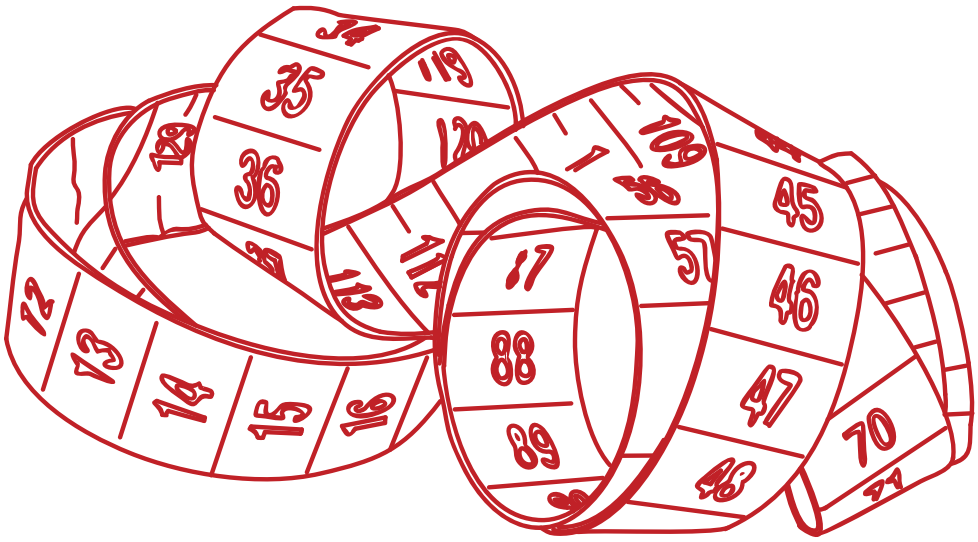

Process safety:
how do you measure up?

Use of process safety performance indicators is on the increase and likely to continue that way. **Wahid Azizi** discusses how best to approach implementing a PSPI programme

IF you want to improve reliability, profitability and safety (and who wouldn't?), then think about implementing a process safety performance indicator (PSPI) programme. Most people know about business performance indicators such as KPIs (key performance indicators). The concept is widely used across the different business sectors and has been for many years. Recently, however, this concept has been extended to process safety (in the form of similarly-named PSPIs), with some companies reporting positive results[1].

why PSPIs?

Major incidents such as the US Texas City Refinery explosion in March 2005, which killed 15 workers and injured 170, have led to calls for process safety KPIs. In this particular disaster, safety performance was assessed solely through measuring *occupational safety* ie the number of slips, trips, sprains and strains. This gave a false impression on the overall safety performance of the organisation and was found to be a contributory factor to the disaster.

As also discussed in {Gary Pilkington's article, see page xxxxx} it's now widely recognised that performance in occupational safety is not reflective of performance in process safety; the two are separate types of risks. PSPI programmes allow for effective monitoring of process safety performance; they give relevant and useful information to facilities about their process safety management systems. This is because a PSPI programme can produce predictive signals and give early warnings of a dangerous deterioration of critical systems. This enables the organisation to foresee the likelihood of a serious incident and take corrective actions before it's too late.

Organisations can also use PSPIs to benchmark process safety performance across their production facilities, or compare their entire process safety performance against other companies in the same industry.

What's more, is that PSPIs can give

Most people know about business performance indicators such as KPIs (key performance indicators). Recently, however, this concept has been extended to process safety (in the form of similarly-named PSPIs)

Although PSPIs are not a particular requirement of existing legislation, health and safety regulators like Britain's Health & Safety Executive (HSE) are already demanding a PSPI programme from major accident hazard (MAH) sites

The barrier-based approach is more suitable for systems because it provides more bespoke indicators.

valuable information to *all* parts of an organisation – from board-level through to plant managers, who are all seeking assurance of safe operation.

From a legal perspective, the drive to implement PSPI programmes is growing stronger and likely to increase in the future. Although PSPIs are not a particular requirement of existing legislation, health and safety regulators like Britain's Health & Safety Executive (HSE) are already demanding a PSPI programme from major accident hazard (MAH) sites[2]. Moreover, the updated version of the legislation (ie Seveso III) goes further in citing "safety performance indicators" in monitoring performance.

what resources are available?

