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HEALTH & SAFETY LABORATORY

Major Hazards Industry Performance Indicators Scoping Study

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CONTENTS

EXECUTIVE SUMMARY

The Health and Safety Executive's (HSE's) Major Hazard Strategic Programme is seeking to develop a HSE-wide model to underpin a series of safety performance indicators (SPIs), and asked the Health and Safety Laboratory (HSL) for support with this. HSL recommended that before embarking on an ambitious project to develop an industry wide performance indicators model, a scoping study should first be carried out to establish the extent to which performance indicators are currently used in different industry sectors, and to determine the scale of the work needed to develop an industry wide model.

Objectives

The aims of the scoping study were to:

1) collect literature and material on performance indicators used worldwide in a range of major hazard and other sectors deemed appropriate (e.g. aviation);

2) carry out interviews with HSE stakeholders to identify:

   - the sophistication of the various industry sectors, including for example the existence of management systems, the size of enterprises and the types of organisation;

   - and the extent to which performance indicators are currently being used and the envisaged acceptability of introducing these measures;

3) to identify options and recommendations for the development of Major Hazards Industry Performance Indicators.

Main Findings

The main findings from the scoping study are as follows:

- There is a large volume of published material on performance indicators. The nuclear industry appears to have a strong lead, but many companies in other sectors are also doing things. In most cases, where they are used, performance indicators seem to be developed in the absence of any underlying rationale or model;

- The diversity of industries means that the development of a single performance indicators model is not straightforward. There is a need to ensure that any cross-sector model that is developed is, where possible, consistent and compatible with any frameworks already being used;

- The use of KPIs will need to be voluntary to ensure success; this will require significant work with industry bodies and stakeholders;

- HSE needs to be clear at the outset as to how performance indicator data will be used. Further work will be needed to identify and 'sell' the benefits to companies;The use of performance indicators may not be viable/reasonable for small and medium sized enterprises or decreasing industries.

Recommendations

The following recommendations for further work are made:

- Development of a high level cross sector performance indicators framework;
- Development of generic principles for developing SPIs to accompany the framework;
- Sector specific worked examples of using the model to determine performance indicators;
- Definition of terms;
- Consideration of different scoring mechanisms.

1 INTRODUCTION

The Health and Safety Executive's (HSE's) Major Hazard Strategic Programme (MHSP) is interested in the development of key health and safety performance indicators (SPIs) for major hazard industries. At present, most industries report on lagging indicators (i.e. events that have occurred) that are not necessarily predictive of major hazard accidents as these are low frequency, high consequence events. Furthermore, it is difficult to assess industry progress in terms of reducing the likelihood of these events occurring.

The MHSP is seeking to develop a HSE-wide model to underpin a series of SPIs, and asked the Health and Safety Laboratory (HSL) for support with this. At present, the nuclear industry is piloting the International Atomic Energy Agency (IAEA) Performance Indicators model (IAEA TECDOC 1141, 2000). In addition, more sophisticated PSA targets are being proposed to follow a more evidence-based approach to programme management and performance reporting, and it is thought that wider use of leading performance indicators may also support this area.

HSL recommended that before embarking on an ambitious project to develop an industry wide performance indicators model, a scoping study should first be carried out to address the following questions:

- The scale of the work – is it a straightforward translation of the nuclear sector IAEA model, or is it development work?Are there a large number of existing SPI models or just a handful?
- Are performance indicators well used in all sectors?
- Are any SPI models used appropriate for the range of hazard profiles, size of firms, complexity of operation?

1.1 AIMS AND OBJECTIVES

The purpose of the scoping study is to identify the work required to develop a single model or framework of performance indicators that could be applied across the whole of the Major Hazards sector, and to suggest how this could be done. Before development of such a model can begin, some initial work is needed to identify the scale of the problem and the scope of the work required. The aims of the scoping study are therefore to:

1) collect literature and material on performance indicators used worldwide in a range of major hazard and other sectors deemed appropriate (e.g. aviation);
2) carry out interviews with HSE stakeholders to identify:
   - the sophistication of the various industry sectors, including, for example, the existence of management systems, the size of enterprises and the types of organisation;
   - and the extent to which performance indicators are currently being used and the envisaged acceptability of introducing these measures;
3) to identify options and recommendations for the development of Major Hazards Industry Performance Indicators.

2 LITERATURE SEARCH

A literature search was carried out to explore the following issues:

- Are performance indicators a well-researched area?
- Are they used in all major hazard sectors?
- Do they have supporting models or frameworks?
- Is there any rationale linking the performance indicators to major accident risk potential?

The literature search was constructed as follows:

Sectors: Safety/Major hazards/nuclear/ rail/ chemical/ process safety/ operational /aviation/ military/ offshore.

Key words: Performance Indicators/ Performance measures/ indices/ score sheets/ scorecards/ metrics. Also, measuring performance, measuring effectiveness, early warning systems, leading performance indicators, upstream indicators, safety performance model Any one of: safety; major hazards; nuclear; rail; chemical; process safety; operational; aviation; military; and offshore; plus any one of: performance indicators; performance measures; indices; score sheets; scorecards; metrics. Additionally, any one of: measuring performance; measuring effectiveness; early warning systems; leading performance indicators; upstream indicators; safety performance model.

Only information dated post 1985 was included in the search.

The literature search was carried out by the HSE information services and the following databases were searched: Ebsco Business Corporate, Aerospace and Healsafe, Management and Marketing Abstracts, OSHROM and Energy, Science and Technology (ES&T) journals. Over 500 references and abstracts were identified by the literature search.

