HSE

Health and Safety Executive

Leading indicators for assessing reduction in risk of long latency diseases

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Research Report

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Leading indicators for assessing reduction in risk of long latency diseases

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The HSE need meaningful 'leading indicators' that provide a real-time measure of progress in reducing long latency occupational disease. This report provides a review of potential leading indicators for long latency occupational disease. The work involved a literature review and 49 stakeholder interviews. The understanding of leading indicators was mixed. Many stakeholder respondents, including some insurers, brokers, firms and health and safety institutes were unaware of the term or of examples of leading indicators, whilst industries working with silica (mines, quarries) and chemicals (oil, gas and chemicals); and certain overseas regulators, had well developed thinking and tools. The review identified a range of indicators covering Occupational Health Management Systems, Key Performance Indicators, implementation of workplace risk controls and worker surveys of awareness, attitudes and behaviours that could be implemented in existing HSE and industry tools. The review identified little work on the predictive validity of leading indicators for assessing the reduction in long latency diseases but suggested approaches to further develop this, including the use of expert judgement.

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HSE Books

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Executive Summary

The Health and Safety Executive's (HSE) Disease Reduction Programme aimed to bring about behavioural change in key industries which would lead to reductions in cases of occupational diseases caused by exposure to harmful substances. For example, reductions in diseases such as dermatitis, asthma, cancer and Chronic Obstructive Pulmonary Disease (COPD is desired. However, the latter two conditions manifest themselves a considerable time after exposure to the associated harmful substances.

Therefore this presents a "challenge when it comes to assessing the success of the programme over the short term". The HSE need meaningful 'leading indicators' for the relevant sectors or activities that provide a real-time measure of progress in reducing exposure. These would then be used as reliable evidence that the incidence of occupational disease will be reduced in the long term.

Aims and method

This work therefore aims to provide an initial picture of:

- What is understood by industry/business of the concept of leading indicators?
- How this is applied to health and safety monitoring? and
- What examples there are of the latter?

This project utilised both a stakeholder consultation through a series of telephone interviews and a literature review (including grey literature) to obtain current information and practice for leading indicators to assess the risk of long latency diseases in practice. The following 49 organisations were split into five types, as follows:

- 8 insurers and brokers;
- 19 UK firms in key sectors, including 3 construction, 4 engineering, 4 chemicals, 4 using silica (quarries, cement firms) and 4 organisations from other relevant industries such as textiles;
- 10 UK trade associations that represent key sectors and/or operate health and safety performance reviews or benchmarking schemes;
- 4 health and safety institutes, and;
- 8 overseas health and safety regulators and occupational health services in continental Europe and elsewhere, including Germany, Australia (2), New Zealand, America, Ireland, Finland and Sweden.

Understanding of leading indicators

The understanding of leading indicators, particularly with respect to occupational disease was very mixed. Many stakeholder respondents, including some insurers, brokers, firms and health and safety institutes were unaware of the term or of examples of leading indicators. In addition,

previous research has focused on safety indicators rather than occupational health leading indicators, with a large part of overseas work focused on health surveillance.

Notwithstanding this there were a number of sources of well developed thinking and tools including:

- Industries working with silica (mines, quarries) and chemicals (oil, gas and chemicals);
- Overseas regulators, particularly Australia and Scandinavia.

These sources present a view of leading indicators that is consistent with the HSE's and have developed or are developing tools and measures.

Indicators and schemes that can be further developed

The literature review and consultation indicates a range of possible types of indicators, including:

- Ratings of occupational health management systems, such as access to occupational hygiene expertise;
- Key Performance Indicators, such as percentage of workforce covered by exposure monitoring;
- Implementation of workplace risk controls, such as provision of training and PPE, hours working in exposed areas;
- Worker surveys of awareness, attitudes and behaviours, such as awareness of health risks and attitude towards use of PPE.

These indicators could be considered to be complimentary rather than mutually exclusive. These indicators could be implemented in existing HSE and industry tools, such as:

- Ratings of occupational health management could be included in existing HSE self assessment tools such as CHaSPI or HaSPi, or new tools dedicated to long term disease prevention, as well as offered as good practice guidance to firms;
- The HSE's WHASS survey could be further developed to cover the questions noted in this report. This option is dependent on the repeated implementation of the WHASS survey;
- The HSE's Risk Control Indicators (RCIs) could be further developed by the HSE to cover long latency diseases. To utilise the risk control indicators for monitoring trend, the HSE would need to introduce a scheme where they (for example) assessed 100 targeted workplaces per year and therefore could have a measure that was directly comparable annually.
- The HSE could build on existing KPI schemes and utilise and develop sector specific leading indicators. To implement such schemes the HSE would need to develop

partnership working with key industry organisations such as Trade Association and other industry associations.

The first three options (namely amending CHaSPI/HaSPI, extending the WHASS and/or the RCIs) have the advantage of their implementation being under the control of the HSE. Therefore, the production of results each year would not be dependent on the co-operation of intermediary organisations. However, they would require application of HSE resources to 1) continue the WHASSs and 2) revise the RCIs and apply them in a repeatable and consistent manner across the years, whilst CHaSPI and HaSPI relay on voluntary completion by firms. The final option of building KPIs into industry based schemes, such as the manufacturing sector targeted initiatives; include 1) engaging industry in self-monitoring and self-improvement and 2) using industry resources to develop the measures.

Our review indicates that few, if any indicators are validated in respect of assessing if results correlate with levels of occupational disease. Given the time lag between exposure and appearance of disease this is impractical. Rather, validation to date tends to involve assessing whether indicators address those factors considered important on the basis of knowledge of occupational disease. Therefore, future development of these indicators could involve a process of drafting, face validity reviews by experts and practical trials of the indicators.

If a questionnaire approach is adopted, whether for occupational health management or worker attitudes and behaviours, further development could include factor analysis and reliability analysis. This would involve applying the questionnaire(s) to a sample of respondents. Statistical analysis then explores whether questions consistently explore the underling constructs, which questions are redundant and whether results are consistent between applications.

It is concluded that sufficient work has already been completed, as reviewed here, to draft a set of indicators. Therefore, given the need for leading indicators, it is recommended that further work is completed to draft and test one or more of the types of indicators identified in this report.

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 The HSE's disease reduction programme

The Health and Safety Executive's (HSE) Disease Reduction Programme aimed to bring about behavioural change in key industries which would lead to a reduction in cases of occupational diseases caused by exposure to harmful substances. For example, reductions in diseases such as dermatitis, asthma, cancer and Chronic Obstructive Pulmonary Disease (COPD is desired. However, the latter two conditions manifest themselves a considerable time after exposure to the associated harmful substances.

Currently employers are bound by RIDDOR (The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations), this makes it a legal requirement for them to report occupational diseases to the enforcing authority. This includes skin diseases such as occupational dermatitis and skin cancer; lung diseases such as occupational asthma, asbestosis and mesothelioma; other conditions such as occupational cancer, and decompression illness must also be reported[1]. In addition to this, work related illness is also reported voluntarily by specialist doctors via The Health and Occupation Reporting network (THOR), which, compiled over the last ten years, can be a beneficial resource illustrating changing trends and relationships in occupational health. Death certificates also form a source of monitoring health implications to harmful exposure. Hence at present management of occupational health risks is largely dependent on the effective reporting of work related illness. Although the HSE recognize that recorded occurrences have an important role to play in monitoring and reducing occupational illness in the future, they also recognize the limitations to using such methods as they are dependent on the outcome measures of illnesses, which have already occurred, and as such are no longer preventable.

There are many difficulties concerning the monitoring and prevention of long-latency illnesses; firstly the latency period between harmful exposure and the occurrence of ill health is variable, with dermatitis evident a few years following exposure, and cancer potentially remaining undetectable for decades after harmful contact. Workplace exposure contributes one influence, however, there are also secondary aspects such as genetics and lifestyle which must be taken into consideration when both formulating and viewing statistics. For example, smoking is reported as a significant risk factor to COPD, and hence will influence disease onset, as well as the rate of progression, making causal attribution difficult. Furthermore, diagnosis also makes quantifying the incidence of such work related diseases challenging, as definitions may vary and the number of un-diagnosed cases are not known.

Therefore this presents a "challenge when it comes to assessing the success of the programme over the short term". The HSE need meaningful 'leading indicators' for the relevant sectors or activities that provide a real-time measure of progress in reducing exposure. These would then

[1] http://www.hse.gov.uk/riddor/guidance.htm

be used as reliable evidence that the incidence of occupational disease will be reduced in the long term.

This work aims to provide an initial picture of:

- What is understood by industry/business of the concept of leading indicators?
- How this is applied to health and safety monitoring? and
- What examples there are of the latter?

This work is specifically concerned with occupational diseases where there is a long latency or delay period between exposure and appearance of a disease, i.e. COPD and cancer.

Occupational disease can be defined as: "All employment-related diseases which result from repeated or long-term exposure to an agent(s) or event(s) which are the result of a single traumatic event where there was a long latency period"[2] . The Health and Safety Executive (HSE) estimate that, each year, there are roughly 8,400 new cases of dermatitis, and 1,700 new cases of occupational asthma. Furthermore, approximately 4,000 deaths are reported to occur annually from asbestos related cancers, and 4,000 deaths due to (COPD) - caused by breathing in excessive amounts of certain dust and fumes, including crystalline silica. Collectively, the HSE propose that work-related dust and chemicals claim around 10,000 lives each year[3]. Other sources, focusing on each of the above areas individually, have found figures which exceed those stated by the HSE, suggesting the actual rate of mortality may exceed these estimations. Thus, the Disease Reduction programme is clearly important, and the application of leading performance indicators is a key matter for the HSE.

1.1.2 What is a leading indicator?

A 'leading performance indicator' is defined by the Step Change programme[4] as "something that provides information that helps the user respond to changing circumstances and take actions to achieve desired outcomes or avoid unwanted outcomes. Their role is to help improve future performance by promoting action to correct potential weaknesses without waiting for demonstrated failures."

For leading performance indicators to play an effective role in performance assessment, there must be an association between the inputs being measured and the lagging outputs. We would define this as 'predictive validity'; does it predict the target outcome in a sufficiently reliable manner? From a resource management perspective, there needs to be confidence that the actions taken to improve the leading performance indicator will be followed by an improvement in the lagging output indicators.

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[2] http://www.ascc.gov.au/NR/rdonlyres/AD149923-2908-43FC-ACC1-0AE1EDFE1537/0/ODIndicatorsreport2004052008.pdf

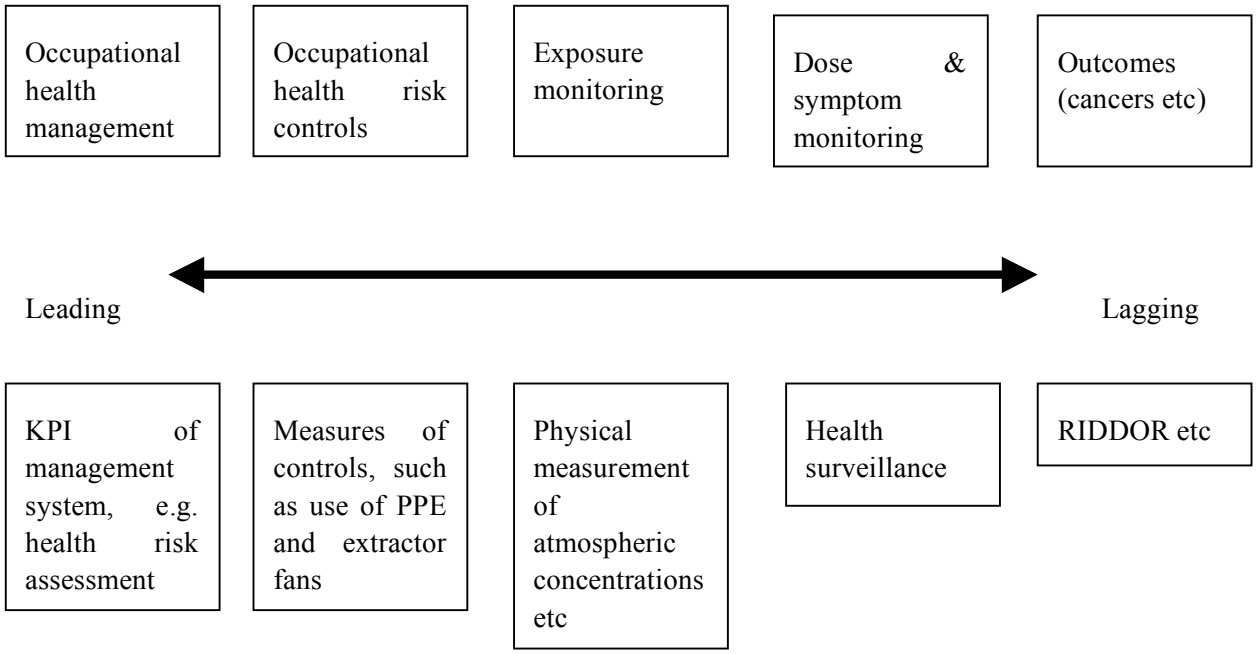
[3] http://www.hse.gov.uk/drp/about.htm

[4] http://stepchangeinsafety.net/stepchange/News/StreamContentPart.aspx?ID=1517

1.1.3 The leading – lagging indicator spectrum

It is possible to conceptualise a spectrum of indicators, as illustrated in Figure 1. This figure suggests a sequence of risk management, starting with adoption of occupational health management systems such as health risk assessment, which should lead to workplace risk controls. These would result in a certain level of exposure and dose, ultimately leading to a certain level of cancers etc. Indicators can be, conceptually, matched to each of these stages, providing ever more leading indicators as you move from right to left. RIDDOR and THOR are lagging "outcome" type indicators.

Figure 1: Conceptual spectrum of leading to lagging indicators



In principle, the leading indicators can be implemented through existing HSE systems, such as:

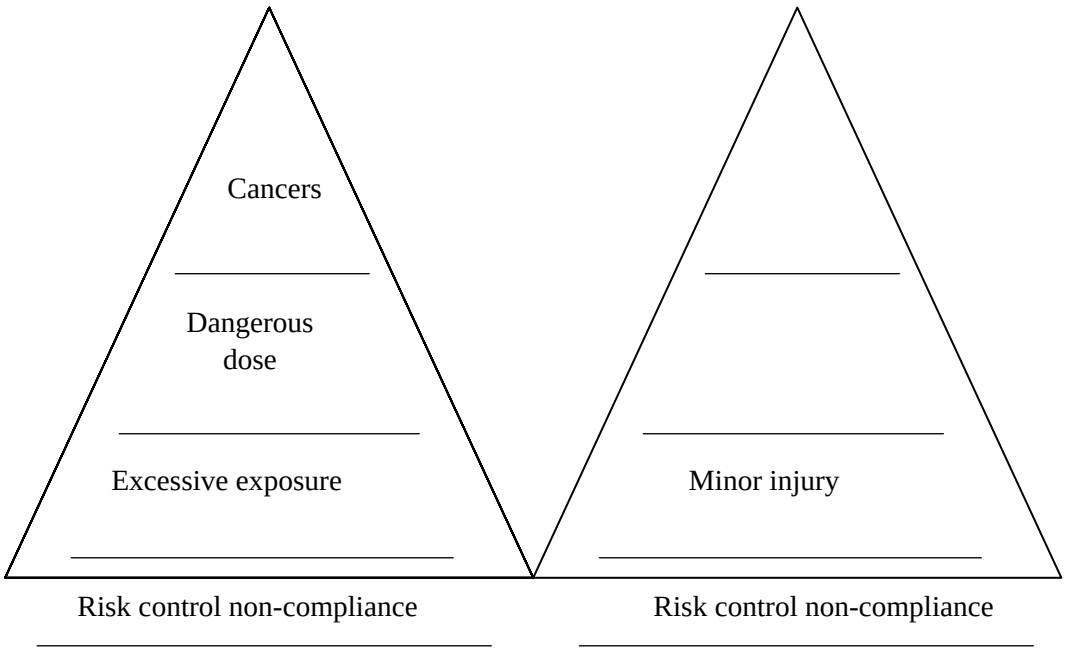
- Occupational health risk management self reporting schemes, such the HSE's CHaSPi online self assessment tool (which briefly covers occupational health but focused on stress and musculoskeletal conditions);
- Audits or inspections of KPIs, such as during routine or programmed inspections, or through benchmarking or audit processes applied by companies as part of a trade association or other industry led health and safety schemes (such as the Chemical Industry Association Responsible Care programme);
- Inclusion in an expanded set of HSE's Risk Control Indicators (the current RCIs do not cover diseases other than asthma and vibration);

- Inclusion of self-reported exposure and risk controls in Workplace Health and Safety Surveys (WHASS – which covers dusts/fumes that may cause respiratory conditions both worker perceived exposure and employer perceived standard of risk control[5]);
- Voluntary reporting of workplace monitoring by companies, again as part of a trade association or other industry led health and safety schemes;
- Reporting of health surveillance results – which could show trends in dose.

1.1.4 A health pyramid

It is also possible to conceptualise an occupational health pyramid, analogous to the traditional accident triangle, as per Figure 2. The concept is that a fraction of exposures lead to dangerous doses, and a fraction of doses lead to cancers, in the same way that the majority of accidents lead to minor injuries with a minority leading to fatal accidents. Non-compliances lead to exposures to risk. Thus, measurement at any one level may allow prediction of the frequency of events higher up the pyramid, if the ratio of exposures to dose and thence cancers is known.

Figure 2: Hypothetical occupational health and safety pyramids



[5] Employers self rated risk control of dust and fumes as about 75% in 2005 where 100%=best, being the 3rd best area of risk control.

Obviously the latter pyramids are conceptual only. In addition, some work has suggested that the ratio from one level to the next varies between hazards. For example, the ratio of minor injury to fatalities is far higher for falls from height than it is for slips on the same level. The same could be true for occupational diseases, with some hazards posing a higher ratio of exposure to cancers than others. This poses a data challenge to the application of any one 'occupational health pyramid' if it is to be applied in a mathematical way.

1.2 AIM OF THIS PROJECT

The HSE commissioned Greenstreet Berman to carry out a literature review and stakeholder consultation to gather information on leading indicators and their use in industry. The aim of the work was to give the HSE an initial picture of what industry/business understand of leading indicators, how these are applied in health and safety monitoring and what examples are there of leading indicators in use.

This research project provided the HSE with:

- An understanding of the range of leading indicators that have been cited in the context of long term latency occupational diseases, drawing on UK and overseas experience and research;
- A summary of any evidence as to the predictive validity of these indicators;
- Examples of leading indicators in use in a range of industries;
- A view as to how these indicators may be applied directly by HSE through instruments such as Risk Control Indicators and workplace health and safety surveys, and indirectly such as by promoting them to self-reporting schemes;
- A basis on which to take forward further work on the development of leading indicators.

This project utilised both a stakeholder consultation through a series of telephone interviews and a literature review (including grey literature) to obtain current information and practice on the use of leading indicators for assessing the risk of long latency diseases.

2 METHOD

2.1 STAKEHOLDER CONSULTATION

2.1.1 Who were consulted

A number of stakeholders were consulted via a telephone interview.

The following 49 stakeholders were split into five types, as follows:

- 8 insurers and brokers;
- 19 UK firms in key sectors, including 3 construction, 4 engineering, 4 chemicals, 4 using silica (quarries, cement firms) and 4 organisations from other relevant industries such as textiles;
- 10 UK trade associations that represent key sectors and/or operate health and safety performance reviews or benchmarking schemes;
- 4 health and safety institutes, and;
- 8 overseas health and safety regulators and occupational health services in continental Europe and elsewhere, including Germany, Australia (2), New Zealand, America, Ireland, Finland and Sweden.

2.1.2 Recruitment

All stakeholders (e.g. where email addresses were available) were contacted by Greenstreet Berman via email to invite them to participate in a telephone interview. The invite included information on the project, examples questions and contact details. Attached to each email was a copy of the telephone interview proforma so that the interviewee could prepare for the interview and a copy of an HSE cover letter explaining about the context of the project and including contact details for both Greenstreet Berman and the HSE.

2.1.3 Proforma

A semi structured interview proforma was developed to guide discussions. This covered points such as:

- Awareness of leading indicators;
- Methods used to manage the risk of long term occupational diseases;
- Assessing the potential for long latency diseases; and
- Industry's position for using leading and lagging indicators.

The other area covered by the interview was practical applications. This covered points such as:

- Tools used to assess the risk of occupational diseases;

- How assessments make improvements in managing long latency diseases;
- Evidence of indicators.

A copy of the pro-forma can be found in Appendix C, section 7.

2.1.4 Process

The interviews were carried out using the following process:

- Requests were issued to identified participants, with an HSE cover letter and interview pro-forma, by email;
- An interview time and date was sought;
- The interview was conducted;
- A synthesis of findings was reported for each of the five types of stakeholders.

2.2 LITERATURE REVIEW

2.2.1 Sources

A variety of sources were used for the literature review including grey literature. The following were used for the literature review:

- HSE research database;
- Specific organisations including:
    - Societies - Society of Occupational medicine, British Occupational Hygiene Society, ILO;
    - UK Institutes - British Occupational Health Research Foundation; IOSH, ROSPA, Centre for Workplace health;
    - International Occupational Hygiene Association; Finish Institute of Occupational Health;
    - Pan European - European Agency for Safety and Occupational health, European Foundation for the Improvement of Living and Working Conditions;
    - US - Centre for Disease Control and Prevention; National Occupational Research Agenda (part of NIOSH); National Institute of Occupational Safety and Health; Council of State and Territorial Epidemiologist;
    - Australia – Workcover;
    - New Zealand - National Occupational Health and Safety Advisory Committee;
    - Sector specific –Quarrysafe, OGPC;
- Ingenta; Elsevier Science direct; PubMed;
- General Google search;

- Journals including:
    - Occupational Health;
    - Occupational Hazards;
    - Safety and Health Practitioner;
    - Occupational Health Review;
    - Policy and Practice in Health and Safety;
    - Occupational Medicine and Toxicology;
    - Industrial Medicine;
    - Occupational and environmental medicine.

In the case of organisations' websites, in addition to a key word search, publication lists were screened manually.

2.2.2 Search terms

A list of key terms were used in the literature review, these consisted of:

- Performance;
- Indicators;
- Audit;
- Health
- Safety;
- Leading
- Disease
- Lagging
- Occupational Health
- Occupational hygiene;
- Occupational disease
- Key Performance Indicator

On identifying a pertinent article, a subsequent search would be completed using the authors names and for articles referenced by the author(s).

