

## REVIEW OF SAFETY MANAGEMENT SYSTEMS

### 1. Introduction

The continued success of the International Safety Management (ISM) Code is dependent upon the maritime industry seeking to continuously improve our understanding of the strengths and limitations of safety management systems (SMS). To do so we need not only to examine and assess the implementation of the ISM Code to date but, importantly, we need also to review and assess the implementation of SMS in other safety related industries as part of a pro-active safety culture.

The Maritime & Coastguard Agency as the United Kingdom's shipping regulator decided to undertake a study of several other safety related industries in the UK. The safety related industries chosen for the study were: Aviation, Rail, Offshore and Process. Without going into detail of the specific regulatory regimes the key findings from this study are highlighted.

### 2. Aviation

#### 2.1 Safety Management Systems

Whilst many of the components of a SMS are present, for example, near miss data collection (CHIRP), incident and accident investigation, and controlled documentation, there is no recognised standard in aviation for defining a typical SMS. In recognising that a wide variety of accident investigations cited management failures as a significant contributory cause, the Safety Regulation Group (SRG) of the United Kingdom's Civil Aviation Authority drew up a number of SMS Policy and Principles aimed at providing a simple SMS framework supported by clear definitions.

These Principles include arrangements to conduct regular internal safety audits, arrangements for ensuring staff are adequately trained and competent for the job they are required to do, arrangements to identify and address potential risks arising from changes in operations, systems, procedures and staff associated with safety significant functions and activities, etc. It is evident that many of the components to the SMS recommended by the SRG are common to the ISM Code, however, a significant difference between the industries is the emphasis placed on industry to gain a greater understanding of human factors<sup>1</sup>.

#### 2.2 Human factors training for maintenance

Aviation industry regulations require for all staff in organisations involved in the maintenance of aircraft to undertake human factors training. The aim of human factors training is to increase safety, quality and efficiency in aircraft maintenance operations by reducing human

---

<sup>1</sup> The term "human factors", in this context, can be considered equivalent to the term "human element".

error and its impact in maintenance activities. This is obtained through the integration of appropriate categories of maintenance personnel's technical knowledge and skills with basic human factors knowledge and skills and promotion of a positive attitude towards safety. The specific learning goals are:

- enhance maintenance personnel's awareness of individual and organisational human factors issues, both positive and negative, that may affect airworthiness.
- develop human factors skills (such as communication, effective teamwork, task management, situational awareness, writing of procedures) as appropriate to the job, in order to make a positive impact on the safety and efficiency of maintenance operations.
- encourage a positive attitude towards safety, and to discourage unsafe behaviour and practices.

Significantly, this requirement recognises that the safety of an aircraft maintenance organisation is dependent upon the actions of all those who work for the organisation and not just those directly involved in the maintenance activity. Hence, the categories of staff to be trained include all personnel whose work has a direct or indirect effect on the safety of the aircraft or compliance with the requirement; this means, but not exclusively, the following categories of personnel require training:

- post-holders, managers, supervisors
- certifying staff, technicians, and mechanics
- planners, engineers
- quality control/assurance staff
- specialised services staff
- human factors staff/human factors trainers
- store department staff, purchasing department staff
- ground equipment operators
- contract staff in the above categories.

### 2.3 Flight Operational Quality Assurance

Flight Operational Quality Assurance (FOQA) programs are an attempt by airlines to identify data from routine airline voyages in order to pick out potential problems and correct them before they lead to accidents. A FOQA program requires the installation of a Quick Access Recorder (QAR) onboard an airliner to record flight parameters. Data is collected to determine whether the aircraft is deviating from standard procedures or operating limitations. A computer analysis is performed to identify safety trends and take action to prevent accidents.

The major distinction between a true FOQA Program and other Safety Reporting Programs is the fact that FOQA depends upon the automatic and digitalized collection of objective flight parameters. Safety Reporting Programs depend upon subjective and voluntary disclosure of errors or non-standard practices. Thus, a FOQA Program objectively determines exactly what happened, whereas a Safety Reporting Program expects people to report why something has happened. FOQA data is used to improve the safety of flight operations, air traffic control procedures, and airport and aircraft design and maintenance.

