GUIDANCE ON DEVELOPING SAFETY PERFORMANCE INDICATORS

related to Chemical Accident Prevention, Preparedness and Response

FOR INDUSTRY

(second edition, 2008)

OECD

IOMC

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This publication is dedicated to the memory of Jim Makris, for his leadership, enthusiasm and dedication to international co-operation regarding chemical accident prevention, preparedness and response and, more specifically, to the OECD Chemical Accidents Programme.

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Series on Chemical Accidents

No. 19

GUIDANCE ON DEVELOPING SAFETY PERFORMANCE INDICATORS related to Chemical Accident Prevention, Preparedness and Response

GUIDANCE FOR INDUSTRY

Environment Directorate

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

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This publication was produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC).

The Inter-Organization Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. The Participating Organizations are FAO, ILO, OECD, UNEP, UNIDO, UNITAR and WHO. The World Bank and UNDP are observers. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organizations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

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For a list of publications associated with the Chemical Accidents Programme see page 135 of this document.

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Acknowledgements

This new *Guidance on Developing Safety Performance Indicators* (2008) was prepared by an Expert Group with representatives of member and observer countries, industry, labour, non-governmental organisations and other international organisations. This Expert Group, under the auspices of the Working Group on Chemical Accidents (WGCA), was chaired by Kim Jennings (US EPA). The development of the *Guidance on SPI* has been undertaken in close co-operation with other international organisations active in the area of chemical accident prevention, preparedness and response.

The effort to develop this *Guidance on Developing Safety Performance Indicators* consisted of a number of stages, starting in 1998 with the establishment of an Expert Group (see below) to explore the possibility of developing a means for facilitating implementation of the *Guiding Principles*, and to help stakeholders assess whether actions taken to enhance safety in fact were achieving desired results. Some of the steps leading to the development of this *Guidance* included:

- In 2003, the WGCA developed and published the initial version of the *Guidance on Developing Safety Performance Indicators*. The WGCA agreed that this should be published as an "interim" document because it presented an innovative approach to measuring safety performance that should be tested and revised based on feedback received. (See text box on the next page.)
- The WGCA established a Pilot Programme to get volunteers from industry, public authorities and communities to test the *Guidance on SPI*.
- During the same period as the Pilot Programme, the UK Health and Safety Executive and the Chemical Industries Association worked with companies in the UK to develop a process for developing a generic model for establishing process safety indicators. In 2006, they published *Developing Process Safety Indicators: A step-by-step guide for chemical and major hazard industries*, setting out a six-step process that can be used by companies interested in establishing a programme for safety performance measurement.
- Following the Pilot Programme, the WGCA convened a small Group of Experts to review the comments received as well as to consider related developments, and to revise the *Guidance on SPI* accordingly.

The Pilot Programme

During the course of the Pilot Programme, feedback was received from participants representing the key stakeholders groups including industry, public authorities (at national, regional and local levels) and communities. The participants provided very constructive comments that led to significant changes from the 2003 version of the *Guidance on SPI*. The volunteers in the Pilot Programme who provided feedback included: Jean-Paul Lecoursière, Robert Reiss and Claude Rivet (Canada, public authority/community); Anne-Mari Lähde (Finland, public authority); Remi Parent (Switzerland, industry); Alberto Susini (Switzerland, public authority); Viki Beckett and Elizabeth Schofield (UK, public authority); Peter Metcalfe (UK, public authority/police); Jonathan Smith (UK, industry); Nigel Taylor and Graham Kirby (UK, public authority/fire service); Simon Webb (UK, industry); Ty Lollini (US, industry); and Randal L. Sawyer (US, public authority).

Group of Experts: Completing the Final Text

The Group of Experts reviewed the feedback from the Pilot Programme participants, and considered other related developments. As a consequence, they agreed that a number of substantial and editorial changes should be made to the 2003 *Guidance*, with the most important being:

- the addition of Chapter 2, setting out seven steps for implementing an SPI Programme (building on the experience in the United Kingdom);
- the creation of two separate publications: one for industry and one for public authorities and communities/public;
- the drafting of a separate chapter for emergency response personnel, as a subset of public authorities;[1] and
- the development of additional guidance on the use of metrics.

[1] The impetus for creating this chapter came from the extremely helpful comments from the representatives of the UK police and fire services. Peter Metcalfe from the police, who also participated in the Group of Experts, provided invaluable insights and guidance for the further development of the Chapter.

As a result, the bulk of the 2003 version is now contained in Chapter 3, amended to take into account experience gained during the years since the interim *Guidance* was published.

The Group of Experts included: Jean-Paul Lacoursière and Robert Reiss (Canada, public authority and local community); Pavel Forint and Milos Palacek (Czech Republic, public authority); Anders Jacobsson (Sweden, consultant); Elisabeth Schofield and Ian Travers (UK, public authority); Peter Metcalfe (UK, police); Neil MacNaughton (UK, industry); Nick Berentzen (UK, industry association); Kim Jennings (US, public authority); Walt Frank (US, industry); Tim Gablehouse (US, local community); Bill Michaud and Francine Schulberg (US, consultants). In addition, Kathy Jones and Dorothy McManus of the US helped to review and edit the text.

A small group was responsible for drafting the text: Chapter 2 and the Annex on metrics was prepared by Bill Michaud (US, consultant); and Chapter 3 was prepared by Anders Jacobsson (Sweden) for the Industry text, Kim Jennings (US) for the Public Authorities text, and Jean-Paul Lacoursière, Robert Reiss and Eric Clément (Canada), for the Communities text. Francine Schulberg was responsible for preparing Chapter 1, compiling the annexes and editing the document. Peter Kearns and Marie-Chantal Huet (OECD Secretariat) assumed an oversight role throughout the process, under the supervision of Robert Visser.

The preparation of the *Guidance on SPI* was made possible by extra-budgetary contributions from Australia, Austria, Canada, Finland, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland and the United States.

The 2003 "Interim" Guidance on SPI

The impetus for developing this document was a suggestion in 1998 by the delegate from France (Marcel Chapron) that the Working Group should develop indicators to facilitate implementation of the Guiding Principles *and to better understand the impacts on safety of different elements of the* Guiding Principles.

The Working Group established an Expert Group on Safety Performance Indicators. This Group that developed the "interim" version of the Guidance on SPI *(2003), was chaired by Kim Jennings (United States), and included Wayne Bissett, Eric Clément, Jean-Paul Lacoursière and Robert Reiss (Canada); Jukka Metso (Finland); Marcel Chapron, David Hourtolou and Olivier Salvi (France); Frauke Druckrey and Mark Hailwood (Germany); Paola de Nictolis, Roberta Gagliardi, Giancarlo Ludovisi, Natale Mazzei and Raffaele Scialdoni (Italy); Jen-Soo Choi, Soon-Joong Kang, Jae-Kyum Kim, Ki-Young Kim, Hyuck Myun Kwon and Sueng-Kyoo Pak (Korea); H.S. Hiemstra, Joy Oh and Eveline van der Stegen (the Netherlands); Mieczyslaw Borysiewicz and Barbara Kucnerowicz Polak (Poland); Josef Skultety (Slovak Republic); Anders Jacobsson (Sweden); David Bosworth (United Kingdom); Kim Jennings, Kathy Jones, Francine Schulberg and Robert Smerko (United States); Juergen Wettig (European Commission); Sigal Blumenfeld (Israel); Simon Cassidy, Stephen Coe and Willem Patberg (Business and Industry Advisory Committee to the OECD); Ralph Arens, Roland Fendler, Angelika Horster, Apostoslos Paralikas and Mara Silina (European Environmental Bureau); and Reg Green and Brian Kohler (Trade Union Advisory Committee to the OECD). In addition, Dafina L. Dalbokova and Dorota Jarosinka (World Health Organization-European Centre for Environment and Health) participated in the review process. The three main sections of the SPI Guidance were drafted by Anders Jacobsson (Sweden) for Part A on Industry; Kim Jennings (United States) for Part B on Public Authorities; and Jean-Paul Lacoursière, Robert Reiss and Eric Clément (Canada), for Part C on Communities. Francine Schulberg (OECD Consultant) was responsible for writing the introductory sections, compiling the annexes and editing the document. Peter Kearns, Béatrice Grenier and Marie-Chantal Huet (OECD Secretariat) assumed an oversight role throughout the process, under the supervision of Robert Visser.*

Relationship to the OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response

This *Guidance on Developing Safety Performance Indicators ("Guidance on SPI")* was created as a complement to the *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response (2nd ed. 2003) ("Guiding Principles").*

The Guiding Principles is a comprehensive document providing guidance to assist industry, public authorities and communities worldwide in their efforts to prevent and prepare for chemical accidents, *i.e.*, releases of hazardous substances, fires and explosions. First published in 1992 and updated in 2003, the *Guiding Principles* contains best practices gathered from the experience of a wide range of experts, and has been internationally accepted as a valuable resource in the development and implementation of laws, regulations, policies and practices related to chemical safety.

Both the *Guidance on SPI* and the *Guiding Principles* are aimed at the same target audiences, recognising that industry, public authorities and communities all have important roles to play with respect to chemical safety and, furthermore, should work together in a co-operative and collaborative way. Through such co-operation, industry can achieve the trust and confidence of the public that they are operating their installations safely, public authorities can stimulate industry to carry out their responsibilities and work with communities to ensure proper preparedness, and communities can provide chemical risk and safety information to the potentially affected public and help to motivate industry and public authorities to improve safety.

The *Guiding Principles* include "Golden Rules," highlighting some of the most important concepts contained in the *Guiding Principles*. Annex III of this Document contains a complete copy of the Golden Rules. Some of the key responsibilities include:

Owners/managers of hazardous installations should:
- know what risks exist at their hazardous installations;
- promote a "safety culture," which is known and accepted throughout the enterprise;
- implement a safety management system, which is regularly reviewed and updated;
- prepare for any accident that might occur.

Workers at hazardous installations should:
- make every effort to be informed and to provide feedback to management;
- be proactive in helping to inform and educate the community.

Public authorities should:
- provide leadership and motivate stakeholders to improve chemical accident prevention, preparedness and response;
- develop, enforce and continuously improve regulations, policies, programmes and practices;
- help ensure that there is effective communication and co-operation among stakeholders.

The public should:
- be aware of the risks in their community and what to do in the event of an accident;
- co-operate with local authorities and industry in emergency planning and response.

Thus, the *Guiding Principles* provides insights on the policies, practices and procedures (including human resources and technical measures) that should be in place to reduce risks of chemical accidents and to respond should an accident occur. This *Guidance on SPI* was prepared to assist enterprises determine whether their own policies, practices and procedures operate as intended and achieve their desired results and, if not, what improvements should be made.

The full text of the *Guiding Principles* is available on-line, along with a searchable version (see: www.oecd.org/env/accidents). With the support of member countries, translations of the *Guiding Principles* are available on the website in a number of languages including Chinese, Czech, French, German, Hungarian, Italian and Korean.

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ANNEXES

Related Guidance Concerning the Role of Public Authorities and the Public/Communities

This *Guidance* recognises that industry has the primary responsibility for the safety of the installations it operates. However, other stakeholders also have important roles to play in accident prevention, preparedness and response including public authorities at all levels (*e.g.*, regulatory agencies, local authorities, emergency response officials and medical/health authorities) and the public (and, in particular, communities in the vicinity of hazardous installations). Therefore, the OECD is also publishing related *Guidance on Developing Safety Performance Indicators for Public Authorities and Communities/Public*.

(see: www.oecd.org/env/accidents)

Web-Based Version of the *Guidance*

The web-based version of this *Guidance* will be periodically updated and supplemented with further examples and new references.

(see: www.oecd.org/env/accidents)

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It is expected that this *Guidance* will be reviewed and revised, as appropriate. Therefore, the OECD would appreciate feedback on both the content of the *Guidance* and its presentation.

Please send comments to ehs@oecd.org

Introduction

Safety Performance Indicators ("SPIs") provide important tools **for any enterprise that handles significant quantities of hazardous substances** (whether using, producing, storing, transporting, disposing of, or otherwise handling chemicals) including enterprises that use chemicals in manufacturing other products. Specifically, SPIs help enterprises understand whether risks of chemical accidents are being appropriately managed. The goal of SPI Programmes is to help enterprises find and fix potential problems before an accident occurs.