2.2.3 Findings

The findings of the literature review were analysed and the findings divided into five key areas which included:

1. General research on leading and lagging indicators;
2. National Studies and Approaches;
3. Sector Level Approaches;
4. Audits, Standards and Guides;
5. Miscellaneous Research;
6. HSE Existing Tools.

The results for each section were developed and discussed under each of the relevant headings. All material was referenced.

3 SYNTHESIS OF FINDINGS

3.1 INTRODUCTION

The findings from the literature review and interviews are synthesized in this section. Findings have been drawn together against a series of research questions.

The literature review and interview summaries can be found in appendix A section 0 and appendix B section 6 respectively.

3.2 UNDERSTANDING OF LEADING INDICATORS

3.2.1 How sophisticated is the understanding of leading indicators?

The understanding of leading indicators, particularly with respect to occupational disease was mixed. Many stakeholder respondents, including some insurers, brokers, firms and health and safety institutes were unaware of the term or of examples of leading indicators. There were a number of examples of limited or no understanding of leading indicators and individuals in the stakeholder interviews that were only aware of leading indicators from the pre-interview reading (e.g. the telephone interview pro-forma and cover letter). In addition, previous research has focused on safety indicators rather than occupational health leading indicators, with a large part of overseas work focused on health surveillance.

Notwithstanding this there were a number of sources of well developed thinking and tools including:

- Industries working with silica (mines, quarries) and chemicals (oil, gas and chemicals);
- Overseas regulators, particularly Australia and Scandinavia.

These sources present a view of leading indicators that is consistent with the HSE's and have developed or are developing tools and measures. Indeed some stakeholders expressed a comprehensive and progressive understanding of leading indicators and a number of firms and one trade association were involved in the development of European Social Dialogue for silica on the subject, a good example of a concerted European approach within industry.

Frequently the use of the terminology "leading indicator" was questioned, some stakeholders felt that this term was "jargon" and did not clearly express the meaning adequately. The vast majority of firms and organisations supported the use of leading indicators, a number of firms mentioned that more detailed guidance from the HSE on leading indicators and how and when to apply them would be very useful. This could also help smaller businesses with limited resources to develop their work in this area.

3.2.2 What is thought to be the role of leading indicators?

The reported role of a leading indicator (in this context) is to provide a pro-active approach to the management and assessment of long term latency diseases. The use of leading indicators is particularly important to the prevention of long term latency diseases due to the latency period

between exposure to a potential hazard and onset of occupational diseases. Leading indicators give a measure to quantify and control the amount of exposure to hazards and the time of exposure and potentially prevent the onset of occupational disease. In contrast lagging indicators only give a measure of the current burden of occupational disease, and with long latency diseases this can be due to exposure many years previously. Leading indicators allow a pro-active approach to occupational disease.

Leading indicators take a preventive approach to occupational health and safety and allow an organisation to be aware of the actual risk that employee are exposed to in real time. Leading indicators allow the employer to take action if and when exposures levels rise, however as discussed in the interviews this is dependent on employers consistently monitoring leading indicators and corrective action being taken on the results.

3.2.3 Range of indicators

Leading indicators for assessing the risk of long latency diseases are referenced within management, workplace risk controls, near miss data, health surveillance data and exposure indicators. A huge range of indicators utilised within the literature review and stakeholder interviews were gathered, some examples of these indicators are summarised in section 3.5.

It is clear from the stakeholder consultation for this report that a range of indicators are used within industry and an overview of the use of leading indicators in a range of industries, see section 3.3.1. Care should be taken when interpreting these findings as not all firms demonstrated the same level of understanding or use of leading indicators. This does give an indication of the best practice demonstrated within a particular industry. In the silica industry a range of indicators across the spectrum of leading indicators are used, within the construction industry the focus was placed on control measures rather than exposure monitoring, the chemical industry demonstrated an array of leading indicators across the spectrum of leading indicators. The engineering industry focus was towards control measures and reduction in exposure and similarly for other industry's including the ceramic industry.

What is apparent from the literature review and supported by some of the stakeholder interviews was the general focus on the safety aspect of Occupational Health and Safety and that health in the past has come second to safety. Some organisations within the stakeholder interviews stated that now they have safety "in hand" they would be focusing their efforts and resources towards health.

3.2.4 Challenges of applying leading indicators?

There are a number of key challenges to the application of leading indicators, particularly due to the very nature of long latency diseases as there is a lag time between the exposure and the onset of symptoms or illness. Therefore in most cases even if symptoms are shown it is frequently when significant ill effect has already occurred. Because of this a number of organisations, in particular the UK firms stated that this could add to the challenge of bringing about action in this area. Another key challenge is the problem of identifying a disease and attributing the effects of particular risk factors. In controlled work environments the attribution process is easier than the varying work environments that other industries deal with.

The stakeholder interviews raised the issue of robust and usable recording processes for risk monitoring. In some cases experiences indicated that unless monitoring (dust monitoring for example) was performed regularly the variations in the data could not be accounted for and spurious results may be achieved. This could lead to misleading results and either under-reporting or over-reporting of exposure.

Other challenges highlighted by the UK firms within the stakeholder interviews included:

- Support from the workforce for schemes such as health monitoring, limited resources;
- Lack of information or guidance on the subject;
- Macho culture leading to underreporting;
- Long latency effect because the results of the effect are not seen they are not taken seriously;
- Changes in Occupational Health Risk Management can be resisted by older members of the workforce who have little previous experience of such measures within their working lives.

3.3 EXAMPLES OF LEADING INDICATORS.

3.3.1 What sorts of industry sectors have leading indicators?

Particularly in the chemical and silica sector a lot of work has gone into the development of applicable and robust leading indicators. A range of indicators are both cited in literature (including grey literature) and were discussed by stakeholders in the stakeholder consultation. Certainly within the Oil and Gas, Mining, Chemicals and Silica industries there has been a real development in the leading indicators used and this apply to the key long latency disease risks such as respirable crystalline silica in the mining and silica industries.

However this does not mean that more work is not needed to further develop the use of leading indicators in industry, particularly at individual firm and site level.

This review has produced a number of pertinent examples of leading indicators in different sectors as summarised in 3.5. The literature review identified that the majority of work and information on leading indicators was contained within the mining/quarrying and oil and gas sectors. The stakeholder consultation identified that organisations within the chemical and silica industries have performed more work and demonstrated a greater understanding of leading indicators.

Mining and quarrying

In the mining sector a range of leading indicators are being used and there appears to be a definite shift towards a more proactive approach to occupational health management. Examples of leading indicators in use within the mining sector include personal and environmental monitoring (including ventilation monitoring, air quality monitoring and dust monitoring),

training, minimising exposure levels, operability and maintenance of all plant equipment, medical surveillance, awareness and health promotion campaigns. Quarrysafe, an organisation created for the UK quarrying industry, provides guidance and advice on health and safety and has developed a leading indicators assessment sheet. This uses a 10 point scales for measuring an organisations compliance with each indicator and includes indicators on:

- Employee awareness of risks involved in their work;
- Health surveillance programme for employees;
- Effective and proper use of personal protective equipment (PPE);
- Risk controls;
- Dust control measures:
    - dust collectors;
    - spray systems;
    - enclosure;
    - dust monitoring;
    - maintenance of equipment;
    - PPE in good condition and fit for purpose.

Quarrysafe also produce audit guidance with check lists for occupational health and leading indicators. Although only yes/no answers are gathered to this check list rather than a measure it does give some useful examples of pertinent leading indicators including:

- Is dust generation kept to a minimum;
- Are all internal work spaces well ventilated;
- Has a risk assessment and control been enacted for persons exposed to welding fumes.

For a comprehensive list of all examples please see Appendix A, section 5.3.1.

Oil and Gas

The Oil and Gas Industry have also produced a lot of work in this area and are based around the work by International Association of Oil and Gas producers (OGP) and Step change. OGP is an association formed to improve communication between industry and regulators and they have been developing health performance indicators since 1999. OGP use of a three tiered approach includes tier 1 health management, tier 2 leading indicators and tier 3 lagging indicators. Both the leading and lagging indicators relate to the 8 components of tier one and include:

1. Health risk assessment and planning;
2. Industrial hygiene and control of workplace exposures;
3. Medical emergency management;
4. Management of ill-health in the workplace;

5. Health surveillance;
6. Health Impact Assessment;
7. Health report and record management;
8. Promotion of good health.

Some examples of leading indicators including in tier 2 are the percentage of health risk assessments completed from the total population being studied and the percentage of people that have completed appropriate job-related health awareness, education and training programmes. For more examples of OGP leading indicators see Appendix A, section 5.3.2.

Chemical

Within the chemical industry the snapshot of interviews identified a comprehensive understanding of leading indicators and numerous examples of their use in practice. A number of organisations still reported utilising lagging indicators but the focus had shifted towards leading indicators. A number of examples of leading indicators used in the chemical industry are detailed below:

- LEV check of airflow indicators, measure compliance and reported back to LEV engineers;
- Operating procedures, measure how many SHE critical procedures are printed off, signed and followed;
- Measure amount of COSSH assessments complete and the number of overdue COSSH assessments.

For a full list of the leading indicators used in the sample of stakeholders from the chemical industry please see Appendix B, section 6.2.1.

Even more encouraging is the fact that in the chemical industry the indicators are used to make decisions as to whether to make improvements in managing long latency diseases. Organisations reported reviewing leading indicators for separate plant areas and job roles to identify key trends and findings. Attention is focused in this case on looking for exposure risks and potential areas where controls could be improved or are failings and suggestions for mitigating strategies raised such as the implementation of exposure controls or asset replacement. Other organisations reported looking at key trends in indicators and investigating any that may be failing in order to make controls more effective.

Silica

In the Silica sector the sample of interviews taken again demonstrated a thorough understanding of leading indicators and this was supported by the citing of numerous indicator examples including:

- Mobile plant training (including cleaning, shutting doors and the use of air conditioning);
- Monitoring and audits of PPE and RPE;
- Personal dust monitoring (Workplace Exposure Limit Level).

For a full list of the leading indicators used in the sample of stakeholders from the silica industry please see Appendix B, section 6.2.1.

Within the silica industry there was variation in reporting on the use and value of lagging indicators, some felt that lagging indicators could still be of use as they referred to a historical situation whereas others reported that lagging indicators were not useful as they only gave a measure of exposure (in the case of long latency diseases) for many years ago. The silica industry were able to demonstrate how the use of leading indicators were managed, some examples included;

- Tracking tool where reminders are given to address an issue;
- Health surveillance traffic light reports;
- WELL monitoring limits – if an employee was over the WELL limit they would be made aware of this and assurances to use protective measures would be sought;
- Review of dust monitoring to identify if and where new measures need to implemented;
- Replacement of direct working with a remote control room to eliminate that problem area.

NEPSI or the European Network for Silica developed the social dialogue "Agreement on Workers' Health Protection through the Good Handling and Use of Crystalline Silica and Products Containing it" in order to develop an appropriate and credible measure for the improvement of working conditions. The agreement which is Europe wide requires information to be collected at site level using a reporting survey and consolidated before being communicated to the NEPSI Council. Some examples of leading indicators included in the survey:

- % of employees covered by exposure monitoring;
- % of employees covered by generic health surveillance;
- % of employees covered by Health Surveillance Protocol for Silicosis.

The NEPSI programme demonstrated a concerted approach to the management of exposure to respirable crystalline silica across Europe. For a copy of the NEPSI survey see: http://www.nepsi.eu/media/273/nepsi_reporting_format_en.xls.

Overall there is a host of evidence particularly in the four sectors mentioned above that demonstrates industries use and understanding of leading indicators.

3.3.2 Do insurers or brokers offer new insights into long term latency predictions?

Within the insurance and brokerage industry there was a general understanding of leading indicators however this wasn't consistent across the interviews that were undertaken, there was limited knowledge from a number of organisations.

One consistent finding was the disparity in the methods by which small and large organisations manage occupational disease; unsurprisingly larger firms use many means of managing risks such as minimising exposure. In certain high risk cases insurers will deploy health and safety specialists that will look for the sufficiency of risk management practices, however only a small proportion of organisations can be surveyed as insurers have a limited resource of health and safety specialists.

There was a mixture of findings for the lagging-leading indicators paradigm. Suggestions that industry is not measuring the risk of diseases and do not believe that disease will occur was met with views that many organisations are moving to more proactive measures. However what is clear is that insurers are unable to utilise leading indicators due to lack of resources (health and safety specialists), limited access to information on leading indicators from firms, the competitive nature of the insurance/broker industry and lack of opportunity for communication.

There was uncertainty surrounding the ability to assess the risk of current exposure to the causative agents of occupational disease. In certain cases it was felt that current tools do allow organisations to assess their current exposure to occupational disease; however others felt that there was an absence of valid assessment techniques, guidance and limits.

In summary there is a mixed findings from the experience of insurers and brokers and although in general they support the use of leading indicator for assessing the risk of long latency disease they are unable (at present) to utilise leading indicators fully within the insurance/brokerage industry.

3.3.3 Do overseas regulators or OH bodies offer examples of leading indicators or good practice?

The occupational health bodies displayed a mixed understanding and use of leading indicators and there use within the audit and assessment process. One occupational health body stated that they did not use leading indicators and another occupational health body stated that they used them within their audits such as health surveillance, environmental monitoring and referrals to occupational health practitioners. In general the application of leading indicators in the occupational health bodies was limited and not industry wide.

In contrast the overseas regulators consulted in this study demonstrated a detailed understanding and appreciation for leading indicators. Some examples of leading indicators used included:

- Closed systems to avoid contact;
- Substitution of dangerous or sensitising substances including ensuring that hazardous substances are properly labelled;
- Assessing the number of workers exposed to specific disease causing agents.

For a full list of the leading indicators cited, see Appendix B, section 6.5.1.

Responses from Scandinavia included that there are regulations on medical controls such as spirometric analysis and some exposures (such as silica dust, asbestos) are subject to mandatory

regulation. In these cases tests must be offered before the employee is registered for work and on an ongoing basis. They also used workers questionnaires to gauge their perception of health and look for the quality of the preventative measure and not just the use of these. Assessment of worker hazards and risks as well as exposure levels and biological monitoring were also used.

In Australia they have used the 2008 National Hazard Exposure Worker Surveillance Survey to identify whether the workforce were undertaking high risk work activities. They measured the extent of their exposure and reported a range of control measures likely to reduce exposure. Using this data a suite of leading indicators for long latency diseases are being developed, which will reflect changing exposure to hazards through improved use of controls. As well as this the literature review revealed that Worksafe Victoria are in the process of developing a number of KPIs which include self assessment of exposure utilising the Australian Hazard Exposure Assessment Database (this is still in development). This will allow Worksafe Victoria to measure success in their commitment to reducing the impact of Occupational Disease in Victoria.

The overseas organisations mentioned an array of methods for managing the risk of occupational diseases including risk assessments, checklists, pre-employment medical assessments, engineering controls, biological monitoring and PPE.

There was still some variation in the use of lagging indicators versus leading indicators although all overseas organisations either were using leading indicators or were working towards using leading indicators. The tools used by overseas organisation included surveys, questionnaires, checklists and risk assessments. The outcomes of the audits and risk assessments were used to determine the necessary preventative measures. Also mentioned was a baseline survey on worker behaviour and perceptions that would be used to determine populations at potential risk of occupational disease.

The findings from the overseas stakeholder interviews give some ideas as to how other nations are combating the risks of occupational disease. The Scandinavian responses demonstrate a proactive approach to managing the risk of long latency diseases and equally the Australian work shows a number of schemes looking to move and progress the management of long term latency diseases. What can be taken from this is the importance of utilising quality methods to measure leading indicators, ensuring workers are aware of the hazards they face and utilising worker questionnaires to gauge their perception of health as has already been demonstrated by the Scandinavian countries and Australia are in the process of developing.

3.3.4 Are there examples of health surveillance or workplace exposure monitoring being used as leading indicators?

There are different examples of both health surveillance and exposure monitoring being used as leading indicators within a number of different sectors.

Within the silica industry exposure monitoring is common place through the use of lapel devices and the use of the Workplace Exposure Limit Level where any employee exposed to more than 50% of the WELL limit would be treated and control measures sought. Both personal and atmospheric dust monitoring were used to estimate exposure levels. Enhanced health surveillance is used within the silica industry and this includes the use of spirometry testing, questions on the use of X-rays as an alternative assessment method were raised on a number of occasions and clarity was sought on this issue.

In the chemical industry similarly WELL exposure limits were measured and a traffic light system used to decipher the action to be taken for the level recorded. Again personal dose monitoring and atmospheric monitoring were also used to measure exposure. Health monitoring such as urine sampling and the amount of overdue health assessments were also utilised too.

Within the engineering sector health surveillance was mentioned as being used, there was no mention of exposure monitoring although control measures were used such as engineering controls and dust suppression. In the construction industry there was concern with the logistics of collecting monitoring data in this sector. One organisation mentioned that they did not monitor exposure and instead they used engineering controls to manage the risks. Health surveillance was not mentioned in the sample of construction firms interviewed.

Examples of leading indicators can be found in section 3.5.

The findings of the stakeholder interviews did demonstrate the use of personal monitoring and health surveillance in use in certain industries. However a number of firms did stress the importance of collecting ample reliable monitoring data. In their experience monitoring data can be weak and often great variations can be seen if monitoring is not made a constant commitment by the company.

3.4 PREDICTIVE VALIDITY OF INDICATORS

The predictive validity of indicators is an area where more work needs to be focused. There were some interesting responses gathered to this question although more works needs to be performed in this area to clearly decipher the predictive validity of the indicators currently in use.

From the stakeholder consultation the UK firms detailed a number of sources of evidence for the predictive validity of leading indicators such as linking exposure to an element to an effect (chemical industry), silica exposure research in Scottish miners (silica industry) and the work of the HSE in this area including the Hazard Assessment Documents.

The Trade Associations reported that there was a limited amount of research and evidence on leading indicators being a valid predictor of long latency disease. There were suggestions that the advice of medical professionals had been used to endorse indicators and HSE review work such as the work on cement and COPD.

Some of the overseas organisations reported research and evidence of these indicators being valid predictors of the risk of occupational diseases. For example, one organisation reported that epidemiological research indicates that exposure to hazardous substances can lead to disease, and another organisation reported that various long term studies exist on the use and validity of the WAI. It was reported by one organisation that *"risk assessment is the cornerstone to European approach to occupational health (and safety) because if the risk management approach is not done well or not done at all, then the appropriate preventative measures will not be put in place"*. One organisation stated that it was imperative that evidence came from robust scientific research and epidemiology and that then exposure levels set would be a useful predictor. However, in contrast other organisations reported there being no evidence that these assessments are valid predictors of the risk of long latency diseases.

It was clear from the literature and the majority of the stakeholder interviews that there was little statistical work on the predictive or construct (the extent to which the scale measures the attributes it intends to) validity of leading indicators. This is in direct contrast to the field of safety where there are numerous examples of the statistical validity of indicators being assessed. For example safety climate questionnaires have been compared directly against injury rates to assess their validity, such as by Cox and Cheyne (2000, 76), Seo et al (2004, 77) and Silva et al (2004, 78). However with long term occupational disease it is difficult to statistically validate whether an indicator of current day management or working practice is predicting the rate of disease in future years, as both the symptoms and onset of long latency disease may not be apparent for an extended length of time. This equates to a unique challenge in being able to assess the predictive validity of leading indicators for long latency diseases.

3.5 WHAT SCHEMES COULD BE FURTHER DEVELOPED BY THE HSE?

3.5.1 Introduction

The literature review and consultation indicates a range of possible types of indicators, including:

- Occupational health management systems, such as access to occupational hygiene expertise;
- Key Performance Indicators, such as per cent of workforce covered by exposure monitoring;
- Implementation of workplace risk controls, such as provision of local exhaust ventilation (LEV) training, PPE and hours working in exposed areas;
- Worker surveys of awareness, attitudes and behaviours, such as awareness of health risks and attitude towards use of PPE.

These indicators could be considered to be complimentary rather than exclusive. They could, in the researchers' opinion, be implemented by:

- Occupational health risk management
    - Extension of the HSE's CHaSPI or HaSPi tools;
    - Inclusion in proprietary audit schemes (such as QSA) and in self assessment systems used by trade organisations such as Quarrysafe;
    - Inclusion in new HSE topic guides.
- Key Performance Indicators
    - These could be operated by associations, such as Trade Associations, as part of sector wide self reporting schemes;
- Implementation of workplace risk controls

    - These could be implemented with an extended set of the HSE's Risk Control Indicators as well as proprietary audit schemes (such as QSA) and in self assessment systems used by trade organisations such as Quarrysafe;

- Workers surveys of awareness, attitudes and behaviours

    - These could be included in a revised WHASS as well as safety culture and safety climate questionnaires.

These options are elaborated below.

3.5.2 Occupational health management indicators

The review identifies the following occupational health management indicators that could be included as an extension to the HSE's current tools and topic guides in this area. These indicators could be promoted by the HSE to companies in a number of ways, including:

- In good practice guidance published by the HSE, outlining how organisations can monitor and score their management of long term disease;

- By promoting these indicators to individual firms through direct contact, such as during inspections or schemes such as the Large Organisation Pilot Project;

- By promoting them to sector wide bodies such as trade associations and professional bodies.

Guidance from the HSE could cover what to measure and example measurement scales.

Whilst this may provide a measure for firms, firms would need to self-report scores to the HSE if the HSE wish to track performance over a series of years.

A further option is to include these types of questions in existing HSE online self assessment tools such as CHaSPI and HaSPI, or a new bespoke online self assessment tool dedicated to long term occupational disease. This would offer the advantage of having access to results but would depend on voluntary completion of the assessment.

The indicators include:

- Policy of completing health risk assessments of potential dangerous materials and dusts;

- Inclusion of occupational hygiene in health and safety improvement and action plans and planning;

- Worker involvement in assessing risks and devising risk controls;

- Pre-employment health screening; and fitness for task assessments;

- Access to occupational hygiene expertise, including specification of ventilation and extraction requirements;

- Policy of replacing/substituting dangerous substances where possible and the use of ventilation and extraction equipment, suppressant equipment, PPE and limiting exposure times otherwise;

- Checking for defective PPE, cleanliness and laundering of PPE and other protective equipment such as RPE;

- Measuring exposure levels (through atmospheric and personnel monitoring) to hazardous substances and ensuring that these fall below the WELL exposure levels and other exposure levels;

- Policy of providing training and instruction on safe use of dangerous materials and control measures such as LEV;

- Maintenance of equipment with respect to minimisation of dust and fume levels, e.g. seals and filters as well as of extraction and dust suppression equipment;

- Policy of auditing occupational hygiene risk controls, worker behavioural observation (with respect to dust and fumes etc) and conducting worker opinion surveys;

- Inclusion of occupational hygiene in management 'tours';

- Collection and use of leading occupational health indicators, such as internal audit reports on achievement of disease reduction risk controls, trend in exposure (dust/fume) levels in workplaces;

- Compliance with health surveillance requirements;

- Inclusion of health promotion and health education in OH strategy;

- Public reporting of occupational health KPIs and performance benchmarking with comparable firms.

