



Fatigue – Key Performance Indicators

May 2017

Summary

Rail organisations need to reduce, so far as reasonably practicable, risks from staff fatigue. This information sheet outlines some of the issues which rail organisations should consider when measuring the effectiveness of their fatigue control measures, and provides links to relevant further information.

Background & purpose

1. Staff fatigue is a significant source of risk across industries including the rail sector. There is extensive guidance to support the industry's efforts on implementing a comprehensive fatigue risk management system (FRMS), as referenced for instance in [ORR's fatigue guidance](#).
2. ORR's fatigue guidance advises (section 5.85) that the organisation's FRMS should include a system for evaluating and reporting the overall effectiveness of fatigue controls, and that metrics or key performance indicators (KPIs) should be established, to help track the effectiveness of the FRMS over time and for instance between roles, sites etc. The organisation should monitor these metrics regularly, looking for signs of fatigue hotspots where controls may need strengthening, and assessing trends over time.

Deriving fatigue KPIs

3. A generic process for deriving KPIs (or SPIs = Safety Performance Indicators) which may be applied to fatigue management arrangements is detailed in [RSSB's Measuring Safety Performance guidance](#) and is summarised in Fig 1 below

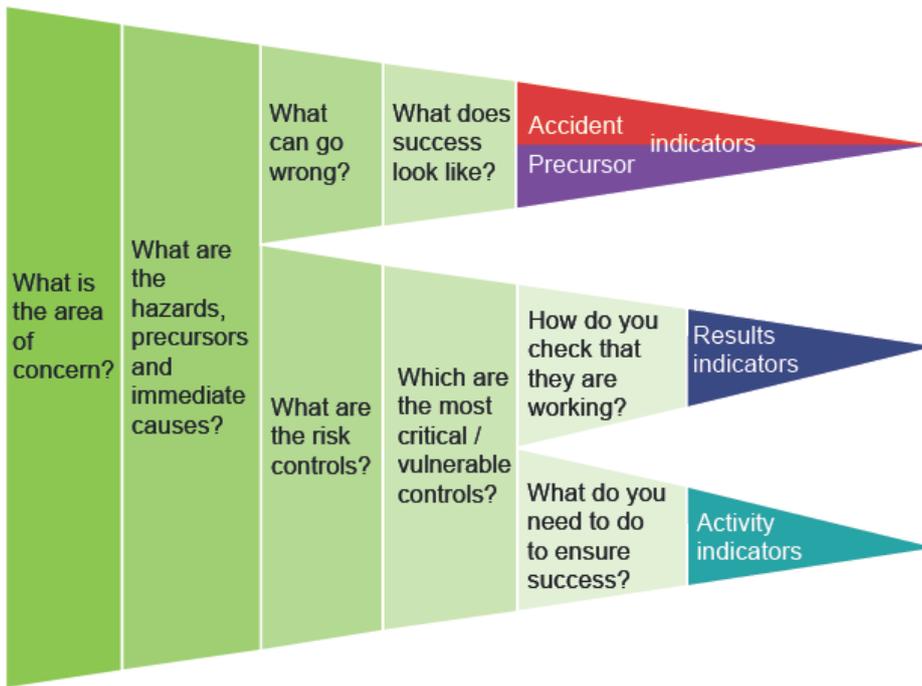


Fig 1. Questions to help derive performance indicators (RSSB)

4. Good fatigue KPIs help measure the presence and effectiveness of fatigue defences, providing an early warning of weaknesses in fatigue controls. In selecting fatigue KPIs, concentrate on those elements which are most
 - **Critical** to controlling fatigue risk, and
 - **Vulnerable** to degradation
5. It is generally best to gain “dual assurance”, by using a mix of both “Activity” indicators and “Outcome” indicators as outlined in Fig 2 below.

