii) Employees trust managers to “do the right thing” in support of safety.
- iv) Managers trust employees to shoulder their share of responsibility for performance, and to report potential problems and concerns.
- v) Peers trust the motivations and behaviors of peers.
- vi) Employees have confidence that a just system exists where honest errors can be reported without fear of reprisals.

6.2 Possible Activities for Improvement

- Document policies that prevent unethical behavior throughout the organization.
- Establish a training program and targets for ethics training.
- Communicate the need/expectation for reporting all incidents and near misses.
- Institute a blameless system for incident investigation, unless willful policy or procedure violations occurred.
- Establish a system that provides fair, consistent treatment of parties involved in incidents.
- Enforce the expectation that the workforce will be dealt with even-handedly.
- Document hiring policy and procedures, and implement them.
- Institute an internship training program.
- Initiate an interviewer training program.
- Provide attractive terms and conditions.
- Provide training matrices to persons involved in new-hires or in transfers of crew between ships to show adequate competency.
- Adopt an employee-driven behavior-based safety program including peer observations.
- Provide appropriate accommodation for different faiths and customs.
- Provide all procedures in native language of the crew members (as well as English).
- See that management response to acceptable and unacceptable safety performance is timely, consistent, and fair.

7 Problem Identification

7.1 Desired Activities, Attitudes, and Behaviors

- i)* All parts of the organization are vigilant for indications of weakness in the system that could lead to significant safety events.
- ii)* Avoidance of complacency – there are constant efforts to avoid the complacency that could accompany good safety records.
- iii)* The organization always places the burden of proof on determining that activities are safe rather than unsafe.

7.2 Possible Activities for Improvement

- Provide safety checklists for all jobs.
- Provide safety procedures, instructions or rules for all jobs.
- Provide policy/procedures for reporting unsafe conditions – and encourage their usage.
- Set targets for the number of jobs with hazard assessments.
- Set targets for the number of hazard analysis techniques utilized.
- Set targets for the number of safety inspections.
- Set targets for the number of corrective action reports originating from audits.
- Set targets for the percentage of incident reports which have causal analysis.
- Investigate and communicate lessons learned from recent accidents and incidents.
- Provide hazard/risk awareness training.
- Provide causal factor training to all employees.
- Modify the incident investigation system to more fully address “what could have happened” (potential consequences) instead of only the actual incident consequences.

8 Promotion of Safety

8.1 Desired Activities, Attitudes, and Behaviors

- i)* Develop a vision statement for safety culture.
- ii)* Establish a continual improvement program as a core value, and a campaign to communicate it to all levels of the organization.
- iii)* Visible, active, consistent support for safety programs from all levels of management through communications, actions, priorities, provision of resources, etc.
- iv)* Management commitment to doing what is right is demonstrated through decisions and actions.
- v)* Openness, honesty, firmness, and flexibility are qualities of the management team.

8.2 Possible Activities for Improvement

- Increase the annual safety budget so that there are sufficient resources for safety systems.
- Provide onboard or in-service training for all employees.
- Set new targets and controls for prompt closure of corrective action reports.
- Set new targets and controls for the number of safety audit recommendations closed out in time.
- Increase number of safety meetings senior management must attend.

- Increase targets for the frequency of safety management meetings.
- Set new targets for time to implement action on complaints or suggestions.
- Set new targets for employee attendance at safety meetings.
- Set new targets for increasing the percentage of new hires put through an induction training program that meets the requirements of the STCW code.
- Set good quality safety goals that are measurable.
- Improve the method of how incident investigation findings are made available to employees.
- Establish procedures to identify and impart any training required in support of safety management systems.
- Institute periodic safety culture evaluations.
- Highlight safety culture as an evaluation area in audits, incident investigations, etc. Look for and correct causal factors of incidents and safety performance problems.
- Hold regular safety management reviews.
- Establish annual safety objectives/goals throughout the organization.
- Implement a policy of zero tolerance for willful violation of safety policies and procedures.
- Effectively communicate expectations by training employees in safety policies and procedures.
- Make safety performance and safety culture a part of every worker's performance evaluation.

9 Responsiveness

9.1 Desired Activities, Attitudes, and Behaviors

- i)* Adequate and timely actions are taken in response to unexpected situations in order to prevent potential hazard consequences and to preserve safety.