3.5.3 KPIs - Self reporting schemes

Key Performance Indicators are metrics that an organisation can use to help define and evaluate how successful they are in progressing towards a long term goal, such as the reduction in the occurrence of long latency occupational disease. They often rely on an organisation reporting their progress in meeting these key performance indicators. There are a number of good examples of the use of key performance indicators within industry and this includes the European Network for Silica (NEPSI) which provides a useful example of a set of KPIs.

The European Network for Silica were formed by the employee and employer sectoral associations developed the social dialogue 'Agreement on Workers' Health Protection through the Good Handling and Use of Crystalline Silica and Products Containing It' in order to develop an appropriate and credible measure for the improvement of working conditions. The organisations that have signed the agreement represent industries such as aggregates, cement, ceramics and foundries. The agreement requires information to be collected at site level using a reporting survey and consolidated before being communicated to the NEPSI Council. This

survey includes items covering exposure risk; risk assessment and dust monitoring; health surveillance; training; good practice and key performance indicators. The key performance indicators include:

- % of employees potentially exposed to respirable crystalline silica;
- % covered by risk assessment;
- % covered by exposure monitoring;
- % with risk assessment requiring Health Surveillance Protocol for Silicosis;
- % covered by generic health surveillance;
- % covered by Health Surveillance Protocol for Silicosis;
- % covered by information, instruction and training on general principles, and
- % covered by information, instruction and training on task sheets.

The NEPSI scheme had its first round of reporting in 2008 and will continue to collect reports biennially; this will give industry a useful insight into what measures are currently in use to monitor the effects of respirable crystalline silica and how these are performing.

This sort of scheme with guidance from the HSE could be adopted by other industries to help structure and encourage firms to collect KPIs and report and benchmark themselves against other UK and potentially international firms. KPIs would be specific dependent on the industry, as seen in the example above but could follow a format such as that drafted below:

Health Risk Assessment

- Number of health risk assessments of potential dangerous materials and dust completed;
- % of employees covered by a health risk assessment (including long latency occupational disease risks);
- % of occupational health related toolbox talks completed and topics covered.

Risk Controls

- % of weekly checking of control measures completed (e.g. RPE, PPE, LEV);
- % of weekly maintenance checks of control measures completed;
- % of employees covered by information, instruction and training on major risk factors;
- % of employees covered by information, instruction and training on the use of control measures (e.g. correct use of LEV and PPE).

Exposure monitoring

- % of employees with risk of exposure to hazardous substances;

- % of daily/weekly atmospheric monitoring completed;
- % of daily/weekly personnel monitoring completed;
- % of employees exceeding exposure levels on a daily basis;
- % of biological testing completed.

Dose and symptom monitoring

- % of new employees covered by pre-employment health screening;
- % of employees covered by health screening.

This sort of scheme could be encouraged on an individual firm to firm basis but would work best by using a central impartial body such as a trade association to collect and evaluate responses. This type of scheme would give industry a useful insight into what measures are currently being used to monitor the effects of hazardous substance within industry and how these are performing.

KPI's and/or self reporting schemes give a range of leading indicators that could be used for the measurement of leading indicators for occupational disease. At present, as was alluded to in the stakeholder consultation, many organisations are implementing indicators to help them track their occupational health management performance. There were also examples of where this has been developed further and trade associations have been involved in developing schemes to collect record and compare scoring for a range of key performance indicators. However currently this is by exception rather than the standard approach across industries in all sectors.

To develop this approach further the HSE could look to develop a pilot project that both devises the pertinent indicators for each industry. It is suggested that although there will be overlap between the indicators for each industry, a bespoke set of indicators would need to be developed for each industry. However although there would need to be sector specific variation a common form of measurement could be developed to aid cross comparison between different industries and also give an overall picture across all industries. A consultation and review process with key industry figures such as trade associations could be used to assist in the development of the indicators.

To successfully implement the pilot project support and advocacy from pertinent trade associations would be needed to ensure that their members assist with the scheme. An option is to promote these KPIs to sector based "targeted initiatives", such as those evaluated by Wright (2008, 71). Each scheme operates in a specific sector, such as cement or glass. Typically the trade association leads a health and safety initiative across the sector. As part of this they tend to apply health and safety performance measures and set targets. Occupational disease KPIs could be included within the wider health and safety measures. Performance indicators would be reported at sector level and, as already used in other good practice examples (such as the NEPSI scheme within the silica industry), the opportunity for organisations to benchmark their performance against other organisations for different measures would be available. This will allow them to have a measure of their actual and relative performance and could be helpful to identify key areas where they need to prioritise development. On successful completion of the

pilot project, partnership schemes and/or targeted initiatives could be used to apply the findings from the pilot across industry within the UK.

3.5.4 Inspection based schemes (e.g. Risk Control Indicators)

Inspectors from HSE's Field Operations Directorate (FOD) have, as part of routine inspections, rated a workplaces' level of risk control against various Risk Control Indicators' (RCIs). For each topic covered during an inspection, inspectors are required to score workplace standards in relation to three specific indicators. The scoring is on a 4-point scale ranging from 'full-compliance' (a score of 1) to 'limited or no compliance' in areas that are important (a score of 4).

Unfortunately the Risk Control Indicators do not cover the main long latency diseases and focus on general health and safety risks. In these cases the risk control indicators can be useful and a review report of the Risk Control Indicators stated that if all other factors remain equal over time (i.e. if RCI data is collected in a strictly scientifically controlled way) then any change in RCI score over time will reflect real changes in workplace health and safety compliance."[72] This suggests that the risk control indicators in use have demonstrated their validity in the field; however the contents of the indicators still show a gap in the field of long latency disease.

The review report also revealed that there were a number of flaws with the use of RCIs, namely that if the workplaces inspected each year are inconsistent then any changes in RCIs scores could be attributable to this variation rather than an improvement or deterioration in scores. There is also the possibility that over time the inspectors become more knowledgeable on each of the RCI subjects and begin to mark harder. Therefore deterioration over time in scores could be due to inspectors increased expectation from their more detailed experience rather than a decline in performance.

The types of risk controls cited by previous research and interviews include:

- Health risk assessments;
- Training and instruction on occupational disease risks, signs and symptoms, and risk controls;
- Dust control, for example cleaning furniture and fittings, washing work clothes;
- Provision and use of PPE, especially respiratory protection and protective clothing;
- Extraction (of dust or fumes) and the provision and maintenance of extraction systems;
- Limiting the time spent working in exposed areas;
- Access to facilities such as washrooms;
- Measuring and monitoring exposure to harmful substances, including both atmospheric and personal monitoring;

- Measuring and monitoring biological indicators of exposure to harmful substances (e.g. lead in the blood);

- Health Surveillance.

These risk controls could be included in the HSE's current Risk Control Indicators to more specifically address the issue of long latency diseases risk in UK firms. An example of how these could be included in the risk control indicators is shown below for long latency occupational diseases; this could be revised to address each occupational disease in isolation.

Long Latency Occupational Disease	
Management approach	Application of health risk assessment to all activities involving hazardous substances or elements. The provision of adequate training and instruction on occupational disease risks and risk controls. Evidence of management commitment and frequent review of occupational health data.
Control Strategy	Where possible alternative methods such as eliminating the problem utilised. In cases where this cannot be achieved adequate engineering controls introduced, utilised, maintained and tested frequently. All relevant staff to be trained on the use and maintenance of such equipment. Suitable PPE to be provided, worn by all employees at risk of exposure, stored correctly, regularly and properly cleaned and suitably maintained. All relevant staff to be trained on the use and maintenance of PPE.
Exposure monitoring	Suitable exposure monitoring to be set up and include measures of the number of employees with risk of exposure to hazardous substances. Daily personnel and atmospheric monitoring facilitated by a suitably qualified and experienced occupational health professional. Comparison against exposure limits and measured actions taken at management level when exposure exceeds limits. Where appropriate biological monitoring taken daily by a suitably qualified and experience technician. Comparison against limits and measured actions taken at management level when levels exceed limits.
Health surveillance	Appropriate health surveillance to the level of risk is provided by suitably qualified and experienced personnel to all employees at risk of exposure. This is repeated as required and all records are kept. All cases of occupational disease are reported under RIDDOR.

Implementation of such a scheme would be key to the success of the approach. The Risk Control Indicators are within the control of the HSE; however the current process in which they are delivered does not necessarily lend itself to a repeatable and quantifiable measure. At present the risk control indicators are used by inspector to assess a workplace during inspections. This means in effect that a variety of workplaces are assessed using the risk control

indicators every year. In order to utilise the risk control indicators as a leading indicators for long latency disease a repeatable approach to inspection would need to be developed. For example a consistent set of 100 targeted inspections from a representative sample of organisations in the UK could be repeated annually and compared and contrasted to give a leading indication of long latency disease risk for this sample.

3.5.5 Survey based approaches (e.g. WHASS)

Worker surveys, with respect to occupational disease tend to cover the following:

- Awareness of risks;
- Perception of management concern about reducing risk of occupational disease;
- Exposures;
- Adequacy and use of PPE;
- Adequacy of training and instructions.

The HSE's WHASS surveys the health and safety conditions across the UK for employees and employers responsible for health and safety through two separate surveys. Part of the survey looks at hazards and there are a number of leading indicators included in the survey, but this list could be added to in detail. Areas currently covered include; control measures used to protect against exposure e.g. dust and fume ventilation, extraction, cleaning, enclosing the source, maintenance of ventilation and extraction equipment. Notably the wider leading indicators are not considered such as training on control measures for example on the correct use of LEV, replacement of LEV equipment, compliance with control measures and violations. More could be added to the WHASS survey to ensure that it is comprehensive and gives the HSE a reasonable picture of the leading indicators in use in the UK.

WHASS employer's survey includes practices on reporting of both lagging indicators (such as incidence reporting) and leading indicators used to assess health risks within the workplace. Again it is a detailed survey covering a detailed topic base. The leading indicators focus on health and safety management (including the involvement of senior management). It also explores the involvement of key health and safety professionals and in particular here the involvement of occupational health professionals. Surprisingly the use of controls is not reviewed in the employer's survey; neither is training on control measures, compliance with control measures and violations.

Below are listed some examples of additional areas that could be added to the HSE's WHASS survey:

Additions to the WHASS employee's survey

- The use of health risk assessment to assess activities involving hazardous substances or elements;
- Training and information on the use of control measures utilised within the workplace (e.g. LEV, RPE and PPE);

- Effectiveness of the training and information provided on the use of control measures;
- Use of exposure monitoring, both personnel and atmospheric;
- Level of exposure (e.g. recorded hours if more than one hour per day/week);
- Inclusion of health promotion activities specifically for long latency occupational disease;
- Violations and compliance with control measures, including reasoning for violations;
- All employees at risk covered by health surveillance.

Additions to the WHASS employer's survey

- The comparison of exposure levels to exposure limits;
- Action taken up to management level when exposure limits are exceeded;
- Adequate supervision of the workforce to ensure they comply and utilise control measures available;
- Replacement policy for control measures.

The key areas listed above would need to be developed into a detailed question set with open and closed response options.

Utilising the WHASS survey could be a useful approach for the measurement of leading indicators. However this would be reliant on further development of the questions as eluded to above and the continued completion of WHASSs. Repeated implementation of the WHASS survey would be pivotal to the success of this approach. The advantage of the WHASS survey approach is that the HSE could implement it under their control and it would allow them to nationally track progress on leading indicators for long latency diseases annually. Cross comparisons and consistent tracking could be performed on an annual or biannual basis.

Survey based approaches by nature are a subjective assessment of sampled individuals opinions and views on specified questions, in this case exposure levels, application of control measures, adherence with health measures etc. This characteristic may need to be considered when utilising a survey based approach for measuring leading indicators as this could have an effect on the robustness of the data collected.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 UNDERSTANDING OF LEADING INDICATORS

The understanding of leading indicators, particularly with respect to occupational disease was very mixed. Many stakeholder respondents, including some insurers, brokers, firms and health and safety institutes were unaware of the term or of examples of leading indicators. In addition, previous research has focused on safety indicators rather than occupational health leading indicators, with a large part of overseas work focused on health surveillance.

Notwithstanding this there were a number of sources of well developed thinking and tools including:

- Industries working with silica (mines, quarries) and chemicals (oil, gas and chemicals);
- Overseas regulators, particularly New Zealand, Australia and Scandinavia.

These sources present a view of leading indicators that is consistent with the HSE's and have developed or are developing tools and measures.

Moreover, it is concluded that sufficient work has already been completed, as reviewed here, to produce a draft set(s) of indicators. Therefore, given the need for leading indicators, it is recommended that further work is completed to draft and test one or more of the types of indicators identified in this report.

4.2 INDICATORS AND SCHEMES THAT CAN BE FURTHER DEVELOPED

There was a range of indicators that could be taken forward by the HSE. These include:

- Developing occupational health risk management indicators, such as those developed by the OGP;
- Key Performance Indicators, such as those developed by NEPSI;
- Risk control indicators, as developed by a variety of trade organisations such as Quarrysafe and companies such as mining firms;
- Worker surveys (akin to WHASS), such as the National Exposure Worker Surveillance survey of Australia.

These indicators could be implemented in existing HSE and industry tools, such as WHASS, the HSE's Risk Control Indicators and trade association self reporting schemes.

All of these indicators have been found to be useful elsewhere. They each offer certain advantages whilst also performing a certain limited role. For example:

- Occupational health risk management indicators enable firms to assess their individual performance and help to identify areas where they need to improve, whilst pooling results can provide a measure of progress over time;

- KPIs can be pooled by firms to provide a sector wide measure of progress, but indicate performance outcomes rather than identify required management improvements;

- Risk Control Indicators may be used directly by the HSE and provide a measure of progress over time, but this would depend on consistent application of RCIs by inspectors across a period of years;

- Worker surveys, if conducted across organisations, can provide a sector or national view of performance and can be repeated across the years to provide a measure of progress. However, they do not provide direct feedback to individual firms to help them improve.

These options are not mutually exclusive. For example, the HSE could complete worker surveys to gain a national view of performance, whilst promoting sector level KPIs to provide sector level performance scores and promote to firms occupational health risk management indicators to support improvement in individual firms.

4.3 RECOMMENDATIONS

Given the need for leading indicators, it is recommended that further work is completed to draft and test one or more of the types of indicators identified in this report. As previously noted, a number of indicators exist that could be drawn on by the HSE.

There are a number of approaches that the HSE could use to develop and implement leading indicators for long latency diseases and recommendations have been devised to address these including:

1. **Amend CHaSPI and/or HaSPI**

CHaSPI and HaSPI could be amended to include additional questions on the management practices and risk controls that help prevent latent occupational disease.

2. **Promote "good practice" in disease prevention management assessment**

The management indicators could be promoted to companies in the form of good practice guidance through publications and direct contact with firms during inspections and schemes such as the Large Organisation Pilot Project.

3. **Expand the WHASS survey and further develop the question sets.**

The WHASS survey could be further developed to cover the questions noted in this report. As previously noted, this recommendation is dependent on the repeated implementation of the WHASS survey.

4. **Develop the risk control indicators and introduce 100 targeted inspections annually**

The risk control indicators could be further developed by the HSE to cover long latency diseases. To utilise the risk control indicators for monitoring trend, the HSE would need to introduce a scheme where they (for example) assessed 100 targeted workplaces per year and therefore could have a measure that was directly comparable annually.

5. **Utilise key performance indicators to develop sector level schemes**

The HSE could build on existing KPI schemes and utilise and develop sector specific leading indicators. To implement such schemes the HSE would need to develop partnership working with key industry organisations such as Trade Association and other industry associations.

Recommendations 1, 2, 3 and 4 have the advantage of being under the control of the HSE and hence do not rely on the co-operation of intermediary organisations. However, they would obviously rely on the application of HSE resources. Recommendation 5 has the advantages of 1) engaging industry in self-monitoring and self-improvement and 2) using industry resources to develop the measures. These recommendations are not mutually exclusive, as previously mentioned.

4.4 ASSESSING THE VALIDITY OF LEADING INDICATORS FOR LONG LATENCY DISEASES

The review revealed limited work or evidence for the predictive validity of leading indicators for assessing the risk of long latency diseases. As discussed this is in direct contrast to the findings within the field of safety where the validity indicators has been assessed, such as by Cox and Cheyne (2000, 76), Seo et al (2004, 77) and Silva et al (2004, 78). In the case of safety climate, data in the rate of injuries has been compared against the safety climate questionnaire results to validate the predictive reliability of the questionnaire. In addition, a comparison of injury rates against specific questions and sub-sets of questions allows the question set to be reduced down to the smallest number of questions needed to predict the injury rate.

Assessing the predictive validity of leading indicators for long latency diseases poses a unique challenge due to the nature of long latency diseases and the delay in onset of symptoms of the disease. Clearly, it is difficult to test whether the results of a questionnaire applied today predicts the occurrence of latent diseases in (for example) 20 years time.

To overcome such a challenge a more subjective approach to predictive validity may be needed to assess leading indicators for long latency diseases. Utilising an approach such as a content validity review of indicators based upon experts review, namely the DELPHI technique. The DELPHI technique was originally used by Helmer & Dalkely (1972) of the RAND Corporation 30 years ago. It elicits open-ended predictions from a selection of "expert individuals" in a subsample and feeds them back to a larger sample in order to arrive at a quantifiable conclusion. Such a technique potentially could be used by to judge the predictive validity of leading indicators for long latency diseases. This is the clearest way forward to judge the predictive validity of leading indicators for long latency disease due to the nature of long latency diseases and the delays seen between exposure and onset of illness.

If a questionnaire approach is adopted, whether for occupational health management or worker attitudes and behaviours, further development could include factor analysis and reliability analysis. This would involve applying the questionnaire(s) to a sample of respondents. Statistical analysis then explores whether questions consistently explore the underling constructs, which questions are redundant and whether results are consistent between applications. An example of such work in the context of safety climate questionnaires is given by Rollenhagen et al (2007, 79) and Hutchinson et al (2006, 80). Factor and reliability analysis helps to develop the consistency and construct validity of the questionnaire, but does not directly test or help develop their predictive validity.

5 APPENDIX A – LITERATURE REVIEW

5.1 GENERAL RESEARCH ON LEADING VERSUS LAGGING INDICATORS

There is much discussion of the need for indicators that measure how well safety is being managed in major hazard industries. Two indicators used to assess safety are leading and lagging indicators.

5.1.1 What are leading and lagging indicators?

Lagging indicators have been reported as loss metrics that are already recorded and measure an organisation's safety performance in the form of past incident statistics. [1] For example, number of incidents and reported accidents, disease incidents, failures, failures of systems or performance standards. Most industries report on these indicators as a measure of the outcomes of their management of health and safety. Whilst these indicators are important in defining the effects and outputs of health and safety management, they provide insufficient information to guide actions and control and ensure success of health and safety management processes. They promote reactive rather than proactive management. Good output may provide reassurance of health and safety management; however it does not provide real assurance in continued success. Therefore, any organisation that seeks to assess how well it is managing safety hazards cannot solely rely on outcome data such as accident or fatality data; it must develop indicators that relate specifically to the potential risks and hazards. [2][3][4]

Leading indicators are reported as the precursors that may lead to an accident, injury or disease. They can be used to monitor the effectiveness of health and safety management systems before accidents, damage or failures happen, thus helping to control and prevent their occurrence. As leading indicators focus on enhancing performance and reducing the probability of serious accidents, they can compensate for any shortcomings of lagging performance indicators. [1][3]

5.1.2 Differences between leading and lagging indicators

It is evident that leading indicators highlight the positive aspects of an organisation and help to illustrate that correct procedures are in place. Gallagher et al (1997) [5] used the term 'positive performance indicators'. Examples of these include the number of safety audits conducted and the percentage of people trained in health and safety. If an organisation is carrying out the required number of these items, or more, the leading indicators will highlight this. Conversely, lagging indicators highlight the number of negative issues that have occurred in an organisation, such as the number of accidents or fatalities. From looking at examples of leading indicators it is apparent that they tend to be very specified, focusing on specific aspects of a health and safety management system; whereas, lagging indicators are non-specific, as the number of accidents or fatalities that may be reported could be due to a number of different causes which the indicator does not specify.

Table 1 identifies some of the suggested differences between leading and lagging indicators [3].

Table 1: Functions of safety performance indicators

Leading performance indicators	**Lagging performance indicators**
Low quantitative analysis	High quantitative analysis
Weak benchmark	Strong benchmark
Future outcomes forecast	Strong data-driven
Weak data-driven	Controlling method for management level
Efficiency-driven on measurement	Weakly continual monitoring in the organisation
Wide monitoring of all activities	Method for investigation, analysis and record of weakness of health and safety management system
Strong continual monitoring in the organisation	Reactive key performance indicators to check goals and targets achievement
Check the consistency of health and safety related activities	
Proactive key performance indicators to check goals and targets achievement	

It has been reported that most industries currently report on lagging indicators. The offshore industry shares information and rates lagging indicators according to a universal framework, an example of which is hydrocarbon release incidents. However, the application of leading indicators is being recognised as an effective strategy in the reduction of serious incident frequency. [6]

5.1.3 Examples of leading indicators

One primary example of a leading indicator is inspection through internal safety audits. It is reported that as an organisation increases its inspections, incidents tend to decrease. This may be due to increased awareness and improved identification of hazardous conditions and behaviours. [1] Other examples of leading indicators include the percentage of required process hazards analyses completed in a required time frame; the proportion of employees who have access to occupational health services; the number of labour safety inspectors per 1000 employees; the percentage of inspections and tests of safety critical equipment/instruments, completed within a required time frame. [7]

The mining industry has carried out much work on the development of occupational health and safety procedures and the development of leading indicators. For example, Van Der Bergh [8] grouped a number of leading indicators under the following categories:

- Leadership (including field visits and communications conducted);
- Safe working (observations of behaviour and inspections conducted);
- Safe place of work (risk assessments and inspections);
- Competence (percentage of training completed); and
- Implementing lessons (percentage of incidents investigated, corrective actions applied).

