The human element – the effects of fatigue on ship safety part 1 – practical advice to shipowners

The human element is consistently found to be a root cause of incidents, and fatigue is a major contributing factor. In this article, we look at some of the research and the measures put in place to resolve this issue. In a future article, we will look at the ways in which crew can manage their own fatigue.

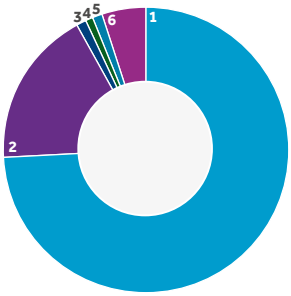
Andrew Russ
Marine Surveyor
T +44 20 3320 8968
E andrew.russ@ctplc.com

Introduction

Investigations into human element incidents, such as the UK Marine Accident Investigation Branch (MAIB) investigation in 2004 (using data from 1989 to 1999), identified fatigue to be the major contributing factor in 82% of the 66 recorded groundings and collisions occurring between 0000 and 0600 hours.[1]

IMO, MSC/Circ.813, defines fatigue as 'A reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; co-ordination; decision making; or balance.'[2]

Top causes of liability loss: Marine (by value of claims)



1	Human error	75%
2	Accidental nature/damage	18%
3	Natural hazards	1%
4	Negligence/poor maintenance	<1%
5	Failure to provide service	<1%
6	Other	5%

Source: 14,828 liability insurance claims analyzed between 2011 and 2016 (September 13)
Global Claims Review: Liability In Focus, Allianz Global Corporate & Specialty

Human error has long been regarded as contributing to the majority of incidents in the shipping sector. It is estimated that **75% to 96%** of marine accidents can be attributed to human error. In addition AGCS analysis of almost 15,000 marine liability insurance claims between 2011 and 2016 shows that human error is behind 75% of the value of all claims analysed, equivalent to over **$1.6bn.**[3]

The Karolinska Institute developed the 'Brief Fatigue Syndrome Scale' to measure levels of fatigue. This is now used as the industry standard.

Research projects such as Horizon (2012) and Martha (2013-2016) made the most significant advancements in understanding fatigue. In project Horizon, 90 experienced seafarers used simulations of common on-board scenarios. The results clearly showed links between performance degradation and certain work patterns.

Project Martha spanned three years and involved 1,000 seafarers from four shipping companies, both European and Asian. Fatigue and stress levels were found to vary considerably between companies despite their operating similar vessels and trading patterns. This indicated the significance of organisational set-up and cultural considerations as well as workload.

Horizon acknowledged that 'fatigue' was often used interchangeably with 'sleepiness', 'tiredness' and 'drowsiness', and was considered a generic term.[4]

Martha was able to define 'sleepiness' and 'fatigue' separately:

'Sleepiness – Resulting in short term effects only on daily activities, identified by a rapid onset, short in duration and resultant from a single cause.'[5]

'Fatigue – Resulting in long term effects that may cause health disorders, both physical and mental, has an insidious onset and can persist over time, as a result of multi-factor causes. It is considered to have significant effect on both behaviour and a person's wellbeing.'[5]

Legislation

Legislation has been introduced to improve the working/living conditions of seafarers, including measures to address fatigue-related issues. International Labour Organization (ILO) Convention No.180 adopted in 1996 was an important development in improving safety at sea and implementing limitations on hours of work and rest for vessels whose flag states ratified it. The 2010 Manila amendments to STCW harmonised the requirements of ILO Convention No. 180. STCW allows for 'overriding operational conditions' under Regulation VIII/1 – Section B as being defined as 'essential shipboard work which cannot be delayed for safety or environmental reasons or which could not reasonably have been anticipated at the commencement of the voyage'[6]. It is paramount that this section of the STCW code is not misused. Unfortunately, this is not always the case.

The convention holds the shipowner responsible for compliance, to ensure necessary resources are provided, including appropriate manning levels; however, final responsibility has remained 'firmly upon the shoulders of the ship's master'.

MLC 2006, which entered into force in 2013, has continued to focus on improving seafarers' welfare. It implements a limit of 12 months' service prior to repatriation 'entitlement', which after deducting annual paid leave, equates to a maximum continuous period of 11 months. However, it should be noted that seafarers do not actually have to be repatriated at that time, but are legally entitled to be.[7]

The impact of legislation

Current legislation has only addressed some of the main factors leading to fatigue. Further amendments are required for it to be truly effective. The main causes of fatigue are:[5]

- **Prolonged work periods and insufficient rest between work periods**
  Legislation has imposed limitations on hours of work and rest, which addresses these issues but only if there is compliance on board. Certain watchkeeping patterns remain an issue and minimum safe manning levels across the industry should be reviewed and increased so that a move away from the '6 on 6 off' watch system is possible.
- **Working at times of low alertness**
  The time at which an operation occurs is an important consideration. An operation which occurs at a time of low alertness is potentially less safe than one conducted during the normal working day. So far, it has proved impractical to alter the routines of terminals or ships to take this into account.