9.2 Possible Activities for Improvement

- Check that all crew have PPE.
- Improve training for emergency procedures.
- Establish a system for ensuring that crew's time off-duty is observed.
- Determine a performance standard on action item completion.
- Do a survey of all safety-related action items to determine their status and due dates.
- Create metrics to measure the organization's performance regarding the resolution of safety concerns, recommendations, lessons learned, and audit findings. Monitor these metrics during regular management reviews.

10 Safety Awareness

10.1 Desired Activities, Attitudes and Behaviors

- i)* All members of the workforce exhibit a high standard of safety performance.
- ii)* The workforce will not tolerate willful violation of safety standards, rules or procedures.
- iii)* Watch-handovers are careful and unhurried.

10.2 Possible Activities for Improvement

- Establish effective and efficient procedures for ship and watch hand-overs.
- Establish a training program for safety awareness.
- Establish a training program and targets for safety investigation.
- Provide training matrices to persons involved in new-hires or in transfers of personnel between ships to show adequate competency.
- Provide training in analysis of job tasks and associated hazards, including hazards affecting quality, (e.g., using cranes with wires that are beyond their useful life for cargo movements wherein a load could be dropped and cargo subsequently damaged or destroyed).
- Provide awareness training on workplace hazards/risks and accident statistics.
- Set targets for number of near misses reported per employee.



APPENDIX 1 Shipboard Safety Culture Questionnaire

Please indicate the extent to which you agree with the following statements by choosing a number from the scale below. *If you don't know please choose '0'.*

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	<i>Don't Know</i>
1	2	3	4	5	0

SECTION A

This section is about ship safety (i.e., the policies, procedures, attitudes and actions that are taken to mitigate risk and prevent collisions, groundings, loss of life, or major injuries).

1. When ship management is told about accidents, incidents, or near misses, corrective action is taken promptly.
2. Shoreside managers never put schedule or costs above safety.
3. Ship management is personally involved in safety activities on a routine basis.
4. Management places a high priority on safety training.
5. Crew members are actively encouraged to improve safety.

6. This company has excellent maintenance standards.
7. Our crew has adequate training in emergency procedures.
8. People are hired for their ability and willingness to work safely.
9. Language differences in multi-cultural crews are not a threat to safety.
10. There are no differences in the performance of crew members from different cultures.

11. There is good communication on this ship about safety issues.
12. I am always informed about the outcome of shipboard meetings that address safety.
13. Watch hand-overs are thorough and not hurried.

14. When I joined this ship I received a proper hand-over, including familiarization with any new tasks.
15. Safety is the top priority for crew on board this ship.

16. Whenever I see safety regulations being broken, I report it.
17. The crew is expected to adhere to the work/rest cycle.
18. There is a system in place for observing my time off-duty.
19. I get adequate rest on the work/rest cycle that I work.
20. I am confident that I can operate the automated equipment within my area of responsibility.
21. I am very satisfied with the follow-up measures taken after accidents, incidents, and near misses.
22. Mistakes are corrected without punishment and treated as a learning opportunity.
23. The crew is always given feedback on accidents, incidents, or near misses that occur on board this ship.
24. I am encouraged to conduct risk assessments and report near misses.
25. An effective anonymous reporting system exists in this company.

SECTION B

This section is about occupational health and safety (i.e., about protecting your physical and mental health and welfare in the workplace).

26. This company cares about my health and safety.
27. Suggestions to improve health and safety are welcomed.
28. I fully understand my responsibilities for health and safety.
29. The crew is always given feedback on injuries that occur on board this ship.
30. The crew has access to all necessary personal protective equipment (PPE).
31. I am always informed about the outcome of shipboard meetings that address health and safety.

SECTION C

This section is about your job.

32. If I am interrupted whilst carrying out a task, I carefully check what I did, or start again, before resuming the task.
33. Safety briefings and training are never overlooked.
34. I have good control over the safety outcomes of my job.
35. I am usually consulted on matters that affect how I do my job.
36. The crew is not encouraged to break the rules to achieve a target.
37. I am comfortable asking for help when unsure how to do a task.
38. Pre-job assessments are completed for all jobs that need them.
39. I always give proper instructions when I initiate any work.
40. I always ask questions if I do not understand the instructions given to me, or I am unsure of the relevant safety precautions.