By taking a pro-active approach to risk management, enterprises not only avoid system failures and the potential for costly incidents, they also benefit in terms of business efficiency. For example, the same indicators that reveal whether risks are being controlled can often show whether operating conditions are being optimised.

This *Guidance on Developing Safety Performance Indicators ("Guidance on SPI")* was prepared to assist enterprises that wish to implement and/or review Safety Performance Indicator Programmes.[2] It was developed by the OECD Working Group on Chemical Accidents,[3] bringing together experts from the private and public sectors to identify best practices in measuring safety performance. It is a complement to *the OECD Guiding Principles on Chemical Accident Prevention, Preparedness and Response* (2nd ed, 2003)[4] (the *"Guiding Principles"*) and is intended to be consistent with other major initiatives related to the development of safety performance indicators.[5]

This *Guidance* is not prescriptive. In fact, each enterprise is encouraged to consider how to tailor its Programme to its own specific needs and to use only those parts of the *Guidance* that are helpful in light of its own circumstances.

The three chapters in this *Guidance* are designed to help enterprises better understand safety performance indicators, and how to implement SPI Programmes. Specifically:

- **Chapter 1** provides important background information on the *Guidance* and on SPIs more generally including (i) a description of the target audience for this *Guidance*, (ii) definitions of SPIs and related terms, and (iii) insights on the reasons for implementing an SPI Programme.

- **Chapter 2** sets out a seven-step process for implementing an SPI Programme, along with three examples of how different types of enterprises might approach the establishment of such a Programme. These seven steps build on the experience of a number of enterprises in the UK that worked with the Health and Safety Executive to develop a practical approach for applying performance indicators.[6]

- **Chapter 3** provides additional support for the development of an SPI Programme by setting out a menu of possible elements (targets, outcome indicators and activities indicators). This menu is extensive in light of the different types of potentially interested enterprises, recognising that each enterprise will likely choose only a limited number of the elements to monitor its key areas of concern. Furthermore, it is understood that an enterprise may decide to implement an SPI Programme in steps, focusing first on only a few priority areas, and then expanding and amending its Programme as experience is gained.

Annexes provide further support with an expanded explanation of metrics and a summary of targets, along with a glossary, a list of selected references and a copy of the *Guiding Principles'* "Golden Rules."

[2] The full text of this *Guidance on SPI*, as well as a searchable version, is available on-line at www.oecd.org/env/accidents.
[3] For further information on the Working Group and its activities, see Annex VI.
[4] The full test of the *Guiding Principles*, as well as a searchable version, is available on-line at: www.oecd.org/ehs. References are made within Chapter 3 of this Document to relevant provisions of the *Guiding Principles*.
[5] This includes the 2006 guidance developed by the Health and Safety Executive (UK) and Chemical Industries Association, *Developing Process Safety Indicators: A step-by-step guide for chemical and major hazard industries*, HGN 254, ISBN 0717661806.
[6] ibid.

Chapter 1: OBJECTIVES AND SCOPE

This Chapter provides background information on safety performance indicators generally and, more specifically, on how to use the guidance set out in Chapters 2 and 3. This Chapter addresses the following four questions: who should use safety performance indicators; what are safety performance indicators; why develop safety performance indicators; and how to use this *Guidance*.

Who Should Use Safety Performance Indicators ("SPIs")?

Any enterprise that poses a risk of an accident involving hazardous chemicals – irrespective of location, size, nature or ownership – should consider implementing an SPI Programme.[7] By helping to focus attention on the critical aspects of an enterprise that create risks, SPI Programmes provide an efficient means for identifying potential problems and addressing them before an accident or incident occurs.

Thus, the audience for this *Guidance* on SPI includes enterprises worldwide – large or small, public or privately owed – that use, produce, store, transport, dispose of or otherwise handle significant quantities of hazardous chemicals.[8]

EXAMPLES OF ENTERPRISES THAT SHOULD CONSIDER USE OF SPIs

Enterprises that pose a risk of an accident – a fire, explosion, spill or other release of chemicals to water, air or on land – include, but certainly are not limited to, enterprises that are part of the chemical industry. There are many other industries that use or handle hazardous chemicals.

Not only large enterprises with complex installations should be concerned about accident prevention, preparedness and response. Enterprises that operate smaller facilities with relatively small quantities of very hazardous materials, as well as facilities that do not produce toxic materials but create some as intermediate or waste products, also create risks of chemical accidents.

The following are just a few examples of the types of enterprises that have had significant chemical accidents (that might have been avoided if management had been aware of safety-related deficiencies):

- chemical manufacturers, including small specialty chemicals companies
- fertilizer producers
- hazardous waste treatment facilities
- refineries and other petrochemical facilities
- steel and iron mills
- pharmaceutical producers
- plastics manufacturers
- steel manufacturers
- cement manufacturers
- pulp and paper mills
- ports (handling or storing hazardous materials)
- train depots and other transport interfaces involved in (un)loading operations
- food refrigeration facilities
- manufacturers of consumer products, such as electronics or painted materials
- small companies that use or store hazardous chemicals (*e.g.*, chlorine, propane)
- storage facilities containing hazardous materials (*e.g.*, fireworks, pesticides)

[7] While the focus of the guidance is on fixed facilities (including port areas and other transport interfaces), much of it is also relevant to the transport of dangerous goods.
[8] There are a number of national and international databases containing information on accidents, as well as accident investigation reports, including for example: the European Union's MARS database (http://mahb-srv.jrc.it) and the report of the US Chemical Safety and Hazard Investigation Board (www.csb.org).

In order to be relevant to such a broad array of enterprises, this *Guidance* is inherently flexible in its application and, at the same time, comprehensive. Thus, the seven-step process for developing SPI Programmes set out in Chapter 2 can be adapted for use in any enterprise. The menu of possible elements (targets, outcome indicators and activities indicators) set out in Chapter 3 is extensive, addressing the range of possible subjects relevant to different types and sizes of enterprises. The objective is for each enterprise to choose, or create, only a limited number of indicators based on their specific priorities.

Within an enterprise, the information generated by SPI Programmes have proven to be valuable to a wide range of employees including senior and middle managers, engineers, process operators, members of the Safety Committee and others at all levels with responsibilities related to process safety, health/environmental performance, evaluation/auditing, emergency planning and other aspects of chemical accident prevention, preparedness and response.

In addition to individual enterprises, this *Guidance* should be of interest to trade/industry or professional associations, research institutes and other groups working with enterprises that pose a risk of chemical accidents. There are a number of ways that these groups can help their constituents, for example, by:

- helping to publicise and distribute this *Guidance*;
- using the *Guidance* to facilitate the efforts of their member enterprises through, *e.g.*, training courses or the preparation of supplementary materials;
- adapting the *Guidance* so that it is particularly relevant for, and targeted to, their members (relating to, for example, particular industries or types of risks posed); and
- establishing a means for the exchange of experience among its members. This can result in reduced costs for individual enterprises and can allow each to benefit from best practices within their industry.

Enterprises should seek support and assistance from their trade/industry associations.

SMALL AND MEDIUM-SIZED ENTERPRISES

Management of SMEs should be particularly concerned about potential chemical accidents and what can be done to prevent them, since one accident could force the enterprise out of business (in addition to possibly harming employees, members of the public and/or and the environment).

Use of SPIs can be a very effective tool for SMEs. Smaller enterprises tend to have more limited expertise and fewer resources dedicated to chemical safety. Management is often directly involved in process activities and employees tend to be responsible for several functions.

An SPI Programme can provide an efficient means to help focus attention on the critical aspects of the enterprise that create risk and aid in setting priorities for action.

What are Safety Performance Indicators?

The term "safety performance indicators" is used to mean observable measures that provide insights into a concept – safety – that is difficult to measure directly.

This *Guidance* divides safety performance indicators into two types: "outcome indicators" and "activities indicators."

- *Outcome indicators* are designed to help assess whether safety-related actions (policies, procedures and practices) are achieving their desired results and whether such actions are leading to less likelihood of an accident occurring and/or less adverse impact on human health, the environment and/or property from an accident. They are reactive, intended to measure the impact of actions that were taken to manage safety and are similar to what are called "lagging indicators" in other documents. Outcome indicators often measure change in safety performance over time, or failure of performance.

  Thus, outcome indicators tell you *whether* you have achieved a desired result (or when a desired safety result has failed). But, unlike activities indicators, they do not tell you *why* the result was achieved or why it was not.

- *Activities indicators* are designed to help identify whether enterprises/organisations are taking actions believed necessary to lower risks (*e.g.*, the types of policies, procedures and practices described in the *Guiding Principles*). Activities indicators are pro-active measures, and are similar to what are called "leading indicators" in other documents. They often measure safety performance against a tolerance level that shows deviations from safety expectations at a specific point in time. When used in this way, activities indicators highlight the need for action when a tolerance level is exceeded.

  Thus, activities indicators provide enterprises with a means of checking, on a regular and systematic basis, whether they are implementing their priority actions in the way they were intended. Activities indicators can help explain why a result (*e.g.*, measured by an outcome indicator) has been achieved or not.

This *Guidance* does not specify which indicators should be applied by an individual enterprise. Rather, as described below, this *Guidance* focuses on the process of establishing an SPI Programme and then provides, in Chapter 3, a menu of outcome indicators and activities indicators to help enterprises choose and/or create indicators that are appropriate in light of their specific situation.

Why Develop Safety Performance Indicators?

SPI Programmes provide an early warning, before a catastrophic failure, that critical controls are not operating as intended or have deteriorated to an unacceptable level.

Specifically, SPI Programmes provide a means to check whether policies, procedures and practices (including human resources and technical measures) that are critical for chemical safety are successful in achieving their desired results (*i.e.*, safer facilities and a decreased level of risk to human health, the environment and/or property). An SPI Programme can also help to identify priority areas for attention and the corrective actions that are needed.

It is important for enterprises to be pro-active in their efforts to reduce the likelihood of accidents and improve preparedness and response capabilities, rather than being reactive in response to accidents or other unexpected events. Often, there is an assumption that facilities and safety management systems continue to operate as planned. But, in fact, changes often occur over time without the knowledge of managers or other employees. These changes can occur due to, for example, deterioration, complacency, inadequate training, breaches of technical parameters, change in personnel or loss of institutional memory. Or it may be that there is a discrepancy between what was planned and what is actually occurring.[9] Chemical accident databases are full of case histories identifying an unknown deterioration in a process or a system as a root or contributing cause of an accident.

Many enterprises rely on failure data to gauge whether they are controlling risks. In such situations, enterprises may first learn that a safety-related policy, practice or procedure was not operating as intended only after an accident (or near-miss) has occurred. This approach is obviously not desirable and may cause irreparable harm to the enterprise and the community (including workers, members of the public, the environment and property). Furthermore, relying on a review of past incidents may not provide the insights needed to understand the complex combination of technical, organisational and human failings that might be contributing causes of incidents and unacceptable risks.

SPI Programmes serve as a complement to, not a substitute for, other efforts to monitor and obtain assurance of reliability. While audits are used by many enterprises, they tend to be too infrequent to identify system deterioration, and audits often focus on compliance rather than ensuring that systems deliver the desired outcomes. Workplace inspections check aspects of worker safety but do not tend to focus on systems that are critical for chemical accident prevention, preparedness and response.

Establishing and implementing an SPI Programme can have a number of benefits in addition to reducing risks and providing an accident early warning system. For example, an SPI Programme generally leads to other improvements in health, safety and environmental performance by:

- helping to increase awareness of safety, health and environmental issues among staff;
- providing a means for checking whether goals are being met (including legal and other requirements, corporate policies, community objectives) and whether these goals are realistic;
- providing a basis for deciding on an allocation of safety-related resources (including financial and human).

An SPI Programme can serve other business functions. In addition to avoiding the direct costs associated with accidents and incidents, evidence has shown that improved safety leads to financial gains by identifying opportunities for improving the overall efficiency of operations. Safe operations also protect the good will and reputation of enterprises. In addition, the use of SPIs can also facilitate communication and co-operation with public authorities, as well as foster improved relationships with members of the local communities.

[9] One classic example involves "alarm overload." This occurs when one operator is responsible for responding to a number of different alarms systems, which may have been installed at different times. This can lead to a situation where an operator has difficulty in determining which alarms to pay attention to and which to ignore and, therefore, may be unable to react to critical failures. If detected before an accident occurs, alarm overload can be resolved in a number of ways, such as reworking the alarm system or adapting the operator training so it is clear which alarms should take priority.

