Guidelines for Developing Fatigue Risk Management (FRM) Systems

FINAL

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International Aluminium Institute (IAI) www.world-aluminium.org

Current IAI membership represents over 60% of global bauxite, alumina and aluminium production. Since its foundation in 1972, members of IAI have been companies engaged in the production of bauxite, alumina, aluminium, the recycling of aluminium, or fabrication of aluminium, or as joint venture partners in such. The key objectives of IAI are to:

- Increase the market for aluminium by enhancing worldwide awareness of its unique and valuable qualities;
- Provide the global forum for aluminium producers on matters of common concern and liaise with regional and national aluminium associations to achieve efficient and cost-effective cooperation;
- Identify issues of relevance to the production, use and recycling of aluminium and promote appropriate research and other action concerning them;
- Encourage and assist continuous progress in the healthy, safe and environmentally sound production of aluminium;
- Collect statistical and other relevant information and communicate it to the industry and its principal stakeholders; and
- Communicate the views and positions of the aluminium industry to international agencies and other relevant parties.

Through IAI, the aluminium industry aims to promote a wider understanding of its activities and demonstrate both its responsibility in producing the metal and the potential benefits to be realised through their use in sustainable applications and recycling.

The IAI would like to acknowledge the following companies for their contributions to these Guidelines.

Alcoa	Qatalum
Hydro	Sohar Aluminium

The IAI also acknowledges the contributions and support of the IAI Fatigue Risk Management Working Group, Dr Michael Donoghue and Dr Ian Arnold, as well as regional associations, the IAI Health Committee and the IAI Communication and Promotion Committee.

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1. Preamble

These Guidelines are considered by the International Aluminium Institute (IAI) to be of the utmost importance in protecting the safety and wellbeing of the aluminium sector workforce and safety in the workplace. They have been developed to provide IAI Member companies and other aluminium industry stakeholders with an initial, concise approach to managing fatigue risk in the workplace.

Fatigue kills.

Public health campaigns around the world, drawing on decades of data linking serious and fatal road accidents with fatigued drivers (up to 20% of motorway crashes), visibly remind us to take a break when driving, to be aware of the signs of fatigue and to take action.

Ensuring that individuals take action is difficult, the focus of such public health campaigns being awareness and education. In occupational settings, however, individual behaviour is embedded in management systems designed to indicate when to take action and what action to take.

Fatigue is about lack of sleep.

It is a feeling of constant tiredness or weakness and can be physical, mental or a combination of both. It can affect anyone, and most adults will experience fatigue at some point in their life.

The causes of lack of sleep are numerous: psychological, underlying health conditions and disease, drug use and lifestyle to name a few.

The causes of fatigue are often multiple, woven together from a range of stressors that can be physical, psychosocial, physiological or chemical, from workplace factors, from personal characteristics, or a combination of both.

Job-related fatigue is a specific responsibility of management, but ensuring that an individual gets enough, quality sleep can only be managed so far by an occupational fatigue risk management system. The system, therefore, needs to be able to indicate actions to take when fatigue (or fatigue precursors) have been recognised, be they occupational or otherwise.

Regular lack of sleep is also associated with long-term health consequences, including chronic medical conditions like diabetes, high blood pressure, heart disease and hypertension, mood disorders, immune function, alcoholism and ultimately reduced life expectancy and quality of life. These chronic fatigue impacts should not be forgotten, in particular in a post-covid world, where sleep is being disrupted more than ever. They are explored in the literature and to some extent in these Guidelines. However, the systems described herein, developed to manage risks of acute fatigue-related incidents, have an application to chronic health risks as well.

2. Recommendations

1. IAI Member companies should include “fatigue” as a specifically listed contributing factor in incident reporting and also in accident investigation systems;

2. The IAI should include “fatigue” as a specifically listed contributing factor in its sector-wide incident reporting surveys;

3. IAI Member companies should review (company and sectoral) data regularly to identify fatal and serious incidents with fatigue as a contributing factor, to inform planning and the regular review of fatigue risk management system(s);

4. IAI Member companies should give thought to how they can start incrementally to build a culture of fatigue awareness (including, for instance, through training, standards development, accident investigation, health and wellbeing behaviours, leadership practices, and communication between leaders and their teams);

5. As appropriate, IAI Member companies should integrate the fatigue risk management approach within existing health & safety, wellbeing, and human resources initiatives;

