OFFSHORE SAFETY CULTURE TOOLKIT

Guidance Document

ABSTRACT

This document is the master guidance document for the offshore safety culture assessment toolkit developed by the American Bureau of Shipping (ABS), ABS Group, Lamar University, and the University of Houston. The National Academy of Science, Engineering, and Medicine Gulf Research Board sponsored this project.

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Abbreviations

ABS – American Bureau of Shipping

LU – Lamar University

MI – Mechanical Integrity

MOC – Management of Change

MOU – Mobile Offshore Unit

OI – Offshore Installations

KPI – Key Performance Indicators

SMS – Safety Management System

UH – University of Houston

NOTE for the user:

There are additional documents referenced in this file that were too big to include in this one document. They are available on the project's website (https://offshoresafety.lamar.edu). These include:

1) Appendix I – Statistical Analysis
2) Sample Safety Culture Report
3) Sample Safety Culture Survey
4) NAS Safety Culture Toolkit SEMS-Audit Job Aid FINAL.pdf
5) NAS Safety Culture Toolkit Worker Interviews Job Aid FINAL.pdf
6) NAS Safety Culture Toolkit SEMS-Incident Investigation Review Job Aid FINAL.pdf
7) NAS Safety Culture Toolkit SEMS-Site Walkthrough Job Aid FINAL.pdf
8) Spreadsheet - NAS Safety Culture Toolkit Site Walkthrough.xlsx
9) Spreadsheet - NAS Safety Culture Toolkit SEMS Incident Investigation Review.xlsx
10) Spreadsheet - NAS Safety Culture Toolkit Worker Interviews.xlsx
11) Spreadsheet - NAS Safety Culture Toolkit Site Walkthrough.xlsx

1. Safety Culture Assessment

The development of this safety culture assessment toolkit was conducted by a team consisting of American Bureau of Shipping (ABS), ABS Group, Lamar University, and University of Houston. The chief goal was to advance overall understanding of safety culture in the Gulf of Mexico (GoM) offshore industry by improving our understanding and offshore use of the various scales, methodologies, and frameworks among offshore facilities, and companies and assemble a pragmatic safety culture tool kit to aid in the evaluation and promotion of a positive safety culture. The goal was accomplished by 1) Increasing the understanding of different safety culture frameworks and the various safety culture factors contributing to a good safety culture; 2) Adapting and consolidating safety culture best practices from various high-risk industries; 3) Providing tools for safety culture measurement; and 4) Serving as a foundation for implementation of a pilot program to further understand, promote, and improve safety culture. This toolkit is expected to result in a more effective path forward for the offshore industry to improve individual and organizational culture, reduce unsafe behaviors and improve human performance, reduce management system failures, near-misses, and accidents resulting in more sustainable, continuously improving offshore industry health, safety, and environmental (HSE) performance.

This toolkit's guidance documents describe the steps of a safety culture assessment (perception survey, site observations, audits, review of incident investigation data, etc.), templates and software for data collection, and procedures and software for data analysis. The toolkit also includes approaches to improve safety culture based on the results of the assessment. The resulting performance improvement will help to improve worker health and reduce the risk of environmental disasters involving offshore energy exploration and production. Figure 1 below graphically represents the different components of this project's toolkit components.

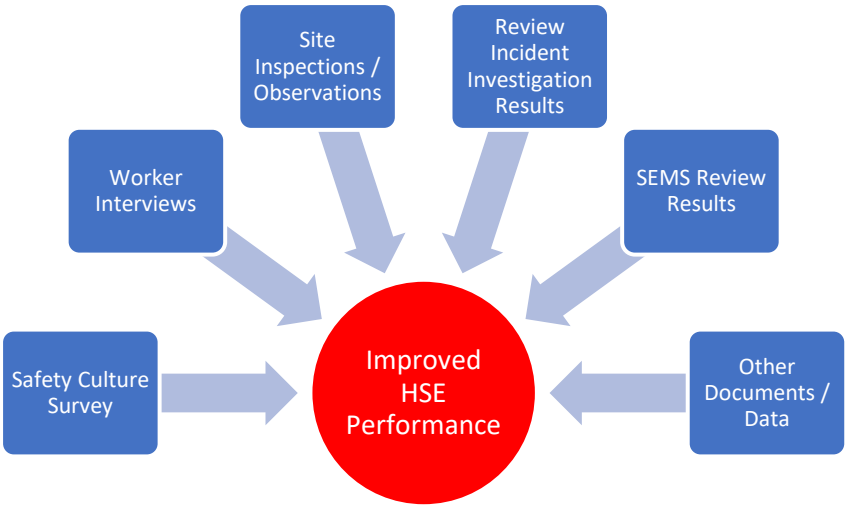


Figure 1. Safety Culture Assessment Toolkit Contents

2. The Safety Culture Survey

2.1. Introduction

The safety culture survey measures safety culture on an organization's facilities and within onshore support centers. The focus areas within these onshore support centers are those who provide direct daily support to offshore activities.

Safety culture is evaluated based on worker responses to a series of questions that are grouped into safety culture factors (SCFs). The SCFs align with organizational goals and objectives related to safety. Individual question responses should be used to measure overall safety culture and identify areas of strengths and weakness within an organization. The identification of an organization's strengths and weaknesses will identify potential areas within their safety culture that are considered opportunities for improvement.

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.

These safety culture survey tools are built on a detailed literature search of many industries, including prior guidance notes from ABS on conducting safety culture surveys (ABS, 2014).

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 routine and emergency operations.

2.2. Planning

These are the issues that should be considered during the decision-making process of determining whether to proceed with a safety culture survey.

2.2.1. Costs and Benefits

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

2.2.1.1 Costs

This is a comprehensive exercise, which requires a particular skill set, including:

- Good organizational and administrative skills to supervise the process
- Knowledge of social science statistics
- Experience of using statistics packages and/or spreadsheets
- Cost of the worker's time in conducting and completing the survey

2.2.2. 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 Considerations

Once the decision has been made to carry out a survey, the distribution format needs to be determined. Typical choices include paper-based, electronic, or a mixture of both (e.g., a web-based electronic distribution for onshore staff and paper-based for offshore personnel).

Distribution considerations include:

1. 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 several weeks.
2. Determine who will be taking the survey, and which installations and offices/departments to include. The Onshore Safety Culture Questionnaire should be answered by staff who work in Operations, or Facility Management, HSE, or who are very knowledgeable about the organization's operations.
3. Determine the scope of the survey. Target all offshore workers, including those on leave. However, note that where the survey responses are used for a Subjective Leading Indicators Program, only the worker responses from offshore installations are used in the statistical analysis for leading indicators as it is done by installations, not by individuals.

2.3. Preparation

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

2.3.1. Prepare Workers

1. Workers should be given advance notice of the safety culture survey and be encouraged to participate. This applies to workers on board installations as well as onshore.
2. Ideally, the announcement should come from the CEO-level and the importance of participation should be reinforced via other communications. For example, by placing an interview with the area or district management in the organization's newsletter.
3. It is essential that the offshore installation managers (OIMs) understand the importance of the survey, as it will be their responsibility to announce, explain, and encourage participation in the survey.
4. Workers 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.
5. Let the workers know that the survey can be completed in fifteen minutes.

6. Let the workers know what to expect (e.g., that it covers safety culture on board facilities, health and safety, and job characteristics, and some demographic questions necessary for conducting the analysis).
7. Workers should be told that participation in the survey is voluntary, and it will be undertaken during working time at the organization's expense.
8. Let workers know that their replies will be anonymous and treated confidentially.

2.3.2. Prepare the Questionnaires

The survey is undertaken using the questionnaires that can be modified based on the proposed surveys in Appendix A, "Offshore Facility Safety Culture Questionnaire" and Appendix B, "Onshore Safety Culture Questionnaire". The survey can be customized to the needs and terminology within your organization. Versions of the survey are available for all major survey tools (SurveyMonkey/Momentive, LimeSurvey, etc.).

2.3.3. Suggested Questions

The recommended question set for the safety culture survey is provided in Appendix A and B. Questions can be slightly modified to accommodate organization specific definitions. Additionally, the free-text questions can be modified to suit the organization's needs.

2.3.4. Distribute the Questionnaires

1. Include a cover letter with the instructions.
2. There are two questionnaires in the survey. The questions cover the same ground but are framed differently. The questionnaires are shown in Appendix A, "Offshore Installation Safety Culture Questionnaire" and Appendix B, "Onshore Safety Culture Questionnaire".
3. Allow several weeks for responses.
4. Shortly before the end of the survey, send a reminder.
5. Be prepared to extend the deadline if more time is needed.

2.4. Analyzing the Responses

2.4.1. Introduction

This Section describes the analysis methodology step-by-step. Worked examples are included to aid understanding the principles.

2.4.2. Analyses

There are two questionnaires, one for the offshore workers and one for onshore support personnel. Each questionnaire contains statements that are identical, or equivalent. Respondents indicate their level of agreement to a statement on a five-point scale, also known as a Likert scale.

2.4.2.1 Demographic Analysis

This analysis is performed to determine any difference in responses based on:

- Job position
- Experience with this organization
- Experience in the offshore industry
- Experience in your current position

2.4.2.2. Offshore Facility versus Onshore Analysis

This analysis is performed to determine any perceived safety culture differences (i.e., difference in responses to the Likert statements) among workers and onshore staff.

2.4.3. Within Groups Analysis

This analysis is performed to determine any differences in responses within each demographic group identified in the "Demographic Analysis" section. For example, statistical analysis may indicate safety culture differences among workers. However, further analysis may need to be performed to determine if this difference is a function of nationality per se or some other factors such as job position.

2.4.4 Qualitative Analysis of the Free Text Questions

The questionnaires conclude with two questions asking for suggestions to improve safety and/or safety culture. As the responses are free text, statistical analysis cannot be easily performed. 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.

2.5. Preparation

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

1. After receiving survey data, develop a plan to format data based on spreadsheet (or statistical package) requirements for analyses.
2. Import the response data into spreadsheet software.
3. Keep the original survey dataset intact and use a copy for sanitization.
4. Sanitize the copy by removing any reference to installation name, office, and individuals.
5. Keep sanitized dataset intact and use another copy for analysis.
6. Have as few analysts as possible handling the data to reduce error and promote consistent methods and analyses.
7. Keep the number of dataset files to a minimum, use proper and standardized folder/file names, and have dates on all files.
8. Assign one individual to keep all files ('central storage').
9. Do not assign one analysis to more than one individual.

2.6. Statistical Testing

A Mann-Whitney U Test is performed for *each* comparison of the demographic factors. An extension of the Mann-Whitney U Test, called a Kruskal-Wallis Test, can be used for the Within Groups Analysis. Appendix C presents a detailed description of the statistical analysis.

2.7 Interpreting the Results

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 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 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.

As the data is not normally distributed, a non-parametric test known as the Mann-Whitney Test is 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.

2.8. Presenting the Findings

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:

1. Summary information (outlining what was done, where, number of participants, response ratio, etc.)
2. An overview of the results
3. Statistically significant findings
4. The implications of the results, especially any unexpected or unusual findings.

Detailed results should be shown in a variety of formats to maintain interest and to facilitate the communication of a large volume of data. Appendix C presents a standard report format for presenting results. Appendix G (available on the project's website) presents a user manual for constructing the reports. Appendix H (available on the project's website) presents a technical manual. Appendix I (available on the project's website) presents discussion on statistical analyses.

2.9 Utilizing the Findings

The value of either exercise cannot be fully realized until the results are incorporated into the organization's continual improvement program. The following steps should be taken to benefit from a safety culture survey or leading indicators assessment:

1. Study the findings and note the safety culture factors (categories of statements or metrics) that should be addressed. The safety culture factors used are shown in Table 1. Safety Culture Factors (Lou, et al., 2021).
2. Look at the appropriate safety factor detailed in this Section which contains desired activities, attitudes, and behaviors as well as possible activities for improvement.
3. Consider if the findings (i.e., significant questions in the safety culture survey, or leading indicators) could relate to a different safety culture 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.
4. 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).
5. Let the workforce know how weak areas will be addressed and monitored. This feedback is important for buy-in to safety culture improvement.
6. Prioritize the opportunities for improvement. Initially identify three to five key areas to focus on and develop an action plan.
7. Consider how those key areas align with other initiatives/needs. Focus on strategies that may address more than one area or need.
8. 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).
9. Engage key front-line personnel in the planning and the trialing of process changes. Typically, action plan development and implementation are more successful if these personnel are included.
10. 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.
11. 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.
12. Track changes for continual improvement efforts.

Table 1. Safety Culture Factors

Safety Culture Factors	Description
1. Leadership	Leadership Commitment to Safety Values and Actions. Leaders demonstrate a commitment to safety and environmental stewardship in their decisions and behaviors
2. Hazard Identification and Risk Management	Hazard Identification and Risk Management. Issues potentially impacting safety and environmental stewardship are promptly identified, fully evaluated, and promptly addressed or corrected commensurate with their significance
3. Personal Accountability	Personal Accountability. All individuals take personal responsibility for process and personal safety, as well as environmental stewardship
4. Work Processes	Work Processes. The process of planning and controlling work activities is implemented so that safety and environmental stewardship are maintained while ensuring the correct equipment for the correct work
5. Continual Improvement	Continual Improvement. Opportunities to learn about ways to ensure safety and environmental stewardship are sought out and implemented
6. Environment for Raising Concerns	Environment for Raising Concerns. A work environment is maintained where personnel feel free to raise safety and environmental concerns without fear of retaliation, intimidation, harassment, or discrimination
7. Effective Safety and Environmental Communication	Effective Safety and Environmental Communication. Communications maintain a focus on safety and environmental stewardship
8. Respectful Work Environment	Respectful Work Environment. Trust and respect permeate the organization with a focus on teamwork and collaboration
9. Inquiring Attitude	Inquiring Attitude. Individuals avoid complacency and continuously consider and review existing conditions and activities to identify discrepancies that might result in error or inappropriate action

The desired activities, attitudes and behaviors and possible activities for improvement for each safety factor are described in the sample report in Appendix C.

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

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

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

3. Interviews

3.1 Introduction

Interview data collected from all levels of an organization is extremely important and helps to gain a clearer understanding of how the organization views various aspects or factors of the safety culture. The interview data is also combined with information from other data streams to provide clarity on the safety climate within the organization. This can then provide insight into the safety culture. Interview data provides an opportunity for an individual to expand on input from the survey that is typically only given in a Likert scale of agree, disagree, etc. The interview provides an opportunity for the individual to cite examples or to expand into areas of the safety culture that were not specifically (or sufficiently) addressed in the survey. A job aid for this task has been developed, the NAS Safety Culture Toolkit Worker Interviews Job Aid FINAL.pdf.

3.2 Workflow

The workflow of the interview procedure is described as in the following figure. The details are described next.

Figure 2. The workflow of the interview procedure

3.2.1 Define the Number of Interviews

Interview participation should achieve a reasonably representative sample. When designing an interview pool, there are some "rules of thumb" to consider. Some suggested roles and numbers to consider are shown below in

Table 2. Typical Target Number of Interviews. Typically, the interviewer will work with the facility management to suggest roles in the organization to invite to participate in the interviews. Specific persons may be selected to interview if an organization chart is provided to the interviewer. This is common with upper and mid-level managers. At the interviewer's option, they may randomly select other individuals to be invited to participate in the interviews. Alternatively, this section may be delegated to the facility representative or scheduler (discussed below in Role of the Scheduler).

NOTE: There is no attempt to interview enough people to attain statistical significance as we would in the survey portion of the assessment. For example, in a facility with 500 individuals, 341 would need to be interviewed to claim a 95% confidence level with a ±3% confidence interval.

Table 2. Typical Target Number of Interviews

Job Role	Small Facility (<100 people)	Medium Facility (100 to 500 people)	Large Facility (>500 people)
Facility Manager	1	1	1
Middle Managers	1	2	4
1st Line Supervisors	2	3	4
Engineers	2	3	4
Operators	4	8	10
Maintenance Techs	2	4	6
Contractors	4	6	8
EHS Personnel	2	3	4
Warehouse, Lab, etc.	2	3	4
Total	20	33	45

Most interviews should be conducted one-on-one in a convenient, private location. Although, through practice, a mixture of group and individual, one-on-one interview settings has been shown to produce valuable interview data.

3.2.2 Schedule Interviews and Verify Availability

3.2.2.1 Role of the Scheduler

The scheduler should be familiar with the facility and personnel and should do the following:

1. Work with the interviewer to determine which roles/people to invite to the interview.
2. Schedule the interviews, ensure that a response has been received from all invited.
3. Fill in the schedule with others if a person declines to be interviewed or is otherwise unavailable.
4. Remind the people scheduled of their appointment on the day of the interview.
5. Respond to last minute openings due to, for example, a person is sick that day or is called into a demanding responsibility at the time of the interview. Locate a substitute interview within the same job function, if possible.

3.2.2.2 Selecting and Scheduling Interviewees

To create a successful interview pool, there should be diversity. Interviewees invited to participate should be selected based on:

1. Levels in the organization. Individuals from all levels of management and supervision should be selected. Priority should be given to selecting individuals from the labor force (e.g., operators, maintenance technicians).
2. Gender. If possible, include each gender.

3. Contractors. Consider including contractors in the interview pool. They have a lot of insight as to the safety culture in an facility and often can compare it with other facilities that they have worked in. They will understand, for example, training and communication given to the contract workforce.
4. Ethnic groups. If an facility has distinct ethnic groups represented in the work force, attempt to include representative selections from the groups identified. Provide a means to accommodate resolve barriers, where needed.
5. Attitude. If possible, select some individuals who are vocal about their opinions (even if they tend to be negative) and some, perhaps reserved individuals, who may be more thoughtful and modest in expressing their opinions.

3.2.2.3 Interview Locations

It is standard for interviews of upper and mid-level managers to take place in their offices. Interviews can be conducted at the workplace of the interviewee, but it requires additional time to relocate after each interview. Also, often visitor requirements for the interviewer require a worker escort and personal protective equipment, which complicate the logistics. Therefore, it is more beneficial to have all interviewees meet the interviewer at a central location.

3.2.2.4 Length of Interview

Experience has shown that one good option is to interview for 30 to 45 minutes and schedule each interview one hour apart. Most people can work in a 45-minute interview into their day, but beyond that, they may interfere with other pressing activities. Also, the attentiveness of the interviewee tends to wane after about 45 minutes. The 15-to-30-minute interval between interviews allows the interviewer time to summarize notes and prepare for the next interview. It also provides a buffer for people who don't arrive on time to the interview, or to locate a substitute, if needed.

3.2.3 Conduct and Record Interviews

3.2.3.1 Guiding Principles of the Interview and Script

1. Participation in this analysis is voluntary.
2. The confidentiality of individual interviewees is of utmost importance.
3. The results of the interviews are non-attributional in documentation, analysis, and findings.
4. The interview script and dialogue strive to avoid limiting what the individual says.
5. The interview script and dialogue strive to not ask a question that is leading or suggesting the answer.
6. There are many more questions in the interview script than can be asked in an interview. The interviewer should attempt to the degree possible to cover at least one question from each of the 9 safety factors. Alternatively, the safety factors can be split among people in the same job function so that interview data can be collected for all applicable factors.

3.2.3.2 Interview Scribe

It is recommended (but not required) to utilize a scribe in interviews. If a scribe is used, they can be more thorough in taking notes and will allow the interviewer to focus on the interviewee, the questions to be asked, and perhaps working through an interview path not formally

intended but needs to be explored based on the response to an interview question. The scribe can also be very useful in compiling notes to be used in the overall safety culture assessment. All these functions can be filled by an interviewer without a scribe, if necessary.

3.2.3.3 Interview Style

The interview script is a guide to achieve a level of consistency during interviews. The interviews will by their nature deviate from script depending on the natural flow of conversation and responses from the interviewee. There will be varying degrees of coverage for the questions. Some questions will be covered very specifically if the interviewee provides details and other areas may be generally covered, some questions may not be covered in all interviews. The interviewer is not expected to read the questions verbatim from the script but should be aware that changes to the questions phrasing may invite a different response than the original intended question (e.g., creating a leading question).

When the person being interviewed provides information that is particularly positive or negative, the interviewer should follow up to ask for specific examples that led to their perception, if possible. If such information leads to conclusions in the assessment report, managers will need as much information as possible, while still maintaining strict anonymity, so that appropriate actions can be taken in to address the concern or build on the positive conclusion.

The goal is to understand the perspective of the person being interviewed. To accomplish this, the interviewer and assessment team will need the input from the participants. Participants in these interviews are likely to be reluctant to share openly if they feel threatened or pressured. The interview scripts are worded with open ended and neutral questions, while maintaining focus on the potential areas of interest.

An adversarial interview yields little to no useful information. The skilled interviewer will build some level of trust within the first few minutes of the interview. General practices that can help lead to a successful interview, include:

1. Start slow, with a focus on the person, and not the topic of the interview.
2. One approach is to interview in a “hey, you can tell me” style.
3. Make some questions open-ended. Our job is to get the interviewee to “tell their story.”
4. Ask what you don’t know.
5. Let the interviewees wander a bit – but be careful.
6. Don’t send advance questions. Results from questions sent ahead of the interview sound like they were pre-prepared by committee. Very little new information may be obtained.
7. Find the overlooked information. Look for information that is not commonly available. A quick review of the safety culture survey data (where available) ahead of the interview is a very good source of direction for the interview.
8. Listen, really listen. The value of the interview is in “what people say.” This is where the scribe approach can be very helpful.
9. Avoid redundant questions. You lose the focus from the interviewee if you ask for information that has already been offered. It is very common for some important

information to come out in the interview before you ask a question designed to solicit the information.

3.2.3.4 Group Interview Settings and Guidance

Two of the common settings for group interviews are the control rooms and maintenance workshops or lunchrooms. In the medium and large facilities identified in

Table 2. Typical Target Number of Interviews, a common target would be to conduct 2 to 4 group interviews. It has also been found useful to interview the evening or night shift, if possible, to get a different perspective which can vary with the shift and even the time of day (e.g., less people around at night often has a more relaxed atmosphere).

Interviews conducted in a group setting have the advantage of individuals expressing synergistic comments, some of which may not have been expressed in a one-on-one setting. For example, one person may make a comment which resonates with another individual who can build on the previous comment or express their own ideas which may have been stimulated from the previous comment.

The group setting does have the potential for introducing error in that it is common for one or two individuals in the group to dominate the conversation which will inject bias into the interview results. A skillful interviewer, however, will recognize this group dynamic very quickly and employ means to overcome the issue. One common way to do this is to use a polling technique where a question is asked and each person in the room is asked to respond. Of course, if an individual is hesitant to respond or is more comfortable in listening rather than talking in the group setting, that preference should be honored, and no pressure applied to the individual get them to respond.

3.2.3.5 Interview Stages

Opening Remarks

The opening remarks may follow this general outline:

a. Introduce names and the name of your company only.
b. Purpose of our discussion (deemphasize the word "interview", stress "discussion" instead).
c. Brief icebreaker discussion, if practical, sincere, and appropriate.
d. Participation in this discussion is voluntary.
e. Emphasize that the discussion is in it for them.
f. Use reassurances to help prevent comments from being attributed to an individual
    i. We are not recording the discussion.
    ii. We will take notes so we can remember the key points that are discussed, but we will not use names in any summaries or reports.
    iii. We take protecting your anonymity very seriously.
g. Reconfirm willingness to participate.
h. Brief introduction. Start with interviewer (business cards can be given to the participants so they know who they are meeting with throughout the interview and to allow them to follow up with additional comments/issues) and include:

        i. Name
        ii. Company
        iii. Location where you work
        iv. What kinds of work you do, brief background
    i. Introduction from person being interviewed
        i. Name
        ii. Relevant work history

3.2.3.6 Interview Questions

Table 3. Sample Interview Questions by Safety Culture Factor contains a potential interview script which is a list of suggested questions that should be considered for each of the interviews. As noted above, it is not intended that every question be asked in every interview, but each should be considered. Further, there will be additional questions that arise during the interview that can and should be asked that may not be contained in the interview script. The interview script is intended to be a guideline document. As such, the interviewer should remain actively engaged in the interview such that as the interviewee is answering the question or expressing a thought, the direction of the interview may change so that additional information can be sought in the direction that the interviewee is leading the conversation. Having said that, it is important for the interviewer to always maintain control of the conversation and if the interviewee is digressing from the topic or obfuscating their answers with irrelevant information, the interviewer is obligated to redirect the conversation in a more appropriate direction. This means that allowing the interviewee to express unscripted information is valuable and does not by definition mean the discussion has left its intended bounds. Sometimes this information is extremely valuable and can provide important insight.

It is desirable to obtain interview data on all 9 safety factors so that interview data plays a meaningful role in the scoring and conclusions reached for each of the safety factors. As stated above, that is virtually impossible in a 45-minute interview. One suggestion to help cover all safety factors involves additional advance planning to split the questions among the persons who are to be interviewed. For example, if four operators are to be interviewed, the assessment team member may select 5 or 10 questions that they want to ask all operators and then divide the rest of the questions into four sets, such that 25% of the questions are asked of each of the four operators.

3.2.3.7 Concluding the Interview

To conclude the interview, thank the person for their time, honesty, and candor. Emphasize that the information is anonymous and that their responses are very valuable in compiling the safety culture picture. Ensure the interviewee that results from the culture assessment will be developed and shared as quickly as possible.

3.2.4 Compile and Score Interview Data

For the interviews, the statements made by the interviewees are considered perception data (except when specific behaviors they have witnessed are included). Unlike the surveys, where the raw data is already numerical (except for the open-ended text questions), data from the interviews is not quantitative and is often unpredictable in content. Therefore, the analyst needs to consider the following:

1. The analyst will review all notes from the interview and compare them with others who may have been in the interview (e.g., scribe, other assessors). The outcome of this review is to (a) achieve consensus as to what was said in the interview, (b) determine which of the interview comments were impactful in describing the culture, and (c) group (and in some cases combine) common interview comments so trends and themes (both positive and negative) are more apparent.
   Note that while "impactful" interview data is subjectively designated as such by the culture assessment team members, the following are two criteria for separating out impactful statements. The first is repeated statements and observations from several people interviewed. The second is an important statement (usually fact-based rather than opinion) made by a single individual. An example would be the mechanical integrity subject matter expert who states testing of critical instruments is not being done on time.
2. The questions in Table 3 below are mapped to the safety culture factors.
3. A spreadsheet has been developed to aid the interviewer. The spreadsheet contains typical questions when discussing safety culture. Some questions align well with the actual survey. Others cover different safety aspects. Some or all the questions in the spreadsheet can be used and tailored to the organization. The file's name is "NAS Safety Culture Toolkit – Worker Interviews – FINAL.xlsx"
4. The spreadsheet automatically generates a score. A traffic light grading system allows easy visualization of the results and a percentage score. Where >85% (Green) – most items appear to be in good practice; 70% - 85% (Yellow) - some items appear to be in good practice, or 70% - (Red) opportunities for improvement have been identified
5. The spreadsheet has several grading options. These options are 1) *Yes*, in the view of the assessor, the attributes of the question/statement are satisfied; 2) *Partial*, where some of the attributes of the question/statement are satisfied; and 3) *No*, where minimal evidence is seen to determine if the question or statement's attributes are satisfied.
6. There is also a comment area where the assessor can further elaborate on any grade that is assigned to a question. These can be positive or represent opportunities for improvement.

Table 3. Sample Interview Questions by Safety Culture Factor

Sample Interview Question	Associated Safety Factor
Primary Questions	
1. Can you think of any examples where you have provided strong HSE leadership?	1. Leadership
2. Are the right people always involved with making HSE decisions?	1. Leadership
3. Do safety-related suggestions get addressed with either timely corrective action or communication as to why it is not implemented? Can you think of any specific examples?	1. Leadership
4. How do you promote learning from significant incidents?	2. Hazard identification and risk management

Sample Interview Question	Associated Safety Factor
5. How do you help the company retain institutional memory from previous significant events?	2. Hazard identification and risk management
6. Are HSE topics discussed in performance evaluations?	3. Personal accountability
7. Is there any "pay at risk" associated with HSE performance?	3. Personal accountability
8. Have you ever used Stop Work Authority or seen others use it?	3. Personal accountability
9. Do contractors feel comfortable using Stop Work Authority?	3. Personal accountability
10. Will supervisors and managers support you if you do use it (even if you are wrong)?	3. Personal accountability
11. How is the SWA message communicated?	3. Personal accountability
12. Does this company/facility use HSE metrics?	5. Continual improvement
13. Do you see them?	5. Continual improvement
14. Is your work affected by them?	5. Continual improvement
15. Can you think of any specific metrics that are tracked and communicated up and down the chain of command?	5. Continual improvement
16. Give examples of how you encourage an environment where workers are comfortable questioning in appropriate ways management/supervision decisions.	5. Environment for raising concerns
17. Near miss reporting is encouraged by managers	6. Environment for raising concerns
18. Near miss reporting is taken seriously by workers.	6. Environment for raising concerns
19. How do you help ensure that you are not being insulated from bad news?	7. Effective safety and environmental communication
20. How is the organization's HSE function viewed by people in your area? (helpful, value adding, not value adding, in the way of progress, etc.)	8. Respectful work environment
21. Do you trust your co-workers, contractors, supervisors, and managers to do the right thing, follow procedures and work safely?	8. Respectful work environment
22. Do you think people get complacent about the hazards they face on the job in the facility? Can you think of any specific examples?	9. Inquiring attitude
23. Do you receive adequate training to perform your job safely?	9. Inquiring attitude
24. How strong do you believe the safety culture is at this facility (1=low; 10=Hi)?	
25. If you could change one thing to improve the HSE programs at the facility, what would it be?	

