Process Safety –
Recommended Practice on Key Performance Indicators

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Section 1 The need for process safety Key Performance Indicators ................................. 1
1.1 Introduction ......................................................................................... 1
1.2 Leading & lagging KPIs ....................................................................... 2
Section 2 Establishing corporate and facility KPIs ......................................................... 4
2.1 Applying industry recommended practice ................................................ 4
2.2 The four tier approach ......................................................................... 6
2.3 Corporate versus facility KPIs ................................................................. 7
2.4 Identifying critical barriers and selecting KPIs .............................................. 7
2.5 Data collection, communication and review ................................................. 10
Section 3 Tier 1 and Tier 2 ............................................................................ 12
3.1 Definitions ............................................................................................ 12
3.2 Consequence levels and material release thresholds .................................... 13
3.3 Normalisation ....................................................................................... 14
3.4 Applicability to Upstream Operations ...................................................... 15
3.5 Applicability to Upstream Activities ......................................................... 16
3.6 OGP Data Collection ............................................................................ 17
Section 4 Tier 3 and Tier 4 ............................................................................ 18
4.1 Tier 3 KPIs .......................................................................................... 18
4.2 Tier 4 KPIs .......................................................................................... 19
4.3 Selection of Tier 3 and 4 KPIs ................................................................. 20
Appendix A: Determining whether to report a recordable Process Safety Event (PSE) ........... 23
Appendix B: Process Safety Event (PSE) consequence and threshold tables ....................... 24
Appendix C: Glossary of terms and definitions ..................................................... 29
Appendix D: List of acronyms ......................................................................... 32
Appendix E: Primary references and sources ....................................................... 33

In addition to the Appendices above, a supplement to this report is available which lists over sixty examples of Process Safety Events (PSE) and will be updated with new examples from companies. It can be downloaded from the publications section of the OGP website (http://www.ogp.org.uk)
1 The need for process safety KPIs

1.1 Introduction

Across the global oil & gas industry, considerable effort has been focused on the prevention of major incidents. The International Association of Oil & Gas Producers (OGP) has previously published Asset Integrity – the key to managing major incident risks (OGP Report No. 415, December 2008) which provides advice on how to implement an asset integrity management system for new and existing upstream assets. It also includes preliminary guidance on ‘monitoring and review’, including how to establish lagging and leading Key Performance Indicators (KPIs) to strengthen risk controls (barriers) in order to prevent major incidents. This report is intended as a companion document to Asset Integrity – the key to managing major incident risks and describes the practical implementation of a KPI system. The terms ‘process safety’ and ‘asset integrity’ are both used throughout the petroleum industry, often synonymously. From the definitions given here, there are small differences in scope as asset integrity can include all structures in facilities and is not limited to processes handling hazardous substances. However, it is clear that – for the oil & gas industry – the emphasis of process safety and asset integrity is to prevent unplanned releases which could result in a major incident. For this reason, this document is focused on KPIs to prevent such releases; however, much of the guidance can be applied to other aspects of process safety and asset integrity.

In response to a number of major incidents such as the disasters in 2005 at the US Texas City Refinery and the UK Buncefield oil terminal, the downstream oil industry has been developing improved process safety KPIs. Recommendations provided by organisations such as the UK Health & Safety Executive (UK HSE), the US Chemical Safety and Hazard Investigation Board (US CSB) and the Independent ‘Baker’ Panel reinforced the pressing need for improved KPIs. This resulted in significant efforts by the American Petroleum Industry (API), the Center for Chemical Process Safety (CCPS) and others to develop and publish guidance on KPIs for companies to manage process plant risks and prevent unintentioned loss of hazardous materials. To ensure the upstream industry benefits from these efforts, this OGP guidance builds a framework and definitions based on a recent ANSI/API standard on Process Safety Performance Indicators for the Refining and Petrochemical Industries (Recommended Practice – RP 754) as well as guidelines on metrics published by UK HSE, CCPS, and OECD.

Process safety

Process safety is a disciplined framework for managing the integrity of operating systems and processes handling hazardous substances. It is achieved by applying good design principles, engineering, and operating and maintenance practices. It deals with the prevention and control of events that have the potential to release hazardous materials and energy. Such incidents can result in toxic exposures, fires or explosions, and could ultimately result in serious incidents including fatalities, injuries, property damage, lost production or environmental damage.

Asset integrity

Asset integrity is related to the prevention of major incidents. It is an outcome of good design, construction and operating practice. It is achieved when facilities are structurally and mechanically sound and perform the processes and produce the products for which they were designed. The emphasis in this guide is on preventing unplanned hydrocarbon and other hazardous releases that may – either directly or via escalation – result in a major incident. Structural failures may also be initiating causes that escalate to become a major incident.

Major incident

An incident that has resulted in multiple fatalities and/or serious damage, possibly beyond the asset itself. Typically initiated by a hazardous release, but may also result from major structural failure or loss of stability that has caused serious damage to an asset (note this is intended to incorporate terms such as ‘Major Accident’ as defined by UK HSE).
1.2 Leading & lagging KPIs

Major incidents rarely result from a single cause but rather by multiple failures that coincide and collectively result in an exceptional event with severe consequences. This relationship between sequential failures of multiple ‘risk control systems’ is illustrated in Figure 1 using the ‘Swiss cheese model’ (after James Reason, 1990\textsuperscript{12} and 1997\textsuperscript{13}). The same principles underpin other similar approaches such as the ‘bow tie’ model or ‘layers of protection analysis’ (LOPA).

Hazards are contained by multiple protective ‘barriers’ or ‘risk control systems’. The barriers – represented here by individual ‘slices of Swiss cheese’ – are management system procedures, physical engineered containment or other layers of protection designed to prevent incidents. In this guidance we are primarily interested in ‘Loss of Primary Containment’ (LOPC) of hazardous material, which is the predominant cause of major process safety incidents in our industry. Barriers can have weaknesses, depicted as ‘holes’ in the Swiss cheese. The alignment of holes in the model below represents the failure of several ‘prevention barriers’ resulting in an LOPC event. In our industry there are sophisticated controls to detect an LOPC event and mitigate its consequences but holes in these ‘escalation barriers’ can also align and serious harm can result from a fire, explosion or other destructive incident.

Figure 1: KPIs applied to the ‘Swiss cheese’ model (based on the work of James Reason\textsuperscript{12,13})
This model can also be used to distinguish two important types of KPI. Recording the number of LOPC events or actual consequences – where one or more barriers fail simultaneously – is a ‘lagging’ indicator. The term lagging indicator may also be used to measure the number and size of holes in the barriers to assess the extent of weaknesses, defects or failures in the risk control system. Whereas monitoring the strength of the barrier – by measuring the company’s performance in maintaining robust risk controls – is a ‘leading’ indicator.

In this guidance, lagging indicators are generally retrospective and outcome based whereas leading indicators are usually forward-looking and input based. In principle, most LOPC events will have no actual consequences but are still failures and therefore lagging outcomes, but low consequence LOPC events also provide leading information when predicting the likelihood of major incidents with serious consequences. Thus the terms leading and lagging are generally useful but companies need to be aware that some indicators can provide both retrospective and forward-looking insights. A good example of a type of indicator that can be either leading or lagging is a ‘near miss’.

Due to the emotional and reputational impact of incidents that harm people or the environment, companies previously focused most of their attention on lagging KPIs by recording workforce injuries or spills to the environment. This ‘reactive’ mode of monitoring and review is important. However, a strategy of waiting for incidents to happen then learning lessons afterwards is insufficient when aiming to eliminate major incidents. In contrast, the combination of leading and lagging KPIs to assess barrier strengths and weaknesses provides the opportunity to be ‘pro-active’, i.e. more predictive and focused on prevention. The pro-active approach should include KPIs that assess ‘hard’ technical barriers such as engineering design or maintenance and inspection as well as ‘soft’ barriers such as training and competence or safety culture and behaviour.

For each critical barrier, the UK HSE recommends a ‘dual assurance’ approach in their guide on developing process safety indicators. This approach uses a combination of one leading input KPI to test barrier strength and correlate with one lagging output KPI to track any defects in the barrier. In this report, we provide guidance on use of both lagging and leading KPIs, including use of dual assurance.

**Near-miss events – a KPI gift!**

A good example of a KPI which is both leading and lagging is the reporting of near-miss events. Near misses include those events with consequences that do not meet the company’s criteria for recordable incidents such as a spill of less than one barrel. Near misses also provide simple observations of an unsafe condition with no consequences. These are recognised as events which had the potential – in other slightly different circumstances – to result in consequences that would have been recordable, particularly ‘high potential events’ where a major incident would have been a realistic worst case scenario. Therefore, near miss events provide leading information on the likelihood of actual incidents and also provide lagging information on barrier weaknesses. Near-miss investigations can contribute significantly to continuous improvement of asset integrity and process safety, whether used to identify barrier weaknesses or as a warning of a potential catastrophe.

**Why report process safety KPIs?**

**Preventing major incidents**

Process safety and asset integrity failures can result in serious harm to people, the environment, property, reputation and financial stability of a company. Recording of major incidents and careful analysis of their root causes can provide lessons to prevent recurrence. As this analysis is retrospective and based on relatively infrequent events, companies cannot afford to rely on these lessons alone to prevent major incidents. It is therefore necessary to broaden the analysis to learn from events with less serious outcomes and management system performance to pro-actively strengthen the barriers which prevent major incidents. Process safety KPIs therefore generate a range of relevant data which can be analysed to improve preventive actions, such as management system revisions, procedural changes, training opportunities, or facility engineering improvements that aim to minimise and eliminate the potential for major incidents.

**Improving reliability**

The quality and productivity of a company’s operations are reflected in its future profitability. Actions to prevent major incidents go hand-in-hand with steps to make operations more reliable, feeding directly into financial performance.

**Avoiding complacency**

The Baker Panel Report (2007) stated ‘The passing of time without a process accident is not necessarily an indication that all is well and may contribute to a dangerous and growing sense of complacency.’ Since major incidents are relatively rare events, it is easy to give priority to other lower consequence risks in the belief that ‘everything is OK’. KPIs provide a constant reminder of asset integrity, the attention needed on process safety management systems and the warnings from near misses and less severe incidents.

**Communicating performance**

It is a constant challenge to communicate the importance of process safety to the workforce. KPIs provide reassuring evidence of management focus, transparency and progress which can, in turn, support process safety culture and behaviours.
2 Establishing corporate and facility KPIs

2.1 Applying industry recommended practice

In April 2010, API published Recommended Practice (RP) Number 754 on Process Safety Performance Indicators for the Refining and Petrochemical Industries, referred to here as RP 754. This standard was developed using an American National Standards Institute (ANSI) multi-stakeholder process and was based on preliminary guidance on metrics from both API and the Center for Chemical Process Safety (CCPS). RP 754 is an important standard because it has been globally supported and adopted by downstream and integrated oil companies. As RP 754 is directed at downstream activities, OGP has recognised the need to provide further guidance to support RP 754’s applicability for upstream activities and to recommend this standard to E&P companies worldwide. Wherever possible consistency with the language of RP 754 is maintained within this report, including the term ‘process safety’ which as previously noted is taken to be synonymous with the term ‘asset integrity’ for the purpose of KPIs. The complete RP 754 is not reproduced here and should be downloaded by companies from the API website.