VALUE OF SPI TO ENTERPRISES*

Companies that have implemented SPI Programmes have reported that they have:

- **increased assurance on risk management and have protected their reputation;**
- **demonstrated the suitability of their risk control systems;**
- **avoided discovering weaknesses through costly incidents;**
- **stopped collecting and reporting performance information which is no longer relevant, thereby saving costs;**
- **made better use of information already collected for other purposes (*e.g.*, quality management).**

* from the *Step-by-Step Guide to Developing Process Safety Performance Indicators*, developed by the UK Health and Safety Executive and the UK Chemical Industries Association (2006)

How to Use this *Guidance*

> ***This* Guidance *has been developed for use on a voluntary basis, to the extent appropriate.***
> ***It has been designed to allow users to adapt the* Guidance *to their particular circumstances.***

This *Guidance* was prepared to help enterprises understand the value of Safety Performance Indicators and to provide a plan for developing appropriate SPI Programmes specific to their circumstances. In addition, this *Guidance* can help those enterprises that already have SPI Programmes in place by providing a basis for reviewing their Programmes and assessing whether improvements can be made or additional indicators would be useful.

This *Guidance* does not define a precise methodology; rather it sets out the steps that can be taken to create an effective SPI Programme based on the collective experience of experts in this field. This *Guidance* also provides a menu of key elements (targets, outcome indicators and activities indicators) that may be relevant to different enterprises that handle hazardous substances. The goal is to help enterprises develop an SPI Programme that meets their specific needs, reflects the risks at their installations and is consistent with their safety culture.

This *Guidance* presumes that enterprises have in place safety management systems and/or other policies, procedures and practices (including human resources and technical measures) designed to address chemical risks. This Document is not intended to provide guidance on the specific actions that enterprises should take to reduce the risk of chemical accidents or to effectively prepare for such accidents. This can be found in the companion document, the *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response.*[10]

Chapter 2: "How to Develop an SPI Programme" sets out a seven-step approach for designing, implementing and revising an SPI Programme. Specifically, Step One focuses on establishing the SPI team so that it includes the appropriate members of staff, has management support and has access to the necessary resources. Each enterprise will need to decide what approach would work best for them in order to optimise their ability to use the indicators to reduce chemical risks and improve accident prevention, preparedness and response. In addition, it is also important for each enterprise to consider who will use the results of an SPI Programme and how to include, or inform, other employees who might be affected by an SPI.

Step Two deals with identifying the key issues of concern for an individual enterprise and priority-setting among issues. Since it is not possible to measure all policies, practices and procedures, enterprises need to consider which are the key areas of concern.

Steps Three and Four address how to define relevant outcome and activities indicators, respectively. These two steps refer to the menu of indicators in Chapter 3 to help enterprises identify and adapt appropriate indicators. Since a key component of all indicators is the *metrics* – *i.e.*, the unit of measurement, or how an indicator will be measured – Chapter 2 also includes suggestions on developing metrics. Further information on metrics is available in Annex I.

Step Five involves collecting data and reporting the results of the SPI Programme. It points out that collecting the data needed for an SPI Programme is generally not burdensome because information gathered by enterprises for other purposes often can be easily adapted to monitor safety.

Step Six focuses on taking action based on the findings, noting that the results of SPIs must be acted upon or there is little point in establishing an SPI Programme.

Step Seven relates to evaluating SPI Programmes to refine and, as appropriate, expand SPI Programmes based on experience gained.

[10] *OECD Guiding Principles on Chemical Accident Prevention, Preparedness and Response* (2nd ed, 2003) can be found at www.oecd.org/ehs. Hard copies can be obtained by contacting the OECD Environment, Health and Safety Division at ehscont@oecd.org.

Chapter 3: "Choosing Targets and Indicators" was developed as a resource to support Steps Three and Four (Chapter 2), by providing a menu of possible outcome and activities indicators. To facilitate use of this menu, the Chapter is divided into six sections addressing the following areas: policies, personnel and general management of safety; general procedures; technical issues; external co-operation; emergency preparedness and response; and accident/near-miss reporting and investigation.

The six sections are divided into a number of sub-sections, each of which addresses a different subject and begins with a short introduction describing its relevance to chemical safety as well as references to related provisions of the *Guiding Principles*.[11] This is followed by a *target* which identifies the ultimate objective that might be achieved relative to the subject. Each subject then includes one or more outcome indicator(s) and a number of activities indicators. The targets and indicators are not meant to be exclusive; enterprises can choose and adapt these to their circumstances and/or create their own. A compilation of the subjects with associated targets is set out in Annex II to help enterprises identify which subjects may be of particular interest to them.

Chapter 3 is not meant to be used as a check-list. It is up to each enterprise to decide how extensive an SPI Programme makes sense in its situation and to use only those parts of the *Guidance* that are helpful.

There are many factors that will influence decisions concerning how many indicators to include in an SPI Programme and which indicators are key. As a general rule, an enterprise will build on existing safety programmes and will only address a limited number of subjects in its SPI Programme (perhaps no more than a dozen), carefully chosen to reflect its own needs and to monitor key policies, procedures and practices.

In choosing indicators, enterprises should identify those that could provide the insights needed to understand where they should take action to avoid potential causes of accidents. Therefore, in deciding on priority issues, enterprises should consider an assessment of their risks as well as historical data showing where there have been problems or concerns in the past. They should also take into account other information or suspicions that might suggest a potential problem, for example, experience at similar hazardous installations. In establishing priorities, enterprises should also consider the resources and information available, the corporate safety culture and the local culture.

It is important to avoid choosing indicators because they make the enterprise look good, or because they are the easiest to measure. It is also important to avoid complacency, thinking that since there has not been a problem in some time, nothing wrong can happen. Instead, enterprises should focus on their safety-critical policies, procedures and practices, and ask questions (even if difficult or awkward) in order to identify potential causes of accidents.

Often, SPI Programmes will be implemented in steps, starting with a limited number of indicators. Once experience is gained, enterprises might expand their SPI Programme, or adapt their Programme in light of shifting priorities.

[11] The *Guiding Principles* provides insights on best practices for chemical accident prevention, preparedness and response. This *Guidance on SPI* is not meant to provide information on what steps should be taken to improve chemical safety but rather provides a means to measure whether the steps that are being taken are effective in achieving their objectives.

Chapter 2: HOW TO DEVELOP AN SPI PROGRAMME
Seven Steps to Create an SPI Programme[12]

Introduction

This Chapter describes a step-by-step process for developing an SPI Programme that will help your enterprise monitor key safety policies, procedures and practices (including human resources and technical measures). The process described in this Chapter is not a programme that can be lifted out and applied as a whole. Rather, it sets out a seven-step process which, along with the menu of indicators set out in Chapter 3, provides the building blocks to help you create an SPI Programme that meets your specific needs and objectives. The goal is to have an SPI Programme that:

- provides your enterprise with an early warning of where safety-related policies, procedures and practices are not operating as intended or are deteriorating over time;
- identifies corrective actions that might be needed; and
- is reviewed and updated, as appropriate.

This *Guidance* should be useful not only for establishing an SPI Programme but also for evaluating the effectiveness of your initial efforts and identifying how to adjust your SPI Programme to incorporate new knowledge and meet changing needs. Thus, if you already have an SPI Programme, this *Guidance* provides a benchmark against which to assess your Programme and identify valuable improvements.

Figure 1 (on page 12) illustrates the seven steps in the process: (1) establish the SPI Team; (2) identify the key issues of concern; (3) define relevant outcome indicator(s) and related metrics; (4) define activities indicator(s) and related metrics; (5) collect the data and report indicator results; (6) act on findings from SPIs; and (7) evaluate and refine SPIs. As indicated in Figure 1, it is an iterative process which allows you to develop and maintain an effective and relevant SPI Programme.

The effort required to complete these steps and implement an SPI Programme will vary depending on a number of factors specific to your enterprise, including the nature of the chemical hazards, the roles within your enterprise for managing chemical safety, the availability of data and the degree of precision required for the indicators to be useful. The effort may be fairly straightforward for smaller industrial enterprises with limited issues. For more complex circumstances (*e.g.*, a large multi-faceted enterprise with several sites), more elaborate and resource-intensive techniques may be required.

It is presumed that your enterprise has put policies, procedures and practices in place to help manage chemical safety including, for example, a safety management system. As further explained in Step Two, the focus in developing an SPI Programme should be on identifying the key policies, procedures and practices to regularly assess in order to be confident of continuing safety. It is important to set priorities, recognising that it is not possible to continually measure everything of interest. To do this, you may consider: what are the hazards of greatest concern; where the greatest assurance is needed (*e.g.*, where changes are being made); what data are available and where are the gaps; where problems have occurred in the past; and where there are concerns regarding the effectiveness of existing "barriers" to a hazard.

To support Steps Three and Four, lists of possible outcome and activities indicators, along with related targets, are set out in Chapter 3. Working through the steps should help you identify which subjects identified in Chapter 3 are most relevant to your enterprise, how to choose, adapt and create indicators in order that the SPI Programme fits your particular circumstances, and how to develop metrics to measure the indicators.

Step Seven describes how an SPI Programme should be reviewed periodically so that it can be revised based on changes in your enterprise over time, as well as the results and experience gained in using the SPIs.

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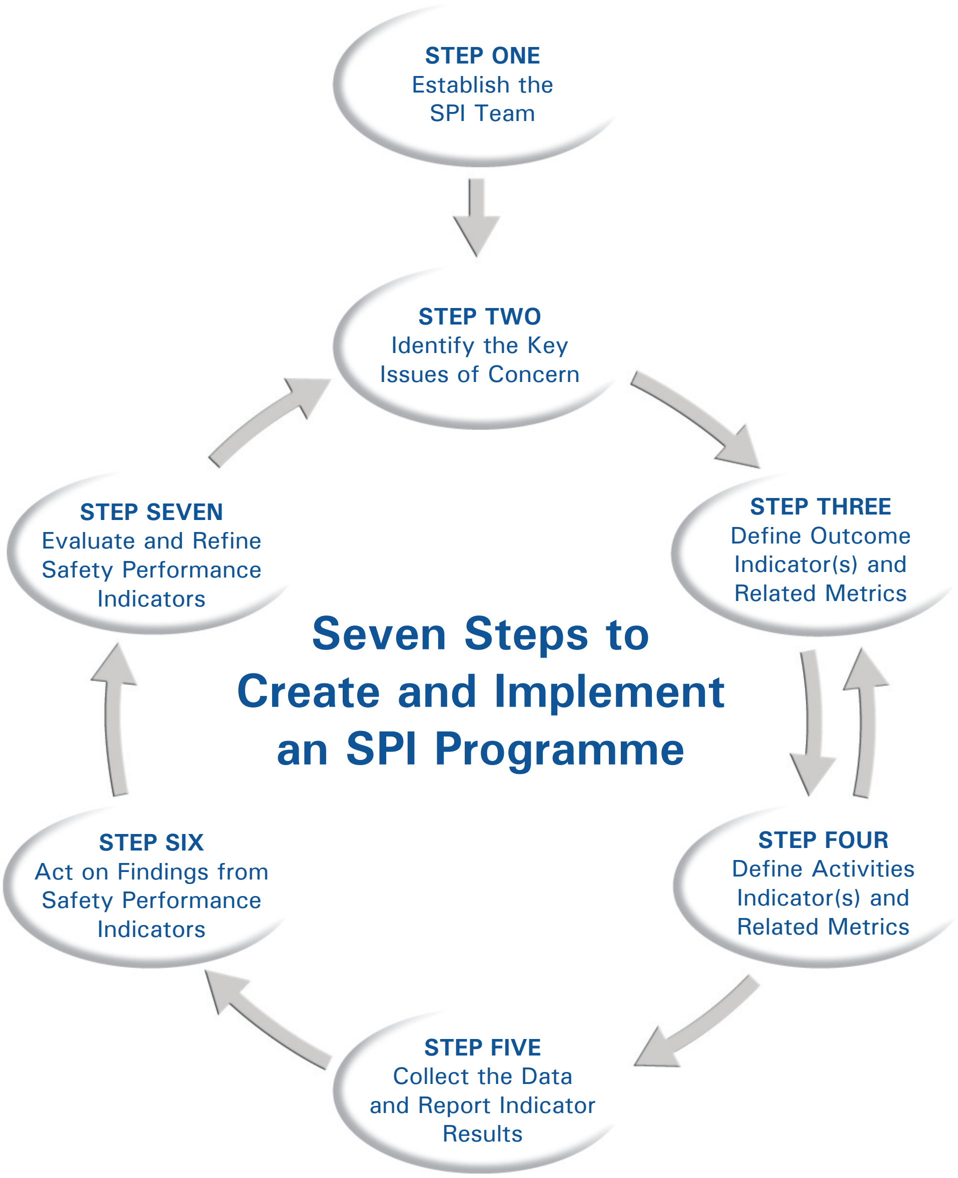
[12] This process is based on the approach set out in the document developed by the Health and Safety Executive (UK) and Chemical Industries Association, (2006) *Developing Process Safety Indicators: A step-by-step guide for chemical and major hazard industries*, HGN 254, ISBN 0717661806. This "Step-by-Step Guide" guide was prepared following a pilot program with a number of hazardous installations in the UK, taking into account the first version of the *OECD Guidance for Safety Performance Indicators* published in 2003.