Sample Interview Question	Associated Safety Factor
Backup Questions	
1. Does your supervisor consistently demonstrate his/her commitment to safety by (1) following the rules and (2) insisting that I follow the rules? Provide examples, positive or negative	1. Leadership
2. Does your facility manager "walk the talk" when it comes to safety. If there is a choice between safety and production, the manager will choose safety every time? Provide examples, positive or negative	1. Leadership
3. Does your facility manager (1) visit your work area often, (2) when she/he does visit they bring a meaningful safety topic to discuss, and they (3) stop talking long enough to listen to my concerns?	1. Leadership
4. Which philosophy is your management inclined to follow: ensure something is safe to proceed, or prove something is unsafe before proceeding? Provide examples, positive or negative	2. Hazard Identification and Risk Management
5. At your facility, is there more to safety than full compliance with all rules and regulations?	2. Hazard Identification and Risk Management
6. Can you think of any instances where the safety message was not clear at your facility? In other words, have there been any times when other very important goals began to get in the way of safety goals?	7. Effective Safety and Environmental Communication
7. Would you say there are enough people (and other resources) available to ensure safe operations? Provide examples, positive or negative	4. Work Processes
8. How would you describe the maintenance backlog for safety-critical tasks? In other words, are these tasks completed soon after the issue is raised?	4. Work Processes
9. Do you understand what a change is, rather than a replacement-in-kind? Were you given any formal training on that concept?	5. Continual Improvement
10. Are MOCs (Management of Change) used whenever there is a change to the process or procedure?	5. Continual Improvement
11. Are the follow-up actions identified in MOCs generally completed before their due dates?	5. Continual Improvement
12. Are disciplinary actions taken at your facility fair? Can you comment on why or why not?	8. Respectful Work Environment
13. When your facility investigates an incident, are they more concerned about assigning blame, or in solving the problem?	9. Inquiring Attitude
14. Would you be comfortable stopping work, or even the process, if you felt that something about the work or process was unsafe?	6. Environment for Raising Concerns
15. Do you know of any examples where your facility has demonstrated that they are concerned about your safety off-the job?	8. Respectful Work Environment

Sample Interview Question	Associated Safety Factor
16. Have you been involved in writing procedures, hazard assessment or JSAs (as a front-line worker)? Otherwise, if not a front-line worker, have you seen front line workers involved in these activities that directly impact their job?	3. Personal Accountability
17. Do you have a written job description? Does it clearly outline your safety responsibilities?	7. Effective Safety and Environmental Communication
18. Would you say that production areas accept ownership of safety programs and performance in their area, or do they look to the EHS department as the owner?	3. Personal Accountability
19. Do workers accept personal responsibility for their safety?	3. Personal Accountability
20. Have you seen times when someone has cut corners on safety, particularly when no one is looking?	3. Personal Accountability
21. Do you feel like workers at this facility understand how and when to report incidents and near misses? Are they doing it?	2. Hazard Identification and Risk Management
22. Are the results of incident investigations and near misses shared with other workers (inside and outside of your facility)?	2. Hazard Identification and Risk Management
23. Do you feel like your facility pays attention to early signals and responds properly to them so that small problems don't become big problems? Examples may be near miss reports or process parameters that are deviating from normal limits (e.g., vibration monitoring on rotating equipment).	2. Hazard Identification and Risk Management
24. Is there an unhealthy sense of comfort and well-being at your facility or within a particular work group who may not fully appreciate the hazards that involved?	5. Continual Improvement
25. Are you comfortable raising safety concerns with your supervisor if you feel like they are wrong?	6. Environment for Raising Concerns
26. Can you think of any work processes that are too complicated; could be simplified? Have you offered suggestions to simplify? How were the suggestions received?	6. Environment for Raising Concerns
27. Have you offered suggestions to simplify? How were the suggestions received? Was action taken?	6. Environment for Raising Concerns
28. Is the rigor given to an incident investigation tailored so that, for example, incidents with low hazard/risk do not require the effort to conduct the investigation and to report the results of the investigation as would an incident with much high hazard/risk?	2. Hazard Identification and Risk Management
29. My manager has a clear expectation that corrective actions (e.g., PHA, investigations, and audits) are completed before their due date? Specifically, my performance review will be negatively impacted if I have a pattern of overdue completion of action items?	2. Hazard Identification and Risk Management
30. Does this facility track open and overdue action items and periodically report those results? Are they currently trending up, down, or steady?	2. Hazard Identification and Risk Management

Sample Interview Question	Associated Safety Factor
31. Do your supervisors, manager, and co-workers value your opinion, especially when your opinion is about something where you are an SME?	8. Respectful Work Environment
32. Is there a collaborative spirit in your work force or does it tend to be dominated by the loudest, most vocal individuals?	8. Respectful Work Environment
33. How do personnel in your facility determine if there is enough redundancy in place to make sure enough protection is in place against a hazard?	4. Work Processes
34. Is there a system in place to make sure protective systems are independent from each other?	4. Work Processes
35. Has there been any effort taken to identify abnormal conditions and put protections in place to mitigate those conditions?	5. Continual Improvement
36. Has adequate staffing (including call outs) has been provided to address hazards that have been identified for abnormal conditions?	4. Work Processes
37. Would you say the equipment at your facility has been designed to minimize incidents due to human error (to a practical extent)?	4. Work Processes
38. How would you characterize the operating and maintenance procedures? For example, (1) do they contain the right amount of detail, (2) are they up-to-date, and (3) are they accurate?	4. Work Processes
39. How would you describe the training programs? For example, (1) do they have the right information, (2) is retraining adequate, and (3) is the delivery method well thought out to help keep your interest?	5. Continual Improvement
40. Do you know what training you are supposed to take over, say, the next year, with reminders to make sure it is completed on time?	5. Continual Improvement
41. Have you been made aware of competencies that are expected of persons in your job role? Have you been given the opportunity to fill any competency gaps that may have been identified?	5. Continual Improvement
42. Is critical equipment tested consistent with its assigned frequency?	4. Work Processes
43. Do you feel like appropriate steps are taken if equipment is found to be at, or beyond, its design parameters (e.g., wall thickness)?	4. Work Processes

4. Site Visits and Audits

4.1 Introduction

The purpose of this section is to describe (1) the motivation for a site visit, (2) the guidance related to how to perform an effective site visit, and (3) a means to document the results of the site visit so that the results can be incorporated into the culture assessment. A job aid for this task has been developed, see NAS Safety Culture Toolkit - Site Walkthrough Job Aid.pdf.

4.2 Workflow

The workflow on the site visit and facility walkthrough data collection in the safety culture assessments is as follows:

Figure 3. Site visits and audits workflow

4.3 Motivation for the Site Visit

In contrast to perception-focused data from surveys and interviews, data obtained from a site visit and facility walkthrough by the assessment team provides "hard" data. The assessor can physically observe the conditions at the facility. The site visit provides the opportunity for the culture assessment team to collect hard data regarding the physical facility. This is important because it helps to provide a clearer picture of the safety climate and culture. The hard, physical data is compared to the softer, perception data from surveys and interviews to support or refute information collected from perceptions. For example, a common perception expressed in the survey may be that housekeeping is a problem. During the site visit, the assessment team may observe that housekeeping is quite good. The assessor can then draw conclusions about the perception vs. reality. If the difference is pronounced, a suggestion may be offered to help remedy the gap between perceptions expressed and the reality that was observed.

Facility workers can sometimes feel like they are being audited, and that is understandable. Indeed, the site visit can feel like an audit; some of the same questions may be asked and some of the same information reviewed as would be asked and reviewed in an audit. There is, however, a very distinct difference in the way that the information collected is used. The auditor typically compares actual performance against some internal or external standard. If there is a gap between the

standard and actual performance, then a finding/observation is offered followed by a recommendation to close the gap.

By contrast, the culture assessor is looking for any information that may help describe the culture. This information can be positive, negative, or indifferent. If negative information is collected in the site visit, such as in the housekeeping example, then the "culture disconnects" can be explored. The anticipated result is not a list of findings. Instead, it is hoped that enough evidence can be collected so that an accurate picture of the culture can be assembled. Ultimately, when the culture is understood, facility workers can build on and leverage the strengths while focusing on improvement opportunities for the weaker safety factors.

4.4 Schedule and Confirm the Visit

Coordinating the site visit with the facility is the key element to success of the site visit. It is important to make sure that all conflicting activities at the site are identified such as planned turnarounds or other activities that may require the attention of key site personnel. It is suggested that site visits are planned several months in advance and that key personnel are identified early in the planning process, both from the site and from the assessment team. The site visit should include an opportunity for the assessment team members to attend one or more routine safety meetings, if possible. This will provide a setting for the assessment team members to observe the content, quality, and participation in these meetings.

It should be clear to site personnel that the assessment team will be reviewing site facilities, but the tone of the site visit will be considerably different from typical assessments that they have previously participated in. The assessment team will not be interested in seeking out violations or findings as would typically be done in a compliance audit. Instead, the assessment team will be looking for cultural evidence in the form of hard data to compare to the soft data from interviews and surveys (perception data). From this comparison, it will be clearer what the current culture is at the facility. The spreadsheet: NAS Safety Culture Toolkit - Site Walkthrough FINAL.xlsx may be used to record and score the results of the site visit. This spreadsheet can be shared with the facility, but the facility is encouraged to not engage in any "assessment preparations" to address items prior to the audit. The greatest benefit to the site will occur if the culture assessment team is introduced to the site in the same condition as is typical for the facility.

Provide ample opportunity for the site leaders to ask questions and gain a clear understanding of the purpose of the visit. Meeting with the facility managers prior to the site visit should be considered. In this meeting, the Assessment Team Leader can present a brief description of what will transpire during the visit and provide an opportunity for the managers to comment and ask questions.

4.5 Conduct the Facility Walkthrough

The length of the site visit can be tailored to accommodate the availability and input from facility personnel. By nature, larger facilities with a higher number of individual processes will extend the length of the visit. Based on past experiences, site visits generally take approximately 2 to 4 hours per facility.

Site visits can be conducted during the same visit in which interviews are conducted, if possible. The facilities that are to be visited will vary. One strategy that has been found useful is to select one of the older units or areas on the facility and one of the newest units or areas. This will provide some sense as to how the facilities are managed. For example, in some cases older facilities may not receive the same amount of attention and resources as newer facilities especially if there is a pronounced difference in the profitability of the various units.

One key to a successful site visit is to make sure that all information being obtained is completely transparent to the facility. In most cases, there will be a facility representative who walks through the facility with the assessor. With the site representative readily available, the team members can ask clarifying questions immediately that otherwise may be misunderstood without access to current information from the facility.

It is desirable, although not always necessary, to take pictures during the site visit. On some facilities this may not be practical due to Facility policies requiring intrinsically safe devices and/or confidentiality concerns. However, in cases where pictures are allowed, they become very useful in describing the concern or positive example to the management team. With a picture, it becomes absolutely clear what the issue was and where the issue may have been observed. In those cases where pictures are allowed, the assessment team will make it clear that all pictures are the property of facility, and that none of the pictures will be used outside of clarity purposes in the closing meeting.

When visiting an facility and performing a walkthrough, there are some health & safety-related items that will almost always be present and should be examined prior to and over the course of the walkthrough. These can be broken up into categories such as the initial site safety briefing/orientation, impromptu discussions with personnel, housekeeping, work observations, equipment conditions, and so on.

4.6 Site Observations and Facility Walkthrough Results Scoring

Safety culture artefacts collected during the facility walkthrough will mainly be behavior data, with the potential for some system-related observations. The observation data will be fact based (from the perspective of the assessor) and will have limited scoring associated with this information.

The spreadsheet has several items that historically have been seen as hallmarks of a good culture and opportunities for improvement, both are noteworthy. Some or all the questions in the spreadsheet can be used and tailored to the organization. The file's name is "NAS Safety Culture Toolkit – Site Walkthrough – FINAL.xlsx". The spreadsheet automatically generates a score. A traffic light grading system allows easy visualization of the results and a percentage score. Where >85% (Green) – most items appear to be in good practice; 70% - 85% (Yellow) - some items appear to be in good practice, or 70% - (Red) opportunities for improvement have been identified. The grades are based on 1) Yes, the attributes of the question are satisfied; 2) Partial, where some of the attributes are satisfied; and 3) No, where minimal evidence is seen regarding the question's attributes; and 4) Not Applicable. There is also a comment area where the assessor can further elaborate on any grade that is assigned to a question. These can be positive or represent opportunities for improvement.

If there are any findings or non-conformities associated with organizational policies/procedures noted over the course of the review, they should be brought to the attention of facility managers or other responsible party so that the findings can be addressed, and if necessary, a corrective action plan can be created.

5. Incident Investigation Reviews

5.1 Purpose

A review of incident investigation reports can provide insight into the safety culture of a facility. This section will describe how a safety culture assessment team can extract safety culture data from the quality of the incident investigation process and from the content of the incident investigation reports.

5.2 Incident Types

At a facility, there are many different types of incidents that are required to be reported. These incidents range in severity of their impacts from mild to major and can be caused by a variety of different failures in a safety management system. These incident type descriptors are commonly used, but are not limited to:

Unsafe Condition: A physical condition existing in a workplace that has the potential to cause a health and safety incident.

Unsafe Behavior/Act: A person performing a task in a manner that may threaten the health and safety of other personnel and or themselves.

Near Miss: A Near Miss is an event where no contact or exchange of energy occurred and thus did not result in personal injury. The following other situations should be reported within the company as near misses:

- Injury/Illness affecting non- workers
- Injury/Illness affecting worker personnel, that is not work-related or a non-work-related event
- Damage to property owned by client's or third parties, where the incident did not occur on company-controlled premises

Contact-Only: An incident which resulted in the contact or transfer of energy to a worker; either resulting in no noticeable injury/illness or was deemed not necessary for treatment (first aid or medical).

First Aid: An incident which resulted in the injury/illness of a worker and did not require treatment beyond first aid. However, the incident did not result in restricted duty, transfer of duty or lost time.

Medical Treatment: An incident which resulted in the injury/illness of a worker and medical treatment beyond first aid was required. However, the incident did not result in restricted duty, transfer of duty or lost time.

Restricted Duty: An incident which resulted in the injury/illness of a worker and was placed restricted duty for the day following the incident or beyond (by a medical professional); regardless of if the next day was a holiday, day off or planned vacation day.

Lost Time: An incident that has resulted in the injury/illness of a worker and the worker was deemed by a medical professional as being unable to return to work in any capacity the day after the incident occurred; regardless of if the next day was a holiday, day off or planned vacation day. The number of lost days can range from one day to several months.

Fatality: An incident resulting in the loss of life of one or more workers.

5.3 Incident Investigations

All incidents reported within an organization's reporting system should have been evaluated for investigative purposes and assignment of possible corrective actions. This task normally lies with a regional HSE or the organization's HSE team. During the investigation, corrective actions may be assigned to reduce the likelihood of similar incidents occurring in the future. Any such actions and their final resolution should be stored in the organization's reporting system.

Based on the severity of the incident a formal investigation may be needed, including on-site visits and witness statements. The organization's HSQE Department will determine when this is necessary and coordinate any follow-on actions with the applicable department or regional personnel. The incident investigation team may consist of personnel from various levels and physical locations. The lead on the team should have attended a formal training course in Incident Investigation from an organization approved by the organization's HSQE Department.

The results of such investigations will be made available to all individuals. Copies of these forms will be stored as attached electronic documents in the incident report within the company review system.

During review and investigation of the incident report, the initial reviewer should perform an analysis to determine the causal factors (root cause analysis) of the incident, for any of the following incident types/scenarios:

- Fatality or Injury/Illness (not including first aid cases)
- RAM (Risk Assessment Matrix) indicating potential severity of Major or Severe.

This information is normally captured within the incident file in the company reporting system. Any recommended corrective actions noted in the report should have been be carried out prior to review, approval, and closure of the final report.

5.4 Workflow

The process for collecting incident investigation reports is as follows:

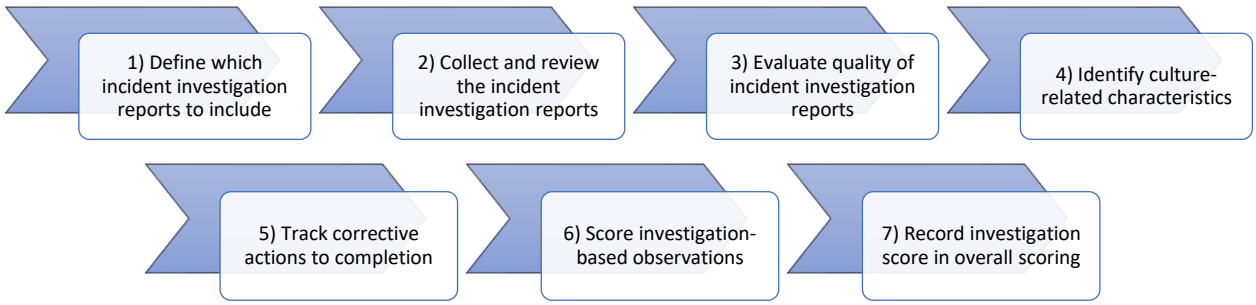


Figure 4 Incident investigation report collection process

5.4.1 Define which incident investigation reports to include.

The number of incident investigation reports at a facility can vary widely depending on factors such as the number of workers at the facility, dates of interest to the assessment team, and accepted or encouraged reporting practices. Accordingly, the number of investigation documents that are reviewed in the assessment will vary. The approach will be to have a list of all incident investigation reports that relate to the topic of the culture assessment (e.g., general safety, process safety) over the period of interest. Without additional direction, a reasonable place to start is by filtering data from the previous 5-year period.

At this point, the assessor reviewing these reports will need to compare the time available for this review with the number of reports that are in scope and request the reports accordingly. That will establish the number of reports that can be reviewed. If there are more reports than time available, a representative sample should be selected randomly across the entire period of interest.

5.4.2 Collect and review the incident investigation reports.

The facility will provide the selected incident investigation reports to the assessment team. If the report format (electronic vs. hard copy) permits, this is preferably done several weeks prior to the assessment and the review of them is complete before the onsite assessment. This step can, however, be done while onsite, but there is a cost/time penalty for doing so.

5.4.3 Evaluate the quality of the incident investigation reports

The quality of the incident investigation reports is indicative of the priority that the facility places on learning from previous incidents; a key element of a safety-conscious culture. contains a checklist of characteristics that may be found in an incident investigation report. The assessment team should evaluate a sampling of investigation reports and use this checklist to provide a qualitative assessment of each incident investigation report.

A spreadsheet has been developed to aid in the review: NAS Safety Culture Toolkit - Incident Investigation Review FINAL.xlsx as well as a job aid: NAS Safety Culture Toolkit – Incident Investigation Review Job Aid FINAL.pdf.

Definitions:
Some of the following terms are used in the Incident Investigation Report Quality Evaluation Form below. To standardize the responses in the form, the following definitions have been provided:

Loss Events: Also referred to as operational events, risk events, or incidents, they refer to any atypical situation where an irreversible physical event occurs with the potential for loss of health or time.

Causal Factor: Any contributing cause to an incident, regardless of the size of its role in the incident. There can be many different causal factors leading up to an incident, and there doesn't have to be a direct cause-effect relationship between these factors.

Root Cause: An initiating cause of either an incident or a causal chain that leads to an incident. It is the deepest, earliest, or most basic cause for an incident, and only one can exist for any incident.

5.4.4 Identify Culture-Related Characteristics

In addition to the general quality of the incident investigation, the investigation report will often contain content that points to a safety culture strength or weakness. These indicators can be found anywhere in the report from the description through the cause-and-effect analysis and the recommendations. The phrases given in

Table 4 can serve as examples of indicators of safety culture data contained in the incident investigation reports. The phrases given in the table are examples only and are given here to illustrate the kinds of content that may prove useful in describing the culture.

Table 4. Example Phrases That May Signal Safety Culture Content

Safety Culture Factors	Culture Attributes	Key Phrases in Incident Investigation Reports
Leadership Commitment to Safety Values and Actions	Leader Commitment to Safety	Production pressure to
		Managers not involved
		Wrong priorities
	Conservative Bias in Decision Making	Decision was made to
	Communication of Safety Importance	Unaware of hazard
	Provision of Sufficient Resources for Safety (people, financial, equipment, resources)	Insufficient (or inadequate) tools, people, resources
Hazard Identification	Reporting and Communication of Threats and Risks	This has happened before
		Unknown hazard

and Risk Management	Risk Detection and Situational Awareness	Not aware
		Wrong place or position
	Work Design is Practical	The design made it impossible/impractical to do the task correctly
		Difficult to access
Personal Accountability	Workforce Commitment to Safety	Contrary to policy
	Roles, Responsibilities and Authorities support Personal Accountability for Safety	Not my job
	Safe Work Behaviors	Made a mistake
		Did not follow procedure
Work Processes	Systemic and Rigorous Management of Changes	MOC was not conducted
		MOC did not identify
	Reluctance to Simplify	Too complicated
		Hard to understand
	Found Errors are Fixed	Repair was not made
		Action was not taken/completed
	Redundancy in Safety System	One of the barriers failed
	Facility and Equipment Health	Equipment failed
		Excessive corrosion
Continual Improvement	Preoccupation with Failure	Assumed incorrectly
	Investigation and Learning from Incidents	This incident has occurred before
Environment for Raising Concerns	Fair Environment	Blame
Effective Safety and Environmental Communication	Adaptability for Abnormal Conditions	We have never seen this before
Respectful Work Environment	Deference to Expertise	The right person was not contacted
Inquiring Attitude	Training Programs	Insufficient training
		Ineffective training
	Competence	Did not know how to

5.4.5 Track Corrective Actions to Completion

The importance that an organization places on timely completion of corrective actions identified in incident investigations is an indicator of the safety culture of both managers and workers. The facility should have a work process in place to track corrective actions to completion. Ideally, this tracking system will have automatic reminders to notify the owner that a corrective action is

approaching its due date. The action tracking mechanism should also include the requirements to extend the due date of open action item, including the review and approval that is required to implement an extension. The safety culture assessment team may want to consider the following items when evaluating the completion of corrective actions:

- A procedure exists that explains requirements for action and corrective action completion
- Investigation reports contain clear corrective actions that are directly traceable to all aspects of the investigation that led to the corrective action
- One person should ultimately be responsible for ensuring the completion of the corrective action
- The corrective action should contain a realistic estimated completion date
- The corrective action plan should include management review and endorsement
- The corrective actions required and associated timings should be clearly communicated to the persons responsible
- An action tracking tool should be used to actively follow all items through to full completion
- The action tracking tool should include a clear description of the work that was done to complete the item, and not just a status column with "complete" noted
- Corrective actions are not to be considered complete until an independent verification is conducted and recorded
- A system should be in place for extending due dates, including the rationale for extending the due date along with the proper approvals
- A process should be in place to communicate the status of action/recommendation completion to facility managers, typically in the form of key performance indicators (KPIs) with high visibility metrics

The assessor should carefully review the completion of a representative sample of corrective actions from each of the audits culture assessment. The number of corrective actions followed to completion will vary depending on the number of incident investigation reports and associated corrective actions available to the culture assessment team and the amount of time available to the assessors. Typically, the assessment team will review approximately 10 corrective actions spanning all reports reviewed, if available. Any concerns from this part of the assessment can also be included with the other incident investigation observations.

5.4.6 Incident Investigation Evaluation Scoring

Safety culture artefacts collected during the evaluations of incident investigations will mainly be behavior data, with the potential for some system-related observations. The evaluation data will be fact based (from the perspective of the assessor) and will have no numerical scoring associated with is information. Unlike the surveys, where the raw data is already numerical (except for the open-ended text questions), data collected during the evaluations of incident investigations is not quantitative and is unpredictable in content. Therefore, the assessor will perform a four-step process to compile, report, and consolidate the raw information ultimately into an overall numeric score:

1. The assessor will review all notes recorded during the evaluation of incident investigations and identify those items which are most impactful.

   Note that while "impactful" data from the evaluation is subjectively designated as such by the culture assessment team members, the following are two criteria for separating out impactful statements. The first is repeated observations (e.g., repeat incidents) or a consistent pattern of incomplete follow up to corrective actions documented in the incident investigation reports. The second is an important observation (e.g., violation of a safety-critical work process).

2. A spreadsheet has been developed to aid the reviewer. The spreadsheet contains typical questions when reviewing previous incident reports. Some or all the questions in the spreadsheet can be used and tailored to the organization. The file's name is "NAS Safety Culture Toolkit – Incident Investigation Review – FINAL.xlsx"
3. The checksheet automatically generates a score. A traffic light grading system allows easy visualization of the results and a percentage score. Where >85% (Green) – most items appear to be in good practice; 70% - 85% (Yellow) - some items appear to be in good practice, or 70% - (Red) opportunities for improvement have been identified.

6. SEMS-related Audit Reviews

6.1 Purpose

A review of previous audit reports can provide insight into the safety culture of the facility. This section will describe how a culture assessment team can extract culture data from audit findings and the resolution of recommendations from the audits that have safety culture indicators.

6.2 Workflow

The following is the workflow for the audit reviews.

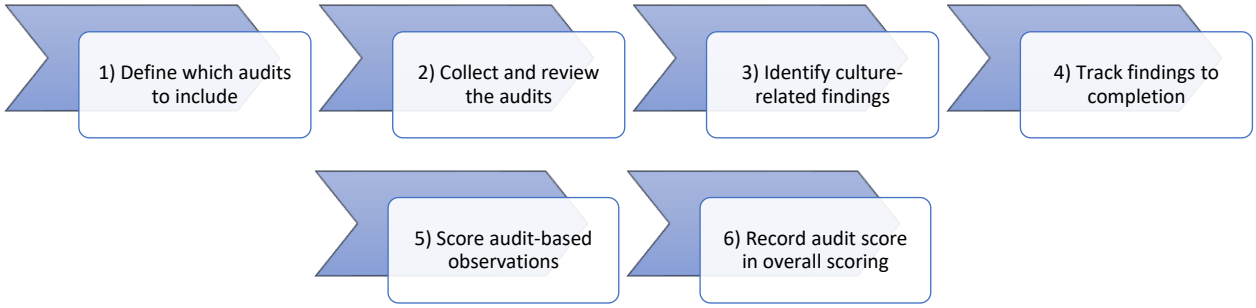


Figure 5. Audit review workflow

6.2.1 Define which audits to include

Audits are a common occurrence in all operating facilities. The culture assessment team should review audits from all available sources. Some of the likely audits that can be included in the culture assessment are:

1. Regulatory audits (e.g., SEMS, ISM, Environmental, Etc.)
2. Internal organization audits (e.g., Internal SEMS or HSQE audits, etc.)
3. Facility site-driven audits
4. Industry benchmarking audits

The number of audits used in the culture assessment would depend on how many audits are available and the time available to the assessment team. The assessment team should limit the audits included in the review to those that are recent. More specifically, audits completed within 12 months shall be in scope and audits, due to their significance or type and/or due to their frequency or cycle, that may be 12-36 months old. If many audits are available to the culture assessment team, then it is suggested that the audits from diverse sources be reviewed and the audits selected should be representative of all audits but limited to perhaps a maximum of four audits total.

6.2.2 Collect and review the audits

The facility will provide the selected audits to the assessment team. This is preferably done several weeks prior to the onsite assessment and the review of them is complete before the assessment. This step can, however, be done while onsite, but there is a cost/time penalty for doing so.