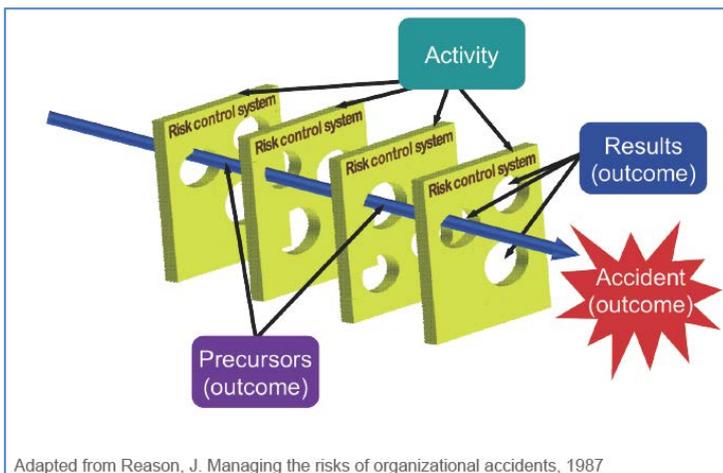


Fig 2. Types of indicators (RSSB)

6. There’s no hard and fast distinction between “activity” and “outcome” indicators, and similar grey areas exist between “leading” and “lagging” indicators – in reality these terms describe points towards opposite ends of a spectrum. Nevertheless, in

devising a suitable mix of fatigue KPIs, it can be helpful to consider the following broad descriptions.

7. **Activity indicators** essentially measure whether barriers (fatigue control layers) are in place to avoid adverse fatigue outcomes.
8. **Outcome indicators** measure whether the fatigue control layers (activities) are having the desired effect on fatigue risk. In devising KPIs for fatigue it can be helpful to think of three kinds of outcome:
 - **Results**, for example the results of fatigue competence assessments
 - **Precursors**, for example working patterns which contain features likely to increase fatigue (see ORR's [Fatigue factors guidance](#)) or produce higher predicted fatigue tool scores
 - **Incidents**, for example accidents or near misses where fatigue appears to have contributed, or reports of fatigue concerns from staff.
9. **Tailoring fatigue KPIs** to your own operation is vital. Consider carefully what the most critical and vulnerable fatigue control elements are in your company's work, involving staff and their representatives. Be honest, and think carefully what metrics would give you a handle on how well your current controls are working. If for instance your biggest problems from fatigue are due to variable, short notice shifts, think through how you can best measure both
 - the extent of the problem (outcomes) and
 - the presence and effectiveness of your controls (activities) to reduce it.
10. In order to assess the effectiveness of fatigue controls for different parts of the operation, you will probably need several layers of indicators of **varying detail** (granularity). Individual depots or management units are likely to require a suite of finer, more detailed tactical indicators than the coarser, summary indicators needed for more senior, strategic management decisions. Quality is more important than quantity of KPIs, and it may often be possible to "bundle together" several lower level indicators into suitable higher level indicators.
11. **Calibrating thresholds** for your KPIs is important, so that you can assess the effectiveness of your controls and detect trends and changes without being repeatedly "swamped" with alerts. However, if you are using risk-based thresholds and are swamped with alerts, this suggests serious weaknesses in your fatigue controls which you should urgently investigate and address. It's no good merely making the threshold less demanding - leading to false re-assurance - unless you address the reasons for so many alerts being generated.

Features of good KPIs

12. When devising fatigue KPIs, think about the features of good performance indicators listed in Fig 3 below from RSSB's guidance:

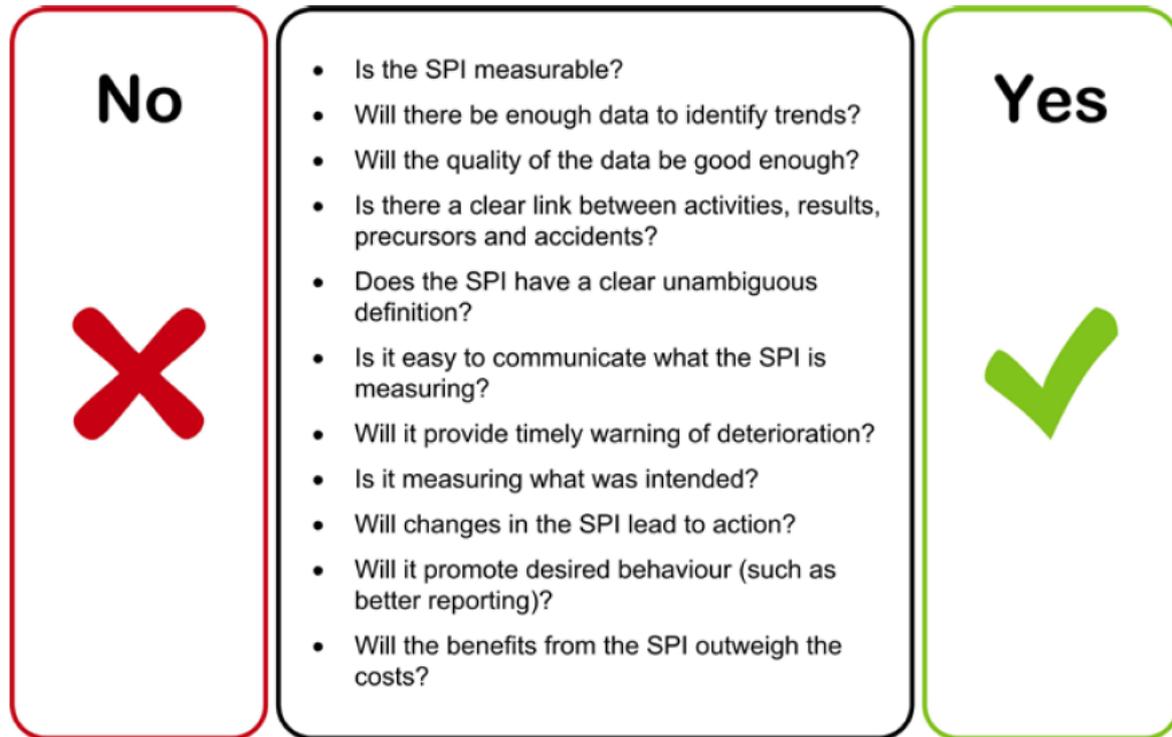


Fig 3. Features of a good performance indicator (RSSB)

Examples of fatigue KPIs

13. Some examples of possible fatigue KPIs, devised with common railway fatigue problems in mind, are listed in **Appendix 1**.
14. Selected further examples of fatigue KPIs from other industries are collated in **Appendix 2**.
15. These are only examples. Some may be suitable for adapting to your own operation, but you should consider your own main sources of fatigue risk and devise a suitable mix of corresponding indicators.

Further information

Generic guidance on Safety Performance Indicators

Health & Safety Executive, 2010. HSG254: Developing process safety indicators. A step-by-step guide for chemical and major hazard industries.

<http://www.hse.gov.uk/pubns/books/hsg254.htm>

Organisation for Economic Cooperation & Development (OECD, 2008), Guidance on developing Safety Performance Indicators related to chemical accident prevention, preparedness and response.

<http://www.oecd.org/chemicalsafety/chemical-accidents/41269639.pdf>

Railway Safety & Standards Board (RSSB, 2014). Measuring safety performance.

<https://www.rssb.co.uk/risk-analysis-and-safety-reporting/safety-intelligence/measuring-safety-performance>

Railway Safety & Standards Board (RSSB, 2013). Measuring Safety Performance – a quick “how to” guide.

https://www.sparkrail.org/_layouts/15/Rssb.Spark/Attachments.ashx?Id=75NEMTS3ZVHP-8-5952

Performance indicators for managing fatigue

IPIECA (2012). Performance indicators for fatigue risk management systems – guidance document for the oil and gas industry.

<http://www.ipieca.org/resources/good-practice/performance-indicators-for-fatigue-risk-management-systems/>

IATA, 2014. Fatigue safety performance indicators (SPIs): a key component of proactive fatigue hazard identification.

http://www.iata.org/whatwedo/ops-infra/Documents/fatigue-spis_a-key-component-of-proactive-fatigue-hazard-identification.pdf

Gander et al (2014). Crew fatigue safety performance indicators for fatigue risk management systems. Aviation, Space and Environmental Medicine, Vol. 85 No.2 Feb 2014.

https://www.researchgate.net/publication/260561035_Crew_Fatigue_Safety_Performance_Indicators_for_Fatigue_Risk_Management_Systems

Office of Rail and Road (ORR, 2016). Good practice guidelines – Fatigue Factors.

http://orr.gov.uk/_data/assets/pdf_file/0003/23682/good-practice-guidelines-fatigue-factors-november-2016.pdf

Civil Aviation Authority (CAA, 215) [CAP 1267 EASA FTL Guidance ORO-FTL-110](#)

Appendix 1. Some example railway fatigue KPIs

Some suggestions for possible fatigue KPIs, devised with common railway fatigue problems in mind, are listed below. These are only suggestions - think about the main risks from staff fatigue in your own operation, and devise a suite of KPIs to assess how well your control measures are working.

