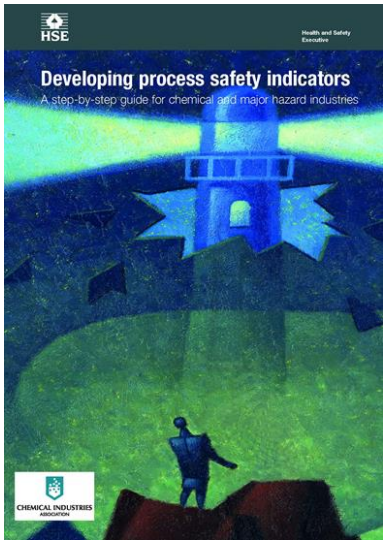
Implementing KPIs to improve process safety performance
Background Notes

Overview



- Operators should adopt systematic approach to managing process safety risk,
- This should be based on an acknowledged process safety management framework,
- Management of process safety risk is not static but dynamic and process safety is never fixed or a done deal,
- Process safety activities such as risk assessment, plant/process design, build, recruiting and training staff and implement systems is never enough as systems deteriorate – so a way to monitor the effectiveness of key elements of process safety management system is needed,
- Auditing is usually too infrequent and often not outcome based,
- Organisations don't need KPIs to monitor everything – focus on a few vulnerable aspects,
- The practice and knowledge on how to develop KPIs is now well established and understood,
- HSE's regulatory expectation for COMAH sites is that they:
    - have a programme for process safety KPIs – as one of the main ways the adequacy/performance of PS risk is being managed,
    - KPI's linked to Leadership and used to inform high level decision making ,
    - KPIs set according to the risk profile of the activities / process,
    - Have both Outcome (lagging) and Activity (leading) indicators,
    - Use the findings from KPIs used to drive improvements on site,

Key Points

Most organisations struggle to come to terms with how best to implement a KPI programme. Typically, this process involves the following stages, and can take up to 3-5 years:

- Discovery and exploration;
- Consideration of Practicality;
- Realisation of Broader issues;
- Detailed Analysis of Options;
- Pilot implementation;
- Review and Full Implementation.

Features and Types of KPIs

- Indicators should be set to reflect the main process safety vulnerabilities,
- focus on what is likely to go wrong most quickly and with the greatest consequences. All process safety management systems deteriorate over time,
- especially where the process involves or relies upon human intervention,
- It is crucial to review the risk profile of the process activities and pinpoint these vulnerabilities.

HSG 254 relies on using the key words – 'what could give to a loss of containment?' onto a process flow map. Typically for chemical industries these challenges to integrity are:

- High pressure/ Low pressure,
- High temperature / Low Temperature
- Overfilling of vessels and tanks
- Corrosion – internal and external
- Wrong substance added / wrong additional rate (incompatible materials/substance reactions or exothermic reaction)
- Accidental Release:
    - in normal operations (failure to close valves, opening when system still charged)
    - during maintenance
- Physical Damage

From this vulnerability profile apply the James Reason 'Swiss cheese model' to identify barriers or key process safety control and mitigation measures. It's often helpful to organise them as a 'bow tie'. To establish a clear hierarchy and hence which KPIs closest and most critical to securing the desired safety outcome.

- Its very important to select indicators that, in the main, directly show how well the systems are working in practice, i.e. those linked to process controls.

Typically we identify three different types of indicator:

1. **Process Operational Indicators**, e.g.
    - Meeting designed process conditions:
        - Temperature
        - Pressure
        - Level
        - Flow, etc

2. **Generic Indicators** – not aligned to a particular process but covering a generic process safety issue; eg
    - Activation of Protective Safety Devices/Equipment
    - Plant Design
    - Plant change
    - Permit to work
    - Emergency arrangements
    - Management of contractors,

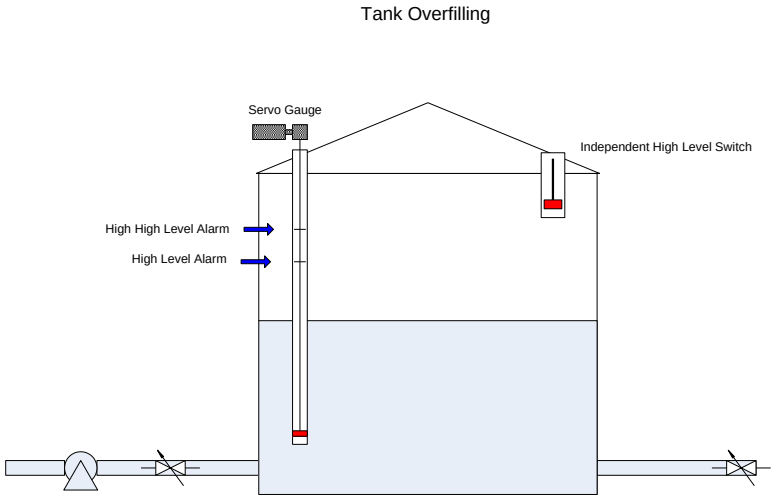
3. **Programme Indicators** – not directly related to controlling risk but monitoring completion of programmes, eg:
    - Completion of training programmes
    - Completion of safety tours
    - Completion of audit programmes
    - Completion of audit inspection items

For each of the fist two categories both leading and lagging indicators can be set against each aspect. These ‘matched pairs’ of leading and lagging indicators for each aspect provide two sources of data as ‘dual assurance’ that the system is working as intended.