6. IAI Member companies should establish a safe and non-judgmental mechanism (as may already exist for psychological health & safety), or process, for allowing employees, co-workers, supervisors, etc. to alert designated personnel when fatigue is recognised;

7. IAI Member companies should consider establishing “STOP CRITERIA” – related to hours of service or other variables – for which countermeasures should be implemented to guard against preventable, fatigue-related incidents;

8. IAI Member companies should deploy comprehensive training that focuses on the science of sleep, fatigue physiology, sleep disorders, alertness, etc. Consideration should be given to integrating this training within any existing initiatives (wellbeing, productivity, safety, etc.) to leverage the considerable overlaps. Particular attention should be given to safety-critical work, and the inclusion of training for onboarding of shift workers, general awareness for families of shift workers

9. IAI Member companies may also make use of technologies (such as app-based personal monitoring, vehicle operator-centred systems, pre-shift testing etc.) to assist in the measurement and management of fatigue, but such technologies in and of themselves do not constitute a comprehensive fatigue risk management approach.

3. Introduction

There is a growing body of scientific evidence suggesting that long working hours and fatigue are related to health and safety impacts. Some of that evidence is recent, some has been known for several years.

For example, from a 2019 analysis of a 150,00-individual cohort by Marc Fadel et al.:

> "This large analysis reveals a significant association between stroke and exposure to long working hours for ten years or more."

…and, historically, from an ICMM-IPIECA report[1]:

> "The cumulative effects of sleep loss and sleep disorders represent an under-recognised public health problem and have been associated with a wide range of health consequences including an increased risk of hypertension, diabetes, obesity, depression, heart attack, and stroke. Almost 20 per cent of all serious car crash injuries in the general population are associated with driver sleepiness." (Institute of Medicine of the National Academies)

> "There is limited data and information available on fatigue incidents due to incident reporting systems not being set up around fatigue. However, anecdotally we know fatigue incidents occur. In particular, there is a common theme around circadian low job/task demand such as driving and body weight." (Ian Duncan, Rio Tinto)

> "There have been some major incidents in the oil and gas sector in which fatigue has been a significant contributing factor. Shell recognises the importance of managing fatigue risk and has adopted an integrated approach to fatigue risk management by which it is embedded into existing risk management strategies." (Dr Lillington, Shell)

The evidence continues to mount. Several key facts have emerged, as understanding of the effects of fatigue has matured. The following are noted in the American College of Occupational and Environmental Medicine (ACOEM) Guidance Statement: *Fatigue Risk Management in the Workplace*:

- Fatigue is related to the duration of sleep and timing (circadian rhythm) of sleep.
- Inadequate sleep is correlated with a variety of adverse medical outcomes.
- Various shift work schedules can affect both the duration and the timing of sleep.
- Inadequate duration of sleep is correlated with injury rate.
- There is ample evidence that fatigue associated with extended hours, night shifts, and rotating shifts can have a negative impact on safety and performance;
- Only 2 hours less sleep per night than optimal over a week can lead to performance decrements equal to 24 hours of consecutive wakefulness;
- Increased risk of fatigue-related incidents in the early morning hours;

[1] Managing fatigue in the extractive industries workshop; 13-14 September 2012, Perth, Western Australia

- Extended shifts also increase risks of attention errors, judgement issues, transportation incidents, etc.;
- Some individuals who are required to function during the normal circadian night are able to adjust to some degree; others are not and may develop a shift work sleep disorder.

Academic articles often discuss the difference between sleepiness and fatigue. While this is of interest from an academic perspective, the clear reality is that fatigue is, first and foremost, about sleep or, more specifically, the lack of sleep.

The ACOEM Guidance notes the following:

"**Sleepiness** is the tendency to fall asleep";

- Sleepiness and the propensity for sleep are often *exacerbated* by sedentary activity or rest;
- Sleep propensity can be accompanied by decreased alertness which then leads to decreased attention to detail, impaired judgment, and slowed response time;
- This can affect productivity, safety, and overall health.

"**Fatigue** is the body's response to sleep loss or to prolonged physical or mental exertion":

- Fatigue may be *reduced* by sedentary activity or rest without sleeping;
- Fatigue can lead to slowed reaction time, reduced vigilance, reduced decision-making ability, poor judgement, distraction during complex tasks, and loss of awareness in critical situations;
- This can affect productivity, safety, and overall health.