2.2 The four tier approach

Major incidents are relatively infrequent so KPIs based only on these rare occurrences may not yield sufficient data to prevent future catastrophic incidents. However, Figure 1 demonstrates that major incidents are the result of not one but a combination of failures of the barriers that are designed to control asset integrity risks. Logic suggests that the same barrier failures causing major incidents also contribute to lower consequence events that could have been much worse in slightly different circumstances. Therefore KPIs can be developed to gather a broader set of more frequent and statistically valid data. These include observations of unsafe conditions, near misses or activations of safety systems which indicate barrier weaknesses. The data can also include proactive KPIs to monitor the extent of a company’s effort to maintain or strengthen barriers through application of its health, safety and environment management system (HSE-MS). In this way the extended dataset from these more specific, systematic KPIs can be used to proactively monitor and improve the most critical safety barriers to prevent major incidents. Thus it has become clear that not one but a combination of measures is needed to monitor barrier performance within an asset integrity or process safety management system. To structure this combination of measures, OGP recommends a four tier framework of process safety KPIs, illustrated by Figure 2. This is also recommended in API RP 754.

Figure 2: Process safety indicator pyramid
(from API RP 754)
The four tiers are expressed as a triangle to emphasise that statistically larger data sets are available from the KPIs at the lower tiers. This approach mirrors the now-familiar personal accident triangle shown in Figure 3, based on insurance claim work in 1931 by H.W. Heinrich\textsuperscript{14}, and refined in 1969 for safety by Bird & Germain\textsuperscript{15}.

Tiers 1 and 2 are more lagging and cover asset integrity major and less severe incidents. For consistency with API RP 754 definitions, an incident is referred to as a Process Safety Event (PSE). The Tier 1 and 2 indicators are fully defined with the intent that these can be reported at the corporate level in both internal and external reports by any company. In order to achieve consistency and comparability, the indicator definitions have narrowly defined scope and are threshold based. A description of Tiers 1 and 2 with upstream specific guidance is provided in Section 3. OGP has adopted PSE at these two tiers to enable benchmarking. Companies may decide to collect event data beyond the scope or thresholds defined but should report any such data separately from their aggregate corporate reporting of PSEs to OGP (see Section 3.6).

Tiers 3 and 4 provide more leading measures. The indicators are intended to be much more specific to a company’s own management system and often will be specific to a particular activity (e.g., drilling) or to an individual asset, facility or plant. While companies may decide to aggregate data from such indicators, care must be taken to ensure that similar facilities or activities form the basis of the aggregation, otherwise comparisons may lead to erroneous judgements. Because comparisons are likely to be challenging, OGP will not benchmark such data initially but will encourage sharing of company experience and good practice using these two tiers. Further information and guidance on Tiers 3 and 4 with upstream specific examples is provided in Section 4.

The continuous improvement cycle

The concept of continuous improvement, whether at corporate, business or facility level, is a fundamental process for any structured HSE-MS, which provides the framework to address Process Safety (PS). There are many versions of the continuous improvement process including the ‘Plan-Do-Check-Act’ cycle, as applied within ISO guides and standards. The cycle illustrated here places emphasis on improving the management system (including legal compliance, company standards and local procedures) by addressing process safety risks through planned controls which are implemented within day-to-day operations. KPIs, particularly the more leading Tier 3 and 4 indicators, underpin the three steps to monitor operational performance, enable internal and external reporting and then finally review outcomes to determine how to revise the management system and embed the continuous improvement. Such a cycle can benefit both local and corporate management through use of leading indicators focused on barriers and lagging indicators focused on operational performance.

The continuous improvement cycle links three OGP guidance reports. Report No. 210 relates to development of HSE management systems\textsuperscript{16}, the starting point for the cycle. Report No. 415 describes how the HSE-MS addresses asset integrity risks, barriers and procedures for E&P operations\textsuperscript{1}. This report continues the cycle by providing guidance on KPIs, their reporting and review.
2.3 Corporate versus facility KPIs

Asset integrity KPIs are established by companies to meet three primary needs:

1. Internal monitoring and review of performance related to the management system and other actions to strengthen process safety barriers and reduce incidents. KPIs are fundamental to continuous improvement, as illustrated on the previous page.

2. Assess whether the measured performance on process safety meets or exceeds industry norms by benchmarking KPI data against industry averages and by sharing lessons learned with other companies. In section 3.6 we outline steps being taken by OGP to promote benchmarking and learning based on the KPIs in this guide.

3. Provide transparent disclosure of performance to stakeholders such as employees, local communities, investors, governmental and non-governmental organisations, and the general public. There are many opportunities for companies to communicate and engage with their stakeholders, but one important channel is through regular, typically annual, reports – often called sustainability or corporate citizenship reports. Through the recent revision of the publication ‘Voluntary Sustainability Reporting Guidance for the Oil & Gas Industry’, IPIECA together with API and OGP have jointly endorsed the process safety KPI framework for both upstream and downstream reporting.

Figure 4: Hierarchy of asset integrity KPIs

Data consolidated across a corporation
Examples: Tier 1 and Tier 2 PSE, overdue asset integrity/process safety actions from corporate audit findings (Tier 4), implementation of corporate safety initiatives (Tier 4)

Data consolidated within a business activity
Example: as above, plus near miss LOPC (Tier 3), demands on safety systems (Tier 3), Process Hazard Analysis action closures (Tier 4), asset integrity training (Tier 4), engineering standards implementation (Tier 4)

Data collected in detail by operations
Example: as above, plus corrosion inspection findings (Tier 3), operational upsets (Tier 3), safety instrumented system testing (Tier 4), scheduled maintenance (Tier 4), competence assessment on safety critical procedures (Tier 4)

Process safety KPIs to meet the three needs above will vary across a company’s organisation from an individual facility up to the corporate level. At the corporate level, data and other information should be selected carefully to be representative of the whole organisation when compiled and consolidated to generate meaningful KPIs. The Tier 1 and 2 KPIs are recommended here for consolidation at company level for corporate reporting against all three needs listed above. In contrast, Tier 3 and 4 KPIs are more appropriate for monitoring facility performance, although some may be consolidated at corporate level to test management system controls implemented across the whole company. Care must be taken to avoid overwhelming operations with corporate KPIs and then relying solely on these KPIs because measures may be overlooked for important control barriers that are critical to local operations. Thus, as illustrated by Figure 4, it is important that additional data is collected at lower levels of the organisation so that performance to address specific but critical safety risks for groups of operations with similar activities, equipment and environments can be analysed. Typically this would mean that different additional KPIs are employed for activities such as production, drilling or pipeline operations, either offshore or onshore. Further, at the facility level, KPIs can be focused on more leading KPIs within Tiers 3 and 4 to locally assess specifically designed technical barriers such as alarm systems, procedural barriers such as start-ups, or people barriers such as competence assessment.
2.4 Identifying critical barriers and selecting KPIs

Selecting effective indicators is a challenge, particularly leading Tier 3 and 4 KPIs which aim to pro-actively improve process safety at the facility level. This requires companies and their facilities to develop knowledge and understanding of the most critical risk control barriers, whether the barriers are facility-specific or apply to groups of similar facilities or even apply across the whole company.

An approach to identifying appropriate barriers and selecting indicators has been provided by the UK HSE in a guide on developing process safety indicators and further developed in a CCPS book on process safety metrics. Based on these, a 6-step approach is recommended, as shown in Figure 5 and detailed overleaf.
Ensure management ownership and establish implementation team

Ownership of the KPIs by senior management is essential to ensure that the data is reviewed at a level where continuous improvement actions can be agreed and actioned, including investment, prioritisation and resource deployment decisions. KPIs that do not result in actions to improve performance are not just a waste of effort, but can mask true performance. Therefore a first step is to establish a team typically bringing together operational and safety expertise with management at facility, business and corporate levels, as appropriate. The KPI implementation team needs to have clear lines of accountability within the company’s management structure and should coordinate the implementation of the next five steps as an integral part of management’s safety review cycle.

Establish industry Tier 1 and Tier 2 KPIs to assess company performance

KPIs need to be selected which are relevant to the operations of the company and reflect its performance in managing major incident risks. The recommended Tier 1 and 2 PSE lagging KPIs in Section 3 provide consistent measures that provide baseline data on industry and company performance, and facilitate trend analysis and benchmarking. Depending on the nature of operational risks, companies may choose to build on and supplement the recommended KPIs by separately collecting additional data, for example on structural integrity failures which do not involve an LOPC. In general, while Tier 1 and 2 PSEs provide baseline performance information, the number of events recorded is unlikely to be statistically sufficient or specific enough to assess barrier strength and drive continuous improvement, and this is a key reason for implementing Tier 3 KPIs. Typically, Tier 1 and 2 PSEs are established with the standardised definitions within and across companies. These two KPIs should be retained year-on-year to provide a consistent record of a company’s performance.

Confirm critical process and integrity barriers to prevent major incidents

It is important to determine and annually confirm the risk control barriers which are critical for prevention of major incidents and to ensure that KPIs are in place to measure the effectiveness of these barriers. At facility or corporate level, there are three types of inputs which can be used together to help identify weak or critical barriers. These inputs are illustrated in Figure 5 and discussed below.

- **Pro-active** input relies upon identification of hazards and risks which could lead to a major incident. Information can be drawn from recent Process Hazard Analysis (PHA) and other risk assessments related to asset integrity/process safety, which will include the barriers identified to manage the risks. Pro-active input confirms which barriers are in place to control the most important process safety risks and the management system elements to maintain and improve those barriers.

- **Reactive** input is based upon root cause investigation of major incidents and high potential events or demands on safety systems that could, in other circumstances, have resulted in an actual incident. The review of root causes should be mapped against both hard technical and soft management system barriers to identify those that are most critical to future incident prevention based on past incidents, or to identify the need for new barriers where gaps exist. Such a review can also be supported by evidence from process safety, asset integrity and occupational safety audit findings. At a more detailed level, reactive input identifies the ‘holes’ in barriers.

- **External** input takes account of experience and best practice risk control systems shared in the oil & gas or other industries, often as a result of past major incidents. Learning from others can highlight critical barriers and often suggests KPIs which can be considered in Step 4.
Select Tier 3 and Tier 4 KPIs to monitor weaknesses in critical barriers at facilities

Companies should select and implement appropriate Tier 3 and Tier 4 KPIs which will generate statistically relevant performance data that is specific to the critical barriers identified in Step 2. Because they need to reflect different operational activities and management systems of the facilities, there is a very wide choice of Tier 3 and 4 KPIs. In Section 4, example KPIs are provided which may provide useful starting points but companies will usually need to tailor and evolve their Tier 3 and Tier 4 measures as some barriers are strengthened and other weaknesses are identified.

Collect quality data, analyse performance and set improvement actions

It is essential that the effort to collect and analyse KPI data is not just about ‘counting the score’ but rather it becomes an integral part of the continuous improvement cycle within the HSE-MS. In order to have confidence in the analysis it is valuable to establish quality assurance processes to verify the accuracy, consistency and completeness of the collected data. Trending, correlations and other statistical analysis should then be performed which takes into account the quality as well as the inherent reproducibility of the KPI. The performance data, highlighting meaningful change, should be transparently communicated to management for review resulting in improvement actions as input to the continuous improvement cycle (see Section 2.3).