The data used are of the same types stored by digital flight data recorders for accident-investigation purposes, but can be downloaded frequently from a QAR. The benefits of FOQA include:

- the vast majority of information gained by FOQA cannot be found in any other way. For example, periodic line checks conducted by check airmen cannot provide the same level of insight into daily operations as the continuous monitoring of FOQA data;
- it provides objective and “actionable” data for all equipped flights. Sharing FOQA data can reveal many things, for example, if an airline's trends are out of the norm, if anomaly is an isolated occurrence or one that has been previously detected by another carrier who may have already developed a solution, and, if occurrence is a significant event that requires prompt decision-making and actions when combined with historical data;
- it confirms problem areas identified by flight crews through voluntary Safety Reporting Programs.

## 2.4 Line Operations Safety Audit

Line Operations Safety Audit (LOSA) has come about as a result of the limitations of statutory safety checks of pilot performance (also known as “line checks”). It is generally acknowledged that these limitations are a consequence of the pilot demonstrating “angel” behaviour to the line checker and not their actual behaviour when flying unobserved. The phenomenon of “angel” behaviour has also been observed in simulators, that is, another occasion in which a pilot is under observation.

The reason for the occurrence of this behaviour as opposed to normal behaviour is because the pilot is being intensely scrutinised and could potentially lose their pilots licence should they make a serious mistake. The consequence of this jeopardy situation is that line checks are failing to identify the “norms” of behaviour that pilots exhibit when they are not under scrutiny. It is now agreed by the aviation industry that it is many of these norms of behaviour that lead to mistakes being made or intentional non-compliance with rules and procedures.

These mistakes and intentional non-compliance errors whilst generally resulting in safe operation can and do lead to incidents. Also, and perhaps more significantly, the aviation industry now recognises that it has been missing a significant learning opportunity to improve safety in the industry. For example, if in certain situations rules or procedures are impossible to follow then the industry needs to learn when, so that improved rules and procedures can be developed. In the majority of instances when rules are broken and/or procedures not followed there are no consequences as the safety systems are such that mistakes and errors are readily mitigated. The difficulty with this position is that eventually there will be a context where the norm of breaking a particular rule or not following the procedure to the letter will lead to an unrecoverable situation. Until LOSA it was impossible to formally identify such norms of behaviour, however, now this is possible greater safety gains are being made.

LOSA is based on a non-jeopardy agreement between the participating airlines, the pilot unions and the pilots participating in the audits. This position is based on the premise that the pilots taking part are not identifiable to any third party, whereas, the safety information generated from each LOSA is widely disseminated including to aircraft manufacturers and maintenance organisations. It is readily acknowledged by all parties involved that should a pilot be linked to a specific observed incident then the scheme would be critically undermined.

Analysis of the data collected by LOSA is undertaken using the Threat and Error Management (TEM) tool developed by the University of Texas to specifically analyse human

error. In 1999 the International Civil Aviation Organization (ICAO) endorsed LOSA as the primary tool to develop countermeasures to human error in normal aviation operations.

The significant benefit that such an approach brings to safety management is that it enables organisations to focus their resources at addressing the safety related issues that statutory audits do not necessarily uncover. Such an approach is necessary if safety management systems are to continuously improve. This focus includes making training match safety requirements more closely so making it more effective which implies a more efficient use of resources. Where training is a significant element of the safety strategy it is imperative that such training meets the specific business needs. To do this, however, those business needs, including making improvements to safety, must be readily identified. In the aviation industry LOSA enables safety improvements to be identified in a pro-active manner.

## 2.5 SMS conclusions from the aviation industry

The study concluded that improvements in safety management systems requires an increased emphasis and effort in human factors training especially in areas where risks are identified as being significant e.g. maintenance and navigation. Training can be made both more efficient and more efficacious if it utilises the findings from systems designed to monitor, collect and analyse data from day to day operations including observations of normal human behaviour. These systems can be either automatic or manual, however, it is imperative that the use of any output from such systems must be viewed by all to be just and fair.

## 3. Rail

### 3.1 Competency framework for senior management

In the UK's rail industry the major issue in the development and successful implementation of safety management systems is the development and assessment of senior manager's competence to adequately manage strategic safety management.

Key to this competence is the ability of those managers to identify and understand the risks that threaten the ability of their organisations to perform to their full potential. Those who lead and manage businesses need to demonstrate that they understand the risks they must manage and also to clearly demonstrate that they do not tolerate unsafe acts and conditions. These are essential components of competent safety management.