It is clear, from the above descriptions, that the end results of sleepiness and fatigue are very closely aligned. In these IAI Guidelines, therefore, the term "fatigue" will be used as the common term and academic differences between sleepiness and fatigue will not be explored further.

The bottom line is that fatigue is closely related to adverse outcomes including fatalities, serious injuries, and serious illnesses (FSIs).

Impacts on workers that are associated with fatigue include decreased alertness, slowed reaction time, reduced vigilance, reduced decision-making ability, poor judgement, distraction during complex tasks, and loss of awareness in critical situations. Every one of these factors can negatively affect health and safety and potentially product quality and environmental control. Opportunities to control these impacts exist from primary, secondary, and tertiary prevention perspectives.

Many environment, health and safety management systems do not specifically include fatigue. Given the issues related to it, it is important that organisations include fatigue management as part of their overall management approach to workplace concerns. Where feasible, the fatigue risk management (FRM) approach may be integrated into existing management systems such as recognised occupational health and safety management systems.

4. Moving Forward, IAI Guidance

Scope

This guidance document is designed to align with approaches used for management of occupational health and safety (e.g.: ISO 45001) and for managing workplace psychological health and safety (under development – ISO 45003). It is provided as a guidance document for organisations to follow to develop their fatigue risk management system, but is not intended to be a detailed management system approach. The latter is adequately covered in the two aforementioned ISO Standards and these should be used in concert with this document.

Leadership and Commitment

Fatigue should be viewed as a shared responsibility of both the employer and the employee – although perspectives from each of these positions may differ. It is, therefore, important to outline the responsibilities of health and safety personnel, but also, importantly, other key stakeholders such as site managers, supervisors and crew leaders, employees, contractors, human resources, industrial relations, and key labour representatives. All these stakeholders, working together, can help to build a culture of fatigue awareness.

To move forward with managing fatigue in the workplace, there must be leadership involvement and commitment. Leadership should include organisational leadership as well as worker representatives who can bring a “boots on the floor” perspective to the question of workplace fatigue. Integration with existing occupational health services is critically important.

Leadership involvement and commitment should include ensuring that there is a knowledgeable champion to orchestrate the development and implementation of the FRM. This champion may first need training on the subject of fatigue risk management prior to moving forward to develop and implement the organisation’s FRM. Numerous organisations offer FRM training and can assist in implementation of the FRM system. The organisational champion should consider the development of an organisational cross-sectional team to assist with planning, implementation, and review. Clarification of roles and responsibilities for the FRM champion and team members is essential to avoid confusion. Clear evidence of commitment can be demonstrated by the development and communication of an sorganisational policy statement on FRM endorsed by the organisational leadership.

Leadership and commitment may be difficult to obtain if those suggesting it do not have facts based on their own organisational data. Sometimes these facts (often obtained during a planning process) have to be developed before any further commitment is obtained from organisational leadership. Nevertheless, the references in the attached bibliography (Appendix A) should provide sufficient data to persuade most organisational leaders to, at a minimum, determine whether fatigue issues are impacting their own organisation.

Appendix B provides examples of the numerous organisations that conduct training on FRM.

CASE STUDY: Alcoa's Global Fatigue Risk Management Standard

In December 2018, as part of a broad review of its HSE standards, Alcoa communicated a fatigue risk management standard to all its Alcoa-controlled entities worldwide. This standard was built on a recognition that all-injury rates increase over extended shifts and that fatigue plays a contributing role in a high proportion of Fatal & Serious Injury/Illness incidents (FSIs). With the strong support of the Alcoa leadership and buy in from operations which recognized the role of fatigue in safety incidents, the company worked for 2 years to develop, negotiate and codify the elements of the standard, which includes a set of required practices and procedures:

1. Hazard identification
2. Process to alert supervisors/crew leaders when fatigue is experienced or observed.
3. Referral to occupational healthcare professional of individuals with potential fatigue.
4. Stop Criteria, minimally to include:
    - Hours per shift exceeding 12.
    - Hours per established seven-day workweek exceeding 60.
    - Countermeasures when Stop Criteria are met, minimally to include:
        - Increased supervisor/crew leader floor observations or scheduled checks.
        - Reinforcement of the signs and symptoms of excessive fatigue.
        - Feasible administrative or work practice controls.
5. Hours-of-service limits
6. Training

Following approval of the global standard by its EHS Council, Alcoa has developed an Excel-based formal gap analysis tool and updated its analysis of FSI "fatigue" incidents.