6.2.3 Identify culture-related findings

While not every type of audit finding with safety culture indicators can be practically listed here, some of the more common types of audit findings that may point towards safety culture indicators are listed below. It will be the responsibility of the assessor to determine from the full context of the finding if a significant safety culture indicator is included in the finding. Findings related to the following may have culture indicators:

- Management system failures
- Management system inadequate
- Action or inaction of managers
- Action or inaction of workers
- Failure to follow procedures
- Operating or maintenance procedures inadequate
- Operating or maintenance procedures confusing
- Excessive stress or pressure to complete a task
- Training inadequate
- Proper tools not available
- Previous actions or recommendations not completed
- Unaware of the hazard
- Insufficient staffing or other resources
- Unusually long work hours or consecutive days required at work
- Repairs not made
- Lack of communication (including for example, shift to shift, shift to maintenance, to/from management, and workers)

When a finding is identified that points to a safety culture deficiency, that culture indicator can be recorded in Table 5. Sample Audit Findings Review Form or file "NAS Safety Culture Toolkit - SEMS-Auditing spreadsheet – FINAL.xlsx," can be used. Typically, a separate form is filled out for each audit reviewed in the assessment. The assessor can provide comments (if any) to help ensure the cultural issue identified with the finding is clear for future reference. The item can then be assigned an attribute that is most closely aligned to the finding.

Table 5. Sample Audit Findings Review Form

Audit Title: ` Audit Date:

Audit Finding	Comment	Safety Culture Attribute

6.2.4 Track findings to completion

The importance that an organization places on timely completion of audit findings and recommendations is an indicator of the safety culture of both managers and workers. The facility should have a work process in place to track recommendations to completion. Ideally, this tracking system will have automatic reminders to notify the owner of the action that an action is approaching its due date. The action tracking mechanism should also include the requirements to extend the due date of open action item, including the review and approval that is required to implement an extension. The safety culture assessment team may want to consider the following items when evaluating the completion of audit recommendations:

- A procedure exists that explains requirements for action and recommendation completion
- Audit reports contain clear recommendations that are directly traceable to all aspects of the finding
- One person is assigned to be ultimately responsible for completing the recommendation
- A realistic estimated completion date is established
- The resolution of findings includes a management review and endorsement of the action plan
- The findings and actions required, including completion dates, are clearly communicated to the persons designated as responsible for completion of the action
- An action tracking tool is in place that actively follows all items to full completion
- The action tracking tool includes a clear description of the work that was done to complete the item (not just a status column with “complete” noted)
- Corrective actions are not considered complete until an independent verification is conducted and recorded to help ensure the item is complete
- A system is in place for extending due dates that include the rationale for extending the due date along with proper approvals
- A process is in place to communicate the status of action/recommendation completion to facility managers, typically a KPI metric with high visibility

The assessor should carefully review the completion of a representative sample of recommendations from each of the audits culture assessments. The number of recommendations followed to completion will vary depending on the number of audits and findings available to the culture assessment team and the amount of time available to the assessors. Typically, the assessment team will review approximately 10 recommendations from each of the audits that are evaluated.

6.2.5 Audit Review Scoring

Safety culture artifacts collected during audit reviews will mainly be behavior and systems data. The audit review data will be fact-based (from the perspective of the assessor) and will have no numerical scoring associated with is information. Unlike the surveys, where the raw data is already numerical (except for the open-ended text questions), data collected during the audit reviews is not quantitative and is unpredictable in content. Therefore, the assessor will perform a four-step process to compile, report, and consolidate the raw information ultimately into an overall numeric score:

1. The assessor will review all notes recorded during the audit reviews and identify those items which are most impactful.

   Note that while "impactful" data from the audit reviews is subjectively designated as such by the culture assessment team members, the following two criteria are for separating out impactful statements. The first is repeated findings in multiple audits or a consistent pattern of incomplete follow up to audit recommendations. The second is important findings recorded in the audits (e.g., violation of a safety-critical work process).

2. To perform the mapping of the audit review data (positive and negative) to the attributes, the analyst will assign attributes to the impactful observations from the review, or groups of common observations.

3. A spreadsheet has been developed to aid the assessor in the review. The spreadsheet contains typical questions when reviewing previous audit results. Some or all the questions in the spreadsheet can be used and tailored to the organization. The file's name is "NAS Safety Culture Toolkit - SEMS-Auditing spreadsheet – FINAL.xlsx". The spreadsheet automatically generates a score. A traffic light grading system allows easy visualization of the results and a percentage score. Where >85% (Green) – most items appear to be in good practice; 70% - 85% (Yellow) - some items appear to be in good practice, or 70% - (Red) opportunities for improvement have been identified.

7. Potential Leading Indicators

7.1 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 improve future safety performance. This Section introduces the basic concepts and principles of a Leading Indicators Program. A more detailed literature review on potential leading indicators can be found in the Appendix.

Objective leading indicators are identified by correlating safety metrics with safety performance data. Safety performance data requires normalization before statistical analysis, to enable valid comparisons of different installations, etc.

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

- The Organization
- Geographical Locations
- The Facilitys (an operator's collection of offshore installations)

Subjective leading indicators are identified by correlating survey responses with safety performance data for the last twelve months. 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. The subjective leading indicator approach does offer the possibility of identifying new metrics for the organization to collect. Subjective leading indicators are mainly based on the safety culture survey which has been discussed in Chapter 2.

7.2 Leading Indicator Program

7.2.1 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 most 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 several 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 should 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 should have been collected for some time: at least five years for an organizational level analysis, and at least one year for both the geographical locations analysis, or the analysis of facilitys.
- A subjective leading indicators assessment requires that a safety culture survey is performed and the results utilized.

7.2.2 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.

The costs of conducting the assessment are:

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

The benefits of the assessment are:

- 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 worker awareness of safety-related issues
- Can identify areas of strength and weakness

7.3 Offshore Leading Indicators

The offshore leading indicators are proposed and categorized based on BSEE safety culture factors (Lou, et al., 2021) as shown in the following table.

Table 6. Offshored Safety Leading Indicators Categorized in Safety Culture Factors

BSEE SCF Title	Leading Indicators
1. Leadership Commitment to Safety Values and Actions	• Routine safety-related meetings where results of safety audits, issues and concerns are shared with the crew • Routine meetings exist where the offshore crew has ample opportunity to express safety-related concerns to managers and supervisors • The annual budgets provide adequate funding for programs to identify and correct safety issues, including, for example adequate funding to support the mechanical integrity preventive maintenance programs • Senior management is visible throughout the facility including routine attendance at safety meetings • Managers and supervisors actively promote stop work authority and have a track record of supporting workers when stop work authority is exercised • Managers include the completion of action items from audits, inspections, hazard assessments, MOCs, incident investigations, etc. are included as KPIs and open items are addressed routinely in management meetings
2. Hazard Identification and Risk Management	• Human factors (including aspects such as ergonomic stresses) are an integral factor included in the design, operation and maintenance of installations • All necessary personal protective equipment (PPE) is provided for the crew and is readily accessible • Personnel at the facility are provided information on the hazards they may encounter and are given the information needed to safely perform their work • Personnel are trained on hazard and risk assessment, including human error • Procedures involving hazardous operations include safety checklists
3. Personal Accountability	• Crew involvement in safety improvement initiatives is an expectation for all job roles and is included as a topic in annual job performance reviews • Crew members understand their roles and responsibilities regarding stop work authority • When the safety of a situation is in doubt, the first assumption is that it is unsafe and a safe situation should be demonstrated before proceeding, rather that assuming it is safe and an unsafe situation should be demonstrated to stop the work • Workers welcome opportunities to share their experience (e.g., process hazard analysis, incident investigation teams, safety committees) • Workers are responsible for completing their safety training on time • Safety checklists in procedures are reviewed upon completion • Mechanical integrity and preventive maintenance inspections are completed on time • Concerns identified in mechanical integrity and preventive maintenance inspections are addressed in a timely manner • Corrective actions from audits, inspections, hazard assessments, MOCs, incident investigations, etc., are completed in a timely manner and are tracked to completion • Required completion dates extended

4. Work Processes	• Responsibilities and accountabilities for safety are clearly documented • The facility has a documented off-the-job safety program • The facility has a safety committee that includes all levels in the organization and meets regularly • Short service workers have received the training necessary to do their jobs safely • Hiring policy/procedure is documented and includes the safety aspects associated with the work the potential worker are required to know • A new hire interviewer training program is documented and includes gauging the potential worker's safety awareness and commitment • Job descriptions are documented for all jobs onsite and they all include requirements to follow safety procedures, instructions, rules, and consequences associated with failure to follow these safety requirements • A policy and/or procedures is documented for reporting unsafe conditions and all worker's onsite are trained on these requirements • A policy exists to complete pre-operational checks (e.g., job safety assessment) and all workers onsite are trained on these requirements • Establishment of a Safety Management System (SMS) in accordance with OHSAS 18001 • The facility has a documented Environmental Management System (EMS)meeting the requirements of ISO-14001. The EMS is routinely audited • Establishment of a Process Safety Management (PSM) consistent with the requirements of the OSHA requirements from 29 CFR 1910.119 and EPA's RMP program from 46 CFR 68 • The facility has a documented fatigue management program consistent with the requirements from API RP 755. All affected workers are trained on the requirements of this program • Presence of an induction training program that meets regulatory requirements • The facility has a documented procedure addressing the proper response to emergencies. All affected workers are trained on this procedure • A procedure is in place and documented for workers and contractors to anonymously express safety concerns and make suggestions. Affected personnel are trained on the use and importance of this system • The facility has a behavior-based safety program and actively promotes its use, by, for example, positive recognition for participation
5. Continual Improvement	• Workers and contractors at the facility are involved in continual safety improvement (e.g., offer suggestions, improve procedures) • The facility periodically solicits worker and contractor opinions and attitudes through safety perception surveys • Facility managers and supervisors (with input from workers) has set and updated safety goals and a leading indicators program • All safety-related training is completed on time • Operating and maintenance procedures, and policies are periodically reviewed on an established schedule
6. Environment for Raising Concerns	• Worker and contractor concerns and suggestions are treated seriously and positively, meaning managers and supervisors act on the suggestions and regardless if action is, or is not, taken feedback is given to person making the suggestion • Workers and contractors are openly recognized for suggestions they have submitted • Managers and supervisors utilize a suggestion tracking system to help ensure all are addressed • Completion of suggestion follow up is included as a KPI that is periodically reviewed by managers

7. Effective Safety and Environmental Communication	• All facility personnel are trained on channels of communication, instructing them on effective means to hear and be heard • A company (or facility) newsletter is published periodically. The newsletter contains (among other things) information on incidents, near misses, and progress against established safety goals and leading/lagging indicators • Lines of communication include bulletins, toolbox talks, or similar regarding lessons learned or alerts regarding incidents that could have installation-wide, or facilities-wide, application • Safety communications and safety-related training are provided in native languages • Leaders are trained to listen • Procedures are documented for safe and effective shift handovers. Tools are provided to help transfer information and affected personnel are trained on the procedures and tools • The facility employs various mechanisms for communicating safety issues to workers (e.g., newsletters, toolbox talks, meetings, training, incident findings) • Information on important safety issues is "pushed" (e.g., meetings, email) rather than pulled (e.g., expectation for workers to "look it up") • The findings and corrective actions from incident investigations are communicated to all affected workers • Managers and supervisors routinely summarize the facility's progress and performance against safety goals and leading/lagging indicators
8. Respectful Work Environment	• Establishment of a fair system for incident investigation and corrective actions • The focus of incident investigations is to solve the problem, not to assign blame • Establishment of a non-retaliatory policy for reporting of incidents • Managers and supervisors welcome input from workers and respect suggestions and comments that are offered
9. Inquiring Attitude	• Near miss reports and hazard identifications are encouraged, rewarded, and acted on • Workers routine question "why?" when the situation is not normal • The facility has a documented troubleshooting procedure outlining the approach to take so safely solve abnormal conditions • Workers actively participate in a behavior-based safety program

7.4 Safety Performance Data

7.4.1 Organizational Level Safety Performance Data

The safety performance data for the organizational level covers both operational data and health and safety data, for both fixed and floating installations; this is shown in Table 7, "Safety Performance Data for the Organization". Survey data can be normalized using Table 9, "Normalizing Safety Performance Data".

Table 7. Safety Performance Data for the Organization

Operations Data for the Organization	Health and Safety Data for the Organization
Loss of Position Incidents Frequency	Lost Time Accidents Frequency
Emergency Disconnects Frequency	Restricted Work Accidents Frequency
DP Loss of Integrity Frequency	Total Recordable Cases Frequency
Emergency Blowdown Frequency	Medical Treatment Case Frequency
Emergency Shutdown Frequency	First Aid Case Frequency
Pressure Operator Relief Valve Frequency	Near Misses Frequency
Equipment Damage Frequency	
Materials Handling Incidents Frequency	

Recoverable System Upset Frequency	
Off-Specification Product Frequency	

7.4.2 Facility Safety Performance Data

The safety performance data for the facilities (an operator's collection of offshore installations) covers both operational data and health and safety. This is shown in Table 8, "Safety Performance Data for each Installation". Survey data can be normalized using Table 9, "Normalizing Safety Performance Data".

Table 8. Safety Performance Data for Each Offshore Installation

Fixed Installation Operations Data	Floating Installation Operations Data	Health and Safety Data for the Installation
Emergency Blowdown Frequency	Emergency Blowdown Frequency	Lost Time Accidents Frequency
Emergency Shutdown Frequency	Emergency shutdown Frequency	Restricted Work Accidents Frequency
Pressure Operator Relief Valve Frequency	Pressure Operator Relief Valve Frequency	Total Recordable Cases Frequency
Equipment Damage Frequency	Equipment Damage Frequency	Medical Treatment Case Frequency
Materials Handling Incidents Frequency	Materials Handling Incidents Frequency	First Aid Case Frequency
Recoverable System Upset Frequency	Recoverable System Upset Frequency	Near Misses Frequency
Off-Specification Product Frequency	Off-Specification Product Frequency	
	Loss of Position Incidents Frequency	
	Emergency Disconnects Frequency	
	DP Loss of Integrity Frequency	

Table 9. Normalizing Safety Performance Data

Data Type	Normalizing Factor	Result
Loss of Position Incidents (LOPI)	The total number of major losses of position incidents multiplied by 1 million, divided by the total number of hours on station in the last year.	Loss of Position Incidents Frequency (LOPIF)
Emergency Disconnects (ED)	The total number of emergencies disconnects multiplied by 1 million, divided by the total number of hours producing on station in the last year.	Emergency Disconnects Frequency (EDF)

DP Loss of Integrity (DPLI)	The total number of DP loss of integrity incidents multiplied by 1 million, divided by the total DP hours on station in the last year.	DP Loss of Integrity Frequency (DPLIF)
Emergency Blowdown (EB)	The total number of emergency blowdown incidents multiplied by 1 million, divided by the total number of hours producing on station in the last year.	Emergency Blowdown Frequency (EBF)
Emergency Shutdown (ES)	The total number of emergency shutdown incidents multiplied by 1 million, divided by the total number hours producing on station in the last year.	Emergency Shutdown Frequency (BSF)
Pressure Operator Relief Valve (PORV)	The total number of pressure operator valve relief incidents multiplied by 1 million, divided by the total number of hours on station in the last year.	Pressure Operator Relief Valve Frequency (PORVF)
Equipment Damage (ED)	The total number of equipment damage incidents multiplied by 1 million, divided by the total number of hours on station in the last year.	Equipment Damage Frequency (EDF)
Materials Handling Incidents (MHI)	The total number of materials handling incidents multiplied by 1 million, divided by the total exposure hours (hours worked) in the last year.	Materials Handling Incidents Frequency (MHIF)
Recoverable System Upset (RSU)	The total number of recoverable upset incidents multiplied by 1 million, divided by the total number of hours producing on station in the last year.	Recoverable Upset Frequency (RSUF)
Off-Specification Product (OSP)	The total number of off-specification incidents multiplied by 1 million, divided by the total number of hours producing on station in the last year.	Off-Specification Product Frequency (OSPF)
Lost Time Accidents (LTA)	The total Lost Time Incidents in the last year multiplied by 1 million and divided by the number of exposure hours (hours worked) in the last year.	Lost Time Accident Frequency (LTAF)
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 (hours worked) in the last year.	Restricted Work Accident Frequency (RWAF)
Total Recordable Cases (TRC)	The total recordable cases in the last year multiplied by 1 million, and divided by the number of exposure hours (hours worked) 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 hours (hours worked) in the last year.	Medical Treatment Case Frequency (MTCF)
First Aid Case (FAC)	The total number of first aid cases in the last year multiplied by 1 million, and divided by the number of exposure hours (hours worked) in the last year.	First Aid Case Frequency (FACF)
Near misses (NM)	The total number of near misses in the last year multiplied by 1 million, and divided by the number of exposure hours (hours worked) in the last year.	Near Miss Frequency (NMF)

7.5 Identifying Objective Leading Indicators

7.5.1 General Approach

The organization's safety metrics are correlated with its safety performance data using the Spearman's *rho* test. Safety metrics that are found to be significantly correlated with safety performance 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 Section 2.6, "Utilizing the Findings".

7.5.1.1 Safety Metrics

- Choose safety metrics from the Core Metrics set and the Subsidiary set in Section 7.4, "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 Section 7.4, "Safety Metrics", are not exhaustive.

7.5.1.2 Safety Performance Data

- Collect safety performance data. This is detailed in Section 7.5, "Safety Performance Data".
- The datasheets for data collection are presented in Appendix D, "Safety Performance Datasheets".
- Normalize all data as shown in Section 7.5, "Safety Performance Data".
- The safety metrics and safety performance data should cover the same time period.

7.5.1.3 Correlating Safety Metrics with Safety Performance Data

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 Table 10, "Instructions for Spearman's *Rho* Correlation".

Table 10. Instructions for Spearman's Rho Correlation

Step	Instructions
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.

	$\rho = 1 - \frac{6\sum d_i^2}{n\left(n^2 - 1\right)}$
6	To determine if the *rho* coefficient is statistically significant compare the magnitude of *rho* versus the value obtained from the look-up table (Table 11). 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: $\rho = \frac{\pm z}{\sqrt{n-1}}$ 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 *rho* is larger than the critical *rho* (in Table 11), reject the null hypothesis and conclude that there is a significant relationship between the two variables at the 95% confidence level. If the *rho* is smaller there is no significant relationship between the two variables. A worked example is presented for $n = 39$.

7.5.1.4 Assessing Significance

Compare the obtained value for *rho* with the value in the appropriate column in Table 11, "Critical Values of Spearman's Rho (Two-Tailed)", considering 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 11.Critical Values of Spearman's Rho (Two-Tailed)

Number of Pairs (n)	95% Confidence Level
5	1.000
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

7.5.1.5 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.

7.5.2 Worked Examples

7.5.2.1 Organizational Analysis Over Time

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

a) Select Safety Culture Metrics

Safety culture metrics to be analyzed were selected from the Core Metrics and Subsidiary Metrics lists in section 7.4, "Safety Metrics".

b) Collect Organizational Safety Performance Data

Safety performance data for the organization was collected using the organizational safety performance datasheet provided in Appendix D, "Safety Performance Datasheets". The data was normalized using Table 9, "Normalizing Safety Performance Data". The metrics and safety performance data covered the same timeframe.

c) 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 (Table 9): 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 di (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 12. Correlation at the Organizational Level (n =10)

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
2014	52	10	5.3	2	8	64
2013	50	9	5.2	1	8	64
2012	44	7	6.1	4	3	9
2011	47	8	6.0	3	5	25
2010	32	4	7.2	7	–3	9
2009	36	5	7.0	6	–1	1
2008	38	6	6.6	5	1	1
2007	25	2	7.7	9	–7	49
2006	26	3	7.4	8	–5	25
2005	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.

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

The resulting coefficient is –0.9879.

Step 6: With a sample size of n (10), the critical value (Table 11, "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 ρ (0.9879) > ρ (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 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.

d) Worked Example (n > 30)

As stated in Step 7 of Table 10, "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, n = 39.

Follow Steps 1 to 5 in the instructions in Table 10, "Instructions for Spearman Rho Correlation". 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) < (calculated value, Table 10, Step 7) the null hypothesis should be accepted. This means that the two variables are not significantly related.

For additional critical values of level of confidence, please refer to Table 14,"Critical Values for Larger *n* (Spearman Rho Coefficient)".

Table 13. Correlation at the Organization Level

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
2014	52	39.0	5.3	2.0	37.0	1369.00
2013	50	38.0	5.2	1.0	37.0	1369.00
2012	44	36.0	6.1	5.5	30.5	930.25
2011	47	37.0	6.0	3.5	33.5	1122.25
2010	32	26.5	7.2	17.5	9.0	81.00
2009	36	33.5	7.0	13.0	20.5	420.25
2008	38	35.0	6.6	9.5	25.5	650.25
2007	25	14.0	7.7	22.0	–8.0	64.00
2006	26	16.5	7.4	20.5	–4.0	16.00
2005	22	7.0	7.8	23.0	–16.0	256.00
2004	22	7.0	6.0	3.5	3.5	12.25
2003	21	4.0	6.1	5.5	–1.5	2.25
2002	20	2.0	6.2	7.0	–5.0	25.00
2001	18	1.0	6.4	8.0	–7.0	49.00
2000	23	10.0	6.6	9.5	0.5	0.25
1999	21	4.0	6.8	11.0	–7.0	49.00
1998	25	14.0	7.0	13.0	1.0	1.00
1997	30	21.5	7.1	15.5	6.0	36.00
1996	32	26.5	7.4	20.5	6.0	36.00
1995	31	23.5	7.3	19.0	4.5	20.25
1994	32	26.5	7.2	17.5	9.0	81.00
1993	33	29.5	7.1	15.5	14.0	196.00
1992	34	31.0	7.0	13.0	18.0	324.00
1991	35	32.0	8.0	24.5	7.5	56.25
1990	36	33.5	8.1	26.0	7.5	56.25
1989	21	4.0	8.2	27.5	–23.5	552.25
1988	22	7.0	8.3	29.5	–22.5	506.25
1987	23	10.0	8.4	31.5	–21.5	462.25
1986	23	10.0	8.5	33.5	–23.5	552.25
1985	24	12.0	8.6	35.0	–23.0	529.00

1984	25	14.0	8.7	36.0	–22.0	484.00
1983	26	16.5	8.0	24.5	–8.0	64.00
1982	27	18.0	8.2	27.5	–9.5	90.25
1981	28	19.0	8.3	29.5	–10.5	110.25
1980	29	20.0	8.4	31.5	–11.5	132.25
1979	30	21.5	8.5	33.5	–12.0	144.00
1978	31	23.5	9.0	37.0	–13.5	182.25
1977	32	26.5	9.1	38.0	–11.5	132.25
1976	33	29.5	9.2	39.0	–9.5	90.25
Total						**11,254.00**

Table 14. Critical Values for Larger n (Spearman Rho Coefficient)

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

7.5.3 Across the Facilities

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

a) Select Safety Culture Metrics

Select safety culture metrics to be analyzed from the Core Metrics and Subsidiary Metrics lists in Section 6.4, “Safety Culture Metrics”.

b) Collect Facilities Safety Performance Data

Collect safety performance data using the offshore installation safety performance datasheet provided in Appendix D, “Safety Performance Datasheets”. Normalize the data using Table 9, “Normalizing Safety Performance Data”. The metrics and safety performance data should cover the last available, consecutive, 12 months.

c) Correlate Metrics with Safety Performance Data

Step 1: In this worked example there are 14 offshore installations, numbered 1–14.

Populate column 2 with the first safety culture metrics for each installation (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 di (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 di2 = 888

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

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

The resulting coefficient is –0.9516.

Table 15. Correlation Across the Facilities

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Installation No. (i)	*No. of meetings*	*Rank*	*TRCF*	*Rank*	d_i	d_i^2
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**

Table 11 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 i.e., 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 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.

7.6 Identifying Subjective Leading Indicators

7.6.1 Method

7.6.1.1 Average the Responses for Each Installation

Find the arithmetic mean for the responses to the statements. Do this for all of the forty statements, for each and every offshore installation. 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 to that question from the analysis.

7.6.1.2 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 offshore installations. The safety performance sheet is in Appendix D, "Safety Performance Datasheets". All data should be normalized as shown in Table 9, "Safety Performance Data".

7.6.1.3 Correlate the Responses and Safety Performance Data

Once all 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 Table 10, "Instructions for Spearman's Rho Correlation".

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

7.6.2 Worked Example

The crew aboard a group of 14 offshore installations 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.

7.6.2.1 Average the Responses for Each Offshore Installation

Step 1: Construct a table as shown in

Table 17, "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 Offshore Installation No. 13 are returned first. Offshore Installation No. 13 has a crew of 20 (who all completed the survey) so there are 20 responses to Statement No. 1:

"When offshore installations 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 Table 16, "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 16. Likert Scale

	Disagree (1)	**Slightly Disagree (2)**	**Neutral (3)**	**Slightly Agree (4)**	**Agree (5)**	**Don't Know (0)**
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 workers.

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 offshore installation No. 13. Find the arithmetic mean for statement No. 1 for the rest of the facilities and finish populating Column 2.

Rank the 14 scores and insert in Column 3. The ranking used here runs from low to high. Either ranking (low-to-high or high-to-low) can be used, but whichever way is chosen should 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 offshore installations. Average the twelve month's data to give one annual figure for each entry. Normalize the data using Table 9,"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 17. Subjective Leading Indicators Example

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
Installation No. (i)	*1st Statement*	*Rank*	*TRCF*	*Rank*	d_i	d_i^2
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 installations) into the formula below.

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

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 exists between these two variables, i.e., as the crew increasingly believes that corrective action is taken promptly (when offshore installations management is told about accidents, incidents or near misses), the TRCF decreases at those offshore installations.

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 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 using a statistics package.

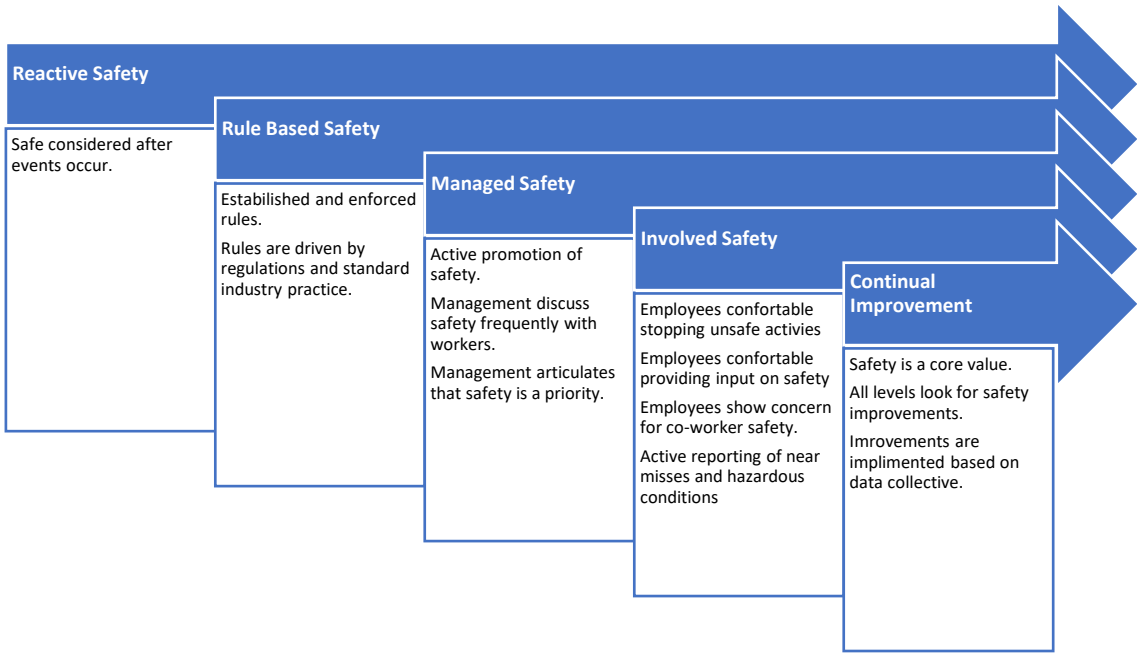
8. Safety Culture Maturity Model

Maturity models are a single number that describes the safety culture within an origination based on the available data. Safety culture maturity examines how a company views and manages safety. At low levels of maturity, safety is defined by a minimum adherence to basic regulatory requirements. Safety is reactive to major incidents as opposed to proactive for continual improvement. At medium levels of maturity, an active effort to monitor and improve safety is done driven primarily by management. At high levels, continual improvement and safety being a core value are widespread within the organization. This toolkit proposes a maturity model using the data elements generated during the development of this toolkit. The predefined standards in this document are a guideline and recommendation. Assessment teams should use the toolkit recommendations as a general guideline and use the team judgement when assigning a level of maturity based on all elements of the safety culture assessment.