As risk is ever present in business as a result of the decisions managers must make, risk management processes are fundamental to improving performance. By placing safety management firmly in the context of risk management, organisations integrate safety as a fundamental contributor to achieving business objectives.

### 3.2 Management and improvement of safety management systems

It was found that there is a need for supervisors to be trained for the appropriate level of supervision of the safety management system. Promoting an individual into a supervisory role without the skills and abilities to succeed in that role will lead to poor supervision and a failure to promote safety management messages/goals to their line.

The railway industry has a “rule book” that contains prescribed rules. Accidents often highlight that rules were violated, and too often the individual is blamed without asking whether the rules as they are written meant the tasks could not be completed without a rule being broken. This problem is compounded by a lack of communication between those formulating the rules and those that have to apply them. The consequence of this situation is that it leads to mistrust of the rules and their universal applicability. As a result norms of behaviour are formed in which a rule is regularly broken.

When individuals are questioned about failings in the SMS they consistently raise issues such as; communication (lack of), consultation (lack of) and equipment (correct tools not supplied for task), materials and rest breaks/facilities. It was also recognised that the most effective way to get the findings of safety audits to be fully and appropriately addressed was for a senior manager to give direct feedback to the managing director of the company being audited. Additionally, if too many recommendations come out of formal inquiries and/or accident investigation reports it makes it difficult for senior managers to review and prioritise on the crucial issues needing to be addressed as opposed to those that just need to be considered.

### 3.3 Monitoring of a safety culture

The measurement of safety culture is required under the current safety plan for the rail industry. The industry is utilising a questionnaire based tool developed specifically for measuring safety culture. The responses to the questionnaire are used to judge the health of the safety culture. The approach is similar to the method outlined in the UK Health and Safety Executive’s document HSG48. It is recognised, however, that the approach needs updating and currently an updated method/tool is being developed.

The study highlighted a need to differentiate between “safety culture” and “safety climate”. One way of differentiating between the two is by stating that culture, in being more deep rooted, is equivalent to an individual’s beliefs, whilst safety climate, in being more transitory, is more akin to an individual’s “mood” on a particular day.

Use of “profiling” tools was seen as useful, however, it was important that such tools were validated to ensure that the proposed profile indicators matched with the reality of industry. Other potential methods used to measure safety culture are “dimensional” and “behavioural” tools. Whilst it is not clear what the significant difference between profiling and dimensional tools is, it is suggested that dimensional tools have a greater element of benchmarking with best practice. Behavioural assessment tools train the workforce to monitor and assess the behaviour of their fellow workers. Findings from these behavioural assessments are then fed into internal reviews. Such an approach has multiple benefits not least in that it gets user buy-in from the workforce and an increase in awareness of the relationship between safety issues.

### 3.4 SMS conclusions from the rail industry

The study concluded that profiling the best practice in a quality shipping company would be a beneficial exercise to undertake. Such an exercise would improve our understanding of potential shipping safety culture indicators and also permit us to validate any safety culture assessment tools developed for the maritime industry.

## **4. Offshore Industry**

### **4.1 Safety Management Systems**

In the United Kingdom it has been identified that most fatal accidents have occurred in mundane and preventable circumstances for which a safety case has been approved and a safety management system is in place. This is because the existence of a SMS is readily associated with its effectiveness. There is also a tendency to emphasise the avoidance of accidents. That is, asking “What barriers can we use?”, rather than recognising a need for proactive day to day management of the system to produce a safe working environment. This approach to safety management leads to an over-emphasis on prediction at the expense of prevention.

### **4.2. Training, Competence and Procedures Model**

The UK’s Health and Safety Executive (HSE) identify three key components for working safely: Training, Competency and Procedures. This model states that for a given task all three components are required to be considered. It is often the case that one or two are considered but not all three. The goal of applying the model to a given task is therefore to find any gaps in training, competency and procedures that could result in unsafe practice.

### **4.3 Maintenance**

The offshore industry, like the aviation industry has also placed a significant emphasis on the maintenance operation in their safety management systems. Indeed the HSE has developed specific human element guidance for use by those either managing or undertaking maintenance activities. Likewise oil companies themselves in recognising the importance of managing human related risks have produced their own guidance on the matter.