Working pattern indicators (good scheduling software can help identify these):

- % of (planned & actual) rosters assessed for selected “fatigue factors” (see [Fatigue factors guidance](#)) (activity indicator)
- % or number of shifts involving selected “fatigue factors” as below (outcome indicators):
 - Time of day factors:
 - Number or % of shifts covering 00:00 and 05:00 (night shifts)
 - Number or % of shifts starting between 05:00 and 07:00 (early shifts)
 - Number or % of shifts starting before 05:00 (very early shifts)
 - Duty length factors:
 - Number or % of shifts starting before 05:00 & over 8h long
 - Number or % of shifts which are day shifts over 12h long
 - Number or % of shifts which are night shifts (covering 00:00 - 05:00) & >10h long
 - Number or % of shifts which are earlies (starting before 05:00) & >10h long
 - Recovery time factors:
 - Instances of less than 2 days rest after a block of consecutive night shifts (00:00 and 05:00)
 - Instances of less than 2 days rest after a block of consecutive early starts (<07:00)
 - Instances of more than 13 consecutive shifts without a 48h break
 - Intervals between duties factors:
 - Instances of less than 12h rest in any 24h period for day shifts

- Instances of less than 14h rest in any 24h period for night shifts
- Instances of only one day rest after night shifts
- Cumulative fatigue factors:
 - Instances of more than 4 consecutive 12h day shifts
 - Instances of more than 4 consecutive nights (covering 00:00-05:00) in a rotating pattern
 - Instances of more than 4 consecutive early shifts (starting between 05:00 and 07:00) in a rotating pattern
 - Instances of more than 3 consecutive night shifts (covering 00:00-05:00) over 8h long
 - Instances of more than 6 consecutive night (covering 00:00 to 05:00) or early shifts (starting between 05:00 and 07:00) in a permanent pattern
 - Instances of more than 12 consecutive day shifts
 - Instances of more than 7 consecutive 8h shifts
 - Instances of more than 55 hours worked in a 7 day period
- Circadian phase shift (body-clock adjustment) factors:
 - Number or % of shifts involving a backward rotating pattern
 - Number or % of shifts involving a rotating pattern of about a week
 - Number or % of shifts where successive shift start times vary by more than 2 hours
 - Number or % of shifts which are a first night shift

Other examples of working pattern indicators:

- % of (planned & actual) rosters assessed using bio-mathematical fatigue tool (activity)
- % of shifts (planned & actual) with predicted biomathematical tool scores exceeding company guidelines.
- % of shifts identified as exceeding company fatigue rules which were fatigue-assessed by a person competent in fatigue management before authorisation or refusal (activity)

- % of shifts more than x mins longer than originally planned (outcome)
- Number or % of shifts covered by overtime or “rest day” working (outcome)
- Number or % of shifts where staff had less than x days notice of a shift / changes to a shift (reduces ability to plan and obtain sleep)

Combined work and journey (door-to-door) time:

- % of mobile worker shifts where door-to-door times were checked against company rules by a supervisor beforehand e.g. using Googlemaps or similar journey planning software (activity)
- No or % of mobile worker shifts with combined door-to-door time over company’s limit e.g. >12h (outcome)

Fatigue competence:

- % of staff carrying out safety-critical staff work who have been assessed as competent in fatigue
- % of staff who design working patterns (or authorise changes) who have been assessed as competent in the company’s fatigue assessment and control processes (activity).
- % of fatigue refresher training completed against programme (activity)

Fitness for duty:

- % of shifts where fitness-for-duty (e.g. recent sleep & time awake check) confirmed (activity)
- % of shifts where staff reported <6h sleep in previous 24h, or <12h sleep in previous 48h
- % of safety critical staff who have been screened for sleep disorders (activity)

Contractual chain:

- % of safety critical contractors whose fatigue controls have been reviewed against client’s fatigue management expectations (activity)
- % of safety critical contractors whose fatigue controls have been reviewed against client’s fatigue management expectations and assessed as satisfactory (outcome)

Fatigue reporting:

- Number of fatigue concerns reported (outcome)
- % of reported fatigue concerns investigated by joint fatigue working group (activity)

Appendix 2

Collation of some fatigue KPIs from other industries

The selection below (not exhaustive) may suggest ideas for fatigue KPIs which you may be able to adapt for your own operation.