SECTION D

This section collects personal information so that differences in responses can be analyzed.

1. What is your age?
2. What is your gender?
3. What is your nationality?
4. Which department are you in?
5. What is your position aboard this ship?
6. What is the email address of your ship?
7. How many years have you been working in the maritime industry?
8. How many years have you worked for your current employer?
9. How many years have you been in your present position?

SECTION E

And finally, please take a moment to answer the following questions before submitting your questionnaire.

1. What could **this** company do to improve occupational health and safety?
2. What could **this** company do to improve ship safety?
3. What could **this** company do to improve shore-to-ship safety?
4. What questions were not asked in this survey, but should have been?

THANK YOU FOR YOUR HELP



APPENDIX 2 Shoreside Safety Culture Questionnaire

Please indicate the extent to which you agree with the following statements by choosing a number from the scale below. *If you don't know please choose '0'.*

Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	<i>Don't Know</i>
1	2	3	4	5	0

SECTION A

This section is about ship safety (i.e., the policies, procedures, attitudes and actions that are taken to mitigate risk and prevent collisions, groundings, loss of life, or major injuries). It asks for YOUR views, from the perspective of a shoreside employee.

1. When line safety managers are told about accidents, incidents, or near misses, corrective action is taken promptly.
2. Shoreside managers never put schedule or costs above safety.
3. Senior management is personally involved in safety activities on a routine basis.
4. Management places a high priority on safety training.
5. Employees are actively encouraged to improve safety.

6. This company has excellent maintenance standards.
7. Our seafarers have adequate training in emergency procedures.
8. People are hired for their ability and willingness to work safety.
9. Language differences in multi-cultural crews are not a threat to safety.
10. There are no differences in the performance of seafarers from different cultures.

11. There is good ship-to-shore communication about safety issues.
12. Our seafarers are always informed about the outcome of shipboard meetings that address safety.
13. Watch hand-overs are thorough and not hurried.
14. When joining a ship our seafarers receive a proper hand-over, including familiarization with any new tasks.
15. Safety is the top priority for seafarers on board our ships.

16. All violations of safety regulations are reported.
17. Our seafarers are expected to adhere to their work/rest cycle.
18. There is a system in place for observing seafarers' time off-duty.
19. Our seafarers get adequate rest on their work/rest cycle.
20. Our seafarers are competent to operate their automated equipment.

21. This company has good follow-up measures after accidents, incidents, and near misses.
22. Mistakes are corrected without punishment and treated as a learning opportunity.
23. Our seafarers are always given feedback on accidents, incidents, or near misses that occur on board ships.
24. Our seafarers are encouraged to conduct risk assessments and report near misses.
25. An effective anonymous reporting system exists in this company.

SECTION B

This section asks about YOUR understanding of this company's health and safety responsibilities.

26. This company cares about health and safety.
27. Suggestions to improve health and safety are welcomed.
28. I fully understand my line responsibilities for shipboard health and safety.
29. Our crews are always given feedback on injuries that occur on board their ship.
30. I have the right equipment to do my job safely.
31. I am always informed about the outcome of shore meetings that address health and safety.

SECTION C

This section asks about your own shoreside job.

32. If I am interrupted whilst carrying out a task, I carefully check what I did, or start again, before resuming the task.
33. Safety briefings and training are never overlooked.
34. I have good control over the safety outcomes of my job.
35. I am usually consulted on matters that affect how I do my job.
36. Our seafarers are not encouraged to break the rules to achieve a target.

37. I am comfortable asking for help when unsure how to do a task.
38. Pre-job assessments are completed for all jobs that need them.
39. I always give proper instructions when I initiate any work.
40. I always ask questions if I do not understand the instructions given to me, or I am unsure of the relevant safety precautions.

SECTION D

This section collects personal information so that differences in responses can be analyzed.

1. What is your age?
2. What is your gender?
3. What is your nationality?
4. Which department are you in?
5. What is your job title?
6. Which office do you work in?
7. How many years have you been working in the maritime industry?
8. How many years have you worked for your current employer?
9. How many years have you been in your present position?

SECTION E

And finally, please take a moment to answer the following questions before submitting your questionnaire.

