OECD GUIDANCE ON SAFETY PERFORMANCE INDICATORS – AN INTERNATIONAL APPROACH TO ASSESSING THE SUCCESS OF INDUSTRY, PUBLIC AUTHORITIES AND COMMUNITIES IN MANAGING MAJOR ACCIDENT HAZARDS

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The prevention of, preparedness for and response to chemical accidents are the key elements of a programme to manage the risks of major accidents. Different roles are played by the various stakeholders, with the main responsibility lying with industry. However relevant tasks, for example in the areas of response, communication about hazards, land use planning, etc. may be more concentrated within the public authorities and communities. For any management system to be successful there needs to be an aspect of assessment and control in which the suitability and performance of the various elements within the management system are determined. Within the Seveso II Directive (and COMAH-Regulations, 1999 in the UK) there is a requirement placed on operators of establishments to implement assessment and control measures to ensure that the Safety Management Systems (SMS) perform appropriately.

The international Organisation for Economic Co-operation and Development (OECD), under the auspices of the Working Group on Chemical Accidents has developed guidance for industry, public authorities, and communities to assist them in designing and implementing safety performance indicators programs. The OECD Guidance on Safety Performance Indicators ("SPI Guidance") was developed in close cooperation with OECD member countries as well as representatives of industry, other international organizations, and non-governmental organizations active in the area of chemical emergency prevention, preparedness, and response. The SPI Guidance is a companion to, and builds on the OECD Guiding Principles for Chemical Accident Prevention, Preparedness, and Response, 2nd edition [OECD, 2003]. During the development of the Guidance note was also taken of the work already carried out in the field of performance indicators in the UK by the Health and Safety Executive (HSE) and in the US by the Center for Chemical Process Safety [CCPS, 2006].

The guidance is contained in two documents, one for industry and the other for public authorities and communities. These documents were designed to serve as a tool to assist industrial enterprises, public authorities and communities in the vicinity of hazardous installations in establishing and implementing specific SPI programs tailored to their individual situations. Specifically, the guidance sets out a process for developing an SPI program and provides examples of key elements – targets, activities indicators and outcome indicators – for each of the three stakeholder groups. The OECD is also developing an on-line, interactive version of this Guidance.

SPI programs should help users to determine how successful they have been in developing and implementing appropriate requirements, policies and procedures designed to improve chemical accident prevention, preparedness and response, and to assess whether actions taken are achieving their desired results. Bearing in mind the recommendations of the Buncefield Major Accident Investigation Board as well as the investigations of the CSB and the Baker Panel into the BP Texas City refinery accident regarding performance indicators, there is a clear need to ensure and demonstrate that major accident hazards are managed effectively.

CHEMICAL ACCIDENT PREVENTION, PREPAREDNESS AND RESPONSE

The prevention of, preparedness for and response to chemical accidents has, over a period of over time developed to encompass a variety of principles and activities involving a wide range of stakeholders. In 1987 the Organisation for Economic Co-operation and Development (OECD) established a Working Group within its programme on chemical safety to address the issues associated with chemical accident prevention, preparedness, and response. This initial work followed the accidents in Bhopal, India and in Schweizerhalle near Basel in Switzerland. The aim of the newly established Working Group on Chemical Accidents (WGCA) was to share best practices, exchange information about accident case histories, identify opportunities for co-operative activities, analyse issues of mutual concern, develop guidance materials and reach agreement on common policies.

This long-standing Working Group has over twenty years of established relationships with member countries

and with industry, through the OECD Business and Industrial Advisory Committee (BIAC), and with labour organisations, through the OECD Trade Union Advisory Committee (TUAC). It works closely with other international organisations involved with issues related to chemical accident prevention, preparedness and response such as the United Nations Environment Programme (UNEP), the International Labour Organisation (ILO), the World Health Organisation (WHO) and the United Nations Economic Commission for Europe (UNECE). Under the auspices of the OECD Chemical Accidents Programme, over twenty workshops have been organised, each addressing different issues relating to chemical safety and bringing together experts from government, industry, labour, non-governmental organisations and academia. Through these workshops the *Guiding Principles for Chemical Accident Prevention, Preparedness and Response* were developed, and first published in 1992. In 2003 an updated second edition (OECD, 2003a) was published which have been translated into a number of languages and are available in electronic form from the OECD website. The *Guiding Principles* provide guidance for all the key stakeholders on the range of activities involved in the safe planning and operations of facilities where hazardous substances are produces, used or handles, as well as guidance for effective land-use planning, emergency preparedness and emergency response.