Occupational health guidelines have also been developed for a major mining company, which comprises of an occupational health management system from policy through to risk assessment, exposure limits, audit and continuous improvement, as well as employee participation, communication and training. [9]

5.1.4 Variations of leading indicators

Different variations of leading indicators have been reported, such as key performance indicators (KPIs). These are based on general safety often using just one measure, and like other leading indicators, KPIs exist at different levels such as work place controls, behaviour and knowledge, and management systems. Other examples are behaviour and cultural surveys which tend to look at a wide range of issues to gain a composite score of safety for the organisation.

It is evident that leading indicators are not just used by individual organisations. They are also used by regulators to gain industry level information. Therefore, this allows regulators to identify the proportion of companies within a sector that have certain hazards present and health and safety management systems in place. [10]

5.1.5 Health versus Safety

It is evident that most industries that are developing leading indicators are doing so for the 'safety' culture of the industry, through the prevention of accidents and incidents. Very few are developing these indicators for the prevention of poor health, particularly long latency diseases. For example, Chen and Yang [11] developed a 'predictive risk indicator' (PRI) that was tested in a petrochemical plant. This involved observation of behaviour and rating unsafe acts against scales for 'probability of danger'; 'frequency of work exposure'; 'number of persons at risk'; and 'maximum probable loss or severity'. Correlation was found between rises in the PRI after stable periods and subsequent accidents at the plant.

The nuclear industry has also conducted research on the use of leading indicators. For example, the US NRC has commissioned reports on the utility and performance of leading safety indicators in nuclear power plants. From this, reliable leading indicators of safety performance in the chemical and nuclear sector were found. These included problem solving capacity; identified diversification of operations and learning; and links between demands placed on management attention and their ability to respond and hence maintain a safe working environment. [6]

The aviation industry is another industry that has used leading indicators. For example the Federal Aviation Administration (FAA) developed the Global Analysis and Information Network (GAIN) to help reach the target of 'zero accident status' within 10 years. GAIN stores and analyses data from digital flight recorders and Air Traffic Control on the effective and safe management of the airline industry and allows trends to be detected and problems rectified being before accidents occur. [6]

Occupational health can be a more difficult area to develop leading indicators for many reasons: frequent lag time between exposure and symptoms; problems with identification; and the area of occupational health itself often taking a lower profile than accidents due to the immediate attention that accidents attract. However, due to the advantages of occupational health indicators such as the measurability of hazards for comparison against national standards (e.g. exposure times Bennett and Foster (2005) [2] developed a template of leading indicators that could be used to assess a company's occupational health and safety performance. This indicator can be customised to monitor the significant health risks of many industries, and includes methods such as having risk-based hazard monitoring and control in place to current nationally quantified standards as well as risk based health surveillance.

It is reported that a relatively large amount of work on leading indicators is conducted on process safety issues (e.g. Webb, 2008), which take a measure of risk control programmes. However, this provides an analogy of what work could be carried out and what indicators could be developed within the area of occupational health. For example, a key leading process safety indicator that has been reported is the *'% of people who have attended defined process safety related training by due date'*. [12] This could easily be used in the area of occupational health to ensure that the training is related to health issues.

Leading indicators provide a company with the ability to identify negative trends or improvement opportunities and following this, prompt preventative action. An occupational health and safety management system provides a strong basis for indicators to be developed; however, procedures need cultural underpinning to make them work well. The use of leading indicators within industry is a developing area with potential for further research, particularly in the area of health, illness and disease.

5.2 NATIONAL STUDIES AND APPROACHES

For the National Studies and Approaches we have reviewed five main areas of work which include:

1. America;
2. International;
3. Nordic;
4. New Zealand and Australia;
5. Europe.

5.2.1 America

Within America there are three main lines of work including:

- CSTE ~ CDC;
- NIOSH;
- NORA (an initiative in the construction sector).

The National Institute for Occupational Safety and Health (NIOSH) has been working to consolidate efforts to build on the Construction Programme. As part of this the National Occupational Research Agenda (NORA) Construction Sector Council has reviewed surveillance information made available by stakeholders as well as any comments that stakeholders have submitted. This has led to 8 strategic goals being developed and overall performance being measured for each. Two of these goals are directly relevant to this work including:

- Strategic Goal 6: Reduce occupational illness among construction workers by reducing inhalation exposures to lead, silica and welding fumes.

  Overall Performance Measures included specific percentage reductions in the exposure to lead, silica and welding fumes (e.g. a 20% reduction overall in welding fume exposures).

- Strategic Goal 8: Improve surveillance of occupational injuries, illnesses, and hazards for the construction industry at the Federal, state and private level.

  Overall Performance Measures included examination of emerging technology and any related hazards and the monitoring and evaluation of interventions as a measure of their effectiveness.

As part of this strategic goal an intermediate goal was for key stakeholders (including professional associations, insurance companies, regulatory and consultation organisations) to develop performance indicators that will complement existing surveillance approaches [48]. A number of research goals have been developed, including a set of leading indicators for the construction industry to help them to evaluate and tailor their health performance, and the development and implementation of a national construction exposure database to key health hazards including silica and welding fumes. However, the status on the CDC website stated that these goals have “no work underway” and subsequently, it is unclear at this stage what progress has been made.

One of the top ten construction issues highlighted in this programme was the need to reduce major health exposures and illnesses of concern. In particular those highlighted were silica and welding fumes and suggestions such as standardized pre-job planning health hazards approaches (e.g. reviewing hazards prior to any work taking place) were suggested for both of these potential hazards.

NIOSH also promotes the use of Health Hazard Evaluations [46] and gives case study examples of how these approaches can contribute to safer working. The use of leading indicators such as

maintainability of ventilation was cited in a case study example of potential health hazards at a vehicle repair shop.

To address a national goal to improve public health, CDC convened the Occupational Health Surveillance Working Group to recommend occupational health surveillance activities. As part of this process the work group developed 19 occupational health indicators [53,56,57], which were included dependent on the ease of obtaining data, public health importance of the exposure to be measured and potential for intervention activities. However these indicators are by and large lagging indicators and include no direct reference to occupational disease. CDC [54] has recognised industries' use of workplace health promotion activities to alleviate the effect of occupational diseases on employee productivity and control health care costs. CDC continues to describe employer's use of "ineffective or unnecessary" interventions such as health risk appraisals and hypertensions screening. They recommend a public health approach to health promotion in the workplace involving a 5 stage process:

1. Defining the problem;
2. Elucidating risk factors (e.g. behaviours);
3. Identifying effective interventions;
4. Implementing suitable interventions;
5. Evaluating their effectiveness.

In North Carolina the Occupational Health Surveillance Unit (OHSU) [55] is responsible for monitoring trends in work-related injury and illness for the state. All physicians must report cases of asbestosis or silicosis within 15 days of diagnosis. After a case is reported information may be provided to the patient or a worksite visit may be required. This again is focused on lagging indicators and gives a reactive rather than proactive approach. The North Carolina Division of Public Health [59] conducts surveillance programmes for a blood lead surveillance (Adult Blood Lead Epidemiology Surveillance), hospitalizations for pneumoconiosis and incidence rate of malignant mesothelioma. The focus here is again on surveillance and utilising lagging rather than leading indicators.

Since 1983 the American Association of Poison Control Centres [60] have been collecting exposure level data from an increasing number of participating centres on toxic exposure surveillance (now over 60 centres). The data is used to identify hazards early, fed back into prevention education and used to direct training. This approach also focuses on lagging indicators; however the system does use the findings for proactive measures such as education and training.

Other organisations in America and Canada promote the use of leading indicators. The Construction Safety Association of Ontario (CSAO) quotes the quality of housekeeping as one of the leading indicators in the construction industry. Some other leading indicators cited in their Network News publication [49] include:

- Commitment to workplace health and safety;
- Awareness of workforce and management of job risks;

- Level of activity of Health and Safety committee;
- Availability of health and safety information on site;
- Level of staff training;
- Awareness and utilisation of health and safety systems.

Although this only covers general leading indicators, and not those specific to long latency diseases, it does demonstrate a focus on involving management and employees in health and safety practice.

The Department of the Interior in the US have developed a Health and Safety Program Evaluation Overview. [51] The program is designed to collect evidence that clearly demonstrates adherence with OHS regulations and overall good practice. The evaluation workbook includes:

- Safety and occupational health program planning (e.g. management leadership, employee participation);
- Safety and occupational health program implementation (e.g. OHS controls such as PPE and engineering, workplace surveys and analysis, education, training and awareness);
- Safety and occupational health program evaluation (e.g. regional leading indicators, monitoring and assessment).

5.2.2 International

Safework, a division of the International Labour Organisation have developed an Occupational Safety and Health Management System through a review of existing OSH management systems. The system that was devised has five main sections that include:

1. Policy;
2. Organising;
3. Planning and implementation;
4. Evaluation;
5. Action for Improvement.

The Evaluation section contains the essentials of performance monitoring and measurement, audit and management review which is the area that leading indicators would apply. Section 3.11 describes the use of active monitoring and the elements needed to have a "proactive system" include as described:

- Monitoring of the achievement of specific plans, established performance criteria and objectives;
- The systematic inspection of work systems, premises, plant and equipment;

- Surveillance of workers' health, where appropriate, through suitable medical monitoring or follow-up of workers for early detection of signs and symptoms of harm to health in order to determine the effectiveness of preventions and control measures; and

- Compliance with applicable national laws and regulations, collective agreements and other commitments on OSH.

Reactive monitoring practices are also detailed including disease. Audit arrangements were specified to meet both prevention and control measures.

The Organisation for Economic Co-operation and Development (OECD) [68] has developed a comprehensive guidance document to assist industrial enterprises, public authorities to implement an assessment of their chemical safety activities. The document gives guidance on how to develop and use safety performance indicators for safety related issues. This is a comprehensive document that provides a useful tool to develop leading indicators but it is specifically safety related. An occupational health equivalent with a focus on long latency disease would be extremely useful.

The 10th Annual Meeting of the Baltic Sea Network [66] discussed the use and development of occupational health leading indicators. This detailed the use of both quantitative and qualitative indicators such as subjective assessments of the performance of occupational health services. Importance was placed on ensuring that the indicators did not emphasise scientific validity as this could be counter-productive. Discussion also revolved around what information and/or data was available in all Baltic Sea Network counties and this included registers of occupational disease, national statistics and in certain cases sickness absenteeism.

5.2.3 Nordic

In Sweden the registry of occupational hygiene measurements (Exponeringsdatabasen) has been set up to provide data on occupational exposures in Sweden. Also in Finland the register of chemical, physical and biological factors at workplace has been set up. The register covers chemical, physical and biological factors and is used to make priorities in OSH activities and in setting air limit values and criteria, however the direct questions for this survey are not publicly available.

In 1992 the Finnish Institute of Occupational Health developed the Finnish Job-Exposure Matrix (FINJEM) [63] which provides occupation specific estimates of exposure levels and the probability of exposure. FINJEM uses industrial hygiene data, information on occupations and incidence of exposure to estimate the probability and levels of exposure. It includes a range of agents such as wood dust, paper/pulp dust, textile dust, other organic dusts etc. The advantages of FINJEM is that it can be used to estimate exposures specific for certain occupations however one of its limitations is that it tends to misclassify exposure because all workers with the same occupational title are assigned to the same group, independent of their actual exposure.

5.2.4 New Zealand & Australia

New Zealand

The National Occupational Health and Safety Advisory Committee (NOHSAC) published its report into the surveillance practices for occupational disease in New Zealand (2005) [52]. This report recommended an emphasis on surveillance but also that action was required to prevent workplace exposure to the causes of occupational disease through controls. NOHSAC's third report, although acknowledging that New Zealand fails to meet internationally accepted practice on the subject, and does provide some useful examples of exposure surveillance. New Zealand are looking to develop joint exposure surveillance initiatives with Australia. The report details a literature review and a series of telephone interviews. The literature review identified that exposure surveillance and control systems do not have a significant role in Occupational Health within New Zealand or Australia.

The review identified three main data collections methods that were used to measure workplace exposure, including workplace and workforce surveys and environmental monitoring surveys, personal monitoring and biological monitoring. Although monitoring both biological (e.g. for blood lead) and environmental is in effect more of the lag end of the spectrum of indicators, workplace and workforce survey could contain key leading indicators. There were two major workforce studies conducted in New Zealand by Massey University and the University of Otago. The survey by the Massey University [47] involved telephone surveys of current exposures and workplace practices with 5000 workforce members, this included current workplace exposures and respiratory symptoms. Key risk exposures included in the survey were dust, smoke or fumes, gas, oil and solvents, acids or alkalis, fungicides etc. and other solvents. Workers were asked what they were exposed to, for how many weeks per year exposed, for how many hours per day and the source of the substance. The survey by the University of Otago is similar to the Massey University survey however it collects more qualitative data and samples fewer workers.

To conclude the New Zealand workforce surveys collect limited information on occupational disease and the focus is on exposure levels rather than the more pro-active approaches to occupational health risk management. The NOHSAC report recommends using regular workforce surveys to begin to obtain baseline data on workplace exposures to high risks elements. They also recommend supplementing this with collecting information on hazard controls, and specific OH&S programme components as well as identifying new and emerging hazards.

Australia

Workplace Health and Safety Queensland have developed an Occupational Disease Strategy for 2007-2010. The purpose of this strategy is to provide a framework for reducing the incidence of occupational disease in Queensland, Australia. Specific targets have not been set as there is under-reporting, partly due to the poor recognition of the work-related connection of occupational disease. In their strategy Workplace Health and Safety Queensland state that they will work with stakeholders to improve the recognition and reduction of occupational disease. They plan to do this by addressing the following activities:

- Prioritising activities and focusing on individuals that have the obligation to prevent exposures;

- Improving data and surveillance of occupational diseases and hazard exposure;
- Increasing awareness and the provision of education for doctors on occupational diseases;
- Adopting a concerted government approach to the prevention of occupational disease; and
- Engaging with industry and developing industry specific intervention programs.

Workplace Health and Safety Queensland have set a number of specific goals for priority diseases, these include:

- Cancer with the goal to improve management of carcinogens in the workplace and the performance indicator to comply with exposure standards;
- Respiratory diseases with the goal to improvement management of exposure in the workplace and the performance indicator including compliance with standards and reduction in incidence of work-related respiratory diseases.

Strategies for both include increasing awareness of risk factors in the workplace, increasing awareness of control measures and enforcing exposure standards.

Worksafe Victoria is committed to reducing the impact of Occupational Disease in Victoria and has developed an occupational disease strategy [69] that looks to:

- Allocate resources;
- Run intervention projects that could be focused on industry awareness, stakeholder engagement and/or compliance and enforcement;
- Utilise action lists – which include a status level for each occupational disease area;
- Ensure an annual review of activities and development which will update the strategy and inform the National Agenda on Occupational disease.

To measure success, a number of KPIs are suggested which include self assessment of exposure, utilising the Australian hazard Exposure Assessment Database (this is still in development) and specific interventions such as recording exposure levels before and after interventions and smoke tube testing of ventilation systems. Within the recommended project interventions for 2009-10 include asbestos in-situ, wood dust and isocynates and respiratory disease and lung cancer from crystalline silica.

Worksafe Victoria have developed inspector prompt tools and checklists which detail key facts on risk examples including: wood dust, isocynates in wood working, anhydrous ammonia refrigeration systems and chemical warehousing checklist. The wood dust inspector prompt tool includes:

- Local Exhaust ventilation Fitted (e.g. dust effectively captured at source);

- Preventative Maintenance (e.g. checks for signs of damage to ducting and dust collectors);

- Housekeeping (e.g. Use of vacuum cleaner fitted with HEPA filter);

- Respiratory Protective Equipment (e.g. Respirators maintained and stored away from dust);

- Training and Supervision (e.g. Training on safe work practices including use and maintenance of LEV, cleaning methods and respirators);

- Dust Explosion (e.g. Effective maintenance and good housekeeping will minimise any fire risk associated with wood dust build up).

Nationally the Australian Government place the "prevention of occupational disease more effectively" as one of their five priorities under the National OHS Strategy 2002-2012 [70]. An Occupational Indicator Project has been set up to support this and there are eight priority diseases which include respiratory disease and occupational cancer. The indicators have been developed using several national data sets, however although the measures are relevant (e.g. respiratory disease, cancer, mesothelioma etc). All indicators are either rates of incidence or incidence of compensation claims, and therefore lagging indicators.

The Office of the Australian Safety and Compensation Council has conducted the 2008 Hazard Exposure Worker Surveillance Survey [49] across a variety of industries in Australia. In the survey workers identified whether they were undertaking high risk work activities which exposed them to hazards, the extent of their exposure (e.g. number of hours per day) and reported use of a range of control measures which could reduce exposure. The exposure to hazards section of the survey looked at airborne hazards and included questions such as:

- On a typical day at work last week, how long did you work in a place where your work or other people's work created dust or made the air dusty?
    - Recorded hours if more than an hour a typical day;
    - Record hours if more than an hour over a typical week.
- On a typical day at work last week, how long did you work in a place where there were gases, vapours, smokes or fumes?
    - Recorded hours if more than an hour a typical day;
    - Record hours if more than an hour over a typical week.
- What were the main types of fumes, gases, vapours or smoke in your workplace last week?
    - Open response.
- Does your employer use any of the following to prevent breathing in dust, fumes, gases, vapours or other things in the air that could damage your health?

- Provide masks;
- Provide respirators;
- Provide ventilation systems;
- Reduce the time spent in places where there are dust, smoke or fumes.

A suite of lead indicators for long latency diseases is being developed from the NHEWS data source which will reflect changing exposure to hazards through improved use of controls. At present it is proposed that the NHEWS survey is repeated every 2-3 years.

5.2.5 Europe

In Europe the European Agency for Safety and Health at Work (OSHA) has a project [61] to monitor occupational safety and health in the EU including combining data systems as well as national systems used to monitor Occupational Health and Safety. The study included:

- Monitoring of outcomes such as ill health, accidents and occupational disease;
- Describing the working environment, including exposures to defined risks, working conditions, working procedures used and employment status;
- Keeping a record of the OSH situation at company level;
- Giving an account of the infrastructure at national level for the implementation of OSH by enterprises, preventive services and authorities.

OSHA have also categorised by the methods applied, and the main methods used by member states includes:

- Labour force and worker surveys (France, Spain and Sweden);
- Databases (Germany)
- Register of accidents, diseases and/or absenteeism (France, Italy, Spain, Sweden, UK, Finland);
- Policy-directed systems (Denmark, Netherlands, Germany, UK), and
- Intervention and OSH-management-oriented systems (Ireland, Netherlands, Norway)

This information was gathered through a questionnaire that was sent out.

The European working conditions survey [65] covers a range of factors that affect workers in Europe. The survey was developed in the early 1990's and is now on its fourth repetition in 2005 and part of it, physical risk factors, are reviewed across Europe. The survey concluded that one in five workers continue to breathe in smoke, powder or fumes and that 15% of workers report themselves not well informed about workplace risks. There was an increase in the proportion of workers wearing protective equipment in 2005 at 32%, compared with 28% in 2000.

CAREX [64] is an international information system that was constructed by the Europe Against Cancer program of the EU. It provides occupational exposure to known and suspected carcinogens, presents some exposure data and provides estimates of the number of workers exposed by industry, country and agents. CAREX is easy to use and provides comprehensive coverage, however the validity of estimates could be improved and results interpreted with caution.

The Netherlands Worker Survey is a yearly publication that is based on Dutch Health Interview Survey and the Dutch Labour Force Survey. Data is collected on chemical/biological exposure, however the exact details of the questions were not available [73].

Estonia carried out a study [62] about working environments in companies and institutions that operate in Estonia. The survey consisted of a company/institution survey and an employee survey. As part of this survey respondents were asked to evaluate their risk of getting an occupational disease or work related disease on a 10-point scale. The findings were analysed by sector and this included recognition that the main risk factors to health in both the industrial and construction industries were dust, quoted by 49% and 57% of respondents respectively. This survey postulated that occupational diseases were not a serious problem for companies/institutions.

In Denmark their approach includes the "Surveillance of progress in action" [67] this was devised in response to the Danish Governments action programme that looked to reduce risks and strains at work in Denmark, this included exposure to cancerogenic and neurotoxic substances. A review of existing data sources identified that there was already a lot of data in existence, however there was very little data on preventive activities in companies. A study of preventive activities was undertaken, consisting of around 3000 telephone interviews with companies. There are seven top-c specific sub-studies and the study provides information on whether companies have completed a workplace assessment, require education for safety and are well organised.

A trend that has been developing in Europe with recent monitoring activities is to combine a number of different data sources to give a more comprehensive picture. A good example of this is in Germany, OSH monitoring is done according to two legal principles:

1. Collecting and processing personal data: self-determination (i.e. person grants or denies consent), and

2. Predetermination, i.e. for administrative exploitation the purpose of data collection must correspond to the purpose of data use.

Data sources in Germany include the following:

- Summary reports of the professional insurance companies (numbers and costs of work accidents and occupational diseases);

- Analysis report of a 10%-sample of commuting and work accidents (case facts, gender, company size, industry);

- Summary report of occupational diseases (diagnosis, gender, industry, geographical region);

- Early retirement statistics (cause of retirement, costs);
- Health insurance report on absenteeism (diagnosis);
- Chemical exposure database (non-random sample);
- OSH-authorities' report (advisory measures, legal actions taken, surveillance personnel on duty).

Data from all these sources are compiled into a yearly government summary report.

5.3 SECTOR LEVEL

5.3.1 Mining and quarrying

What do they do with respect to monitoring performance of Occupational Health?

Within the mining industry there is variation in the monitoring of Occupational Health performance. The gold standard is for a top down approach to occupational health performance with the use of demonstrable leading indicators benchmarked to industry to feed into this process and the adoption of astute and innovative control measures. Not all companies appear to meet this gold standard, however there is definite evidence that many companies are striving for this approach.

Eskom report [29] measuring the number of fatalities and disability injury rate to measure their hygiene performance however they also specifically quote using occupational hygiene audits at many sites to identify areas for focus, such as asbestos programmes.

Goldfields report [30] their long term occupational health approach to provide a "*proactive response to significant root causes that may give rise to poor health and safety performance*." As part of this their focus on occupational hygiene includes the control of airborne pollutants through a risk assessment process and they are looking to further integrate this approach so that hygiene measures can be linked to medical surveillance programmes.

Rio Tinto [31] specifies within their Occupational Health Standards, that there must be an occupational health policy and strategy that sets targets and is subject to regular review. Further to this an occupational health improvement action plan for preventing all new occupational illnesses is currently in operation. **BHP** for example use leading indicators to support the measurement and tracking of their safety critical interventions [34]. Although they still collect data on lagging indicators their vision is for a more proactive approach such as that of **Ashanti** who have established leading indicators to manage progress at meeting targets on exposure to silica [38]. **Inmet** [35] mining states that they are improving their occupational health systems and also use a "Safety Task Force" to evaluate and improve current performance. **Kumba Iron Ore** [36] management board takes overall responsibility for SHE monitoring and performance and the SHE management process is largely seen through their well-established risk management principles and policies.