1. What could **this** company do to improve occupational health and safety?
2. What could **this** company do to improve ship safety?
3. What could **this** company do to improve shore-to-ship safety?
4. What questions were not asked in this survey, but should have been?

THANK YOU FOR YOUR HELP



APPENDIX 3 Questionnaires and Safety Factors

Safety Factors and Their Codes

<i>Safety Factor</i>	<i>Codes</i>
Communication	COM
Empowerment	EMP
Feedback	FDB
Mutual Trust	MTR
Problem identification	PID
Promotion of safety	POS
Responsiveness	RSP
Safety awareness	SAW

1 Statements (on Shipboard Questionnaire) by Safety Factor Communication (COM)

<i>Statement Number</i>	<i>Statement</i>
9	Language differences in multi-cultural crews are not a threat to safety.
11	There is good communication on this ship about safety issues.
25	An effective anonymous reporting system exists in this company.
39	I always give proper instructions when I initiate any work.
40	I always ask questions if I do not understand the instructions given to me, or I am unsure of the relevant safety precautions.

Empowerment (EMP)

<i>Statement Number</i>	<i>Statement</i>
5	Crew members are actively encouraged to improve safety.
27	Suggestions to improve health and safety are welcomed.
34	I have good control over the safety outcomes of my job.
35	I am usually consulted on matters that affect how I do my job.
37	I am comfortable asking for help when unsure how to do a task.

Feedback (FDB)

<i>Statement Number</i>	<i>Statement</i>
12	I am always informed about the outcome of shipboard meetings that address safety.
21	I am very satisfied with the follow-up measures taken after accidents, incidents and near misses.
23	The crew is always given feedback on accidents, incidents or near misses that occur on board this ship.
29	The crew is always given feedback on injuries that occur on board this ship.
31	I am always informed about the outcome of shipboard meetings that address health and safety.

Mutual Respect (MTR)

<i>Statement Number</i>	<i>Statement</i>
8	People are hired for their ability and willingness to work safely.
10	There are no differences in the performance of crew members from different cultures.
22	Mistakes are corrected without punishment and treated as a learning opportunity.
26	This company cares about my health and safety.
28	I fully understand my responsibilities for health and safety.

Problem Identification (PID)

<i>Statement Number</i>	<i>Statement</i>
16	Whenever I see safety regulations being broken, I report it.
20	I am confident that I can operate the automated equipment within my area of responsibility.
24	I am encouraged to conduct risk assessments and report near misses.
32	If I am interrupted whilst carrying out a task, I carefully check what I did, or start again, before resuming the task.
38	Pre-job assessments are completed for all jobs that need them.

Promotion of Safety (POS)

<i>Statement Number</i>	<i>Statement</i>
1	When ship management is told about accidents, incidents or near misses, corrective action is taken promptly.
2	Shoreside managers never put schedule or costs above safety.
3	Ship management is personally involved in safety activities on a routine basis.
4	Ship management places a high priority on safety training.
6	This company has excellent maintenance standards.

Responsiveness (RSP)

<i>Statement Number</i>	<i>Statement</i>
7	Our crew has adequate training in emergency procedures.
17	The crew is expected to adhere to the work/rest cycle.
18	There is a system in place for observing my time off-duty.
19	I get adequate rest on the work/rest cycle that I work.
30	On this ship, the crew has access to all necessary personal protective equipment (PPE).

Safety Awareness (SAW)

<i>Statement Number</i>	<i>Statement</i>
13	Watch hand-overs are thorough and not hurried.
14	When I joined this ship I received a proper hand-over, including familiarization with any new tasks.
15	Safety is the top priority for crew on board this ship.
33	Safety briefings and training are never overlooked.
36	The crew is not encouraged to break the rules to achieve a target.