SAFETY PERFORMANCE INDICATORS

For any management system to be successful there needs to be an aspect of assessment and control in which the suitability and performance of the various elements within the management system are determined. Within the Seveso II Directive (and COMAH-Regulations in the UK) there is a requirement placed on operators of establishments to implement assessment and control measures to ensure that the Safety Management Systems (SMS) perform appropriately.

In 1997 the OECD WGCA concluded that they should consider ways in which the specific guidance contained within the *Guiding Principles* is successful in achieving its objectives. Thus it was decided to develop a companion to the *Guiding Principles* to provide guidance to the same group of stakeholders addressed by the *Guiding Principles* which enables them to develop measures of assessing the degree of success of actions taken to improve accident prevention, preparedness and response.

One of the main differences in the approach of the *Guidance on Safety Performance Indicators* (SPI) to that of the Seveso II Directive is that it not only addresses the role played by industry (the operators of a facilities with hazardous substances) in managing its chemical accident prevention adequately. It also considers the roles played by public authorities (government agencies) as well as local communities and others. If these stakeholders play a role in a chemical accident programme, which is undisputed, then the effectiveness of this role can be assessed and evaluated.

A programme to develop and use Safety Performance Indicators can not only indicate to industry how its own efforts are performing, but also be utilized as a communication tool to inform authorities, other operators, the local communities, trade associations and NGOs. Likewise authorities, in assessing their own efforts, could establish priorities for inspection or enforcement measures or discover where gaps or duplication in their existing measures exist.

The WGCA established a group of experts in 1998 to develop guidance for implementing SPI programmes. The group of experts consisted of representatives of OECD member countries, the EC, industry, labour, NGOs and other international organisations. Their mandate was to prepare flexible guidance that can be adapted for use in different countries, different industries and in a variety of contexts. It was agreed that the indicators should include both measures of activities/organisation of work, so called leading indicators and measures of outcome/impact, so called lagging indicators. The group should provide guidance for three target groups: industry, public authorities and communities/public.

In 2003 the OECD published its interim Guidance on Safety Performance Indicators [OECD, 2003b] with the intention of gaining experience during a test phase and receiving general feedback from the stakeholder groups. The SPI Guidance was also made available on the web and in electronic form. A pilot programme was established to test the interim guidance. About twenty companies and agencies agreed to participate in the pilot programme and to establish SPI programmes along the lines of the guidance. They also agreed to provide regular reports on how useful the guidance was and how it might be improved. The intention was to provide a revised edition of the guidance after the completion of the pilot programme.

At about the same time the UK Health and Safety Executive (HSE) was working together with the UK Chemical Industries Association (CIA) to develop the means by which companies could develop key performance indicators for major hazards and ensure process safety performance is monitored and reported against these parameters. The aim was to produce guidance aimed at senior managers and safety professionals within major hazard organisations. These activities were carried out in follow-up to the publication of the Major incident investigation report by the COMAH competent authority in 2003 regarding the series of events at BP Grangemouth in 29 May–10 June 2000 [HSE, 2003]. This report describes serious deficiencies in the safety management system which resulted in the accidents. The HSE guidance "Developing process safety indicators – A step-by-step guide for chemical and major hazard industries" [HSE, 2006] was published in 2006 and provided a valuable basis for a new chapter of the revised edition of the OECD *Guidance on SPI.*

REVISED EDITION OF THE OECD GUIDANCE ON SAFETY PERFORMANCE INDICATORS

The experience gained in the pilot programme led the expert group to conclude that it should:

- add a new chapter describing how to develop an SPI Programme (to complement the existing text on what could be the content of such a programme);
- include more detailed guidance on developing and using metrics;
- separate the guidance into two publications, with one directed to industry and one to public authorities and communities; and
- provide targeted guidance for emergency responders (e.g. police, fire, hazardous materials response teams, emergency medical personnel).

