# HUMAN FACTORS

BRIEFING NOTE No. 17

# Performance indicators

Monitoring performance is a key element of an organisation's safety management system. This should comprise both 'proactive' and 'reactive' monitoring. Proactive monitoring relies on leading indicators – signs that provide some measure of the adequacy of an organisation's risk controls before there is a problem; reactive monitoring relies on lagging indicators – evidence that shows how those risk controls have performed once a problem occurs.

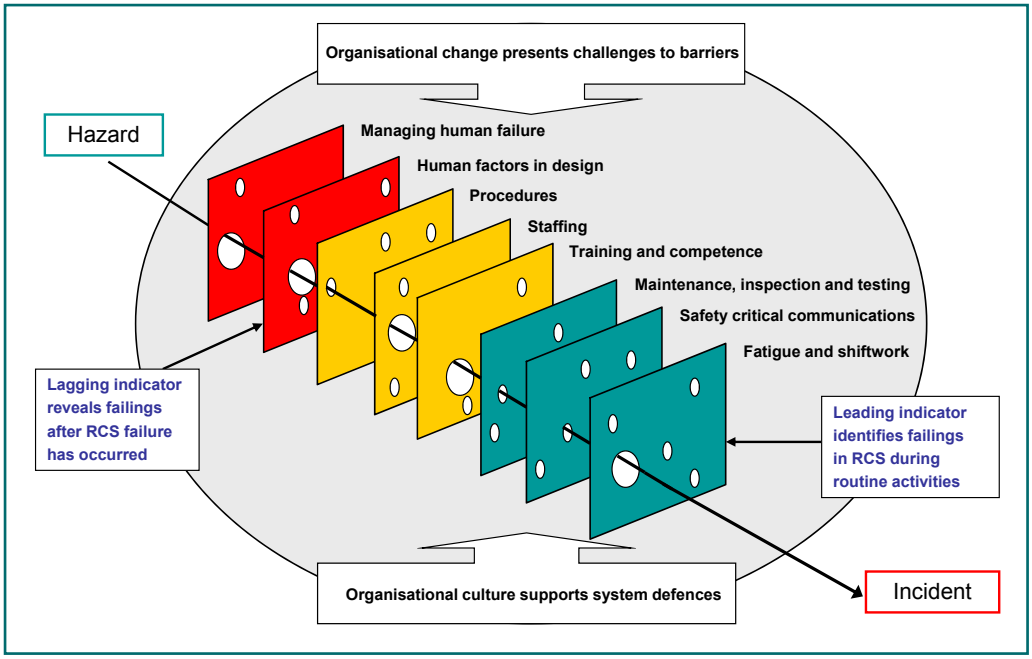
## Why performance indicators?

A number of guides are available for developing performance indicators (see References). These are very useful and should help to clarify this sometimes confusing area of risk control. The purpose of this briefing note is to describe how to develop performance indicators for the human and organisational factors covered in this resource pack. Case studies 1 and 2 refer to process safety. All process safety events are loss of integrity of systems that should provide a barrier between the hazard and anything that could be damaged by the hazard. Human and organisational factors form part of those systems and barriers. The use of human factors performance indicators is therefore the proactive and reactive measurement of the effectiveness of these barriers using leading and lagging indicators.

The issue of performance indicators related to human factors remains controversial and problematic. This briefing note is provided as an item for discussion and to advance progress on this issue, and should not be taken as mature guidance.

### Leading versus lagging indicators

The difference between leading (proactive) and lagging (reactive) indicators is a source of some contention. In theory, what is a leading indicator for one problem may be a lagging indicator for another. For example, a lagging indicator may show that a company already has a problem with human factors, but if that problem hasn't led to an incident or accident, it can also be considered a leading indicator predicting an incident or accident in future. Some people therefore consider the distinction between leading and lagging indicators to be useful only in relation to what is being measured. Others consider lagging indicators to be more concrete issues that have already arisen (such as an incident, accident, or failure of a system/barrier, identified through incidents, accidents or near-misses) and leading indicators to be metrics/issues that predict whether a barrier may fail in future.




Note that each human factors issue can be treated as a barrier in the system, illustrated in the Swiss cheese model

# Management responsibility

Management should develop leading and lagging performance indicators for human and organisational factors, and arrange checks, inspections, observations etc, to measure performance against the leading indicators. Performance against lagging indicators will become evident from incidents, accidents or near-misses, and should be investigated to identify and eliminate causes.

# Identifying performance indicators

The process for identifying performance indicators is similar to risk assessment and consists of the following steps (adapted from Reference 2):

1. Consider what could go wrong in your organisation's activities involving hazards; how could failure to control those hazards lead to an incident or accident?
2. What human and organisational risk control measures are in place to prevent incidents and accidents? Does incident avoidance rely, for example, on operators responding to alarms, on maintenance crew competence, on good procedures for key operations etc.?
3. Identify leading indicators against these controls; that is, any signs that could give advance warning of possible failure. Decide how to measure whether the controls are working.
4. Identify lagging indicators – signs and symptoms that controls have deteriorated or failed. Define measures and acceptable limits: for example, whether a single failure of a system, or three or five or some other number, should trigger remedial action.