2 Statements with Safety Factor Codes

Section A

No.	Survey	Statement	SF Codes
1	Shipboard	When ship management is told about accidents, incidents, or near misses, corrective action is taken promptly.	POS
	Shoreside	When line safety managers are told about accidents, incidents, or near misses, corrective action is taken promptly.	
2	Shipboard	Shoreside managers never put schedule or costs above safety.	POS
	Shoreside	Shoreside managers never put schedule or costs above safety.	
3	Shipboard	Ship management is personally involved in safety activities on a routine basis.	POS
	Shoreside	Senior management is personally involved in safety activities on a routine basis.	
4	Shipboard	Management places a high priority on safety training.	POS
	Shoreside	Management places a high priority on safety training.	
5	Shipboard	Crew members are actively encouraged to improve safety.	EMP
	Shoreside	Employees are actively encouraged to improve safety.	
6	Shipboard	This company has excellent maintenance standards.	POS
	Shoreside	This company has excellent maintenance standards.	
7	Shipboard	Our crew has adequate training in emergency procedures.	RSP
	Shoreside	Our seafarers have adequate training in emergency procedures.	
8	Shipboard	People are hired for their ability and willingness to work safely.	MTR
	Shoreside	People are hired for their ability and willingness to work safely.	
9	Shipboard	Language differences in multi-cultural crews are not a threat to safety.	COM
	Shoreside	Language differences in multi-cultural crews are not a threat to safety.	
10	Shipboard	There are no differences in the performance of crew members from different cultures.	MTR
	Shoreside	There are no differences in the performance of seafarers from different cultures.	
11	Shipboard	There is good communication on this ship about safety issues.	COM
	Shoreside	There is good shore-to-ship communication about safety issues.	
12	Shipboard	I am always informed about the outcome of shipboard meetings that address safety.	FDB
	Shoreside	Our seafarers are always informed about the outcome of meetings that address safety.	
13	Shipboard	Watch hand-overs are thorough and not hurried.	SAW
	Shoreside	Watch hand-overs are thorough and not hurried.	
14	Shipboard	When I joined this ship I received a proper hand-over, including familiarization with any new tasks.	SAW
	Shoreside	When joining a ship our seafarers receive a proper hand-over, including familiarization with any new tasks.	
15	Shipboard	Safety is the top priority for crew on board this ship.	SAW
	Shoreside	Safety is the top priority for seafarers on board our ships.	

No.	Survey	Statement	SF Codes
16	Shipboard	Whenever I see safety regulations being broken, I report it.	PID
	Shoreside	All violations of safety regulations are reported.	
17	Shipboard	The crew is expected to adhere to the work/rest cycle.	RSP
	Shoreside	Our seafarers are expected to adhere to their work/rest cycle.	
18	Shipboard	There is a system in place for observing my time off-duty.	RSP
	Shoreside	There is a system in place for observing seafarers' time off-duty.	
19	Shipboard	I get adequate rest on the work/rest cycle that I work.	RSP
	Shoreside	Our seafarers get adequate rest on their work/rest cycle.	
20	Shipboard	I am confident that I can operate the automated equipment within my area of responsibility.	PID
	Shoreside	Our seafarers are competent to operate their automated equipment.	
21	Shipboard	I am very satisfied with the follow-up measures taken after accidents, incidents, and near misses.	FDB
	Shoreside	This company has good follow-up measures after accidents incidents, and near misses.	
22	Shipboard	Mistakes are corrected without punishment and treated as a learning opportunity.	MTR
	Shoreside	Mistakes are corrected without punishment and treated as a learning opportunity.	
23	Shipboard	The crew is always given feedback on accidents, incidents, or near misses that occur on board this ship.	FDB
	Shoreside	Our seafarers are always given feedback on accidents, incidents, or near misses that occur on board ships.	
24	Shipboard	I am encouraged to conduct risk assessments and report near misses.	PID
	Shoreside	Our seafarers are encouraged to conduct risk assessments and report near misses.	
25	Shipboard	An effective anonymous reporting system exists in this company.	COM
	Shoreside	An effective anonymous reporting system exists in this company.	

Section B

No.	Survey	Statement	SF Codes
26	Shipboard	This company cares about my health and safety.	MTR
	Shoreside	This company cares about health and safety.	
27	Shipboard	Suggestions to improve health and safety are welcomed.	EMP
	Shoreside	Suggestions to improve health and safety are welcomed.	
28	Shipboard	I fully understand my responsibilities for health and safety.	MTR
	Shoreside	I fully understand my line responsibilities for shipboard health and safety.	
29	Shipboard	The crew is always given feedback on injuries that occur on board this ship.	FDB
	Shoreside	Our crews are always given feedback on injuries that occur on board their ship.	
30	Shipboard	The crew has access to all necessary personal protective equipment (PPE).	RSP
	Shoreside	I have all the right equipment to do my job safely.	
31	Shipboard	I am always informed about the outcome of shipboard meetings that address health and safety.	FDB
	Shoreside	I am always informed about the outcome of shore meetings that address health and safety.	