Three examples are used throughout this Chapter to further explain each step. Each example addresses a different type of enterprise. They are color-coded and labeled to help you follow the scenarios that are most helpful to you and include: a chemical manufacturer, a small specialty chemical formulator and a warehouse operation.

These fictitious examples do not attempt to represent complete solutions or best practices; rather, they are intended to provide simple examples to help explain the concepts discussed in this Chapter.

FIGURE 1



Example Scenarios - Background

CHEMICAL MANUFACTURER

1

SCENARIO 1: A recent trade association meeting discussed the use of SPIs as a new approach for addressing safety issues. A chemical manufacturer who attended the meeting was aware of several safety issues within its facilities that had been difficult to resolve. The manufacturer decided to undertake an SPI Programme to help better understand the root causes underlying these issues and develop indicators to provide early warnings of failing safety practices before these failures resulted in incidents.

SMALL SPECIALTY CHEMICAL FORMULATOR

2

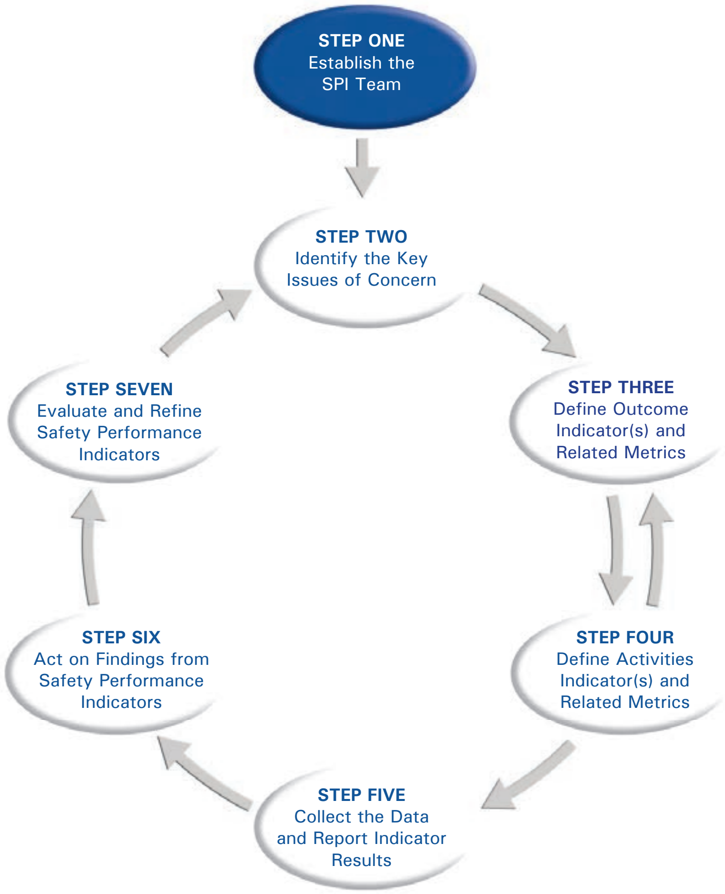
SCENARIO 2: A small enterprise that formulates small batch specialty chemicals has historically experienced a significant number of near-misses and loss of containment incidents. Although few incidents resulted in personal injury, significant time was spent investigating the incidents and correcting procedures. As a result, the enterprise was less profitable. During a conversation with a former colleague, the enterprise's president learned of SPIs. The president saw this as an opportunity to improve safety, as well as to help address the enterprise's liability, reduce costs associated with incidents and improve its profitability. The president directed the safety manager to explore the implementation of an SPI Programme.

WAREHOUSE OPERATION

3

SCENARIO 3: A local warehouse owner contracts warehouse space for companies to manage excess inventory or to manage local delivery logistics. Chemical hazards associated with warehousing operations were highlighted at a recent industry association meeting. Although the owner tried to comply with applicable laws and regulations, the discussions raised concerns about how well the warehouse was keeping track of the materials being stored, the areas where they were being stored and the potential risks. The owner decided to use SPIs to help assess and monitor the safety of the warehouse operation.

STEP ONE: ESTABLISH THE SPI TEAM



Identify SPI leader(s): The starting point for establishing an SPI Programme is to identify leader(s) to initiate the effort, promote and co-ordinate the introduction of the SPI Programme, ensure effective communication and generally oversee the Programme's implementation. This could consist of a single person or group of people, depending on the size and complexity of the enterprise and availability of resources.

Involve management: It is critical to the success of the effort that senior managers of the enterprise who are in a position to take action are committed to the SPI Programme. To accomplish this, the SPI leadership team should seek input from senior management on the objectives and expectations of the SPI Programme. Following these initial discussions, senior managers should be kept informed on a regular basis of progress made and should be given opportunities to help steer the effort. Management should receive the results of the SPI Programme and will be expected to take the actions needed for chemical safety.

Involve staff including technical experts and employees with hands-on knowledge: It is important that the indicators reflect a detailed understanding of the hazards associated with an enterprise, the safety measures in place and the types of data collected on a formal or informal basis to monitor safety. Therefore, the SPI team should include and/or have access to safety managers, engineers, operators and other members of staff with an understanding of relevant operations and safety-related policies, procedures and practices (*e.g.*, the enterprise safety management system). It is also important that the concept of the SPI Programme be communicated to other potentially affected staff members, from the outset, in a manner that is consistent with the corporate culture. This can help to address any concerns and help to ensure that the results of the Programme are accepted and utilised appropriately.

Commit resources: There needs to be sufficient support and resources to develop and implement the SPI Programme. To determine the appropriate level of investment, it may be necessary for the SPI team to start by developing a business case for the SPI Programme, including an evaluation of implementation costs and business benefits (such as improved efficiency, reduction in the costs associated with accidents and improved asset management).

Establish a timetable: Finally, the SPI team should set a reasonable timetable, including milestones to ensure adequate progress in developing the SPI Programme. Depending on the particular indicators selected, it may be useful to have a test period prior to full implementation. Timetables for reporting SPI results and for periodically assessing the SPI Programme are addressed in Steps Five and Seven.

Example Scenarios - Step One

CHEMICAL MANUFACTURER

1

SCENARIO 1: As a first step, the enterprise set-up an SPI team to make recommendations for an SPI Programme. Initially, the SPI team consisted of the plant manager and the plant's health and safety officer. Eventually, the team was expanded to include other personnel with specific experience in the relevant process areas, management systems and safety issues to be addressed. The SPI team was allocated a budget and was given a timetable for reporting back to management. The decision to develop an SPI Programme was communicated to employees through the Safety Committee, and opportunities were provided to ask questions and provide feedback.

SMALL SPECIALTY CHEMICAL FORMULATOR

2

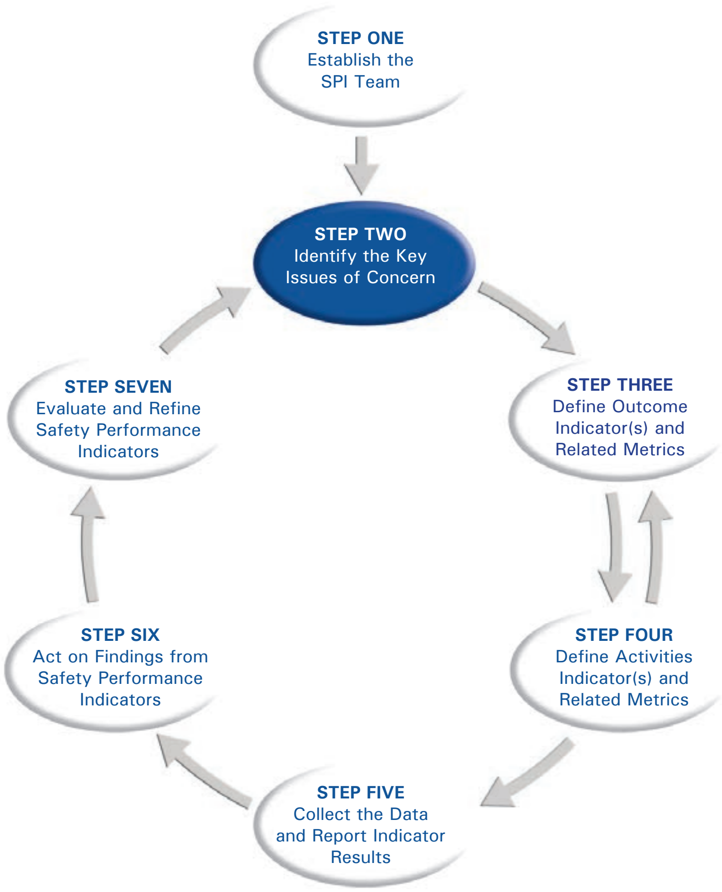
SCENARIO 2: The enterprise assigned the health and safety manager and one of its most experienced shift foreman to explore the use of SPIs. This team would develop a proposed SPI Programme for review and approval by the company president. The company president stated that the team should consult with other relevant employees and that the proposals should include estimates of the cost of implementing the Programme as well as estimated savings associated with the reduction in lost-time incidents.

WAREHOUSE OPERATION

3

SCENARIO 3: The warehouse owner asked the day-shift manager to work with him to develop an SPI Programme.

STEP TWO: IDENTIFY THE KEY ISSUES OF CONCERN



Clarify the scope of your SPI Programme: Once the SPI team and other arrangements are in place, the next step is to identify the subjects to be addressed by the SPI Programme. Each enterprise will have different hazards and risks, management systems, activities, monitoring programmes and corporate culture. Therefore, each enterprise will need to decide on its own priorities, in order to choose the appropriate indicators and the way they will be measured.

In order to identify the issues that would benefit most from SPIs, it is necessary to consider which policies, procedures and practices (including human resources and technical installations) could fail and result in a serious chemical incident.

One way to begin is by looking at each process in your enterprise and identifying critical hazards. Analysing relevant processes on a step-by-step basis will help to identify potential hazards. For each of the hazards, you can review the related safety policies, procedures and practices that are in place, and then identify those that are most critical to risk control or most vulnerable to deterioration over time.

As an alternative to this process-level focus, you could start by identifying all safety policies, procedures and practices in place at a site level. You could then consider the potential consequences of failure of each of these policies, procedures and practices, and the likelihood that multiple failures could align and result in a serious accident taking into account the possibility that an accident can affect nearby facilities (domino effects).

Regardless of how you choose to approach this step, your most recent process hazard analysis (PHA) can provide vital information to help you get started. The PHA could include, for example, a hazard and operability (HAZOP) study, a what if/checklist analysis, a layers of protection analysis, a major hazards analysis or a quantitative risk analysis.

Set priorities: After identifying issues of concern, it may be necessary to limit the scope of your SPI Programme to focus on a manageable number of indicators, gain experience and keep within resource constraints. Enterprises often increase the number of indicators and the scope of their Programme as they gain more experience with SPIs.

To determine priorities, it may be helpful to answer the following questions:

- Are there likely scenarios (*i.e.*, accident trajectories involving concurrent breakdowns) where failure of an identified safety policy, procedure or practice would lead to an incident? Of the safety policies, procedures or practices involved in these scenarios, which are the most critical for preventing a serious accident?
- Will monitoring a particular safety policy, procedure or practice help you identify and prevent root or contributing cause(s) of a potential incident? Are there more fundamental safety policies, procedures or practices that should be monitored?
- What failures associated with the incident scenarios identified above can your organisation prevent? What aspects of an incident scenario can your organisation control, and what information would you need to exercise effective control?