Regularly review critical barriers, actions, performance and KPI effectiveness

It is important to confirm that process safety KPIs remain focused on the most important barriers to prevent major incidents. While some KPIs, particularly the Tier 1 and 2 measures, are intended to be implemented and established for long-term review of performance, other KPIs may be used for a few years and then evolve to provide more detailed information on barrier strength. It is therefore recommended that the implementation team revisit Steps 3 and 4 to ensure that process safety barriers and Tier 3 and 4 KPIs are regularly reviewed, typically annually, as part of management’s review of safety actions and performance. KPIs should be removed or replaced if they do not provide information that enables performance improvement or if they monitor a barrier which is no longer critical to address.

For example, a facility may choose to establish a leading Tier 4 KPI to record the number of scheduled inspection and maintenance tasks which are overdue. Over 2-3 years the indicator may show that performance has improved and is satisfactory. However, Step 3 may confirm that the inspection and maintenance remains a critical barrier. In this example, the facility may then decide to improve the effectiveness of its leading KPI by collecting statistical data on the number and categories of safety critical findings from the already tracked inspection and maintenance tasks. Using the dual assurance approach, the data could then be correlated annually with data on PSEs or other events related to inspection and maintenance with the aim of identifying priorities for improvement of the barrier.
2.5 Data collection, communication and review

The aim of asset integrity KPIs is to help prevent major incidents that are generally the result of multiple, simultaneous barrier failures. As such incidents do not occur very frequently, it can take a very long time to gather statistically relevant data on major incidents alone. Therefore, systems need to be implemented for consistent collection and analysis of data and related information on more than just major incidents. Companies should consider the following for each KPI:

- Engage all parties who will be involved in the data collection and review process to ensure that there is common understanding of the importance and value of the data, and commitment to regularly submitting a complete set of data which has been checked for accuracy.

- Establish a clear boundary for the facility, business or company which lists all discrete assets which will collect data. IPIECA has provided guidance on developing a reporting boundary, and recommends applying the ‘operational approach’ for collection of Tier 1 and 2 data. This approach is based on collecting data from ‘reporting units’ which are assets operated by the company (irrespective of the company’s ownership in the company or joint venture). Companies should clarify whether any assets operated by a contractor on the company’s behalf are to be included.

- Clarify the scope of the KPI. The scope should clarify which activities are included for reporting. In Section 3, further information is provided on the E&P activities included for Tier 1 and Tier 2 reporting. Companies may decide to widen the scope of a KPI, but should ensure that the data system can separate out information which is beyond the guidance in Section 3 in order to preserve consistency for benchmarking purposes.

- Ensure that the definition of the KPI is clearly understood and is not ambiguous. For a new KPI, a period of pilot testing may be necessary. There will always be cases where there is debate about inclusion of data and therefore a mechanism should exist to provide additional guidance, when required. The set of examples included as a supplement to this report provide a useful reference on determining whether an event should be reported based on the definitions in Section 3.

Communicating the data is important. If the data is communicated well it will quickly highlight relevant trends and changes to promote management review and action. If communicated badly, the presentation of the data may mask performance information and or even misdirect management attention. Regular reporting typically includes a combination of graphical output to show trends, tabulated data and interpretative text. The concept of a ‘dashboard’ can be effective, especially when automatically populated from an electronic database or plant control system. Typically a dashboard combines and highlights asset integrity together with related operational data to quickly show change using ‘traffic lights’, ‘dials’, or other icons. For larger organisations, it will be appropriate to communicate the data to various levels of management by consolidating data in different views and degrees of detail. Figure 7 illustrates how different dashboards may be ‘stacked’ in a data system to serve the various needs of an organisation.
Having communicated the process safety KPI data in a timely manner to the right audience, the most important final step is to put the data to work and strengthen the risk control barriers in the management system. For this to be part of the continuous improvement cycle, regular review of the data is required, typically with a full annual review and several interim progress reviews. While the review can focus on asset integrity performance, it is good practice in the annual review to broaden the range of inputs so that the KPIs are not reviewed in isolation.

Examples of other inputs can include:
- High-level management system or specific process safety audit findings
- Summary of investigation outcomes and implementation of lessons learned from Tier 1 and 2 incidents, or high potential events
- Responses to major incidents elsewhere in the industry
- Overview of plant reliability and correlation with process safety KPIs
- Changes to staffing levels, safety critical competencies, training, demographics
- Impact of major start-ups/shut-downs, new developments or acquisitions
- Regulatory compliance performance or changes
- Safety culture surveys or behaviour based safety findings
- Benchmarking data from OGP or other associations
- Shared good practices from peer companies
- Proposals for new or modified or eliminated KPIs

While not all of these inputs may be relevant, it is nevertheless important to use such sources of existing data and information to support interpretation and decisions based on the process safety KPIs. The annual review should also link to the other data needs of the company which will normally include external/public reporting to stakeholders or regulators and also submission of data to enable benchmarking against industry performance norms or comparison with peers.

Figure 7: Use of dashboards in a larger organisation

<table>
<thead>
<tr>
<th>Corporate</th>
</tr>
</thead>
<tbody>
<tr>
<td>More emphasis on Tier 1 and 2 KPIs, greater aggregation, limited or no detail at facility, plant or shift levels, more text on high-level interpretation of data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Business activity</th>
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<tbody>
<tr>
<td>Great specificity, more emphasis on Tier 3 and 4 KPIs, less aggregation, more data and greater integration with operational parameters.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Business unit</th>
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<tbody>
<tr>
<td>Facility</td>
</tr>
<tr>
<td>Plant</td>
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<tr>
<td>Shift</td>
</tr>
</tbody>
</table>
### 3.1 Tier 1 and 2 KPI definitions

The Tier 1 and Tier 2 KPIs count LOPC incidents that are reportable as Process Safety Events (PSEs), i.e. the incident results in any of the consequences stated in RP 754⁶. Tier 1 PSE records incidents with greater consequence and is the most lagging performance indicator within the four tier approach (Figure 2). Tier 2 PSE records incidents with a lesser consequence. Tier 2 PSEs, even those that have been contained by secondary systems, indicate barrier system weaknesses that may be precursors of future, more significant incidents.

When used in conjunction with lower tier indicators, the two PSE KPIs contribute to a company’s assessment of its process safety and asset integrity performance and can provide a company with opportunities for learning and improvement.

The Tier 1 and Tier 2 KPI definitions are reproduced below directly from RP 754 and list the LOPC consequences which result in a recordable PSE. The definitions refer to material release threshold quantities, which have been reproduced in Appendix B. The full text of RP 754 should be consulted when further details are required⁶.

Tier 1 and Tier 2 PSEs have been adopted by OGP with the intent that these KPIs are applied across production and drilling operations for the oil & gas industry worldwide. Therefore, it is recommended that, where practical to do so, companies adhere closely to these definitions. Companies will commonly provide internal guidance, particularly in order to align definitions with existing company terminology and management systems. Appendix A provides a useful flow chart to help determine whether an LOPC is reportable.

<table>
<thead>
<tr>
<th>Table 1 – process safety event definitions, reproduced from API RP 754</th>
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<tbody>
<tr>
<td><strong>Tier 1 Indicator Definition and Consequences</strong></td>
</tr>
<tr>
<td>A Tier 1 Process Safety Event (PSE) is a loss of primary containment (LOPC) with the greatest consequence. A Tier 1 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g. steam, hot condensate, nitrogen, compressed CO₂ or compressed air), from a process that results in one or more of the consequences listed below:</td>
</tr>
<tr>
<td>- An employee, contractor or subcontractor ‘days away from work’ injury and/or fatality;</td>
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<tr>
<td>- A hospital admission and/or fatality of a third-party</td>
</tr>
<tr>
<td>- An officially declared community evacuation or community shelter-in-place</td>
</tr>
<tr>
<td>- A fire or explosion resulting in greater than or equal to $25,000 of direct cost to the Company</td>
</tr>
<tr>
<td>- A pressure relief device (PRD) discharge to atmosphere whether directly or via a downstream destructive device that results in one or more of the following four consequences:</td>
</tr>
<tr>
<td>- liquid carryover</td>
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<tr>
<td>- discharge to a potentially unsafe location</td>
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<tr>
<td>- an onsite shelter-in-place</td>
</tr>
<tr>
<td>- public protective measures (e.g., road closure) and a PRD discharge quantity greater than the threshold quantities in Appendix B in any one-hour period</td>
</tr>
<tr>
<td>- A release of material greater than the threshold quantities described in Appendix B in any one-hour period</td>
</tr>
</tbody>
</table>

| **Tier 2 Indicator Definition and Consequences** |
| A Tier 2 Process Safety Event (PSE) is an LOPC with lesser consequence. A Tier 2 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g. steam, hot condensate, nitrogen, compressed CO₂ or compressed air), from a process that results in one or more of the consequences listed below and is not reported in Tier 1: |
| - An employee, contractor or subcontractor recordable injury; |
| - A fire or explosion resulting in greater than or equal to $2,500 of direct cost to the Company; |
| - A pressure relief device (PRD) discharge to atmosphere whether directly or via a downstream destructive device that results in one or more of the following four consequences: |
|   - liquid carryover |
|   - discharge to a potentially unsafe location |
|   - an onsite shelter-in-place |
|   - public protective measures (e.g., road closure) and a PRD discharge quantity greater than the threshold quantities in Appendix B in any one-hour period |
| - A release of material greater than the threshold quantities described in Appendix B in any one-hour period |

*Note: Non-toxic and non-flammable materials (e.g., steam, hot water, nitrogen, compressed CO₂ or compressed air) have no threshold quantities and are only included in this definition as a result of their potential to result in one of the other consequences.*
3.2 Consequence levels and material release thresholds

To determine whether an LOPC event is a recordable PSE at the Tier 1 or Tier 2 level it is necessary to collect and analyse data on the consequences of the unintended release, as detailed in Table 1. If the LOPC causes actual harm or damage – a fatality or injury, or a fire or explosion – then the level of consequence is relatively straightforward to determine. In the case of fatality or injury, the severity criteria are aligned with standard industry practice for reporting occupational safety performance in the E&P industry, including the annual data submission to OGP. Most companies also internally capture data on fire and explosion damage. While the direct cost thresholds of $25,000 for Tier 1 and $2,500 for Tier 2 in Table 1 might appear low consequences for upstream operations, it is important to capture these events because further ‘escalation’ barriers have failed to prevent ignition of the LOPC and cause property damage. When an LOPC falls below the criteria for Tier 1 or Tier 2, the event may be reported for company internal reporting using a Tier 3 KPI (i.e. a near miss or demand on a safety system). For convenience, the definitions of consequence provided in the previous sub-section have also been summarised in Appendix B. When an LOPC event happens but there are no or low actual consequences in terms of harm to people or property damage, it is still important to record the event in order to recognise that at least one barrier has failed, there was potential for serious consequences and that there is an opportunity to learn. For this reason, an LOPC event is also recordable if the material is hazardous and the amount released is significant in terms of potential consequences. To determine whether the LOPC is a recordable PSE at either Tier 1 or 2 level, tables of release thresholds for different categories of material are included in RP 754 and summarised in Appendix B.