Section C

<i>No.</i>	<i>Survey</i>	<i>Statement</i>	<i>SF Codes</i>
32	Shipboard	If I am interrupted whilst carrying out a task, I carefully check what I did, or start again, before resuming the task.	PID
	Shoreside	If I am interrupted whilst carrying out a task, I carefully check what I did, or start again, before resuming the task.	
33	Shipboard	Safety briefings and training are never overlooked.	SAW
	Shoreside	Safety briefings and training are never overlooked.	
34	Shipboard	I have good control over the safety outcomes of my job.	EMP
	Shoreside	I have good control over the safety outcomes of my job.	
35	Shipboard	I am usually consulted on matters that affect how I do my job.	EMP
	Shoreside	I am usually consulted on matters that affect how I do my job.	
36	Shipboard	The crew is not encouraged to break the rules to achieve a target.	SAW
	Shoreside	Our seafarers are not encouraged to break the rules to achieve a target.	
37	Shipboard	I am comfortable asking for help when unsure how to do a task.	EMP
	Shoreside	I am comfortable asking for help when unsure how to do a task.	
38	Shipboard	Pre-job assessments are completed for all jobs that need them.	PID
	Shoreside	Pre-job assessments are completed for all jobs that need them.	
39	Shipboard	I always give proper instructions when I initiate any work.	COM
	Shoreside	I always give proper instructions when I initiate any work.	
40	Shipboard	I always ask questions if I do not understand the instructions given to me, or I am unsure of the relevant safety precautions.	COM
	Shoreside	I always ask questions if I do not understand the instructions given to me, or I am unsure of the relevant safety precautions.	



APPENDIX 4 Safety Performance Datasheets

Definitions:

Please use these definitions when completing the datasheets.

Accidents: Accidents are undesired events that result in personal injury.

Conditions of Class: Any deficiencies identified, or recommendations made, by the classification society's surveyor.

Conditions of Class (Frequencies): The total number of conditions of class in the last year, multiplied by 100, divided by the number of port calls in the last year.

First Aid Case (FAC): Minor work-related injuries only requiring simple first aid treatment.

First Aid Case Frequency (FACF): The total first aid injury cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Lost Time Incident of 24 Hours or More (LTI \geq 24 hrs): Any work related injury other than a fatal injury which results in a person being unfit for work for a period of 24 continuous hours immediately after the occurrence of the incident.

Lost Time Incident Frequency – LTIF: The total Lost Time Incidents multiplied by 1 million, divided by the number of exposure (working) hours in the last year

Medical Treatment Case (MTC): Work-related injuries that are not severe enough to be reported as fatalities or Lost Time Incident cases or Restricted Work Accident cases but are more severe than requiring simple first aid treatment; however the injured person is able to carry out all his duties after treatment.

Medical Treatment Case Frequency (MTCF): The total medical treatment cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Near Misses (NM): Events or chain of events, which, under slightly different circumstances, could have resulted in an accident, injury, damage, or loss of personnel, equipment, or the vessel.

Near Miss Frequency (NMF): The total number of near miss cases in the last year multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Operational Incidents: Operational incidents are events that include steering failures, propulsion failures, navigational equipment failures, collisions, groundings, or other navigational or equipment failures.

Operational Incidents (Frequency): The total number of operational incidents in the last year, multiplied by 100, divided by the number of port calls of that vessel in the last year.

Port State Deficiencies: Any deficiencies identified by Port State Control.

Port State Deficiencies (Frequencies): The total number of port state deficiencies in the last year, multiplied by 100, divided by the number of port calls of that vessel in the last year.

Restricted Work Accident (RWA): Any work-related injury (other than a fatality or lost time incident) that results in a person being unfit to perform all of his/her regular job after the accident.

Restricted Work Accident Frequency (RWAf): The total restricted work accident cases in the last year, multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Total Recordable Cases (TRC): The sum of all work-related fatalities, lost time incidents, restricted work accidents and medical treatment cases. $TRCs = LTIs + RWAs + MTCs$.