IPIECA, 2012:

SPIs for fatigue contributors

1. Rostered work hours

- Possible leading indicators:
 - Planned rosters have been adequately risk assessed for fatigue.
- Possible supporting leading metrics:
 - Percentage of rosters that have elevated predicted levels of fatigue (as identified by the organization's risk assessment).
 - Percentage of each shift that exceeds an action level (as defined by the organization's fatigue risk assessment).
 - Percentage of shifts where shift swaps have taken place to minimize the adverse impact of fatigue.
 - The number of workers reporting having a sleep opportunity of less than 6? (too tolerant) hours in any 24-hour period.
- Possible lagging indicators:
 - Evidence of incidents or near misses occurring within periods of the roster, where the likelihood of fatigue-related impairment is increased.
- Possible supporting lagging metrics
 - Percentage of incidents or near misses that occur during periods of the roster where there is an elevated risk of fatigue.
 - Number of fatigue-related incidents occurring while travelling to or from work, involving employees working rosters associated with elevated predicted levels of fatigue.

2. Actual work hours

- Possible leading indicators:
 - Assessment of actual work hours indicates whether sufficient sleep and recovery opportunity is being provided.
 - The distribution of additional work hours across the workforce.
 - Assessment of the number of 'open' shifts.
- Possible supporting leading metrics:
 - Percentage of shifts that comply with rostered work hours.
 - Percentage of actual work hours that are likely to produce an elevated risk of fatigue based on a fatigue risk assessment.
 - Percentage of unfilled positions.

- Possible lagging indicators:
 - Evidence that overtime, call-outs or additional shifts have contributed to reduced sleep or recovery, and to an incident or near miss.
- Possible supporting lagging metrics:
 - Percentage of incidents or near misses that occur during or following deviations from the roster, particularly during periods where there is a high likelihood of fatigue-related impairment.

3. Types of work tasks

- Possible leading indicators:
 - Work tasks are planned to maximize alertness, and minimize the effect of fatigue.
 - A degree of task variation across a typical shift.
 - Evidence that workers have elected to change or 'swap' tasks to self-manage fatigue.
- Possible supporting leading metrics:
 - Percentage of employees who report that they change tasks or take a break if they start to feel fatigued.
 - Percentage of safety-critical tasks scheduled outside the window of circadian low
- Possible lagging indicators:
 - Recognition from incident investigation that performance of a task was impaired due to fatigue.
- Possible supporting lagging metrics:
 - None currently proposed.

4. Working environment

- Possible leading indicators:
 - Environmental conditions are managed to minimize the impact on worker performance.
- Possible supporting leading metrics:
 - Percentage of shifts exposed to environmental conditions that induce fatigue.
 - Percentage of shifts that have management strategies in place, or for which alternative duties are allocated.
 - Percentage of sites that have facilities in place for managing working conditions (e.g. air-conditioned rooms for hot days).
- Possible lagging indicators:
 - Evidence that fatigue-inducing environmental conditions had been experienced leading up to, or during, an incident or near miss.
- Possible supporting lagging metrics:
 - Percentage of incidents or near misses that occur in environmental conditions known to exacerbate or cause fatigue.

5. Amount of sleep obtained

- Possible leading indicators:
 - Workers understand the importance of obtaining sufficient quality sleep.
 - Workers are aware of the elements of good sleep hygiene.
 - Procedures exist to report and manage instances of insufficient sleep.
- Possible supporting leading metrics:
 - Frequency of workers reporting insufficient sleep before a work shift.
 - Frequency of workers reporting less than an average of 7 hours' sleep per 24 hours.
 - Any occurrence of workers reporting less than five hours' sleep over more than three consecutive work days.
- Possible lagging indicators:
 - Evidence that insufficient sleep has contributed to an incident or near miss.
- Possible supporting lagging metrics:
 - Percentage of incidents or near misses that have occurred where the individual involved has obtained less than 7 hours' sleep in the prior 24 hours.

6. Sleeping environment

- Possible leading indicators:
 - Worker reports of disturbed sleep due to aspects of the sleeping accommodation.
- Possible supporting leading metrics:
 - Percentage of camp rooms that comply with requirements following a sleep hygiene assessment.
 - Percentage of camp rooms that have been reported as having levels of noise, light, vibration, etc. sufficient to disrupt sleep.
 - Percentage of camp rooms that have been reported as having inadequate bedding or climate control, etc. sufficient to promote sleep.
 - Percentage of camp rooms that have been upgraded to improve sleeping conditions.
- Possible lagging indicators:
 - Evidence that insufficient sleep caused by sleeping accommodation disturbances has contributed to an incident or near miss.
- Possible supporting lagging metrics:
 - Percentage of incidents or near misses that have occurred where the individual involved has obtained less than 6 hours sleep in the prior 24 hours, which has been caused by sleeping accommodation disturbances.