8.1. Maturity Levels

The maturity levels of this model are:

1. **Reactive Safety** – Safety is only considered after an event occurs.
2. **Rule-based Safety** – Safety is driven by rules that are set by regulatory standards and industry practice.
3. **Management Driven Safety** – Management actively promotes a safe workplace.
4. **Involved Safety** – Workers participate in the safety process and are comfortable with raising issues. Examples of involved safety include effective stop card procedures and effective worker feedback.
5. **Continual Improvement** – Safety is a core value with clear indications of continual improvement.



These maturity levels were developed based on a review of existing models:

- DuPont Bradley Curve, people move from externally applied discipline to self-discipline and then to a state of interdependency when they help each other do better (Rains, 2014). The four levels are defined as Reactive (safety is focused on compliance and delegated to the safety manager), Dependent (emphasis is laid on fear and discipline, rules, and procedures), Independent (safety management is internalized and people believe that personal commitment makes the difference), and Interdependent (teams feel a sense of ownership for safety and coordination is valued).
- Bernard proposed a four-level model for nuclear regulation (Bernard, 2018). The levels are defined as Bureaucratic (Driven by rules), Individual Commitment (Individually involved), Cooperative (Teamwork), and Holistic.
- Westrum's model has Pathological, Calculative, and Generative safety culture maturity levels (Westrum, 1996).
- International Atomic Energy Agency (IAEA) has external requirements, internal requirements, and continual improvement with an awareness of the impact of behavior on safety (IAEA, 1998).
- Hudson model has five maturity levels: Pathological safety culture (problems caused by worker), Reactive safety culture (Actions after incidents), Calculative safety culture: (Safety is driven by management systems and data), Proactive safety culture (Workforce involvement), and Generative safety culture (Safety part of all levels and activities) (Hudson, 1999; Hudson, 2007). Shell Hearts and Minds is similar to Hudson's model. Filho et al. formulated a framework for the petrochemical companies in Brazil, based on the Hudson model (Filho, Andrade, & Marinho, 2010).
- Fleming proposed five maturity levels for the oil and gas industry with five levels of Emerging (regulatory), Managing (Risk Assessment), Involving (Worker Participation), Cooperating (Active Engagement), and Continual Improvement (Safety as Core Value) (Fleming, Safety culture maturity model, 2000).
- Sharp et al. proposed a five-level maturity model for designing safety offshore installation focused on how changes occur with states of Initial, Repeatable, Defined, Managed, and Optimized (Sharp, Strutt, Busby, & Terry, 2002).

The team developed our maturity levels using past research with a focus on how safety improvement occurs. Our scale goes from rules-based to worker involvement to continual improvement. Worker involvement is split into management and worker involvement with the assumption that management involvement should be achieved first.

8.2. Scoring Maturity

Maturity can be estimated with data in this tool kit. A maturity estimate can be developed from multiple sources of input. At least three individuals should evaluate each input to demonstrate that the estimate is repeatable based on a review of existing information. Based on multiple reviews, a single maturity estimate should be developed for each data source. Not all data sources are required but having multiple data sources provides support for the findings. The estimates for individual data sources can be fractional if the raters cannot agree or if the next level is mostly achieved.

The following section describes guidelines for evaluating the individual data sources. By predefining the guidelines, the repeatability of maturity estimates is improved, and the ranking rules are established prior to data collection.

8.3. Evaluating Maturity with the Safety Culture Survey

To evaluate the maturity of safety culture survey results, reviewers are recommended to use the following guideline.

Level 1 Reactive– Base level.

Level 2 Rule-Based– Safety rules are understood and enforced. The indication that level 2 has been active are:

A. No more than one question should be worse than 4.0 for these questions:
   19. Workers on this facility routinely wear the required PPE.
   20. My co-workers follow the safety procedures for the jobs they will perform.
   22. Operating procedures are clear, accurate, and easy to follow.
   23. Maintenance procedures are clear, accurate, and easy to follow.
   27. Offshore personnel have ready access to all necessary tools, including PPE, to do their jobs safely.
   41. Offshore personnel have adequate training in emergency procedures.
   42. All the workers onboard have sufficient language skills to perform their jobs safely and respond properly in emergency situations.
   47. I have been trained sufficiently so I am confident that I can safely operate the equipment within my area of responsibility.
B. No clear pattern in comments from the safety culture survey exists that contradicts the Likert Scale responses.

Level 3 Management – Level 2 variables met plus a demonstration of management commitment to safety. The following would demonstrate a commitment to safety:

A. No more than one question should be worse than 4.0 for these questions:

   7. My supervisor ensures that safety briefings are held at the beginning of every shift.
   8. Our managers show their commitment to safety through their actions.
   9. Managers place a high priority on safety training.
   10. Onshore managers never put schedule or costs above safety.
   11. When we have to choose between safety and production/schedule, safety is given the highest priority.
   12. We have enough operations personnel on board to safely operate the facility in all operating conditions, including emergencies.
   13. My supervisor encourages me to report near misses.
   30. Corrective action is taken promptly when my manager is told about accidents, incidents, or near misses.
   32. I receive timely feedback on accidents, incidents, or near misses that occur on this facility.

35. I am encouraged to ask questions when I am unsure about the safety precautions related to my work.
38. My supervisor tells me about safety issues that were discussed in management meetings.
44. The managers on my offshore facility, are genuinely concerned about my safety.
45. I have not been asked to break the rules or take shortcuts to achieve a production/schedule target.

C. No clear pattern in comments from the safety culture survey exists that contradicts the Likert Scale responses.

Level 4 Involved Safety – Level 3 variables met plus generally positive responses to worker participation in safety.

A. The following questions are above 4.0:

16. My safety-related training is completed on time.
17. I fully understand my safety and health responsibilities.
18. Housekeeping is a demonstrated priority on this facility.
25. While offshore I get adequate rest to do my job safely.
28. Pre-job (safety) assessments are completed for all jobs that need them.
33. My coworkers are willing to report instances where safety rules are violated.
34. I am willing to report instances where safety rules are violated without fear of negative consequences.
39. We have good communication during hitch handover so that important information is transferred.
40. We have good communication during shift handover so that important information is transferred.
43. I am usually consulted on matters that affect how I do my job.
49. If I am interrupted in the middle of a task, I routinely review the procedure to help make sure no steps are left out.
51. I am comfortable asking for help when unsure how to do a task.

D. No clear pattern in comments from the safety culture survey exists that contradicts the Likert Scale responses.

Level 5 Continual Improvement – Comments section of the safety culture survey has a clear indication that workers are providing feedback about improving safety in terms of length, quality, and a fraction of workers with responses to questions. Beyond the comments, almost all of following questions (all but 3) should be above 4.5:

14. We have an easy-to-understand system in place to report near misses.
15. Our near miss reporting system is effective in keeping the person submitting the event anonymous.
21. Visitors to our facility follow our safety procedures and standards.
24. This offshore facility has excellent preventive maintenance practices.
29. Our workspaces are well designed and organized.

31. Causes of accidents, incidents, and near misses are effectively resolved.
36. I am able to constructively question the decisions or actions of those with more authority without fear of negative consequences.
37. My supervisor stresses that I have the authority and responsibility to stop work I consider to be unsafe.
46. Workers treat others with respect at this facility.
48. My supervisor encourages us to make suggestions to improve safety.
50. When mistakes occur, our facility managers and supervisors are more interested in solving the problem than assigning blame.

8.4. Measuring Maturity with Worker Interviews

More worker than 20 worker interviews are graded to provide input into the maturity level. The following guidelines are recommended for evaluating the interview transcripts.

Level 1 – Reactive Safety.
Base level.

Level 2 – Rule-Based
Safety rules are understood and enforced. The indication that level 2 has been achieved is that no more than 10% of interviewees contain clear examples of rules being unenforced or violated.

Level 3 – Managed
Level 2 is achieved plus no more than 10% of interviewees indicate problems with management on safety issues and agree that management encourages a safe work environment.

Level 4 – **Involved**
Level 3 is achieved plus no more than 10% of interviewees indicate issues with workers who are not involved with identifying safety issues. Also, no more than 10% of survey respondents indicate issues with stopping work for safety issues and feel empowered to improve their work environment.

Level 5 – **Continual Improvement**

Level 4 is achieved plus no more than 10% of the interviewees indicating that safety improvements are not quickly identified and implemented.

8.5. Measuring Maturity with Site Visits and Audits

Level 1 – Reactive Safety.
Base level.

Level 2 – Rules Based
Audits and site visits show no major safety issues that violate safety rules.

Level 3 – Managed
Level 2 is achieved plus audits and site visits show that management is involved with safety as demonstrated by clear safety instructions and well-designed workspaces.

Level 4 – **Involved**
Level 3 is achieved plus audits and site visits show that workers are involved with safety as demonstrated by good housekeeping, JSA, safety practices, etc.

Level 5 – **Continual Improvement**
Level 4 is achieved plus audits and site visits show outstanding safety practices and clear empowerment to stop work under unsafe conditions.

8.6. Measuring Maturity with Safety Management System Review

Level 1 – Reactive Safety
Base level.

Level 2 – Rule-Based
Violations of rules and policies are recorded, stored, and reviewed.

Level 3 – Managed
Level 2 is achieved plus near misses, hazardous conditions, maintenance issues, and minor injury incidents can be reported, stored, and reviewed.

Level 4 – **Involved**
Level 3 is achieved plus workers understand and use the process for reporting near-misses, hazardous conditions, maintenance issues, and minor injury incidents.

Level 5 – **Continual Improvement**
Level 4 is achieved plus investigations of reported issues are used to drive changes. The company should be able to demonstrate safety improvement plans and how they were constructed. The company should also demonstrate sharing of lessons learned in the organization.

8.7. Measuring Maturity with Leading Indicators and Safety Performance

Level 1 – Reactive Safety
Base level.

Level 2 – Rule-Based
Safety rules are understood and enforced. Violations of rules are tracked and reported.

Level 3 – Managed

Level 2 is achieved plus management has access to a wide range of safety performance and leading indicator data.

Level 4 – **Involved**
Level 3 is achieved plus workers understand leading indicators and performance data.

Level 5 – **Continual Improvement**
Level 4 is achieved plus leading indicators and safety performance data are used to drive improvements.

8.8. Reporting Maturity

Reporting maturity requires a presentation of how the data was collected and an interpretation of the results. Each estimate should be discussed with a brief description of the procedure used to collect the data. A mosaic approach should be used to display the different estimates of maturity. Each estimate should be displayed with the maturity level and a reason for the ranking (see Table 18). Ideas for raising maturity levels should be presented based on the reasons for the ranking. Maturity models are a single number to describe safety culture and should not be presented separately from the detailed analysis of the safety culture study.

Table 18. Sample maturity report.

Estimate	Maturity level	Reason for Ranking
Safety Culture Survey	3	Several questions related to worker involvement had low responses on the survey. Question 49 If I am interrupted in the middle of a task, I routinely review the procedure to help make sure no steps are left out had an average response of 3.7, and Question 51 I am comfortable asking for help when unsure how to do a task had an average response of 3.8.
Leading Indicators and Safety Performance	4	Data is collected and presented to all levels of the organization. No specific instances of using the data to drive improvements were presented to the team.
Site Visits and Audits	5	Safety procedures are clear. The work environment is well organized.
Maturity with Interviews	5	All workers in interviews were positive about the safe environment of the company and commitment to continual improvement.
Average Estimate	4.25	

9. Improving Safety Culture

The following steps should be taken to benefit from the overall safety culture assessment:

1. Study the findings for the data streams collected.
2. Develop a single source of data for the project. Summary files of data in Excel or similar spreadsheet tool can be an effective tool for summary since due to familiarity with the tool.
3. Develop a single report that presents a quantitative assessment of safety culture. To effectively present the multiple data streams, the final report should be organized with summary of finding first that compares and contrasts the results of the different data streams. The summary should be followed by chapters about the individual data streams that describe how the data was collected and present summary results. Appendix chapters should be employed to provide in- depth statistical analysis, copies of survey instruments, and detailed data collected such as free text responses.
4. Beyond numeric safety culture overall assessment, specific improvements should be documented from each data stream (Safety Culture Survey, Worker Interviews, Site Inspections / Observations, Incident Investigation Review Results, SEMS Review Results). The free text responses and other non-numeric feedback should be analyzed in detail to look for common response patterns and suggestions for improvement. Review these suggestions as a team. While all inputs should be analyzed, free text responses may provide a unique insight into factor not considered in the original survey design.
5. Look at the appropriate safety factors' desired activities, attitudes, and behaviors as well as possible activities for improvement. Develop a list of actionable items to be presented to the workforce.
6. Consider if the findings 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.
7. Communicate the results to the workforce. Feedback should include strengths as well as areas of weaknesses. This can be done in a variety of ways (e.g., written reports, team briefings, emails, and meetings). Communicate the results with senior management and board of directors.
8. Let the workforce know how weak areas will be addressed and monitored. This feedback is important for buy-in to safety culture improvement.
9. Prioritize the opportunities for improvement.
10. Consider how those key areas align with other initiatives/needs. Focus on strategies that may address more than one area or need.

11. 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).
12. Engage key 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 included.
13. 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.
14. 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.
15. Track changes for continual improvement efforts using your SEMS system.
16. Make sure that all employees understand that the safety improvement is a continual process.

Appendix C provides more detail about safety culture improvement opportunities.

Appendix A – Offshore Survey

		Mapping to SCF	
Q#	**Offshore Question**	**SCF #**	**SCF Name**
1	Do you mainly work onshore or offshore?		
2	At which offshore facility do you spend most of your work time?		
3	What is your job title?		
4	Are you a company worker or contractor?		
5	How long have you worked for your current employer?		
6	How long have you worked in your current position?		
7	My supervisor ensures that safety briefings are held at the beginning of every shift.	1	Leadership
8	Our managers show their commitment to safety through their actions.	1	Leadership
9	Managers place a high priority on safety training.	1	Leadership
10	Onshore managers never put schedule or costs above safety.	1	Leadership
11	When we have to choose between safety and production/schedule, safety is given the highest priority.	1	Leadership
12	We have enough operations personnel on board to safely operate the facility in all operating conditions, including emergencies.	1	Leadership
13	My supervisor encourages me to report near misses.	2	Hazard Identification and Risk Management
14	We have an easy-to-understand system in place to report near misses.	2	Hazard Identification and Risk Management
15	Our near miss reporting system is effective in keeping the person submitting the event anonymous.	2	Hazard Identification and Risk Management
16	My safety-related training is completed on time.	3	Personal Accountability
17	I fully understand my safety and health responsibilities.	3	Personal Accountability
18	Housekeeping is a demonstrated priority on this facility.	3	Personal Accountability
19	Workers on this facility routinely wear the required PPE.	3	Personal Accountability
20	My co-workers follow the safety procedures for the jobs they will perform.	3	Personal Accountability

21	Visitors to our facility follow our safety procedures and standards.	3	Personal Accountability
22	Operating procedures are clear, accurate, and easy to follow.	4	Work Processes
23	Maintenance procedures are clear, accurate, and easy to follow.	4	Work Processes
24	This offshore facility has excellent preventive maintenance practices.	4	work processes
25	While offshore I get adequate rest to do my job safely.	4	work processes
27	Offshore personnel have ready access to all necessary tools, including PPE, to do their jobs safely.	4	Work processes
28	Pre-job (safety) assessments are completed for all jobs that need them.	4	Work Processes
29	Our workspaces are well designed and organized.	4	Work Processes
30	Corrective action is taken promptly when my manager is told about accidents, incidents, or near misses.	5	Continual Improvement
31	Causes of accidents, incidents and near misses are effectively resolved.	5	Continual Improvement
32	I receive timely feedback on accidents, incidents, or near misses that occur **on this facility**.	5	Continual Improvement
33	My coworkers are willing to report instances where safety rules are violated.	6	Environment for Raising Concerns
34	I am willing to report instances where safety rules are violated without fear of negative consequences.	6	Environment for Raising Concerns
35	I am encouraged to ask questions when I am unsure about the safety precautions related to my work.	6	Environment for Raising Concerns
36	I am able to constructively question the decisions or actions of those with more authority without fear of negative consequences.	6	Environment for Raising Concerns
37	My supervisor stresses that I have the authority and responsibility to stop work I consider to be unsafe.	6	Environment for Raising Concerns
38	My supervisor tells me about safety issues that were discussed in management meetings.	7	Effective Safety and Environmental Communication
39	We have good communication during hitch handover so that important information is transferred.	7	Effective Safety and Environmental Communication
40	We have good communication during shift handover so that important information is transferred.	7	Effective Safety and Environmental Communication
41	Offshore personnel have adequate training in emergency procedures.	7	Effective Safety and Environmental Communication

42	All of the workers onboard have sufficient language skills to perform their jobs safely.	7	Effective Safety and Environmental Communication
43	I am usually consulted on matters that affect how I do my job.	8	Respectful Work Environment
44	The managers on my offshore facility, are genuinely concerned about my safety.	8	Respectful Work Environment
45	I have not been asked to break the rules or take shortcuts to achieve a production/schedule target.	8	respectful Work Environment
46	Workers treat others with respect at this facility.	8	Respectful Work Environment
47	I have been trained sufficiently so I am confident that I can safely operate the equipment within my area of responsibility.	9	Inquiring Attitude
48	My supervisor encourages us to make suggestions to improve safety.	9	Inquiring Attitude
49	If I am interrupted in the middle of a task, I routinely review the procedure to help make sure no steps are left out.	9	inquiring Attitude
50	When mistakes occur, our facility managers and supervisors are more interested in solving the problem than assigning blame.	9	inquiring Attitude
51	I am comfortable asking for help when unsure how to do a task.	9	Inquiring Attitude
52	If you could make ONE change to improve safety at your location, what would it be?		
53	Please use this space to make additional comments about the safety culture at your site. Some potential topics include training, procedures, equipment, freedom to report incidents, and management commitment to safety, etc.		

Appendix B – Onshore Survey

Q#	Onshore Question	SCF #	SCF Name
1	Do you mainly work mainly offshore or onshore?		
2	At which facility do you spend most of your work time?		
3	What is your job title?		
4	Are you a company worker or contractor?		
5	How long have you worked for your current employer?		
6	How long have you worked in your current position?		
7	Offshore supervisors ensure that safety briefings are held at the beginning of every shift.	1	Leadership
8	Offshore managers show their commitment to safety through their actions.	1	Leadership
9	Offshore managers place a high priority on safety training.	1	Leadership
10	Onshore managers never put schedule or costs above safety.	1	Leadership
11	When offshore personnel has to choose between safety and production/schedule, safety is given the highest priority.	1	Leadership
12	We have enough operations personnel onboard to safely operate our facilities in all operating conditions, including emergencies.	1	Leadership
13	Offshore supervisors encourage workers to report near misses.	2	Hazard Identification and Risk Management
14	We have an easy-to-understand system in place to report offshore near misses.	2	Hazard Identification and Risk Management
15	Our offshore near miss reporting system is effective in keeping the person submitting the event anonymous.	2	Hazard Identification and Risk Management
16	Offshore personnel complete their safety-related training on time.	3	Personal Accountability
17	Our offshore personnel fully understand their safety and health responsibilities.	3	Personal Accountability
18	Housekeeping is a demonstrated priority on our offshore facilities.	3	Personal Accountability
19	Workers on our offshore facilities routinely wear the required PPE.	3	Personal Accountability
20	Our offshore workers follow the safety procedures for the jobs they will perform.	3	Personal Accountability
21	Visitors to our offshore facilities follow our safety procedures and standards.	3	Personal Accountability
22	Offshore operating and maintenance procedures for offshore personnel are clear, accurate, and easy to follow.	4	Work Processes

23	Offshore maintenance procedures are clear, accurate, and easy to follow.	4	Work Processes
24	Our offshore facilities have excellent offshore preventive maintenance practices.	4	work processes
25	Offshore personnel get adequate rest to do their jobs safely.	4	work processes
27	Offshore personnel have ready access to all necessary tools, including PPE, to do their jobs safely.	4	Work processes
28	Pre-job (safety) assessments are completed for all offshore jobs that need them.	4	Work Processes
29	Our offshore workspaces are well designed and organized.	4	Work Processes
30	Corrective action is taken promptly when managers are told about offshore accidents, incidents, or near misses.	5	Continual Improvement
31	Causes of offshore accidents, incidents and near misses are effectively resolved.	5	Continual Improvement
32	Offshore personnel are routinely given feedback on accidents, incidents, or near misses that occur **on their offshore facility.**	5	Continual Improvement
33	Offshore personnel are willing to report instances where safety rules are violated.	6	Environment for Raising Concerns
34	I am willing to report instances where safety rules are violated.	6	Environment for Raising Concerns
35	Offshore personnel are encouraged to ask questions when they are unsure about the safety precautions related to their work.	6	Environment for Raising Concerns
36	Offshore workers are able to constructively question the decisions or actions of those with more authority without fear of negative consequences.	6	Environment for Raising Concerns
37	Our offshore supervisors stress that all workers have the authority and responsibility to stop work they consider to be unsafe.	6	Environment for Raising Concerns
38	Offshore supervisors routinely tell workers about safety issues that were discussed in management meetings.	7	Effective Safety and Environmental Communication
39	Our offshore personnel have a good system in place to transfer important information at hitch handover.	7	effective Safety and Environmental Communication
40	Our offshore personnel have a good system in place to transfer important information at shift handover.	7	effective Safety and Environmental Communication
41	Our offshore personnel have adequate training in emergency procedures.	7	Effective Safety and Environmental Communication
42	All of the workers onboard have sufficient language skills to perform their jobs safely.	7	Effective Safety and Environmental Communication

43	Offshore personnel are usually consulted on matters that affect how they do their jobs.	8	Respectful Work Environment
44	The managers on our offshore facilities, are genuinely concerned about worker safety.	8	Respectful Work Environment
45	Our offshore workers are not asked to break the rules or take shortcuts to achieve a production/schedule target.	8	respectful Work Environment
46	Workers treat others with respect on this offshore facility.	8	Respectful Work Environment
47	Our offshore personnel have been trained sufficiently so they can safely operate the equipment within their areas of responsibility.	9	Inquiring Attitude
48	Supervisors on our offshore facilities encourage workers to make suggestions to improve safety.	9	Inquiring Attitude
49	When our offshore workers are interrupted in the middle of a task, they routinely review the procedure to help make sure no steps are left out.	9	inquiring Attitude
50	When mistakes occur, offshore managers and supervisors are more interested in solving the problem than assigning blame.	9	inquiring Attitude
51	Our offshore workers are comfortable asking for help when unsure how to do a task.	9	Inquiring Attitude
52	If you could make ONE change to improve safety at your location, what would it be?		
53	Please use this space to make additional comments about the safety culture at your site. Some potential topics include training, procedures, equipment, freedom to report incidents, and management commitment to safety, etc.		

Appendix C – Sample Safety Culture Survey Analysis

1. Summary

This illustrative report presents ideas for improvement for the different safety culture factors. Implementation in an actual company would require selecting improvement ideas specific to their environment. This sample report is intended to present ideas for formatting and a starting point for constructing company specific improvements.

This example presents an analysis of the safety culture survey. This report presents the overall results by safety factor followed by 11 chapters that analyze the individual questions organized by safety factor. The report is intended as a starting point for analysts to review and interpret the safety culture survey. It is a starting point for developing improvement for safety culture.

Insert the key findings from the results and free text questions here based on the real data in the summary.

2. Results by Safety Factor

The results of the safety culture survey are grouped into safety factors.

Safety Factors	Description
1. Leadership	Leadership Commitment to Safety Values and Actions.
2. Hazard Identification and Risk Management	Issues potentially impacting safety and environmental stewardship are promptly identified, fully evaluated, and promptly addressed or corrected commensurate with their significance
3. Personal Accountability	All individuals take personal responsibility for process and personal safety, as well as environmental stewardship
4. Work Processes	The process of planning and controlling work activities is implemented so that safety and environmental stewardship are maintained while ensuring the correct equipment for the correct work
5. Continual Improvement	Opportunities to learn about ways to ensure safety and environmental stewardship are sought out and implemented
6. Environment for Raising Concerns	A work environment is maintained where personnel feel free to raise safety and environmental concerns without fear of retaliation, intimidation, harassment, or discrimination
7. Effective Safety and Environmental Communication	Communications maintain a focus on safety and environmental stewardship
8. Respectful Work Environment	Trust and respect permeate the organization with a focus on teamwork and collaboration.
9. Inquiring Attitude	Individuals avoid complacency and continuously consider and review existing conditions and activities to identify discrepancies that might result in error or inappropriate action.

The following report examines the results of the safety culture survey by topic.

3. Leadership

Leadership should embrace safety as a core value and use safety as the foundation on which decisions are made. Leadership should support continual improvement of the safety program through communications, actions, priorities, and provision of resources, etc. Leadership should visibly

demonstrate a non-wavering commitment to safety at each level of the organization. Leadership should 'walk-the-talk' of safety.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
1. My supervisor ensures that safety briefings are held at the beginning of every shift.	4.27	3263	2543 (77.9%)	77 (2.4%)	94 (2.9%)	87 (2.7%)	463 (14.2%)	16.9%
2. Our managers show their commitment to safety through their actions.	4.2	3263	2492 (76.4%)	80 (2.5%)	69 (2.1%)	83 (2.5%)	540 (16.5%)	19.1%
Managers place a high priority on safety training.	4.21	3263	2495 (76.5%)	77 (2.4%)	94 (2.9%)	81 (2.5%)	517 (15.8%)	18.3%
3. Onshore managers never put schedule or costs above safety.	3.36	3263	1647 (50.5%)	199 (6.1%)	180 (5.5%)	153 (4.7%)	1085 (33.3%)	37.9%
4. When we have to choose between safety and production/schedule, safety is given the highest priority.	4.25	3263	2536 (77.7%)	79 (2.4%)	81 (2.5%)	77 (2.4%)	491 (15%)	17.4%
5. We have enough operations personnel on board to safely operate the facility in all operating conditions, including emergencies.	4.2	3263	2481 (76%)	84 (2.6%)	83 (2.5%)	100 (3.1%)	516 (15.8%)	18.9%

The desired activities, attitudes, and behaviors for Strong Leadership are:

1. Management/supervision commitment to engage in the safety program at a personal level.
2. Management/supervision commitment to communicate (and listen) about safety related matters with the field personnel at their workplace.
3. Management/supervision communicates safety related matters to all levels of the organization.
4. Active leadership of safety programs from all levels of management/supervision through priorities, actions, communications, provision of resources, etc.
5. Management commitment to doing what is right is demonstrated through decisions and actions.

Possible Activities for Improvement of Strong Leadership are:

1. Incorporate OH&S into the overall business model; not as a separate/auxiliary/complementary function ('woven into the fabric').
2. Increase the annual safety budget so that there are sufficient resources for safety program and systems.
3. Revise targets and controls for prompt closure of corrective action reports.
4. Revise targets and controls for the number of safety audit recommendations closed out in time.
5. Revise targets for time to implement action on complaints or suggestions.
6. Revise targets for employee (all) attendance at safety meetings.
7. Revise targets for increasing the percentage of new hires put through an induction training program.
8. Establish/revise good quality safety goals that are measurable.
9. Improve the method of how incident investigation findings, corrective actions and lessons learned are made available to employees.

10. Establish procedures to identify and impart any training required in support of safety management systems.
11. Institute periodic safety culture evaluations.
12. Highlight safety culture as an evaluation area in audits, incident investigations, etc.
13. Look for and correct causal factors of incidents and safety performance problems.
14. Hold regular safety management reviews.
15. Establish/revise annual safety objectives/goals throughout the organization.
16. Implement a policy of zero tolerance for willful violation of safety policies and procedures.
17. Effectively communicate expectations by training employees in safety policies and procedures.
18. Make safety performance and safety culture a part of every worker's performance evaluation.
19. Educate managers in safety culture, vision, expectations, roles, responsibilities, and standards (by increasing effectiveness).
    a. Culture, vision, expectations, standards, roles, and responsibilities are discussed with new managers.
    b. A formal training program on safety culture has been implemented for all new and current managers.
    c. A formal training program on safety culture with periodic refresher training has been implemented and is updated as needed.
20. Demonstrate personal values, priorities, and concerns for safety through what is asked about, measured, commented on, praised, or criticized (by increasing effectiveness).
    a. Management behaves in a fashion consistent with strong personal values, priorities, and concerns for safety.
    b. Management seeks opportunities to proactively demonstrate their personal values, priorities, and concerns for safety.
21. Require that responsibility and accountability for safety leadership be shared at all levels of the organization (by increasing effectiveness).
    a. Responsibilities and accountabilities are established only for middle managers and supervisors.
    b. Responsibilities and accountabilities are established only for all managerial and supervisory levels.
    c. Responsibilities and accountabilities are established for everyone.
22. Ensure that managers visit the work areas frequently and that the visits are visible to the workforce. Share a safety message as one purpose of the visit and include ample time for employees to express their concerns. Handing out an inexpensive token (e.g., candy with a safety message) has been shown to increase the impact of the visit.
23. Train and coach new and existing managers that a key component of their jobs is to observe worker behavior and provide positive and corrective intervention as needed. Include effective intervention in the manager's performance reviews.
24. The work process for discipline should be revised to include consequences for good behaviors. Managers should acknowledge good safety behaviors in employees.