Many of the briefing notes in this resource pack include a self-assessment questionnaire and comments on management responsibilities for each human factors issue described. These should help in identifying best practices and good performance, and can be used to develop human factors performance indicators. Members of the workforce may also help in identifying indicators.

Some indicators that are identified will be 'indirect' and should be used with caution. For example, the number of inspections and checks carried out on time on critical plant items will indicate whether or not monitoring of plant condition is being done, however it will not indicate whether this is being done effectively – a better indicator might be the number of critical plant items inspected and found to be defective. In addition, analysts should think about the 'weighting' given to any indicator, for example whether a defect found could be considered a 'major', 'intermediate', or 'minor' indicator.

## Sample indicators

A sample of proposed indicators is listed in the tables on pages 3 and 4 and should be used as the stimulus for ideas (a more complete list is provided in Reference 3). Management should develop their own indicators and review them regularly to ensure that they remain valid measures of performance. In general, the number of incidents, accidents or root cause investigations in which failures of any of the human factors areas set out below are identified as a causal factor can be used as a lagging indicator for that issue.

### CASE STUDY 1

"Loss of containment is an important process safety lagging indicator, because a potential for an accident exists when hydrocarbons 'get outside the pipe.'…the number of loss of containment incidents at the Texas City refinery increased each year from 2002 to 2004. In 2002, the refinery experienced 399 loss of containment incidents. That number increased in 2003 to 493. The number of loss of containment incidents at Texas City peaked in 2004 at 607."

Source: Reference 1.

### CASE STUDY 2

The sole use of lagging safety indicators, such as injury rates or numbers of incidents, has been described as trying to drive down the road looking only in the rear view mirror – it tells you where you have been but not where you are headed. Process safety good practice guidelines recommend using both leading and lagging indicators for process safety. Leading indicators provide a check of system functioning – whether needed actions have been taken, such as equipment inspections completed by the target date or process safety management (PSM) action item closure. Lagging indicators, such as near-misses, provide evidence that a key outcome has failed or not met its objective.

Source: Reference 2.

## Sample indicator tables

| BN 2: Alarm handling | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Number of alarms that operators fail to acknowledge per shift.<br>Compliance with EEMUA guidance on human/machine interfaces and alarm handling, for example: counts of overall alarm frequency; number of standing alarms, alarms failing to initiate, false alarms etc.<br>Evaluation of alarm follow-up actions (e.g. accepted/disabled) and standing alarm reviews, based on sampling. | Number of alarms failing to initiate on demand per shift.<br>Number of standing alarms.<br>Number of false alarms. |

| BN 3: Organisational change | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Number or percentage of organisational changes that are risk assessed as part of management of change process.<br>Number or percentage of management of change requests closed out or signed off versus number remaining live (for period/against targets).<br>Percentage of adherence to management of change procedures, based on spot checks, audits, etc.<br>Staff workload assessment (workload assessment is particularly important for safety critical tasks).<br>Maintenance backlog. | Number of tasks carried over to next shift.<br>Number of issues arising from failure in management of change process (e.g. delays, impact on operations etc.).<br>Number of times work stopped because of lack of personnel.<br>Number or percentage of staff off work because of stress.<br>Number of identified skills shortages.<br>Increase in overtime worked.<br>Increased reporting of fatigue. |

| BN 4: Maintenance | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Maintenance backlog (percentage of equipment not maintained against prioritised targets).<br>Percentage of maintenance jobs not checked (that require to be checked).<br>Relative percentage of reactive (corrective) versus proactive (planned) maintenance.<br>Timescale for closure of work orders, against targets.<br>Number or percentage of equipment inspections/tests undertaken against target schedule. | Number of loss control reports/ reported failures, including key component failures, attributable to lack of maintenance.<br>Total number of critical system breakdowns.<br>Percentage of reported maintenance errors/number of tasks requiring re-work.<br>Number of times issues reported with equipment that has been maintained or repaired (i.e. maintenance incorrectly performed leading to latent defects/maintenance induced failure). |

| BN 5: Fatigue | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Average number of hours worked (or percentage overtime worked) from timesheet analysis (a trend towards more overtime might suggest increased potential for fatigue/reduced alertness).<br>Results of shift reviews either with or without fatigue risk indicators/shift assessment or other tools.<br>Number of non-compliances with documented shift pattern.<br>Number of consecutive shifts worked by individuals.<br>Percentage of work breaks missed (sampling/interview). | Any instance of falling asleep at work.<br>Number of workforce reports of drowsiness or inattention.<br>Number of near-misses arising from shiftwork/fatigue issues.<br>Levels of sickness absence (may be indicative of fatigue issues if sickness absence is a means to avoid working a shift. Care is required in interpretation). |