A release from a Pressure Relief Device (including a flare) is not considered a recordable PSE unless the amount of release exceeds a Tier 1 or Tier 2 threshold and the release also results in one of four actual consequences listed in Table 1. Of these, ‘liquid carryover’ and ‘discharge to a potentially unsafe location’ are relatively straightforward to apply. The consequence ‘public protective measures’ would only apply to onshore facilities with public receptors which could be potentially exposed to impact from the release. The consequence ‘an on-site shelter-in-place’ may be a more difficult consequence to apply for offshore facilities, and some onshore facilities. In this situation, a company should interpret ‘an on-site shelter-in-place’ as ‘a complete or partial evacuation of the workforce off the facility’. Mustering alone does not constitute a criterion for a Tier 1 or Tier 2 PSE.

Concept of an Acute Release
Tier 1 and 2 both apply the concept of an acute release to differentiate a PSE from other LOPCs which occur over a prolonged period (such as fugitive emissions) and are unlikely to constitute a major incident risk of a fire or explosion. An acute release of material is defined as LOPC which exceeds the reporting threshold for a Tier 1 or Tier 2 PSE within any period of one hour during the event. Acute releases include but are not limited to equipment and piping failures due to corrosion, overpressure, damage from mobile equipment, sabotage, etc.

For example:
- Valves being left open
- Tanks being overfilled
- Flare or relief systems not operating as intended
- Process upsets or errors that result in process materials entering other process containment systems with no provisions or design considerations
- Corrosion of a pipe or a gasket failure where the release over an hour exceeds thresholds

Primary containment
A tank, vessel, pipe, truck, rail car, or other equipment designed to keep a material within it, typically for purposes of storage, separation, processing or transfer of gases or liquids. The terms vessel and pipe are taken to include containment of reservoir fluids within the casing and wellhead valving to the surface.

Loss of Primary Containment (LOPC)
An unplanned or uncontrolled release of any material from primary containment, including non-toxic and non-flammable materials (e.g. steam, hot condensate, nitrogen, compressed CO₂ or compressed air) For drilling operations, any unplanned or uncontrolled release to the surface (seabed or ground level) should be included.

Secondary Containment
An impermeable physical barrier specifically designed to prevent release into the environment of materials that have breached primary containment. Secondary containment systems include, but are not limited to, tank dykes, curbing around process equipment, drainage collection systems into segregated oily drain systems, the outer wall of double walled tanks etc.
The material categories used in RP 754 are based on the classifications within the United Nations Recommendations on the Transport of Dangerous Goods (UNDG) commonly used in Material Safety Data Sheets (MSDSs). While these classifications differ from some of the other hazardous material classifications used by the petroleum industry in some countries, the UNDG lists represent a common international basis for use in these KPIs. The UNDG lists are comprehensive in terms of pure chemicals however for hydrocarbon mixtures, such as crude oil or fuels, the UNDG classifies flammable liquids in terms of their physical properties. Whenever possible, when determining whether an LOFC is Tier 1 or Tier 2, the hydrocarbons released should be classified based on boiling point and flash point. To promote consistency and for convenience, the tables in Appendix B have been supplemented with examples of hazardous materials common in production and drilling operations for each of the RP 754 material categories.

3.3 Normalisation

Both Tier 1 and Tier 2 PSEs can be reported as normalised rates to aid comparability over time and between facilities or companies. As there is no uniformly applicable normalisation factor for process safety/asset integrity indicators based on facility configuration, a general consensus was reached to use worker exposure hours (as used for personal injury rates), as a convenient, easily obtained factor for both KPIs. This factor enables OGP to calculate a Tier 1 and 2 Process Safety Event Rate (PSER) for annual upstream benchmarking and ultimately to benchmark across the entire petroleum industry with API and other associations. The rates are calculated as follows:

\[
\text{Tier 1 PSER} = \frac{\text{Total Tier 1 PSE Count}}{\text{Total Hours Worked (for drilling and production activities)}} \times 1,000,000
\]

\[
\text{Tier 2 PSER} = \frac{\text{Total Tier 2 PSE Count}}{\text{Total Hours Worked (for drilling and production activities)}} \times 1,000,000
\]

Total hours worked includes employees and contractors for applicable company functions within the scope of reporting i.e. drilling and production activities are included; exploration, construction work hours are excluded. In addition companies may choose to use additional normalisation factors such as mechanical units, or production volumes.

Because the frequency of PSEs is likely to be low, care should be taken when assessing PSER because the rates are only likely to be statistically valid for comparisons at an upstream industry or company level. Tier 1 PSER is unlikely to be valid at a facility level, however a Tier 2 PSER is more likely to be valid for tracking statistical performance at a corporate or facility level as Tier 2 events are likely to occur with a higher frequency.
3.4 Applicability to Upstream Operations†

The Tier 1 and Tier 2 PSEs are limited to drilling and production activities because of the inherent potential for LOPC consequences as described in Table 1. The following list describes those operations that are included as drilling and production activities for the purpose of reporting. This list is aligned with the OGP Health and Safety Incident Reporting System Users’ Guide18 which is updated annually.

Drilling includes all exploration, appraisal and production drilling, wireline, completion and workover activities as well as their administrative, engineering, construction, materials supply and transportation aspects. For this guidance, Tier 1 and 2 PSEs are recorded only when LOPC occurs when operating ‘in hole’ because this is consistent with the principle of including only those activities ‘connected to the process’.

For drilling operations, Tier 1 and Tier 2 PSEs are excluded for:
- Drilling/workover/wireline operations when not ‘in hole’ (during site preparation, rigging up, site restoration, etc.)
- Loss of circulation, loss of drilling mud, well kick or underground blowout unless there is an associated LOPC of material (e.g. gas, oil, other fluids or mud) released above ground or above sea-bed or onto the rig floor. (Note that it is good practice for companies to report such events using Tier 3 KPIs and – in particular – to identify, investigate and learn from any such events that had high potential for a major incident, such a blowout preventer activation on a high pressure well).

Production for this guidance covers petroleum and natural gas production operations, including administrative and engineering aspects, repairs, maintenance and servicing, materials supply and transportation of personnel and equipment. It covers all mainstream production operations including:
- Work on production wells under pressure
- Oil (including condensates) and gas extraction and separation (primary production)
- Heavy oil production where it is inseparable from upstream (i.e. steam assisted gravity drainage) production
- Primary oil processing (water separation, stabilisation)
- Primary gas processing (dehydration, liquids separation, sweetening, CO₂ removal)
- Floating Storage Units (FSUs) and sub-sea storage units
- Gas processing activities with the primary intent of producing gas liquids for sale:
  - Secondary liquid separation (i.e., Natural Gas Liquids [NGL] extraction using refrigeration processing)
  - Liquefied Natural Gas (LNG) and Gas to Liquids (GTL) operations
- Flow-lines between wells and pipelines between facilities associated with field production operations
- Oil & gas loading facilities, including land or marine vessels (trucks and ships) when connected to an oil or gas production process
- Pipeline operations (including booster stations) operated by company E&P business

Production excludes:
- Production drilling or workover
- Mining processes associated with the extraction of heavy oil tar sands
- Heavy oil when separable from upstream operations
- Secondary heavy oil processing (upgrader)
- Refineries

Tier 1 and 2 PSEs are not required to be reported for exploration (except drilling as noted above), construction, and other unspecified activities as listed in the OGP Health and Safety Incident Reporting System Users’ Guide18.

† At joint venture sites and tolling operations, the company should encourage the joint venture or tolling operation to consider applying Tier 1 and Tier 2 PSE KPIs.
3.5 Applicability to Upstream Activities†

All activities related to drilling and productions operations (as detailed in 3.4 above) are applicable to PSE reporting, including related facility start-up or shut-down operations, related brown-field construction activities, or decommissioning operations, and events resulting from sabotage, terrorism, extremes of weather, earthquakes or other indirect causes.

Events associated with the following activities fall outside the scope and shall not be included in data collection or reporting efforts:

- Marine transport operations, except when the vessel is connected to the facility or process.
- Truck or rail operations, except when the truck or rail car is connected to the process for the purposes of feedstock or product transfer, or if the truck or rail car is being used for onsite storage.
- Vacuum truck operations, except connected to the process, e.g. onsite truck loading, discharging operations or use of the vacuum truck transfer pump.
- Routine emissions that are allowable under permit or regulation.
- Office, shop, warehouse, or camp/compound building activities (e.g. resulting in office fires, spills, personnel injury or illness, etc.).
- Activities leading to personal safety incidents (e.g., slips, trips, falls) that are not directly associated with onsite response to an LOPC.
- Activities resulting in LOPC from ancillary equipment not connected to the process (e.g., small sample containers). The exclusion includes fuel/oil leaks involving trucks or other vehicles or other mobile equipment not considered part of the process.
- Quality Assurance (QA), Quality Control (QC) and Research and Development (R&D) laboratory activities (except pilot plant activities, which are within scope for PSE reporting).
- Onsite fuelling operations of mobile equipment (e.g., pick-up trucks, diesel generators, and heavy equipment).

The term “process” for production and drilling operations includes facilities such as production equipment (e.g., separators, vessels, piping, heaters, pumps, compressors, exchangers, refrigeration systems, etc.), drilling equipment above ground, storage tanks, ancillary support areas (e.g. boiler houses and waste water treatment plants), onsite remediation facilities, and distribution piping under control of the Company.

† At joint venture sites and tolling operations, the company should encourage the joint venture or tolling operation to consider applying Tier 1 and Tier 2 PSE KPIs.
3.6 OGP Data Collection

With the issue of this report, OGP’s general aim was to identify a small number of KPIs that were reliable, clearly defined, implementable across the upstream oil & gas industry, and – ideally – aligned with the downstream petroleum industry.

The annual OGP benchmarking collection of health and safety data now includes the Tier 1 and Tier 2 PSE KPIs detailed in this guide, which are aligned with API RP 754. OGP also recognised the need for companies to adopt leading indicators. Therefore, this guide also promotes the use of Tier 3 and Tier 4 KPIs within companies. Numerical Tier 3 or 4 data is not currently requested by OGP as these KPIs will be specific and appropriate to a particular company’s safety controls and management system and thus unlikely to be comparable to those of a different company. In future years, as the data collection process matures, OGP will encourage companies to share process safety lessons learned and best practices related to both leading and lagging KPIs through workshops and similar processes.

The collection of process safety KPI data is fully integrated with OGP’s existing health and safety data collection process. Collection of offshore and onshore Tier 1 and Tier 2 PSE data commenced in 2011 (for 2010 data). The initial intent is to review and validate the data received to ensure sufficient consistency and accuracy. Subject to sufficient confidence in the validity of the first one to two years of data collection, the data collected will be integrated into OGP’s annual public report on health and safety performance indicators for the E&P industry worldwide.