4. Hazard Identification and Risk Management

Employees at every level should be vigilant for indications of weakness in the system that could lead to significant safety events. Every level of the organization should avoid complacency and have systems in place to constantly be vigilant. The organization should place the burden of proof on ensuring that activities are safe rather than unsafe. The organization should do a good job-sharing corrective actions and lessons learned from injuries, illnesses, near misses, accidents, incidents and hazard studies.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
6. We have enough operations personnel on board to safely operate the facility in all operating conditions, including emergencies.	4.2	3263	2481 (76%)	84 (2.6%)	83 (2.5%)	100 (3.1%)	516 (15.8%)	18.9%
7. My supervisor encourages me to report near misses.	4.29	3263	2556 (78.3%)	99 (3%)	71 (2.2%)	68 (2.1%)	470 (14.4%)	16.5%
8. We have an easy-to-understand system in place to report near misses.	4.24	3263	2512 (77%)	96 (2.9%)	72 (2.2%)	83 (2.5%)	501 (15.4%)	17.9%
9. Our near miss reporting system is effective in keeping the person submitting the event anonymous.	4.29	3263	2572 (78.8%)	76 (2.3%)	65 (2%)	81 (2.5%)	470 (14.4%)	16.9%

The desired activities, attitudes, and behaviors for Sense of Vulnerability are:

1. All parts of the organization are vigilant for indications of weakness in the system that could lead to significant safety events.
2. Avoidance of complacency. There are constant efforts to avoid the complacency that could accompany good safety records.
3. The organization always places the burden of proof on determining that activities are safe rather than unsafe.
4. The organization does a good job sharing corrective actions and lessons learned from injuries, illnesses, near misses, accidents, incidents and hazard studies.
5. Possible Activities for Improvement of Sense of Vulnerability are:
6. Provide safety checklists for all jobs.
7. Provide safety procedures, instructions or rules for all jobs.
8. Provide policy/procedures for reporting unsafe conditions and near misses â€ ” and encourage their usage.
9. Set targets for the number of jobs with hazard assessments.
10. Set targets for the number of hazard analysis techniques utilized.
11. Set targets for the number of safety inspections.
12. Set targets for the number of corrective action reports originating from audits.
13. Set targets for the percentage of incident reports which have causal analysis.
14. Investigate and communicate corrective actions and lessons learned from recent accidents and incidents.
15. Provide hazard/risk awareness training.
16. Provide causal factor training to all employees.
17. Modify the incident investigation system to more fully address “what could have happened” (potential consequences) instead of only the actual incident consequences.
18. Ensure that all staff are adequately educated on, and appreciate, the hazards of operations.
19. Ensure that all staff are adequately educated on, and appreciate, the consequences of deviating from established safe operating practices and conditions.

20. Ensure that lessons learned from investigations of incidents and near misses, audits, and hazard assessments are broadly, frequently, and effectively shared (by increasing effectiveness).
21. Lessons learned are distributed to the immediately affected work group.
22. Lessons learned are widely shared throughout the organization.
23. The organization (1) seeks to gather and share lessons learned from diverse sources, including from other organizations, locations, or companies, and (2) has an effective means to validate that appropriate action has been taken.
24. Monitor for, and combat, organizational overconfidence that can be stimulated by past good performance (by increasing effectiveness). a. Managers and supervisors implement informal approaches to maintaining a sense of vulnerability within the organization. b. A formal effort has been implemented to maintain a sense of vulnerability within the organization through efforts such as: (1) effectively sharing lessons learned from recent incident and near miss investigations, both from within and outside the organization, (2) periodically refreshing memories of past significant events within the company and industry, (3) effectively sharing lessons learned from hazard assessments, and (4) providing periodic refresher training on hazards of operations. c. Item (b) and management reviews and surveys are used to determine if attitudes are softening with respect to the needs for continued safety diligence. Hazard assessment and investigation reports are audited to determine if teams are appropriately focusing on the potential for what could happen.
25. Set management expectation that all meetings, including toolbox meetings begin with a safety message.
26. Identify all locations where (1) fixed fall protection is required, (2) all locations where hot surfaces are present, (3) toxic chemicals (e.g. ammonia) are handled, rotating equipment without adequate guarding, and (5) flammable liquids are stored.
27. Establish a corporate policy/standard/procedure that addresses hazard identification.

5. Personal Accountability

Employees at every level should be vigilant for indications of weakness in the system that could lead to significant safety events. Every level of the organization should avoid complacency and have systems in place to constantly be vigilant. The organization should place the burden of proof on ensuring that activities are safe rather than unsafe. The organization should do a good job sharing corrective actions and lessons learned from injuries, illnesses, near misses, accidents, incidents and hazard studies.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
10. My safety-related training is completed on time.	4.27	3263	2552 (78.2%)	83 (2.5%)	73 (2.2%)	68 (2.1%)	488 (15%)	17%
11. I fully understand my safety and health responsibilities.	4.86	3263	3135 (96.1%)	9 (0.3%)	14 (0.4%)	11 (0.3%)	95 (2.9%)	3.2%
12. Housekeeping is a demonstrated priority on this facility.	4.25	3263	2520 (77.2%)	93 (2.9%)	75 (2.3%)	92 (2.8%)	484 (14.8%)	17.7%
13. Workers on this facility routinely wear the required PPE.	4.23	3263	2514 (77%)	87 (2.7%)	79 (2.4%)	81 (2.5%)	503 (15.4%)	17.9%
14. My co-workers follow the safety procedures for the jobs they will perform.	4.26	3263	2530 (77.5%)	85 (2.6%)	96 (2.9%)	84 (2.6%)	469 (14.4%)	16.9%
15. Visitors to our facility follow our safety procedures and standards.	4.22	3263	2516 (77.1%)	66 (2%)	70 (2.1%)	97 (3%)	515 (15.8%)	18.8%

The desired activities, attitudes, and behaviors for personnel accountability are:

1. All parts of the organization are vigilant for indications of weakness in the system that could lead to significant safety events.
2. Avoidance of complacency. There are constant efforts to avoid the complacency that could accompany good safety records.
3. Individuals always places the burden of proof on determining that activities are safe rather than unsafe.
4. Individuals do a good job sharing corrective actions and lessons learned from injuries, illnesses, near misses, accidents, incidents and hazard studies.

Possible Activities for Improvement of personnel accountability are:

1. Ensure that all test and inspection activities are completed on time.
2. Equipment deficiencies are identified and corrected in a timely manner.
3. Managers consistently and frequently stress individual ownership of personal safety.

6. Work Processes

Employees at every level should demonstrate on a daily basis a high standard of safety performance. Employees at any level should not tolerate willful violations of safety standards, rules or procedures. Employees should not hesitate to correct one another when a co-worker is working unsafe. All injuries, illnesses, incidents, accidents and near misses should be reported.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
16. Operating procedures are clear, accurate, and easy to follow.	4.25	3263	2535 (77.7%)	84 (2.6%)	73 (2.2%)	73 (2.2%)	499 (15.3%)	17.5%
17. Maintenance procedures are clear, accurate, and easy to follow.	4.3	3263	2574 (78.9%)	94 (2.9%)	70 (2.1%)	69 (2.1%)	457 (14%)	16.1%
18. This offshore facility has excellent preventive maintenance practices.	4.3	3263	2565 (78.6%)	87 (2.7%)	89 (2.7%)	70 (2.1%)	453 (13.9%)	16%
19. While offshore I get adequate rest to do my job safely.	4.27	3263	2550 (78.1%)	84 (2.6%)	70 (2.1%)	83 (2.5%)	477 (14.6%)	17.2%
20. Offshore personnel have ready access to all necessary tools, including PPE, to do their jobs safely.	4.26	3263	2543 (77.9%)	65 (2%)	88 (2.7%)	84 (2.6%)	484 (14.8%)	17.4%
21. Pre-job (safety) assessments are completed for all jobs that need them.	4.23	3263	2511 (77%)	83 (2.5%)	76 (2.3%)	86 (2.6%)	508 (15.6%)	18.2%
22. Our workspaces are well designed and organized.	4.25	3263	2546 (78%)	67 (2.1%)	78 (2.4%)	80 (2.5%)	493 (15.1%)	17.6%

The desired activities, attitudes, and behaviors for high standards of work procedures are:

1. All members of the workforce exhibit a high standard of safety performance.
2. The workforce will not tolerate willful violation of safety standards, rules or procedures.
3. The workforce does not hesitate correcting one another if someone is doing something unsafe.
4. All injuries, illnesses, incidents, accidents and near misses will be reported.

Possible Activities for Improvement of High Standards of work procedures are:

1. Make sure all work activities are reasonable documented.
2. Have clear procedures for JSA.
3. Provide training matrices to persons involved in new-hires or in transfers of personnel between positions to show adequate competency.
4. Establish/revise training program for safety awareness.
5. Establish a mechanism where employees feel comfortable correcting each other.
6. Enforce the expectation that the workforce will be dealt with even-handedly.
7. Provide training in analysis of job tasks and associated hazards, including hazards affecting quality of work.
8. Enforce the expectation that all injuries, illnesses, incidents, accidents, and near misses be reported.
9. Provide awareness training on workplace hazards/risks and accident statistics.
10. Make safety performance and safety culture a part of every worker's performance evaluation
11. Set targets for number of near misses reported per employee.
12. Implement a process for defining safety goals (by increasing effectiveness).
    a. Safety goals are established in an informal fashion.
    b. A formal system exists for establishing and periodically reviewing safety goals for the organization.
    c. Employees perform a meaningful role in helping establish and review safety goals for the organization.
13. Ensure that employees know what is expected of them by effectively communicating the safety policies, goals, and plans for achieving the desired safety performance (by increasing effectiveness).
    a. Safety performance expectations are shared with employees in an ad hoc fashion.
    b. A formal communications system exists for sharing information on safety policies, goals, and plans to achieve the desired safety performance (for example, through written program documentation or in employee job descriptions and training).
    c. Item (b. and the effectiveness of the communications system is monitored to ensure that this information is reaching all facility personnel.
14. Establish responsibilities and reinforce accountabilities for safety roles (by increasing effectiveness).
    a. Responsibilities and accountabilities for safety roles are addressed in an ad hoc fashion.

    b. Responsibilities and accountabilities for safety roles have been established and are informally reinforced.
    c. Responsibilities and accountabilities for safety roles have been established and are periodically reviewed and updated as warranted. Management response to acceptable and unacceptable performance of safety responsibilities is timely, consistent, and fair.
15. Implement a policy of zero tolerance for willful violations of safety policies, procedures, and rules. Delineate those attitudes and behaviors that the organization will not tolerate under any circumstances (by increasing effectiveness).
    a. Safety policies, procedures, and rules are enforced, but sometimes inconsistently.
    b. The consequences of willful violations of safety policies, procedures, and rules have been established and are actively enforced.
16. Ensure that safety performance rewards and corrective actions are consistently applied (by increasing effectiveness).
    a. Rewards and corrective actions are implemented in an informal fashion.
    b. A formal system is established for implementing performance rewards and corrective actions.
    c. Employees or their representatives have an appropriate role in determining performance rewards and corrective actions.
17. Determine and address the causes of significant or persistent non-compliances and failures to fulfill safety program deliverables (by increasing effectiveness).
    a. The causes of non-compliances are investigated in an informal fashion.
    b. Formal root cause analysis is conducted of significant or persistent non-compliances with the intent of identifying root causes and preventing such non-compliances in the future.
18. Establish a management change of program.
19. Ensure operating and maintenance procedures are current and accurate.
20. Develop and maintain an energy isolation procedure.
21. Develop and maintain an emergency response plan, including drills.
22. Ensure that contractors have all of the information and company oversight necessary to work safely.
23. Establish a general safe work permit where job hazards can be communicated for all jobs and not just the critical work (e.g., hot work, physical entry).

7. Continual Improvement

Efforts to improve safety management systems should always be proactively pursued with the goal of continual safety performance improvement. Continual improvement should address all practices, processes and procedures based on benchmarking, best practices and lessons learned. Reporting should result in learning that is then used to update best practices and current processes. Processes should be living and useful; otherwise, people will begin anew to work around them, devising their own unofficial (and therefore unknown) practices. Effective processes for noticing potential OH&S problems (e.g., near miss reporting or frequent safety walk-throughs, etc.) should be available and utilized. OH&S performance indicators should be routinely tracked (such as incomplete inspections, number of injuries). Injuries and illnesses should be tracked and analyzed. Employee safety values/performance should be included their annual performance review.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
23. Corrective action is taken promptly when my manager is told about accidents, incidents, or near misses.	4.22	3263	2513 (77%)	79 (2.4%)	77 (2.4%)	69 (2.1%)	526 (16.1%)	18.2%
24. Causes of accidents, incidents and near misses are effectively resolved.	4.24	3263	2514 (77%)	85 (2.6%)	82 (2.5%)	86 (2.6%)	497 (15.2%)	17.9%
25. I receive timely feedback on accidents, incidents, or near misses that occur on this facility.	4.3	3263	2564 (78.6%)	91 (2.8%)	80 (2.5%)	73 (2.2%)	456 (14%)	16.2%

The desired activities, attitudes, and behaviors for Continual Monitoring of Performance are:

1. Good process for noticing potential OH&S problems (e.g., near miss reporting or frequent safety walk-throughs, etc.).
2. OH&S performance indicators are routinely tracked (such as incomplete inspections, number of injuries).
3. Safety performance is communicated throughout the organization
4. This company utilizes benchmarking, best practices and lessons learned for safety improvement.
5. Employee safety values/performance are included their annual performance review.
6. Continual improvement methods are utilized in safety improvement plans.

Possible Activities for Improvement of Continual Monitoring of Performance are:

1. Develop an effective safety management systems that tracks a wide range of issues (problems, leading and lagging indicators).
2. Track all pertinent OH&S performance indicators are routinely tracked (such as incomplete inspections, % employees with training, etc.). This will also allow the company to develop leading safety indicators and perform a leading safety indicator assessment.
3. All business decisions should be evaluated while considering any safety implications.
4. Effective measures of an employee's value and impact on safety performance should be an integral part of their annual performance review.
5. Establish effective means to utilize benchmarking, best practices and lessons learned for continual improvement of all practices, processes and procedures.
6. All data collected should be used for continual improvement or do not collect it.
7. Employees from all levels should be involved in the continual improvement efforts.
8. Additional leading and lagging safety indicators/metrics/performance data should be measured and analyzed.
9. Regular safety culture audits should be performed and compared.
10. Implement and track a diverse set of metrics that encompasses a balanced mix of leading and lagging indicators. Trend results over time, and respond to patterns (by increasing effectiveness).
    a. The organization places primary emphasis on measuring lagging indicators.

b. The organization monitors a mix of leading and lagging indicators that are directly relevant to safety culture.
c. The organization closely monitors leading and lagging performance trends and promptly responds to indications of weakening safety culture.

11. Maintain standards of performance with respect to timely, forthright reporting of performance statistics (by increasing effectiveness).
    a. Reporting and follow-up occurs in an informal fashion.
    b. Formal responsibilities and accountabilities have been established for timely, forthright reporting of performance statistics.
    c. Item (b. and management aggressively follows up on missing or late reports.
12. Conduct periodic reviews of the organization's safety culture (by increasing effectiveness).
    a. Informal assessments are conducted by management.
    b. Periodic reviews are conducted by non-facility, company personnel.
    c. Protocols exist for special reviews by independent third parties when circumstances warrant.
13. Strive to identify and correct cultural issues that underlie failures to adequately fulfill safety responsibilities (e.g., why does the organization tolerate this?) (by increasing effectiveness).
    a. Investigations of failures to adequately fulfill safety responsibilities are limited to the identification of the immediate causes.
    b. Investigations of failures to adequately fulfill safety responsibilities address the identification of the management system causes.
    c. Investigations of failures to adequately fulfill safety responsibilities are extended to identify and address any underlying cultural causes.
14. Implement an effective management review system.
15. Compare the culture assessment results from the various demographic work groups and share strengths and areas for improvement with other work groups to learn from successes and focus on topics where improvement is warranted. (see recs 14, 25, 39)

8. Environment for Raising Concerns

Employees at every level should have the authority and responsibility to terminate a task or activity if there are legitimate safety concerns. All employees should feel able to voice their concerns and to make suggestions to improve safety. Every employee should continually try to improve safety. All of the workforce should be provided with all necessary training and information to do their jobs safely. All members of the workforce should exhibit a high standard of safety performance.

The desired activities, attitudes, and behaviors for Individuals Empowered to Fulfill Safety Responsibilities are:

1) Every employee has the authority and responsibility to terminate a task or activity if there are legitimate safety concerns.

2) All employees feel able to voice concerns and to make suggestions to improve safety.

3) Every employee tries to improve safety.

4) All of the workforce are provided with all necessary information to do their jobs safely.

5) All members of the workforce exhibit a high standard of safety performance.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
26. My coworkers are willing to report instances where safety rules are violated.	4.26	3263	2518 (77.2%)	96 (2.9%)	93 (2.9%)	84 (2.6%)	473 (14.5%)	17.1%
27. I am willing to report instances where safety rules are violated without fear of negative consequences.	4.22	3263	2517 (77.1%)	66 (2%)	87 (2.7%)	84 (2.6%)	510 (15.6%)	18.2%
28. I am encouraged to ask questions when I am unsure about the safety precautions related to my work.	4.24	3263	2532 (77.6%)	75 (2.3%)	80 (2.5%)	66 (2%)	511 (15.7%)	17.7%
29. I am able to constructively question the decisions or actions of those with more authority without fear of negative consequences.	4.23	3263	2512 (77%)	87 (2.7%)	74 (2.3%)	81 (2.5%)	510 (15.6%)	18.1%
30. My supervisor stresses that I have the authority and responsibility to stop work I consider to be unsafe.	4.21	3263	2500 (76.6%)	82 (2.5%)	81 (2.5%)	84 (2.6%)	517 (15.8%)	18.4%

Possible Activities for Improvement of Individuals Empowered to Fulfill Safety Responsibilities are:

1. Check that all employees know how to voice concerns, whether proactively as an opportunity for improvement or reactively as notice of deficiency.
2. Solicit workforce opinions on effective communication means and frequency.
3. Check that employees consistently have the resources necessary to satisfy safety responsibilities.
4. Clearly define accountability for safety systems.
5. Celebrate employee safety decision/action successes.
6. Institute an off-the-job safety program.
7. Promote highlighting of employee safety concerns through formal and non-traditional means.
8. See that employee safety concerns and suggestions are resolved in a credible, timely fashion.
9. Establish safety committees that include a vertical slice of the organization.
10. Establish clear, documented accountabilities for safety.
11. Create an anonymous safety issue reporting system.
12. Provide safety checklists for all jobs.
13. Provide safety procedures, instructions or rules for all jobs.
14. Provide and document all required safety training.
15. Provide reasonable time to safely perform tasks.
16. Continually reinforce that all employees have responsibilities to themselves, their co-workers, the company, and the community (by increasing effectiveness).
    a. Such responsibilities are reinforced in an informal fashion.
    b. Employees are given formal training on these issues.

c. Managers and supervisors, through training, written and oral communications, meetings, performance reviews, and so forth, make a conscientious effort to ingrain these concepts within the culture.

17. Provide employees with the resources necessary to achieve their safety responsibilities (by increasing effectiveness).
    a. Resources are provided for the more critical initiatives.
    b. Safety initiatives are properly resourced, or alternative approaches to suitably achieve objectives with available resources are identified.
    c. Resource requirements in support of safety initiatives are given explicit consideration in the budgeting process and quality resources are assigned to the initiative.
18. Give employees the necessary authority and support commensurate with their safety responsibilities (by increasing effectiveness).
    a. Individual authority is implicitly associated with the safety responsibilities.
    b. Authorities are explicitly addressed, for example in job descriptions that outline safety responsibilities.
    c. Management provides support when necessary to reinforce an individual's authority.
19. Improve the incident/condition reporting system with better guidance/procedures, clear management expectations, and user friendly reporting tools.

9. Effective Safety and Environmental Communication

Organizations should have communications that are open and effective. Healthy communication channels should exist vertically and horizontally within the organization. Managers/supervisors should listen as well as speak. Everyone should understand the information required for safe operations. Communication channels should be monitored for their effectiveness.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
31. My supervisor tells me about safety issues that were discussed in management meetings.	4.24	3263	2511 (77%)	94 (2.9%)	82 (2.5%)	84 (2.6%)	493 (15.1%)	17.7%
32. We have good communication during hitch handover so that important information is transferred.	4.32	3263	2603 (79.8%)	59 (1.8%)	80 (2.5%)	81 (2.5%)	441 (13.5%)	16%
33. We have good communication during shift handover so that important information is transferred.	4.26	3263	2523 (77.3%)	88 (2.7%)	88 (2.7%)	94 (2.9%)	471 (14.4%)	17.3%
34. Offshore personnel have adequate training in emergency procedures.	4.2	3263	2483 (76.1%)	81 (2.5%)	100 (3.1%)	75 (2.3%)	525 (16.1%)	18.4%
35. All of the workers onboard have sufficient language skills to perform their jobs safely.	4.25	3263	2537 (77.8%)	77 (2.4%)	73 (2.2%)	83 (2.5%)	494 (15.1%)	17.7%

The desired activities, attitudes, and behaviors for Open and Effective Communications are:

1. Managers/supervisors listen as well as speak.
2. The entire workforce is provided with all necessary information to do their jobs safely.
3. The workforce is informed of outcomes of incident investigations, audits, etc., in a timely manner.
4. Mismatches between practices and procedures (or standards. are quickly resolved to prevent normalization of deviance.
5. Employee concerns are resolved quickly.

Possible Activities for Improvement of Open and Effective Communications are:

1. Increase the number of mechanisms for communicating safety to employees (e.g., newsletters, toolbox talks, meetings, training, and incident findings).
2. Increase safety training (including printed formats. in native languages.
3. Provide a mechanism for anonymous input to management so that those fearful of reprisal have an alternate communication pathway.
4. Emphasize the importance of, and expectations of management for, timely and effective communication throughout the chain of command.
5. Provide positive, public reinforcement of communications even bad news. Do not shoot the messenger.
6. Provide communications training to everyone.
7. Create newsletters and other modes of management communication.
8. Include safety messages in periodic newsletters or other communications.
9. Provide access to internet sites that have regulatory activity that affects the organization.
10. Disseminate relevant information from management reviews which indicate continuance or change of direction in policies and/or procedures.
11. Increase safety and/or information meeting frequency and effectiveness.
12. Distribute summaries of external incidents and communicate how the lessons learned from them might apply locally.
13. Disseminate organizational policies for health, safety, and environmental (OH&S).
14. Disseminate bulletins throughout the organization regarding lessons learned or alerts regarding incidents that could have company-wide application.
15. Develop an expectation for safety training attendance, record attendance, and provide feedback.
16. Implement an employee suggestion/feedback program.
17. Increase the percentage of employees who have their performance appraised annually.
18. Establish a feedback system to employees on safety audits, issues, and concerns.
19. 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.

20. 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.
21. Discuss QHSE policies, objectives, and progress made during OH&S meetings.
22. Communicate lessons learned from internal and external audits.
23. Enable employees to fulfill their responsibilities for sharing concerns by listening to them and acting in response (by increasing effectiveness).
    a. Management listens to employee concerns, but response may be slow.
    b. Management promptly responds to relevant employee concerns.
    c. Management has implemented a proactive system for soliciting and responding to employee concerns.
24. Stress the importance of timely communication of information (by increasing effectiveness).
    a. Training or counseling is provided on this topic in an ad hoc fashion.
    b. This topic is covered with new employees during basic orientation and safety management training.
    c. Managers and supervisors seek additional opportunities to reinforce these concepts, for example through incorporation into incident investigation lessons learned or table top drills.
25. Assess relevant avenues of communication to ensure that messages are properly communicated and acknowledged, and that they are not filtered as they are relayed (by increasing effectiveness).
    a. Management relies on anecdotal information to gain confidence that safety messages are properly communicated.
    b. Management relies on personal conversations with employees to gain confidence that safety critical messages are getting through.
    c. Management monitors a variety of information sources to gain confidence that safety critical messages are communicated. Information sources include meeting minutes, employee surveys, formal suggestion programs, and personal conversations.
26. Establish a system for ensuring that management is accessible to the workforce for reporting potential hazards and providing input on operational safety management policy, issues, and needs (by increasing effectiveness).
    a. Management relies on ad hoc mechanisms for receiving such information.
    b. Multiple means exist for the workforce to report potential hazards and to provide input to management on operational safety management policy, issues, and needs.
    c. Supplemental, secure means exist for anonymous reporting by staff members who may otherwise fear repercussions from reporting.

10. Respectful Work Environment

All workers in the organization should fully understand individual and team responsibility. Employees should respect each other. There exists a mutual trust between employees and management as well as within peer groups. All employees have confidence in a just system.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
36. I am usually consulted on matters that affect how I do my job.	4.28	3263	2532 (77.6%)	113 (3.5%)	82 (2.5%)	76 (2.3%)	461 (14.1%)	16.5%
37. The managers on my offshore facility, are genuinely concerned about my safety.	4.21	3263	2502 (76.7%)	74 (2.3%)	86 (2.6%)	82 (2.5%)	520 (15.9%)	18.4%
38. I have not been asked to break the rules or take shortcuts to achieve a production/schedule target.	4.3	3263	2568 (78.7%)	86 (2.6%)	73 (2.2%)	88 (2.7%)	449 (13.8%)	16.5%
39. Workers treat others with respect at this facility.	4.26	3263	2537 (77.8%)	82 (2.5%)	82 (2.5%)	78 (2.4%)	485 (14.9%)	17.3%

The desired activities, attitudes, and behaviors for a Respectful Work Environment are:

1. There is a good understanding of individual and employee responsibility for safety.
2. Relationships are characterized by respect.
3. Employees trust managers to 'do the right thing' in support of safety.
4. Managers trust employees to shoulder their share of responsibility for performance, and to report potential problems and concerns.
5. Peers trust the motivations and behaviors of peers.
6. Employees have confidence that a just system exists where honest errors can be reported without fear of reprisals.

Possible Activities for Improvement of respect withing the work environment are:

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

22. Develop a disciplinary system which has clear criteria for acceptable and unacceptable behaviors, and which distinguishes situations involving willful misconduct from human errors prompted by system causes. Apply such criteria firmly and fairly (by increasing effectiveness).
    a. The organization has an unwritten disciplinary system that addresses these issues.
    b. The organization has a written disciplinary system and applies it consistently.
    c. The organization has a written disciplinary system and continuously monitors its application. The organization actively seeks to address system root causes and fairly identifies those situations in which human error can be attributed to such causes. The organization has developed a 'no fault' policy for such instances and has communicated it effectively to employees.
23. Utilize knowledgeable resources from other facilities and/or third parties to get a fresh perspective.

11. Inquiring Attitude

Employees at every level should be vigilant for indications of weakness in the system that could lead to significant safety events. Inquiring attitude starts with effective training, stopping work for safety and being comfortable asking for help. Every level of the organization should avoid complacency and have systems in place to continuously improve. The organization should place the burden of proof on ensuring that activities are safe rather than unsafe.