Taking these conclusions into account the revised OECD guidance was approved by the WGCA and published in 2008 [OECD 2008a, 2008b]. It was published in two volumes as recommended by the expert group. The primary focus is however the chapter "How to develop an SPI Programme" which sets out a seven step process:

- *Step One*: Establish the SPI Team
- *Step Two*: Identify the key issues of concern
- *Step Three*: Define "Outcome Indicator(s)" and related metrics
- *Step Four*: Define "Activities Indicator(s)" and related metrics

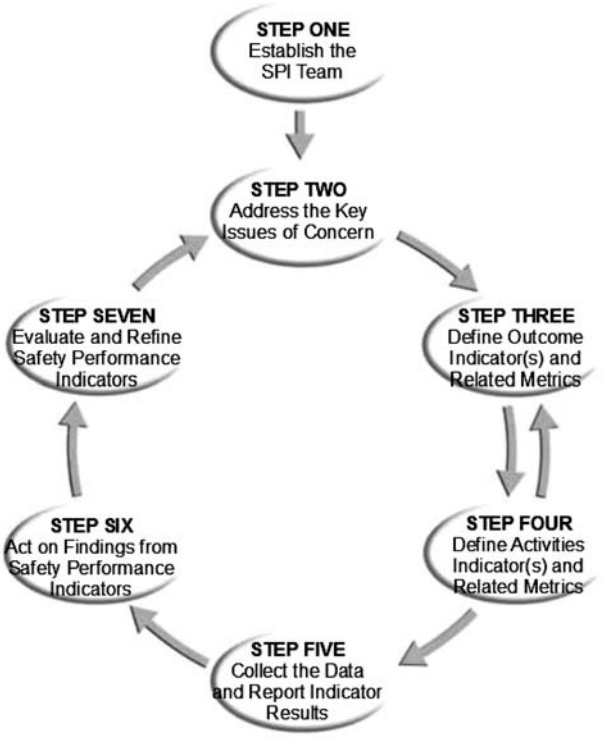

Figure 1. Seven steps to create and implement an SPI Programme [Jennings, 2009]

- *Step Five*: Collect the data and report indicator results
- *Step Six*: Act on findings from SPIs
- *Step Seven*: Evaluate and refine SPIs

This is a cyclical process incorporating Steps Two to Seven, although experience shows that Steps Three and Four are often undertaken on an iterative basis.

STEP ONE: ESTABLISH THE SPI TEAM

This step is critical in that the team has the general oversight of the development and implementation of the SPI-Programme. The efforts of the team must be effectively communicated. The team should involve appropriate staff members and reflect the hazardous processes and their safety control measures within the facility. Above all management involvement is key to the success of the programme. Management needs to provide not only the financial resources but also the personal commitment and leadership.

STEP TWO: IDENTIFY THE KEY ISSUES OF CONCERN

Appropriate SPIs should be relevant to the issues of concern. The SPI Team should identify which processes are associated with hazards in the facility and which policies, procedures and practices are critical for achieving and maintaining safety, i.e. that which is safety critical. It is of benefit to link this step closely to the most recent HAZOP or risk analysis.

Care should be taken not to initially try to cover too much. In the beginning it is necessary to gain experience in implementing the programme and the focus should be on what to measure rather so much on how to measure it. Also care should be taken to measure that which should be measured rather than choosing the easy option of that which is easily identified as being measurable.

STEP THREE: DEFINE "OUTCOME INDICATOR(S)" AND RELATED METRICS

"Outcome Indicators" are means of collecting data and providing results to help assist in determining whether the desired result has been achieved or not. Each indicator consists of a description of what is being measured and the metric i.e. the unit of measurement. This should be precise enough to indicate trends over time or highlight deviations from safety expectations.

STEP FOUR: DEFINE "ACTIVITIES INDICATOR(S)" AND RELATED METRICS

"Activities Indicators" are closely related to "Outcome Indicators" and assist in measuring whether critical elements of safety programmes, procedures and policies are in place for achieving the desired outcomes. They are designed to provide information about why or why not the desired outcome was achieved and thus provide information as to the necessary measures for corrective action in the programmes, procedures and policies.

The closer an activity indicator is to achieving the desired result of the outcome the closer the link between changes in the activity indicator and the outcome indicator. As mentioned above the two sets of indicators are commonly developed in an iterative process to ensure that the relationship between the indicators is optimised.

