

# **A database of Safety Performance Indicators for the Explosives Industry: A report on an initiative to create a database of Safety Performance Indicators (SPIs) in the UK**

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## **Introduction**

In July 2011, a group was formed comprising representatives from the major UK explosives industry participants; Chemring, BAE Systems, AWE, Roxel, EPC, Qinetiq, Orica, the Ministry of Defence and the UK regulator (HSE) to share experiences and current practice in the use of Safety Performance Indicators (SPIs). The group also met representatives from the oil and gas and electrical distribution industries to gain a wider view.

Their aim was not to produce new guidance or research; there is plenty of that about already there is plenty of that about already (OECD, HSG254, CCPS, Step Change in Safety, API, EPSC etc.).

A more interesting question is; what works?

Their aim, therefore, was to gather and publish a database of real examples as a means of encouraging wider adoption of SPIs. A business looking to improve performance can look at the examples and try to spot an indicator that might work for them. If necessary, the provider of the entry can be contacted for further information on their experiences and challenges.

## **Some terms and definitions**

### **Safety performance indicators**

The OECD (2008) came up with a useful definition: "The term safety performance indicators is used to provide observable measures that provide insights into the concept of safety, which is inherently difficult to measure"

### **Leading v lagging**

Leading indicators measure activities that prevent incidents whereas lagging indicators tend to measure the frequency of incidents or the consequence. Leading and lagging indicators are both important though leading indicators tend to be more varied and often less accurate.

However, some can be argued to be either, like, for example, near misses and so this debate has been avoided by not categorising the collected SPIs in this way.

### **Process safety v Personal (or occupational) safety**

Safety is commonly measured using workforce injury statistics (e.g. lost time incidents) but these imply nothing about how well process safety is being managed. Major hazards tend to have high consequence, low frequency events. To paraphrase Professor Andrew Hopkins (Lessons from Longford) "An airline that had an excellent personal safety record amongst its baggage handlers, ticketing staff or maintenance personnel would not use this data to judge that the aircraft was safe to fly."

From the Baker report:

*Personal safety hazards give rise to incidents such as slips, falls and strains that primarily affect one worker for each occurrence. Process safety hazards give rise to major accidents involving the release of energy or potentially dangerous materials, or both, which can result in multiple injuries and fatalities as well as substantial economic, property and environmental damage.*

The American Petroleum Institute (API) in their API 754 Recommended Practice provided this useful model of process safety indicators in which lagging indicators tend to be at the top of the accident pyramid and leading indicators tend to be towards the bottom:

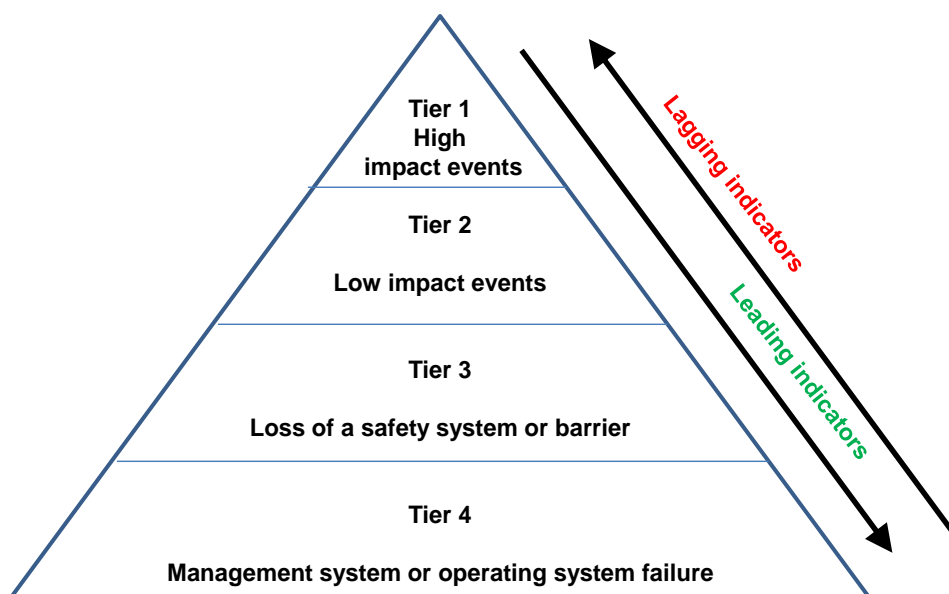


Figure 1. API 754 Model of process safety indicators

In a major hazard industry something is needed that demonstrates that the planned prevention and consequence barriers are in place and are working. SPIs must provide assurance that major hazards are being managed.