Question	Average	Total Responses	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Percent Negative
40. I have been trained sufficiently so I am confident that I can safely operate the equipment within my area of responsibility.	4.19	3263	2474 (75.8%)	86 (2.6%)	82 (2.5%)	80 (2.5%)	542 (16.6%)	19.1%
41. My supervisor encourages us to make suggestions to improve safety.	4.26	3263	2536 (77.7%)	83 (2.5%)	83 (2.5%)	86 (2.6%)	476 (14.6%)	17.2%
42. If I am interrupted in the middle of a task, I routinely review the procedure to help make sure no steps are left out.	4.25	3263	2540 (77.8%)	70 (2.1%)	85 (2.6%)	78 (2.4%)	491 (15%)	17.4%
43. When mistakes occur, our facility managers and supervisors are more interested in solving the problem than assigning blame.	4.26	3263	2541 (77.9%)	84 (2.6%)	69 (2.1%)	82 (2.5%)	488 (15%)	17.5%
44. I am comfortable asking for help when unsure how to do a task.	4.24	3263	2528 (77.5%)	81 (2.5%)	74 (2.3%)	73 (2.2%)	508 (15.6%)	17.8%

The desired activities, attitudes, and behaviors for Inquiring Attitude are:
1) All employees should be trained in their area.
2) All parts of the organization are vigilant for indications of weakness in the system that could lead to significant safety events.
3) Avoidance of complacency. There are constant efforts to avoid the complacency that could accompany good safety records.
4) Mistakes should be resolved without blame.

Possible Activities for Improvement of Inquiring Attitude are:

1. Provide safety checklists for all jobs.
2. Provide safety procedures, instructions or rules for all jobs.
3. Provide policy/procedures for reporting unsafe conditions and near misses and encourage their usage. Avoid blame in safety investigations.
4. Set targets for the number of jobs with hazard assessments.
5. Set targets for the number of hazard analysis techniques utilized.
6. Set targets for the number of safety inspections.
7. Set targets for the number of corrective action reports originating from audits.
8. Set targets for the percentage of incident reports which have causal analysis.
9. Investigate and communicate corrective actions and lessons learned from recent accidents and incidents.
10. Provide hazard/risk awareness training.
11. Provide causal factor training to all employees.
12. Modify the incident investigation system to more fully address "what could have happened" (potential consequences) instead of only the actual incident consequences.
13. Ensure that all staff are adequately educated on, and appreciate, the hazards of operations
14. Ensure that all staff are adequately educated on, and appreciate, the consequences of deviating from established safe operating practices and conditions
15. Ensure that lessons learned from investigations of incidents and near misses, audits, and hazard assessments are broadly, frequently, and effectively shared (by increasing effectiveness).
    a. Lessons learned are distributed to the immediately affected work group.
    b. Lessons learned are widely shared throughout the organization.
    c. The organization (1) seeks to gather and share lessons learned from diverse sources, including from other organizations, locations, or companies, and (2) has an effective means to validate that appropriate action has been taken.
16. Monitor for, and combat, organizational overconfidence that can be stimulated by past good performance (by increasing effectiveness).

12. Demographic Analysis Appendix

Presents cross tabs by demographic factors and discusses statistical significance of differences between groups. One effective way to present demographic analysis is to present cross tabs to the reader. A color coding scheme with arrows is often an effective method for highlighting outlying groups.

Values	Asset A	Asset B	Asset C	Asset D	Asset E	Asset F	Asset G	Total
Respondents	350	140	340	837	552	71	69	3264
1. My supervisor ensures that safety briefings are held at the beginning of every shift.	4.20	4.51	4.20	4.27	4.29	4.04	4.20	4.27
2. Our managers show their commitment to safety through their actions.	4.22	4.24	4.17	4.22	4.15	4.09	4.23	4.20
3. Managers place a high priority on safety training.	4.26	4.13	4.18	4.29	4.26	4.28	3.94	4.21
4. Onshore managers never put schedule or costs above safety.	3.46	3.21	3.47	3.31	3.41	3.83	3.68	3.36
5. When we have to choose between safety and production/schedule, safety is given the highest priority.	4.16	4.25	4.29	4.27	4.20	4.38	4.65	4.25
6. We have enough operations personnel on board to safely operate the asset in all operating conditions, including emergencies.	4.20	4.19	4.23	4.21	4.24	4.23	4.48	4.20
7. My supervisor sfdaasdgesadme to report near misses.	4.25	4.24	4.31	4.26	4.25	4.58	4.33	4.29
8. We have an easy-to-understand system in place to report near misses.	4.18	4.25	4.37	4.30	4.22	4.06	3.96	4.24
9. Our near miss reporting system is effective in keeping the person submitting the event anonymous.	4.20	4.51	4.31	4.27	4.28	4.17	4.28	4.29
10. My safety-related training is completed on time.	4.27	4.02	4.22	4.23	4.35	4.55	4.39	4.27
11. I fully understand my safety and health responsibilities.	4.82	4.95	4.80	4.89	4.87	5.00	4.64	4.86
12. Housekeeping is a demonstrated priority on this asset.	4.23	4.19	4.29	4.31	4.18	4.19	4.35	4.25
13. Workers on this asset routinely wear the required PPE.	4.28	4.59	4.26	4.27	4.22	4.13	4.16	4.23
14. My co-workers follow the safety procedures for the jobs they will perform.	4.33	4.28	4.29	4.23	4.31	4.26	4.35	4.26
15. Visitors to our asset follow our safety procedures and standards.	4.02	4.35	4.25	4.14	4.33	4.32	4.13	4.22
16. Operating procedures are clear, accurate, and easy to follow.	4.33	4.16	4.37	4.27	4.24	4.16	4.30	4.25
17. Maintenance procedures are clear, accurate, and easy to follow.	4.25	4.21	4.30	4.32	4.25	4.38	4.35	4.30
18. This offshore asset has excellent preventive maintenance practices.	4.41	4.06	4.23	4.38	4.29	4.46	4.29	4.30
19. While offshore I get adequate rest to do my job safely.	4.21	4.07	4.36	4.30	4.23	4.42	4.20	4.27
20. Offshore personnel have ready access to all necessary tools, including PPE, to do their jobs safely.	4.23	4.27	4.19	4.19	4.29	4.39	4.30	4.26
21. Pre-job (safety) assessments are completed for all jobs that need them.	4.33	4.40	4.22	4.21	4.28	4.22	3.86	4.23
22. Our workspaces are well designed and organized.	4.30	4.22	4.23	4.24	4.29	4.01	4.09	4.25
23. Corrective action is taken promptly when my manager is told about accidents, incidents, or near misses.	4.36	4.16	4.03	4.25	4.24	4.26	4.12	4.22
24. Causes of accidents, incidents and near misses are effectively resolved.	4.05	4.23	4.32	4.20	4.24	4.33	4.20	4.24
25. I receive timely feedback on accidents, incidents, or near misses that occur on this asset.	4.26	4.21	4.34	4.27	4.35	4.12	4.48	4.30
26. My coworkers are willing to report instances where safety rules are violated.	4.24	4.21	4.30	4.25	4.27	4.36	4.29	4.26
27. I am willing to report instances where safety rules are violated without fear of negative consequences.	4.19	4.23	4.19	4.23	4.35	4.32	4.17	4.22
28. I am encouraged to ask questions when I am unsure about the safety precautions related to my work.	4.29	4.24	4.37	4.27	4.22	4.12	4.06	4.24
29. I am able to constructively question the decisions or actions of leadership without fear of negative consequences.	4.33	4.29	4.26	4.20	4.16	4.26	3.70	4.23
30. My supervisor stresses that I have the authority and responsibility to stop work I consider to be unsafe.	4.18	4.04	4.22	4.14	4.31	4.23	4.19	4.21
31. My supervisor tells me about safety issues that were discussed in management meetings.	4.27	4.34	4.23	4.25	4.22	4.16	4.26	4.24
32. We have good communication during hitch handover so that important information is transferred.	4.39	4.25	4.41	4.28	4.38	4.12	4.54	4.32
33. We have good communication during shift handover so that important information is transferred.	4.21	4.31	4.06	4.28	4.28	4.14	4.22	4.26
34. Offshore personnel have adequate training in emergency procedures.	4.12	4.11	4.17	4.24	4.23	4.41	4.29	4.20
35. All of the workers onboard have sufficient language skills to perform their jobs safely.	4.17	4.25	4.19	4.29	4.20	4.33	4.23	4.25
36. I am usually consulted on matters that affect how I do my job.	4.31	4.36	4.29	4.28	4.27	4.32	4.55	4.28
37. The managers on my offshore asset, are genuinely concerned about my safety.	4.17	4.21	4.30	4.19	4.19	4.13	3.99	4.21
38. I have not been asked to break the rules or take shortcuts to achieve a production/schedule target.	4.27	4.21	4.39	4.33	4.23	4.23	4.23	4.30
39. Workers treat others with respect at this asset.	4.35	4.35	4.21	4.27	4.20	4.22	4.57	4.26
40. I have been trained sufficiently so I am confident that I can safely operate the equipment within my area of responsibility.	4.11	4.24	4.12	4.21	4.14	4.25	4.16	4.19
41. My supervisor encourages us to make suggestions to improve safety.	4.31	4.34	4.24	4.27	4.19	4.55	4.41	4.26
42. When mistakes occur, management are more interested in solving the problem than assigning blame.	4.36	4.19	4.29	4.27	4.26	4.17	4.03	4.26
43. If I am interrupted in the middle of a task, I routinely review the procedure to help make sure no steps are left out.	4.24	4.46	4.19	4.18	4.31	4.23	4.16	4.25
44. I am comfortable asking for help when unsure how to do a task.	4.37	4.11	4.18	4.19	4.24	4.19	4.35	4.24

After cross tabs are presented, statistical analysis should show the significance of respondents. The statistical significance of the groups on the individual questions using Kruskal-Wallis Test. While many relationships might be significant due to the large sample size, the actual amount of the relationship is not established. To find strength of relationship, the table also displays Epsilon square (e^2) and Freeman's Theta. These are measures of the predictive power of categorical responses. They range from 0 to 1 with zero being no correlation and 1 being perfect association. Epsilon square (e^2) and Freeman's Theta do not have negative correlations since one of the demographic variables is categorical and the other variable is ordinal. The statistics are to be used with the cross tabs in the above table report.

Interpretation is similar to the interpretation of simple correlation coefficient with value going between 0 and 1. A reasonable interpretation for social science for correlations is:

- < 0.01 – Negligible
- < 0.16 - Weak
- 0.16 < 0.36 – Moderate
- 0.36 < 0.64 - Moderately Strong
- 0.64 < 1.00 - Strong

The question is listed and all relationships with p-value for the Kruskal-Wallis test less than .05 are displayed. Note if you allow blank demographics for anonymous reporting, individuals who did not enter demographic information tended to have lower responses to the Likert questions.

A sample of the results would be as follows.

1. My supervisor ensures that safety briefings are held at the beginning of every shift.

- For Job Title, the Kruskal-Wallis Test (p-value = 3.426e-07) for '1. My supervisor ensures that safety briefings are held at the beginning of every shift.' shows significant relationships. The power of this relationship is estimated with a Freeman Theta of 0.208 and a square root of Epsilon Squared of 0.0969.
- For Facility, the Kruskal-Wallis Test (p-value = 2.809e-08) for '1. My supervisor ensures that safety briefings are held at the beginning of every shift ' shows significant relationships. The power of this relationship is estimated with a Freeman Theta of 0.106 and a square root of Epsilon Squared of 0.0518.

All other relationships are not statistically significant.

13. Free Text Appendix

Presents a summary of the free text response questions. Highlights from this summary should be included in the summary of results chapter.

An example of this analysis would be as follows:

> Many employees (x/y = z%) responded with long comments of over 50 characters for ways to improve safety. While the questions only asked for improvements, 172 respondents had positive free text statements about safety culture and safety staff that are displayed in Appendix D. Overall, the Safety Program is perceived as a comprehensive and efficient system based on the free text responses. Most of the positive comments were short without citing specific reasons for being positive such as "Safety Program is really good" and similar comments without elaboration.
>
> Almost all respondents were positive or neutral in tone with very few negative tone responses.
>
> Suggestions for improvements:
>
> - Contractor Training: xx responders (X/Y = Z%) were concerned about contractor training and skills. Specific areas of concern were ____, ___, and ___.
> - Excessive Workload: Several respondents stated that workload is a problem on vessels. A total xx respondents (X/Y = Z%) commented on ideas for reducing stress and fatigue.
> - Sharing of near misses: Reporting and discussing near misses was cited in x/Y = z% of comments. The comments were mostly acknowledged that a system exists, but they are not easy to use to make reports
> - PPE was only discussed by 20 employees. However, 18 of the 20 were on one vessel.
> - Work life balance: x/y= 0.z% employees stated general work life balance issues. This percentage is relatively small percentage given the preference of some employees to work from home and other approaches to work life balance.
>
> Potential actions from the comments should be considered:
>
> - Contractor training.
> - Near miss system should be reviewed for improvements in ease of reporting and dissemination.
> - More effective use of safety cases and case studies should be considered.
> - Examine ways to reduce stress and fatigue especially for field workers.

After the summary, put all responses by question with identifying information removed.

Appendix D – Safety Performance Datasheets

Definitions:

Please use these definitions when completing the datasheets. Before use, raw safety performance data needs to be normalized as shown Table 9,"Normalizing Safety Performance Data".

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

Facilities*:* A collection of an operator's offshore installations.

DP Loss Of Integrity: - for dynamically positioned installations any loss of required redundancy whether or not there is a loss of position

Emergency Blowdown: Any event that requires activation of the emergency blowdown system, including emergency venting or flaring.

Emergency Shutdown*:* Activation of any emergency valve or system either automatically or manually.

Equipment Damage*:* Any event that requires repair or replacement of any process train equipment due to excessive flow pressure or temperature.

Emergency Disconnect: TBD

First Aid Case: TBD

Loss Of Position: - An excursion beyond the allowable watch circle that results either in an emergency shutdown or an emergency disconnect

Lost Time Accident of 24 Hours or More*:* Any work-related injury, other than a fatal one, that results in a person being unfit for work for at least twenty-four continual hours, immediately after the accident.

Materials handling incidents*:* Any incident due to materials handling that results in a near miss or injury, damage to equipment or material or environmental release.

Medical Treatment Case*:* Work-related injuries that are not severe enough to be reported as fatalities, Lost Time Accident, 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.

Near Miss*:* 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 offshore installation.

Off-Specification Product*:* Any product output that does not meet the specification for export to the shore.

Pressure Operator Relief Valve*:* Activation of any pressure relief valve, or failure to activate due to overpressure condition.

Recoverable System Upset*:* Any upset event which may have resulted in an accident except for intervention of the automated protection systems, or the operator.

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

Total Recordable Cases*:* The sum of all work-related fatalities, lost time accidents, restricted work accidents and medical treatment cases. TRCs = LTAs + RWAs + MTCs.

Organizational Safety Performance Data

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

1. Loss Of Position Frequency (LOPF) for the facilities (for floating installations).
2. Emergency Disconnects Frequency (EDF) for the facilities.
3. DP Loss Of Integrity Frequency (DPLIF) for the facilities (for floating installations).
4. Emergency Blowdown Frequency (EBF) for the facilities.
5. Emergency Shutdown Frequency (BSF) for the facilities.
6. Pressure Operator Relief Valve Frequency (PORVF) for the facilities.
7. Equipment Damage Frequency (EDF)
8. Materials Handling Incidents Frequency (MHIF) for the facilities.
9. Recoverable Upset Frequency (RUF) for the facilities.
10. Off-Specification Product Frequency (OSPF) for the facilities.
11. Lost Time Accident Frequency (LTAF) for the facilities.
12. Restricted Work Accident Frequency (RWAF) for the facilities.
13. Total Recordable Cases Frequency (TRCF) for the facilities.
14. Medical Treatment Case Frequency (MTCF) for the facilities.
15. First Aid Case Frequency (FACF) for the facilities.
16. Near Miss Frequency (NMF) for the facilities.

Additional Data

1. Total number of hours worked on the facilities.
2. Total number of hours producing on the facilities.
3. Total number of DP hours on the facilities.
4. Total number of exposure hours (hours worked on the facilities).

Offshore installations Safety Performance Datasheet

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

1. Loss Of Position Frequency (LOPF) for each offshore installation (for floating installations).
2. Emergency Disconnects Frequency (EDF) for each offshore installation.
3. DP Loss Of Integrity Frequency (DPLIF) for each offshore installation (for floating installations).
4. Emergency Blowdown Frequency (EBF) for each offshore installation.
5. Emergency Shutdown Frequency (BSF) for each offshore installation.
6. Pressure Operator Relief Valve Frequency (PORVF) for each offshore installation.
7. Equipment Damage Frequency (EDF) for each offshore installation.
8. Materials Handling Incidents Frequency (MHIF) for each offshore installation.
9. Recoverable Upset Frequency (RUF) for each offshore installation.
10. Off-Specification Product Frequency (OSPF) for each offshore installation.
11. Lost Time Accident Frequency (LTAF) for each offshore installation.
12. Restricted Work Accident Frequency (RWAF) for each offshore installation.
13. Total Recordable Cases Frequency (TRCF) for each offshore installation.
14. Medical Treatment Case Frequency (MTCF) for each offshore installation.
15. First Aid Case Frequency (FACF) for each offshore installation.
16. Near Miss Frequency (NMF) for each offshore installation.

Additional Data

1. Total number of hours worked on each installation.
2. Total number of hours producing on each installation.
3. Total number of DP hours on each installation.
4. Total number of exposure hours (hours worked on each installation).

Appendix E. Literature Review on Potential Leading Indicators

E.1 Background Information of Offshore Industry Safety

The oil and gas sector is a high-risk sector whereas offshore sector workers face not only process hazards but also other hazards related to harsh working conditions, environment and transportation (Broni-Bediako & Amorin, 2010). Generally, there are two domains governing offshore safety: process safety and personal safety (Swuste, Theunissen, Schmitz, Reniers, & Blokland, 2016).

- **Process safety** concerns the hazards of oil and gas installations leading to injuries, fatalities, and property and environmental damage. The term "process safety" includes facility integrity, which aims to monitor facilities to check their performance in three main areas: structural, operational, and technical. Facility integrity management covers the entire lifecycle of an facility and has a broader scope. "Process safety" primarily aims to prevent major accidents through operating systems and process integrity. The Center for Chemical Process Safety (CCPS)defines process safety as "a disciplined framework for managing the integrity of operating systems and processes handling hazardous substances by applying good design principles, engineering, and operating procedures" (CCPS, 2011). Other aspects of process safety include hazard identification, training, operating procedures, audits, management of change, etc. Process safety is the key to managing *operational risk* whose failures led to major disasters such as those involving Deepwater Horizon and the Texas City refinery (Crude Oil, 2020).
- **Personal safety** (**occupational safety**) deals with chemical and noise exposure, ergonomics, mechanical and electrical hazards, etc., which may result in injuries and fatalities. While process safety has elements of personal safety, in the oil and gas sector, personal safety has conventionally been managed as a separate domain. It is focused on occupational exposure, fatigue management, work arrangement, ergonomics, prevention of occupational illnesses, and control of hazards causing injuries, near-misses, and fatalities at the personal level (Tang, Leiliabadi, Olugu, & M.d. Dawal, Factors affecting the safety of processes in the Malaysian oil and gas industry, 2017).

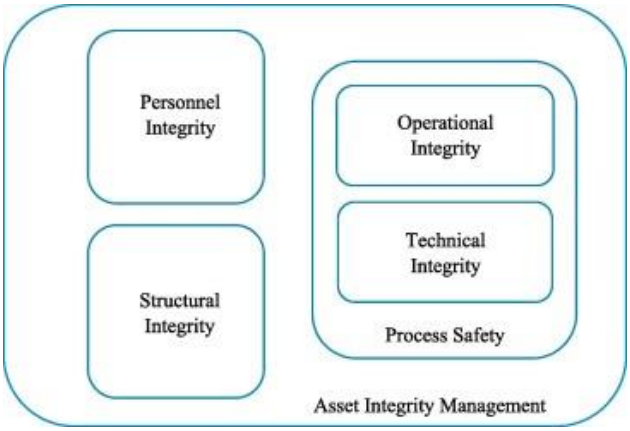


Figure 6. Elements of facility integrity management (Tang, Md Dawal, & Olugu, 2018)

Multiple approaches have been employed to manage offshore safety consisting mainly of organizational and human factors, safety culture, resilience engineering and risk-based approaches.

- Organizational and human factors focus primarily on leadership, management, organizational culture, ergonomics and psychosocial aspects (Mearns & Flin, 1999).
- Safety culture represents a large, generalized area of whether safety is internalized as a core value which directs actions and behaviors (Rentsch, 1990) of an individual or an organization.
- Resilience engineering centers on how well a system or organization maintains or recovers its stable state following an accident or operational distress, so that it can continue operations (Hollnagel, Woods, & Leveson, 2006).
- The risk-based approach upholds risk assessment where safety of an equipment or process is defined in terms of risk score. The risk score generated from failure probability and consequence serves as the basis of determining inspection intervals and risk mitigation (Hasan & Khan, 2012).

E.2 What are Leading Indicators?

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 (ABS, 2014). They can:

- Reveal areas of weakness in advance of adverse events
- Be associated with proactive activities that identify hazards
- Aid risk assessment and management
- Help focus the organizational resources in the areas where safety can best benefit

Leading Indicators are the most important safety metrics for the organization as they correlate with the organization's safety performance. Leading indicators are crucial to drive and monitor inputs into safety systems. They need to be specific, measurable, achievable, relevant, timely, evaluated, and reviewed. There is limited research in developing a comprehensive safety LI's (or safety performance indicators, high potential indicators, key performance indicators) for the offshore oil and gas sector. Examples of the limited research on lagging and leading indicators are

- American National Standards Institute/American Petroleum Institute (ANSI/API) RP-754 Process Safety Performance Indicators for the Refining & Petrochemical Industries (ANSI/API, 2010)
- Center for Chemical Process Safety (CCPS), Process Safety Leading and Lagging Metrics (CCPS, Process Safety Leading and Lagging Metrics, 2011)
- Trends in Risk Level in the Petroleum Activity Summary Report 2016 – The Norwegian Continental Shelf (Petroleum Safety Authority Norway, 2016)

There is one framework proposed by Tang et al. (2017) which has been applied to Malaysian offshore industry (Tang, Leiliabadi, Olugu, & M.d. Dawal, Factors affecting safety of processes in the Malaysian oil and gas industry, 2017).

E.3 Safety Expert Metaphors, Models, and Theories

Safety expert metaphors, models and theories should serve as the basis for process safety indicators. These metaphors, models, and theories have been developed at different periods in time for different reasons and in different industries, explaining their different conclusions and insights. These include:

- Bowtie metaphor (Figure 7): The bowtie metaphor illustrates the relationships between scenarios barriers and management factors. In the center is a state where energy (hazard) has become uncontrollable, the central event, leading to consequences (Nielsen, 1971). This is used in CCPS 2010 and OGP 2011 (CCPS, 2010; OGP, 2011).
- Swiss cheese metaphor (Reason, Managing the Risk of Organisational Accidents, 1997; Qureshi, 2007) (Figure 8). This is used in ANSI/API RP754 2010, CCPS 2010, HSE 2006, and OGP 2011 (ANSI/API, 2010; CCPS, 2010; HSE, 2006; OGP, 2011; UK Oil and Gas Industry, 2012)
- Henrich's pyramid (Figure 9, Figure 10): This is used in ANSI/API RP754, CCPS 2010, and OGP 2011 (ANSI/API, 2010; CCPS, 2010; OGP, 2011).
- Tripod theory: technology, management, organization (Groeneweg, 1992)
- System dynamics model (Rasmussen, 1997)

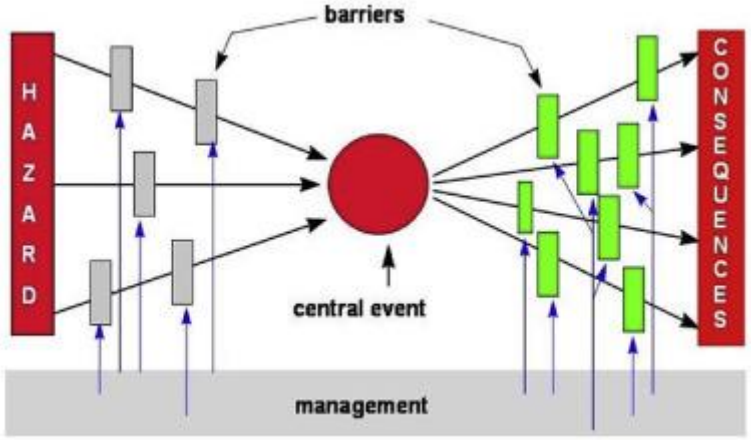


Figure 7. Bowtie Metaphor

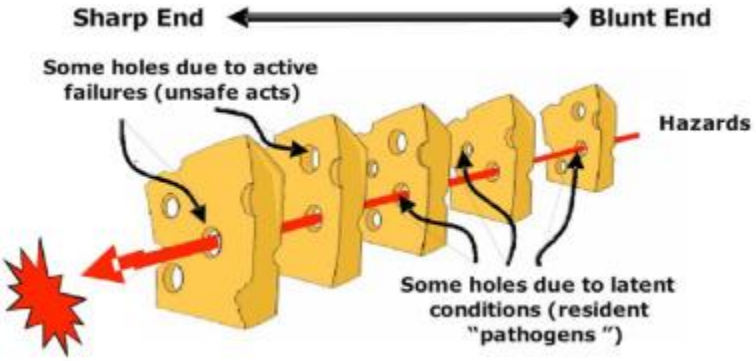


Figure 8. Swiss Cheese Metaphor

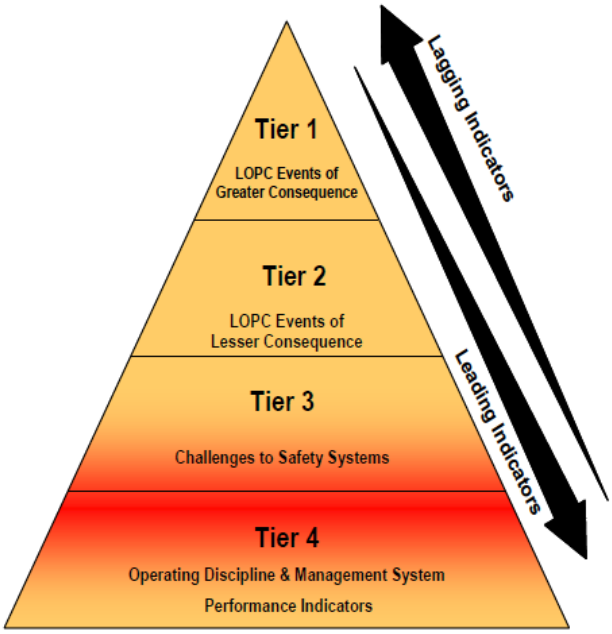


Figure 9 Process Safety Indicator Pyramid used in API RP 754 (ANSI/API, 2010)

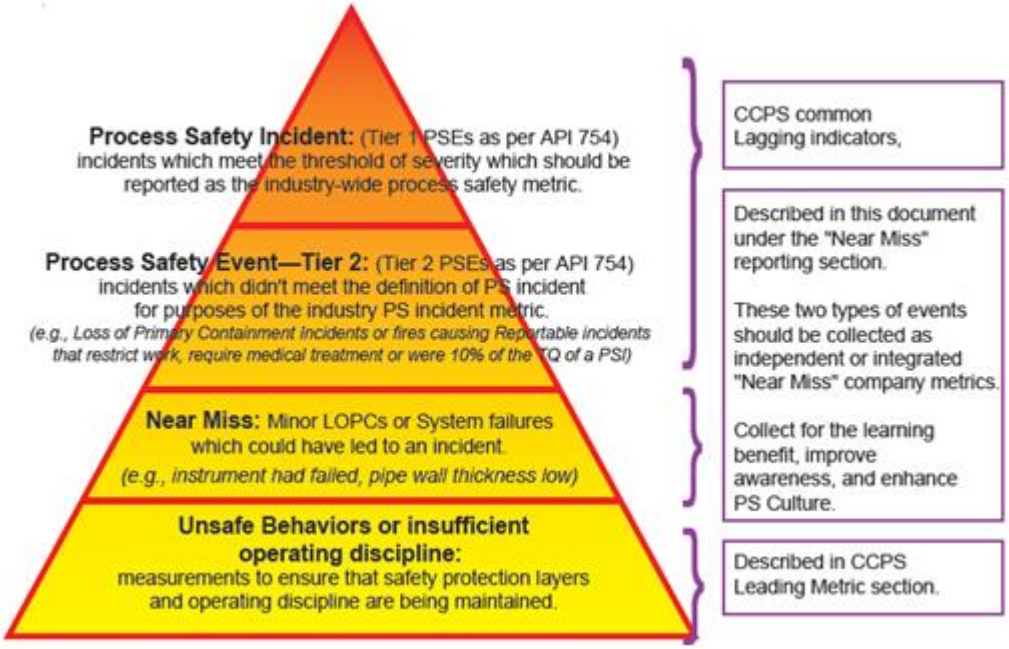


Figure 10. Process Safety Metric Pyramid used by CCPS (CCPS, 2011)

E.4 Leading and Lagging Indicators

Literature often categorizes the indicators to be Leading and Lagging (following) indicators. United Kingdom's Health and Safety Executive (2006) describes them as follows (HSE, 2006):

- ***Leading indicators*** are a form of active monitoring focused on a few critical risk control systems to ensure their continued effectiveness. **Leading indicators require a routine systematic check that key actions or activities are undertaken as intended.** They can be considered as measures of process or inputs essential to deliver the desired safety outcome.
- ***Lagging indicators*** are a form of reactive monitoring requiring the reporting and investigation of specific incidents and events to discover weaknesses in that system. These incidents or events do not have to result in major damage or injury or even a loss of containment, providing that they represent a failure of a significant control system which guards against or limits the consequences of a major incident. **Lagging indicators show when a desired safety outcome has failed or has not been achieved.**

CCPS described three types of metrics (indicators) (CCPS, 2011):

- ***"Lagging" Metrics*** – a retrospective set of metrics that are based on incidents that meet the threshold of severity that should be reported as part of the industry-wide process safety metric.
- ***"Leading" Metrics*** – a forward looking set of metrics which indicate the performance of the key work processes, operating discipline, or layers of protection that prevent incidents
- ***"Near Miss" and other internal Lagging Metrics*** – the description of less severe incidents (i.e., below the threshold for inclusion in the industry lagging metric), or unsafe conditions which activated one or more layers of protection. Although these events are actual events (i.e., a "lagging" metric), they are generally considered to be a good indicator of conditions which could ultimately lead to a more severe incident.