Since 2019, Alcoa locations have completed gap analyses against the standard's requirements, costing solutions and countermeasures and working towards gap closure at appropriate pace.

Shiftwork and overtime analysis has been carried out at one location and some locations have initiated 'home-grown' training. Corporate-facilitated training module and vendor(s) are being implemented, along with potential technology pilot(s).

Planning

Planning is essential to:

- Understand the impact of fatigue on the workforce and on the organisation;
- Ensure that the organisation is aware of legal requirements that may impact fatigue management;
- Identify specific activities that may be impacted by fatigue and assess the risks of that impact;
- Determine the level of workforce and organisational risk related to fatigue;
- Develop plans to deal with risks assessed in the planning processes including provision of competent resources necessary for implementation of the planned responses;
- Establish a baseline to establish the efficacy and effectiveness of programmes developed to deal with the identified impact of fatigue on the workforce and the workplace;

To develop measures to minimise and eliminate the impacts of workplace fatigue in any organisation/worksite, it is essential to know how the workforce and workplace is being affected and the level of risk that is present when fatigue factors may play a critical role in adverse outcomes. Some data may be readily available, other data may require the development of new approaches.

Reviews of incidents and accidents have not always looked at fatigue as a potential human factor in the fault tree analysis. Nor has this approach considered psychological factors which, in some cases, may lead to fatigue or be the result of fatigue itself. Therefore, organisations not yet gathering these types of data should develop systems to understand how fatigue is a factor in incidents and accidents.

In particular, organisational fatality and serious injury and illness data (e.g. over the preceding year) should be reviewed to determine if fatigue may have been a/the contributing factor in the adverse outcome. These data may also be powerful incentives for organisational change.

Equally important is the need to determine if specific jobs/tasks are more likely to have the potential for an increased risk of fatigue. This can be part of the review of existing data on fatalities and serious injuries/illnesses and is also important to assess in reviewing jobs/tasks in a proactive manner.

In determining whether fatigue is related to incidents and accidents,organisations should watch for evidence of risk factors such as decreased alertness, slowed reaction time, reduced vigilance, reduced decision-making ability, poor judgement, distraction during complex tasks, and loss of awareness in critical situations.

Other health and safety data (depersonalised for confidentiality purposes) that can also provide evidence of fatigue affecting workers include:

- data from employee surveys (if appropriate questions are asked);
- sickness/absence data (e.g. stress resulting from overwork, sleeplessness, and fatigue);
- insurance benefits data;
- occupational health records

- human resources data, including employee hours worked;
- anecdotal reports.

Evidence of fatigue impacts may also be found in records that show declining product output/quality and increasing environmental incidents. Conversely evidence of such impacts will not be found if the records are not interrogated from the perspective of fatigue risk.

The results from the planning process should be documented and communicated to the workforce to assist with the successful implementation of new measures developed to manage fatigue risk issues.

CASE STUDY: Sohar's Use of a Fatigue Management Questionnaire (FMQ)

Sohar Aluminium has been using a FMQ developed by IPIECA, the global oil and gas industry association for advancing environmental and social performance, to identify aspects of its operations that may be contributing to fatigue and the controls that are in place or could be put in place to manage better any issues identified.

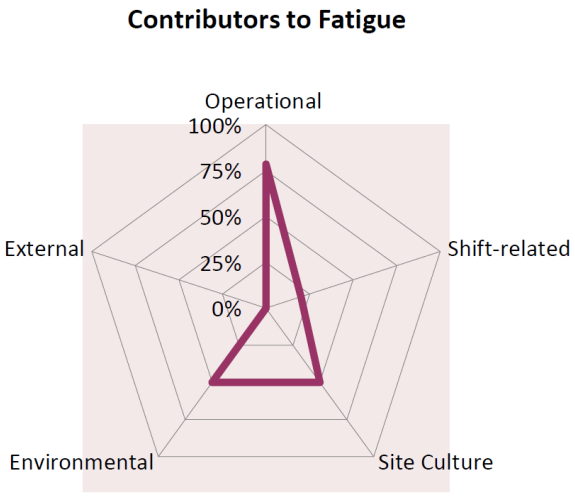
The FMQ is divided into 3 sections: Fatigue Contributors, Fatigue Controls and Fatigue Management Programme.