There are currently five practices or standards giving guidance on PSPIs:

- HSG254, *Developing process safety indicators, A step-by-step guide for chemical and major hazard industries*, HSE, 2006;
- *Process Safety Leading and Lagging Metrics*, Centre for Chemical Process Safety (CCPS), revised edition, January 2011;
- *Process Safety Performance Indicators for the Refining and Petrochemical Industries*, American Petroleum Institute (API), RP 754, 1st edition, April 2010;
- *Process Safety – Recommended Practice on Key Performance Indicators*, International Association of Oil & Gas Producers (OGP), Report no 456, November 2011; and
- *Guidance on Process Safety Performance Indicators*, CEFIC, 2nd edition, May 2011.

These practices feature two distinct approaches – the barrier-based approach (given by HSG254) and the tier-based approach (given by CCPS and API standard and adopted by OGP and CEFIC guidance).

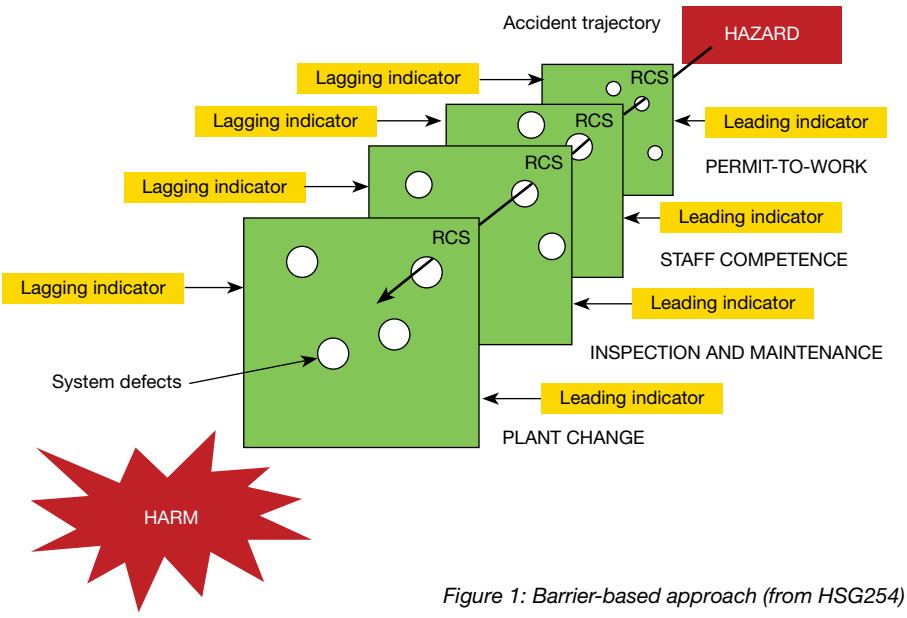

Figure 1: Barrier-based approach (from HSG254)

tier-based vs barrier-based

In the barrier-based approach, major process safety risks are identified first, followed by a study of their causes and the safety barriers that guard against them (also known as RCS – risk control systems – in HSG254). Leading and lagging indicators are then defined around these barriers (see Figure 1). The result of this exercise is that each barrier will have leading and lagging indicator(s) to measure its effectiveness in managing the process safety risk(s) identified. The leading indicators give early warning of dangerous deterioration of the barrier, ie the likelihood of an incident in the future due to the failure of the barrier. The lagging indicators say something about the barrier's historic performance in averting process safety incidents.

The tier-based approach essentially places all process safety events and related activities onto the *safety pyramid* (See Figure 2). The highest part (the smallest part) of the pyramid represents the worst of process safety incidents and near misses and these are deemed as lagging indicators. Lagging indicators are retrospective and say something about an organisation's historic process safety performance. The lowest part (the widest part) of the pyramid represents the challenges to/and effectiveness of

safety systems, and are deemed as leading indicators. Leading indicators are forward-looking and say something about an organisation's likelihood of having process safety incidents in the future.

obtaining lagging indicators

The barrier-based approach identifies three steps to obtaining the right lagging indicators: identify the barriers for the process; using these barriers, state the 'desired safety outcomes'; and define the lagging indicators based on whether the desired safety outcomes are achieved.

For example, a bulk storage and transfer process may be vulnerable to overfilling which could lead to loss of containment and maybe even a large fire. One of the safety barriers identified could be *staff competency* due to the manual nature of the process. The desired outcome is to no have safety incidents linked to staff competency, and so the lagging indicator(s) are chosen based on this desired outcome, for example: "*Number of times product transfer not proceeded as planned due to errors made by staff without the necessary understanding, knowledge or experience to take the correct actions*" .