7. Sleep disorders

- Possible leading indicators:
 - Training provided to workers on the symptoms and treatment for common sleep disorders.
 - Sleep disorder screening offered to workers.
 - Procedure to manage potential impairment of workers diagnosed with sleep disorders.
- Possible supporting leading metrics:
 - Percentage of workers performing safety-sensitive work who have been trained to understand the symptoms, consequences and treatment of sleep disorders.
 - Percentage of workers performing safety-sensitive work who have been screened for sleep disorders.
 - Percentage of workers performing safety-sensitive work who have been screened for sleep disorders that obtain diagnostic testing.
 - Percentage of workers diagnosed with a sleep disorder, and who are being actively managed.
- Possible lagging indicators:
 - Evidence that a diagnosed sleep disorder contributed to an incident or near miss.
 - Consideration of a non-diagnosed sleep disorder as a contributor to an incident or near miss.
- Possible supporting lagging metrics:
 - Percentage of incidents or near misses that have occurred, involving an individual who has, or is at risk of having, a sleep disorder.

8. Other health issues

- Possible leading indicators:
 - Workers understand the relationship between general health issues and the impact on alertness and fatigue.
 - Procedures exist to report and manage health issues where fitness for work may be compromised.
- Possible supporting leading metrics:
 - Percentage of random drug and alcohol screening that indicates drugs known to have an impact on sleep/fatigue.
 - Percentage of random drug and alcohol screening that indicates drugs known to promote alertness.
 - Percentage of workers that have reported personal health issues impacting on alertness at work.
- Possible lagging indicators:
 - Evidence that a person's general health or medication has contributed to an incident or near miss.
- Possible supporting lagging metrics:

- Percentage of incidents or near misses that have occurred where the individual had taken medications, or was experiencing health issues known to have an impact on sleep or fatigue.

SPIs for Fatigue Risk Management System (FRMS) components

1. Roles & responsibilities

- Possible leading indicators:
 - A single point of accountability for programme introduction and management.
 - Evidence that performance against the FRMS is reviewed and discussed in senior management meetings.
- Possible supporting leading metrics:
 - Percentage of sites that have convened a 'fatigue management working group' recognizing the importance of key stakeholder involvement.
 - Percentage of sites where supervisor responsibilities about fatigue are clearly defined and documented (e.g. in the job description).
 - Percentage of job descriptions that include clearly defined and documented employee responsibilities concerning fatigue (e.g. in the job description).
 - Percentage of relevant external contracts that have a requirement for an FRMS.
 - Percentage of contractors who have an FRMS in place.
 - Percentage of audit findings where a deficiency in roles and responsibilities has been identified.
 - Percentage of audit findings where a deficiency in stakeholder engagement has been identified.
- Possible lagging indicators:
 - Incident investigations identify the lack of management control or responsibility for fatigue management as a contributing factor.
- Possible supporting lagging metrics:
 - Percentage of incident investigations in which a lack of clear roles and responsibilities for fatigue management is identified.

2. Training and competence

- Possible leading indicators:
 - Existence of a competency-based fatigue management training programme for relevant target employee groups.
 - Evidence of application of the learning in the workplace.
- Possible supporting leading metrics:
 - Percentage of employees trained per period as compared with schedule.
 - Percentage of supervisors who have received additional specific training regarding their responsibilities per period as compared with schedule.
 - Percentage of occupational drivers who have received additional specific training per period as compared with schedule.

- Percentage of employees completing refresher training per period as compared with schedule.
- Percentage of training records completed.
- Percentage of employees assessed to be competent in the application of their knowledge of fatigue and its application in the workplace based on post-training knowledge/competency tests.
- Possible lagging indicators:
 - Incident investigations identify lack of awareness of the risks of fatigue in the workforce as a contributing factor leading to:
 - people involved in incidents being in a significantly fatigued state; and/or
 - failure to intervene to prevent a seriously fatigued individual performing safety-critical work.
- Possible supporting lagging metrics:
 - Percentage of incident investigations in which a lack of adequate training in fatigue management is identified.
 - Percentage of incident investigations in which a lack of competence in the management of fatigue is identified.
 - Percentage of incident investigations in which recognized alertness strategies were not used effectively.

