HID Instruction: Assessment of Key Performance Indicators During Inspection/Investigation

Open Government status Fully Open

Target audience HID Inspectors

Summary

This instruction complements the HID Regulatory Model – Safety Mangement in Major Hazard Industries. It gives further detail on the check, measure and review elements of a Major Hazard Management Systems (MHMS) and defines HID's operational expectations for the assessment of dutyholder Key Performance Indicators (KPIs)[1] during inspection and investigation.

Introduction

Risk control systems tend to detioriate over time. This can go unnoticed, particularly in the case of MHMS where deterioriation may not have an obvious impact on day-to day site operations. For example, failure to maintain a pressure relief valve on a vessel will probably not affect normal operation but could lead to catastrophic failure during a process upset.

It is good practice to use KPIs to proactively detect weaknesses or failures within the critical systems of an MHMS. This enables remedial action to be taken before, rather than in the wake of, a major accident. Without this information, operators in major hazards sectors cannot demonstrate that their MHMS is effective.

Action

The use of KPIs is no longer a new or novel concept and should become an integral part of HID's onsite regulation. In some cases KPIs have been inspected as a standalone topic, however, the expectation now is that dutyholders have integrated the use of KPIs into their MHMS. Consideration of the adequacy of the KPIs used to monitor the key elements of a MHMS should therefore be an integral part of HID's consideration of the adequacy of duty holder's management of risks.

Where larger or more sophisticated businesses are undergoing significant changes or mergers, or the business is displaying leadership failures, it may be appropriate to plan for a standalone KPI intervention.

Inspection HID inspectors should evaluate how well duty holders are managing their principal risks. This will involve the targetted testing and sampling of risk control measures. As part of this process inspectors should establish whether, at a senior management level, the dutyholder:

- is gathering information to show how their key control systems are performing

[1] Also can be called process safety performance indicators (PSPIs) as in HSE publication HSG 254.

- understands the importance of the information collected, and
- is using this information to make the appropriate management decisions

Investigation HID inspectors should test whether key elements of risk control, e.g. protective or mitigatory barriers have failed. Inspectors should establish whether KPIs were being used to monitor them. If so, they should check:

- the usefulness of the information received, e.g.
    - were they measuring the wrong things e.g. parameters where there is no 'line of sight' to a credible major accident scenario,
    - was the indicator too far removed from the critical control, e.g. competence being measured by training courses attended rather than assessment of critical staff against clear competence criteria,
    - was the indicator set against frequent enough events to give useful information, and
    - was the indicator tolerance appropriate e.g. KPI set against damaging excursions beyond design tolerance of plant
- in cases where the KPI was appropriate, were safety decisions being made based on the information received?

Regulatory Context

Where KPIs have not been set or where KPIs exist but are not effective, this should be considered in the context of the wider major hazard management arrangements, for example:

- Is this part of a wider issue? If there are no KPIs in the majority of the critical control areas and there are no other effective means of monitoring performance, this indicates that significant weaknesses exist in the MHMS. Inspectors should consider raising this as a formal issue requiring follow up enforcement if appropriate.
- Are the lack of KPIs part of other managerial failings identified that are sufficiently serious to require enforcement?
- If KPIs are being monitored but findings are not acted upon, this suggests leadership failures. KPIs are a means to an end, not an end in themselves and senior management may need to be reminded of this.

For further information, see:

- Appendix 1 for further detail on assessing KPIs.
- Appendix 2 for scoring
- Appendix 3 for KPI case studies

Monitoring of how risks are being controlled is also a requirement of the Management of Health and Safety Regulations 1999. The use of KPIs is now established practise in major hazard industries and therefore is a regulatory expectation.

COMAH - Schedule 2, paragraph 4(f) requires effective monitoring as part of a Safety Management System.

Organisation

Targeting: Which sites/elements to inspect will be informed by the prioritisation methodologies, the assessment process and in year planning.

Timing: Inspection of KPIs as an integral part of HID's inspection and investigation activity should commence 1 April 2015**.**

Resources: The assessment of KPIs should be done by regulatory inspectors, however specialist input may be required if technical concerns are found .