STEP FIVE: COLLECT THE DATA AND REPORT INDICATOR RESULTS

The initial step in the collection and reporting of results is to review the existing data sources; that is, the information which is already collected within the facility for quality control or other business processes should be assessed as to its suitability and relevance for an SPI-Programme. The data collection procedures should consider the frequency of data collection. This should be frequent enough to be able to recognise trends and allow for appropriate actions to be taken. For those indicators which have threshold indicators, the procedures should record the specific thresholds and their tolerances; that is the point at which deviations in performance should be flagged for action.

The data should be reported in a simple and relevant way to ensure that any deviations are recognised and understood, and that trends or problems in processes, policies or procedures are identified. Within the reporting of the results consideration should be given as to which results should be reported to which level within the organisation. The key concept is that if a person or unit is responsible for achieving a particular result or making particular decisions, then they must receive the necessary information as a basis for the actions or decisions. It should be also understood that at the highest level of an organisation there is often insufficient time or possibility to handle a large number of indicators and to weigh up all of the various possible outcomes. At this level Key Performance Indicators (KPI) are required which show the most important aspects for the key management decisions. However the SPI-Programme should not be reduced to the few KPIs needed for senior management level as other operating units require information for their spheres of decision making.

STEP SIX: ACT ON FINDINGS FROM SPI

Without the commitment and assurance that results from a SPI-Programme will lead to action, then there is little point in commencing such a programme. Although this is Step Six of the programme, there is a strong link between this step and the very first step of the programme in which the SPI team is established and management commitment is assured.

The SPIs (outcome and activities indicators) must provide sufficient information to the decision makers to enable the appropriate action to be taken. This means that report must be timely, precise, clearly presented and targeted towards the intended readership (e.g. departments for maintenance will need information on corrosion rates, failure of components, time to act on reported defects; production unit managers will more likely to need information regarding deviation from process conditions, time to respond to alarms, safety related training of staff).

STEP SEVEN: EVALUATE AND REFINE SPIs

The SPI Programme, including the indicators and metrics, should be periodically reviewed and evaluated. Indicators and metrics may need to be refined so that their response to changes in the system is as reliable as possible and that safety relevant changes are shown at an early stage.

The indicators should continually address areas of concern. In particularly once particular aspects have improved and the relevant indicators no longer show improvement, there may be no further justification for maintaining particular indicators in the programme and therefore other aspects will need to be included.

Ther may over time as experience with SPIs is gained be a wish to share experience with other facilities in the same company or between similar organisations across an industry. This may in turn lead to benchmarking exercises.

SAFETY PERFORMANCE INDICATORS AND INSPECTION OF THE SAFETY MANAGEMENT SYSTEM BY PUBLIC AUTHORITIES

Operators of establishments which fall under the requirements of the Seveso II Directive are required to set up a Safety Management System. Questions which will be posed by the authorities at some point, are “How good is the Safety Management System?” and “How good does the operator believe the Safety management System is?” What is certain is that the time between accidents is not an adequate measure and that operators who offer this as their measure of effectiveness are not fulfilling their responsibilities as defined in Annex III of the Directive.

Are Safety Performance Indicators (SPIs) a better alternative? Do they offer objectivity and do they have consistency? The use of SPIs by an operator requires planning and management commitment, they cannot be produced, “as if by magic”, to be shown to the inspector. In developing SPIs an operator should identify the critical safety relevant activities together with measures which are “SMART” – Specific, Measurable, Achievable, Result orientated, and Time-based. Merely using LTIR (Lost Time Injury Rate) or FAR (Fatal Accident Rate) as SPIs is not sufficient. Research has shown that Heinrich’s accident pyramid, which may be a good indicator for occupational accidents (slips, trips, falls, cuts, etc.) is not a good indicator of process safety: that is the safety with regard to the control of major accident hazards. This means that it is necessary to record and use other data. In many cases the data is already recorded, but possibly in another form or for another purpose. Indicators may be developed for a wide range of safety relevant activities, e.g.

- Management of corrosion (Does a corrosion inspection system exist? Have specific limits been set for each inspection point? Are reference points for inaccessible equipment truly representative?)

- Management of process control (How often is a continuous process run outside of the agreed/planned operating envelope – this might also be a quality control indicator too. Operating outside of the envelope can lead to higher alarm rates or spurious alarms or even to situations which are more difficult to control and thus more likely to runaway.)
- Management of training (How often? Which skills? Time between refresher trainings/practices/drills, quality of training – have the trainees learnt and are they able to implement the lessons?)
- Management of Alarms (How many? Time to response? How often are alarms triggered, e.g. max. fill-level, max. pressure? Is the potential for alarm overload considered when changing a process? Are alarms over-ridden or trigger levels adjusted?)