You may decide that your Programme should focus on a single process or hazard where there are few redundant safety systems in place or, instead, that it should focus on site-level or enterprise-level policies, procedures or practices that encompass multiple hazardous processes. Usually, an SPI Programme will focus on issues relating to both process-specific as well as site-level or enterprise-level aspects. Figure 2 on page 19 presents an approach for organising your review of possible issues of concern and setting priorities.

Avoid pitfalls: During this Step, many enterprises fall into the trap of asking what they *can* measure instead of what they *should* measure. This could result in identifying subjects that are the most obvious and will lend themselves to indicators that are easy to measure rather than indicators that are most valuable for safety purposes. Therefore, at this Step of the process, it is important to focus on what to monitor and avoid discussions of how to monitor. Questions concerning how to measure performance should be addressed after you have completed Step Two and have moved on to Steps Three and Four.

Example Scenarios - Step Two

CHEMICAL MANUFACTURER

1

SCENARIO 1: The SPI team at the chemical manufacturer first focused on reviewing incident reports. They looked at root and contributing causes as a way to identify key safety issues of concern. This review indicated that several incidents were related to recent changes in equipment, processes and/or personnel, suggesting that SPIs could be used to assess the facility's management of change (MOC) process. Other incidents were related to specific process areas and personnel issues. The team agreed to develop SPIs in each of these areas. They also recognised that other key issues included contractor safety and on-site preparedness planning. For simplicity, the remainder of this example will focus on efforts to develop SPIs for the MOC process.

To assist with the development of SPIs for the MOC process, the plant manager decided to add three additional people to the SPI team: the MOC process co-ordinator; a process engineer with experience in both initiating and reviewing change requests; and a shift manager with experience in implementing changes. The expanded team agreed that the initial purpose of the MOC-focused SPI effort would be to develop and implement indicators that would help find the root of the problem with the MOC process so it could be fixed. The indicators could continue to be used to monitor the MOC process to make sure that it continues to work effectively to control process risks.

SMALL SPECIALTY CHEMICAL FORMULATOR

2

SCENARIO 2: The SPI team started by reviewing its most recent HAZOP and considering possible accident scenarios. They realised that safety is an issue when there are new formulations or significant changes to existing formulations. Based on this analysis, the team concluded that their priority for indicators should be operator competence, process engineering or implementation of safety-related procedures. The team decided to consider the use of SPIs for each of these areas. For simplicity, the remainder of this example will focus on efforts to develop SPIs for safety-related procedures.

WAREHOUSE OPERATION

3

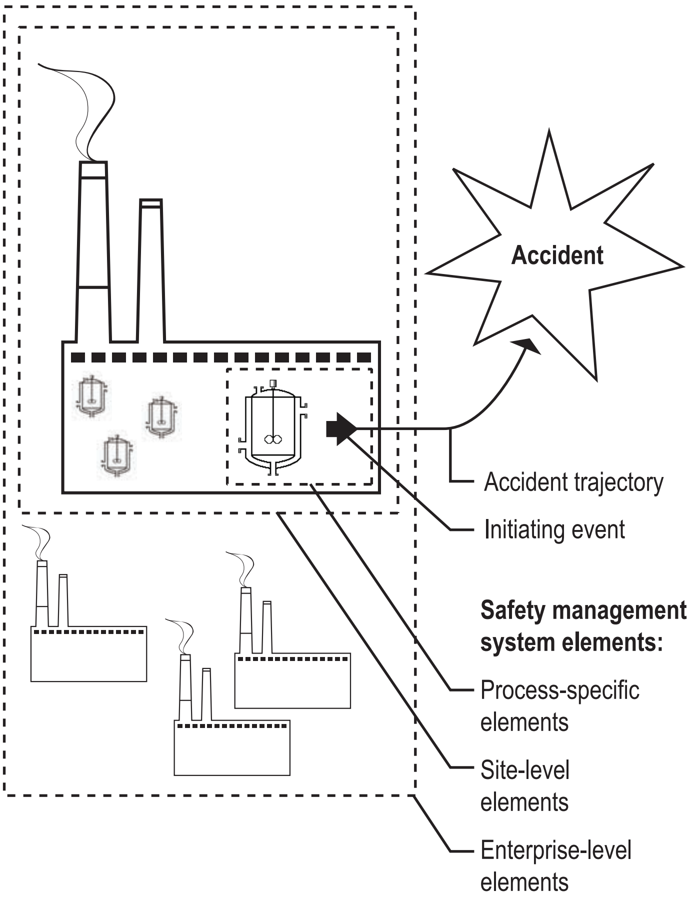
SCENARIO 3: Working with a clerk from the invoicing department, the owner and shift manager identified all of the companies currently storing materials in the facility. They collected information, including material safety data sheets (MSDSs) on all of the materials being stored as well as storage locations. The shift operator conducted a floor check to verify the storage information and to look for situations that could pose a potential hazard, including the storage of incompatible materials in the same area, degraded packaging, etc. The shift manager identified some products for which the warehouse did not have a record, some products stored in areas other than their designated areas, and a few instances where packaging had been degraded.

Upon review of the MSDSs and other safety information, the owner and shift manager determined that there was no immediate danger, but the lack of inventory control suggested that there was a potential for a chemical accident. Based on this, the owner and shift manager decided to focus on developing SPIs related to internal communication of safety information, hazard identification and risk assessment and hazardous materials storage. For simplicity, the remainder of this example will focus on efforts to develop SPIs in the area of hazard identification and risk assessment.

*For some enterprises, deciding on the scope of an SPI Programme may be complicated by the number of process hazards within their installations and the safety policies, procedures and practices in place to address them. It may not be possible to measure all of these policies, procedures and practices, and, therefore, it is necessary to set priorities. Figure 2 represents an approach for visualising and organising hazards and safety measures to help decide on priorities for SPIs. As this Figure shows, one way to get started is to identify each major hazard within an installation, describe possible accident scenarios or "trajectories," identify the safety measures that provide barriers or layers of protection between initiating events and chemical accidents, and describe the level at which the measures apply (*i.e., *process-specific, site-level or enterprise-level). This information should be available in your PHA or should be addressed in your safety audit.*

FIGURE 2

Scoping an SPI Programme by Visualising Accident Trajectories



How to Read this Diagram

The diagram to the left shows an enterprise with multiple hazardous installations (represented by factory buildings), each with multiple hazardous processes (represented by the reactor vessels).

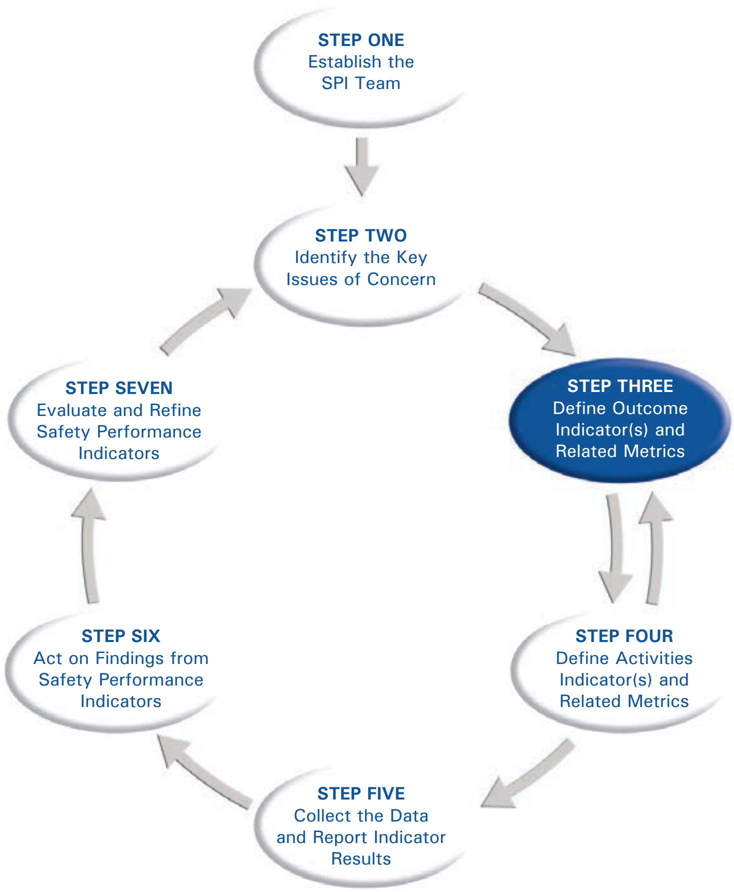
For any hazardous process, there could be several safety measures that act as barriers or layers of protection between an initiating event and a chemical accident. These measures can be:

- Process-specific – for example, design of valves to control inter-connection hazards, maintenance of containment systems, etc.
- Site-level – for example, review of informal work practices and attention to alarm overload, co-ordination with local emergency responders, etc.
- Enterprise-level – for example, communication among installations of incident investigations, investment in safety training and personnel.

Breakdowns in safety systems can align to form a complete accident trajectory, creating the possibility that an initiating event can result in an accident.

When deciding on the scope of your SPI Programme, you should identify the major hazards within the installation, as well as the related safety policies, procedures and practices, and the level at which these apply. You can then identify indicators that will monitor at least one barrier or layer of protection for each major hazard. This can include process-specific SPIs for the most significant hazards and site- or enterprise-level SPIs that encompass multiple hazardous processes.

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



Steps Three and Four describe how to identify the appropriate *outcome* and *activities indicators*, respectively, for the key issues of concern identified in Step Two. The combination of outcome and activities indicators provides two perspectives on whether a safety-related policy, procedure and/or practice is working as intended. (See page 5 for definitions of the terms "outcome indicators" and "activities indicators.")

For clarity, this *Guidance* describes Steps Three and Four sequentially. Typically, however, SPI teams will define outcome and activities indicators (*i.e.*, conduct Steps Three and Four) for one issue of concern at a time, rather than identify outcome indicators (Step Three) for all issues before moving on to Step Four. Defining outcome and activities indicators is usually an iterative process, and focusing on one issue of concern at a time can be a more effective use of available resources.

An effective safety performance indicator conveys clear results regarding safety performance to those with the responsibility and authority to act on matters related to chemical safety. Both outcome and activities indicators consist of two key components:

- A definition, which should clearly state what is being measured in terms that are meaningful to the intended audience;
- A metric, which defines the unit of measurement or how the indicator is being measured. This should be precise enough to highlight trends in safety over time and/or highlight deviations from safety expectations that require action.

a. Definition of Relevant Outcome Indicator(s)

Outcome indicators are designed to collect data and provide results to help you answer the broad question of whether the issue of concern (*i.e.*, the safety policy, procedure and practice that is being monitored) is achieving the desired results. Thus, an outcome indicator can help measure the extent to which a targeted safety policy, procedure or practice is successful.

Once you decide on the key issues of concern, you need to consider which outcome indicator(s) may be relevant. When choosing *outcome indicators*, it is useful to ask "what would success look like?" and "can this successful outcome be detected?" The answer to these questions can help define in specific terms what a safety policy, procedure or practice is intended to achieve or, in the terminology of this *Guidance*, the *target* of the policy, procedure or practice.

After answering the question, "what would success look like?" you can review Chapter 3 (or the summary in Annex II) to identify the *target* or *targets* that most closely match your response. This will lead you to the sub-sections of Chapter 3 where you can identify useful outcome and activities indicators and consider how to adapt these to your circumstances, or you can create indicators that are tailored to your specific needs.

For example, if you have identified operator competence as a critical issue to be monitored using an SPI, you might define success in this area as, "operators handle hazardous materials safely." Looking at Chapter 3, the target for sub-section A.5a ("Management of Human Resources" under "Personnel") is "appropriate staffing levels – with employees (including contractors and others) who are competent, trained and fit for their jobs – which can ensure safe handling of all hazardous substances and other hazards at the enterprise."