The process safety data collection is based on numbers of Tier 1 and 2 PSEs recorded by companies, separately reported for production and drilling activities, and sub-divided into offshore and onshore data. The data is also broken down to understand the consequences that determined the PSEs, including:

* the proportions resulting in harm to people (injuries and fatalities)
* damage to property (fires and explosions)
* releases of hazardous materials (from primary containment or pressure relief device discharge)

More help

Determining whether an event is reportable as a Tier 1 or Tier 2 PSE can be complex and definitions open to interpretation. For this reason, OGP has developed a supplement to this report that lists over 60 example events with interpretation. Over time, OGP intends to update the list with new examples to aid interpretation of the PSE definitions. The supplement can be downloaded from the publications section of the OGP website (http://www.ogp.org.uk).

Companies have the option to provide additional information on the categories of material released and whether the events occurred during normal operations, start-up, shutdown or other circumstances. Companies are also able to provide a detailed description of any PSE, including causal factors and lessons learnt, that either involved or had the potential to result in fatalities.

Further details of the data collection process, including instructions, definitions and templates, are now available in the annually published OGP Health and Safety Incident Reporting System Users’ Guide.
Tier 3 and Tier 4 indicators are primarily designed for monitoring and review of risk control systems (i.e. barriers), especially at the operational level. Barriers may be hard physical barriers or soft human barriers. As shown in the ‘Swiss Cheese’ diagram (Figure 1), hard barriers are intended to block or respond to LOPC events and may include:

- prevention controls such as engineering design of containment systems and automatic distributed control systems
- escalation controls such as detection, shutdown and blow-down systems
- mitigation controls such as deluge, secondary containment and automated emergency systems

Soft barriers are typically management system-related, such as procedures and processes, or workforce-related, such as training, competence, behaviours and culture.

4.1 Tier 3 KPIs

A Tier 3 indicator records an operational situation, typically considered a ‘near miss’, which has challenged the safety system by progressing through one or more barrier weaknesses to result in an event or condition with

- consequences that do not meet the criteria for a reportable Tier 1 or Tier 2 event; or
- no actual consequences, but the recognition that, in other circumstances, further barriers could have been breached and a Tier 1 or Tier 2 event could have happened.

Tier 3 indicators are intended primarily for internal Company use at the facility, business or corporate level, but may occasionally support public reporting. However, because these indicators are specific to particular facilities or company systems, Tier 3 indicators are not generally suitable for company-to-company benchmarking or year-on-year corporate performance reporting.

Tier 3 indicators are typically based on more lagging ‘outcomes’, i.e. retrospective recording of undesirable events or findings. A Tier 3 indicator may be associated with one or more specific barriers which have an associated leading Tier 4 indicator to achieve dual assurance (see section 4.3 for further information).

Types of KPIs implemented at Tier 3 could include numerical data or other parameters related to:

- Demands on safety systems, e.g. pressure relief devices (see example)
- Safe operating limit excursions (see example)
- Primary containment inspection or testing results outside acceptable limits
- LOPC below Tier 2 thresholds
- Near misses with potential for LOPC
- Asset integrity/process safety audit findings indicating barrier weaknesses
- Non-compliances with asset integrity or process safety voluntary standards or legislation

The two examples in this section are brief descriptions of Tier 3 KPIs provided in RP 754, which should be consulted for the complete text. Further examples of Tier 3 KPIs are provided in Table 2 and as a supplement linked to this report on the OGP website.

Tier 3 KPI example: Demands on safety systems

This KPI monitors demands on safety systems designed to prevent LOPC or to mitigate the consequences of an LOPC. A system may include sensors, logic solvers, actuators and final control devices designed to prevent an LOPC, or it may include a Pressure Relief Device (PRD) and flare or scrubber that function together to mitigate the consequences of an LOPC. All of these elements function together as a system and when a demand is placed on the system, a single event is counted, regardless of the number of devices that must function within the system. A Demand on a Safety System is counted, regardless of the phase of operation (e.g. start-up, shutdown, normal, temporary, emergency) when one of the following occurs:

- activation of a safety instrumented system
- activation of a mechanical shutdown system
- activation of a PRD not counted as Tier 1 or Tier 2, with release of material directly to atmosphere
- activation of a PRD not counted as Tier 1 or Tier 2, with release of material to atmosphere via a destructive device (e.g. flare or scrubber)

The KPI count is typically segregated by the four types of demand above. Some companies may find that a rate of demands per safety system type provides a more useful indicator than a simple count.

A demand resulting from intentional activation of the safety system during periodic device testing, or manual activation as a part of the normal shutdown process is excluded. A PRD is considered to have been activated when the system pressure reaches the device set point whether or not the PRD performs as designed. Activation of PRDs includes safety valve (SV) lifts above the set point, capture disc or pin replacement (except preventive maintenance) and deflagration vent re-seats but excludes pressure/vacuum (PV) vents (e.g. on tanks) unless the vent fails to function as intended.
4.2 Tier 4 KPIs

A Tier 4 KPI represents performance of the individual risk control barriers, or its components, within a facility’s management system, and operating discipline. These KPIs are typically more leading and proactive because they reflect activities of the company directly associated with maintaining and improving its risk control barriers. Measures can be focused on barriers such as:

- engineering and inherently safe design
- equipment maintenance, inspection and testing
- process hazard and major incident risk assessments
- quality of, and adherence to, operating procedures
- facility management of change
- contractor capability and management
- audit improvement actions
- asset integrity and process safety initiatives
- workforce and management training and development
- technical competence assessment and assurance

Tier 4 KPIs are more effective when applied in combination with lagging indicator information. This would include correlation with Tier 1, 2 and 3 data, and particularly when root-cause analysis provides specific indications of barrier weaknesses related to the effective implementation of management system requirements.

Tier 4 indicators are intended primarily for use by operators, first-line supervisors, engineers and managers at the facility or business level where awareness of specific hazards, detailed understanding of the plant and local ownership of risk management is most critical. However, a few Tier 4 indicators may be rolled up to business or corporate level to assess management system barriers which are highly standardised across a company. Because of specificity to facilities or company systems, Tier 4 indicators are not generally suitable for company-to-company benchmarking or corporate performance reporting.
4.3 Selection of Tier 3 and 4 KPIs

It is important to choose Tier 3 and 4 KPIs which operators and engineers recognise as meaningful and applicable to the specific barrier systems in place at the facility. The indicators selected should provide actionable information which directs activities to further improve barrier strength and addresses identified weaknesses. CCPS has provided a comprehensive selection of possible KPIs for each of 20 management system elements. This list of KPIs was updated in 2010 in their guidelines on process safety metrics. In RP 754, API has also suggested 10 Tier 4 KPIs and UK HSE has illustrated their dual assurance concept by providing a selection of possible leading and lagging indicators for 9 common risk control barriers. Table 2 provided here is updated from OGP Report No. 415 taking into account these references and also illustrates the dual assurance approach advocated by UK HSE.

As noted earlier, it is recommended that facilities determine which barriers which are most critical for management of major incident risk then select suitable leading and lagging KPIs for each critical barrier. Care must be taken to avoid overwhelming staff with too many metrics, and therefore companies are encouraged to be selective and focus KPIs on barriers which are either important in terms of mitigating major risk or because there are known weaknesses in the barrier that need to be addressed.

It is important to view risk control barriers and KPIs used in the context of the overall management system and continuous improvement. Risk control barriers are generally equivalent to management system elements or sub-elements; therefore it is advisable to align barrier names with the terminology of the company’s own management system. As the system improves over time, the KPIs should be reviewed regularly and subjected to their own continuous improvement cycle to ensure that effort is maintained on strengthening those barriers which are most critical for prevention of major incidents.

Selecting leading and lagging KPIs for “dual assurance”

While Tier 4 indicators are clearly leading, it has been noted that Tier 3 indicators can be considered as either leading or lagging depending on how the data is used, e.g. a level alarm going off frequently could be a leading indicator of the potential for Tier 1 or 2 events or a lagging indicator of maintenance not having been performed on schedule. Equally, Tier 2 indicators can be considered leading relative to Tier 1 — or lagging relative to Tiers 3 and 4.

For each critical barrier, those few of highest concern to the company or facility, a good practice is to identify one leading KPI at Tier 4 level and one lagging KPI from a higher tier. These two ‘matched’ KPIs can then be used in combination to assess the performance of the selected barrier. This approach is called ‘Dual Assurance’ by UK HSE and links a lagging and leading pair of indicators that can be correlated to statistically test whether a specific barrier is getting weaker or stronger.