The lagging indicator therefore gives information on the historic effectiveness of the staff competency barrier. When this indicator is implemented in a PSPI programme, it will show how effective this barrier is and the continuous count (ie incidents) triggered by the PSPI programme should drive the plant to address the issue.

In the tier-based approach, lagging indicators are the tier 1 and tier 2 process safety events (PSEs) on the safety pyramid. Tier 1 and tier 2 PSEs are defined with precision in the standards. Tier 1 PSEs include:

"*An unplanned or uncontrolled release of any material... from a process that results in one or more of the consequences listed below:*

days away from work, injury and/or fatality for an employee, contractor or subcontractor;

an officially declared community evacuation or community shelter-in-place;

a fire or explosion resulting in greater than or equal to US$25,000 of direct cost to the company..."

Therefore, obtaining lagging indicator(s) when using the tier-based approach is akin to picking an indicator 'off-the-shelf', as it has a precise definition. The advantage of this is that it enables benchmarking. A company may find this especially insightful when comparing its own facilities with one another, or indeed comparing itself as an entity to the rest of the industry.

The standards also give formulae for calculating performance much like the well-known TIR (total incident recording) used for occupational safety, ie:

Tier 1 PSE rate = Total tier 1 PSE count
Total work hours x 200,000

There are some aspects of the definitions given in these standards that should be reviewed for applicability to industries outside of the petroleum industry. Two questions that should be asked are:

- are all the listed consequences that qualify for a PSE (Tier 1 or Tier 2) present in the industry in question? For example, does the industry in question have a community shelter-in-place?
- are the financial losses and definition of acute releases (ie the one hour rule) conservative enough and representative of the typical types of incidents?

obtaining leading indicators

The barrier-based approach involves two steps: identify the 'critical parts' of each safety barrier, and then base leading indicators on whether the barrier is performing as intended; and set a tolerance level (or action trigger level) for each leading indicator. For example, at what stage of the deterioration will an action take place to remediate?

Revisiting the example of the storage and transfer process given earlier; leading indicator(s) are chosen based on the critical part of the safety barriers. The critical part of a staff competency safety barrier would most likely be training completion and

Obtaining lagging indicator(s) when using the tier-based approach is akin to picking an indicator 'off-the-shelf', as it has a precise definition. The advantage of this is that it enables benchmarking. A company may find this especially insightful when comparing its own facilities with one another, or indeed comparing itself as an entity to the rest of the industry.

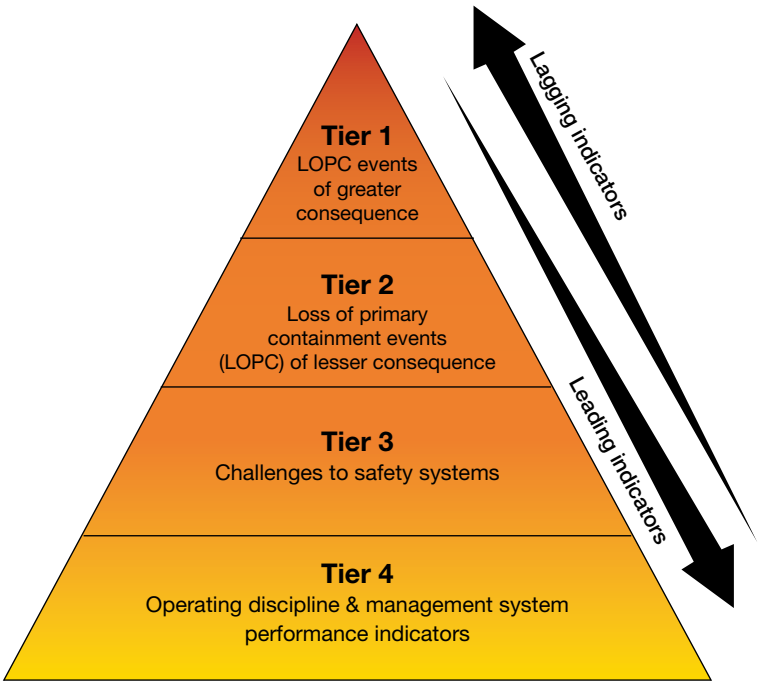

Figure 2: Safety pyramid for PSPIs (from API RP 754)

Staff competency may be an important process safety barrier in manual operations and so monitoring performance is essential

competency evaluation on the job, so the leading indicator may be phrased: *"Percentage of staff involved in product transfers who have the required level of competence necessary for the successful transfer and storage of products."*

Therefore, this leading indicator can give an early warning before an incident is linked to staff competency.