The South African mining industry inspectorate [33] reviewed occupational hygiene practices and concluded that methods to control against exposure should be included. They also recommend using best practice engineering solutions to improve environmental conditions. Finally they touch on competency of occupational hygienist.

Are leading indicators used? What types of indicators are being used?

Within the mining industry a range of indicators are being used to monitor performance. Both lagging and leading indicators are being used and there appears to be a definitive shift towards a more proactive approach to occupational health management. From our search of grey literature, a number of examples of this in practice are described below.

1. Goldfields measures the amount of airborne pollutant (silica) and they commit to meeting the industry milestone. They also look to achieve full compliance with the workplace health and safety management including risk management.

2. Rio Tinto's Occupational Health Standards details a host of measures that are minimum requirements, these include:

    a. Exposure needs to be minimised through control of hazardous substances, physical agents and activities;

    b. A system for ensuring that employees are trained and equipped to carry out their work with minimal exposure to hazards, including their understanding and capability of this evaluated;

    c. Operability and maintenance of all plant and equipment; and audit schemes that comply with Rio Tinto's HSE policy and Objectives.

    Rio Tinto also have a detailed health organisation and communication system that includes, but is not limited to, promoting awareness of OH&S, communication of hazardous conditions, competence managements of hygiene advisers and systems for encouraging, collecting, evaluating, documenting and implementing any feedback or suggestions on occupational health.

3. BHP collect a range of leading indicators that they use to drive and measure activities however the focus of these indicators is on safety activities and measures and there is little consideration of health measures particularly for long latency diseases.

4. Inmet mining on the other hand state that they are committed to improving their occupational health systems and are monitoring the following as leading indicators ventilation monitoring, air quality monitoring and dust monitoring.

5. Kumba Iron Ore focus on risk reduction improvements and the introduction of "proactive" or leading indicators to support the elimination of silicosis, one of the two main occupational risks. Medical surveillance, dust exposure awareness campaigns, measuring and benchmarking of air quality and the use of formal health committee comprising of employee and management representatives.

6. Ashanti have established leading indicators to help them to measure progress to achieving the South African Mine Health and Safety Council's targets on silicosis. Ashanti have adopted a number of different approaches including spraying of dust suppressant on footwalls, development of standards on dust controls and workshops held for Mine Occupational Hygienists. Medical surveillance facilities are in place for new employees, those returning from more than 30 days sick leave and when leaving the company.

In response to the government's launch of the "Revitalizing Health and Safety" Strategy the Quarries National Joint Advisory Committee (QNJAC) launched the "Hard Target" initiative. This successful initiative that ran from 2000-05 has been developed into the "Target Zero" initiative which aims to achieve a further 50% reduction in injuries by 2010 with the ultimate aim of zero incidents by 2015. The focus of this initiative is heavily concentrated on lagging indicators such as decreasing reported injuries. However it is noteworthy that a number of control measures are mentioned including: fitting drill rigs with dust extraction equipment; maintenance and upkeep (e.g. cleanliness) of control equipment; dust filters should be fitted that are appropriate to the risk created by the dust; intake for air should be in the area of clean air and the quantity of air introduced into the cab should be measured to check that it is working properly.

Quarrysafe, an organisation created for the UK quarrying industry, provides guidance and advice on health and safety and has developed a leading indicators assessment sheet [45]. The rating sheet provides a quick method to assess a quarry site through health and safety good practice that relates to future performance. Each indicator is rated on a 10 point scale and there are indicators for 'safe and healthy person' and 'safe and healthy place', as well as indicators for health and safety management and related processes. The leading indicators under 'safe and healthy person' are most relevant to occupational disease, and include questions on employee awareness of the risks involved in their work, the health surveillance programme for employees, and whether PPE is used properly and effectively. The leading indicators for 'safe and healthy place' are also relevant and these include questions on risk controls, dust control measures (e.g. dust collectors, spray systems, enclosure, dust monitoring, maintenance of equipment, and, is PPE in good condition and fit for purpose?). For a copy of the Quarrysafe leading indicators assessment sheet see http://www.quarrysafe.com/ManagementSystem.htm.

The Audit Guidance (with Check Lists compiled by Quarrysafe [58]) comprises Check lists for Occupational Health and Leading Indicators; with a yes/no answer section and space for comments. Checklist 5 – Occupational Health comprises of the following pertinent indicators:

- Is a regular health surveillance programme in place for all employees?
- Does the HS professional hold the necessary specialist qualifications?
- Has consultation taken place to ensure that health surveillance is appropriate for the risks that exist?
- Does the HS process help employees with a healthy lifestyle and general health issues?
- Are sickness absences analysed to identify any disease-related patterns?
- Are all internal work spaces well ventilated?

- Is there an appropriate cleaning programme for internal work areas and places such as wash rooms, rest areas, toilets etc.?
- Have all surfaces requiring cleaning been provided in easily cleanable form?
- Is dust generation kept to a reasonable minimum?
- Are seals, filters, positive pressure etc., well maintained to prevent dust exposure?
- Are dust levels monitored, using ambient and personal monitoring?
- Are dust exposure levels fully understood and limits complied with? (E.g. for respirable crystalline silica?)
- Is appropriate respiratory protective equipment available and used where needed?
- Do new employees have a medical examination, including respiratory checks and lung function?
- Are persons working with or near welding equipment appropriately protected from UV effects and eye damage?
- Has a risk assessment and control been enacted for persons exposed to welding fumes?
- Are overalls regularly laundered to remove petroleum products and other irritants?
- Does HS include lung function and respiratory checks for asthma?
- Is there confidence that the health of contract personnel is subject to the same level of protection on all the above checks?

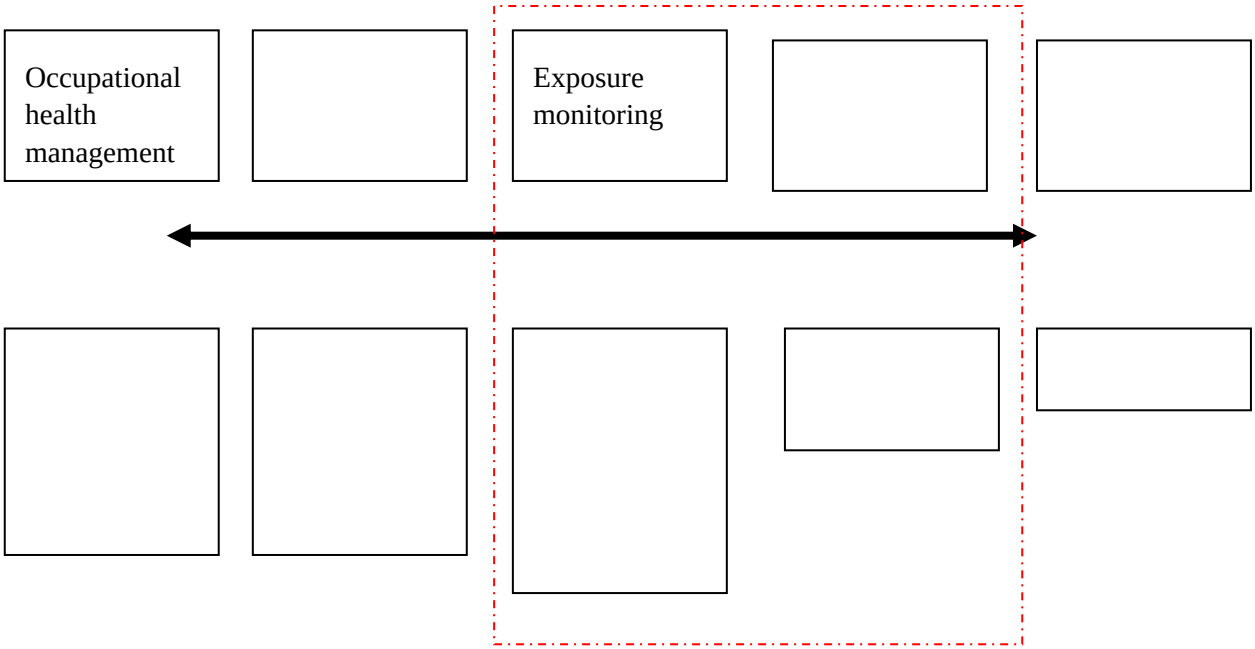
Checklist 8 contains leading indicators, however the only leading indicator related to occupational disease is:

- Whether occupational health is well managed to prevent exposure to risk. (i.e. adherence to QNJAC OH guidance)

How far back down the causation chain are they going with respect to these indicators?

The literature suggests that the impetus to "reach the end of the chain" is definitely demonstrated within this industry with the use of leading indicators such as the workplace safety management systems cited at Goldfields. However this is not mirrored across the whole of industry. For example, Anglo Americans' published safety and health data purely focuses on work-related fatalities and lost-time injuries and from this perspective is only reviewing at the lagging end of the causation spectrum. However details from their management systems suggest that they aim to eliminate exposure through engineering controls and design [37]. Equally control measures such as spraying dust suppressant, local exhaust ventilation systems and the use of PPE are all seen demonstrated here. Further to this the use of exposure monitoring (such as air quality monitoring) and dose symptom monitoring (e.g. health surveillance) cover the mid range of the spectrum, see Figure 3.

Figure 3 – Conceptual spectrum of leading to lagging indicators



5.3.2 Oil and Gas

What has been done in this sector?

There are two main bodies of work on occupational health and disease in the oil and gas industry and these include Stepchange, the UK based partnership organisation in the oil and gas industry, and International Association of Oil and Gas producers (OGP), an association formed to improve communication between industry and regulators.

OGP[39] have been developing health performance indicators since 1999 and include both proactive and reactive indicators. OGP have strived for a clear separation between health and safety and have adopted a three tier approach to occupational health. This three tier approach includes the implementation of a health management system, the use of leading indicators and the use of lagging indicators. The tier one health management system comprises of eight components including health risk assessment and planning, industrial hygiene and control of workplace exposures, management of ill-health in the workplace, health surveillance, health report and record management, and promotion of good health. The tier two leading indicators relate to each of the eight elements in tier 1 with a maximum of 2 leading indicators for each. The tier three lagging indicators also relate to the elements of tier one, although, some elements may not have a leading indicator. OGP do however accept that although progress has been made in the area of work-related illnesses, the use of leading indicators is still poorly recognised, and accurate injury data often remains easier to collect.

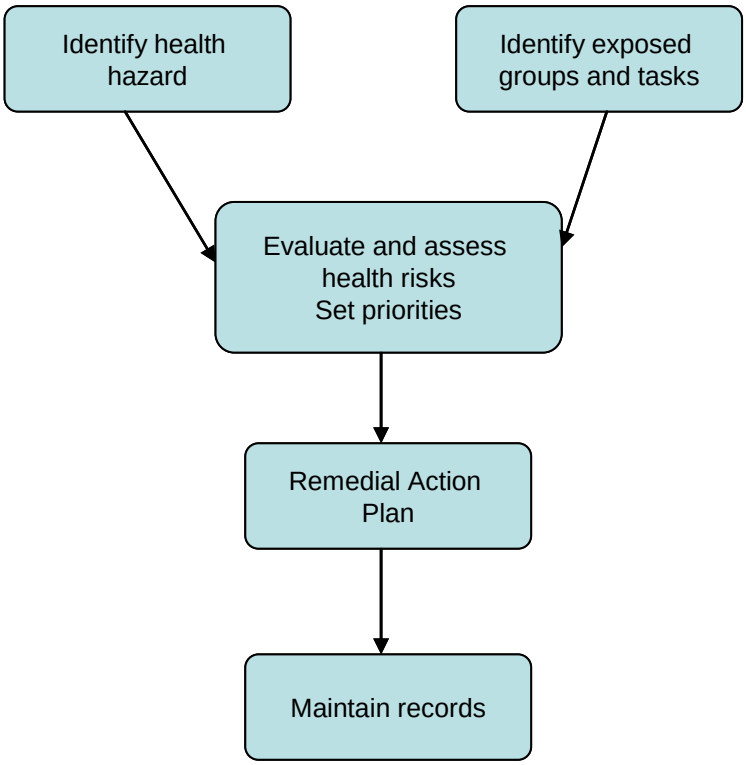
In 2007 the OGP [40] updated their previous guide on health performance indicators with a new guide for industry, maintaining the familiar three tiered approach. Included in this are leading indicators that support health management. Leading indicators listed here include:

- The percentage of health risk assessments completed from the total population being studied;
- The percentage of 'at risk' people that have completed appropriate job-related health awareness, education and training programmes;
- Regular medical emergency drills are conducted at all locations to a defined standard;
- Percentage compliance with defined response times;
- Identification of jobs/tasks with specific physical, mental and social requirements, and the process for assessing worker ability to meet requirements with or without restriction or limitation;
- The percentage of a defined cohort of at-risk employees who have undergone health surveillance appropriate to the hazardous exposure;
- A description of health impact assessments complete for new projects;
- A description of how the company manages the interface between employees in different locations and the public health situation in those locations;
- The percentage of sites at which the health concerns of employees are represented at an appropriate group, e.g. health circle, health and safety committee;
- The efficient reporting of work-related illness.

Each leading indicator is accompanied by a definition, details of the scope of the indicator, and its purpose. The indicators are both quantitative and qualitative data sources; this is not seen in many other industries.

In 2006 OGP-IPIECA's Health Committee developed a roadmap to health risk assessment in the oil and gas industry [41], based on an original template provided by Shell International Health Services. The aim of this health risk assessment tool is to identify and evaluate any risks to health, and determine the relevant control and recovery measures. Their health risk assessment (process summarised in Figure 4) includes the consideration of both delayed effects (e.g. lung cancer) and chronic effects (e.g. asbestosis). The health risk assessment process includes indicators at the lagging end of the spectrum including reviewing records (e.g. health surveillance records, occupational illness reports) and the use of exposure monitoring (e.g. benchmarking against accepted standards). Equally it cites controls (e.g. engineering controls, the use of PPE) and a review of HRA as leading indicators.

Figure 4 – Health Risk Assessment Process (taken from [41])



Step Change in Safety has developed guidance for the effective use of leading and lagging indicators in the Oil and Gas Industry. The guidance was produced by the 'Leading and Lagging Indicators Workgroup' following their review of current practices across the Oil and Gas Industry. Step change recognises that leading performance indicators are related to the organisations' level of maturity and, therefore, they may vary between organisations. However, they also point out that caution should be taken when developing leading indicators for occupational health to ensure that the key focus of the indicators is on health issues and that they are not just an extension to a safety related indicator.

Their approach is similar to that of OGP-IPIECA using a three tiered approach. Level 1 indicators that are mentioned include health and safety policy and plan, health surveillance and health risk assessment but health management systems are not covered in this level. Within level two there are performance indicators for the organisation's health management system, such as:

- Adequate communication of health and safety policy;
- Management commitment to health perceived by staff;
- The inclusion of health elements in managers' safety tours;
- Achievement of health related plans and objectives;

- The understanding by staff of the health risks and corresponding controls that prevail in their workplace;
- Staff health promotion briefings, including their frequency and effectiveness;
- Compliance with risk control measures (e.g. use of LEV and PPE).

Finally level three indicators are local measures that may be developed by the work sites and/or employees, such as:

- % of planned training courses completed;
- % of jobs for which health risk assessments are carried out;
- % of tool box talks with a health element;
- % of permits to work reviewed, and controls found to meet health requirements;
- % of staff with agreed health related responsibilities.

Although the Step Change approach uses a similar tiered system, the nature of this approach is somewhat in contrast to the method used by OGP-IPIECA.

In industry Shell Malaysia reports looking at health performance indicators to monitor health risks including occupational illness [42]. There are no details given of what occupational diseases are covered, however, Shell do state that all are regularly monitored, documented and reported internally to the Shell group.

5.3.3 Other

What leading indicators are being used in other industries to judge health performance and/or health management?

The steel producer Corus [44] in 2007 reviewed their approach to occupational health through working groups including members of the Executive Committee, key members of the business senior management team and occupational health and hygiene specialists. This working group was used as a forum to discuss and share good practice and develop a strategy on improving health within workforce. As part of this, two key performance indicators were developed including a 25% year-on-year reduction in potential occupational health exposures.

The electrical supplier Horizon Utilities Corporation [43] mentions explicitly the use of leading indicators for measuring safety performance. They also mention using a Healthy Workplace Assessment however they do not detail what this includes, or whether it gives reference to long latency diseases.

5.4 AUDITS, STANDARDS AND GUIDES

A number of survey formats and audit protocols are used in industry, designed to assess the health and safety management system in a company. A selection of audits have been indentified and these have been split into three categories – general health and safety audits and guidance, occupational health audits and sector specific audits.

5.4.1 General Health and Safety

Audits

The general health and safety audits have been developed by health and safety organisations. Those identified include:

- Royal Society for the Prevention of Accidents (RoSPA) Quality Safety Audit [13];
- Occupational Health and Safety Assessment System (OHSAS) Compliance Audit [14]; and
- British Safety Council Five Star Health and Safety Management System Audit [15].

These audits focus on health and safety in general with a larger emphasis placed on safety within industry, such as the prevention of accidents and short term health issues. Within some of these audits there are specific occupational health items and some of the items in the audits could cover both safety and health risks in the workplace such as personal protective equipment. Table 2 identifies some of the common items of these audits that cover general safety issues as well as specific health issues.

Table 2: Common general health and safety audit items

Common Safety Items	Common Health Items
Manual handling; lifting operations and equipment; PPE assessment; Fire risk assessment; Pressure systems; Work at height; use of equipment; Noise; Workplace transport; Use of PCs and laptops.	Occupational health management; Control of hazardous substances; respiratory protection – covering issues such as dust and fumes.

Although, these audits do cover aspects of occupational health it is unclear what specific health issues these items cover and whether they cover long latency diseases or focus on short term health problems.

5.4.2 Occupational Health

Audits and standards have also been identified that focus on health issues. For example, one organisation's assessments [16] cover areas such as:

- Analysis of indoor air, worker exposure, plant and process emissions;

- Hazard assessments for chemical and physical agents such as dusts, fibres, fumes, carcinogens, radiation and metals. These assessments involve recognition, evaluation and provision of recommendations on noted exposures;

- Occupational disease investigation to evaluate the evidence and assess the cause and effect relationship;

- Respiratory protection programmes;

- Statutory LEV examinations – these include visual inspections with measurements of static pressures, face velocities, volume flows; fan performance and integrity of abatement filtration.

Occupational hygiene standards are also used within industry to minimise the risk of ill health through exposure to workplace stressors. Key requirements for the management of occupational hygiene include:

- Where there is evidence of acute or chronic health effects from exposure to agents, a qualified occupational hygienist shall conduct a quantitative risk assessment;

- Procedures should be developed for routine inspection and maintenance to ensure the ongoing implementation and effectiveness of control measures such as exhaust ventilation;

- Personnel who may be exposed to a health hazard shall receive basic training at induction or job transfer in relevant occupational hygiene principles, applicable exposure limits and relevant control measures;

- Personal exposure and biological monitoring data should include sufficient personal and work details to facilitate epidemiological analysis. [17]

These assessments and standards are relevant as the items included could potentially be leading indicators for long latency occupational diseases.

5.4.3 Sector Specific

Sector specific audits cover specific occupational health issues common with that sector. When looking at published work it is apparent that certain sectors have conducted much work in the area of health and safety audits, such as the textile industry, silica industry, chemical industry and health care industry. However there appears to be a lack of evidence for such work conducted in other sectors. The construction industry is a prime example, as it is regarded as a high risk industry by HSE, and therefore a noticeable absence.

Textile Industry

For example, the textile industry can involve exposure to chemical agents and respiratory and skin sensitizers such as reactive dyes and formaldehyde. Due to this, the textile industry has been evaluated as a sector with increased carcinogenic risk. Exposure to dusts from material during weaving, spinning and cutting etc. can also be a hazard in the textile industry. Exposure to fibres and yarns may also cause nasal or bladder cancer. Due to hazards such as these, the

European Agency for Safety and Health at Work has developed a checklist for identifying hazards as part of the risk assessment for this industry [18]. In addition to covering issues such as mechanical hazards, manual handling and noise and vibration, this checklist covers the chemical hazards that are classified as carcinogenic. Examples of these items include:

- *"Do workers use hazardous chemicals; for example, those classified as toxic, harmful, corrosive, irritant, sensitising, carcinogenic, mutagenic, or toxic reproduction?"*

- *"Do employees work with carcinogenic or mutagenic substances?"*

Silica Industry

Industries dealing with silica have also carried out a lot of work in the area due to the risk of silicosis and other diseases developing when working with silica. Due to this NIOSH have developed recommendations for industry to reduce the risk of silica exposures in the workplace and prevent silicosis and silicosis related deaths [19]. These recommendations are:

- Before mining begins, assess the potential for exposing workers to crystalline silica during removal of the overburden;

- Conduct air monitoring to measure worker exposures;

- Use control measures such as wet drilling and exhaust ventilation to minimise exposures;

- Practice good personal hygiene to avoid unnecessary exposure to silica dust;

- Wear washable or disposable protective clothes at the worksite, shower and change into clean clothes before leaving the worksite to prevent contamination of cars, home and other work areas;

- Use respiratory protection when source controls cannot keep silica exposures below the NIOSH REL;

- Provide periodic medical examinations for all workers who may be exposed to crystalline silica;

- Post signs to warn workers about the hazard and to inform them about required protective equipment;

- Provide workers with training that includes information about health effects, work practices, and protective equipment for crystalline silica;

- Report all cases of silicosis to State health departments and OSHA or MSHA.

These recommendations on how the silica industry should be managing occupational health could, potentially, be leading indicators for the development of silicosis and related diseases.