Further References

HSG 254 Developing Process Safety Performance Indicators – A Step by Step Guide

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Appendix 1:

Assessing the quality of KPIs whilst inspecting a particular major hazard risk, piece of equipment or control system

Assessing KPIs when inspecting a particular major hazard risk

Step 1. Identify the challenges to integrity, what can go wrong
Step 2. What risk control systems would you expect to be in place?
Step 3. From the risk control systems in place, we would expect KPIs against the critical elements/most important part of these RCS, ie the controls that support:

- Activities or operations that must be undertaken correctly on each and every occasion
- The aspects of the control systems liable to deterioration over time
- Controls that are a last line of defence
- Activities undertaken most frequently
- Activities which involve human intervention at safety critical points

This can be worked out in the office as part of the inspection planning process, with the gaps being filled by asking relevant questions on site. KPIs should have been set against these critical elements.

Assessing KPIs when inspecting a safety critical piece of equipment

Step 1. What could go wrong with the piece of equipment you are inspecting, e.g. over/under pressure, overfilling, corrosion, mechanical failure, impact etc.
Step 2. Think about how these challenges could occur, eg inspection or maintenance on safety critical instrumentation not being done to schedule, safety critical tasks not being carried out by operators correctly
Step 3. Use this information to identify the critical aspects of control.
Step 4 We would expect indicators to be set against the critical tasks to maintain the function of the equipment, instruments etc. This would normally involve inspection, testing, repair and calibration.

Assessing KPIs when inspecting a generic risk control system: Example: Permit to Work

Step 1. Work out/ask company why the control system is in place, eg

Q. Why is a Permit to Work Control System in place?

A. To ensure that the steps that need to be taken to control risks during critical non-routine activities are in place.

Potential lagging indicator

- Number of incidents where plant/equipment could be damaged due to failure to control high-risk maintenance activity.

Step *2*. What are the critical elements of a permit to work system?

- Scope of activities covered by the permit-to-work system is clearly identified – **this cannot be measured using a KPI.**
- Permits specify the hazards, risks and control measures, including isolations.
- Permits are properly authorised.
- Permit/task is time limited.
- Correct sign off procedures followed to verify satisfactory completion of work and confirm status of plant at permit handover.
- Active monitoring (i.e. live checks to ensure permit conditions adhered to) carried out.

Potential leading indicators

- Percentage of permits to work issued where the hazards, risks and control measures were adequately specified – **sample checks**.
- Percentage of permits authorised prior to work commencing - **would want 100% target.**
- Percentage of permits issued where the time period for completing the task is specified.
- Percentage of work conducted in accordance with permit conditions and where completion of work has been demonstrated. – **sample checks**

Assessing the Quality of the Indicators in place – Are they collecting the right information?

General pointers to ensuring the KPIs used are the right ones:

- Have the appropriate staff been involved in the production the KPIs you are assessing:
  - Safety professionals and engineers for knowledge of process safety management
  - Workforce involved in the operational procedures for their knowledge of the process 'in practice', also to encourage shared understanding and ownership of the risks/controls and why the information is being collected.
  - Senior management – they are the key customers for the information and need to understand and buy into the process

- Have appropriate tolerances been set for each KPI – i.e. the point at which information is brought to senior managers attention as a safety issue. It is unlikely that operators will get this 100% right first time so piloting may be necessary. The KPI should not measure 'business as usual' (e.g. routine fluctuations in parameters that occur during normal operation), but equally it

should not just measure infrequent, significant and potentially damaging events.

- Does the company understand:
  - What each KPI is monitoring,
  - Why this is key,
  - What does this information tell them, and
  - If the outcome is 'poor' – what does it mean and what improvements to risk control would be required

Process Control Vs Programme Indicators

To give the most accurate picture of how well major hazard risks are being managed it is always best to set indicators against direct operational controls and the safe operational envelope rather than to use indicators that monitor progress with particular programmes of work. The diagram below helps illustrate this. Duty holders should have a range of indicators and it is important that the right balance is struck between these types of indicators.