The tolerances are then set and may be zero (ie absolutely no deviation), which means complete and continuous performance is required. In this particular case, the percentage of relevant staff completing training and competency evaluation could be set to 100%. Any number lower than 100% must trigger a management response. Tolerances should be in alignment with senior managers' expectations and intervention strategy.

In the tier-based approach, leading indicators are tier 3 and tier 4 process safety events and activities. Suggestion for tier 4 indicators include:

- *training completed on schedule: percentage of process safety required training sessions completed with skills verification; or*
- *safety critical equipment inspection: percentage of inspections of safety critical equipment completed on time."*

It can be seen that there is overlap between tier 4 indicators and the barrier-based approach.

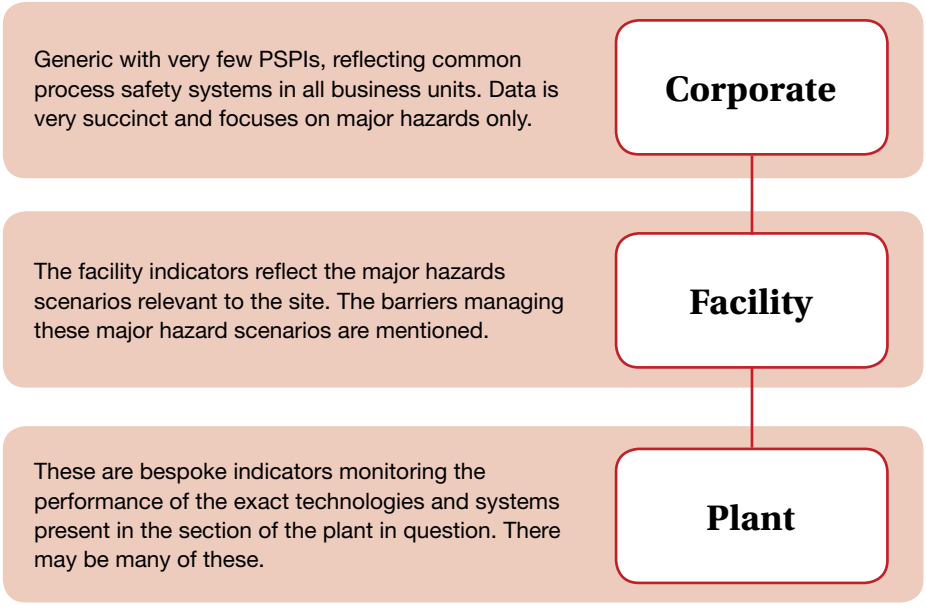

Figure 3: A hierarchical PSPI programme for a multi-site organisation

Although bespoke indicators are useful at the facility level, they can be very difficult to use for benchmarking at corporate level due to inapplicability. Conversely, generic benchmarkable indicators are more useful at a corporate level yet less useful at the facility level

striking a balance

The call for PSPIs in the process industry is growing stronger and is being reinforced by regulatory bodies. There are presently two approaches in developing and selecting PSPIs. The barrier-based approach is flexible and in-depth, which will result in a better set of indicators at the facility level because it leads to more bespoke indicators. The tier-based approach is generic and whilst less flexible, it can lead to a set of more benchmarkable indicators.

Although bespoke indicators are useful at the facility level, they can be very difficult to use for benchmarking at corporate level due to inapplicability. Conversely, generic benchmarkable indicators are more useful at a corporate level yet less useful at the facility level.

Given this, a balanced methodology between the two approaches should be adopted across an organisation (see Figure 3). This will enable organisations to benefit from an effective PSPI programme at the facility level while also providing useful information for benchmarking at corporate level. tce

Author credit name in bold (name@email.com), is a xxx at xxx

further reading:

1. Sedgwick, M, et al, *Scottish Power Goal: to make Process Safety risks as visible as Health and Safety Risks?*, ScottishPower, February 2012.
2. COMAH Competent Authority Workstream 2e, Process Safety Performance Indicators, HSE.