After deciding that this target reflects your concerns, you can then review the possible indicators presented in sub-section A.5a. For example, you might decide that training is a concern, and identify "(ii) extent employees (including contractors and others) pass periodic assessments of competence" as a useful outcome indicator.

b. Metrics for Outcome Indicator(s)

Once you have identified the outcome indicator(s) of interest, you then need to decide on the appropriate "metrics." The metric is the approach by which safety data will be compiled and reported for use in SPIs. Safety data provide the raw material for SPIs; metrics define the way in which data are used. Sound data are necessary for useful SPIs, but the ways in which the data are used, as defined by the metrics, determine whether SPIs provide the insights necessary to assess and act on safety performance issues.

You will need to consider what metric is appropriate for <u>each</u> indicator in your SPI Programme. Types of metrics useful for safety performance indicators are described in the text box on page 25. Detailed information regarding measurement methods, data types and applicable metrics is presented in Annex I.

To help you focus your choice of metrics for outcome indicators, consider the following questions:

- *Who will use the indicator to make decisions?* When defining a metric, consider who will use the SPI results, and make sure that the metric will highlight the results necessary for decision-making in a format that will meet the end-users' needs. Users of SPI results could include: senior management who are responsible for organisational risk management and allocation of resources for safety management; safety officers with responsibility for implementing safety management systems; other employees who have responsibilities related to process safety or for reporting deficiencies; and/or members of the enterprise's Safety Committee.

- *How will the indicator be used to make decisions?* SPIs should be useful for improving safety policies, procedures and practices. It is not enough to collect data and report results; if the results are not used, it will not meet its intended goal – improved safety. Therefore, it is important to be clear regarding how the SPI results be will used to make decisions and then to define the metric in terms that will support the SPI's intended function. Senior managers may be more interested in seeing trends, or changes in safety performance over time, to help them assess the overall status of safety management systems and review staffing and budget priorities. Safety managers or members of a Safety Committee may be more interested in identifying deviations from safety expectations requiring immediate or near-term action.

- *How can the outcome be measured?* How an outcome can be measured will depend on a number of factors, including: what is being measured (*e.g.*, people, organisational systems, technical installations, physical state); data that are currently available or can be collected; and resources available for collecting the data and reporting SPI results. The choice of data collection methods and data types will depend, in part, on what is being measured.

- *What data is already collected by the enterprise?* When developing metrics, it is important to look at data that are already collected by the enterprise (*e.g.*, from existing safety-focused or business-focused activities) and ask whether this data might be useful for an SPI. When existing data can be used, developing a new indicator will be simplified. As a general rule, SPI metrics should use existing safety data to the extent that it meets the needs of the indicator and it produces valid results (*i.e.*, results that represent what it is intended to measure). Sometimes, you might think that a certain outcome indicator cannot be measured. However, it is often useful to challenge yourself to think about how existing safety data could be used in new ways to provide data for a desired indicator. This can result in innovative uses of existing data and more efficient use of safety management resources.

When existing data will not be available or reliable enough to meet the needs of an indicator, new data will be required. When this is the case, using data collection and reporting approaches that align with the enterprise's "measurement culture" can help simplify the introduction of an SPI Programme. Thus, in developing metrics, it is important to review the "measurement culture" of your enterprise – the ways in which the enterprise collects and uses data to evaluate its performance, including safety or business performance – and align the SPI Programme with this culture. For example, if the enterprise regularly surveys its employees, additional questions could be added to the survey to collect data for a personnel-focused SPI. If an enterprise produces quarterly management reports, data for use in SPIs could be collected at the same frequency and added to management reports.

Some additional considerations when developing metrics include:

- When evaluating appropriate metrics, it is sometimes necessary to adjust the definition of the indicator based on practical decisions regarding what data can be reasonably collected to support the indicator.

- In defining indicators and associated metrics, it is valuable to consider the type and quantity of information that is likely to be produced. Metrics should be designed such that the SPI results do not overwhelm the user but, rather, provide just enough information to provide necessary insights.

- SPI metrics should be as transparent as possible. Overly complex equations and scoring systems can mask safety trends and defeat the purpose of the indicator.

- When considering alternative metrics for an indicator, focus on metrics that are likely to show change when change occurs. For example, for an indicator such as, "extent ideas and suggestions from employees on safety within the enterprise are implemented," a binary "yes/no" metric (*i.e.*, ideas and suggestions "are" or "are not" implemented) would not show change resulting from efforts to improve two-way communication of safety information. A trended metric based on sums (*e.g.*, number of ideas and suggestions from employees on safety within the enterprise are implemented) would be more likely to vary with improvements and/or deterioration in two-way communication over time.

Annex I provides information to help identify the most appropriate metric for your indicators, taking into account the questions and considerations described above. Note that the answers to the questions will generally be different for different indicators. Therefore, SPI Programmes generally include different types of metrics (*i.e.*, it is unlikely that the same type of metric will be used for all your SPIs).

Example Scenarios - Step Three

CHEMICAL MANUFACTURER

1

SCENARIO 1: In response to the question, "what would success look like?" the SPI team agreed that a successful MOC process would ensure that changes in operations and other activities do not increase the risk of a chemical accident at the facility. The team referred to sub-section B.4 ("Management of Change") of Chapter 3 and its target: "change is managed to ensure that it does not increase, or create, risks." They then identified "number of incidents resulting from failure to manage change appropriately . . ." as the best outcome indicator for their needs. The team noted that investigations were conducted for the types of incidents relevant to their work and concluded that incident reports would be used as the data source for this indicator.

In considering the type of metric to use, the shift manager noted that, in his experience, the number of incidents generally increased with the number of changes introduced during a given period. The SPI management team agreed that this was an important factor, and decided to index the results on number of changes. The resulting outcome indicator would be reported as "number of incidents attributed to management of change as a root or intermediate cause per number of implemented changes."

SMALL SPECIALTY CHEMICAL FORMULATOR

2

SCENARIO 2: In response to the question, "what would success look like?" the SPI team agreed that a successful process for implementing procedures would result in a set of procedures that ensure that employees carry out their tasks safely. As a result, the team referred to sub-section B.3 ("Procedures") of Chapter 3 which has the target: "employees carry out their tasks safely and under conditions necessary to satisfy the design intent of the installation." In reviewing the possible outcome indicators, the team identified "extent incidents are attributed to procedures (due to, *e.g.*, procedures lacking, procedures inadequate and/or procedures not followed)" as one that addresses their needs.

The team noted that the percentage of incidents attributed to issues related to procedures might remain high even if the enterprise was successful in decreasing overall incidents (*i.e.*, if total incidents and number of incidents attributable to procedures decreased proportionally). Therefore, in considering possible metrics, they chose to track raw tallies of incidents attributed to issues related to procedures.

WAREHOUSE OPERATION

3

SCENARIO 3: In response to the question, "what would success look like?" the owner and shift manager agreed that a successful hazard identification and risk assessment process would provide enough information so the warehouse could store materials safely and reduce risk. The owner and shift manager agreed that sub-section B.1 ("Hazard Identification and Risk Assessment") of Chapter 3 had a relevant target: "hazards are properly identified and risks are adequately assessed." They then identified "extent hazard analyses and risk assessments are used to develop proper policies, procedures and practices to address risks" as an appropriate outcome indicator for their needs.

The owner and shift manager agreed to hire a local university professor who provides consulting services to small and medium-sized enterprises to conduct a baseline hazard analysis and risk assessment for the warehouse and identify the critical policies, procedures and practices that should account for hazard and risk information. They decided that they would periodically review each critical policy, procedure and practice, and use a 5-point Likert scale to measure the extent to which they accounted for hazard and risk information. A score of "5" would be used to indicate that a policy, procedure or practice accounted for hazard and risk to a "high degree" and a "1" would mean that a policy, procedure or practice accounted for hazard and risk "not at all," with appropriate gradations in between.

TYPES OF METRICS USEFUL FOR SAFETY PERFORMANCE INDICATORS

The following types of metrics are useful for both outcome and activities indictors. These descriptions are intended to provide a starting point for considering alternative metrics for an individual indicator. These are not exclusive; there are other types of metrics that may be more appropriate for specific circumstances. See Annex I for additional information about metric types.

Descriptive Metrics: A descriptive metric illustrates a condition measured at a certain point in time. Descriptive metrics can be used by themselves but, more typically for SPIs, they serve as the basis for threshold or trended metrics (see below). Descriptive metrics include:

- Simple sums – Simple sums are raw tallies of numbers (*e.g.*, number of employees who passed a training assessment exam, number of incidents).
- Percentages – Percentages are simple sums divided by totals or normalised on a population (*e.g.*, percentage of employees who passed a training assessment exam, percentage of incidents attributed to a poor working environment as a root or intermediate cause).
- Composite – Composite metrics are descriptive metrics that involve more complex calculations using raw data or a combination of data types (*e.g.*, a simple sum can be presented in two categories, such as number of operators vs. number of safety managers who passed a training assessment exam).

Threshold Metrics: A threshold metric compares data developed using a descriptive metric to one or more specified "thresholds" or tolerances. The thresholds/tolerances are designed to highlight the need for action to address a critical issue. Threshold metrics include:

- Single threshold – A single threshold metric compares results developed using a descriptive metric to a single tolerance level. When the tolerance level is exceeded, this indicates that a specified action should be taken.
- Multiple threshold – A multiple threshold metric highlights the need for different types of actions based on different tolerance levels. For example, a first tolerance level could indicate the need for a safety review; whereas, a second (higher) level could indicate the need to also take specific actions.

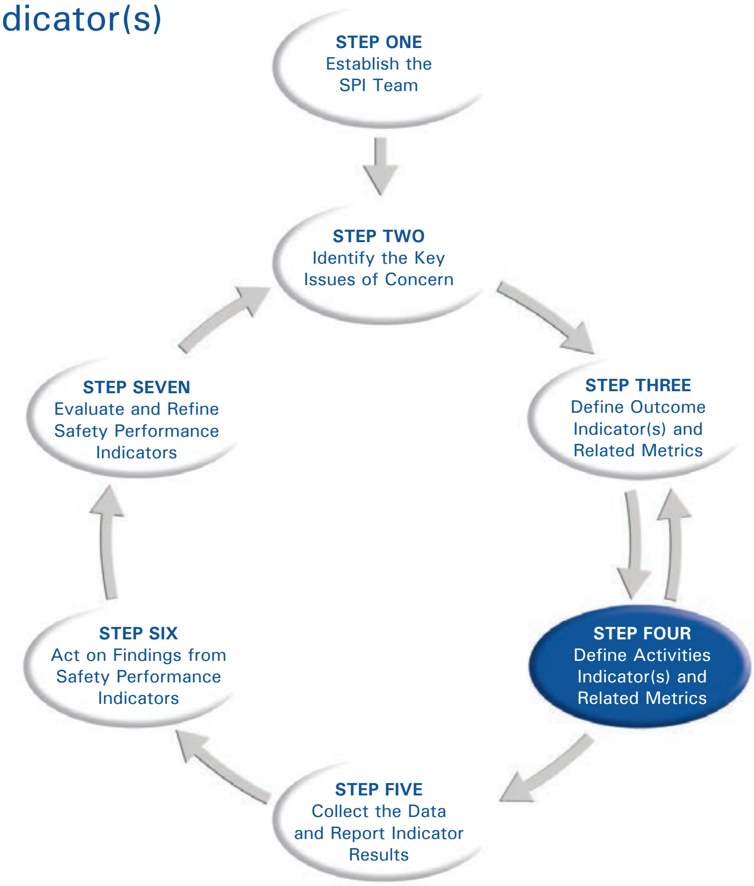
Trended Metrics: A trended metric compiles data from a descriptive metric and shows the change in the descriptive metric value over time. Trended metrics can present results in raw form (*e.g.*, bar chart showing annual number of near-misses), as absolute or relative change (*e.g.*, difference in annual number of near-misses over time) or rate of change (*e.g.*, percentage decrease in number of near-misses from previous year). Trends can include simple changes in values over time or can index the data to capture the influence of outside factors to isolate safety performance, for example:

- Simple trend – Simple trends present the output from descriptive metrics at different points in time to show changes in safety results over time. Simple trends are not manipulated to account for outside influences on the safety result.
- Indexed on a variable – To account for outside factors, metrics can be indexed on one or more variables that effect, but are not affected by, safety. For example, a sharp decrease in production could be solely responsible for fewer incidents. To isolate the influence of safety performance, an indicator of incident frequency could be indexed on production rates.
- Indexed on a data set – Metrics can also be indexed on a common data set. For example, where there is employee turn-over, changes in attitude could reflect changes in the employee population. To isolate the influence of safety-related activities on employee attitudes, an unchanging set of employees could be monitored over time (*i.e.*, a longitudinal survey).