| BN 6: Safety critical procedures | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Number or percentage of procedures documented/up-to-date/within scheduled review date, or as compared with total number of procedures.<br>Percentage of procedures meeting quality criteria/ number of errors found in procedures (based on procedural 'walkthroughs' undertaken by managers and operators to confirm appropriateness).<br>Backlog of procedures updates.<br>Number or percentage of safety critical tasks for which appropriate procedures are in place.<br>Percentage of permits to work (PtWs) reviewed and considered fit-for-purpose. | Number of non-compliances with procedures.<br>Number of incidents/accidents citing problems with procedures. |

| BN 7: Training and competence | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Presence of a formal competence management system.<br>Number or percentage of employees trained per period as compared with schedule.<br>Percentage training records complete/up-to-date.<br>Number or percentage of safety critical staff assessed to be competent in their roles (based on competency assessment programme / use of simulator re-assessment).<br>Number or percentage of staff satisfactorily completing refresher training as compared with schedule (this is not the same as competence; also, the number of non-attendees may indicate staffing pressures). | Percentage of candidates failed after training and assessment.<br>Shortage of required skills and experience for specific tasks.<br>Workmanship problems in maintenance.<br>'Mission failures' during operations.<br>Feedback on staff competence from third-party body (based on annual audits). |

## Sample indicator tables (cont.)

| BN 8: Ergonomics | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Strategy in place to integrate ergonomics in design projects and compliance with HFI plan, based on review of site activities, interviews, and documentation.<br>Human factors assessment tools available and used within the organisation.<br>Number of items of equipment non-compliant with ergonomic standards (based on spot check).<br>Number or percentage of design reviews with defined team competencies including human factors/ergonomics specialist knowledge.<br>Compliance of equipment/ workplaces with ergonomic environmental design requirements (lighting, noise, etc.) based on sample audits. | User feedback on systems identified as not fit for purpose or not 'user friendly'.<br>Human errors or 'workarounds' related to design problems.<br>Task or equipment design-related injuries or ill-health reported.<br>Number of items not accessible for maintenance (ergonomic considerations for accessibility have not been addressed).<br>Number of repeat incidents/ accidents associated with specific equipment (NB: repeated problems may be indicative of a problem in the design).<br>Number of design issues raised on issues register. |

| BN 9: Safety culture | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Results from HSE safety climate surveys (or other safety culture/ climate surveys or external audits).<br>Leadership:<br>• Measure of visibility of senior executives in the workplace (number of site visits, etc.).<br>• Number of safety tours undertaken by managers and middle managers.<br>• Number of task observations undertaken by leaders (behavioural safety measure).<br>Number of incidents/accidents reported upwards (and in a timely fashion) through the reporting chain.<br>Effectiveness of incident/accident investigation process, including circulation of reports, and effectiveness of interventions. | Number of observations of poor safety culture from application of behavioural safety methods.<br>Number of remedial actions required following safety culture audits.<br>Number of reported near-misses (should not be zero).<br>Percentage of incidents/accidents that are repeat incidents/ accidents (measure of how well the organisation is learning from incident/accident investigations).<br>Breaches of company policy. |

| BN 10: Communications | |
|---|---|
| **Leading indicators** | **Lagging indicators** |
| Workforce perceived usefulness of information provided by: word of mouth, emails, posters, memos etc.<br>Percentage of compliance with communication protocols (based on spot checks/sampling audits).<br>Correct use of communications proformas (identify percentage of non-compliance via sampling).<br>Percentage/number of shift handovers meeting required criteria*/number of errors found in handover process (quality checks based on sample auditing of handover process and review of logs). | Number of reported failures of communication systems.<br>Accuracy and 'usefulness' of shift logs.<br>Number of reported end-of-tour or shift handover problems. |

* Checks to include correct completion of handover documentation, quality of spoken handover, and acceptance of handover by incoming team.

## References


1. Baker, J.A. et al (2007), *The report of the BP US refineries independent safety review panel*, BP, http://www.bp.com.
2. HSE (2006), *Developing process safety indicators: A step-by-step guide for chemical and major hazard industries*, HSG254, HSE Books.
3. Energy Institute (2010), *Research report: Human factors performance indicators for the energy and related process industries*, http://www.energyinst.org/hofpi.


## Further reading


- HSE (2009), *Safety and environmental standards for fuel storage sites*, Process Safety Leadership Group Final report.
- OECD, *Guidance on safety performance indicators*, http://www2.oecd.org/safetyindicators.
- UKPIA, *Management of change* Self Assessment Module 1, http://www.ukpia.com.
- Safety Science (2009), *Process safety indicators/SRAE 2006*, Volume 47, Issue 4, Elsevier Ltd.


For background information on this resource pack, please see Briefing note 1 *Introduction*.