3. Risk assessment

- Possible leading indicators:
 - Evidence that the site has assessed the risk from fatigue and the effectiveness of existing controls.
 - Evidence that, where necessary, the site has implemented additional controls to reduce fatigue-related risk to ALARP (as low as reasonably practicable).
- Possible supporting leading metrics:
 - Percentage of sites that have undertaken a fatigue risk assessment.
 - Percentage of employees who have completed a personal fatigue risk assessment (including both work and personal factors).
 - Percentage of fatigue risk assessments per period as compared with schedule.
 - Percentage of existing fatigue risk assessments reviewed per period as compared with schedule.
 - Percentage of fatigue risk assessments relating to contractor activities or personnel.
 - Percentage of fatigue risk assessments that have considered the work environment.
 - Number of ad hoc operational fatigue risk assessments triggered by deviations from scheduled hours of work.

- Number of ad hoc operational fatigue risk assessments triggered as a result of fatigue-related behaviour by employees that has been observed in the workplace.
- Possible lagging indicators:
 - Incident investigations find no evidence that risk associated with fatigue had been assessed prior to the incident.
- Possible supporting lagging metrics:
 - Percentage of assessments and incident investigations in which the lack of fatigue risk assessment is identified.

4. Risk reduction

- Possible leading indicators:
 - Evidence of fatigue reduction and/or fatigue proofing controls within the FRMS.
- Possible supporting leading metrics:
 - Percentage of 'open' shifts per rolling period.
 - Percentage of unfilled positions.
 - Percentage of hours worked that are overtime.
 - Percentage of employees who have exceeded the maximum number of consecutive working days/hours before taking a rest day.
 - Percentage of single rest days between shift cycles per rolling period.
 - Percentage of task swaps intended to reduce the adverse impact of fatigue on employee performance.
 - Percentage of shifts worked following shift swaps (measure of stability of shift patterns).
 - Percentage of safety-critical activities performed during the window of circadian low (24:00–06:00).
 - Percentage of control room watches exceeding six hours.
 - Maximum length of time between breaks on shift.
 - Percentage of sites that have dedicated facilities or arrangements to enable workers to practise alertness strategies.
- Possible lagging indicators:
 - Incident investigations find no evidence of attempts to implement fatigue mitigation measures or to assure that they are effective.
- Possible supporting lagging metrics:
 - Percentage of incident investigations in which a lack of fatigue risk reduction measures is identified as a contributor to the incident.
 - Percentage of incident investigations which cite ineffective fatigue risk reduction measures as a contributor to the incident.

5. Health issues including the management of sleep disorders

- Possible leading indicators:
 - Evidence that the impact on health of extended hours of work or continuous operations involving shift changes is addressed by the site.
 - Evidence that the impact of health on working extended hours of work or continuous operations involving shift changes is addressed by the site.
- Possible supporting leading metrics:
 - Percentage of employees working extended hours or working on continuous operations involving shift changes, and who were offered a fitness-for-duty assessment which included questions relating to fatigue.
 - Percentage of employees working extended hours or working on continuous operations involving shift changes, and who completed a fitness-for-duty assessment which included questions relating to fatigue.
 - Percentage of employees identified as being 'at risk' with regard to sleep disorders on initial screening.
 - Percentage of 'at risk' employees who were diagnosed with a sleep disorder.
- Possible lagging indicators:
 - Incident investigations identify underlying health issues affecting sleep as contributing to fatigue associated with incidents.
- Possible supporting lagging metrics:
 - Percentage of incident investigations in which a health-related fatigue issue was identified.

6. Incident investigation

- Possible leading indicators:
 - The possibility that fatigue could be a contributing factor is included in all incident investigations.
 - Completeness of the process for assessing the possible role of fatigue.
- Possible supporting leading metrics:
 - Percentage of incident investigation reports that contain an assessment of the contribution of fatigue.
 - Percentage of cumulative incident investigation summaries (e.g. quarterly or year end) that include a section on fatigue.
 - Percentage of near miss reports (i.e. not just incidents that led to an injury) that make reference to fatigue.
 - Percentage of incident investigators who have received additional training in fatigue.
 - Percentage of investigation reports that provide data on the prior sleep/wake history of both direct actors in the incident and those who may have created latent errors.
- Possible lagging indicators:
 - The role of fatigue is included in all incident investigations.
- Possible supporting lagging metrics:

- Percentage of incident investigations that do not address fatigue (or any references that are deemed to be incomplete).
- If fatigue is relevant to an incident, it is only discovered by chance (i.e. not through a systematic assessment of the incident).