We therefore wanted to be sure to get as many *process* safety indicators as possible.

## Collecting the indicators

The Stakeholder Forum participants ranged in size and scope of operations; and included multinational PLCs, UK subsidiaries of international groups and government organisations.

All the participants were at a different level of understanding and implementation of Safety Performance Indicators, although all companies had safety management systems in place.

Previous work has been carried out within the explosives sector (Threlfall 2012, HSE 2010, Sugden 2009 & Ferguson 2008) and other industries (for example Lauder 2012, Beale 2009, HSE 2006, 2011a, 2011b, IAEA 2000).

The group held several sessions each focusing in on one of the following agreed subject areas; leadership, culture, process safety, competence, audit and compliance. The team collected all indicators in use at participant companies and others that representatives were aware of.

135 different indicators were recorded with the following noted for each in an Excel spread sheet:

- The SPI;
- The organisation using it;
- Background;
- What it is measuring;
- Typical sources of data;
- The status of the SPI (new, embedded or discontinued);
- Frequency of reporting;
- The amount of effort required to produce the report;
- Target stakeholders;
- Method of presentation;
- Does this indicator influence the actions of target stakeholders?
- How easy is it for senior management to influence the indicator;
- Safety and other business benefits;
- Problems or challenges.

Microsoft Excel was chosen rather than something more advanced to ensure that the information was accessible to all sizes of organisation.

The maturity of the indicators varies. Some have been recently introduced and their value not proven and there are others that have stood the test of time.

The group considered the amount of effort required to collect the data, the ease of verification (during an audit for instance) and the impact on management when presented. They had to be credible, compelling and drive improvement.

The spread sheet looks like this:

TYPE OF PEOPLE, PROCESS OR PLANT INTEGRITY	SPI CATEGORY	SPI	STATUS OF SPI (Is it new, embedded or discontinued)	SAFETY BENEFITS AND OTHER BUSINESS BENEFITS	PROBLEMS OR CHALLENGES	BACKGROUND/CONTEXT	TYPICAL SOURCES OF DATA	HOW MUCH EFFORT IS REQUIRED TO PROVIDE THE REPORT? (Scale 1 - Easy, 5 - Fully automated, 10 - None automated, 15 - High data manipulation and consolidation required)	HOW IS THE DATA PRESENTED TO MANAGEMENT?	HOW EASY IS IT FOR SENIOR MANAGEMENT TO REFERENCE THE INDICATOR?
PEOPLE	Leadership	Rotation of senior management posts completed (months)	Embedded	1. Demonstrates to the workforce that the business are interested and care. 2. Promotes an understanding of the industry issues to the Directors. 3. Improves communication and trust. 4. Directors can challenge the standards and promote improvement in the workplace. Improved communication and trust helps all aspects of the business.	The challenge lies with the management team having sufficient time to undertake the inspection, audits and visits.	This is about completion of one monthly workplace visit, audit or inspection by each director. The visibility, leadership and standard setting achieved by senior management through people oriented, multi-disciplinary, participative, multi-disciplinary, inspections and audits.	Director's calendar/monthly	Completed each director monthly. Medium	Number of hypothetical HSE and safety incidents with a traffic light.	Requires complete commitment of directors.
PEOPLE	Leadership	Leadership stability (Number of talk with discussions completed)	Embedded	There are about 1000 'talk with' discussions at the workplace recorded per month. This has improved the safety culture and workplace standards. Improvement in the safety culture has a knock on effect on quality.	Difficult as it requires extensive training programme and a high commitment. Keeping the programme going and the safety discussions to a high enough quality. If talk with programme will spend £100,000 per month.	This is about completion of 4 talk with discussions monthly by directors, managers, supervisors and other personnel. 100 people have been trained to undertake discussions at the workplace on how safety can be improved through individual competence and responsibility for themselves and others.	Individual senior discussion on a data base	Report (collation) every 6th month. Data base set up. Easy	Data provided associated with numbers and traffic lights. Periodic reports on the type of safety issues discussed. Logging of the 1000 top priority safety talk with discussions to programme.	Easy
PEOPLE	Leadership	Local safety meetings chaired by Managing Director	Embedded	Shows Leadership and commitment.	None	MD should chair all safety meetings to demonstrate commitment.	Minutes of meetings	Easy	Traffic lights and charts	Easy