### **4.4 Interoperability**

New guidance for the offshore industry on the management of safety related risks also stresses the concept of interoperability between the human and any equipment they utilise. In the offshore industry this seeks a demonstration of fit for purpose based upon industry agreed standards. Although these industry standards already contain human element considerations there is now a requirement for an increased focus to be placed on the human element during design.

### **4.5 Benchmarking**

The offshore industry, like the rail industry, is beginning to make use of benchmarking tools because those managing SMS frequently believe they are employing best practice when in fact they are not. Benchmarking or profiling tools enable operators to identify best practice and implement this into their safety management systems. Importantly, benchmarking gives the operator a before and after appraisal of their SMS so enabling continuous improvement to be identified.

### **4.6 SMS conclusions from the offshore industry**

The study concluded that the offshore industry has identified a need to distinguish between

the presence of SMS and the effectiveness of a SMS. Whilst all efforts can be made to implement a SMS, the key components for which are readily audited, there is a need to identify if the SMS is producing effective safety related outputs. Benchmarking is being utilised to do this and, importantly, extends the influence of SMS outputs to other issues, for example, design of equipment.

## **5. Process Industry**

Swiss Re, the international insurance company, has developed a method called the Safety Management Audit in Process Industry (SMAPI). This method has been designed to ensure uniform and reliable results from the on site safety management audits.

The driver for introducing the method was that detailed safety management audits were providing a poor picture of risk within the process plants they insured. Hence, whilst plants appeared to be implementing and managing the same standardised safety management system on the surface, in reality significant differences resulted in varying accident rates. Indeed Swiss Re concluded that standardised audit systems made assessment of the risks more difficult as they did not permit exploration beyond the scope of the audit.

SMAPI uses a systematic list of questions to provide a common basis for conducting interviews in different plants. Various departments and sections are interviewed including management, operations, maintenance, inspection, loss prevention and engineering.

The interviewer talks with small groups usually made up of staff from various hierarchical levels including management. The interviews systematically highlight various aspects of the safety system: organisation, production equipment and facilities, procedures, job instructions and general safety aspects. The audit examines several overlapping areas to check for the homogeneity of the attitude toward safety. The questionnaire is divided into four parts:

- questions to be answered prior to the visit;
- questions to be answered during meetings;
- questions on the auditor's subjective assessment (that cannot be asked directly);
- questions that can only be answered by inspecting the plant first hand.

The aim of using such a systematic technique in the information-gathering process enables the visit to provide sufficient information to undertake the required risk assessment for insurance purposes, whilst also permitting a subjective assessment of the safety management system to be determined.

The SMAPI philosophy states that the weakest link in the organised chain of safety measures will permit errors to filter through and potentially lead to an incident. In other words, vulnerability is a function of the weak points in the safety management system, and the risk surveyor should inform the company of any signs that they consider being indicative of such weakness.

### **5.1 SMS conclusions from the process industry**

The study concluded that companies providing insurance to the process industry are pro-actively seeking to influence the continuous improvement of safety management systems.

## 6. Conclusions

A review of safety management systems has been undertaken. It is acknowledged that there are some fundamental differences between the maritime industry and other safety related industries, not least in the management structures used to manage safety and a tendency for the workforce to be itinerant. This review, however, has identified several key conclusions that should be considered when developing both a strategic plan to address the human element, and when considering measures for obtaining continuous improvement in the implementation of the International Safety Management Code.

### 6.1 The conclusions of the study are:

- successful implementation and continuous improvement of a safety management system depends, inter alia, upon the competency and leadership skills of the senior managers;
- provision of specific human element training should be considered at all levels for all safety related disciplines in ships and ship operating companies;
- use of real-time monitoring of operations should be considered to provide further data to support a learning culture;
- limitations of jeopardy audits in observing normal behaviour should be recognised to support a just culture and promote crew and worker buy-in;
- ships and companies should benchmark their SMS so that they can be sure that they are employing best safety management practice and, as a result of several benchmarking exercises, have a measure of their progress over time to support the goal of continuous improvement.

Dr Edmund Hughes  
Risk, Analysis and Prevention  
Maritime & Coastguard Agency  
Bay 2/18, Spring Place  
105 Commercial Road  
Southampton, SO15 1EG  
Tel: 023 8039 7872  
[edmund.hughes@mcga.gov.uk](mailto:edmund.hughes@mcga.gov.uk)

September 2004