A simple example of dual assurance would be a leading Tier 4 KPI to monitor ‘the percentage against plan of completed tests on a facility’s alarm system’ linked with a more lagging Tier 3 KPI which monitors ‘the number of alarm system failures (recorded from testing, near misses or any actual Tier 1 and 2 events)’. In combination these two KPIs provide data to assess whether the ongoing maintenance and testing regime of safety critical alarms is sufficiently effective to ensure that any ‘holes’ in the barrier are monitored and minimised to an acceptably low level.
<table>
<thead>
<tr>
<th>Barrier/risk control system</th>
<th>Example KPI (Tier 3)</th>
<th>Example KPI (Tier 4)</th>
</tr>
</thead>
</table>
| **Management and workforce engagement (MWE) on safety/asset integrity** | • Percentage of manager inspections delegated to subordinates  
• % of safety meetings not fully attended by staff working that day  
• Number of barrier weaknesses, including unsafe conditions, identified from MWE | • % of manager inspections of work locations completed  
• Total hours spent on MWE activities by managers and by staff  
• % MWE suggestions implemented  
• Staff opinion/attitude survey outcomes on health of asset integrity/process safety barriers, including leadership, competence, safety culture and equipment design |
| **Hazard identification and risk assessment (HIRA)** | • Number of recommendations/actions unresolved by their due date  
• Number of actual or near-miss LOPC events where inadequate HIRA was a causal factor  
• Numbers of P&ID corrections and other actions identified during PHAs | • Number of planned HIRA completed on schedule  
• Average number of hours per P&ID for conducting  
a) baseline PHAs  
b) PHA revalidations |
| **Competence of personnel (categorised as employees and supervised contractors, also a) operators b) first-line supervisor, c) managers, and d) technical authorities)** | • Number of actual or near-misses, LOPC events, plant trips, equipment damage linked to  
a) trainees  
b) lack of technical understanding  
c) lack of experience  
d) inadequate training  
e) absence of skills in team  
• Number of workers in each personnel category whose training is overdue  
• % time that asset integrity/process safety critical positions have gone unstaffed | • % personnel assessed to be i) partly, ii) fully, and iii) exceeding local competence criteria for all asset integrity/process safety critical roles in each personnel category  
• Number and outcome of periodic reviews to check accuracy of asset/process knowledge |
| **Operational procedures** | • Number of operational errors due to incorrect/unclear procedures  
• Number of operational shortcuts identified by near misses and incidents  
• Number of PHA recommendations related to inadequate operating procedures | • % of procedures reviewed and updated versus plan |
| **Inspection & maintenance (focused on equipment critical to asset integrity/process safety)** | • Number of actual or near-miss LOPC events where inadequate inspection or maintenance  
• Number of non-routine and emergency maintenance work orders  
• No. of process leaks identified during operation or downtime  
• Number of temporary repairs or deferred maintenance items in service  
• % of safety-critical plant/equipment that performs to specification when tested was a causal factor | • % maintenance plan completed on time  
• % of planned preventative maintenance versus total maintenance (including unplanned) |
<table>
<thead>
<tr>
<th>Barrier/risk control system</th>
<th>Example KPI (Tier 3)</th>
<th>Example KPI (Tier 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant design</td>
<td>• Number of incidents or near-misses where errors in plant design are identified as a contributory cause</td>
<td>• Number of post-startup modifications required by Operations</td>
</tr>
<tr>
<td></td>
<td>• Number of deviations from applicable codes and standards</td>
<td>• Number of deviations from applicable codes and standards</td>
</tr>
<tr>
<td></td>
<td>• % safety-critical equipment/systems fully in compliance with current design codes</td>
<td>• % safety-critical equipment/systems fully in compliance with current design codes</td>
</tr>
<tr>
<td>Safety instrumentation and alarms (SIA)</td>
<td>• Total number of SIA activations reported by operations</td>
<td>• Mean time between alarm activations and operator responses</td>
</tr>
<tr>
<td></td>
<td>• Total number of SIA faults reported during tests</td>
<td>• % relevant personnel trained on S&amp;S prior to commencing S&amp;S</td>
</tr>
<tr>
<td></td>
<td>• Alarms per hour</td>
<td>• % relevant personnel present during S&amp;S versus plan</td>
</tr>
<tr>
<td>Start-ups and shutdowns (S&amp;S)</td>
<td>• Number of near-misses or incidents during S&amp;S</td>
<td>• Number of individual SIA tests versus schedule</td>
</tr>
<tr>
<td></td>
<td>• Number of deferred start-ups and unplanned shutdowns</td>
<td>• Number of individual SIA tests versus schedule</td>
</tr>
<tr>
<td>Management of change (MOC)</td>
<td>• Number of actual or near-miss LOPC where inadequate MOC was a causal factor</td>
<td>• Number of planned MOCs performed and time taken</td>
</tr>
<tr>
<td></td>
<td>• % MOCs for which the drawings or procedures were not updated</td>
<td>• % plant changes suitably risk assessed and approved before installation</td>
</tr>
<tr>
<td></td>
<td>• Number of emergency or temporary MOCs</td>
<td>• Average time taken to fully implement a change once approved</td>
</tr>
<tr>
<td>Permit to work (PTW)</td>
<td>• % incidents/near misses during work covered by a PTW</td>
<td>• Number of PTW issued</td>
</tr>
<tr>
<td></td>
<td>• % PTWs sampled which failed to identify all hazards or specify suitable controls</td>
<td>• Average time per permit spent on writing, reviewing, and approving PTW</td>
</tr>
<tr>
<td>Contractor Management</td>
<td>• Asset integrity and general safety KPIs for contractor companies, average for all clients and when under contract to company</td>
<td>• % required contractor training conducted on schedule</td>
</tr>
<tr>
<td></td>
<td>• Number and % of open/unresolved contractor safety suggestions</td>
<td>• Frequency of, and percentage attendance during, contractor safety meetings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Percentage of qualification audits/checks/criteria met prior to entry</td>
</tr>
<tr>
<td>Emergency management</td>
<td>• Number of emergency response elements that are not fully functional when activated in a) a real emergency</td>
<td>• Number of emergency exercises on schedule and total staff time involved</td>
</tr>
<tr>
<td></td>
<td>b) an emergency exercise</td>
<td>• % of staff who have participated in an emergency exercise</td>
</tr>
<tr>
<td>Compliance with standards</td>
<td>• Number of compliance violations related to asset integrity/process safety</td>
<td>• Number of emergency equipment and shutdown devices tested versus schedule</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• % of existing standards reviewed as per schedule to ensure evergreen status</td>
</tr>
</tbody>
</table>
Determining whether to report a Recordable Process Safety Event (PSE)

With reference to the six tables in Appendix B, the flow chart recommends four questions to ask when determining if a LOPC or PRD activation is recordable as a Process Safety Event (PSE) for the purpose of OGP benchmarking.

1. **Was the event the result of an LOPC or PRD discharge from part of a production or drilling process?** (See Sections 3.4 and 3.5 and definitions in Appendix B)
   - **Yes**
     - **Yes**
       - Event is OGP recordable by the Company as a PSE and should be classified as either Tier 1 or Tier 2
     - **No**
       - Event is not OGP recordable but may be reportable by the Company as part of a broader or different KPI

2. **Did the event (LOPC or PRD activation) result in an incident with any of the harmful or damaging consequences listed in Table 1?**
   - **Yes**
     - Event is OGP recordable by the Company as a PSE and should be classified as either Tier 1 or Tier 2
   - **No**

3. **If LOPC, as noted in Table 2, did the amount of the material released exceed any threshold in Tables 4-6?**
   - **Yes**
     - Event is OGP recordable by the Company as a PSE and should be classified as either Tier 1 or Tier 2
   - **No**

4. **If PRD activation, did the material release (either directly to atmosphere or via flare or other destructive device) exceed any threshold listed in Tables 4-6 as well as any of the four consequences in Table 3?**
   - **Yes**
     - Event is OGP recordable by the Company as a PSE and should be classified as either Tier 1 or Tier 2
   - **No**

Event is not a Tier 1 or Tier 2 PSE and not OGP recordable but the Company may report the event within one of its internal process safety KPIs (i.e. at Tier 3)
As described in the report, practical implementation of the Process Safety Event (PSE) KPIs can be challenging due to the complexity of applying the hierarchy of Tier 1 and Tier 2 definitions and consequences as listed in Section 3.1 of this report, which are in turn reproduced from the API/ ANSI Standard Recommended Practice (RP) 754: Process Safety Performance Indicators for the Refining and Petrochemical Industries. Companies implementing the Tier 1 and 2 KPIs in this report should use RP 754 as a source document for detailed definitions and guidance. However, RP 754 was developed for the refining and petrochemical industry, and not specifically for the upstream oil & gas industry.

In order to gain the KPI consistency and benchmarking value that took many years to achieve for personal safety, OGP have aligned definitions in this report with RP 754 but offers guidance on how to implement the Tier 1 and Tier 2 KPIs for recording PSEs in upstream operations. As an aid to implementation, this Appendix provides further detail in the form of six tables which summarise the hierarchy of LOPC (and PRD discharge) consequences and thresholds in RP 754. The tables are intended to be used to help companies decide whether an LOPC or PRD discharge should be recorded as a PSE.

Table B–1 below lists the consequences related to harm to people of damage to property which would result in a Tier 1 or Tier 2 PSE. However most PSE recorded by companies are unlikely to result in significant acute harm or damage, but instead result from an LOPC or PRD discharge which has exceeded material release thresholds as described below in Table B–2 or B–3, respectively. The relevant thresholds for the amount of material released are based on Tier 1 and Tier 2 categories listed in RP 754, which are in turn based on international UNDG regulations for transport of materials. To help companies, examples of materials commonly found in upstream operations are provided in Tables B–3 to B–6. However, companies may need to provide more detailed guidance on hydrocarbon mixtures or other gases or liquids specific to their operations.

It should be noted that when an event results in multiple thresholds exceeded, the PSE should be recorded at the highest Tier applicable to any one of the exceeded thresholds. A downloadable supplement to this report may be downloaded from the OGP website that also provides examples of PSEs which help demonstrate how these tables are applied in practice.

Appendix A provides a flow chart which may be helpful in understanding how to use the following six tables.

---

**Table B–1 (of 6): Thresholds for LOPC resulting in actual harm or damage**

<table>
<thead>
<tr>
<th>LOPC or PRD discharge is recordable as a PSE when it results in one or more of the consequences in this table (irrespective of the amount of material released)</th>
<th>PSE Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury to Employee or Contractor</td>
<td>Fatality and/or Lost Workday Case (‘days away from work’ or LTI)</td>
</tr>
<tr>
<td>Injury to Third Party</td>
<td>Fatality, or injury/illness that results in a hospital admission</td>
</tr>
<tr>
<td>Impact to the Community</td>
<td>Officially declared community evacuation or community shelter-in-place</td>
</tr>
<tr>
<td>Fire or Explosion</td>
<td>Fire or Explosion resulting in greater than or equal to $25,000 of direct cost to the Company</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Fire or Explosion resulting in greater than or equal to $2,500 of direct cost to the Company</td>
</tr>
</tbody>
</table>
### Table B–2 (of 6): Thresholds for LOPC material releases

<table>
<thead>
<tr>
<th>LOPC is recordable as a PSE, even when no serious harm or damage results, if the amount of material released exceeds specified thresholds</th>
<th>PSE Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tier 1</strong></td>
<td><strong>Tier 2</strong></td>
</tr>
<tr>
<td>An LOPC release of a gas or liquid exceeds the material release threshold quantities in any one hour period</td>
<td>See Tables B–4, 5 or 6 for Tier 1 threshold quantities</td>
</tr>
</tbody>
</table>

### Table B–3 (of 6): Thresholds for PRD discharges

<table>
<thead>
<tr>
<th>A PRD discharge event is recordable as a PSE if it results in serious harm or damage, or exceeds the material release threshold quantities while resulting in any of four listed criteria</th>
<th>PSE Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tier 1</strong></td>
<td><strong>Tier 2</strong></td>
</tr>
</tbody>
</table>
| A pressure relief device (PRD) discharges either directly to atmosphere or to a destructive device (e.g. flare, scrubber) | Event results in a Tier 1 PSE if the consequence is listed in Table B–1, regardless of the quantity released, or Event results in any of:  
  - liquid carryover, or  
  - discharge to a potentially hazardous location, or  
  - on-site shelter in place, or  
  - public protective measures, and quantity discharged equals or exceeds any Tier 1 threshold in Tables B–4, 5 or 6 | Event results in a Tier 2 PSE if the consequence is listed in Table B–1, regardless of the quantity released, or Event results in any of:  
  - liquid carryover, or  
  - discharge to a potentially hazardous location, or  
  - on-site shelter in place, or  
  - public protective measures, and quantity discharged equals or exceeds any Tier 2 threshold in Tables B–4, 5 or 6 |
LOPC is recordable as a PSE only when release is ‘acute’, i.e. exceeds a threshold quantity in any one hour period. PSE Tier is highest of all that apply.