To answer the questions the literature search was intended to address, it was not considered necessary to carry out detailed reviews of all identified references, and this would not have been feasible within the time and cost constraints of the scoping study. Instead, all reference titles and abstracts were reviewed to gain an overview of the following issues: the range of industries represented; whether the material identified related to occupational health and safety or major hazard accident risks; and the presence of any patterns in the material.

In this review, the prominence and application of SPIs was investigated; specific examples of indicator application were considered and the outcomes of such applications reviewed. In addition, indicators were considered in more detail with a focus upon potential management and organisational improvements that could be experienced as a result of their application.

An Internet search was also carried out to supplement the information gained from the literature search.

2.1 OVERVIEW OF FINDINGS

The material on performance indicators reviewed was heavily biased towards the nuclear sector, specifically variations of the IAEA model. There is also some work in other sectors, including

aviation, chemical, rail, offshore and military. In addition, the offshore and aviation sectors appear to have developed industry based metrics. This is possibly in part due to the presence of public concern, strong regulation and active industry bodies.

Most performance indicators seem to have been developed in the absence of any underlying rationale or holistic model. There are some suggestions that the use of performance indicators leads to improvements in system safety, but no concrete evidence of this; this is discussed further in section 2.1.1.

The amount of published material on the development of performance indicators within the major hazard industries indicates that this is not a new phenomenon. As the process of making companies safe has evolved, a new tool to aid the goal of zero accidents has risen to prominence. The term Key Safety Performance Indicator (KSPI) encompasses a variety of sub-indicators: lead, lag, barrier or precursor to name a few. Although the terminology may change in each case, the main purpose of indicators is to reduce the frequency of accidents or incidents in the workplace.

2.1.1 Efficacy of performance indicators

There is a lack of literature concerning the success or otherwise of performance indicators, although this may not be altogether surprising. Once performance indicators are identified, whether they are leading, lagging, precursor or otherwise, it is via their reduction that companies judge their programme to be a success or a failure. In many industries, catastrophic failures are so rare that the data required proving the connection between indicator and incident may be years apart, or, if the zero accident goals are reached, may never be established. This paradoxical situation is unique to the leading/precursor indicator; the connection between the lagging indicator and the incident is explicit and therefore without controversy.

There are, however, signs that the application of leading indicators is an effective strategy in the reduction of serious incident frequency. Following a directive to incorporate PI's into an overall strategy to reduce road deaths the European Transport Safety Council has reported a direct relationship between indicator introduction and subsequent death reduction (ETSC Transport Safety Performance Indicators, 2001). There are also company specific examples in which policy change to incorporate indicators has impacted on overall incident frequency (Baxter internet[1], BHP internet[2]), although with both examples the link between indicator introduction and subsequent incident reduction would not stand up to academic scrutiny.

The relationship between KSPI prevalence and industry safety record reliance is also supported by the occurrence of published work in some sectors. Whilst nuclear, aviation and chemical journals outline work done to date concerning the inclusion of safety indicators, other industries are either unwilling or unable to publish similar volumes.

Other industries have attempted to use Key Safety Performance Indicators through adaptation of the performance management system already in use. This process offers a variety of advantages to the companies involved, the primary one being reduction in investment during early stages. Whilst the use of safety performance indicators has excellent face validity - their adoption should help to reduce accident and incident occurrence - little published work supports this correlation. Without this work, those that push for KSPI proliferation throughout all high-risk industry may face justified objections on the basis of cost and added bureaucracy. Complaints of this nature could be circumvented through the promotion or adaptation of existing safety systems in place. In addition, if safety systems are integrated into core management strategies

there is excellent support for their positive impact upon efficiency and therefore profitability. In the real world, however, this argument may seem optimistic.

2.2 SECTOR SPECIFIC FINDINGS

2.2.1 Nuclear Industry

There are numerous examples of IAEA regulation led KSPI interventions within the nuclear industry, many of which focus upon the detail outlined in NEA/CNRA/R(2001)3. Although IAEA guidelines are designed to form a framework by which KSPI can be isolated, a majority of published work in this area focuses upon the alterations required to ensure performance indicators can be used in a meaningful way within existing individual safety management systems (Lee et al, 1996; Dyer 2000; Vidal, 2003, Mandula, 2005; Ohashi, 2001; Weiss, 1991). Indeed, such are the adjustments necessary, when national regulatory differences are considered that only one KSPI is found to be universal amongst all management systems – SCRAMs ((NEA/CSNI/R(2001)11). A SCRAM can be defined as an unplanned emergency nuclear reactor shutdown and can be considered an accurate safety performance indicator. Further research finds that, even for this single universal indicator, variation exists between regulatory bodies with some counting all SCRAMS and others counting only those initiated manually ((NEA/CSNI/R(2001)11).

The US NRC has also commissioned a series of reports concerning the utility and performance of leading safety indicators in nuclear power plants. Organisational factors such as problem solving capacity, diversification of operations and learning were identified; researchers subsequently suggested a link between the demands placed upon management attention and the impact this may have upon their ability to respond to the above factors and hence maintain a safe working environment (Nicholas and Marcus, 1990). Further research has found a correlation between audit type, unsafe act assessment results and safety indicators. Both assessment methods were found to be reliable leading indicators of safety performance in the chemical and nuclear sector (van Hemel, Connelly and Haas, 1991). In addition, Jacobs and Haber (1994) attempted to define and measure organisational factors related to nuclear power plant safety. Their research of previously conducted studies identified 20 performance indicators along with a number of methods by which each indicator could be measured and monitored. Action based research provided good support for their model with implementation resulting in improvements in identification of potential safety issues and probabilistic risk assessment performance.