- Category 1 indicators typically give rise to an outcome (lagging) indicator that shows whether the process condition is being met,

- activity indicators (leading) relate to two aspects – the functioning of instrumentation and sensors that monitor the process condition and correct completion of key actions by personnel involved in that stage of the process. This is easily explained by way of an example.

Tank Filling: Buncefield as example of setting KPIs



The risk to a loss of containment is – failure to correctly manage the liquid level in the tank.

When setting 'outcome' indicators use the guide words/stages:

- Is there agreement on what the desired successful outcome from the activity?
- Can the outcome be readily detected? If not, it can't be measured
- Is the information/data on the outcome already recorded, captured somewhere? This makes its adoption as a KPI easier.

The key point about outcome indicators is that they reveal no direct information on the cause of the outcome. Adverse outcomes therefore need to be reported and investigated to find out why, and what went wrong. This may touch on cultural issues within an organisation as reporting failure may not be welcomed or rewarded.

Process Control Indicators

- The outcome (lagging) indicator is whether the desired/intended level is always achieved when filling (this level can of course vary but will always be predetermined before the tank is filled (hopefully!)

- The metric becomes – *the number or percentage of tanks that were filled beyond the intended level.* The period can be any length of time eg per week, month, year, etc.

The safety success parameter should preferably be set the same as the process/business success parameter, as too much in a tank for whatever reason always indicates a process problem/ error and provides an opportunity to learn about what gave rise to that error.

- The metric **should not** be '*the number of times the tank is overfilled until a loss of containment occurs*' (eg over topping) as this is way too late in terms of picking up on systematic failure.

- The metric **could be** '*number/percentage of tanks filled to the high level alarm*' as these will be less frequent events and perhaps easier to identify

when such an adverse or un-intended outcome has occurred. But this metric is not as advantageous of *'filled beyond the intended level'*.

- The first activity (leading) indicators would be '*whether the instrument, in this case the tank level gauge, sensor and control room readout system is inspected and maintained to the appropriate schedule'*.

Note: many organisations simply focus on capturing inspection or maintenance of alarms or shut down systems as being safety critical, whereas the real critical item, as with Buncefield, is the functioning of the tank level gauge.

- Taken across an organisation as a whole if level control is critical (as it is at tank farms) the metric would be '*the percentage of tank gauge instrumentation systems inspected and maintained to schedule'*.

If pressure control was the dominant risk then it would be '*pressure sensors/indicators'* etc.

A second and just as important activity KPI relates to the completion of the correct action by operators to achieve the desired successful outcome. There will be lots of operator actions, probably all recorded in safe operating procedures, SOPs. Some analysis is needed to work out which is more important.

Again guide words can help:

- Which actions are done frequently, and perhaps needed every time the task is undertaken?
- Which are closest in time to achieving the desired outcome?
- Which allow for some degree of variation or personal judgement?

So for the tank filling example these may include:

i. Select the tank with the right design specification for the product
ii. Work out the tank head space (ullage) before filing the tank
iii. Design the flow route, valve sequence to get the product to the selected tank,
iv. Set the tank alarm levels on the control system
v. Set the correct flow route valves/ connections
vi. Open the valves in the right sequence, start the pumps
vii. Monitor the change in level
viii. Close off the pumps when at the desired level

So the most critical would be ii, iii, v and vi.

- But actually the metric would be '*when checked (by observation) the percentage of critical tank level control actions completed correctly'.*

Collection of this metric data could be by a period sample check for each key operator undertaking these activities. So for instance every operator is checked at least annually – more frequently if new or the tasks are very critical. This KPI is much more useful than measuring how many operators have been trained in the process or indeed how many tasks have appropriate SOPs (up to date etc).

Examples of Generic Risk Control Indicators

Generic risk control indicators typically relate to site-wide control systems rather than those covering specific operational processes. Typically the outcome indicator could be whether there was a loss of containment or adverse consequence relating to the activity.

- *For instance for Plant Change' it would be to detect whether the desired improvement achieved, plant process decommissioned without incident etc.*

The same would apply for a permit to work system eg:

- *To detect whether there any unplanned loss of containment or energy release associated with the work*.

The activity measures (leading) again based on critical task analysis, typically would be a retrospective check (audit) to see that the correct authority was given to the change or for the PTW maintenance work to go ahead, and or was the change implemented according to the approved design, or for PTW were the correct isolations made.

Sometimes, it is not possible to set an outcome measure (lagging KPI) for a generic control system, for example emergency arrangements. This is because a 'successful outcome' for a mitigatory measure is always that less harm was done in the event of an emergency than would have been the case had the measure not been in place. In such circumstances activity measures become much more critical.

Once again the activity (leading) indicators would typically be measured during drills and tests of the emergency arrangements e.g. whether critical actions within the emergency plan were undertaken correctly.