The European Network for Silica (NEPSI) formed by the employee and employer sectoral associations developed the social dialogue 'Agreement on Workers' Health Protection through the Good Handling and Use of Crystalline Silica and Products Containing It' in order to develop an appropriate and credible measure for the improvement of working conditions [20]. The organisations that have signed the agreement represent industries such as aggregates, cement, ceramics and foundries. The agreement requires information to be collected at site level using a reporting survey and consolidated before being communicated to the NEPSI Council. This survey includes items covering exposure risk; risk assessment and dust monitoring; health surveillance; training; good practice and key performance indicators. The key performance indicators include:

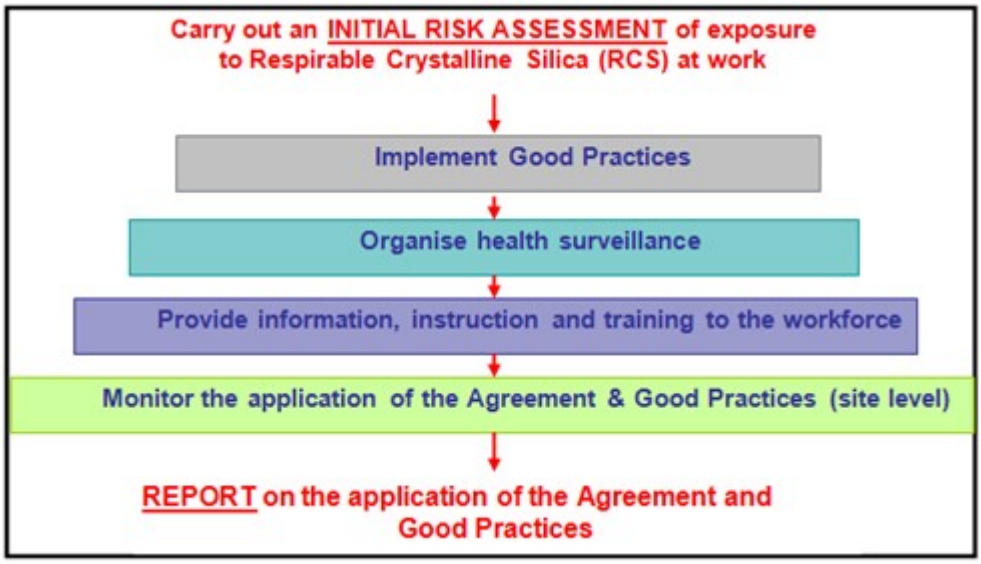
- % of employees potentially exposed to respirable crystalline silica;
- % covered by risk assessment;
- % covered by exposure monitoring;
- % with risk assessment requiring Health Surveillance Protocol for Silicosis;
- % covered by generic health surveillance;
- % covered by Health Surveillance Protocol for Silicosis;
- % covered by information, instruction and training on general Principles, and
- % covered by information, instruction and training on Task Sheets.

The reporting format used by NEPSI allows the signatory EU sector associations to provide the NEPSI Council with quantitative data on the application of the Agreement after it has been collected and consolidated from site to EU sectors level.

The NEPSI council have also developed a good practice guide which helps organisations to progressively improve the protection for their workforce, to enhance compliance with EU and EU Member States' existing workers health & safety legislation and widen knowledge of the potential effects of respirable crystalline silica. The guide contains specific recommendations for reducing exposure in all industry settings that have signed the NEPSI agreement, a list of these can be found at http://www.nepsi.eu/signatories.aspx.

Pivotal to the NEPSI agreement is a risk assessment procedure which must be regularly performed and used to decide which measures of good practices need to be applied for continuous improvement. The main provisions for the Agreement are detailed in Figure 5.

Figure 5 - Main provisions of the NEPSI Agreement



Taken from http://www.nepsi.eu/agreement.aspx.

The NEPSI scheme had its first round of reporting in 2008 and will continue to collect reports biennially; this will give industry a useful insight into what measures are currently in use to monitor the effects of respirable crystalline silica.

Chemical Industry

It is evident that work has been carried out to reduce the risks of chemical hazards. For example, the National Institute for Occupational Safety and Health (NIOSH) have developed a pocket guide to chemicals [21]. This provides industrial hygiene information to workers, employers, and occupational health professionals in the chemical industry and assists them to recognise and control occupational chemical hazards. Included in the guidance are personal protection and sanitation recommendations such as:

- Wear appropriate personal protective clothing to prevent skin contact;
- The worker should wash daily at the end of each work shift and prior to eating, drinking and smoking etc;
- Work clothing that becomes wet or significantly contaminated should be removed and replaced; and
- Workers whose clothing may have become contaminated should change into uncontaminated clothing before leaving the work premises.

These recommendations have the potential to become leading indicators. In addition to these recommendations the guidance presents key information in a tabular form for the majority of chemicals or substance groupings that are often found in the work environment. Included in this

information are respiratory and sanitary recommendations for that certain chemical. This too could be a leading indicator by determining if organisations in the industry have this information and recommendations for all the chemicals used by the organisation.

Health and safety guidance has also been developed to aid the awareness and knowledge of risks in the chemical industry by ensuring risk information is communicated effectively to the workforce. For example, the European Agency for Safety and Health at work has developed guidance on how to convey occupational safety and health information effectively for dangerous substances [22]. Some of the examples of good practice reported in this guidance include:

- Training – a variety of training sessions depending on the target group. One organisation reported organising training courses to teach aspects of health and safety in the workplace, and the importance of using the intranet databank containing databases of information on safety data sheets, and on hazardous substances;

- Checklists on the art of writing and reading safety data sheets – this provides users with good quality tools to assess the extent that safety data sheets cover all the risks and hazards that can occur;

- Safety manuals for laboratory workers – for information on the safety principles and procedures such as hygiene and disinfection, storage and handling of certain products, lists of carcinogenic products, definitions and significance of risk symbols and codes, and prevention and management of accident dispersal; and

- Safety posters – clear and colourful posters placed in strategic places to attract workers' attention. These concern the safe use of dangerous products, good practice of storage and handling of substances and basic hygiene rules.

Practices such as these have the potential to be leading indicators and make sure that the workforce understands the risks that are present, as well as ensuring that these risks are communicated effectively.

Healthcare Industry

Occupational health audits are also carried out in the healthcare industry. For example, an occupational health and safety self assessment audit tool has been developed for NHS Scotland Occupational Health and Safety Services. This assessment includes items such as exposure to serious communicable diseases; hazard identification, risk assessment and control; health surveillance and immunisations [23].

Another occupational health and safety survey tool has been identified for use in hospitals and medical care facilities, developed by the centres for disease control and prevention. This assessment includes items such as:

- Is data collected for illness/ injury among health care workers?

- Is personal protective equipment (PPE) available to health care workers?

- Were PPE requirements included in training?

- Are procedures in place for infectious waste handling, isolation of potentially infectious patients, handling laundry and cleaning the facility?

- Is information or technical assistance needed for any specific occupational risks or exposures?

Items such as these could be used as leading indicators for the risk of long latency diseases for the health care industry.

Standards and programmes such as these are beneficial to health care workers. For example, Shigayeya et al (2007) [24] found that adherence to recommended barrier precautions, among healthcare workers providing care to critically ill patients with severe acute respiratory syndrome (SARS), was significantly improved by education programmes. Therefore, education programmes to increase knowledge about self protection could be a leading indicator for occupational diseases in the health care industry.

Overall, it is evident that high risk industries with known risks to health problems have developed audits and standards for employees to identify risks and put control measures in place. However, health and safety audits from health and safety organisations do not tend to have specific occupational health audits that could have the potential to become leading indicators for occupational long latency diseases.

5.5 MISCELLANEOUS RESEARCH

5.5.1 Introduction

This section identifies the work and research conducted by the Health and Safety Executive (HSE) in the area of occupational health and safety. It is evident that HSE has conducted large amounts of research in the area of occupational health and safety. The following research was identified as relevant to the development of indicators for occupational health and safety:

- Defining best practice in corporate occupational health and safety governance [25];

- Occupational health and SMEs: Focused intervention strategies [26];

- Proceedings of HSE's Health Models [27]; and

- Development of a Health and Safety Performance Measurement Tool [28].

5.5.2 General health and safety

HSE has conducted research to improve general health and safety management in industry.

Health and safety at a Director level

One of the areas that HSE have been interested in is encouraging businesses to move beyond regulatory compliance and recognise the social and economic benefits of health and safety management. Therefore, their work is aimed at company directors as it is essential that individuals at this high level take responsibility for health and safety in their organisations [25]. It is reported that in many sectors there is a lack of engagement at the highest levels in UK organisations, and directors are unclear of their role in occupational health and safety (OHS) leadership and ensuring risks within their organisation are properly controlled. As a result, best practice guidance in occupational health and safety governance has been developed covering seven main principles. These are:

- Director competence – directors should have a clear understanding of OHS and continually develop their skills and knowledge;
- Director roles and responsibilities – directors should understand their legal responsibilities in governing OHS matters and roles should be supported by formal terms of reference such as OHS policy and performance monitoring;
- Culture, standards and values – the Board of Directors should take ownership for key OHS issues and be ambassadors for good OHS performance;
- Strategic implications – the board should be responsible for driving the OHS agenda and market any pressures which might compromise the values and standards, and ultimately establish a strategy to respond;
- Performance management – the board should set out key objectives and targets for OHS management and create an incentive structure for senior executives;
- Internal controls – the board should ensure that OHS risks are managed and controlled adequately and that a framework to ensure compliance with core standards is established; and
- Organisational structures – the board should integrate the OHS governance process into the main corporate governance structures with the business.

These key principles of the guidance have the potential to be leading indicators in occupational health and safety ensuring that directors of organisations are making sure good occupational health and safety management systems are in place. However, this refers to general health and safety and does not focus on specific health issues such as illness and disease prevention.

Small and medium organisations

HSE have also conducted research on health and safety practices in small and medium enterprises (SMEs) and have developed recommendations on how to develop a focussed intervention strategy for Occupational Health that targets SMEs [26]. As part of this some direct interventions were recommended. These are directed at the workplace by the removal or reduction of occupational health hazards at the source. The interventions consider the following:

- Design of equipment;

- Design and provision of PPE;
- Task design and work arrangements; and
- Improved training on tasks.

These interventions take a main focus on general health and safety in the workplace. They do not however provide an analogy of what interventions regarding illness and disease could be developed.

5.5.3 Occupational health

It is evident that HSE has not only researched general occupational safety issues but has also looked at occupational health issues. However, it has been recognised that more work needs to be conducted in this area. HSE and stakeholders have suggested that there are a number of different ways of thinking about health and developing approaches to tackling problems. From conducting research in this area, HSE has developed recommendations to address health issues in the work place [27]. Some of these recommendations include that:

- Risk assessments need to be evolved to be enhanced to deal with emerging workplace health issues;
- Principles derived from health models should underpin the development and design of strategies, approaches and tools for tackling complex occupational health needs. Tools and interventions incorporating philosophies developed using health models will need to be translated into user-friendly language in order for them to be understood by lay-people;
- Interventions need to be evaluated to show how they are progressing against their goals. For example, return to work could be used as it is a readily measurable health outcome; and
- The effectiveness of risk assessment needs to be evaluated to provide an evidence base. Appropriate health indicators, such as disease incidence and prevalence rates, biomarkers and quality of life measures will need to be chosen to allow monitoring for occupational health continuity and intervention effectiveness.

These recommendations have the potential to be developed into leading indicators for occupational health. Examples of these indicators could be whether the organisation has a risk assessment that deals with emerging health issues or, if the organisation has interventions that are based on appropriate health models. This work shows that there is increasing work conducted in the area of occupational health and disease; however this work mainly focuses on short term health problems and psychological problems. Therefore there is a need to develop the work further to incorporate long latency occupational diseases.

Other work that has been conducted by HSE does incorporate occupational health. For example, HSE developed a tool to measure health and safety performance and improvement over time within a sector [28]. A literature review identified a list of key performance indicators (KPIs) to be included in the tool. Although these KPIs have a focus on general safety issues such as

accidents and events, they do include items that are related to occupational health. Examples of these KPIs include:

- Medical monitoring – this can be an indicator of overall performance success in the prevention of inhalation related disease;
- Exposure assessment; and
- Dust – the level of dust can be monitored to identify the risk of respiratory diseases.

Other KPIs used in the tool are not specified to occupational health but have the potential to be applied to such issues. For example:

- Audits;
- Supply of PPE;
- Training; and
- Workforce and management participation in safety promotion.

This tool identifies areas where occupational health and disease are included in health and safety management, and identifies potential occupational health indicators that could be used in industry.

Overall, it is evident that work is moving towards health issues such as illness in the workplace. Some of the general health and safety work does incorporate health issues; however there is only a small amount of work conducted on specific occupational health issues and these do not tend to focus on long latency occupational diseases.

5.6 HSE EXISTING TOOLS

5.6.1 Introduction

This section looks at the extent to which the HSE are already measuring Occupational Health and Disease Prevention. The existing HSE tools that are used to evaluate Occupational Health and Disease prevention include:

- Workplace Health and Safety Surveys (WHASS);
- Corporate Health and Safety Performance Indicators (CHASPI);
- Health and Safety Performance Indicators (HASPI);
- Risk control indicators;
- Topic Guides.

5.6.2 WHASS

WHASS surveys the health and safety conditions across the UK for employees and employers responsible for health and safety through two separate surveys; one aimed at employees and one aimed at employers.

WHASS employee's survey considers and uses both lagging and some leading indicators to assess health risks for employees within the workplace. It is a detailed survey that takes the interviewee thoroughly through many aspects of health and safety within the workplace. The key lagging indicators, leading indicators and hazards covered are listed in Table 3. This breakdown highlights that a number of leading indicators are included in the survey, they are by no means exhaustive. It does cover control measures used to protect against exposure to (for example) dust and fumes such as ventilation, extraction, cleaning, enclosing the source and also consider maintenance of ventilation and extraction equipment. However, they do not consider wider leading indicators such as training on control measures e.g. on the correct use of LEV equipment, replacement of LEV equipment, compliance with control measures and violations. The main respiratory hazards are covered in this survey.

WHASS employer's survey includes practices on reporting of both lagging indicators (such as incidence reporting) and leading indicators used to assess health risks within the workplace. Again it is a detailed survey covering a detailed topic base. The breakdown in the table suggests that the leading indicators focus on health and safety management (including the involvement of senior management). It also explores the involvement of key health and safety professionals and in particular here the involvement of occupational health professionals. Surprisingly the use of controls is not reviewed in the employer's survey; neither is training on control measures, compliance with control measures and violations. The main respiratory hazards are covered in this survey.

5.6.3 CHASPI

CHASPI is a tool that enables organisations to assess their health and safety performance against a number of key indicators. The health and safety performance targets within the CHASPI tool largely cover safety, including aspects of workforce involvement, but not health. Health and safety performance is covered, however the vast majority of the indicators covered are lagging indicators rather than leading indicators. The tool contains a separate section that reviews occupational health and includes encouraging self reporting of symptoms, management of ill health, absence and rehabilitation, and a number of indicators for occupational health including stress and RSI. However, notably the tool does not contain occupational health indicators for long term latency diseases, but merely asks if there is a occupational health service available to employees. CHASPI focuses on health and safety at a management level and allows a very thorough review of this, however, the tool would benefit from containing more leading indicators for occupational disease.

5.6.4 HASPI

The HASPI tool helps organisations to find out how they are performing in a number of areas of health and safety. The tool contains a number of sections; the only relevant section to this project is the section on hazardous chemicals and products. This section does contain leading indicators such as assurance of safety equipment maintenance , training on the use of hazardous chemicals and materials and relevant safety equipment, in addition to PPE availability. The HASPI tool looks in detail at a number of key risk areas for general health and safety however does not directly consider long latency diseases or the management of occupational health and/or long latency diseases.

5.6.5 Risk Control Indicators

Inspectors from the HSE's Field Operations Directorate (FOD) have, as part of routine inspections, rated a workplaces' level of risk control against various Risk Control Indicators' (RCIs).

The risk control indicators cover the breadth of workplace health and safety (such as stress, musculoskeletal disorders, HAVs etc.) and only a small section contains details on respiratory based indicators. This does consider occupational asthma, however, none of the other long latency diseases are considered within these indicators. There are indicators on management of risks and working environment that would, in a general sense, cover some of the risk controls required for long latency diseases, however, there is no specified section on long latency diseases.

The HSE compiled a review of risk control indicators for compliance with workplace and health and safety between April 2002 and September 2005. This review concluded that "If all other factors remain equal over time (i.e. if RCI data is collected in a strictly scientifically controlled way) then any change in RCI score over time will reflect real changes in workplace health and safety compliance."[72] This suggests that the risk control indicators in use have demonstrated their validity in the field; however the contents of the indicators still show a gap in the field of long latency disease. The review report also revealed that there were a number of flaws with the use of RCIs, namely that if the workplaces inspected each year are inconsistent then any changes in RCIs scores could be attributable to this variation rather than an improvement or deterioration in scores. There is also the possibility that over time the inspectors become more knowledgeable on each of the RCI subjects and begin to mark harder. Therefore deterioration over time in scores could be due to inspectors increased expectation from their more detailed experience rather than a decline in performance.

Table 3 – HSE existing tools, breakdown of function

HSE existing tools	**Lagging indicators used/cited that relate to assessing the risk of long latency diseases**	**Leading indicators used/cited that relate to assessing the risk of long latency diseases**	**Long latency disease hazards covered**
WHASS (employees) [74]	Sickness absence Accidents resulting in injury at work Return to work following injury Description of injury (does not include long latency diseases) Cause of accident (only includes exposure to a harmful substance, no other measures for long latency diseases) Illness caused or made worse by your job (does include lung problems) Absence due to illness	Looks at general: Safety culture, Behavioural safety, Management support for health and safety, Health and safety violation Exposure to dust, fumes, smoke, gas or vapour (page 87) Training on health effects of fumes, dust etc. and how to protect yourself (page 89) Effectiveness of training (e.g. self report on whether it prevented developing a health problem) (page 89) Use and checking of PPE to protect against respiratory conditions (page 90) Other controls (ventilation, extraction, cleaning, enclosing the source, signposting contaminated areas, safe disposal) (page 90) Maintenance of extraction equipment (page 91) Awareness of ill effects of breathing substances at work (page 91)	Dust Fumes Smoke Gas Vapour Including: Flour Spray paints Solder fumes Welding fumes

HSE existing tools	Lagging indicators used/cited that relate to assessing the risk of long latency diseases	Leading indicators used/cited that relate to assessing the risk of long latency diseases	Long latency disease hazards covered
WHASS (employers survey) [75]	Sickness absence (including data collection, review, management and feedback into risk assessments of work related ill health) Near miss reporting Return to work following illness	Management involvement in health and safety Transparency of health and safety performance (e.g. to workforce, public) Review risk assessments and health and safety management. Involvement of health and safety professionals, especially occupational health, looks at their basis for support. Health and safety culture	Dust Fumes Smoke Gases Vapours
CHASPI	Accident and incident rates Self reporting of symptom Management of ill health Absence management Rehabilitation	Health and safety representation and reporting at board level Health and safety improvement plans Health and safety management performance verification	Asbestos

HSE existing tools	**Lagging indicators used/cited that relate to assessing the risk of long latency diseases**	**Leading indicators used/cited that relate to assessing the risk of long latency diseases**	**Long latency disease hazards covered**
HASPI	Risk of exposure for the whole workforce Health monitoring	Maintenance of safety equipment Training for the use of hazardous chemicals/materials and safety equipment PPE availability	Hazardous liquids Dusts Fumes Chemicals
Risk Control Indicators	Health monitoring Illness reporting	Engineering controls PPE – worn, maintained and cleaned Training and instruction on the use of PPE and engineering controls. Management commitment to and review of health and safety. Adequate information, training and supervision for the workforce Clean and well ventilated workspace.	Occupational asthma

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6 APPENDIX B – STAKEHOLDER INTERVIEWS

6.1 INSURERS

6.1.1 What is understood by a leading indicator?

Organisations have reported understanding the term 'leading indicators'. One organisation reported it as something that would give prior warning of a situation as apposed to statistics that inform of historic events. Another organisation reported it to be *'individual or a combination of elements that can be observed and possibly evaluated, that are known contributing factors to diseases'*.

Some of the indicators that were reported include:

- Biological monitoring results and health surveillance programmes to observe and assess indicative precursors of physiological effects in at risk subject groups. E.g. lead in blood, fluoride in urine, measurement of lung function; skin surveillance and care programmes and audiometry;
- Workplace monitoring - measurement of levels of hazardous substances in the workplace;
- LEV – the number of firms that have it installed and working;
- Consumption of potentially hazardous materials;
- Subject and workplace cultural evaluations to determine the level of take up and deployment of such control measures introduced to prevent or control exposures to harmful agents/factors;
- Verified maintenance of control systems to prevent agents of concern.

Detecting levels of fluoride and lead in urine and blood was reported by one organisation as the main method used to assess the potential for long latency diseases. However, another organisation reported that one or more of the methods mentioned above are initiated but often limited in their deployment due to cost restraints or misunderstandings of what information the programs will reveal. One insurer believed that organisations predominantly manage the risk of long term latency diseases by keeping in line with HSE regulations and ensuring they have adequate employer's liability insurance. Other organisations stated that they looked beyond regulation and looked to decrease losses occurring.

It was reported by one organisation that there is a large difference in the way small and large firms manage the risk of occupational diseases. Larger firms use many means of managing the risk such as minimising exposure. For example, in the dye industry there is now no air-borne exposure to reactive dyes. Larger firms also use LEV, and ensure it is working on a regular basis. However, it was reported that smaller firms have less ways of managing occupational disease, and that there tends to be a level of avoidance associated with them. Equally one organisation stated that insurer may deal with firms in differing ways, for examples insurers will deploy health and safety specialists to review high risk organisations. They will look to see that health and safety surveys are being carried out and that risks are being managed. However they are only able to survey a small proportion of organisations as they have a limited number of health and safety specialists.

One organisation reported that industry is not moving away from lagging indicators as organisations do not believe that diseases will occur and so are not measuring their risk. One area where the issue of diseases is being dealt with is the asbestos regulations for property owners. However, one organisation reported assessing whether businesses have moved away from using lagging indicators and that many businesses do appear to be moving to more proactive measurement. One organisation mentioned that they would expect clients to observe leading indicators; however, they would not be able to monitor or check this.

One organisation mentioned the competitive market place for major liability insurers. They felt that claims history gives little idea of how a company is managing risk, they need to take a view on how they are adhering to regulations. It was stressed that competitive products need to be offered to clients and if there are too many requirements the organisation will loose out. Negligence is the key factor, if the company is not negligent then the insurance organisation will not be required to compensate, as compensation is a fault based action. For example insurance organisations will only cover claims for the period they were insuring exposure and not before or after this period. In light of this, this insurance company tried to proactively encourage clients to manage risks and protect themselves with documentation.

Generally insurers and brokers do not have one to one contact with most clients; they engage with clients through the following means, one organisation described this as:

1. One-to-one contact – this is with a minimal number of their client base (one insurer estimated approximately 1%). In this case best practice such as leading indicators for long term latency diseases would be used.