The World Association of Nuclear Operators (WANO) also has a performance indicator programme (www.wano.org.uk) that supports the exchange of operating experience information by collecting, trending and disseminating nuclear plant performance data in 9 key areas. The data are gathered for a set of quantitative indicators of plant performance that are intended principally for use as a management tool by nuclear operating organisations. WANO published and distributed the first indicator report in 1991 and currently 99 % of the operating power plants report at least seven indicators.

2.2.2 Offshore Industry

The offshore industry has used safety performance indicators for some time, however, companies have now started to share information and rate lagging indicators according to a universal framework. This change, initiated through HSE's Stepchange programme (internet[3]) has the explicit goal of reducing accidents through a cycle of blame free reporting and learning.

During the design and implementation of Stepchange, many problems were encountered that may offer insight into how KSPI's may be introduced industry wide in the future. Integral to the offshore process was ensuring all companies were "on board" and therefore willing to share information. To facilitate this, a collaborative element was introduced to ensure stakeholders were able to offer their opinions; a feedback mechanism ensured these opinions are constantly addressed as time progressed. It was decided that indicator severity would depend upon fatality and potential for fatality. This allowed for a uniform reporting mechanism in which all incidents could be recorded and therefore all activities included. This methodology differs markedly from that suggested by the IAEA; instead of a hierarchical system enforced from the top down, Stepchange relied and continues to rely upon the data to drive policy. Potential criticism of this method, that it is blind to any incidents that have yet to occur, is addressed through the predictive element built into the incident reporting stage. Individuals are requested to rate incidents based upon what might have happened; in doing so they are required to consider outcomes in much the same way that an individual may be asked to spot potential safety indicators. Of course, this process is still framed by the originating accident, however, in this case the framing allows the system to remain flexible and manageable by all staff members. In addition, the simplicity of the rating system ensures that all individuals can understand and classify accidents; they therefore take ownership of the indicator scheme, an effect that has been repeatedly positively correlated with safety improvements in the past.

Although Stepchange includes hydrocarbon release incidents in its reporting framework these events are also recorded on a bespoke Hydrocarbon Release Database (HRD). Results from offshore and onshore installations are collated, and, working in partnership with the HSE, targets are set for release reduction. Whilst classified as a lagging indicator, hydrocarbon release incident rates can also give valuable information regarding the condition of physical and human on site assets. Indeed, the HRD came about as a result of recommendations made by Lord Cullen following the Piper Alpha disaster and its value has been recognised by safety authorities and industry alike.

2.2.3 Aviation Industry

Performance indicators have been used in the aviation industry for many years although, again, this process has taken place on an individual basis rather than at an industrial level (Tennant, 2003; Statler, 1997). Recent cross cutting initiatives have seen this isolationist approach replaced with an industry wide initiative (Chidester, 2001). The Global Analysis and Information Network (GAIN) has been established by the Federal Aviation Administration (FAA) with the objective of reaching "zero accident status" within 10 years (Gosling, 1998). The concept of GAIN is to develop a privately owned and operated international information infrastructure in which data concerning the effective and safe management of the airline industry is stored and analysed (Gosling, 1998). Using information extracted from sources such as digital flight recorders and Air Traffic Control (ATC) systems, trends are detected that allow problems to be identified before accidents occur.

The success or otherwise of the GAIN programme is difficult to determine. The rarity of major accidents means it will take many years before any meaningful conclusions can be made. It is clear, however, that this system displays excellent face validity and can be considered similar to those KSPI programmes applied in the nuclear sector. GAIN is interesting as it is almost completely automated; once the key indicators have been identified logging is completed via computer and statistics compiled as companies go about their day-to-day business. This methodology has disadvantages – the statistics gathered are only as good as the indicators

identified, however, automated analysis may well reduce Hawthorne effects and therefore give a true representation of the shop floor.

The air sector represents an interesting example of a high reliability industry that has evolved through adaptation to deal with the suite of safety issues presented to it. Whilst many other safety critical sectors can be viewed as closed environments in which cause and effect is both predictable and manageable, aviation represents a more chaotic backdrop in which incidents can be difficult to trace and understand. Near miss reporting, for example, can be utilised as an indicator of safety problems; however, this is only possible if the system used is both fair and accountable. Inappropriate apportioning of blame, or even the existence of a blame culture, can seriously affect participation in these schemes and therefore prevent lessons being learned. As such two successful examples of incident reporting systems, BASIS (British Airways Safety Information System) and ASRS (Aviation Safety Reporting System) both emphasise the following key requirements:

- Indemnity against disciplinary proceedings (as far as possible);
- Confidentiality;
- Separate body or agency to handle reports;
- Rapid feedback;
- Ease of use.

(Reason, 1997)

In addition, in the aviation sector there is a UK industry confidential reporting system (CHIRP: Confidential Human Factors Incident Reporting Programme) that is seen as an essential safety net to pick up incidents not reported elsewhere; it has been running for about 20 years and is a UK industry wide approach, independent of the regulator and others (Gadd et al. 2005).

2.2.4 Chemical Industry

In 2003 HSL investigated the underlying causes of 718 chemical accidents over an 11-year period. Conclusions suggested 81% of these came about as a consequence of ineffective risk management strategies (Collins et al, 2003). The chemical industry agreed to work to reduce incident numbers, and, through the Chemical Industries Association, undertook a review of strategies that could help to achieve this reduction. Performance indicators were highlighted as a good potential option although this was with the proviso that certain controls were in place. As with the nuclear and offshore sectors, intra-industry diversity ensured that a fixed suite of indicators was out of the question. Instead, a plant level model was suggested with indicators originating directly from areas in which risk management was required most. In addition, it was suggested that indicator number should be kept to a minimum in order to reduce exposure fatigue (Shikdar et al, 2003). In many respects, the work carried out through the CIA was more complex than that attempted through the GAIN programme. Whereas airline companies may have had their indicators chosen for them as a result of the infrequency of dangerous incidents, certain sectors of the chemical industry encounter potentially hazardous scenarios on a daily basis. Each scenario has to be identified, investigated and rated according to experience and opinion. Through this process, most reasonably sized chemical manufacturers have developed a bespoke list of risk indicators that are utilised to improve overall site safety e.g. GE, Dupont, Aldrich.