Figure 2. Extract from the Forum SPI spreadsheet

Some of the 135 SPIs were very specific to an organisation, were difficult to manage, had overlap or were of less value. However, we did not want to lose this information and so these were placed into a 'Reserve List'.

The remaining 80 SPIs were organised into separate sheets within Excel as follows:

- People (leadership, resources, culture, training and competence);
- Processes (incident reporting, audits, procedures, risk assessments, alarms, contractor safety, emergency preparedness, management of change, permits to work, waste, etc.);
- Plant Integrity (planned and reactive maintenance, workplace inspections, safety critical equipment identification).

The Excel tabs look like this:

3	PEOPLE	Leadership	Number of talk safe discussions completed	Embedded	Improvements in workplace standards
4	PEOPLE	Leadership	% of safety meetings chaired by Managing Director	Embedded	Shows Leadership

Figure 3. Detail from SPI spreadsheet.

## Extracts from the database

### People

#### Leadership

Senior management (Executive level) safety engagement is being measured at several sites, by auditing workplace visits or delivery of 'toolbox' safety talks against a target set by the board. The quality and effectiveness of these visits is very hard to assess but felt to provide value. To be fully effective, management must also be supported by active promotion of a process safety throughout the organization by being given time and resource to listen to message from the workplace and take action.

The key benefits from visible Senior Management engagement in safety were felt to be:

- Demonstrates to the workforce that the Directors are interested and care
- Promotes an understanding of workplace issues to the Directors
- Improves communication and trust
- Directors can challenge the standards and promote improvement in the workplace

#### Safety Action Close Out

Measurement of 'safety action' close out against action raised during inspections, is used widely across many participants. These can range across workplace, company and national regulator inspections, and are usually time bound for completion.

Safety actions are raised from many sources, and every action closed should make the organisation a little safer. A falling close out rate is a strong indicator of a wider problem.

#### Safety Culture

Determining the workplace safety culture through employee surveys or observational studies has proved very difficult and can be very subjective (influenced by employee short term dissatisfaction). Some of the larger organisations in the forum have used Pulse type surveys and the HSL / HSE Safety Climate tool questionnaire approach.

#### Training and Competence

There were very many attempts to find suitable measures, with over twenty options being explored. Monitoring training attendance and 'knowledge' is relatively easy! Measuring competence and attitude is very difficult. Most companies had a variety of measures for SHE training attendance (operators) and SHE training delivered (management). Where suitable HR resource is available then an audit of operators training records against assigned job responsibilities and activities can be done.

Initial and 'refresher' training delivery was measured across all Organisations. This can be through formal classroom session, hazard demonstrations or 'tool-box' talks.

The approaches taken to measuring competency performance can be grouped together as;

- % staff rated / assessed to be 'competent'
- % staff who have had competency assessment
- % availability of suitably competent staff / supervisors

## Process

### *Near Miss Reporting*

Near miss reporting was one of the few measures with universal appeal and existing recording systems, as a key source of information from the 'base' of the accident pyramid. This acts as a very powerful leading indicator however the Forum found that where targets for the number of reports have been set then this can generate trivial reports that obscure more serious incidents. Specific Near Miss indicators have been defined such as:

- Failure to wear correct PPE
- Observation of unauthorised activities
- Number of Loss of Containment incidents
- Lack of valid risk assessment
- Number of near misses linked to Major Accident Hazards

The Near Miss reporting system can also be mined to help root cause analysis, and where past accident studies have identified common causes these can be investigated separately.