Some researchers do not distinguish between leading and lagging indicators anymore. Because of this ambiguity, a more general terminology is used in the literature, like *key indicator*s, *safety performance indicator*s, or *key performance indicators* (KPIs).

According to literature review, the discussion below provides a summary of references from ***scientific literature*** (academia) and ***professional literature*** (industry), most of which are from a review paper by (Swuste, Theunissen, Schmitz, Reniers, & Blokland, 2016), as discussed below.

E.4.1 Definition of Process Safety Indicators

The following shows the list of definitions from references of *scientific literature*.

1) The definition should contain; name, range, information required. The indicator is mathematical, and linked to the information necessary for the evaluation of the indicator
2) Safety Performance Indicators are measurable units indicating processes/activities performances to manage these processes and activities
3) Repeated disturbances, both technical, as organizational, as on human performance
4) Indicators show how process safety risks are managed
5) Building blocks of accidents, conditions, events, preceding unwanted events, and are to some extent capable to predict these events
6) Indicate the level of management of individual barriers to achieve goals

7) A measure of root causes and safety performance of a production process
8) A measure of a safety level of a system, and if necessary responsible persons taking actions
9) A measure providing feedback for improvements, if safety is sufficiently accomplished. An observable measure giving insight is a difficult to measure concept as safety
10) Predicts future changes in risk levels
11) A measure for disturbances, failures in a process system, and for interaction between those involved in safety management
12) A proxy for items from underlying safety models.
13) Lagging indicators, precursors of LOC incidents, leading indicators measure the quality of the management system
14) Based upon the prevention of incidents, near-incidents, barrier performances
15) A measure for the status of risk reducing factors
16) Provides an indication of the present state, or the development of organizations key functions, of processes, and the technical infrastructure of a system
17) Risk based indicators measure the integrity of resources, operational, mechanical, human
18) Detection of failures in hazard analysis, design, non-adequate controls, and cause by extreme conditions

The following is a list of main professional organizations involved in process / offshore industry.

- ANSI/API: American Petroleum Industry
- CCPS: Centre for Chemical Process Safety
- Cefic: European Chemical Industry Council
- EPSC: European Process Safety Centre
- HSE: British Health and Safety Executive
- OECD: Organization for Economic Cooperation and Development
- OGP: International Association of Oil and Gas Producers
- UK Oil and Gas Industry: Step Change in Safety of the British Oil and Gas Industry

The following table shows the list of definitions from references of *professional literature*.

Definitions	References
Leading and lagging system guards are a double assurance the risk control system is operating as intended, or giving warnings of problems in development	HSE, 2006
Give results of a risk control system (lagging) or (mal)functioning of critical elements of risk control system (leading).	HSE, 2006
Provide information on outcomes of actions (lagging) or the current situation, affecting future performances (leading).	UK Oil and Gas Industry, 2006
Allow organizations to verify if risk control measures taken are still active	OECD, 2008a, OECD, 2008b

Definitions	References
Performance indicators quantify objectives set and measure performances, enabling to manage, improve, and being accountable.	Olivier and Hove, 2010
A standard for measuring the efficiency and performance of process safety	CCPS, 2010
An indicator gives information, effective in improving safety	ANSI/API, 2010
Indicators are standards of performance and effectiveness of the process safety management system, and associated elements and activities are tracked.	CCPS, 2010
Serious safety incidents (lagging) or performance of parts of the safety management system (leading).	CCPS, 2011
Measurement, analysis of incidents in the area of process safety and facilitate benchmarking	Cefic, 2011
Information indicating a company controls its main risks, equipment integrity and the level of safety of the (production)process.	OGP, 2011
Indicators are the measured variables, linked to safety critical measures	EPSC, 2012
Provides information on the safety situation	Bellamy and Sol, 2012
A key factor for the success of process safety	Bhandari and Azevedo, 2013
An indicator is representative to achieve the possibility/capacity of a result suggested	Heuverswyn and Reniers, 2012

E.4.2 Process Safety Indicators

From *scientific literature*, the following *process safety indicators* have been identified.

1) Alarms, failures, numbers per time period
2) Exposure to dangerous substances/activities
3) Process deviations, number
4) State of safety, unwanted
5) Incidents, number
6) Leakages, number, amount
7) Quality barriers
8) Fires, explosions, number, costs
9) Loss of containment, amount, number
10) Process design, failures, maintenance, quality control, failures
11) Tests, failures
12) Safety system, frequency of activation
13) Inherent safe installations, number

From *professional literature*, the following *process safety indicators* have been identified.

Indicators	References
Alarms, failures, number per time period	OGP, 2011, OGP, 2008
Exposure dangerous materials/activities	UK Oil and Gas Industry, 2006
State of safety, unwanted	OECD, 2008a, OECD, 2008b
Incidents, number	CCPS 2011
Leakage, number, amount	CCPS, 2011, ANSI/API, 2010, Cefic, 2011
Fires, explosions, number, costs	OGP, 2011, HSE, 2006, CCPS, 2011, ANSI/API, 2010, Cefic, 2011
Loss of containment, amount, number	OGP, 2011, HSE, 2006, CCPS, 2011, ANSI/API, 2010, Cefic, 2011
Process design, failures Maintenance, quality control, failures	UK Oil and Gas Industry, 2006, OGP, 2011, OGP, 2008, HSE, 2006, OECD, 2008a, OECD, 2008b, OGP, 2011, OGP, 2008, OECD, 2008a, OECD, 2008b,
Tests, failures	OGP, 2011, HSE, 2006
Safety system, frequency of activation	OGP, 2011, ANSI/API, 2010
Installations inherent safe, number Process disturbances outside design envelop, number	OECD, 2008a, OECD, 2008b EPSC, 2012, ANSI/API, 2010
Safety system, frequency of failure	HSE, 2006, ANSI/API, 2010
Storage dangerous materials, amounts	OECD, 2008a, OECD, 2008b

E.4.3 Management and organizational indicators

Management and organizational indicators seem to be mainly based on experience from companies or on common sense. The most commonly used indicators were the lost-time accidents, unsettled issues of safety reports, safety training of workers and near-accidents with potentially serious consequences. From *scientific literature*, the following management and organizational indicators have been identified.

1) Behavior, unsafe situations, positive feedback
2) Safety management, activities
3) Safety culture, climate, index
4) Audits, number performed, settled action items
5) Inspections, settled action items
6) Safety observations, number
7) Safety procedures, accessibility
8) Safety training, program, frequency
9) Toolbox meetings, frequency, presence
10) Safety commissions, settled action items
11) Work procedures, correctly followed, shift changeovers

12) Safety stops during enhanced risk
13) Human performance meetings, number
14) Work permits, transfer, correct performance
15) Contractor-subcontractor, selection, training
16) Decisions, safety decisions
17) Competence profiles, training
18) Manning, shift size
19) Contingency plan, training
20) Risk assessment during process changes (MoC)
21) Safety analyses, number, trends
22) Safety documentation
23) Safety initiatives personnel

From *professional literature*, the following management and organizational indicators have been identified. Most of these indicators are similar to the ones found in *scientific literature*.

Indicators	References
Behavior, unsafe situations, positive feedback	OECD '08
Safety management activities	UK Oil & Gas Industry, '06, OECD '08
safety culture, climate, index	OECD '08
Audits, number performed, settled action points	UK Oil & Gas Industry, '06, OECD '08, CCPS '11, ANSI_API '10
Inspections, number performed	HSE '06, UK Oil & Gas Industry, '06, CCPS '11, ANSI_API '10
Inspections, settled action points	EPSC '12, OGP '11, CCPS '11, ANSI_API '10
Safety observations, number	UK Oil & Gas Industry, '06, OECD '08
Safety procedures, accessibility	OECD '08
Safety training, program, frequency	OGP '11, OECD '08, CCPS '11
Toolbox meetings, frequency, presence	OGP '11
Work procedures, correctly followed, transfer of shifts	OGP '11, HSE 2006, CCPS '11
Human performance meetings, number	OECD '08
Work permits, transfer, correct performance	UK Oil & Gas Industry, '06, OGP '11, OGP '08, OECD '08, CCPS '11, ANSI_API '10
(Sub)contractors, choice, training	OGP '11, OECD '08
Competence profiles, training	UK Oil & Gas Industry, '06, OGP '11, OGP '08, HSE '06, OECD '08, CCPS '11, ANSI_API '10
Manning, shift size	OECD '08

Indicators	References
Contingency plan, training	OECD '08, ANSI_API '10
Risk assessment during process changes (MoC) Temporarily shutting down safety systems	OGP '11, OGP'08, HSE'06, OECD'08, CCPS '11, ANSI_API '10 EPSC '12, CCPS '11
Inspection program installation	EPSC '12, OGP '11
Safety analyses, number, trends Safety meetings personnel & management	UK Oil & Gas Industry, '06 UK Oil & Gas Industry, '06, OGP '11
Safety documentation	OECD '08, SCiS '12
Safety studies, number	UK Oil & Gas Industry, '06, OGP '11, OECD '08, ANSI_API '10
Operational procedures, correctness/availability	OGP '11, OGP '08, HSE '06, CCPS '11, ANSI_API '10
Emergency procedures, correctness/availability	HSE '06, OECD '08, CCPS '11, ANSI_API '10
Law offences, deviation of standard	UK Oil & Gas '06, OGP '11, HSE '06, OECD '08
Communication during normal operation and emergencies	HSE '06, OECD '08
External communication and cooperation	OECD '08
Hazard identification and risk analysis	OECD '08
Product safety	OECD '08
Reports/studies of (near) accidents	OECD '08
Safety culture, number/frequency of evaluations	CCPS '11
Safety policy published and communicated	UK Oil & Gas Industry, '06
Suggestions for safety improvements, number	UK Oil & Gas Industry, '06

E.4.4 Personal / Occupational safety indicators

From scientific literature, the following management and organizational indicators have been identified.

1) Near misses, number
2) Accidents with/without lost days, number/rate
3) Total recordable injuries, number/rate
4) First aid injuries, number/rate
5) All injuries, number/rate
6) Housekeeping and cleanliness

E.5 Example Procedures for Identifying Leading Indicators

E.5.1 ABS Guidance Notes on Safety Culture and Leading Indicators of Maritime Industry

ABS Guidance Notes provide procedures on identifying safety leading indicators (ABS, 2014). The central premise of the ABS Model, shown in Figure 11. "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.

Figure 11. 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 Facilities

ii) By the identification of ***subjective*** **leading indicators** from a safety culture survey. These indicators are based on the values, attitudes, and observations of workers. 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.

Objective Leading Indicators

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.

Subjective Leading Indicators

Subjective leading indicators are identified by correlating survey responses with safety performance data for the last twelve months. The method is:

a. 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.
b. 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".
c. Correlate the Responses and Safety Performance Data with the non-parametric test Spearman's rho for ranked correlations.

(ABS, 2014) Guidance Notes were designed for the maritime industry; however, the potential leading indicator processes described in the Guidance Notes can be adapted for offshore installations and mobile offshore drilling units.

E.5.2 International Association of Oil & Gas Products (IOGP) Report 456: Process Safety – Recommended Practice on Key Performance Indicators

IOGP Report 456 suggested a six-step approach for selecting Process Safety KPIs, as shown in Figure 12**Error! Reference source not found.** (OGP, 2011). In alignment with API RP 754, IOGP recommends the four-tier framework of process safety KPIs:

- Tier 1: Loss of Primary Containment (LOPC) events of greater consequences, a.k.a., Process Safety Events (PSEs).
- Tier 2: LOPC events of lesser consequences.
- Tier 3: challenges to safety systems
- Tier 4: operation discipline & management system performance indicators

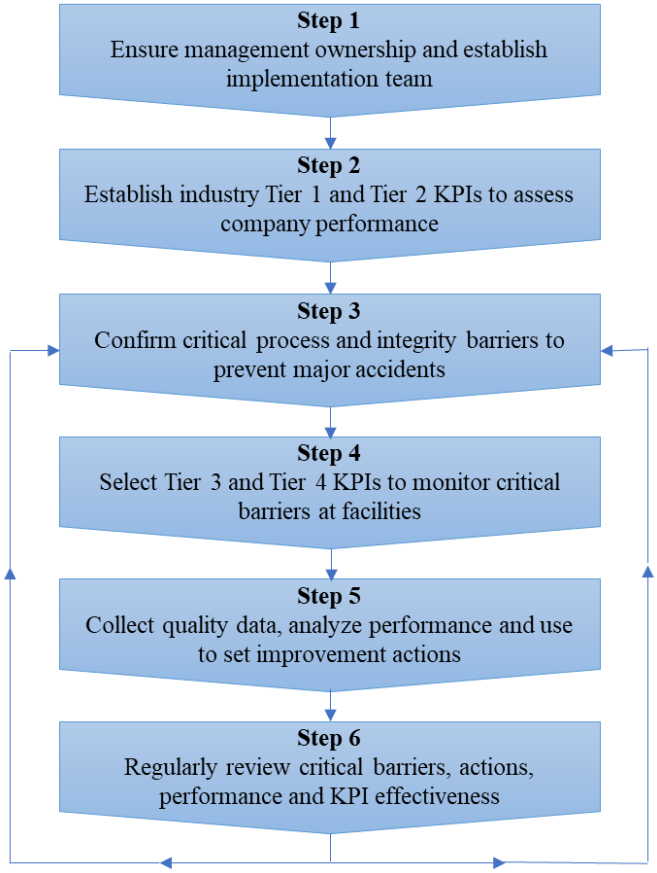


Figure 12.Six-step Approach for Selecting Process Safety KPIs (OGP, 2011)

E.6 Applications of Finding and Using Leading Indicators in Offshore Industry

E.6.1. Safety Indicators for Preventing Offshore Oil and Gas Deepwater Drilling Blowouts (2011)

In response to the Macondo blowout accident, Skogdalen, Utne, and Vinnem proposed safety indicators as shown in the figure below (Skogdalen, Utne, & Vinnem, 2011). This figure gives an overview of areas where indicators related to deepwater drilling are needed. The indicators are related to: 1) schedule and cost, 2) well incidents, 3) operators' well response, 4) operational aspects, and 5) technical condition of safety critical equipment. All the suggested areas for indicators are based on available data, and in several cases, the data is recorded and has been recorded for years by the regulatory authorities in Norway, research communities, companies, and rigs.

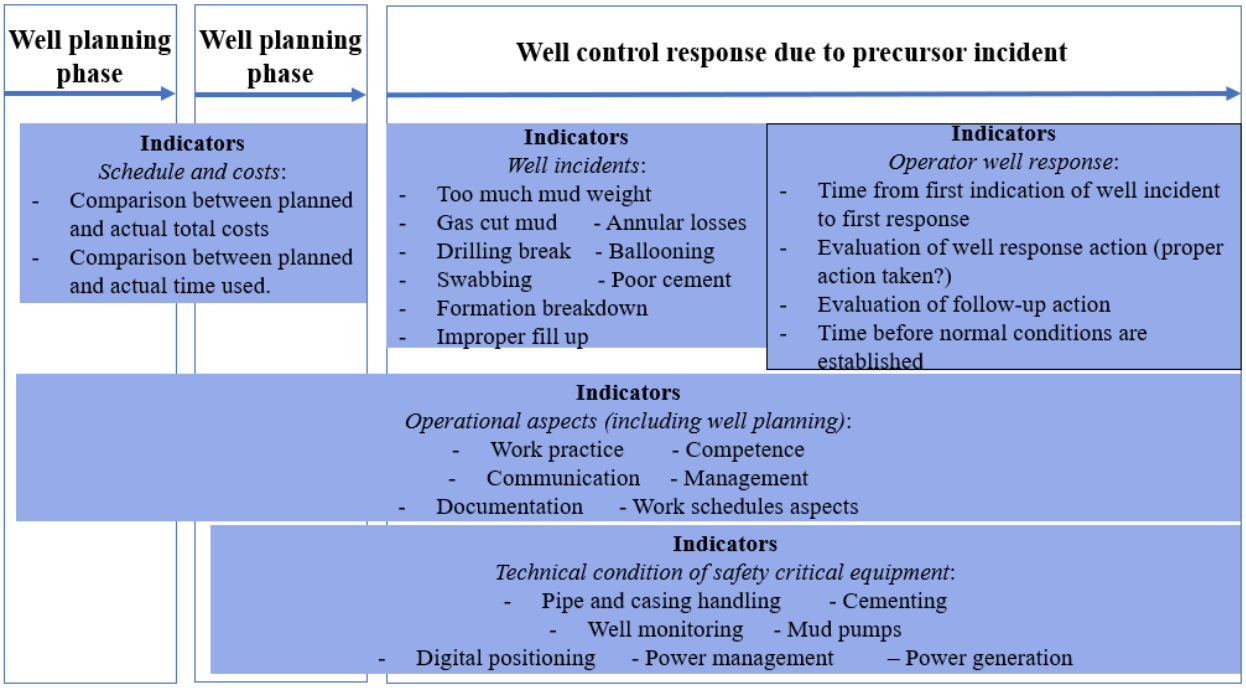


Figure 13. Summary of Suggested Indicators Related to Deepwater Drilling

E.6.2 Safety Indicators for Offshore Drilling (2012)

This was a report in response to the CSB inquiry into the BP Macondo blowout accident in 2010. API 754 is applicable to any industry where a loss of containment has the potential to cause serious harm. It specifically applies to refining and petrochemicals industries. The standard is potentially relevant to upstream oil and gas production, but **drilling is different** (Hopkins, 2012)**:**

- **Gas**: Gas can be and is released from wells during the drilling process and can reach dangerous levels on a rig.
- **Oil Spills**: Another indicator that is widely used in offshore operations is number and volume of oil spills. Some CSB interviewees suggested that this was an indicator of process safety.
- **Kicks**: Blowouts do not happen frequently. Consider therefore the immediate precursor to a blowout, namely a well kick or well control incident (these terms are used interchangeably). These are more numerous, and it is widely recognized that reducing the number of kicks reduces the risk of blowout. For any one well, the number of kicks may be too small to serve as a useful indicator, but number per company per year is something companies could usefully compute and seek to drive downwards. It is sometimes objected that wells differ in complexity and hence propensity to kick, and that any indicator based simply on number of kicks would therefore be misleading. This may be so. But there are ways in which levels of complexity can be taken into account so that valid comparisons to be made. One possibility is to make use of the **Dodson Mechanical Risk Index (MRI**). The MRI divides wells into five complexity levels, based on water depth, well depth, number of casing strings and salt penetration.

Regulatory reporting requirements:

Some jurisdictions already require that operators report kicks, among other things, to the offshore regulator. Here are the main reporting requirements of three different regimes - Norway, Australia, and the USA:

Norway:

- Non-ignited hydrocarbon leaks
- Ignited hydrocarbon leaks
- Well kicks/loss of well control
- Fire/explosion in other areas, flammable liquids
- Vessel on collision course
- Drifting object
- Collision with field-related vessel/installation/shuttle tanker
- Structural damage to platform/stability/anchoring/positioning failure
- Leaking from subsea production
- systems/pipelines/risers/flowlines/loading buoys/loading hoses
- Damage to subsea production equipment/pipeline systems/diving equipment caused by fishing gear

Australia

- death or serious injury
- dangerous occurrences that could have caused death or serious injury
- hydrocarbon releases, well kicks
- fires or explosions
- safety-critical equipment damage
- implementation of Emergency Response Plan
- marine vessel and facility collisions

Hydrocarbon releases are singled out for special attention and the regulator computes a rate of gas release normalized by volume of production.

USA

- deaths
- fires
- explosions
- blowouts
- serious injuries
- releases of hydrogen sulfide gas
- collisions
- structural damage
- Incidents involving cranes, personnel handling, or materials handling equipment

- damage to safety systems or safety equipment
- evacuations
- gas releases that initiate equipment or process shutdown

It is notable that the list for the USA does not include all gas releases, or even all gas releases of more than a certain size, that is, it does not require the reporting of LOPCs as defined in API 754. Nor does it require that kicks be reported. In contrast, both the Norwegian and Australian regulators require that all hydrocarbon releases and all kicks be reported.

The author suggested other potential safety indicators for offshore drilling.

- **Response to Kicks**: Blowout prevention relies on drillers recognizing kicks as soon as possible after they have occurred, and taking corrective action, such as closing in the well.
- **Cement failures**: The Macondo blowout was initiated by an unrecognized cementing failure. Moreover, there had been two previous cementing failures higher up the well.

As a conclusion, the author suggested that the regulator should develop the following indicators for drilling operations and mandate their reporting:

- Number of kicks
- Response time to kicks
- Number of cementing failures
- Number of gas alarms

E.6.3 Suggested Indicators of Environmentally Responsible Performance of Offshore Oil and Gas Companies Proposing to Drill in the US Arctic (2014)

This report from Harvard Law School suggested indictors for offshore oil and gas drilling in the Arctic (Harvard Law School, 2013):

Leading Indicators:

1. Personnel Surveys regarding operator's safety and environmental management systems
2. Safety and pollution prevention equipment maintenance backlog
3. Air pollution

Intermediate indicators

4. Civil and administrative violations
5. Kick frequency and kick response time

Lagging indicators

6. Loss of primary containment events
7. Oil releases
8. Work-related fatalities and reportable injuries

E.6.4 A Framework for Developing Leading Indicators for Offshore Drillwell Blow Incidents (2017)

Tamim et al. developed a framework for developing leading indicators for offshore blowout incidents (Tamim, Laboureur, Mentzer, Hasan, & Mannan, 2017). They argue that the offshore drilling industry is similar to the aviation industry, as shown in the following figure, and they created a framework for developing leading indicators for offshore drill well blow incidents.

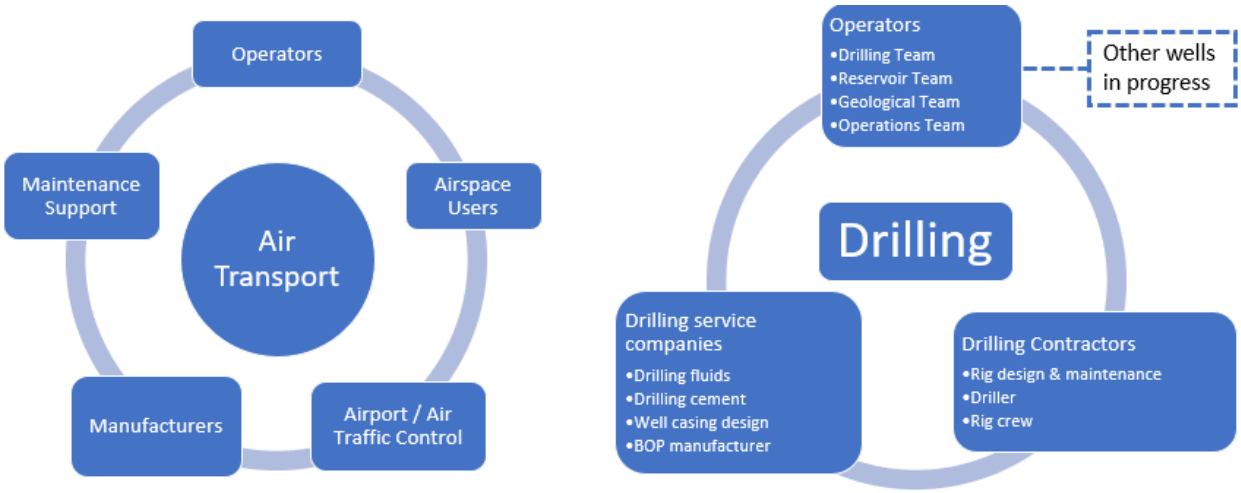


Figure 14. Multi-stakeholder Operations in Aviation and Drilling

Lagging to leading transition of drilling events can be represented with the arrow diagram shown below.

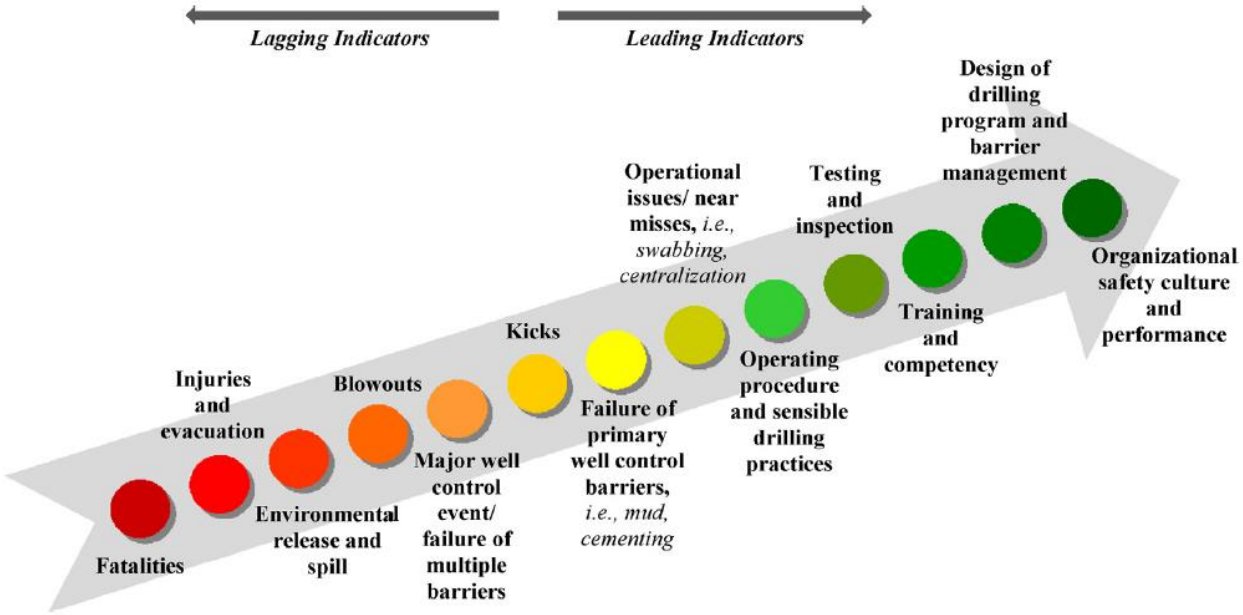


Figure 15. Gradual Transition from Lagging to Leading Indicators in Drilling Operations

The authors categorize leading indicators as summarized in the following figure.