<table>
<thead>
<tr>
<th>Material hazard classification (with example materials)</th>
<th>Outdoor release</th>
<th>Indoor release</th>
<th>Outdoor release</th>
<th>Indoor release</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flammable Gases</strong> – e.g. methane, ethane, propane, butane, natural gas, ethyl mercaptan</td>
<td>500 kg (1,100 lb) (Cat.5)</td>
<td>250 kg (550 lb) (Cat.5)</td>
<td>50 kg (110 lb) (Cat.5)</td>
<td>25 kg (55 lb) (Cat.5)</td>
</tr>
<tr>
<td><strong>Flammable Liquids with Boiling Point ≤ 35°C (95°F) and Flash Point &lt; 23°C (73°F)</strong> – e.g. liquefied petroleum gas (LPG), liquefied natural gas (LNG) isopentane</td>
<td>500 kg (1,100 lb) (Cat.5)</td>
<td>250 kg (550 lb) (Cat.5)</td>
<td>50 kg (110 lb) (Cat.5)</td>
<td>25 kg (55 lb) (Cat.5)</td>
</tr>
<tr>
<td><strong>Flammable Liquids with Boiling Point &gt; 35°C (95°F) and Flash Point &lt; 23°C (73°F)</strong> – e.g. gasoline/petrol, toluene, xylene, condensate methanol &gt; 15 API Gravity crude oils (unless actual flashpoint available)</td>
<td>1,000 kg (2,200 lb) or 7 bbl (Cat.6)</td>
<td>500 kg (1,100 lb) or 3.5 bbl (Cat.6)</td>
<td>100 kg (220 lb) or 1 bbl (Cat.6)</td>
<td>50 kg (110 lb) or 0.5 bbl (Cat.6)</td>
</tr>
<tr>
<td><strong>Combustible Liquids with Flash Point ≥ 23°C (73°F) and ≤ 60°C (140°F)</strong> – e.g. diesel, most kerosenes, &lt; 15 API Gravity crude oils (unless actual flashpoint available)</td>
<td>2,000 kg (4,400 lb) or 14 bbl (Cat.7)</td>
<td>1,000 kg (2,200 lb) or 7 bbl (Cat.7)</td>
<td>100 kg (220 lb) or 1 bbl (Cat.6)</td>
<td>50 kg (110 lb) or 0.5 bbl (Cat.6)</td>
</tr>
<tr>
<td><strong>Liquids with Flash Point &gt; 60°C (140°F)</strong> released at a temperature at or above its flash point – e.g. asphalts, molten sulphur, ethylene glycol, propylene glycol lubricating oil</td>
<td>2,000 kg (4,400 lb) or 14 bbl (Cat.7)</td>
<td>1,000 kg (2,200 lb) or 7 bbl (Cat.7)</td>
<td>100 kg (220 lb) or 1 bbl (Cat.6)</td>
<td>50 kg (110 lb) or 0.5 bbl (Cat.6)</td>
</tr>
<tr>
<td><strong>Liquids with Flash Point &gt; 60°C (140°F)</strong> released at a temperature below its flash point – e.g. asphalts, molten sulphur, ethylene glycol, propylene glycol lubricating oil</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>1,000 kg (2,200 lb) or 10 bbl (Cat.7)</td>
<td>500 kg (1,100 lb) or 5 bbl (Cat.7)</td>
</tr>
</tbody>
</table>
LOPC is recordable as a PSE only when release is “acute” i.e. exceeds a threshold quantity in any one hour period. PSE Tier is highest of all that apply.

<table>
<thead>
<tr>
<th>Material hazard classification (with example materials)</th>
<th>Outdoor release</th>
<th>Indoor release</th>
<th>Outdoor release</th>
<th>Indoor release</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TIH Hazard Zone A materials – includes:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• acrolein (stabilised)</td>
<td>5 kg (11 lb) (Cat.1)</td>
<td>2.5 kg (5.5 lb) (Cat.1)</td>
<td>0.5 kg (1 lb) (Cat.1)</td>
<td>0.25 kg (0.5 lb) (Cat.1)</td>
</tr>
<tr>
<td>• bromine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TIH Hazard Zone B materials – includes:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• hydrogen sulphide (H₂S),</td>
<td>25 kg (55 lb) (Cat.2)</td>
<td>12.5 kg (27.5 lb) (Cat.2)</td>
<td>2.5 kg (5.5 lb) (Cat.2)</td>
<td>1.3 kg (2.8 lb) (Cat.2)</td>
</tr>
<tr>
<td>• chlorine (Cl₂)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TIH Hazard Zone C materials – includes:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• sulphur dioxide (SO₂)</td>
<td>100 kg (220 lb) (Cat.3)</td>
<td>50 kg (110 lb) (Cat.3)</td>
<td>10 kg (22 lb) (Cat.3)</td>
<td>5 kg (11 lb) (Cat.3)</td>
</tr>
<tr>
<td>• hydrogen chloride (HCl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TIH Hazard Zone D materials – includes:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• ammonia (NH₃)</td>
<td>200 kg (440 lb) (Cat.4)</td>
<td>100 kg (220 lb) (Cat.4)</td>
<td>20 kg (44 lb) (Cat.4)</td>
<td>10 kg (22 lb) (Cat.4)</td>
</tr>
<tr>
<td>• carbon monoxide (CO)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other Packing Group I Materials – includes:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• aluminum alkyls</td>
<td>500 kg (1,100 lb) (Cat.5)</td>
<td>250 kg (550 lb) (Cat.5)</td>
<td>50 kg (110 lb) (Cat.5)</td>
<td>25 kg (55 lb) (Cat.5)</td>
</tr>
<tr>
<td>• some liquid amines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• sodium cyanide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• sodium peroxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• hydrofluoric acid (&gt;60% solution)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other Packing Group II Materials – includes:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• aluminum chloride</td>
<td>1,000 kg (2,200 lb) or 7 bbl (Cat.6)</td>
<td>500 kg (1,100 lb) or 3.5 bbl (Cat.6)</td>
<td>100 kg (220 lb) or 1 bbl (Cat.6)</td>
<td>50 kg (110 lb) or 0.5 bbl (Cat.6)</td>
</tr>
<tr>
<td>• phenol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• calcium carbide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• carbon tetrachloride</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• some organic peroxides</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• hydrofluoric acid (&lt;60% solution)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table B–6 (of 6): Other Material Release Threshold Quantities for LOPC

LOPC is recordable as a PSE only when release is “acute” i.e. exceeds a threshold quantity in any one hour period. PSE Tier is highest of all that apply.

<table>
<thead>
<tr>
<th>Material hazard classification (with example materials)</th>
<th>Tier 1 (Categories below refer to API/ANSI standard RP 754)</th>
<th>Tier 2 (Categories below refer to API/ANSI standard RP 754)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor release</td>
<td>Indoor release</td>
<td>Outdoor release</td>
</tr>
<tr>
<td>Other Packing Group III materials – includes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• sulphur</td>
<td>2,000 kg (4,400 lb) or 14 bbl (Cat.7)</td>
<td>1,000 kg (2,200 lb) or 7 bbl (Cat.7)</td>
</tr>
<tr>
<td>• lean amine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• calcium oxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• activated carbon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• chloroform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• some organic peroxides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• sodium fluoride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• sodium nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong Acids or Bases – includes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• sulphuric acid, hydrochloric acid</td>
<td>2,000 kg (4,400 lb) or 14 bbl (Cat.7)</td>
<td>1,000 kg (2,200 lb) or 7 bbl (Cat.7)</td>
</tr>
<tr>
<td>• sodium hydroxide (caustic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• calcium hydroxide (lime)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate Acids or Bases – includes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• diethyamine (corrosion inhibitor)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

Glossary of terms and definitions

Asset integrity
Asset integrity is related to the prevention of major incidents. It is an outcome of good design, construction and operating practice. It is achieved when facilities are structurally and mechanically sound and perform the processes and produce the products for which they were designed.

Barriers
A functional grouping of safeguards, such as primary containment, process equipment, engineered systems, operational procedures, management system elements, or worker capabilities designed to prevent LOPC and other types of asset integrity or process safety events, and mitigate any potential consequences of such events. A set of barriers is also often referred to as a risk control system.

Company
When designated with a capital C or “the Company”, refers to the specific oil & gas industry company reporting the KPIs. The Company may be an OGP member or its reporting boundary should include its divisions and its consolidated affiliates/subsidiaries. For guidance on general reporting boundaries, please see reference 17 (Oil and gas industry guidance on voluntary sustainability reports), Appendix A (Detailed guidance on developing a reporting boundary).

Company employee
Any person employed by and on the payroll of the reporting Company, including corporate and management personnel specifically involved in exploration and production. Persons employed under short-service contracts are included as Company employees provided they are paid directly by the Company.

Construction
Major construction, fabrication activities and also disassembly, removal and disposal (decommissioning) at the end of the facility life. Includes construction of process plant, yard construction of structures, offshore installation, hook-up and commissioning, and removal of redundant process facilities.

Contractor
An individual or organization performing work for the reporting company, following verbal or written agreement. ‘Sub-contractor’ is synonymous with ‘Contractor’.

Contractor employee
Any person employed by a Contractor or Contractor’s Sub-Contractor(s) who is directly involved in execution of prescribed work under a contract with the reporting Company.

Direct cost
Cost of repairs or replacement, cleanup, material disposal, environmental remediation and emergency response.

Direct cost does not include indirect costs, such as business opportunity, business interruption and feedstock/product losses, loss of profits due to equipment outages, costs of obtaining or operating temporary facilities, or costs of obtaining replacement products to meet customer demand. Direct cost does not include the cost of the failed component leading to LOPC, if the component is not further damaged by the fire or explosion.

Drilling
All exploration, appraisal and production drilling and workover as well as their administrative, engineering, construction, materials supply and transportation aspects. It includes site preparation, rigging up and down and restoration of the drilling site upon work completion. Drilling includes all exploration, appraisal and production drilling.

Escalation
The process by which an initial – sometimes small – event triggers a further – sometimes larger – event that may be classified as a near miss or an incident

Event
An unplanned or uncontrolled outcome of a business operation or activity that has or could have contributed to an injury, illness or physical damage or environmental damage.

Exploration
Geophysical, seismographic and geological operations, including their administrative and engineering aspects, construction, maintenance, materials supply, and transportation of personnel and equipment; excludes drilling.

Explosion
A release of energy resulting from an LOPC that causes a pressure discontinuity or blast wave (e.g. detonations, deflagrations, and rapid releases of high pressure caused by rupture of equipment or piping).

Fire
Any combustion resulting from an LOPC, regardless of the presence of flame. This includes smoldering, charring, smoking, singeing, scorching, carbonizing, or the evidence that any of these have occurred.

First Aid
A consequence of an event that required medical attention, often consisting of one-time, short-term treatment and requiring little technology or training to administer. First aid can include cleaning minor cuts, scratches, or burns; treating a minor burn; applying bandages and dressings; the use of non-prescription medicine; draining blisters; removing debris from the eyes; massage; and drinking fluids to relieve heat stress. A full list of 14 first aid treatments is provided by OGP in Reference 18. First aid cases are not classified as recordable incidents for the purpose of reporting to OGP but may be used by companies as a criterion for reporting of events as Tier 3 KPIs.

High potential event
Any event (incident or near miss) that could have resulted in one or more fatalities but had the potential to do so in other circumstances.

Hospital admission
Formal acceptance by a hospital or other inpatient health care facility of a patient who is to be provided with room, board, and medical service in an area of the hospital or facility where patients generally reside at least overnight. Treatment in the hospital emergency room or an overnight stay in the emergency room would not by itself qualify as a ‘hospital admission’.

Hours worked
The actual ‘hours worked’, including overtime hours, are recorded in the case of onshore operations. The hours worked by an individual will generally be about 2,000 per year.
For offshore workers, the ‘hours worked’ are calculated on a 12-hour work day. Consequently average hours worked per year will vary from 1,600 to 2,300 hours per person depending upon the on/off shift ratio. Vacations and leaves are excluded.
For drilling, hours worked includes all activities whether the operation is ‘in hole’ or not ‘in hole’.