2.2.5 Rail industry

Whilst there is a lack of published academic research concerning the use of KSPIs in the rail sector (Muttram, 1993; Peterson, 2001) the Rail Safety and Standards Board (RSSB) have adopted PIs in a practical approach to aid the identification of safety performance. The RSSB have utilised a precursor indicator methodology (Precursor Indicator Model outlined in internet[4]), choosing to focus upon the potential that an incident has to indicate underlying systemic problems. Rail accident precursors can range from the number of Signals Passed at Danger (SPADs) through to the number of broken rail reports or landslip frequency. Precursor performance data are compared year on year to further understanding of the relationship between the indicators used and relevant outcome measures (accident/incident rates etc).

Interestingly, what could be assumed to be a simple task, such as classifying SPADs, actually involves a highly complex classification system. Some SPADs represent a minor risk, and, as such, are rated lower than those that might have more serious consequences. In addition, potential passenger involvement must be included leading to over 18 error types. There are parallels between PI identification problems in all industries identified in this report. How do companies successfully choose incidents to measure i.e. that relate directly to underlying causes and how do these measurements evolve over time? As technology improves, what could be classed as an accident precursor may progress to be a simple incident precursor that requires no intervention and therefore no action.

As in the aviation sector, there is also a confidential reporting system for the rail industry, CIRAS (Confidential Incident Reporting and Analysis System) that started as a pilot system in 1999. CIRAS collects information from railway personnel on safety concerns that may not be captured in other ways; however within the industry there are mixed views as to whether CIRAS helps with the identification of lessons (Gadd et al. 2005).

2.2.6 Brief comparison of sector approaches

Issues concerning variance in KSPI implementation in the nuclear sector highlight the problems inherent in attempting to develop a universal regulatory framework for the identification and management of KSPI's. Although nuclear power station maintenance is by no means simple, the process is similar whether it is occurring in the UK or Argentina; energy is released from nuclear material in a controlled fashion to produce heat. Despite these similarities each indicator programme in its completed and operational form is almost entirely unique. The relative levels of homogeneity experienced in the nuclear industry are not representative of other high-risk environments that could benefit from a universal regulatory framework. Chemical or explosives regulation may require the integration of a wide spectrum of activities ranging from the lone fireworks traders through to multinational chemical-manufacturing firms. It is for this reason, perhaps, that these companies seem to have entered into the KSPI arena individually, developing their own frameworks in house or through loose knit associations.

Similarities between the programmes outlined to this point are numerous. The introduction of each system has been catalysed through the auspices of a voluntary governing body or association. This process has allowed companies to share information with the knowledge that all participants are in the same position. The inclusion of an independent third party may also have allowed for the effective identification and resolution of issues without claims of favouritism or dominance by one company over another. Interestingly, however, the methodology of each programme has varied to some extent. Whilst the chemical and offshore industries were happy to adopt a grounded approach in which the data drove the identification process bottom up, the nuclear and aviation sectors both looked to adopt a top down hierarchical system. Whilst the success of each methodology is difficult to judge, it may be fair to assume

that bottom up structures offer more in the way of flexibility and therefore ease of adaptation, however this flexibility may come at the cost of empirical validity and increased chances of blind spots in the risk identification process.

3 STAKEHOLDER CONSULTATION

3.1 FACT FINDING ACTIVITIES

The aim of the stakeholder consultation was to carry out interviews with HSE stakeholders to identify:

- the sophistication of the various industry sectors, including for example the existence of management systems, the size of enterprises and the types of organisation;
- and the extent to which performance indicators are currently being used and the envisaged acceptability of introducing these measures.

Due to time constraints of the scoping study, stakeholder interviews were limited to those attending the Major Hazards Strategic Programme Cross-Cutting Project CC4 – Learning and Performance. The findings from these interviews are summarised in Appendix 1.

In addition to the HSE stakeholder interviews, the following other fact finding activities were carried out:

- a half day meeting with Vince Green and Ana Gomez from NSD to discuss the IAEA model and its development;
- attendance at a workshop by Ian Travers on HID performance indicators;
- a brief discussion with Denise McCafferty from the American Bureau of Shipping.

The key findings from these activities are documented below.

The IAEA model is nuclear power plant (NPP) specific. It took many years to get agreement for the model, and not all components of the model are used. Its application tends to be pragmatic. The extent of industry 'buy-in' is variable. Buy-in from British Energy was straightforward to achieve as it coincided with an internal review of their KPIs (i.e. its introduction was timely as there was a level of senior management commitment to the utility of KPIs), however Magnox (the other NPP operator) are less keen. Many of their power plants are about to embark on decommissioning, and management commitment to collect more data (and potentially spend more money) is not there. It is unlikely that NSD will use enforcement to persuade them to adopt the model, which indicates the importance of persuasion and the voluntary nature of the schemes. NSD will not be using this approach for BNFL Sellafield who share more in common with chemical process industries as the model would not be applicable. Furthermore, NSD believe development work is required to tailor the model for decommissioning plant (this work is planned for later this year with WSAtkins).