Nested Metrics: Nested metrics are two or more of the above types of metrics used to present the same safety-related data for different purposes. For example, one metric may provide point-in-time results for comparison with tolerances (*e.g.*, to highlight specific deviations from safety expectations) and another metric may compile information in a condensed format for senior managers (*e.g.*, number of deviations from expectations within a given period).

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

a. Definition of Relevant Activities Indicator(s)



The next step in developing your SPI Programme is to choose *activities indicators* to monitor the key issues of concern (or key safety-related policies, procedures and practices) identified in Step Two.

Activities indicators relate to your identified outcome indicators and help to measure whether critical safety policies, procedures and practices are in place to achieve the desired outcomes. Whereas outcome indicators are designed to provide answers about whether you have achieved a safety outcome, activities indicators are designed to provide information about why or why not the outcome was achieved. Therefore, well-designed activities indicators provide insights needed to correct policies, procedures and practices when the desired outcome is not being achieved. (See page 5 for the definition of "activities indicators.")

To identify the appropriate activities indicator(s), look at the activities that are most critical to achieving the intended target and are most closely related to the chosen outcome indicators. In deciding this, you might consider, for example:

- which activities must always be performed correctly (zero tolerance for error);
- which activities are most vulnerable to deterioration over time; and
- which activities are performed most frequently.

As noted above, Chapter 3 provides a menu of possible outcome and activities indicators organised by subject, with associated targets. You can refer to the same sub-sections of Chapter 3 that you used to define your outcome indicators, in order to identify the activities indicators that best fit your situation, and then adapt the indicators to your needs. You can also choose to develop your own activities indicators that are tailored to your specific circumstances.

For example, if you think that the quality of training is a key issue, you might identify "Management of Human Resources" (sub-section A.5a) as a focus, with the target "there are appropriate staffing levels – with employees (including contractors and others) who are competent, trained and fit for their jobs – which can ensure safe handling of all hazardous substances and other hazards at the enterprise." You may then decide that a valuable outcome indicator would be "extent employees (including contractors and others) pass periodic assessments of competence." Looking under the "activities indicators" in A.5a to identify possible indicators that would measure quality of training, you might choose two indicators: "(xiii) are there training programmes for all categories of employees" and "(xiv) are there mechanisms to ensure that the scope, content and quality of the training programmes are adequate." You can then focus on certain specific subpoints associated with these two activities indicators. For example, you may decide that regular assessment of training programmes is critical and select "is there a formal checking of training results by an independent resource." You might decide to supplement this with an indicator that is very specific to your training activities.

When reviewing and evaluating alternative indicators, it is useful to ask whether a change in the underlying activity is likely to create a change in the outcome. If not, the activity may be too far removed from the outcome to be useful as an activities indicator. For example, if you decide that if "formal checking of training results by an independent resource" was to deteriorate, there would be little evidence of this in workforce performance, you may wish to consider activities that more directly affect the outcome. Your particular circumstance might suggest that a better indicator would be, "do programmes include topics for all the skills needed for the job?"

b. Metrics for Activities Indicator(s)

As in Step Three, once you have defined your activities indicators, the next step is deciding on the appropriate metrics, or measurement approach. To help establish metrics for each activities indicator you have chosen, you might consider the following questions:

- *Who will use the indicator and how will the indicator be used to make decisions?* Consider who will use the SPI results and make sure that the metric will highlight the results necessary for decision-making in a format that will meet the end-user's needs.
- *How can the activity be measured?* Consider what is being measured, data that are currently available or can be collected, alternative collection methods and resources available for collecting the data and reporting results.

When designing the specific metrics, consider opportunities to use existing data. If such data are not available, then you should consider how to collect and report data using methods that are consistent with your enterprise's measurement culture. It is also useful to take into account:

- the type and quantity of information that is likely to be produced;
- the need to produce SPI results that provide insights into potential safety issues and help explain safety outcomes (*i.e.*, as measured by the associated outcome indicator) without overwhelming the user; and
- whether a change in the activity will be reflected in the activities indicator since metrics should show change when change occurs.

Additional, more detailed guidance on metrics is provided in Annex I.

Example Scenarios - Step Four

CHEMICAL MANUFACTURER

1

SCENARIO 1: The SPI team identified the activities associated with the MOC process and considered which of these activities were most likely to influence the effectiveness of controlling risks resulting from change. As part of this assessment, the team interviewed personnel responsible for designing changes and personnel responsible for reviewing and approving changes.

Based on this, the team concluded that the quality of change requests was a key issue. Reviewers complained that many change requests did not address critical requirements for review and were rejected, sometimes more than once. They stated that the need to review requests multiple times created a larger than necessary workload, and they had less time to spend reviewing the most critical requests. Those making the requests complained that they received inadequate feedback from the reviewers and were uncertain about the additional information that was required to meet their needs.

The SPI team decided that, although procedures were in place and documented for the MOC process, additional training was needed. Therefore, the plant manager directed training personnel to implement new training in how to analyse and document change requests. It was expected that improvements in these areas would result in a more effective MOC process, free up reviewers to focus on critical requests, and result in fewer incidents from changes.

To track the effectiveness of this approach, the SPI team defined the following activities indicators and related metrics in light of their particular situation:

- "Percentage of employees submitting change requests that have received MOC training," where the metric would be defined as the number of trained employees submitting change requests divided by total number of employees submitting change requests as measured at the time of SPI reporting.
- "Number of times that the same change has to be resubmitted for review prior to approval," where raw tallies of change requests would be compiled at the end of each SPI reporting period by number of times resubmitted (*i.e.*, number of requests resubmitted once, number resubmitted twice), and portrayed using a bar chart.
- "Number of change requests reviewed per reviewer," where the number of change requests reviewed since the last SPI report would be tallied and divided by the number of reviewers.

SMALL SPECIALTY CHEMICAL FORMULATOR

2

SCENARIO 2: The team reviewed the possible parts of the procedures process that could result in safety issues and incidents. The incident investigations suggested that "new or changed formulations requiring additional or updated procedures" was a key issue. Therefore, the team defined the following activities indicators and related metrics adapting the suggestions presented in sub-section B.3 of the *Guidance*:

- "Is relevant information passed on from one stage to another and incorporated in procedures when developing or introducing new products, processes or equipment?" This would be measured by asking the degree to which each new or updated procedure incorporated safety information, using a three-point scale (*i.e.*, "complete," "somewhat complete" or "incomplete") based on periodic reviews.
- "Are users informed about changes in the procedures?" with relevant users periodically asked whether they were aware of specific changes in procedures. Their responses would be compiled by identifying the percentage of users aware of procedures relative to total users.
- "Are new procedures being implemented?" where periodic spot checks would be conducted to observe whether procedures were being followed. The percentage of spot checks where procedures were being followed would be periodically calculated and reported.

WAREHOUSE OPERATION

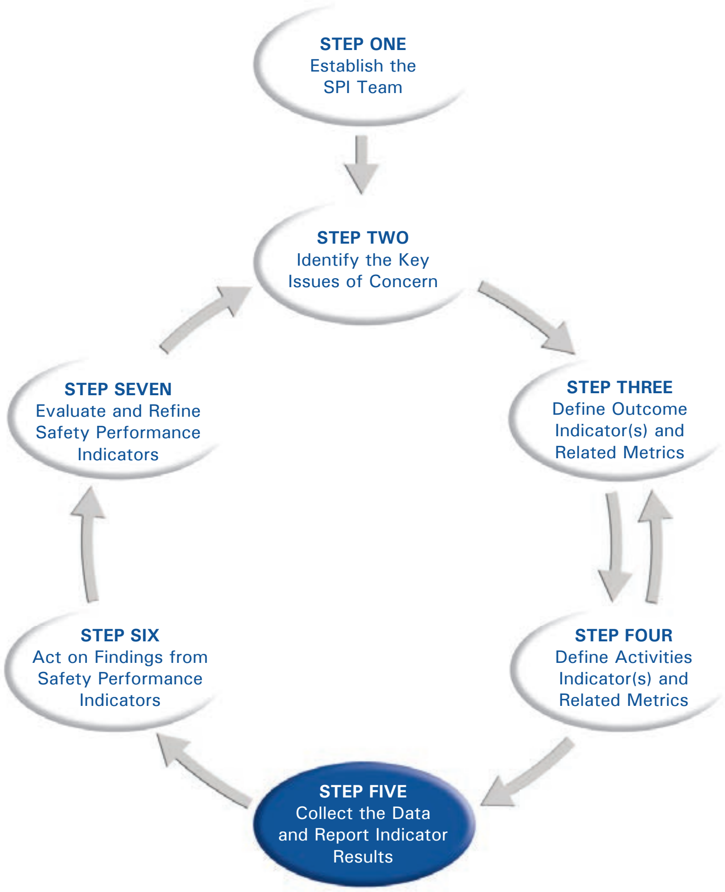
3

SCENARIO 3: The owner and shift manager decided to work with the professor/consultant to put hazard identification/risk assessment-related systems in place and then focus initial SPI efforts on measuring the degree to which the systems were being used to inform policies, procedures and practices. Therefore, for the initial phase, they defined the following activities indicators based on the suggestions presented in sub-section B.1 of the *Guidance*:

- "Are there systematic procedures for hazard identification and risk assessment, and do these procedures address criteria for deciding on whether to undertake an analysis?"
- "Are there clear rules concerning the roles and responsibilities for participation of persons in hazard identification and risk assessments?"
- "Are all types of hazards and risks covered by suitable hazard identification and risk assessment methods?"

The owner and shift manager defined a work plan for development of hazard identification and risk assessment procedures with milestones associated with each of the activities indicators. For the initial development-oriented metrics, it was decided that the shift manager would periodically compare the status of the implementation to the milestones and report percent complete.

STEP FIVE: COLLECT THE DATA AND REPORT INDICATOR RESULTS



Once you have defined your SPIs, the next step is to decide how you will collect and report the safety performance results. Data collection procedures (*e.g.*, data sources, how the data will be compiled and how often and what the reports will look like), as well as roles and responsibilities for collection and reporting, should be specified. Some of these issues will have been addressed when deciding on the metrics in steps Three and Four.

In evaluating data sources, it is often useful to review data that are already available and decide whether they could be used to support SPIs. Existing data may have been collected for other activities such as quality control or business efficiency. If useful existing data are identified, it is important to evaluate whether the data are of adequate quality for the SPI and to organise and/or apply the data (*e.g.*, as one input to an indexed indicator) to achieve the purposes of the SPI Programme.

Data collection procedures should take into account the frequency with which data should be collected and results reported in light of the function of each indicator relative to safety performance. Data should be collected and results reported at a frequency necessary to ensure that they can detect changes in safety-critical systems in time for action. In addition, reports should be provided in a timely manner to management, appropriate safety officers and/or other relevant employees with responsibility for acting on the specific safety issues addressed by the indicators.

For indicators that use threshold metrics, the procedures should identify specific thresholds or tolerances, *i.e.*, the point at which deviations in performance should be flagged for action. The procedures should also note specific actions to be taken when thresholds are exceeded. Note that the act of setting thresholds sometimes requires reconsideration of the metric chosen for an indicator. For example, if a metric using binary (yes/no) measurement was chosen for an indicator of system failure, but it is desirable to take action prior to failure, an alternative metric (*e.g.*, relying on ratio or ordinal measurements) may be more appropriate. The consideration of thresholds in setting metrics is addressed in more detail in Annex I.

The presentation of indicator results should be as simple as possible in order to facilitate understanding of any deviations from tolerances and to identify any important trends. The presentation should also allow the reader to understand the links between outcome indicators and associated activities indicators. The presentation should take into account the target audience. For example, it may be useful to identify a subset of the most critical indicators to be given greater emphasis for reporting to top-level management.

Example Scenarios - Step Five

CHEMICAL MANUFACTURER

1

SCENARIO 1: Based on the expected frequency of incidents, the SPI team decided to compile and report the SPI data on a quarterly basis. Data on changes, including number of requests, number of times that change requests were resubmitted, and number of change requests per reviewer, would be obtained from the organisation's MOC tracking software. Data on employees who had received training would come from the training programme managers.