Incident
An event or chain of events that has resulted in recordable injury, illness or physical damage or environmental damage.
Key Performance Indicator (KPI)
Information or data that provides evidence of a company’s performance in managing its key risks, which in this guide are those risks related to asset integrity and process safety. KPIs may also be referred to as performance metrics.

Lost Time Injury (LTI)
A fatality or lost work day case. The number of LTIs is the sum of fatalities and lost work day cases.

Lost Time Injury Frequency (LTIF)
The number of lost time injuries (fatalities + lost work day cases) per 1,000,000 work hours.

Lost Work Day Case (LWDC)
Any occupational injury or illness, other than a fatal injury, which results in a person being unfit for work on any day after the day of occurrence of the occupational injury. ‘Any day’ includes rest days, weekend days, leave days, public holidays or days after ceasing employment. A LWDC is a recordable incident.

Loss of Primary Containment (LOPC)
An unplanned or uncontrolled release of any material from primary containment, including non-toxic and non-flammable materials (e.g. steam, hot condensate, nitrogen, compressed CO₂, or compressed air). For drilling operations, any unplanned or uncontrolled release to the surface (seabed or ground level) should be included. LOPC is a type of event. An unplanned or uncontrolled release is an LOPC irrespective of whether the material is released into the environment, or into secondary containment, or into other primary containment not intended to contain the material released under normal operating conditions.

Major incident
An incident that has resulted in multiple fatalities and/or serious damage, possibly beyond the asset itself. Typically a major incident is initiated by an LOPC event, but may also result from major structural failure or loss of stability that has caused serious damage to an asset. (Note this definition is intended to incorporate terms such as "Major Accident" as defined by UK HSE).

Medical Treatment Case (MTC)
A recordable incident involving injury or illness that has required management and care of the patient above and beyond first aid, but not severe enough to be a reportable fatality or lost work day case or restricted work day case.

Mitigation
A barrier which limits consequences, generally by limiting escalation, but which does not prevent the initial event.

Near miss
An event or chain of events that has not resulted in recordable injury, illness or physical damage or environmental damage but had the potential to do so in other circumstances.

Number of employees
Average number of full-time and part-time employees involved in exploration and production, calculated on a full-time basis, during the reporting year.

Number of fatalities
The total number of Company’s employees and/or Contractor’s employees who died as a result of an incident. ‘Delayed’ deaths that occur after the incident are to be included if the deaths were a direct result of the incident. For example, if a fire killed one person outright, and a second died three weeks later from lung damage caused by the fire, both are reported.

Occupational illness
Any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. Occupational illness may be caused by inhalation, absorption, ingestion of, or direct contact with the hazard, as well as exposure to physical and psychological hazards. It will generally result from prolonged or repeated exposure. Refer to OGP/IPIECA Report No. 393, Health Performance Indicators (2007).

Occupational injury
Any injury such as a cut, fracture, sprain, amputation, etc. which results from a work-related activity or from an exposure involving a single incident in the work environment, such as deafness from explosion, one-time chemical exposure, back disorder from a slip/trip, insect or snake bite.

Officially declared
A declaration by a recognised community official (e.g. fire, police, civil defense, emergency management) or delegate (e.g. Company official) authorised to order the community action (e.g. shelter-in-place, evacuation).

Offshore work
All activities and operations that take place at sea, including activities in bays, in major inland seas, such as the Caspian Sea, or in other inland seas directly connected to oceans. Events involving transportation of people and equipment from shore to the offshore location, either by vessel or helicopter, should be recorded as ‘offshore’.

Onshore work
All activities and operations that take place within a landmass, including those on swamps, rivers and lakes. Land-to-land aircraft operations are counted as onshore, even though flights may be over water.

Pressure Relief Device (PRD)
A device designed to open and relieve excess pressure (e.g. safety valve, thermal relief, rupture disk, rupture pin, deflagration vent, pressure/vacuum vents).

Primary containment
A tank, vessel, pipe, truck, rail car, or other equipment designed to keep a material within it, typically for purposes of storage, separation, processing or transfer of gases or liquids. The terms vessel and pipe are taken to include containment of reservoir fluids within the casing and wellhead valving to the surface. Note that primary containment for a specified material may comprise a vessel or pipe that is inside another vessel that is also designed as primary containment for a different material; for example, a heating tube is primary containment for fuel gas or fuel oil, even though the tubes may be inside a firebox which is in turn within an oil-water separator.

Process
Facilities used in drilling and production operations in the oil & gas industry. This includes rigs and process equipment (e.g. vessels, piping, valves, boilers, generators, pumps, compressors, exchangers, refrigeration systems) and includes storage tanks, ancillary support areas (e.g. boiler houses and waste water treatment plants), on-site remediation facilities, and distribution piping under control of the Company.
**Process safety**

Process safety is a disciplined framework for managing the integrity of operating systems and processes handling hazardous substances by applying good design principles, engineering, and operating and maintenance practices. It deals with the prevention and control of events with the potential to release hazardous materials and energy. Such releases can result in toxic effects, fire, explosion, and could ultimately result in serious incidents including fatalities, injuries, property damage, lost production and environmental damage.

**Process Safety Event (PSE)**

A Loss of Primary Containment (LOPC) from a process that meets the Tier 1 or Tier 2 definitions in this guide. A PSE is a Key Performance Indicator (KPI) and is recordable. For the purpose of recording a PSE:
- Drilling facilities are considered to be part of a process when operations are ‘in-hole’.
- Land or marine vessels (trucks and ships) are considered to be part of a process when physically connected to a production facility.

**Process Safety Event Rate (PSER)**

The number of process safety events per 1,000,000 (1 million) work hours (production and drilling work hours only).

**Production**

Petroleum and natural gas producing operations, including their administrative and engineering aspects, minor construction, repairs, maintenance and servicing, materials supply, and transportation of personnel and equipment. It covers all mainstream production operations including pipeline. Gas processing activities with the primary intent of producing gas liquids for sale including:
- secondary liquid separation (i.e. Natural Gas Liquids (NGL) extraction using refrigeration processing)
- Liquefied Natural Gas (LNG) and Gas to Liquids (GTL) operations

**Recordable**

A type of event or incident, including an LOPC or an occupational injury or illness, or other outcome which has been determined to meet or exceed definitions, criteria or thresholds for inclusion and classification in data provided to OGP (or other agencies or stakeholders). The broader term ‘reportable’ is often used to indicate the wider range of KPI data collected within the company for local or corporate use, of which only part will also be recordable.

**Restricted Work Day Case (RWDC)**

Any work-related injury other than a fatality or lost work day case which results in a person being unfit for full performance of the regular job on any day after the occupational injury. Work performed might be:
- an assignment to a temporary job
- part-time work at the regular job
- working full-time in the regular job but not performing all the usual duties of the job

Where no meaningful restricted work is being performed, the incident should be recorded as a lost work day case (LWDC). This is a recordable incident.

**Secondary containment**

An impermeable physical barrier specifically designed to prevent release of materials into the environment that have already breached primary containment (i.e. an LOPC). Secondary containment systems include, but are not limited to: tank dykes, curbing around process equipment, drainage collection systems into segregated oily drain systems, the outer wall of double walled tanks, etc.

**Tier**

One of the four levels of the OGP framework for asset integrity KPIs as described in this report, which is in turn based on the API/ANSI standard RP 754 (see Reference 6).

**Third party**

A person with no business relation with the Company or contractor.

**Material release threshold quantity**

The weight of gas, liquid, or solid material released from an LOPC which, if exceeded, results in the event being recordable as either a Tier 1 or Tier 2 PSE. The threshold quantities are described more fully in API/ANSI standard RP 754 (see Reference 6) and follow the UNDG classification system.

**Total Recordable Incidents (TRI)**

The sum of fatalities, lost work day cases, restricted work day cases and medical treatment cases.

**United Nations Dangerous Goods (UNDG)**

A classification system used to evaluate the potential hazards of various materials when released, which is used by most international countries as part of the product labeling or shipping information (see Reference 19).

**Unsafe location**

An atmospheric pressure relief device discharge point or downstream destructive device (e.g. flare, scrubber) discharge point that results in a potential hazard, such as the formation of flammable, toxic or corrosive mixtures at grade level or on elevated work structures, or ignition of relief streams at the point of emission.

**Work-related injury**

See occupational injury.
**List of Acronyms**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<tr>
<td>API</td>
<td>American Petroleum Institute</td>
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<tr>
<td>CCPS</td>
<td>Center for Chemical Process Safety</td>
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<tr>
<td>E&amp;P</td>
<td>Exploration and Production</td>
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<td>HIRA</td>
<td>Hazard Identification and Risk Assessment</td>
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<tr>
<td>HSE-MS</td>
<td>Health, Safety and Environment Management System</td>
</tr>
<tr>
<td>IPIECA</td>
<td>International Petroleum Industry Environmental Conservation Association</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator</td>
</tr>
<tr>
<td>LOPC</td>
<td>Loss Of Primary Containment</td>
</tr>
<tr>
<td>LWDC</td>
<td>Lost Work Day Case</td>
</tr>
<tr>
<td>LTI</td>
<td>Lost Time Injury</td>
</tr>
<tr>
<td>LTIF</td>
<td>Lost Time Injury Frequency</td>
</tr>
<tr>
<td>MOC</td>
<td>Management Of Change</td>
</tr>
<tr>
<td>MTC</td>
<td>Medical Treatment Case</td>
</tr>
<tr>
<td>MWE</td>
<td>Management and Workforce Engagement</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Coordination and Development</td>
</tr>
<tr>
<td>PHA</td>
<td>Process Hazard Analysis</td>
</tr>
<tr>
<td>PRD</td>
<td>Pressure Relief Device</td>
</tr>
<tr>
<td>PS</td>
<td>Process Safety</td>
</tr>
<tr>
<td>PSE</td>
<td>Process Safety Event</td>
</tr>
<tr>
<td>PSER</td>
<td>Process Safety Event Rate</td>
</tr>
<tr>
<td>PTW</td>
<td>Permit To Work</td>
</tr>
<tr>
<td>RP</td>
<td>Recommended Practice</td>
</tr>
<tr>
<td>RWDC</td>
<td>Restricted Work Day Case</td>
</tr>
<tr>
<td>SIA</td>
<td>Safety Instrumentation and Alarms</td>
</tr>
<tr>
<td>S&amp;S</td>
<td>Start-ups and Shutdowns</td>
</tr>
<tr>
<td>SOL</td>
<td>Safe Operating Limit</td>
</tr>
<tr>
<td>TIH</td>
<td>Toxic Inhalation Hazard</td>
</tr>
<tr>
<td>TRI</td>
<td>Total Recordable Incidents</td>
</tr>
<tr>
<td>US CSB</td>
<td>US Chemical Safety and hazard investigation Board</td>
</tr>
<tr>
<td>UK HSE</td>
<td>United Kingdom Health and Safety Executive</td>
</tr>
<tr>
<td>UNDG</td>
<td>United Nations recommendations on the transport of Dangerous Goods</td>
</tr>
</tbody>
</table>
Appendix E

Primary references and sources


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