2. Newsletters – this includes intelligence and information for clients on key issues, such as long term latency diseases and the use of leading indicators;

3. Internet – all newsletters are also displayed on the internet.

One insurer stated that where possible they will research into an industry that they wish to insure and will look for factors such as health and safety management including long-term latency disease risk. For example, with asbestos they would look for policy and training on asbestos, how asbestos training is managed, procedures used, personal protective equipment utilised and engineering controls that have been implemented.

6.1.2 Practical application

One organisation was not aware of audits or questionnaires taking place to assess the risk of occupational diseases. It was reported that the risk of injury rather than disease is more prominent. However, the organisation did report trying to make policy holders aware of occupational disease.

In contrast, another organisation reported being aware of the range of techniques used by industry to complete risk assessments. For example, they reported that at recruitment stage, organisations often deploy either pre-employment questionnaires or pre-employment medical screening to establish the baseline health and past employment history of any new hires. Future screening and evaluations can be compared against this, and also it informs of any pre-existing health issues that may require additional care. Auditing as part of organisations' proactive management of health and safety will usually encompass occupational health issues. Auditing would normally review both statutory compliance and also measure performance against the organisation's own management system. In the case of occupational diseases, the test of the management system will normally be that it has the ability to identify those disease hazards, assess the risks and manage them such that the risk of exposure is prevented or minimised to acceptable levels (i.e. either statutory or recognised best practice). KPIs will be set around proof that risks are controlled, managed and maintained; only in the long term will evidence be available as to the effectiveness of these controls being measured. The use of a checklist was mentioned by one insurer however they stated that this is often just a check and that it is important that insurers and brokers understand the industries that they work in. Another insurer mentioned trying to understand the mindset of the business and how they function as a business before they are willing to insure them, they believe if they behave correctly at the corporate level they behave well at the "coal face".

It was reported by one organisation that trend data from assessments will enable an organisation to plan strategically and decide what resources are needed in the medium to long term to ensure that risks are managed or controlled; or even to determine if this is an area in which it wishes to continue doing business. Another organisation felt that industry as a whole is now safer due to advances in detection systems, advanced machinery and extraction and that the focus needs to be on other such advances going forwards rather than looking back. Another insurer stated that they may advise clients on how to reduce their risk if and when appropriate.

A practical challenge mentioned by one of the organisations was getting information from trade associations; it was felt that they could do more to demonstrate the standard of risk management. Equally in their experience small businesses had often fallen foul of adhering to regulations rather than strict adherence. Companies that do not manage claims very well will experience higher premiums.

One organisation reported that they do keep up to date of scientific research and ahead of emerging risks for disease or any other factors. This acts as a protection mechanism for the organisations as they are required to make provision for what they believe will happen in the future. Therefore, if they believe a substance may cause disease, reserves need to be put away for claims that may be made in the future. Other evidence of the indicators being valid predictors of the risk of occupational diseases reported by one organisation is epidemiological data that correlates cause and effect. However, they also reported that even though the volume of this data does give confidence in the overall outcome in the dose response relationship, it cannot predict too closely or guarantee that any particular level of exposure will result in a defined health effect. It will only give a statistical likelihood.

The ability to assess the risk of current exposure to the causative agents of long latency diseases is unsure. For example, one organisation reported that their experience suggests that current tools available do allow organisations to assess exposure to many causative agents, although not all, and in many cases the full epidemiology is not yet known; guidance or limits have not been set, or there is an absence of valid assessment techniques to allow true assessments to be made. One insurer mentioned that some of their members were involved with the Asbestos Working Party, which produces reports on current and future trends in asbestos exposure.

One barrier mentioned by insurers was that information, such as on leading indicators, was not readily available to them and so they could not utilise this to assess a claim. It was felt that working with trade associations and working towards legislation and good practice would help to develop this area.

6.2 UK FIRMS

6.2.1 What is understood by a leading indicator?

Engineering

One organisation reported an indicator to be a measure of exposure rather than measuring effects. Other organisations' responses regarding leading indicators included:

"*What really causes someone's exposure to a harmful substance*".

"I am not aware what a leading indicator is".

"A predictive measure of an employee's exposure to certain risks".

There was a real mix of experience and understanding of leading indicators in this sector.

Some of the indicators one organisation reported being aware of included:

- Reducing the number of people exposed to certain hazards;
- Reductions in the population undergoing health surveillance;
- Reductions in sickness absence;
- Training managers;

- An increase in employees taking up health promotion exercises;
- An increase in employees taking up occupational health training;
- Engineering controls (e.g. Local Exhaust Ventilation);
- Occupational health tests;
- Dust suppression;
- Maintenance of engineering controls;
- Health surveillance.

One organisation reported that the main method used to manage the risk of long term occupational diseases is reducing the number of people exposed to a risk. Risks are also managed through the hygiene hierarchy of control and eliminating risks and substituting hazardous substances. If a potential hazardous issue is suspected, it is applied to the risk assessment. Another organisation mentioned that the main method to manage risk was through improvements to engineering controls (such as LEV) and also trying to reduce exhaust levels and therefore exposure to the workforce. Other methods mentioned include chest x-rays, risk analysis such as using an outside body for health surveillance and auditing to ensure that this is independently assessed.

The methods used by one organisation to assess the potential for long latency diseases are workplace monitoring and health surveillance. This helps to identify risks at early stages. Other methods used included reviewing the history of the industry to identify risks, spirometer testing, checking that the LEV is working correctly, risk assessments and looking for controls to prevent exposure to harmful substances or particles.

One organisation reported that although they have introduced proactive activity and will continue to pursue it, there has not been an attitude shift towards leading indicators and away from lagging indicators in the organisation. It was reported that accomplishing shifts in attitude is an enormous task, and HSE has a long way to go to embed leading indicators in industry. They are perceived by organisations to be costly as business cases would have to be made to put them into place. Other organisations were in agreement on this point and stated that they would still use lagging indicators as it was important to review this information too, and that lagging health indicators could be informative too.

Construction

In the construction industry descriptions of leading indicators for long term latency diseases included:

"A leading indicator is a predictive measure"

"Leading indicators help an organisation to foresee long latency diseases before they occur"

"I don't know what a leading indicator is, I had only heard about it from this study"

One organisation in the construction industry stated that they did not measure exposure to silica they monitored exposure instead. They complete a risk assessment and agree a safe system of work, but do not measure exposure to silica. Another organisation mentioned that when they are cutting pre-cast concrete they use a drench system to ensure minimal contamination from the silica.

From the organisations interviewed it appeared that leading indicators were not in wide spread use and that there were concerns with both the reliability of the use of leading indicators and the data that needed to be collected, e.g. monitoring data. Some examples of leading indicators used include:

- Personal exposure monitoring;
- Training and awareness;
- Inspection;
- Behavioural safety – observation of compliance;
- Compliance with safe systems of work
- Health management systems.

Within the construction industry it was generally felt that adequate action was being taken to combat the challenge of occupational disease and silica risk. One organisation mentioned that they contracted out any asbestos removal and that their employees would only re-enter the site when a re-occupancy certificate had been issued.

Lagging indicators are still used in this industry and in particular the following lagging indicators were mentioned:

- RIDDOR;
- Service strikes;
- Hospital visits;
- Near miss reporting;
- Unsafe acts and behaviours.

Chemicals

One organisation reported that a leading indicator is something that would "*predict the likelihood of a performance"*. Responses from other organisations included:

"I have dealt with leading indicators as far as Process Safety Indicators, they are measures that predict the success or failure of a system prior to that event occurring".

"Leading indicators are pro-active monitoring".

"A leading indicator is a measure that predicts an outcome".

"A measure of activity used for benchmarking".

From this snapshot of the chemical industry there appears to be an understanding of leading indicators and their use in industry.

Indicators mentioned by organisations within the chemical industry, each were measured for how often it occurs and percentage compliance:

- Mandatory SHE training;
- Training on COSHH at awareness level;
- Competence training champions;
- Training on PPE and RPE to ensure all employees are aware of how to check equipment for damage;
- LEV training on how to effectively use it.

Other examples of leading indicators include:

- Urine sampling;
- Atmospheric monitoring measured daily;
- Personal dose monitoring on lapel badges – samples taken annually;
- Personal monitoring – measure number of personal monitors (reported being worn verses the number worn), measures compliance;
- Workplace Exposure Limit Level (WELL) monitoring, traffic light system:
    - If less than a 10^{th} of WELL exposure level – green, assume controls are working well;
    - If more than 10^{th} of WELL exposure level but less than ½ of exposure level – amber monitor levels;
    - If more than ½ exposure levels – red, forced to investigate.
- Measure amount of COSSH assessments complete;
- Measure overdue COSSH assessments;
- Material safety data sheets – review and measure number overdue and percentage overdue;

- Measure amount of overdue health assessments, if more than 6 months overdue stop working and go for a check up;
- LEV checked weekly, managed by a SAP system;
- LEV check airflow indicators, measure compliance and reported back to LEV engineers;
- Monthly check of RPE to ensure that it is fit for purpose, measure percentage checked;
- Six monthly clean of RPE – measure percentage of masks cleaned;
- PPE measure defects in suits – this is also fed back into employee trainer;
- PPE measure number of suits greater than 10 years old, all are replaced;
- PPE dispensation for those employees that cannot wear standard PPE – the number of people requesting unique PPE is recorded;
- Operating procedures – measure how many SHE critical procedures are printed off, signed and followed;
- Laundering of protective clothing – measure how many have not been laundered in over a year;
- Measure the number of toolbox talks completed.

One of the organisations' major concerns is cancer, and therefore a leading indicator relevant to them is a measure that could predict the development of cancer.

Two organisations reported that the main methods they are using to manage the risk of occupational disease were risk assessments. One organisation also reported blanket PPE, reducing the number of people exposed and using the best available equipment to be the methods used to manage the risk of occupational disease. Another organisation mentioned that they measure actions and these are put into their management system. There is a prioritisations system for actions so that they can ensure that actions are completed and that all recommendations are managed, this allows for continual improvement. Other organisations mentioned:

- Over-reliance on PPE,
- Introduction of exposure/engineering controls such as LEV,
- Measures to reduce levels at source,
- Use of hazard data sheets,
- Occupational health support for education and prevention,
- Training and education on precautions,

- Signs and symptoms of key problem areas,
- Education (e.g. what are the health risks, utilising toolbox talks, factsheets on a theme);
- Validation of training;
- Biological monitoring (e.g. lead in the blood);
- Personal monitoring (dust, chemicals, welding fumes);
- Health promotion (links to local and national campaigns);
- Reduction at source.

One organisation reported toxicology to be a common method to assess the potential for long latency diseases. This identifies health hazards and is used to assess the safety of a process. Substances are assumed to have a chronic hazard such as carcinogens and therefore controlled to the best level of ability. Linked to this, one organisation reported a measure of exposure to hazards as a method to assess the potential for long latency diseases. Once this is measured controls such as substituting chemicals or changing shift systems can be put in place. Other organisations mentioned using biological monitoring, regular check ups, lung function spirometry testing, WELL monitoring, training, education, management review and annual medicals.

It was reported by one organisation that they are moving away from lagging indicators as a measure of occupational illness is the only lagging indicator they use, otherwise only leading indicators are used. One organisation reported focusing on lagging indicators as they are easy to benchmark and compare performance with competitors. However, they reported their desire to add leading indicators, focussing on process safety measures and indicators for acute and chronic events. Other organisations stated that they use both lagging and leading indicators, one organisation felt that it was important to record lagging indicators too, and another had moved towards using predominantly leading indicators.

Silica

Leading indicators were described as:

"*A pro-active indicator to give advance warnings".*

"Leading indicators are things we can identify to control and improve on before a disease is contracted".

"Proactive rather than reactive indicators, reactive indicators have little value for measuring long latency disease risk".

"Something that pre-warns of circumstances if not adequately controlled could result in ill-health".

"*A management system that minimises exposure to risk*".

Some of the indicators reported include:

- Personal dust monitoring (treat any employees exposed to more than 50% of the WELL, comparison to WELL);
- Key Performance Indicators for NEPSI (see http://www.nepsi.eu/reporting.aspx;
- IMA dust sampling programme measures – this records exposure levels for 95% of the workforce;
- Statistical analysis on IMA data which identifies long term trends;
- Local Exhaust Ventilation systems (including maintenance and measurement of performance);
- Enhanced health surveillance on an annual basis for silica workers (includes spirometry testing)
- Personnel and atmospheric dust monitoring;
- Mobile plant training (including cleaning, shutting doors, use of air conditioning);
- Monitoring and audits of PPE and RPE;
- COSSH assessments and other control measures;
- Training for use of PPE, periodic refresher training in "tool box talks";
- Six-monthly inspection of PPE;
- Chemical dust suppressants;
- Near-miss reporting system which gives details of usage of PPE, RPE and trends in housekeeping;
- Policy of purchasing the most effective equipment.

One organisation mentioned that in their experience dust monitoring is a very powerful indicator as it gives a real measure of exposure. Also by monitoring, exposure levels are reducing as there is increased awareness and buy-in on the subject from the workforce and management.

Some of the reported methods used by organisations to manage the risk of long term occupational diseases include:

- Health surveillance programmes such as lung function tests and chest x-rays;
- Inductions;
- Monitoring silica dust levels in the workplace;

- Risk assessment;
- Effective design of new plant equipment;
- Training;
- Control measures to manage exposure levels – one organisation suggested that in house management of this was more effective than external as a greater understanding of the main issues could be developed;
- Assessing medical problems prior to employment.

The methods reported to assess the potential for long latency diseases include:

- Chemical analysis conducted on limestone to assess the silica levels;
- HSE guidance such as EH40;
- Workplace exposure limits as these can help a company assess the potential for detrimental effects;
- Historical situation such as research studies;
- Comparing to good practice guides;
- COSSH assessments;
- Health screening e.g. lung testing.

Conflicting findings were reported regarding whether industry has moved away from using lagging indicators. For example, two organisations reported that they are still using lagging indicators as well as leading indicators, whereas another organisation reported that most of industry is moving toward using leading indicators and best practice is being shared within the UK. Another organisation reported that they did not generally find lagging indicators useful, particularly for long latency diseases as they referred to a historical situation.

Other (Ceramic and Cotton)

The understanding of leading indicators in this sector was mixed: one organisation had not heard of leading indicators; whereas stipulated that they were "*a predictive indicator for assessing the risk of disease*".

Examples of indicators used included:

- Asbestos surveys and internal inspections;
- Silica measured in the atmosphere through personal sampling;
- Use of extraction and maintenance and checking of pressure gauges to ensure that the system is performing well;

- Monitoring of fire mist system;
- Personal monitoring;
- Spirometer testing and/or X-rays.

The main methods used for managing the risk of long latency diseases were very much dependent on the industry. Due to the fact that cotton is no longer spun in the UK the vulnerability of workers to diseases from cotton was reported to be minimal. However weaving mills are still present in the UK and fize is placed onto the yarn as a control measure as this in turn improves the strength of the yarn and prevents fibres flying around. Within the ceramic industry the main methods used include control measures, personal monitoring and health screening.

Both industries used a limited number of leading and lagging indicators.

6.2.2 Practical application

Engineering

One organisation reported being aware of audits that address compliance and management arrangements in terms of risk and local policy. They also conduct formal audits against company specifications. Some of the issues that the audits and surveys address are; whether employees are aware of the risks?; Are vibration reduction plans in place?; As well as others. They also have checklists in place such as asbestos checklists and legionnaires checklists. It has been found by this organisation that in the mid 1990's they experienced 50/60 cases of vibration related cases. They have now reduced the number of people exposed to the risks and now have only experienced 5/6 cases. One organisation reported using a medical questionnaire (and medical screening questionnaires) when an employee joins the company. If they were to find evidence that an individual may already have a condition that may be exacerbated by working in a particular environment they may question whether to employ that individual. Other organisations mentioned using Climate Surveys, although this did not tackle occupational disease. External and internal auditing was used and also attendance records were reviewed to look for trends in sickness absence. In one organisation the findings of audits and surveys are sent to the board and reviewed at top level and the results and actions are fed into company directives, bulletins and safety meetings.

It was reported by one organisation that it is difficult to make the shift of culture in industry and move towards leading indicators rather than lagging indicators. In general, organisations react when claims have been made for injury or disease. That then costs the organisation, rather than them putting measures in place prior in order to prevent such hazards occurring and claims then being made.

Practical challenges to assessing the standard of management of occupational disease include backing and support from the workforce, and in certain cases unions, limited resources and cultural problems when implementing Occupational Health Assessments. The problems implementing Occupational Health Assessments have included responses such as “Why do you want to know that?” and “What if when I am tested there is something wrong?” In many cases the individual would rather not know and it can be challenging encouraging them to be screened. Methods used to help combat this included keeping the workforce informed and ensuring that there was appropriate record keeping.

Chemicals

Two organisations reported having audits in place such as management system audits and specialist audits focusing on whether certain systems are in place and if they are the correct systems. Management audit systems were used to check for compliance, if non-compliance occurred, this would be put into an action register, which is then followed up in meetings. They also reported having a new set of health, safety and environment standards in place focusing on areas such as LEV, health surveillance, stress, ergonomics and biological hazards. The organisation collects data on illnesses that may be occupation related, and ensures employees that have been exposed to a carcinogen undergo health surveillance. Another organisation reported task compliance audits that were used to check if the workforce had read their job method and were aware of the main hazards.

Gap analysis was reported to be used by one organisation. This analysis looks at reporting methods, data collected, how data is managed, and ensuring policies and processes are in place and are practiced.

Quarterly hazard spotting tours were conducted by one organisation which were completed by senior managers. These looked at behaviour towards hazards, people working and methods that were being used; they would also ask if there were any concerns. Another organisation used culture questionnaires to review the organisation, employees and work activities. Organisations also reported using incident analysis and root cause analysis and worker behaviour surveys. This ensures that organisations are aware of hazards, controls are being utilised in practice and compliance can be demonstrated.

Indicators are used to decide whether to make improvements in managing long latency diseases in an organisation through a review process of the organisation, which looks at both different plant areas and the role of each individual. Attention is focused in this case on looking for exposure risks and potential areas where controls could be improved or are failing. In these cases introducing more controls or asset replacement may be considered. Other organisations mentioned looking at trends in key indicators such as mercury in urine and atmospheric mercury. If this was seen to be increasing it would be investigated and current controls would be reviewed to establish whether they are effective. One organisation stated that they would look to identify opportunities for improvements such as best practice guidance or standards that could be adhered to.

It was reported by one organisation that there is good evidence available for acute illnesses such as asthma suggesting that symptoms are reduced by reduced exposure. However, there is little evidence for chronic illnesses. Two organisations were aware of studies where the results suggested that there was a link between exposure to an element and effect (e.g. long latency diseases). Other organisations used their own experience as evidence for the effects.

Practical challenges that have been faced by organisations include the plethora of information available; where does industry look for relevant information? In certain cases organisations have found that there is not enough information and they have needed to look to American or overseas recommendations. Other challenges included: the clarity of information provided, practical challenges of accurate sampling, cost of laboratory testing, macho culture, reminding employees of the risk, confidentiality of long term latency diseases, individuals' focus on acute rather than long term diseases as the effects cannot be seen and ageing workforces that have previously had little exposure to controls may resist new controls and measures being implemented. It was also reported by one organisation that it can be difficult to carry out exposure monitoring and gain a true exposure dosage. This is due to resistance from employees, as some do not want a risk to be found due to fear of losing their jobs.

Construction

Within the construction industry the following tools and checklists were mentioned:

- Workplace inspections – all staff participate in these inspections;
- Audit and score card inspections – this is performed twice monthly by the health and safety team. The results are feedback through a traffic light system to employees and management;
- Toolbox talks and consultation with the employees;
- Formal auditing.

One organisation mentioned that this information is used to indicate if there is something to change in the business that may help to manage occupational disease. Another organisation mentioned that they will use the findings from the inspection to inform changes in the controls measure they have in place. One organisation mentioned their "Zero Harm Campaign" which reviews everything the company does to ensure that it prevents the risk of long term ill health including long latency diseases. This would include the process, people, plant and the product. No other sources of evidence were mentioned by the organisations.

Some of the challenges faced by the construction industry include: the nature of the workplace and the diversity of environments that the construction sector work in; foreign speakers working in the construction industry that have limited English communication; difficulty differentiating what causes long latency diseases; and challenge of measuring exposure levels accurately.

Finally one organisation mentioned that they would like clear guidance from the HSE on leading indicators and their uses and value within the construction industry.

Silica

Some of the tools reported to help assess the risk of occupational diseases include:

- Pre-employment health related questionnaire – to disclose information on past illnesses and industries employees have worked in;
- Health surveillance questionnaires (these assessments are for issues such as headaches, pain injuries and medical disorders);
- Exposure assessments;
- COSHH assessments;
- Audits to ensure risks are being controlled, cover percentage compliance for:
    - Health screening;
    - PPE;
    - PPE Training;
    - PPE audit;
    - Dust monitoring;
    - COSSH assessments;
- Campaigns on different elements of health including:
    - Training;
    - Questionnaires;
    - Posters.
- Management "walk and talk" assessments.

One organisation reported that safety audits are completed every three months to indicate if hazardous materials can be replaced with less hazardous ones. Audit information was reported by one organisation to be reviewed at management meetings. All actions are reported on a tracking tool, managers have time as well as reminders to address the issue. Another organisation described how they used the health surveillance information to contribute to a summary traffic light report, which indicates whether the risk is stable or has deteriorated. If it has deteriorated it is reviewed by line management and related environmental assessments may be performed. In one organisation if an employee's exposure levels were over the WELL levels they would be made aware of this and assurances would be made to use protective measures.

Indicators and measures are used to make improvements in managing long latency diseases, an example of which is reviewing dust monitoring where there is a high level of silica and assessing whether more monitoring or controls are needed. Another example is replacing direct working with a remote control room to eliminate that problem area.

Two organisations reported that there is no evidence they know of that these indicators are valid predictors of the risk of occupational diseases. Other organisations mentioned that they were aware on research on silica exposure in Scottish miners and also the work of the HSE in this area, particularly the Hazard Assessment Documents.

Organisations felt that they could only assess current exposure on the basis of available evidence and knowledge. One organisation mentioned that dust monitoring is used to manage risk by ensuring that the workplace was below exposure limit.

Practical challenges faced by organisations in assessing the standard of management of occupational disease included:

- Challenges of individual susceptibility to silica;
- Data protection issues;
- Resources for collection and analysis of data;
- Resistance to health screening;
- Exposure limits are based on an 8 hour shift within 24 hour day, but it would be easier to monitor exposure if limits could be calculated on a weekly basis.