If the Safety Management System is effective then the operator should be able to demonstrate that the SPIs are improving or at least constant; and be able to do this over an extended period of time. An operator cannot produce one set of indicators for the inspection in one year and a completely different set the following year or two years later.

PITFALLS TO BE CONSIDERED WHEN INTRODUCING SAFETY PERFORMANCE INDICATORS

Safety is about managing risk so that the potential for harm to humans or the environment is reduced to an acceptable level and this level is maintained as low as reasonably practicable. In the chemical processing industry this is carried out using technical organisational and managerial measures.

When developing safety performance indicators it is important not to loose sight of this issue and thus reduce discussion of safety to a "numbers game". Safety will not be maintained if management is more concerned about how big the numbers are or which selection of indicators will show the company in the best light possible. In fact choosing and monitoring the selection of indicators is a difficult task which must itself be under continual review (not to keep changing the indicators, but to ensure that the indicators are still providing useful information related to chemical and process safety).

Management needs to learn to ask the question "Why?" more often. It is just as important to understand why the numbers got better as to have better numbers. If the process of SPIs is left to its own devices then there will be a tendency to massage the figures into the right form; perhaps not even knowingly. The Baker Panel Report describes very clearly what happens if the wrong set of numbers is followed for any length of time.

It is extremely important to ensure that the discussion between site operators and public authorities does not become one of whether the correct set of indicators has been chosen or how the annual results are to be interpreted. Similar discussions from the past have taken place in the field of risk assessment relating to likelihood of events or sizes of holes, where a discussion of the process of getting to these results would have been more meaningful.

It is also important never to forget that these are indicators. The values are not absolute measures of safety or risk. They are a simplification and an aggregation of observations. Safety performance indicators should be used as an aid to communication. They are not the entire message.

FUTURE DEVELOPMENTS IN INSPECTION

Over time it is to be expected that inspections by public authorities will change to take account of the use of SPI by industry. However this does not mean that inspectors will just be interested in the numbers. Inspectors will still visit for on-site inspections. They will still carry out their traditional role, however they will expect the operator to be able to demonstrate that the SMS is functioning effectively based on the safety performance indicators. This means that inspectors will want to see how the specific aspects which are measured by the indicators are carried out in reality and they will want to see how the control processes function, in particular when corrective measures should have been identified and have led to follow-up activities. The role taken by management and senior management in particular, is important i.e. assessing the operator's commitment to the Safety Management System and the measurement of its effectiveness and performance through the use of safety performance indicators.

EFFECTIVENESS MEANS: DOING THE RIGHT THINGS IN THE RIGHT WAY

If this is not happening then the SPIs should demonstrate this and management should take corrective action immediately. Inspectors will never accept the defence of "The SPIs didn't show the problem" as an excuse for deficient or unsafe operation or even an accident. If operators are going to offer SPIs as their demonstration of effectiveness and performance of the SMS, then Inspectors will expect to see evidence of the "SMART" approach.

Any changes in inspection regimes will take time to filter through and are dependent on a number of prerequisits.

- Operators need to decide that they are going to develop SPIs
- Operators also need to decide that they are going to use the SPIs to demonstrate effectiveness and performance of the SMS
- Public authority inspectors need training in the development and use of SPIs and how to integrate them into the Seveso II on-site inspection
- Public authority inspectors must then take time to consider the SMS and the SPIs used by the operator, including their suitability and robustness, in the preparation phase of the on-site visit
- It would be helpful for both the operators and the public authorities if legislation/regulations made reference to the use of SPIs as an example of a suitable method for assessing the effectiveness and performance of the SMS.

All stake holders need to remember SPIs do not measure the level of safety. SPIs indicate how the measures to achieve safe operation are performing.

Safety Performance Indicators offer a chance to improve transparency and communication between operators and inspectors. It is up to senior management to decide whether they wish to implement these tools. Government policy makers need to realise the potential and provide suitable training and resources to allow inspectors to be competent partners in the use of SPIs and thus enable the necessary dialogue to take place.

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