The HID approach to the use of performance indicators is risk-based and involves the use of both lagging and leading indicators. A key element of the approach is that it is voluntary; Ian Travers has firms coming to him to use the approach. The approach is being used across a range of sectors. Within the chemical industry, the Chemical Industries Association (CIA) has acted in partnership with HID in terms of recruiting firms, mentoring and supporting them in the process of the development of leading and lagging industries.
The American Bureau of Shipping experience is that many people say they use leading KPIs, but upon examination the majority are found to be lagging indicators. They have found it very difficult to identify objective leading indicators and are instead now looking at more subjective indicators.

3.2 STAKEHOLDER INTERVIEWS

HSE stakeholder interviews were held with HSE staff attending the Major Hazards Strategic Programme Cross-Cutting Project CC4 – Learning and Performance. The findings from the interviews are summarised in Appendix 1. Prior to the interviews, a short briefing note outlining the background of the work and the questions to be used for the consultation was sent to all interviewees. This is included in Appendix 2.

The questions used were centred around exploration of the following areas:

- Profile of the industry;
- Degree of sophistication of the industry;
- What data the industry currently collects;
- Industry interest in Performance Indicators;
- Key industry stakeholders.

4 SUMMARY OF FINDINGS

The key findings from the scoping study are summarised below:

- There is a large volume of published material on performance indicators;
- In most cases, where they are used, performance indicators seem to be developed in the absence of any underlying rationale or model;
- The nuclear industry appears to have a strong lead, but many companies in other sectors are also doing things;
- The IAEA model is nuclear power plant specific;
- The NSD route to collecting performance indicator data is effectively via the monitoring loop of safety management systems;
- Sector experience suggests that a title of a KPI does not necessarily mean the same thing for all companies;
- From HSE experience to date, industries are generally not happy to share performance data, although there are some exceptions;
- The diversity of industries means that the development of a single performance indicators model is not straightforward;
- There is a need to ensure that any cross-sector model that is developed is, where possible, consistent and compatible with any frameworks already being used;
- It is not a straightforward task to 'de-nuclearise' the IAEA model and apply it in other sectors
- The use of KPIs will need to be voluntary to ensure success; this will require significant work with industry bodies and stakeholders;
- Many companies already collect KPIs; achieving cross sector cooperation on changing these may be difficult;
- The use of indicators that involve aggregation of scores can be problematic, for example it could smooth out danger signs;
- HSE needs to be clear at the outset as to how performance indicator data will be used;
- Further work will be needed to identify and 'sell' the benefits to companies;It may not be possible to link performance indicator data to PSA targets;
- The use of performance indicators may not be viable/reasonable for SMEs or decreasing industries.

5 CONCLUSIONS AND RECOMMENDATIONS

As indicated in section 4, the development of a single cross-sector model or framework of performance indicators is not a straightforward task, and could not be achieved simply by 'de-nuclearising' the IAEA model and applying it to other sectors. The existing top level in the IAEA model hierarchy is not meaningful outside the nuclear industry context.

However, while it would not be straightforward, the authors believe that it would be possible to develop a high level cross sector performance indicators model. It is thought that a hierarchical model, similar to the IAEA model, but based on a rational set of principles, would be most suitable. At the highest level, a framework could be developed that would apply across all sectors. Below this level, the detail of the model would need to be industry sector-specific, but a common structure could be used across all sectors.

In addition to developing the high level framework, generic principles for developing SPIs could be developed to accompany the framework (drawing on the HID chemicals sector guidance), along with sector-specific worked examples to illustrate what they would look like. The HID chemical sector guidance is process oriented and therefore cannot be applied directly in industry sectors that are not, but it would provide a useful starting point for the development of cross sector generic guidance on the development of performance indicators. This guidance would include details of key questions or factors to consider when trying to identify good indicators or measures of safety performance.

For a range of sectors (e.g. mines, explosives, etc.), an example 'vertical slice' through the model (i.e. looking at one key risk, and identifying one key safety performance indicator) could be developed to illustrate how the model could be used in each sector to provide meaningful data. An advantage of this approach would be that in addition to the high-level framework, and guidance on how to develop SPIs, each sector would have limited, but detailed sector specific information, and the worked example could be used as part of the 'selling performance indicators to industry' process.

As part of the work to develop the high level framework and generic principles, it would also be useful to provide a definition of terms (e.g. to collate the final 'agreed' definitions of leading and lagging indicators, etc.) and to explore the various mechanisms for scoring to provide indicators of change, e.g. is a simple traffic light system the best approach, or are more complicated systems more suitable in some situations?

In summary, the following recommendations for further work are made:

- Development of a high level cross sector performance indicators model;
- Development of generic principles for developing SPIs to accompany the framework;
- Sector specific worked examples of using the model to determine performance indicators;
- Definition of terms;
- Consideration of different scoring mechanisms.

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Internet[5] www.wano.org.uk

7 APPENDICES

7.1 APPENDIX 1 – HSE STAKEHOLDER INTERVIEWS

7.1.1 Gas and Pipelines

Position within HSE: Inspector, Gas and Pipelines Operational Policy Team
Industry Sector: Gas and Pipelines

Profile of industry

The industry is comprised of predominantly large companies with more than two hundred employees. It is dominated by a number of major players, with Transco/ The National Grid as the main organisation. The enterprise is high consequence with few employees and potentially large numbers of the general public. The industry is primarily involved in the transportation of products and not production. The primary transportable fluid is natural gas, with other fluids such as ethylene also being transported. The industry body that collects information and participates on safety issues is the UK Onshore Pipeline Operator's Association (UKOPA). The hazard types are fire and explosion. The Gas and Pipelines industry is a mature industry that utilises mature technology. The market is static at present and it is profitable.