Other (Ceramic and Cotton)

In the ceramic industry audits and checklists are used, however, in the organisation consulted for this research it is mainly focused around asbestos in the buildings used. Until recently there had been no or little history of silicosis in the industry, therefore further measures were being looked at to deal with this risk.

There was very little information available from the cotton industry on long latency diseases, as they felt that there was no risk presented anymore due to the absence of the spinning sector in the UK. They did mention conducting other occupational health surveys such as noise surveys, monitoring hearing and healthcare. No measures were mentioned for dealing with the respiratory risk factors.

6.3 TRADE ASSOCIATIONS

6.3.1 What is understood by a leading indicator?

The level of understanding of the term 'leading indicators' differs amongst trade associations. Five of the eight organisations reported understanding the term with definitions focusing on measures that predict an outcome. For example, one organisation reported their understanding of the term as *"a measure by which you can predict what will happen in the future"*. Another organisation reported it as *"something that gives industry the opportunity to improve the outcome of health by changing work patterns, exposure or altering a company for the need to apply engineering improvements"*. However, two organisations reported not understanding the term; *"until I read the papers provided I was not aware of it"*. Two trade associations refused to take part in an interview as they felt that they were unable to contribute to the project.

One of the main indicators that the organisations reported being aware of was a measure of exposure to hazards. Two organisations reported being part of the European Social Dialogue for Silica. This covers KPIs such as percent of employees exposed, percent of employees covered by risk assessment and percent covered by health surveillance. One organisation reported using an assessment by NEPSI that includes similar KPIs.

The organisations reported a range of main methods by which the risk of long term occupational diseases is managed. For example, two organisations reported using risk assessments and audits, one organisation reported following the HSE code of practice, one organisation reported the use of PPE and training, and another organisation reported the use of job rotation in order to reduce exposure to employees.

The most common method reported to assess the potential for long latency diseases was dust monitoring, and was reported by three organisations. Other organisations reported methods relating to dust such as measuring the amount of silica in the air and ensuring an air conditioning system is in place and is checked regularly. One industry reported that due to the change in processing of the industry in the UK, the UK workforce were not longer at risk from long latency diseases. One industry also used other measures to reduce the risks of long latency diseases, for example placing Fize on cotton fibres to strengthen and decrease the loss of fibres.

Most (six) organisations reported not moving away from lagging indicators. For example, one organisation reported that they still look at incident and accident rates, and another organisation reported that it is difficult to determine what a cause of death may be, as it could be due to personal behaviours such as smoking. Two organisations did report that although they have not moved away from lagging indicators they are trying to also incorporate leading indicators.

6.3.2 Practical application

The level of awareness of the organisations interviewed on the tools used to assess the risk of occupational diseases amongst workers is unclear. Three organisations did not report any tools they were aware of and one organisation reported being aware of tools to assess injury but not occupational health. Three organisations reported being aware of audits that identify worker behaviour, such as checks on the use of PPE, two organisations reported being aware of health surveillance methods being used by industry.

One organisation reported using a questionnaire developed by NEPSI which allows information to be shared locally in order for other organisations to benchmark themselves against.

These assessments have the ability to make improvements in managing long latency diseases. For example, one organisation reported that audits identify where weaknesses exist in the assessment process, such as whether training needs to be re-done. It was also reported that health surveillance shows early signs of diseases. This is then used to inform whether control measures are being used effectively. One organisation also reported that if high levels of silica are identified, control measures can be put in place.

A limited amount of research and evidence for the indicators being valid predictors of long latency diseases was reported by the organisations. For example, one organisation reported being advised by medical experts. Another organisation reported that as the European Social Dialogue for Silica agreement was drawn up, there must be evidence to support that the methods suggested by the agreement are the best methods to deal with the issue. However, no specific evidence was reported. One organisation reported being aware of the HSE review on cement and COPD.

Some methods for assessing the risk of causative agents of long latency diseases were reported. One organisation stated using x-rays and CT scans. However, this method needs medical guidance. It was also reported by two organisations that it can be difficult to persuade employees to take health checks and medical examinations. Often, employees are also not honest about where they have worked before (e.g. exposed to asbestos) due to fear of not being employed due to health risks.

Other methods of assessment reported include assessing the current exposure level and making sure it is below the level set by HSE. Another organisation reported putting leading indicators in place based on KPIs, particularly regarding maintenance. This gave them the ability to assess any failures and issues that have been corrected as a result of these indicators.

Some of the other challenges reported include that the quality of documentation is poor, and the evidence available is not credible. This does not encourage employers to adhere to it. It was also reported that technology is not always sophisticated enough to put engineering controls in place.

6.4 HEALTH AND SAFETY INSTITUTES AND AUDITORS

6.4.1 What is understood by a leading indicator?

From the organisations that were interviewed it is unclear what the level of understanding of the term 'leading indicators' is currently. One organisation reported the term to mean *"an indicator that can predict performance in advance of an event transpiring."* However, definitions were not provided by the other organisations.

One organisation reported that they were unaware of any indicators being used by themselves or any other establishment. Audits were reported by one organisation as being the indicators they are aware of and use. These consist of primary audits focusing on issues such as pre-employment health surveillance and health promotion; secondary audits focusing on issues such as health surveys, health surveillance, and environmental monitoring (e.g. airflow monitor); and tertiary audits focusing on issues such as adjusting the workplace and referrals to occupational health practitioners.

The main methods of managing the risk of long term occupational diseases reported by one organisation were control of exposure, particularly taking care to not expose people with pre-existing conditions, and medical assessments. Another organisation suggested health surveillance such as testing for lung function to be the main method. However, it was also reported that this method is expensive and requires a skilled person to conduct the surveillance. The methods required by COSH regulations were reported by one organisation.

One organisation reported toxicological assessment to be the main method to assess the potential for long latency diseases. Another organisation reported health surveillance, risk assessment and technical improvements to machinery to be the main methods. It was suggested by one organisation that information from suppliers is the best method for assessing the potential for long latency diseases.

It is evident that three organisations are moving away from lagging indicators. For example, one organisation reported being far more pro-active than reactive and that the audits that they carry out are looking for a proactive approach. It was reported by one organisation that they do not favour waiting for an accident to occur and want to prevent an event occurring. However, they reported a proactive way of assessing long latency diseases would be incident monitoring and looking at causative agents which are often seen as lagging indicators.

6.4.2 Practical application

A variety of tools being used to assess the risk of occupational diseases were reported. One organisation reported using more epidemiology in recent years such as body mapping to assess the risk of occupational diseases. They also reported using constant active monitoring to assess risk and the need for self monitoring. This helps to identify if there is significant non-conformance. Another organisation reported the COSH regulations framework to be the tool they use. These generate a leading indicator of performance in health and safety.

Audits were the tools reported being used by one organisation. These include a five star audit, OSAF 2001, and an environmental audit, which cover and consider long latency diseases such as dealing with asbestos. These are requisite audits for gap analysis and a requirement for getting a job. These audits involve making recommendations to managing long latency diseases. If a gap is identified by the audits, the organisation will identify if legislative HSE can enforce the gap to be filled.

One organisation out of those interviewed was able to assess the risk of current exposure to causative agents of long latency diseases. In this case they were able to assess the exposure to silica and asbestos.

The organisations reported a number of challenges in assessing the standard of management regarding occupational diseases. For example, one organisation reported that it is difficult to assess the risk of long latency diseases due to the multi-factorial nature of occupational health. For example, it is difficult to disentangle occupational and non-occupational (e.g. lifestyle choices such as smoking) causations. The organisation reported the need to control for individual employees and their health deficits in order to protect the employees in the best way that they can within the workplace. For example, it an employee has been identified to have respiratory problems, the organisation will not assign them to work in dusty conditions for long periods of time. Another organisation reported challenges to be a lack of commitment from senior management and a lack of knowledge and training, such as whether management are trained to identify early detection of health problems.

6.5 OVERSEAS

6.5.1 What is understood by a leading indicator?

Meaning of 'leading indicator'

Overseas organisations reported a relatively accurate understanding of the term 'leading indicators'. One organisation reported the term to mean "*education and understanding of health hazards and controlling hazards"*, while another organisation reported the terms to mean *"the opposite of outcome indicators such as deaths or causes of emphysema."* Other definitions of 'leading indicators' reported included:

"Conditions, events or measures that precede an undesirable event and have some value in predicting the arrival of the event";

"Associated with proactive activities that identify hazards and assess, eliminate, minimise or control risks to developing long latency occupational diseases";

"Descriptor that predicts untoward health effects in the future";

"A real-time measure of potential hazards"; and

"*An index of exposure or a biological marker of disease that acts to identify diseases that might present in the longer term".*

Examples of leading indicators

Examples of indicators provided included:

- Substitution of dangerous or sensitising substances including ensuring that hazardous substances are properly labelled;
- Closed systems to avoid contact;
- Increased use of protection (e.g. PPE);
- Checking and reducing exposure levels of workers to hazardous/dangerous substances, perhaps through analysis of ambient air or effective LEV;

- Assessing the numbers of workers exposed to specific disease causing agents;
- Providing pre-employment medical assessments and ongoing health surveillance;
- Utilising biological monitoring (e.g. blood levels of cadmium and lead), or using x-rays to check biological markers in the lungs of coal mine workers;
- Increasing numbers of occupational health and safety professionals; and
- Ensuring attendance of workers at safety courses, or providing other information and training measures.

An example from Sweden includes that there are regulations on medical controls, for example spirometric analysis. Some exposures are subject to mandatory regulation (e.g. silica dust, asbestos) and tests must be offered before the employee is registered for work, as well as on an ongoing basis. For silica, spirometric analysis must be repeated every three years and for curing plastics, every two years.

The Office of the Australian Safety and Compensation Council reported that they had conducted the 2008 National Hazard Exposure Worker Surveillance (NHEWS) Survey (a nationally representative survey of Australian workers across a variety of industries). In this survey workers identified whether they were undertaking high risk work activities which exposed them to hazards, the extent of their exposure (number of hours on a typical day or week) and reported use of a range of control measures which are likely to reduce exposure. Using this data a suite of lead indicators for long latency diseases is being developed, which will reflect changing exposure to hazards through improved use of controls.

Organisational management of risk to long term occupational diseases

The main methods by which organisations manage the risk of long term occupational diseases reported by one organisation include risk assessments (i.e. remove substance if possible or prevent worker exposure to substance, or try to control exposure levels through ventilation, PPE or RPE to reduce progression of diseases); checklists; pre-employment medical assessments; employing occupational health and safety professionals. Two organisations reported the main methods by which organisations manage the risk for long term occupational diseases to be technical measures, such as integrated exhaust systems. However, one organisation did report that the maintenance of LEV systems can be an issue. One organisation reported blood monitoring to be a method. However, they reported that there is not a great deal of compliance with this method as it is not regulated nationally. Two organisations reported the use of PPE to be the main control. From a survey conducted by one of these organisations, examples of how disease and injury was managed by PPE included[6]:

- Exposure to dust was controlled by provision of masks (61%), reduction of time spent in places where there is dust, smoke, fumes or gases (41%), ventilation systems (40%), respirators (32%). 25% reported no controls were provided.

[6] '%' represents the % used by the responding sample who were exposed.

- Exposure to gases, vapours, smoke or fumes was controlled by provision of ventilation systems (59%), masks (49%), reduction of time spent in places where there is dust, smoke, fumes or gases (41%), respirators (28%). 22% reported there were no controls provided.

- Exposure to biological materials (bodily fluids – human or animal; faeces; animal flesh; human tissue) was controlled by provision of gloves (89%), training on safe handling of biological materials (71%), labelling and warning signs (68%), protective clothing (67%), masks (64%), safety goggles (61%), ventilation systems (56%), safety cabinets (47%). 7% reported no controls were provided.

- Exposure to chemical substances was controlled by provision of washing facilities (84%), gloves (83%), labelling and warning signs (69%), training on safe handling of chemical products or substances (61%), protective clothing (60%). 6% reported there were no controls provided.

Methods to assess potential for long latency diseases within industry

One organisation reported the methods used to assess the potential for long latency diseases to be: number of day's sick; number of occupational diseases; number of notifications of occupational diseases; costs of occupational disease and costs of absenteeism. Another organisation reported these methods to be health surveillance and air monitoring, research on toxicology and epidemiological studies were also reported by one organisation. Conversely, two organisations reported that this is a very weak area and industry is not driven to develop preventative programmes. The organisations are asked to identify hazards and the focus is very much on lagging indicators. However one of these organisations also reported that a survey they conducted will be used to inform the reduction in exposure to disease causing agents, on the assumption that this will reduce the incidence of long latency diseases in the long term. Their aim is to examine the survey results in light of the epidemiological, toxicological, occupational hygiene literature and to estimate the potential of disease in the future based on the current exposures identified in the survey. One organisation stated that in practical terms organisations assess risk by periodic medical examination, although this is not effective prevention. In general, effort would be placed to try and improve working conditions. One organisation stated that they look to speak to employer and employee representatives on this subject.

Finally, the last respondent did not feel in a position to comment on this as he did not have enough contact with industry, though he stated that he hoped they would have industrial hygienists.

Industry use of leading indicators

Four organisations reported that their industry is not moving away from lagging indicators and that industry is still focusing on measuring deaths and causes of disease. One organisation stated that reporting of injuries and deaths has gone down in their industry and they felt this was due to under-reporting rather than an improvement in the situation. This respondent made it clear however that this was his personal opinion only and that he could not vouch for the accuracy of his statement. Two of these organisations did report recognising a need to move away from using lagging indicators and towards using leading indicators. One organisation stated that they do not use lagging measures such as the number of fatalities as this is not an effective measure, although this may still be looked at nationally.

It has been reported however that leading indicators are being used by some organisations. For example, one organisation reported using a combination of leading and lagging indicators and one organisation reported using risk assessments which can be used as anticipatory methods, and large organisations in the industry use the work ability index (WAI). Furthermore, they reported that some instruments of work place health promotion that they use (e.g. 'work in health circles') can be seen in the context of moving away from lagging indicators.

6.5.2 Practical application

Tools used to assess risk of disease among workers and their uses

The tools to assess the risk of occupational diseases amongst workers reported by one organisation were material safety data sheets and audit checklists for inspectors. These are used to assess issues such as noise and asbestos.

Another organisation reported that larger organisations would use ISO management standards, WAI and surveys and questionnaires amongst workers which consider the personal perspective of strain or risk at work. Smaller organisations were reported to use checklists or easy to apply risk assessments. These would all be used to asses the work place situation; individual needs, behavioural assessment; and participation of workers.

One organisation reported that larger companies belong to a compensation authority and receive insurance levies if they carry out good health and safety procedures such as health monitoring. Pre-employment questionnaires to assess for predisposition and fitness to work; risk assessments to identify hazards and determine appropriate control measures; safety audits to compile initial safety statements or use periodically to review implementation of control measures were reported by one organisation. The outcomes of safety audits and risk assessments were reported to determine the necessary preventative measures to be taken. One organisation mentioned that most small businesses will use nothing however larger enterprises will use checklists and national questionnaires, these will look to gather perception amongst workers of health and wellbeing.

One organisation reported working in several areas to help assess the risk of occupational diseases amongst workers. For example, they have:

- Conducted a baseline survey conducted in 2008 (NHEWS) of worker behaviours and perceptions to collect self reported exposure to hazards, extent of exposure, and controls used to prevent exposure. Further analysis of this data is being undertaken to determine populations at potential risk of occupational disease;

- Calculated the burden of disease for priority sub disease categories within the working population which is attributable to work with reference to the hazards reported on in the NHEWS survey;

- Conducted nanotechnology research and policy programme.

Another organisation stated that *"good enterprises"* will make an assessment of the function of occupational health and management systems and the quality of processes in these systems, however they could not state how many did this and felt that it would be a low number.

This will guide national policy development and implementation and highlight priorities for preventative action regarding the management of long latency diseases. It is generally unknown how these assessments will be used to decide whether to make improvements in managing long latency diseases. However, one organisation reported that the WAI assessment allows good assessment of the work ability through transparency and comparability of data that includes many different indicators on a personal and work related basis.

Finally, one respondent reported only being aware of 'control banding' whereby groups of sources of hazard are put together and controlled as a group rather than controlled individually. He was unsure what this was used for however; or how it was used in subsequent decision-making concerning managing long latency diseases.

Evidence of research to support indicators being valid predictors of risk

Some organisations reported research and evidence of these indicators being valid predictors of the risk of occupational diseases. For example, one organisation reported that epidemiological research indicates that exposure to hazardous substances can lead to disease, and another organisation reported that various long term studies exist on the use and validity of the WAI. It was reported by one organisation that *"risk assessment is the cornerstone to European approach to occupational health (and safety) because if the risk management approach is not done well or not done at all, then the appropriate preventative measures will not be put in place"*. One organisation stated that it was imperative that evidence came from robust scientific research and epidemiology and that then exposure levels set would be a useful predictor. However, in contrast two organisations reported there being no evidence that these assessments are valid predictors of the risk of long latency diseases.

One respondent was only aware of 'control banding' and stated that HSE had research evidence to support this. Other than this, he was not aware of any other evidence.

Ability to assess risk of exposure levels to causative agents of long latency diseases

Three organisations reported that they have not been able to assess the risk of current exposure to the causative agents of long latency diseases. Some of the practical challenges reported in assessing this include:

- Low awareness of diseases – need more assistance from medical professionals;
- Little strategic management of the situation;
- Difficulty getting organisations to co-operate even with reporting;
- Failure to recognise what level is 'safe';
- Diseases are often multi-factorial diseases;
- Epidemiological studies are resource and cost intensive;
- Inability to control working conditions;
- Psychological issues e.g. workers do not take seriously the risks posed as there is often no immediate affect with long latency diseases;

- Too few can do the work – requires specialist knowledge; and
- Lack of equipment to undertake the work – usually only large companies can afford it.

7 APPENDIX C – STAKEHOLDER TELEPHONE INTERVIEW PROFORMA

Leading Indicators for Assessing Reduction in Risk of Long-Latency Diseases

Health and Safety Executive

Telephone interview proforma

Introduction

Thank you very much for agreeing to this interview which we are completing on behalf of the Health and Safety Executive. This interview aims to capture your understanding and awareness of leading indicators, how they are practically applied in industry and any examples you may have of their application. The feedback from this interview will be used by the HSE to understand the range of leading indicators in use, their predictive validity and practical application in industry.

The ultimate objective is to be able to assess current progress in reducing exposure to the causative agents of long latency diseases. Data on the rate of diagnosed cancers and other diseases only provide a measure of exposures in previous decades, rather than indicating current performance in preventing exposure. The conclusions of this work may be used to guide how the HSE tracks the impact of its disease reduction programme[7] as well in helping industry to track its performance.

This interview will last for approximately 35-45 minutes. You do not have to provide a written answer to any of our questions, our interviewer will summarise your responses. The interviewer will then write up the findings of the interviews into a report, all responses will be kept strictly anonymous unless you wish to be identified. If you require further confirmation of HSE's involvement with this research, you may contact Mark Lawton of HSE on 0151 951 4782.

What is a leading indicator?

A "leading indicator" in this context provides a real-time measure of progress at reducing exposure to the causative agents of long latency diseases, such as cancer. An example might be to monitor the proportion of local exhaust ventilation equipment (LEV) fitted with airflow indicators. This is a good indication that the LEV will be kept functioning properly as defective extraction will be easy to identify. One could therefore assume that this would result in improved extraction, reduced exposure and therefore less disease in the long-term. This is just one example; we expect there are many other potential examples.

[7] http://www.hse.gov.uk/drp/index.htm

Long latency diseases

These diseases include things such as chronic obstructive pulmonary disease (COPD), mesothelioma, silicosis, lung cancer and asbestosis. COPD[8] is a term used to describe a number of lung conditions that encompasses chronic bronchitis and emphysema. There is evidence to show that exposure to a wide variety of dust or fume have the potential to cause some of these diseases. Examples are;

- Cadmium dust/fume
- Coal dust
- Cotton dust
- Grain and flour dust
- Organic dusts
- Silica dust
- Welding Fumes

Some of the sectors where there might be significant exposure to dusts, fumes etc include;

- Brick making
- Construction, building trades
- Stonemasonry
- Welders
- Foundry workers
- Pottery/ceramic workers
- Quarrying

[8] http://www.hse.gov.uk/copd/index.htm

Background information on the interviewee	
Sector/organisation	
Contact name	
Organisation name	
Job title	
Email	
Contact telephone	Office:
	Mobile:
Other information	

Section 1 – What is understood by a leading indicator?

1. What do you understand by the term "leading indicator" in the context of long latency occupational diseases such as emphysema and bronchitis?

2. Please describe any such indicators that you use or are aware of. They should indicate how the risk of long latency diseases is currently being managed, and / or the extent to which workers are taking appropriate precautions etc?

3. What would you say are the main methods by which organisations manage the risk of long term occupational diseases?

4. To the best of your knowledge, what methods are used to assess the potential for long latency diseases? Please cite any examples.

5. Has your industry moved away from using lagging indicators, such as the number of fatalities? What is the industry using now?

Section 2 – Practical application

6. What tools, such as audit checklists, questionnaire etc are you aware of being used by your own or other organisations to help assess the risk of occupational diseases amongst workers? Examples could include surveys of worker behaviour, management audits, KPIs etc? Please describe them.

7. What are these indicators/assessments for?

8. In what way are these indicators/assessments used to decide whether to make improvements in managing long latency diseases? Please cite examples of how they have been used?

9. What evidence, research or reasoning do you know of that these indicators are valid predictors of the risk of occupational diseases such as COPD?

10. In your experience, have your or other organisations been able to assess the risk of current exposure to the causative agents of long latency diseases? What practical challenges have been faced in assessing the standard of management of these occupational diseases?

Thank you very much for participating in this research. The anonymous results from all interviews will be compiled into a report for the HSE.

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HSE

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Leading indicators for assessing reduction in risk of long latency diseases

The HSE need meaningful ‘leading indicators’ that provide a real-time measure of progress in reducing long latency occupational disease. This report provides a review of potential leading indicators for long latency occupational disease. The work involved a literature review and 49 stakeholder interviews. The understanding of leading indicators was mixed. Many stakeholder respondents, including some insurers, brokers, firms and health and safety institutes were unaware of the term or of examples of leading indicators, whilst industries working with silica (mines, quarries) and chemicals (oil, gas and chemicals); and certain overseas regulators, had well developed thinking and tools. The review identified a range of indicators covering Occupational Health Management Systems, Key Performance Indicators, implementation of workplace risk controls and worker surveys of awareness, attitudes and behaviours that could be implemented in existing HSE and industry tools. The review identified little work on the predictive validity of leading indicators for assessing the reduction in long latency diseases but suggested approaches to further develop this, including the use of expert judgement.

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