Total Recordable Case Frequency (TRCF): The total recordable cases in the last year multiplied by 1 million, divided by the number of exposure (working) hours in the last year.

Organizational Safety Performance Datasheet

Please provide the following data for at least the last five years.

1. Total Recordable Cases Frequency for the fleet.
2. Lost Time Incident Frequency for the fleet.
3. Medical Treatment Case Frequency for the fleet.
4. Restricted Work Accident Frequency for the fleet.
5. [First Aid Case Frequency for the fleet](#)

Operational Incidents

6. Operational incidents frequency for the fleet.

Near Misses

7. Near miss frequency for the fleet.

Conditions of Class

8. Conditions of Class frequency for the fleet.

Port State Deficiencies

9. Port State Deficiencies frequency for the fleet.

Additional Data

10. Hours worked for the fleet.
11. Number of port calls for the fleet.

Business Units Safety Performance Datasheet

Please provide the following data for the last year. The data should be the most recent, preferably the last twelve months compounded to a single figure.

1. Total Recordable Cases Frequency for the fleet in the business unit.
2. Lost Time Incident Frequency for the fleet in the business unit.
3. Medical Treatment Case Frequency for the fleet in the business unit.
4. Restricted Work Accident Frequency for the fleet in the business unit.
5. [First Aid Case Frequency for the business unit](#)

Operational Incidents

6. Operational incidents frequency in the business unit.

Near Misses

7. Near miss frequency in the business unit.

Conditions of Class

8. Conditions of Class frequency in the business unit.

Port State Deficiencies

9. Port State Deficiencies frequency in the business unit.

Additional Data

10. Hours worked for the business unit.
11. Number of port calls for the business unit.

Vessels Safety Performance Datasheet

Please provide the following data for the last year. The data should be the most recent, preferably the last twelve months compounded to a single figure.

1. Total Recordable Cases Frequency for the vessel.
2. Lost Time Incident Frequency for the vessel.
3. Medical Treatment Case Frequency for the vessel.
4. Restricted Work Accident Frequency for the vessel.
5. [First Aid Case Frequency for the vessel](#)

Operational Incidents

6. Operational incidents frequency for the vessel.

Near Misses

7. Near miss frequency for the vessel.

Conditions of Class

8. Conditions of Class frequency for the vessel.

Port State Deficiencies

9. Port State Deficiencies frequency for the vessel.

Additional Data

10. Hours worked for the vessel.
11. Number of port calls for the vessel.

THANK YOU FOR YOUR HELP



APPENDIX 5 Electronic Distribution

Electronic distribution is preferable to paper because it avoids the need to type responses into a spreadsheet or statistics package, which is labor-intensive and potentially error-prone. Reliable sophisticated web-based survey tools are available. Use of such a tool is strongly recommended.

1 Consideration in Choice of Electronic Tool

The user should take into consideration the following questions before implementing an electronic survey instrument.

- i)* Size – is there any restriction on the number of questions?
- ii)* Does the tool enable encryption of data across the internet?
- iii)* Can the questionnaire be customized (e.g., allowing use of the company's logo)?
- iv)* Once the questionnaire is inputted, can the look and feel be tailored to suit?
- v)* Is the tool easy to use?
- vi)* Does the tool allow for a crew member to halt a survey and resume at a later time, if necessary?
- vii)* Does the survey instrument support crew member confidentiality?

2 Shipboard Survey Considerations

The web-based survey tools usually do not work on ships because they require permanent access to the internet. For this reason, some organizations have developed their own in-house survey tools, which should be used for this survey. Note that the PC on which the survey is installed must be in a publicly-accessed part of the vessel as all crew will need to use it.