Recording Lost Time Accidents (LTAs) and Accident Frequency Rates acts as a Lagging indicator, for a small organization (or using a small dataset) one-off minor accidents, such as slips, trips and falls, can skew the value. However the link between Near Miss reporting and LTAs has not proved to be robust when used as an indicator. The reliance on accident data in the past has distracted organisations from fundamental issues of process safety (Baker (2007)).

At the level between Near Miss and Minor Incidents – Loss of Containment incidents were selected to add detail to near miss reporting. Where a process involves hazardous materials then a loss of containment is a very common precursor to a major accident.

Timely investigation of incidents is used as an indicator within one organisation, this helps prioritise actions to prevent serious incidents in the future.

### *Risk Assessments*

The maintenance of a Risk Assessment review schedule with indicators based on meeting a required number or proportion of reviews was another 'universal' indicator. The terminology and the management systems differed between participants, depending on their access to database and document management systems.

Indicators used for monitoring performance for maintenance of 'suitable and sufficient' risk assessments' are:

- % of reviews completed to schedule
- % of hazardous activities assessed
- % of Risk Assessments beyond review date

A large number of reviews present a challenge, prioritisation of assessments into low, medium and high risk can be used to spread the burden.

### *Procedures*

Operating procedures and method statements should reflect the controls determined by the risk assessment process. A very similar suite of performance indicators are used for procedure and method monitoring:

- % of reviews completed to schedule
- % of hazardous activities with suitable procedures
- % of procedures beyond review date
- Compliance of workplace to procedure

### *Audit*

A high quality audit scheme is needed to demonstrate compliance with safety standards, procedures and housekeeping. Audit scores (running averages and trends over time) and the completion of audits to schedule provide key performance indicators.

### *Contractor Safety*

Only two companies have defined indicators for the performance of contractor safety, both relying on auditing by the company of the contractor. One company reaches a safety performance score by observation of adherence to method statements in the workplace and the other measures incidents with contractors as causal factor. Checks are also made of a contractor's safety certification and equipment.

### *Emergency Preparedness*

Although not an accident prevention barrier, the quality and rapidity of emergency response can mitigate incidents and prevent escalation. Several companies have indicators based on adherence to exercise schedule for fire and evacuation response.

### *Management of Change*

The development of SPIs around Management of Change was judged difficult by all the participants. All relied on an audit of the process, some examples are given below:

- Number of changes in-line with procedure
- % of audits carried out to schedule
- % of changes that were unauthorised
- % of changes where control measure found inadequate

The audit is post change so a lagging indicator, and also resource intensive. As Management of Change has been identified as a critical element in several major incidents the forum is keen to bring it forward to a leading indicator.

### *Permits to Work*

The performance of the permitting system is assessed by an audit review of permits in place or after 'completion'. As with all the measures that rely on collecting data through audits and inspection this requires a significant input of time by competent assessors, examples are given below:

- Score from audit of permits – correctly issued, signed, returned and closed
- Number of incidents arising from permit to work failures

## **Plant Integrity**

### *Planned Maintenance*

Where the Forum companies maintained a Planned Preventative Maintenance (PPM) management system this provided a rich source of data for developing metrics:

- Outstanding tasks
- Overdue priority (safety critical) items
- Service schedule adherence
- Calibration schedule adherence for instruments
- Availability of essential spares

Several companies run campaign or batch type processes where pre-run / pre-operation inspection scores can be used instead of a PPM schedule.

The explosives industry has been through phases of expansion and contraction in the past, and in general is operating ageing plant across a shrinking number of sites. The management of ageing plant is central to maintaining safe operation; alongside PPM the use of Non-Destructive Testing (NDT) inspection to determine integrity of assets can provide very valuable indicators. Where an asset has an expected rate of change for integrity (e.g. wall thickness or vibration) NDT results can feed directly into a graphical plot of results (change over time) identifying out of tolerance results immediately.