7. Monitoring and processes for the internal and external assessment of the FRMS

- Possible leading indicators:
 - Number of internal/external FRMS audits.
- Possible supporting leading metrics:
 - Percentage of internal/external assessment protocols that include fatigue.
 - Percentage of internal/external assessment findings that include fatigue.
- Possible lagging indicators:
 - Percentage of incident investigations in which the absence of, or problem with, the monitoring or internal/external assessment of the FRMS was identified.
- Possible supporting lagging metrics:
 - The role of fatigue is included in all incident investigations.

IATA, 2011 FRMS implementation guide for operators:

At section 4.6:

“The effectiveness of implemented controls and mitigations must be assessed, which requires setting safety performance indicators such as the following

Schedule-related indicators:

- Number of flight deviations (or flight completion not accomplished) on specific city pairings, due to fatigue, lack of staff, medical emergencies, etc.
- Number of bids for pairings identified as high fatigue risk (e.g. back-to-back night flights).
- Number of crew duty day exceedences into allowable excesses (as determined through risk assessment. For example, longer than 14 (?) hours.) 1)
- Number of flight duty periods determined to be “significantly” later than scheduled*.
- Number of flight duty periods longer than a specified number of hours without a rest break within the duty.
- Number of flight times more than a specified number of minutes longer than planned (e.g., 30 or 60 minutes).
- Number of flight duty periods starting within Window of Circadian Low (WOCL = time in the circadian body clock cycle when subjective fatigue and sleepiness are greatest)
- Number of landings within the WOCL.
- Number of duty periods with more than a specified number of flight sectors.
- Number of duty periods with more than a specified number of aircraft changes.

- Number of successive early wakeups, especially combined with long “sits” between flights or long duty days.
- Number of reduced rest breaks within duties (by more than a specified number of minutes determined to be “significant”)*.
- Number of reduced rest breaks between duties (by more than a specified number of minutes determined to be “significant”)*.
- Number of reserve crew call-outs (on particular flights, at a particular crew base, etc).

...and at section 5.2:

“Examples of safety performance indicators specific to an FRMS will include measures obtained through the FRM processes, such as:

- The number of exceeded maximum duty days in operations covered by the FRMS.
- The number of voluntary fatigue reports per month.
- The average “fatigue call” rate by flight crews on a specific pairing (trip).
- The ratio of fatigue reports from ULR operations covered by the FRMS to fatigue reports from the long haul operations covered by the prescriptive flight and duty time regulations.
- Attendance at FRMS training sessions.
- Results on FRMS training assessments.
- The level of crew member participation in fatigue-related data collection.
- The number times fatigue is identified as an organizational factor contributing to an event.

Proactive/reactive fatigue indicators:

- Measured data outside acceptable thresholds (e.g., sleepiness ratings, PVT scores, or inadequate layover sleep duration).
- Numbers of fatigue reports (sorted in many ways such as by crew base, seat, augmented flights, fleet types, operational types, etc)
- Number of fatigue-related incidents.
- Number of fatigue-related FOQA (flight operational quality assurance) events associated with a particular schedule for which fatigue reports have been received.
- Absenteeism/fatigue calls.

Gander & Mangie (2011 fatigue conference on ICAO website):

- Mean Psychomotor Vigilance Test (PVT) reaction speed early in duty / late in duty
- % crew with Karolinska Sleepiness Scale (KSS) of 7 or more (at top of climb/xyz stage of duty)
- % duty periods extending >30mins later than scheduled

Gander et al 2014 - Crew fatigue safety performance indicators for fatigue risk management systems:

- % of duties exceeding maximum duty time
- % of duties starting/ending/spanning the Window of Circadian Low (WOCL)
- Total sleep and time awake in the previous 24h at start of duty / top-of-descent (by actigraphy)
- Subjective sleepiness (KSS) and fatigue (Samn-Perelli)
- PVT performance

Civil Aviation Authority Guidance material for ORO.FTL.110:

Examples of some roster metrics:

- Duty placement
- Night duties
- Deep early starts
- Consecutive day sector count
- Transitions between late/early and early/late duties
- Multi-sector FDPs
- Circadian parity in report
- Combined short and long haul flying in a working block
- Combinations of duties crossing time zones
- Combinations duties with east/west time zone crossings
- Rest length
- Rest placement in relation to WOCL
- Recovery days off
- Roster disruption/stability
- Standby usage
- Planned versus actual