Operational RCS examples		**Generic RCS examples**		**Programme Indicator examples**
Process / operating envelope. Control of: • Overfill • Overpressure • Corrosion/ageing • Over temperature • Flow rate • Accidental leakage		PTW Management of Change Inspections completed to time Instrumentation and alarms		Audits done to time Audit actions closed out Staff trained to specified competence Safety tours / toolbox talks completed

The examples below show how the two different types of indicator can be set against a risk control topic.

Operational Control Indicator	Programme Indicators
% Inspection of process control instruments and safety critical alarms completed to time	% statutory inspections completed to time.
% Critical operational control – competence monitoring completed	% staff trained to specified competence

Operational Control - Leading/Lagging Indicators

Lagging Indicators typically give rise to a metric that shows whether the desired condition is being met. Indicators should be set at a point before an adverse outcome occurs by selecting the lowest detectable event (eg excursion beyond or a breach of the process control envelope) and setting a lagging indicator at that point.

Leading Indicators typically relate to two aspects – the functioning of instrumentation and sensors that monitor the desired condition and correct completion of critical actions by personnel involved in that task.

Duty holders should not get too concerned about whether an indicator is leading or lagging. The most important consideration is whether the information that it gives them is useful.

Appendix 2 – Scoring

Success Criteria (Based on Appendix 1)

- Indicators are set against all the critical elements of control. If there are large numbers of indicators in place, the company is aware of the most critical indicators and gives weight to these.
- The information is understood and presented to senior management on an agreed regular basis.
- The information is used to inform both safety and business decisions
- Agreed tolerances have been set, and senior management is immediately notified when a tolerance has been breached.
- The workforce have been involved in the development of indicators and understand their importance (linked to the safety critical processes they are involved in).
- Indicators are reviewed at least annually, not just set and left.

Indicators are:

- Set against operational controls
- A mixture of leading and lagging

Performance Rating

Performance Rating	Description	Score
Exemplary	**Good practice of above in all respects**. **All success criteria fully met.** Quality indicators have been set against the critical elements of the control being inspected. The company understands what the information is telling them and acts upon this information as appropriate. All other good practice (Appendix 1) is followed.	**10**
Good	**Good practice in most respects. Most success criteria met.** The company has indicators set against the critical elements of the control being inspected. The information is understood and acts upon this. However, the company does not fully meet the good practice outlined in appendix 1 in on one or two areas.	**20**
Broadly Compliant	**The majority of the success criteria are met.** The company understands the	**30**

	importance of having KPIs and has implemented their use, but need to improve in certain areas.	
Poor	**Many of the success criteria not met or not fully met.** The company have not met some of the key success criteria eg have indicators in place but have gaps in terms of ensuring they are against critical elements of control or have good indicators in place but are not using the information they provide effectively.	**40**
Very Poor	**Majority of success criteria not met or not fully met.** The company has patchy performance indicators in place, but don't understand their relevance and the good practice in Appendix 1 is not being followed.	**50**
Unacceptable	**None of the success criteria met.** The company have no indicators in place; do not know if any of their critical controls are operating effectively and so how close to having a major incident they are.	**60**

Regulatory Expectations

The following table shows how the initial enforcement expectations map onto the performance ratings contained within delivery guides . However, decisions on enforcement remain the responsibility of the inspector.

EMM RISK GAP					
EXTREME	**SUBSTANTIAL**	**MODERATE**	**NOMINAL**	**NONE**	**NONE**
TOPIC PERFORMANCE SCORE					
60	**50**	**40**	**30**	**20**	**10**
Unacceptable	**Very Poor**	**Poor**	**Broadly Compliant**	**Fully Compliant**	**Exemplary**
EMM INITIAL ENFORCEMENT EXPECTATION					
Prosecution / Enforcement Notice.	Enforcement Notice / Letter.	Enforcement Notice / Letter.	Letter / Verbal warning.	None.	None.