### *Reactive Maintenance*

The performance of the PPM system may also be monitored through availability measures however setting a suitable benchmark across new and old equipment can be difficult. Examples from the database are given below:

- Time to Repair
- Lost Time
- Breakdown rate (unplanned outages)
- Failure to function on demand (alarms & safety systems)

Reactive or unplanned maintenance carries additional pressures and risks compared to planned maintenance.

### *Safety Critical Equipment Identification*

Identifying safety critical features of operational assets is fundamental to a comprehensive PPM and calibration schedule. Performance indicators suggested are the creation of a Safety Critical Equipment list, and the on-going percentage of Safety Critical Equipment with an up-to-date process safety review (such as Failure Modes Effects and Criticality Analysis).

### *Workplace Inspections*

A wide range of measures are in place for indicators classed as workplace inspection. These are measures derived from an independent view of local (manufacturing cell or team) safety performance. They are broad and cover such things as:

- Number of inspections completed to schedule
- Quality of housekeeping
- Inspection score
- Number of adverse reports from inspection
- All equipment meets specification
- % actions from previous inspections completed on time
- Statutory inspections up-to-date

## **Discussion**

The Forum discovered that:

- ‘Leading’ indicators, those that measure pre-cursors to incidents or near misses, are harder to collect – they can take a lot of time and effort; we are trying to develop measures to identify the early signs for very low probability incidents. Most leading indicators require proactive collection of data, such as audits or inspections. Leading indicators are also often measuring against a poorly understood target. Even where legislation sets a target, such as review of risk assessments, is this appropriate for the process?
- It is very difficult for an external group; for example, corporate auditors, to verify SPI data. Reporting bias (good news) can often lead to conscious or unconscious skewing of targets, data and analysis;
- Setting targets for lagging SPIs is a problem. It is a little easier for leading indicators (but harder to verify that target performance has been achieved). How many near misses or minor injuries (LTAs) are acceptable? Setting targets can lead to trivial reporting to meet the quota, e.g. near miss reporting targets;
- It is more difficult to implement SPIs around ‘people’ issues. Behavior tends to change when observed. Surveys and questionnaires are costly and time consuming; they are also open to short term influence, such as disputes around pay or recruitment. Training (attendance and understanding) is a lot easier to measure than competence (performance ‘on the job’);
- The amount of resource required for SPI implementation and data collection is significant and therefore it is important to implement those that provide the greatest impact.

We discussed the possibility of having one or two common indicators that could be collected and reported by each business to provide the basis for benchmarking and comparison but, at the time of writing, this has not progressed.

## **Presentation of the indicators**

A strong visual display was used by all the Forum participants to present SPI reports. A combination of ‘traffic lights’, charts and line graphs have been used, depending on the nature of the data. The use of colour coding in combination with trend lines can highlight the difference between an improving reducing trend and a worsening reducing trend. Poor scores are largely accompanied with narrative to provide additional detail and highlight remedial actions.

## **Summary**

The purpose of this exercise was not to prescribe SPIs; it is for the individual company to consider what might work best for them.

We aimed to:

- Provide the explosives industry with a database and thereby inform the practical implementation of SPIs;
- Encourage wider adoption of SPIs among industry.

When considering the adoption of a set of PSPI the following should be taken into account:

- Do you collect this data (or something similar) already?
- Who collects the data – is it independent?
- How and by whom can the SPIs be influenced?

The choice of SPIs may need to change over time, either because the indicator stays persistently healthy (not a good sign) or the activities across the organisation change. All the participants found difficulties with setting and monitoring some SPIs, especially for human factors.

The data base is freely available and can be obtained from a group participant company or from the UK HSE Explosives Industry SPI Web Community site.

[http://webcommunities.hse.gov.uk/connect.ti/explosives/?](http://webcommunities.hse.gov.uk/connect.ti/explosives/)

New users need to register to gain access to the page hosting the database. This can be found under the link to Safety Performance Indicators.

The group continues on a correspondence basis and would welcome additions, corrections or observations.

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