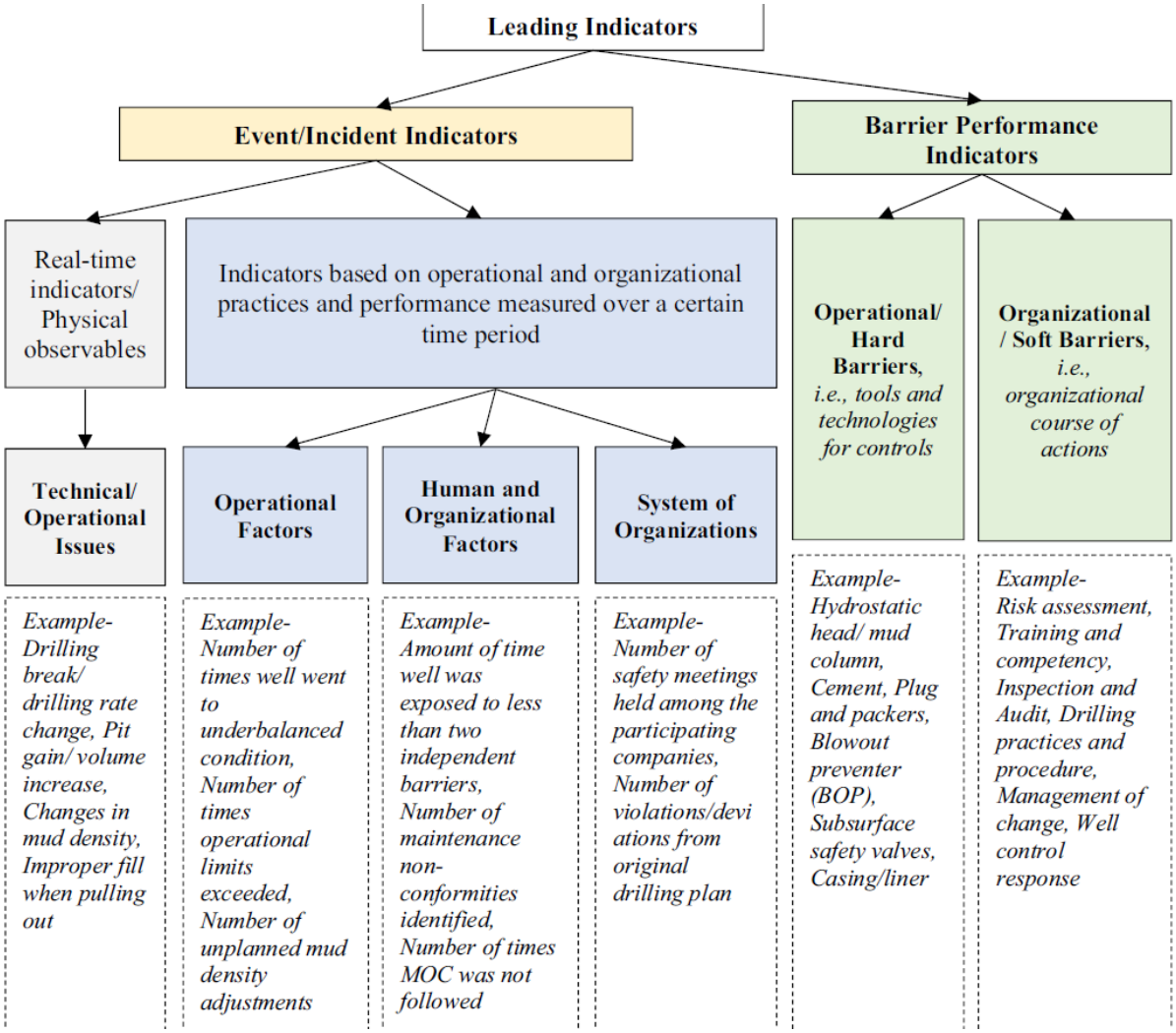


Figure 16. Categorization of Leading Indicators

H1 well of the Montara Wellhead Platform in the Timor Sea, Australia, kicked and uncontrolled hydrocarbon started to flow on August 21, 2009. Using this as a case study, the authors suggested a list of potential indicators:

- Real-time indicators: Differential flow volume—pumped 9.25 bbl of fluids; 16.5 bbl returned; Changes in annular pressure—pressure increased after initial test.
- Operational factors: Non-installation of one of the pressure containing valves (PCCC) 13 3/8" PCCC; Insufficient density of overbalance well fluid.
- Organizational factors: Absence of BOP, diverter system or any independent secondary barrier; Change of plan without formal risk assessment; lack of compliance with MOC system; Improper well barrier management system and risk assessment − Installation of PCCC instead of cement plug; Lack of inspection and compliance audit.
- System of organization: Lack of understanding between the operator and the contractors on drilling safety, integrity, and individual responsibilities

E.6.5 Malaysian offshore industry application (2017)

Tang, Leiliabadi, and Olugu investigated safety factors in the Malaysian oil and gas industry (Tang, Leiliabadi, Olugu, & M.d. Dawal, Factors affecting safety of processes in the Malaysian oil and gas industry, 2017). The most common safety indicator used across multiple industries including on the offshore oil and gas installations is the number of injuries and fatalities (Hopkins, 2009). Through the statistical study and literature review, a list of 70 indicators (details not given) were sorted into 14 categories with example indicators as shown in the following table. The details of these indicators were not given in their paper; only examples were provided.

Table 19. Factor and example indicator for each factor

Safety Factor	Number of items	Example indicator
Inspection and maintenance	6	Percentage of safety critical plant/equipment that performs within specification when inspected
Management and workforce engagement (MWE) on safety	4	Number of barrier weakness including unsafe conditions identified from MWE
Number of incidents/near misses	12	Number of near-misses or incidents during start-ups and shutdown
Personal safety	9	Number of medical surveillance showing exceeded threshold values
Contractor's safety	2	Percentage of contractors' acting in accordance with company's policy
Management of plant changes	6	Number of hazard and operability (HAZOP) actions associated with plant change completed
Plant operation and operating procedures	11	Number of exceedances of allowed burning time in restricted areas
Competence	3	Number/percent time that facility integrity/process safety critical positions have gone unstaffed
Plant design	3	Number/percentage of replacement of inferior components or systems with safer ones
Instrumentation and alarms	4	Number of safety instrumentation and alarms faults during tests
Hazard identification and risk assessment	3	Average number of hours per process & instrument diagram (P&ID) for conducting baseline & revalidation of PHA (process hazard analysis)
Documentation	2	Number of facility related safety documents retained as per organization and legal requirements
Start-ups and shut down	2	Number of personnel trained on start-ups and shutdowns prior to commencing start-ups and shutdowns
Emergency management	3	Number of elements of the emergency procedure that fail to function to performance standard

Using the developed instrument, Tange, Md. Dawal, and Olugu (2018) measure the actual safety performance of the Malaysian offshore oil platforms (Tang, Md. Dawal, & Olugu, 2018). In their final instrument, the number of indicators were reduced to 63 which forms the basis of safety performance measurement framework for offshore oil and gas platforms in Malaysia.

Appendix F. Literature Review on Safety Culture Maturity Model

The purpose of safety culture maturity model is to judge the maturity level of an organization's safety culture. Maturity models are a single number that describes the safety culture within an organization based on the available data. Safety culture maturity examines how a company views and manages safety. According to the literature, there are several different types of maturity models as discussed below.

F.1 Three-Level Model

Earlier maturity models have three levels (Westrum, 1996; IAEA, 1998). Westrum's model has three levels as 'pathological', 'calculative', and 'generative.' (Westrum, 1996)

- At the "Pathological" level of maturity, there is a focus on the personal needs, power, and glory of those in charge. This implies that information is hidden ("messengers are shot"), responsibilities avoided, and failures covered up: the pathological culture is power oriented and related organizations see safety as a problem.

- Organizations with the "Bureaucratic" culture tend to be fixated on rules, positions, and departmental territories. As a result, information may be ignored, responsibilities are compartmentalized, and failures lead to local repairs: the bureaucratic culture is then rule oriented.

- At the highest level of safety culture, "Generative" refers to a culture where safety is embedded in every activity of the organization. This implies that information is actively sought, responsibilities are shared, and failures are resolved with deep inquiry.

  International Atomic Energy Agency (IAEA) has a three-stage model (IAEA, 1998).

- At Stage I, the organization sees safety as an external requirement and handles it mainly through a technical perspective.
- At Stage II, safety is considered as important even in the absence of regulatory pressure. However, behavioral issues are still missing.
- At Stage III, an organization has adopted the idea of continual improvement and there is an awareness of the impact of behavior on safety.

F.2 Four-Level Model

More recent maturity models have four or five levels (Reason, Managing the Risks of Organizational Accidents, 1997; Hudson, Safety Culture - Theory and Practice, 1999; Thomson, 1997). The DuPont Bradley Curve is a four-level model as the leading quantitative leading indicator of organizational safety culture and maturity. In the DuPont Bradley Curve, people move from externally applied discipline to self-discipline and then to a state of interdependency when they help each other do better (Rains, 2014). As shown in Figure 17, the four levels are defined as:

- "Reactive" (safety is focused on compliance and delegated to the safety manager)
- "Dependent" (emphasis is laid on fear and discipline, rules, and procedures)

- "Independent" (safety management is internalized and people believe that personal commitment makes the difference), and
- "Interdependent" (teams feel a sense of ownership for safety and coordination is valued).

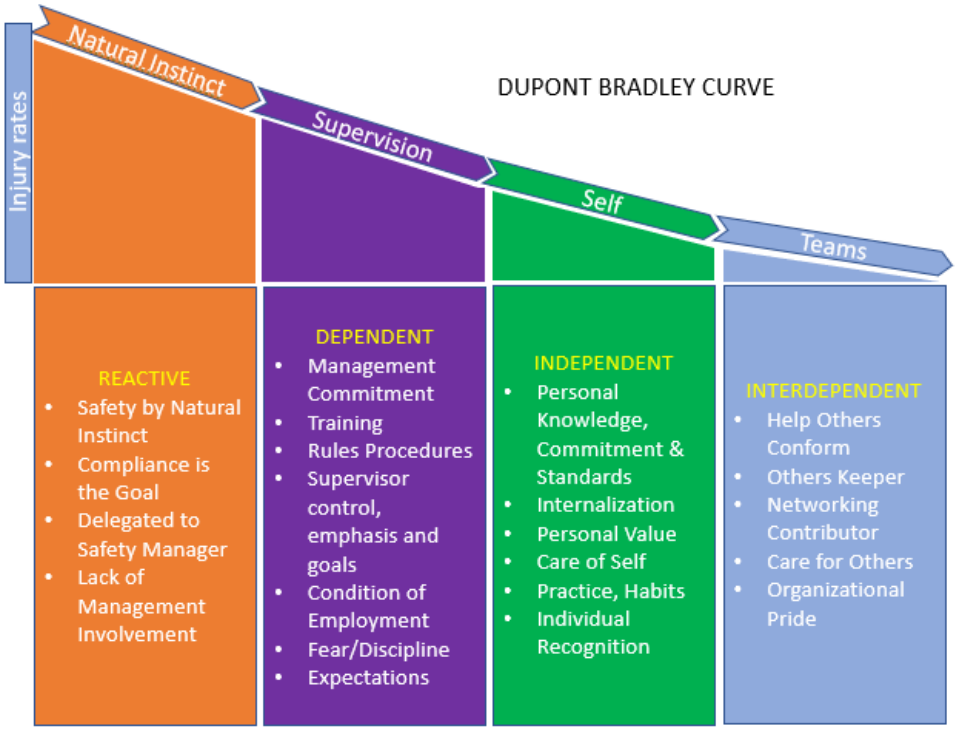


Figure 17. The DuPont Bradley Curve as a Maturity Model

As an example of DuPont model's application, it can be used to measure the maturity of a Safety Management System (SMS). An SMS may have 10 typical standard elements of practice (Braun, 2019):

1. Management Commitment and Leadership
2. Roles, Responsibilities, Accountabilities
3. Hazard Identification, Control, Mitigation
4. Worker Engagement, Motivation, Ownership
5. Training, Competence, Safety Staff Qualifications
6. H&S Communications
7. Performance Verification and Assurance
8. Continual Improvement
9. Contractor Management
10. Administrative Programs

Each of these ten elements may be measured with the four levels of DuPont model.

Bernard proposed a four-level model for nuclear regulation (Bernard, 2018). The levels are defined as (Figure 18**Error! Reference source not found.**):

- Bureaucratic: "We are driven by rules: our organization is like clockwork"

- Individual commitment: “We are individually involved”
- Cooperative: “We are interdependent: our job needs teamwork”
- Holistic: “As a regulatory body (RB), we share and promote a holistic view of safety”

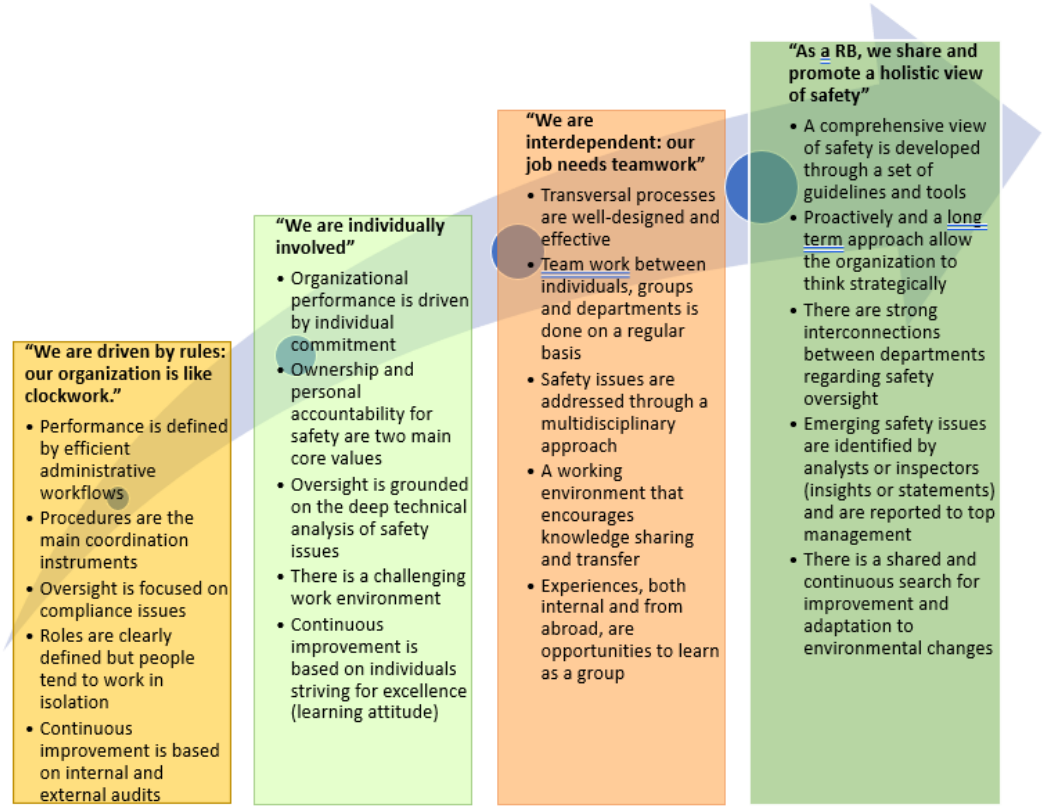


Figure 18. The four levels of the Safety Culture Maturity Matrix

Bernard’s model assesses the maturity level through five safety culture dimensions at each level:

- Leadership for safety;
- Individual responsibility;
- Safety oversight;
- Open Communication;
- Continual improvement.

F.3 Five-Level Model

Hudson extended Westrum’s model to five maturity levels as (Hudson, 1999; Hudson, 2007) (Figure 19):

- *Pathological safety culture*: Safety is a problem caused by the workers. The drivers are the business and a desire not to get caught by the regulator;
- *Reactive safety culture*: Organizations start to take safety seriously, but action is taken only after incidents;

- *Calculative safety culture*: Safety is driven by management systems, with much collection of data. Safety is still primarily driven by the management and imposed rather than looked for by the workforce;
- *Proactive safety culture*: With improved performance, the unexpected is a challenge. Workforce involvement starts to move the initiative away from a purely top down approach;
- *Generative safety culture*: There is active participation at all levels. Safety is perceived to be an inherent part of the business. Organizations are characterized by chronic unease as a counter to complacency.

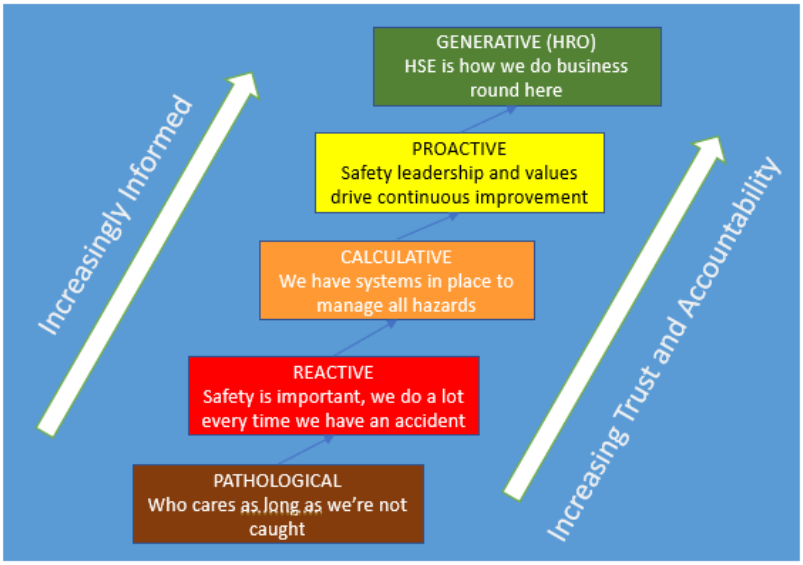


Figure 19. Hudson's Safety Maturity Model

Hudson's safety maturity model serves as the proprietary assessment tools 'Hearts and Minds' by Shell International (Table 20. The full set of Hearts and Minds tools).

Table 20. The full set of Hearts and Minds tools

Tools available	What they do and When to use them
HSE Understanding your culture	What: An engagement tool to identify local strengths and weaknesses identifying a way to improve. When: Use 1st to engage people, discover their aspirations and build a case for change (2-3 hours + follow up)
Seeing Yourself as Others See You	What: HSE upwards appraisal tool to understand other's perception and identify how commitment is turned into action. When: Use 2nd to challenge the commitment and behaviors of any "safety leaders", (20 minutes + follow up).
Making Change Last	What: A general tool for managing change the supporting any improvement process or organizational change programs. When: To design your own tools (1-2 hours to start).
Risk Assessment Matrix: Bringing it to life	What: Helps people understand their risks, makes them personal and stimulate action. When: Anytime to better manage the risks. (1 hour).

Achieving Situation Awareness: The Rule of 3	What: To help everyone make better risk-based decision and be able to justify them. When: If people lose sight of their risks, or if complacency threatens to set in. Can be used anytime, especially when there is change (<5minutes).
Managing Rule-Breaking	What: To prevent incidents being caused by rule breaking. When: If procedures are not being followed, or a need to improve procedures (2-3 hours) initially then, 1 hour per issue).
Improving Supervision	What: To improve the non-technical skills of supervisors. When: If the quality of supervision, is identified as a (possible) cause of incidents (4-5 hours first time).
Working Safely	What: Intervention program that builds on and supports existing programs or can be run by itself. When: If safe working practices are not being followed (8 hours in total, 1-hour slots).
Driving for Excellence	When: a suite of exercises to change the behavior of drivers and the people who manage them. When: When driving is a significant risk, professionally or personally (8 hours in total, 1-hour slots).

Filho et al. formulated a framework for the petrochemical companies in Brazil, based on the Hudson's model (Filho, Andrade, & Marinho, 2010).

Sponsored by UK HSE, Sharp et al. proposed a five-level maturity model for designing safety offshore installations (Sharp, Strutt, Busby, & Terry, 2002). Their five maturity levels for design safety are defined as follows:

- Optimized: The organization is 'best practice', capable of learning and adapting itself. It not only uses experience to correct any problems, but also to change the nature of the way it operates.
- Managed: The organization can control what it does in the way of processes. It lays down requirements and ensures that these are met through feedback.
- Defined: The organization can say what it does and how it goes about it.
- Repeatable: The organization can repeat what it has done before, not necessarily define what it does
- Initial: Lowest level, by absence of the above quality

The design safety maturity model was improved to be a Design Safety Capability Maturity Model (DCMM) by the authors (Strutt, Sharp, Terry, & Miles, 2006). The following table provides the description of key processed used in the DCMM model.

Table 21. Elements of design safety maturity

	Elements	Details of characteristic	Set
1	Setting of safety requirements, framework and direction	How comprehensively the organization determines safety requirements during design and defines them for clear communication. How the organization sets a fundamental direction to achieve safety and continuously improve through incentives, culture etc.	Formal safety demonstration
2	Major hazard identification and risk analysis	How well the organization operates the process of major hazard identification and risk analysis. The completeness with which major hazards are identified and logged into the project processes.	
3	Safety improvement and risk reduction	How well the organization manages the activities and tasks related to making safety improvements and implementing risk reduction during the design process How well the organization operates the process of demonstrating that risks are ALAR	
4	Safety assurance and independent checking	How well the organization conducts its checking processes especially validation and verification.	
5	Understanding and implementing technical standards	How well the organization uses, develops and maintains standards.	Safety implementation
6	Measuring and benchmarking	How well the organization measures its own performance and compares it with that of other, comparable organizations	
7	Recognition and handling of unconventional features	How well the organization anticipates and manages the ways, in which unconventional elements of projects benefit or compromise safety	
8	Managing safety in the supply chain	How well the organization manages its supply chain partners in meeting and demonstrating design safety	
9	Managing design and management changes	How well the organization manages change that can impact on design for safety including life cycle transitions e.g. from FEED to detail design	

10	Managing the level of organizational learning	How well the organization adds to and uses its stock of knowledge to support design for safety	Longer term investment in safety
11	Managing education and training	How well the organization determines, acts on and exploits the need for education and training relevant to design for safety	
12	Managing the approach to research and development	How well the organization conducts and exploits R and D to support design for safety	

The overview of the DCMM is presented in the following figure.

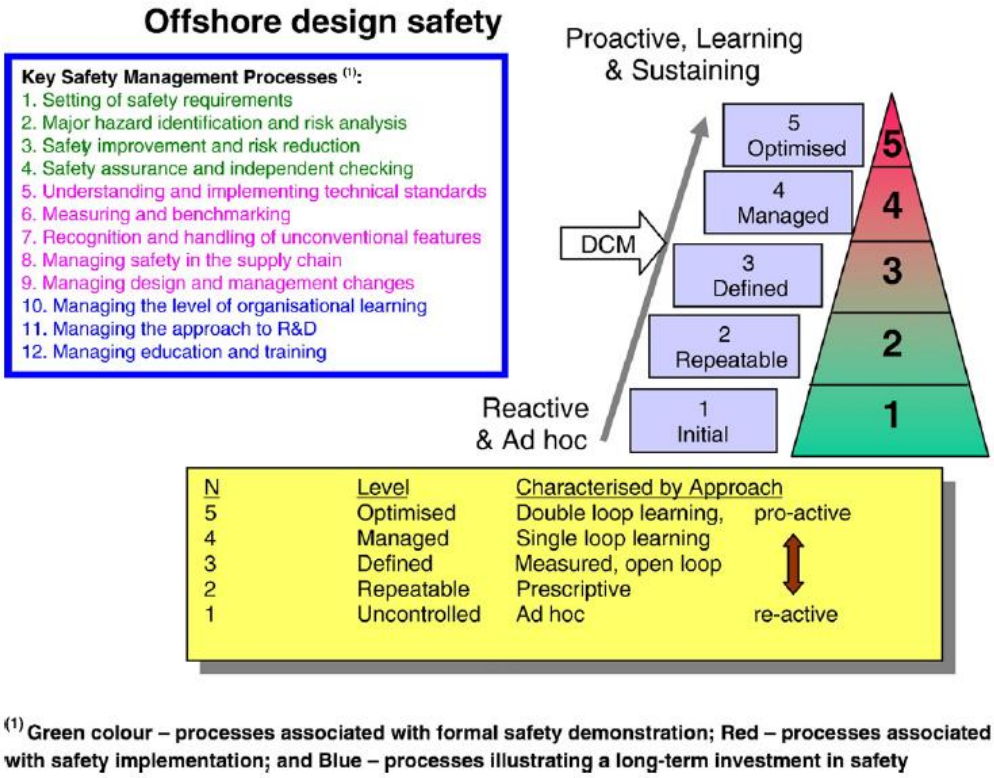


Figure 20. The overview of the Design Safety Capability Maturity Model

Modeled after the five levels of maturity (Initial, Repeatable, Defined, Managed, and Optimizing) in software engineering and inspired by UK HSE model, DuPont model, and Hudson's model, Fleming proposed five maturity levels for oil and gas industry (Fleming, 2000; Fleming & Meakin, 2004) (Figure 21):

1. Level 1 **Emerging**: Safety is defined in terms of technical and procedural solutions and compliance with regulations. Safety is not seen as a key business risk and the safety department is perceived to have primary responsibility for safety. Many accidents are seen as unavoidable and as part of the job. Most frontline staff are uninterested in safety and may only use safety as the basis for other arguments, such as changes in shift systems.

2. Level 2 **Managing**: Safety is seen as a business risk and management time and effort is put into accident prevention. Safety is solely defined in terms of adherence to rules and procedures and engineering controls. Accidents are seen as preventable. Managers perceive that the majority of accidents are solely caused by the unsafe behavior of front-line staff. Safety performance is measured in terms of lagging indicators such as LTI and safety incentives are based on reduced LTI rates. Senior managers are reactive in their involvement in health and safety (i.e., they use punishment when accident rates increase).

3. Level 3 **Involving**: Accident rates are relatively low, but they have reached a plateau. The organization is convinced that the involvement of the frontline worker in health and safety is critical, if future improvements are going to be achieved. Managers recognize that a wide range of factors cause accidents, and the root causes often originate from management decisions. A significant proportion of frontline workers are willing to work with management to improve health and safety. The majority of staff accept personal responsibility for their own health and safety. Safety performance is actively monitored, and the data is used effectively.

4. Level 4 **Cooperating**: The majority of staff in the organization are convinced that health and safety is important from both a moral and economic point of view. Managers and frontline staff recognize that a wide range of factors cause accidents, and the root causes are likely to come back to management decisions. Frontline staff accept personal responsibility for their own and others health and safety. The importance of all workers feeling valued and treated fairly is recognized. The organization puts significant effort into proactive measures to prevent accidents. Safety performance is actively monitored using all data available. Non-work accidents are also monitored, and a healthy lifestyle is promoted.

5. Level 5 **Continual improvement**: The prevention of all injuries or harm to workers (both at work and at home) is a core company value. The organization has had a sustained period (years) without a recordable accident or high potential incident, but there is no feeling of complacency. They live with the paranoia that their next accident is just around the corner. The organization uses a range of indicators to monitor performance, but it is not performance-driven, as it has confidence in its safety processes. The organization is constantly striving to be better and find better ways of improving hazard control mechanisms. All workers share the belief that health and safety is a critical aspect of their job and accept that the prevention of non-work injuries is important. The company invests considerable effort in promoting health and safety at home.

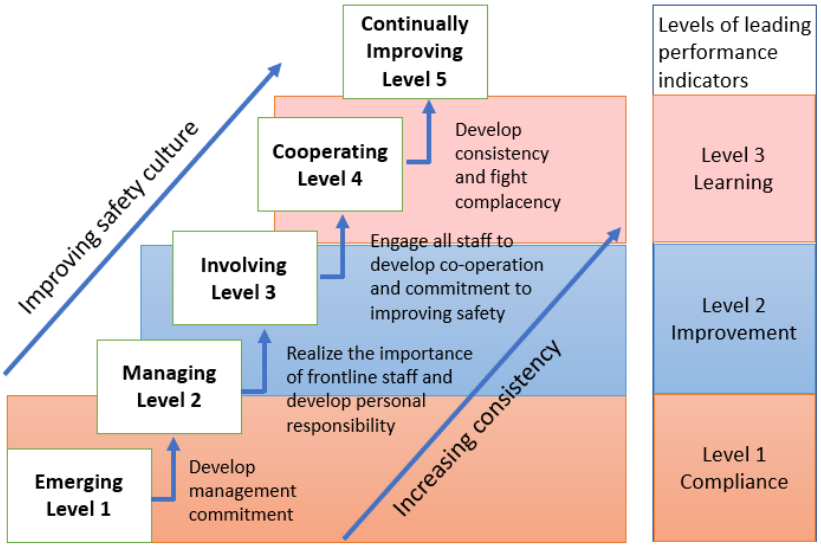


Figure 21. Fleming's Safety Culture Maturity Model

These five levels are evaluated through 10 elements of safety culture:

1. Management commitment and visibility
2. Communication
3. Productivity versus safety
4. Learning organization
5. Safety resources
6. Participation
7. Shared perceptions about safety
8. Trust
9. Industrial relations and job satisfaction
10. Training

Appendix G – Software User Manual – Located on the project's website - https://offshoresafety.lamar.edu/

Appendix H – Software Technical Manual - – Located on the project's website - https://offshoresafety.lamar.edu/

Appendix I – Statistical Analysis – Located on the project's website - https://offshoresafety.lamar.edu/

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