- **Stress and excessive workloads**
  Legislation has imposed limitations on workloads; however, strict compliance is required by seafarers supported by ship managers to ensure commercial interests are not permitted to influence or pressurise crew into flouting legislation.
- **Noise, vibration and motion**
  Stricter legislation is required. In 2012, IMO Resolution MSC.337(91) was adopted to make noise level limits mandatory on all new vessels of 1,600GRT or over. This was brought into force on 1 July 2014. The 'Code on Noise Levels Onboard Ships' was also included into the International Convention for the Safety of Life at Sea (SOLAS). For new builds, noise limits were imposed of 110 dB(A) for machinery spaces, 85 dB(A) for other work spaces, 75 dB(A) for galleys & serveries, between 60 to 70 dB(A) for the various navigating areas, between 55 to 65 dB(A) for various accommodation areas, with zoning introduced to ensure seafarers were protected from prolonged exposure to excessive noise levels. These are now tested and confirmed during sea trials prior to delivery. An absolute maximum of 120 dB(A) (even when wearing hearing protection) is also stipulated. However, new builds of under 1,600GRT, certain ship designs and existing tonnage (pre-1 July 2014) are exempt. The code states that the measures are to be taken 'as far as reasonable and practical, to the satisfaction of the Administration'.
- **Duration of crew contracts**
  Limitations imposed by MLC 2006 have substantially improved this situation, although seafarers' contract lengths vary within the 11 months' limitation, dependent on a variety of factors. Research has indicated an optimum tour length of between three and six months, dependent on service, rank and ship type.
- **Pre-existing medical conditions**
  Current legislation requires seafarers to obtain a certificate of medical fitness prior to joining ship, but the standard of examinations is not consistent. Enhanced PEME schemes have been introduced by P&I clubs and shipping companies to try to supplement the mandatory requirements and ensure the standard of medical examinations.

Fatigue Risk Management Systems[5]

The introduction of Fatigue Risk Management Systems (FRMS) into the marine industry is anticipated to greatly assist in identifying shortfalls in existing regulations and what amendments could be made to address them. These systems have already had considerable success in other safety-critical industries such as aviation, road and rail transportation.

FRMS uses a comprehensive, systematic approach, reviewing all aspects of the workplace including operational requirements/ restrictions, quality assurance as well as company procedures. The standard core elements being implemented across the industry are:

- fatigue awareness training and cultural change programmes
- a fatigue reporting system within a just culture
- data-driven analysis for operational fatigue risk assessment, workload management and monitoring of adequate sleep for seafarers.

For FRMS to be truly effective, it will require full commitment from shipowners, shore-side personnel as well as seafarers to report issues and develop tailored approaches for the company.

Potential for improvement

Amendments to operational schedules
Operational schedules should be developed taking into consideration seafarers' and shore personnel's work and rest hours. This will require shipowners or technical managers to collaborate with charterers and terminal operators. Operations requiring additional crew, whenever practical, should be arranged during times of highest alertness (ideally 1400 to 1800 according to studies) and especially avoiding the 0000 to 0600 period.

Review of ship designs and equipment to further address outstanding issues relating to noise, vibration and motion
Unfortunately, as certain clauses/ appendix of the 'Code on Noise Levels Onboard Ships' are considered as recommendations on exempted ships (new builds of under 1,600GRT, certain ship designs and tonnage existing pre-1 July 2014), seafarers' wellbeing is potentially being compromised for economic considerations. Considering that 87% of the world fleet is older than 1 July 2014[8] and therefore does not have to comply, it is important that viable economic options for reducing noise levels on older tonnage are found, as well as developments and innovations for new builds. Continual improvements in ship design and operation to reduce levels of vibration and motion on ships are also key elements in improving the overall wellbeing of seafarers and close review of the FRMS results will greatly assist in not only identifying areas in need of improvement but also prioritising them.

Review of safe manning levels
Manning levels on many ships often only meet the flag state minimum for that size and type of ship. Often, this fails to allow for additional watchkeeping requirements whilst sailing through restricted waterways, port operations, non-routine maintenance requirements and/or off-duty/overtime work performed by seafarers in order to satisfy commercial pressures, particularly on busy, short-haul trading routes.

It is of paramount importance for shipowners to take the initiative and review their current manning levels. Whilst the minimum manning level is considered the safe lower limit to sail from point A to point B, organisations should consider whether these arrangements are truly adequate in the face of the pressures of the modern maritime industry.

Conclusions

The importance of the human element in shipping must be acknowledged and addressed as it is the major factor in marine incidents, with fatigue as the main root cause. The legislation brought into force to address the factors leading to fatigue have fallen short in reducing/removing these and significant changes in operational practices, ship design as well as manning levels are still required. Research studies and proactive work systems such as FRMS must be embraced and welcomed into the industry and their results acted upon. To move forward will require industry-wide recognition of the issues involved with the human element in incidents and considerable changes in shipowners'/seafarers' reaction to commercial pressures.

1 UK Marine Accident Investigation Branch (MAIB), Investigation report 2004
2 International Maritime Organization, MSC/Circ 813
3 AGCS Safety Shipping Review 2017
4 Project Horizon 2012
5 Project Martha 2013–2016
6 STCW 2010
7 MLC 2006
8 Clarksons Research