Degree of sophistication of industry

Individual companies within the industry all have well-established safety management systems (SMS). There is a joint emphasis on both Occupational Health and Safety and loss control. Companies tend to have mature safety departments and employ their own safety professionals. HSE inspections are concerned with both legal compliance and auditing SMS.

Data collected

Companies currently go above and beyond RIDDOR requirements and all have individual suites of performance indicators on a range of issues. At present, the information obtained is provided to the Office of Gas and Electricity Markets (OFGEM) and is used by individual organisations to make improvements to risk management systems. As of the start of next year the information will also be provided to HSE.

Will the industry be interested in Performance Indicators?

The industry is interested in performance indicators and has already been persuaded of the value of collecting performance indicator material.

Stakeholders

The main industrial stakeholder is UKOPA and buy-in has been obtained. Trade Unions have had no involvement thus far but could do so in the future.

7.1.2 Chemicals Industries

Position within HSE: Principal Inspector, Chemicals Industries
Industry Sector: Chemicals and Major Hazard

Profile of industry

The average size of company in terms of number of employees ranges from Shell, BP and similar with thousands of employees, to very small companies. The industry is not dominated by a number of major players; there are a multitude of companies within six individual sectors

(e.g. fine chemicals, pharmaceuticals and paints and coatings). The COMAH sites are all high consequence, however the number of employees can vary. A diverse range of products is produced. Approximately five or six industry bodies collect information and participate on safety issues. These include the Chemical Industries Association and the UK Petroleum Industries Association. The hazard types are flammables and toxic chemicals. The Chemicals industry is a mature industry that utilises mature technology. The global market is expanding, however, the UK market is contracting and the industry has become less profitable over recent years.

Degree of sophistication of industry

Safety management systems are present within the sector but are limited to only a few of the individual sectors, such as the Chemicals Industries Association. Occupational Health and Safety and loss control are both emphasised, however there tends to be an emphasis on the measurement of ill health, rather than major hazards. Safety professionals are employed and HSE inspections concern both legal compliance and auditing SMS.

Data collected

Companies currently go above and beyond RIDDOR requirements. However, reporting is within trade associations and not to HSE. At present, the industry uses a variety of performance indicators on a range of issues. The information obtained is used in a public way through the publication of annual reports and is used by individual organisations to implement change and make improvements to risk management systems.

Will the industry be interested in Performance Indicators?

The industry is currently interested in performance indicators. HSE is involved in an on-going process aimed at persuading the Chemicals industry of the value of collecting performance indicator material.

Stakeholders

There are key stakeholders that buy-in would need to be obtained from. However, the specific stakeholder involved is dependent on the individual sector.

7.1.3 Specialised Industries – Biosciences

Position within HSE: HID Specialised Industries Division
Industry Sector: Biosciences (Healthcare, Research, Bio-technology)

Profile of industry

The size of companies within the Biosciences sector varies from small University departments to the National Health Service. There is not a single industry but instead various different individual sectors. The industry is dominated by a number of major players, including Imperial College, the Health Protection Agency and Glaxo-Smith Kline. The enterprise is high consequence but low probability. A diversity of products are produced, such as vaccines, pharmaceuticals and food products. Diagnostic and research activities are also carried out. There is no single industry body that collects information and participates on safety issues. Instead, there are two scientific advisory bodies, ACDP (Advisory Committee on Dangerous Pathogens) and SACGM (Scientific Advisory Committee on Genetically Modified Organisms). The hazard types are infection, toxic/ allergenic hazards and environmental damage. The Biosciences industry is an emerging market that utilises both mature, e.g., basic science and novel technology, e.g., gene therapy. The market is currently expanding. However, its level of profitability is dependent on the specific Biosciences sector. For example, pharmaceutical companies are very profitable.

Degree of sophistication of industry
Safety Management Systems are not present within the sector. The emphasis is on Occupational and Public Health and Safety. Universities, the NHS and the Health Protection Agency all employ their own safety professionals.

Data collected
Companies do not go above and beyond RIDDOR. RIDDOR itself is a major problem for the sector and HSE are working with HSL to improve the reliability of RIDDOR data. Performance indicators are not currently used within the industry sector.

Will the industry be interested in Performance Indicators?
Some companies may be interested in performance indicator schemes. However, it is very unlikely that academics would be willing to get involved. It is not known how the industry could be persuaded of the value of collecting performance indicator material but HSE plan to work on this issue.

Stakeholders
The key stakeholders that buy-in would need to be obtained from are The Health Protection Agency and the research sectors (Universities, etc).

7.1.4 Process Safety

Position within HSE: Specialist Inspector, SI5, Process Safety Discipline
Industry Sector: Not applicable, provides expertise across a full range of industries

Unable to answer the questions during the telephone interview as he provides a supportive role across the full range of major hazard industries. Is not close enough to any specific industry to be able to answer the questions accurately.

Is attending the CC4 meetings to see where the applicability lies to other parts of HSE and to fulfil a horizontal knowledge-sharing role.

7.1.5 Nuclear

Position within HSE: Operational Strategy Unit
Industry Sector: Nuclear

The Nuclear Energy Agency has been working on developing performance indicators for ten years and an international working group has been set up. The IAEA is also working on this topic. HSE are using this as a framework for their performance indicators work.