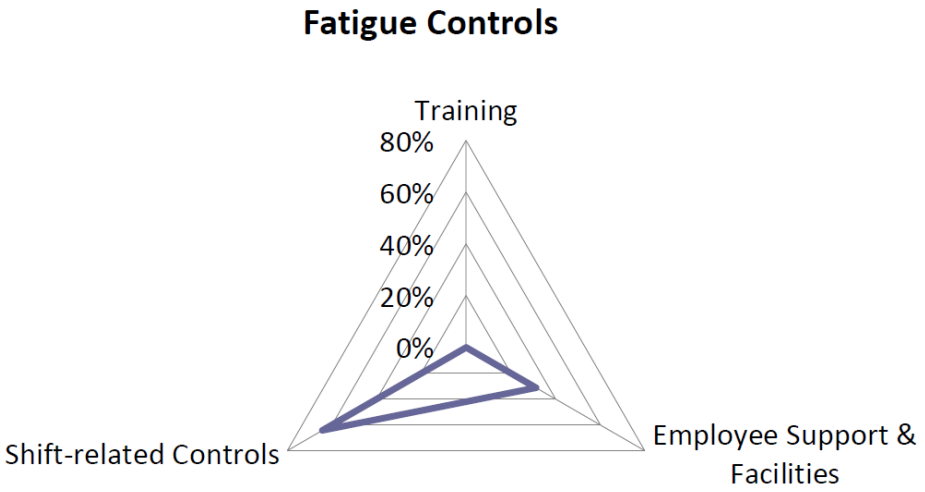
Answers to the questionnaire are developed collaboratively by Sohar's EHS Coordinators, with summary reports automatically generated by the FMQ Microsoft Excel-based workbook and % scores delivered for each of the three sections.

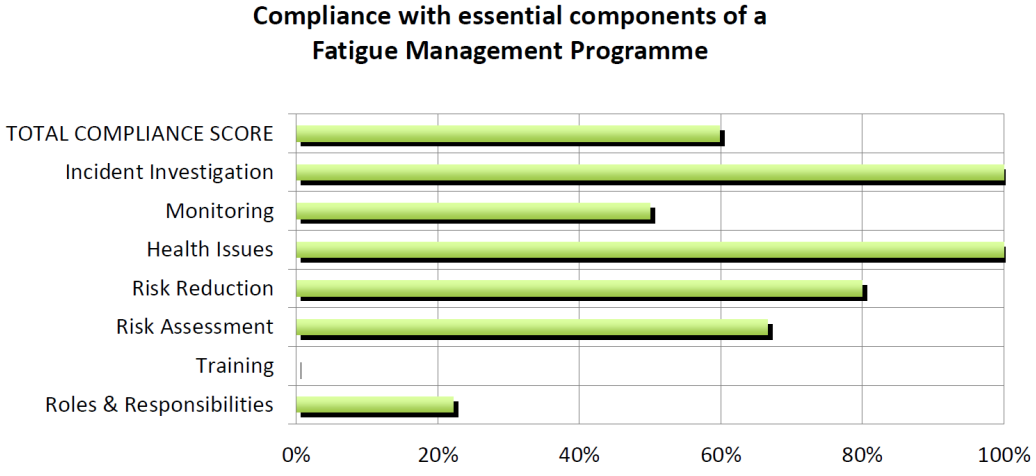
This quantitative output allows Sohar Aluminium to identify where improvements can be made to the management of fatigue risk. Based on these initial results, the company has formulated an action plan for fatigue risk management and is following up by:

- Developing a fatigue management procedure;
- Developing fatigue management training modules;
- Assigning roles within a fatigue management group (including champions);
- Developing a self-verification plan for the fatigue management programme

CASE STUDY: Sohar's Use of a Fatigue Management Questionnaire (FMQ)







Support

Results from the planning processes will determine what the organisation and the workforce can do to minimise or eliminate risk related to fatigue. The same results should be used to plan for the support necessary to communicate, develop, implement, and operate the new policies and programmes used to address fatigue related concerns. These supports may include financial support, dedicated personnel, support for fatigue management programmes at the primary, secondary, and tertiary levels of prevention, and physical and psychological support modalities.