COIN Input

IRF Scoring – the COIN Inspection Rating Form (IRF) tab on the relevant Divisional Intervention Plan Service Order should be used to record the operator's KPI score on the "Key Performance Indicators" performance rating topic.

CEMHD Specific Instructions
For companies within the lead Unit System, we would expect each site to have developed their own suite of indicators against their bespoke risks and associated controls, so each site should be marked individually.

Time recording – Under the category box choose the category " StratTop PSPI KPI".

Appendix 3 – Exemplar KPIs in different sectors

CEMHD example: Bulk tank filling

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 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 metrics is that they reveal no direct information on the cause of an 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 unintended outcome has occurred. But this metric is not 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 the process operators to achieve the desired successful outcome. There will be lots of operator actions, probably all recorded in operating procedures, SOPs. Some analysis is needed to work out which are more important.

Again we use guide words to 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 are any unplanned loss of containment or energy releases 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 emergency arrangements eg whether critical actions within the emergency plan where undertaken correctly.

KPIs for the Mining Sector

Interventions made in accordance with the intervention plan should include discussions with mining company senior management to gauge the degree to which they use KPIs to:

- monitor progress;
- set priorities for improvement; and
- demonstrate assurance that the risks from major hazards at their sites are being effectively controlled in a sustainable way.

During site interventions Inspectors should review the indicators in place (if any) to assess whether they are adequate to demonstrate that the risks are being properly controlled. KPIs should also be an important part of major hazard incident investigations, particularly where there is a history of such incidents.

This section provides inspectors with examples of broad categories of KPIs being used across the mining sector. This should be helpful for duty holders who are at an early stage of KPI development.

The major hazard topics in mines will generally include:

- Underground fires
- Explosions of flammable gas/dust
- Inrushes of water or suffocating gases
- Falls of ground
- Transport through shafts
- Mass transport of people underground

Each topic will need detailed consideration in relation to the hazards relevant to a particular site. Duty holders will have to determine the most applicable KPIs to manage the major hazard risk specific to that site.

<u>Example: Ground Control</u>

Lagging Indicators might include RIDDOR reportable incidents as well as the numbers of non reportable roadway support failures.

Leading indicators for ground control could include:

- The number of tell tale audits carried out against plan
- The percentage of tell tales in action levels
- The number of sites/locations where remedial action has not been completed within a specified time frame.
- The percentage of powered roof supports without any structural defects or control defects

NB: the above is generic and is not intended for use at any specific site.

KPIs for the Gas & Pipelines Sector

Use of KPIs is a central part of the SMS performance monitoring arrangements described in Gas Safety (Management) Regulations (GSMR) safety cases, Pipelines Safety Regulations (PSR) Major Accident Prevention Documents and COMAH safety reports.

Examples of Categories of KPIs in the Gas and Pipelines Sector

This guidance provides inspectors with examples of broad categories of KPIs for the sector. This should also be helpful for dutyholders who either have no KPIs in place or are at an early stage of KPI development. However, it is generic and does not provide detailed examples of KPIs used at site, pipeline or installation level.

Gas Distribution Networks:

1. Process safety leadership
2. Plant design and modifications
3. Operational procedures
4. Workforce competence
5. Human factors
6. Emergency arrangements
7. Protective devices, instrumentation and alarms
8. Inspection and maintenance
9. Permit to work
10 Asset records and data quality
11. Third party activities
12. Audit, review and close-out

Gas Transmission Pipelines:

1. Route management
2. Asset records
3. Operating procedures
4. Competence and training
5. Emergency response
6. Leadership
7. Third party interference management
8. Modification & repair process
9. Maintenance and inspection
10. Integrity

COMAH sites:

1. Process safety management
    - Management of change
    - Process hazard review (PHR) progress
    - COMAH safety report validation
    - High/medium priority safety critical and PHR actions overdue
    - Delivery of process safety awareness workshops
2. Operations

- High potential or RIDDOR events
- Safety critical tasks and alarm management
- 'Inhibits' and overrides events (versus safe operating levels)

3. Mechanical integrity and safety systems

- Failures of safety critical systems (including tests)
- Demands on emergency shutdown systems
- Relief valve lifts and bursting disk ruptures
- Alarms and trips in standing or override status

Although there are no prescriptive legal requirements for major hazard operators to develop and implement major hazard KPIs, the legislation listed below places duties on operators within the gas & pipelines sector with respect to the monitoring arrangements within their SMS.