Various links were provided that offer information on the nuclear industry both in the UK and internationally:

The Performance-Based Management Handbook - US Dept of Energy
http://www.orau.gov/pbm/documents/documents.html
http://www.orau.gov/pbm/pbmhandbook/pbmhandbook.html

IAEA Publications – Tech Docs, Guides and Standards

http://www-pub.iaea.org/MTCD/publications/publications.asp
http://www.iaea.org/worldatom/Meetings/2001/infcn82summary5.pdf
http://www-pub.iaea.org/MTCD/publications/PDF/te_1141_prn.pdf
http://www-pub.iaea.org/MTCD/publications/PDF/te_1458_web.pdf

OECD - Nuclear Energy Agency (NEA)

http://www.iaea.org/worldatom/Meetings/2001/infcn82-topical5.pdf
http://www.nea.fr/html/nsd/reports/2004/nea3669-indicators.pdf
http://www.nea.fr/html/nsd/docs/1998/cnra-r98-3.pdf
http://www.olis.oecd.org/olis/2005doc.nsf/0/458842bc5d2b81acc12570180057e1b1?OpenDocument
http://www.olis.oecd.org/olis/2005doc.nsf/0/458842bc5d2b81acc12570180057e1b1/$FILE/JT00185661.PDF
http://www.nea.fr/cgi-bin/websearch.cgi?wf=3251&q=performance+indicators&ps=20&o=0&m=all&wm=sub

World Association of Nuclear Operators – WANO

http://www.neimagazine.com/storyprint.asp?sc=2033038
http://www.wano.org.uk/WANO_Programmes/Performance_Indicators.asp
http://www.nea.fr/html/pub/newsletter/2003/NEA_news_21_02_interface.pdf
http://www.stuk.fi/julkaisut/stuk-b/stuk-b-yto241app1.pdf

7.1.6 Railway Industry

Position within HSE: Inspector, HMRI
Industry Sector: Railways

Profile of industry

The railway industry is predominately made up of large employers, with one major company that dominates and numerous smaller companies. Incidents occurring in this industry were judged to be of high consequence, with high numbers of employees and members of the public likely to be involved. Activities across sites in this sector were generic. The industry body is the Rail standards and safety board (RSSB)

Degree of sophistication of industry

Formal safety systems are already widely used across the railway industry. Although it is a contentious issue, the railway industry inevitably has a focus on ‘loss control’, partly due to the public focus on this, however this is not at a cost to occupational health and safety. Dedicated safety professionals are used, and HSE inspections cover both legal compliance and auditing existing SMS.

Data currently collected

The railway industry currently exceed RIDDOR requirements in terms of data collected, with a whole suite of performance indicators on a wide range of issues.

Industry interest in Performance Indicators

Currently used across the industry sectors, this information is published quarterly and used to identify trends of precursors to incidents. Eighty-four precursors are then monitored and used to target interventions by RSSB.

Stakeholders
There are a number of key stakeholders who have already bought in to the practical use of performance indicators. RSSB now want to actively engage with companies to develop 'modelling' data.

7.1.7 Specialised Industries: mines, explosives, gas and pipelines, bio agents, and process safety

Position within HSE: HID SI Divisional Business Manager
Industry Sector: HID Specialised Industries

Profile of industry
A variety of companies make up this industry, from small to medium sized in the bio agents sector, to large in the gas and pipeline sector. Additionally each sector is made up of a couple of major companies that dominate, and a number of smaller companies.

The consequences of incidents range from catastrophic in mines, where few members of the public would be harmed, to less dangerous in explosives (e.g. explosives factory) where fewer workers but larger numbers of the public would be harmed.

The nature of activities is highly variable across sites, with a mixture of mature and novel technologies in use. However the sectors are mostly made up mature markets, where most (excluding mines) are expanding.

Degree of sophistication of industry
Formal safety management systems are currently used, with the emphasis dependent on the sector (i.e. the emphasis in mines is on occupational health and safety, whilst in bio agents, 'loss control' is also emphasised.)

Data currently collected
Data is currently collected beyond the RIDDOR requirements, as RIDDOR doesn't cover all relevant fields. Companies vary from having a whole suite of PIs to currently being in the development/ implementation stages. (PIs are generally currently used, although they may not be recognised as such.)

Industry interest in Performance Indicators
Unable to gauge sectors' interest in PIs. However, relevant companies could be contacted through the normal health and safety channels; most companies will do what they are 'told to do'.

Stakeholders
Key stakeholders differ between sectors. Heads of Units within HSE would be in the best position to identify these people.

7.1.8 Mining Industry

Position within HSE: HM Inspector Mechanical engineering
Industry sector: Mines, including working, tourist and storage mines.

Profile of industry
Working mines range from 6-600 employees, averaging around 250. Opencast Coal Sites (OCCS) average around 50-250, and Tourist, storage and gas extraction sites average less than

50 employees. Working mines and OCCS are dominated by 5 large companies, whilst other sites tend to be single site operations. Incidents are mainly high consequence, with high numbers of workers being exposed (with the exception of smaller mines where less employees are exposed).

There are currently the 'Mining Industry Committee' and sub committees, Small Mines Federation, Mining Association UK, and the Quarry Industry National Joint Advisory Committee.

Degree of sophistication of industry

The industry is generally quite highly sophisticated, with some exceptions at smaller coal mines where the hazards and numbers exposed are lower. Formal SMS are generally used, with the emphasis equally on occupational health and safety and loss control. Safety professionals are employed, but consultants are used for specialist work.

Data currently collected

Data is collected beyond the RIDDOR requirements. A suite of PIs are used, although they tend to centre around health and safety management, rather than major hazards.

Industry interest in Performance Indicators

Providing the information is fairly easy to obtain, record, extract value from and is relevant, there could potentially be good interest in PIs.

Stakeholders

There would be some persuading/coaching to be done, especially for the smaller companies. There would also be a need to develop user friendly, valued indicators. However the mining sector is so diverse that there would have to be hazard specific (in some cases site specific) indicators.