Operation

Operationalising new approaches requires careful planning, communication and management of change. Consideration of what, who, when, where and how to move forward will ensure successful implementation of these new approaches to minimise fatigue related risks. Specific operational considerations may include (but are not limited to):

- Training, which overlaps into the wellbeing space and includes areas such as sleep hygiene, sleep physiology, nutrition, hydration, sleep disorders, personal napping tactics, etc.;
- Fatigue alert systems, focusing on self-identification and awareness of early signs and symptoms of fatigue as well as co-worker/supervisor identification;
    - Fatigue alert systems should be safe and non-judgmental (i.e. psychological H&S) mechanisms or processes for allowing employees, co-workers, supervisors, etc. to alert designated personnel when fatigue is recognised;
- Establishing “STOP CRITERIA” – related to hours of service or other variables – for which countermeasures should be implemented to guard against avoidable fatigue-related incidents;
- Hours-of-service (HOS) limits (these are the “PPE” of fatigue management), when no other solutions are available. Such limits are NOT the FRM as fatigue-related incidents will not be prevented if personnel still have inadequate sleep;
    - Exceptions to the HOS limits may be necessary. Efforts should be made to define when these are likely to occur and a permit system developed to ensure appropriate management and control of exceptions;
- Management of overtime managed with FRM in mind, including a clear approval process;
- Hard and soft technologies to assist in the measurement and management of fatigue, for example
    - App-based personal monitoring,
    - Vehicle operator-centred systems (see case study below)
    - Pre-shift testing etc
- Assessment of environmental factors, such as lighting, naps and exercise breaks, Specific issues may need to be considered/negotiated and included in the program, for example:
    - caffeine strategies;
    - on or off-the-job (i.e. inter-shift) napping strategies consistent with existing company policies and culture;
- company-provided transport for individuals working excessive hours, etc.)

Napping can be a controversial topic, with formal incorporation into FRM currently limited to transportation sector programmes, but napping strategies may have usefulness in specific situations.

TECHNOLOGY CASE STUDY:
Anti Fatigue and Collision Avoidance System at Mineração Paragominas

The operation of equipment at Hydro's bauxite mine in Paragominas, Brazil is characterized as risk 4 (major) and as a result, it is necessary to seek measures to eliminate or reduce risks associated with the mining activity. In (bauxite) ore transport the main risks are collision between equipment and overturning caused by fatigue events.

In addition to other measures, such as speed control, Mineração Paragominas, has implemented technology-based anti-fatigue and collision avoidance systems.

The anti-fatigue system monitors operator fatigue and alerts them during work shifts, as well as providing online reports to the control room.

Among the fatigue events that are monitored are:

- Microsleep (criterion: continuously closed eyes over 2.9 seconds)
- Slow blink (criterion: above 60% of the time with eyes closed in a 10 seconds period);
- Distraction (characterized by looking sideways, losing focus on the track).

The systems artificial intelligence creates an event history for each operator, including the hours worked by those individuals, and files it in a database, mapping the date and time of fatigue events and types of events recorded.

Based on this database, the system can develop an individualized profile of each operator registered.

The system generates alarms in case of fatigue both in the equipment cabin and in the operations control room, which requests the equipment to be stopped immediately, thus preventing an accident. Regarding the employee who presented fatigue signs, their supervisor is communicated and goes to the equipment to take the employee to assistance from occupational medicine.

In addition to triggering these immediate actions, the system works in concert with the Mineração Paragominas collision avoidance system (based on the equipment's GPS positioning) both of which are connected to the dispatch system. Thus, the mine control room has the ability both to operationalize the dimensioning of the mine and to request a stop due to fatigue issues.

Since implementation of the two systems Mineração Paragominas has seen a reduction of 100% in overturning events and of 60% in fatigue events.

Performance Measurement

Organisations should develop specific approaches to evaluate change related to fatigue risk management. This could encompass a regular assessment (e.g. every 2 – 3 years) of progress towards implementing the FRM system as well as an assessment made against the baseline data acquired during the original planning process. Measures of success may include an assessment of how far the FRM has actually been implemented in the organisation as well as a review of improvements seen in the original baseline data sets

Improvement

Data generated by the performance measurement process is best used to review the changes made originally to deal with concerns identified by the planning process and to determine how these changes (programmes, support methodologies, etc., etc.) can be further refined to drive continual improvement, These revisions can drive further change until the next round of performance measurement and improvement.

5. Appendix A – selected references and resources

American College of Occupational and Environmental Medicine (ACOEM) Guidance Statement (2012), *Fatigue Risk Management in the Workplace*. Journal of Occupational & Environmental Medicine Volume 54, Number 2, February 2012.

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