An alternative to an in-house survey tool is an email-embedded survey. However, these do have potential drawbacks that may preclude their use. The company's information technology group will need to do a thorough investigation of the viability of those tools, taking into account:

- i)* Email client MIME capabilities (the ability to embed or attach documents to emails)
- ii)* SMTP Server Configuration (for outgoing messages)
- iii)* The software has to be installed and configured on the survey administration PC
- iv)* Whether or not crew members have individual email addresses

3 Expertise Required

- Basic knowledge of online surveys and HTML
- Knowledge of social science statistics especially the Mann-Whitney U Test and Spearman Correlation Tests
- Experience of using statistics packages

4 Preparation of the Electronic Questionnaire

- i)* Terminology – is it correct for crew and shoreside staff? Note that the terms such as operational incidents and accidents are used as defined in 1-1/6 of these Guidance Notes.
- ii)* Customize the Demographics section to the organization. Check department names, positions, ranges for experience and age, etc., are appropriate.
- iii)* Fill out all menu options such as office locations with the organization's details
- iv)* Section D Question 6 asks for ship email address, but name of ship may be preferred, and can be used instead. Unique identifier for each ship is required.
- v)* Gain access to the electronic tool (e.g., sign up for use of the chosen web-based survey tool).
- vi)* Input the tailored questionnaire.
- vii)* Adjust look and feel to that required. For example, the Likert scale should always be visible on the screen, the questions should be wrapped so they don't spread across the screen cramping the response scale; questions should be clearly delineated (e.g., by highlighting alternate rows).
- viii)* Consider whether or not to allow users to save partial responses and continue later. This will be an issue if participants are sharing a computer unless they have unique email addresses – see below.
- ix)* Anonymity of data issues. It is possible to have a completely anonymous survey in which no data can be traced to an individual, but this is achieved at a price. For example, where crew are sharing a PC, they must complete the questionnaire in one sitting if they wish to remain anonymous. If they cannot complete in one sitting they have to abort the survey and start again from the beginning. Also, reminders need to be sent towards the end of the survey. Anonymous responses preclude the possibility of targeting those who have not responded – everyone will have to receive the reminder. Anonymity means that it is not possible to stop an individual from answering the survey more than once.
- x)* Confidentiality of responses issues. Consider who is going to see the responses before they are rendered anonymous.
- xi)* Use drop-down lists where appropriate.
- xii)* Provide a front page explaining the purpose of the survey, stating whether or not it is anonymous, the need to answer ALL questions, and end-date of survey.
- xiii)* Consider how to end the survey: The system should detect any unanswered questions, let the participant know that the survey cannot end because of unanswered questions and bounce to them so that the participant does not have to search for them. Participants should be thanked for their contribution, and receipt of their submission should be acknowledged. Consideration needs to be given to the exit screen as the default will be to the service provider.
- xiv)* Pilot it with at least two crew onboard ship and two staff shoreside. Pilot every stage of the process including the preliminary emails right through to checking that the returns are formatting correctly.

5 Collection of Responses

- i)* At the end of the survey, the web-based tool will automatically shut down and advise that collection is ready.
- ii)* The data will be delivered in a format ready for analysis.



APPENDIX 6 References

- ACSNI Study Group (1991) Study Group on Human Factors, report: Human Reliability Assessment – a Critical Overview. *Advisory Committee on the Safety of Nuclear Installations*.
- Dufort, V. and Infante-Rivard, C. (1998). Housekeeping and Safety: An Epidemiological Review, *Safety Science*. 28,127-138.
- International Civil Aviation Organization (1993) *Human Factors, Management and Organization. Human Factors Digest No.10*. Montreal: ICAO.
- National Academy of Engineering (NAE) (2004). *Accident Precursor Analysis and Management: Reducing Technological Risk Through Diligence*. Washington, D.C.: The National Academies Press.
- Ryan, T.G. (1991) *Organizational Factors Regulatory research Briefing to the ACSNI Study Group on Human Factors and Safety*. London, July. Advisory Committee on the Safety of Nuclear Installations.
- Sleire H. (2008) *Shipping KPI: An Industry Initiative to Enhance Excellence in Ship Operation by Setting Standards for Corporate Governance*. Marintek-Sintef Final Report. The Research Council of Norway Contract No. 175978. InterManager.
- Toellner, J. (2001) Improving Safety & Health Performance: Identifying & Measuring Leading Indicators. *Professional Safety*, 46(9), 42-47.
- UNSCEAR (1988) *Sources, Effect and Risks of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation, 1988 Report to the General Assembly with annexes. United Nations sales publications E.88.IX.7* United Nations, New York.
- Zimolong, B, and Elke, G. (2006). Occupational Health and Safety Management. In G. Salvendy (Ed), *Handbook of Human Factors & Ergonomics*. New York: Wiley, 1- 66.