7.1.9 Business Involvement Unit

Industry Sector: Not applicable, provides expertise across a full range of industries

Data currently collected

Some sectors are known to collect data; it is assumed this is for the purposes of drawing out lessons to be learned.

Industry interest in Performance Indicators

Performance indicators are currently used across the board, especially by the major firms. But Laurence suggests there may not be the same take-up in small and medium sized enterprises (SMEs).

Stakeholders

The key stakeholders would be major corporations, including those in the public sector (Health trusts and LAs), also the construction sector.

7.1.10 Regulatory Inspector, covering numerous different industries.

Position in HSE: Previous frontline Inspector

Industry interest in Performance Indicators

Performance Indicators were not used 18 months ago, when the Inspector was more closely involved with industries. She has indirect knowledge that it is an area that is currently being developed.

7.1.11 Explosives Industry

Position in HSE: HM Inspector Explosives
Industry sector: Explosives

Profile of industry

There are between 10,000 and 15,000 people employed in the industry. Sites vary enormously in terms of size from storage facilities through to large production and manufacturing sites. A wide range of products are involved, from the storage of fireworks, through small arms manufacture through to bunker buster bombs and blasting explosives. There are 235 licensed sites in the UK, although licensing depends on inventory size. There is a wide range of consequences and the industry mitigates risk through physical separation (guarding, interlocks and personnel), automation and the use of robotics. Furthermore less risky explosives are now used in a number of products. The industry is traditional in its organisation and as a result is decreasing as more sophisticated weapons are developed elsewhere.

There are currently the 'Mining Industry Committee' and sub committees, Small Mines Federation, Mining Association UK, and the Quarry Industry National Joint Advisory Committee.

Degree of sophistication of industry

The industry varies in terms of its sophistication. Although the 19 top tier and 22 lower tier COMAH sites tend to have safety management systems, many smaller sites do not have any formal safety management systems or even employ safety professionals. Explosives sites tend to have greater regulatory intervention and are visited more frequently due to the hazards and the relatively low number of sites.

Data currently collected

Data is collected to meet RIDDOR requirements. Some of the larger firms collect other performance indicators.

Industry interest in Performance Indicators

Some will be keen to participate, however it is important that this is not a burden to industry and must not be perceived as a weapon for HSE.

Stakeholders

There would be some persuading/coaching to be done. HSE chairs the Explosives Industry Forum that has representatives from industry and the Ministry of Defence sitting on it. There are a number of stakeholder groups, including: British Pyrotechnics Association (BPA), Institute of Explosives Engineers (IEE), the CBI Explosives Industry Group (EIG) and the British Fireworks Association (BFA).

7.2 APPENDIX 2 - BRIEFING DOCUMENT: DEVELOPMENT OF MAJOR HAZARDS INDUSTRY PERFORMANCE INDICATORS

Over the next few weeks, I will be contacting you to discuss your views on Performance Indicators, with the aim being to provide better data on the performance of major hazards industries. This work is being carried out for the Major Hazards Programme and for Neil Johnson and Kulvinder McDonald.

Aim of this document

To provide you with background details concerning the rationale underlying the development of key health and safety performance indicators for major hazard industries and to outline how you can support this initial phase of work.

Background

At the moment most industries report on lagging indicators (i.e. events that have occurred, for example via RIDDOR) that are not necessarily predictive of major hazard accidents. Major hazard accidents are characterised as being low frequency, high consequence events, and lagging indicators are not good indicators of major accidents occurring. The Major Hazards Programme is seeking to develop an HSE-wide model to underpin a series of safety performance indicators.

We are carrying out a scoping study to identify what actions are required to develop a model and method for UK Major Hazards Industries to adopt. This work involves the following steps:

- Collect literature and material on performance indicators used worldwide in major hazards sector;
- Characterise major hazard sectors in terms of their sophistication, safety management systems and size.
- It is this latter point that we would like your help with. This scoping study will be used to guide future work.

Collation of information

We are speaking to the various participants from the Major Hazards Community of Practice on Performance Indicators to try and characterise the industry sector to identify whether a single performance indicators model is viable.

Questions to think about

- Profile of industry
- Degree of sophistication of industry
- What data they currently collect
- Will the industry be interested in performance indicators
- Are there any key stakeholders that we'd need to get buy-in from

The questions are shown overleaf. I look forward to speaking to you soon.

Stakeholder Questions and Consultation

Profile of industry	
▪ Size of companies – no. employees	
▪ Size of sector – i.e. number of players/duty holders – Is the industry dominated by a number of major players or a multitude of companies	
▪ Scale of enterprise – i.e. high consequences but few employees?	
▪ Diversity of companies – e.g. production of single product, many products. Degree of complexity?	
▪ Industry bodies collect information or participate at appropriate levels – e.g. CIA, UKOOA etc. Are they helpful and participative	
▪ Type of hazards/inventory	
▪ Mature technology or novel/innovative/emerging technologies	
▪ Mature industry or emerging market	
▪ Is the market expanding or contracting? Profitable?	
Degree of sophistication of industry	
▪ Formal SMS/Risk management system	
▪ Emphasis on OH&S or loss control	
▪ Do they employ safety professional(s)	
▪ Are inspections about legal compliance or about auditing SMS/specific topics	
▪ Extent to which PIs currently used and for what purpose	
What data do they collect now?	
▪ Above and beyond RIDDOR requirements?	
▪ A whole suite of performance indicators – do they have a framework for this?	
▪ Barely comply with RIDDOR	
Will the sector be interested in performance indicators schemes?	
Are there any key stakeholders that we'd need to get buy-in from	