Gas Conveyors: GSMR Schedule 1 – particulars to be included in a safety case of a person conveying gas (monitoring of health and safety performance).

Onshore and Offshore Major Accident Hazard Pipelines: PSR Regulation 23(1)(c) - *the operator shall, before the design of a major accident hazard pipeline is completed prepare, and thereafter revise or replace as often as may be appropriate, a document relating to the pipeline containing, subject to paragraph (2) sufficient particulars to demonstrate that the safety management system is adequate*

COMAH sites: COMAH Schedule 2 - Monitoring performance.

KPIs for the Offshore Sector

The specific legal basis for requiring the use of KPIs lies in Regulation 5(1) of the Management of Health and Safety at Work Regulations 1999, which state: "Every employer shall make and give effect to such arrangements as are appropriate, having regard to the nature of his activities and the size of his undertaking, for the effective planning, organisation, control, *monitoring* and review of the preventive and protective measures." Duty holders may use a suite of KPIs as part of their demonstration of monitoring the effectiveness of their preventative, protective and mitigatory measures.

Safety Critical Elements

A key aspect of the regulatory framework for health and safety offshore is the concept of safety critical elements (SCEs) and the associated verification scheme. SCEs are defined as: "Such parts of an installation and such parts of its plant (including computer programmes), or any part thereof –

(a) the failure of which could cause or contribute substantially to; or

(b) a purpose of which is to prevent, or limit the effect of;

a major accident.

A verification scheme is a suitable written scheme for ensuring that SCEs and specified plant (identified in the PFEER assessment, are:

- Where they remain to be provided, will be suitable; and
- Where they have been provided, remain in good repair and condition.

Inspectors may therefore find that KPIs are linked to SCEs and verification activities. Another area that has received close scrutiny from HSE is hydrocarbon releases (HCRs), and Inspectors may find KPIs that are linked to the duty holder' HCR reduction plans..

Examples of areas that might be subject to monitoring via KPIs include:

- SCE maintenance - e.g. backlogs, deferrals, impaitment risk assessments (ORAs)
- Verification Scheme – inspection and assurance
- SSIVs - tests completed (leading KPI), failures to operate within design parameters (lagging)
- Completion of compliance audits for key risk control systems e.g. permit to work
- Temporary refuge integrity management
- ICP verification findings

The suite of Offshore Inspection Guides published in 2014 to support the Offshore Strategy require inspectors to consider duty holder KPIs for the relevant risk control system.

Sector-wide or Corporate KPIs - inspectors may find that dutyholders are monitoring performance against suites of KPIs that are also reported by others in the same sector or within the same corporate structure. These KPI suites can be useful because they allow performance to be benchmarked across a number of installations. This in turn can lead to the sharing of good practice and may stimulate performance improvements. Inspectors should, however, be mindful that such suites of KPIs are often high-level rather than process-specific. Dutyholders using such an approach should be challenged to demonstrate that the KPIs they are measuring truly reflect the major accident hazard profile at that particular installation.

Applying 'weightings' to KPIs - some operators may have sophisticated systems where the relative criticality of different systems is reflected by their performance score against a KPI being 'weighted'. While there is nothing wrong with this approach, although it is always worth remembering that setting KPIs is a means to an end, not an end in itself, and by developing an overly-complex system or seeking perfection there can be a risk that dutyholders lose sight of this.

Under the Offshore Sector Strategy 2014 – 2017, industry leaders have been set an objective to promote the adoption of major hazard KPIs. Initially this is being taken forward by the Step Change in Safety Asset Integrity Steering Group. Their work programme to deliver this is on-going.