The team decided that the outcome and activities indicator data would be plotted on a timeline to identify trends. The MOC co-ordinator was given the responsibility for collecting and distributing the SPI information to the rest of the team, including the plant manager and other relevant employees.

SMALL SPECIALTY CHEMICAL FORMULATOR

2

SCENARIO 2: The team decided to use investigation reports as the source of information for the outcome indicator, "extent incidents are attributed to procedures…." For activities indicators, the team decided that they would work with shift foremen and monitor all new formulations and significant changes to existing formulations. They would: collect and review new and updated procedures for completeness; observe the degree to which the procedures were made available to users; and analyse the degree to which they were followed using the metrics defined in Step Four.

The team calculated that the cost of implementing this programme would be low. It did not require any additional resources. If the programme could identify and prevent even a few incidents, it would result in a net benefit. The president approved the approach.

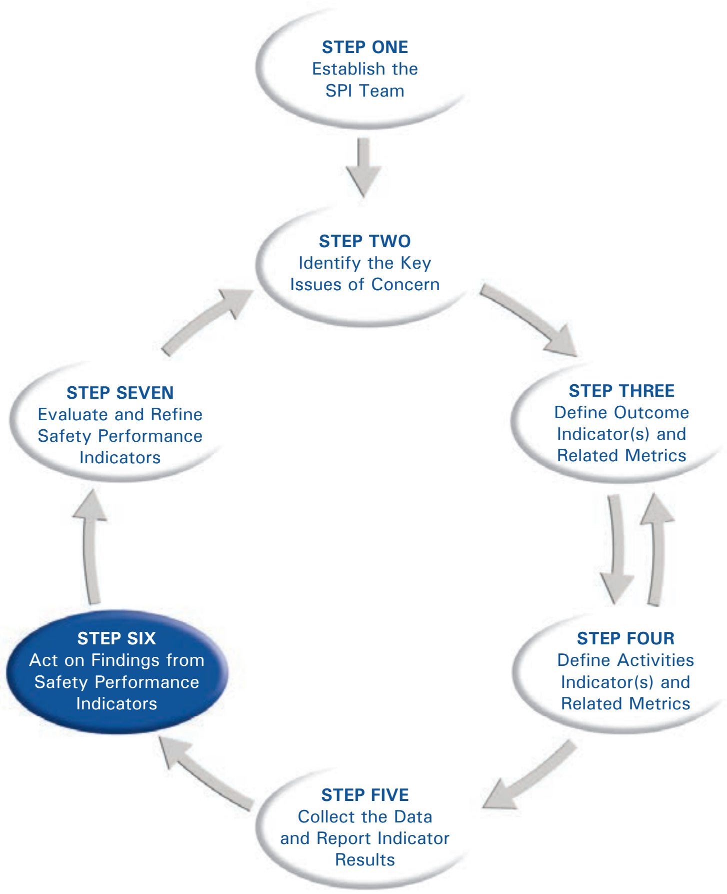
WAREHOUSE OPERATION

3

SCENARIO 3: The owner and shift manager decided that the professor/consultant would conduct a baseline hazard analysis and risk assessment, identify critical policies, procedures and practices and rate each on the 5-point Likert scale to provide a baseline for measuring changes in the integration of hazard identification and risk assessment practices. The professor/consultant would periodically review the critical policies, procedures and practices to evaluate the effect of new hazard identification and risk assessment processes. The shift manager reported the percentage of completed procedures during the warehouse's regular monthly management meetings.

STEP SIX: ACT ON FINDINGS FROM SAFETY PERFORMANCE INDICATORS

Results from SPIs (such as tolerances being exceeded, disturbing trends over time, inconsistent results) must be acted upon; otherwise, there is little point in implementing an SPI Programme. Senior managers, safety management personnel, engineers, operators and other relevant employees should receive SPI results in a timely way and should follow up adverse findings to fix defects in the associated safety policies, procedures and practices.



When a deviation is noted, it may provide insights not only into the safety issue, but also the SPI itself – *i.e.*, whether it was defined well enough to detect the safety issue of concern and whether improvements can be made to the indicator. Thus, deviations detected using SPIs represent an opportunity for learning and adjusting SPIs (see Step Seven).

While implementing an SPI Programme, you may also encounter situations where outcome and activities indicators associated with the same subject provide contradictory results. When this occurs, it is an indication that one or both indicators are not working as intended. The indicators should be reviewed and redefined, as necessary.

For example, if your activities indicator shows good safety performance (relative to the activities being measured) but the associated outcome indicator shows poor safety results, the activities indicator should be evaluated to ensure that it is focused appropriately. The activities being measured may be too far removed from the outcome or the SPI and associated metric may not be defined well enough to capture critical information. Similarly, if your activities indicator suggests poor safety performance but the associated outcome indicator shows satisfactory results, either the poor performance relative to the activities being measured has yet to result in an unwanted outcome due to other factors or the activities indicator is not well focused. In any case, this type of finding warrants further review.

Example Scenarios - Step Six

CHEMICAL MANUFACTURER

1

SCENARIO 1: After a year of collecting SPI data on the MOC process, the SPI team saw that all relevant employees had received MOC training. The team saw a corresponding reduction in the average number of times that changes were resubmitted for review prior to approval. The team also noted that although the indicator of incidents attributed to MOC as a root or intermediate cause had decreased, the number of incidents attributed to MOC remained unacceptably high. The team noted that the number of change requests reviewed per reviewer stayed fairly constant over the year.

The MOC co-ordinator noted that one of the engineers who used to review change requests had retired during the year, and was not replaced; his workload was shifted to others. As a result, the impact of fewer re-submittals was offset by an increase in number of original requests seen by each reviewer. Based on this, the plant manager decided to assign a new, junior engineer to the team to review less critical change requests and reduce the workload of more experienced engineers. The manager requested that the MOC process be evaluated and refined to ensure that change requests are classified appropriately (*e.g.*, by level of risk). The plant manager also decided to require annual change request training for all personnel responsible for submitting change requests.

SMALL SPECIALTY CHEMICAL FORMULATOR

2

SCENARIO 2: Over the first few months, the team noted that the number of incidents attributed to procedures did not change significantly. They also noted that when new and modified formulations were introduced, some but not all of the safety-related procedures were updated (*i.e.*, the majority were rated "somewhat complete"). For example, sometimes changes to procedures for filling and start-up were covered but not changes for shut-down and unloading. Some procedures addressed changes in normal operations but not changes associated with abnormal or emergency situations. The health and safety manager worked with process engineers to correct this problem.

The team noticed that without exception, operators were informed of new and modified procedures (*i.e.*, 100% of users were aware of the changes). However, the team also noticed that new and modified procedures were not always followed. Based on this, the health and safety manager interviewed several operators to determine the reason for these deviations. Operators described situations where new procedures conflicted with other existing procedures or relied on instrumentation that was not installed on all of the batch tanks. In order to meet production demands, the operators developed "workarounds" to deal with these issues. The team reviewed the incident reports for the period and noted that almost all of the incidents involved situations where workarounds were used.

Based on this, the health and safety manager implemented changes to the procedures process where operators would be consulted by engineers during the development of new or updated procedures. In addition, the introduction of new or significantly modified procedures would include a "shake-down" period where engineers would be on-call to receive feedback and address conflicting or unworkable procedures.

WAREHOUSE OPERATION

3

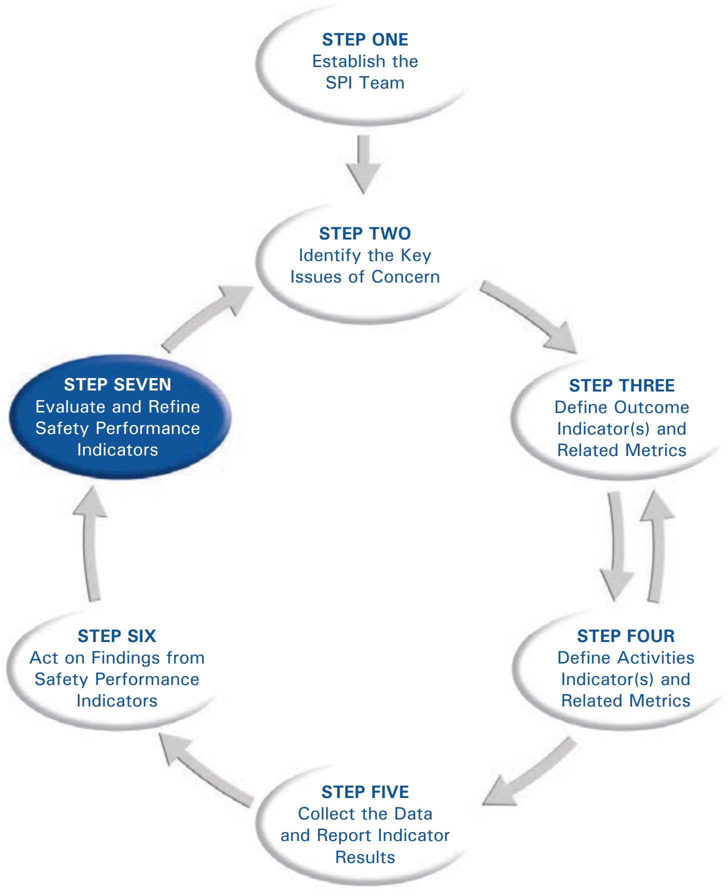
SCENARIO 3: During the first three months, the professor/consultant inspected the warehouse and its contents and reviewed past records of warehousing inventory. He also inspected the facility design and basis for operational decisions regarding storage, including controls used for segregating incompatible materials, avoiding ignition sources, maintaining dry areas, inspecting container integrity, etc. The professor/consultant identified and rated critical policies, procedures and practices in the contracting and materials handling areas of the warehouse operation. Though some of the policies, procedures and practices reflected a general understanding of safety issues, most of them received low ratings due to the lack of systematic hazard identification and risk assessment procedures.

At the end of six months, the hazard identification and risk assessment procedures were complete, roles and responsibilities had been defined, and a determination was made that all types of hazards and risks associated with current and foreseeable warehouse operations were covered by the procedures. The work was 100% complete. At the end of a year, the professor/consultant re-rated the critical policies, procedures and practices to evaluate the impact of the new hazard identification and risk assessment processes. Although most of the policies, procedures and practices were better informed by hazard identification and risk assessment, they still relied too much on informal knowledge of hazards and risks and were rated in the middle of the scale. The extent to which hazard identification and risk assessments are used in policies, procedures and practices to control risks was "moderate." The professor/consultant also noted that the warehouse had contracted to store some materials not considered in the baseline hazard identification and risk assessment. The activities indicator, "are all types of hazards and risks covered by suitable hazard identification and risk assessment methods" was no longer 100% complete.

Upon examining these findings, the shift manager determined that although hazard identification and risk assessment were routinely conducted by the responsible people, the information was not fed back throughout the operation to all those with responsibility for implementing safe practices. The warehouse implemented procedures to create better feedback of hazard identification and risk assessment information. It also worked with its contracting staff to identify situations (*e.g.*, new types of materials) that would trigger a review of the hazard identification and risk assessment process to ensure thorough coverage of hazards and risks.

STEP SEVEN: EVALUATE AND REFINE SAFETY PERFORMANCE INDICATORS

The SPI Programme, including the indicators and metrics, should be periodically reviewed and evaluated. Developing an effective SPI Programme is an iterative process, and the Programme should be refined as experience is gained or new safety issues of concern are identified (*e.g.*, due to the introduction of new technologies or processes).



Periodic reviews help to ensure that the indicators are well-defined, continue to address priority areas of concern, and provide the information needed to monitor safety measures and to respond to potential safety issues. In addition, it will help to identify when specific indicators are no longer needed (*e.g.*, if monitoring has led to an inherently safer operation) and allow adjustments to the Programme to focus on the most important issues and indicators.

For example, it may be discovered that some indicators do not provide useful measurements for the enterprise or that the metrics are not precise enough to recognise small but significant changes that require action. This may lead to the conclusion that new indicators are needed or the metrics should be refined. It may also be discovered that more important activities associated with a specific outcome (*i.e.*, activities that have a more direct effect on the outcome) are not being measured and, therefore, new indicators should be developed.

In addition, the issues of concern can change over time due to improvements in safety or insights into previously unidentified issues. Changes in priorities for an SPI Programme could result from: improvements in management systems; alterations in plant design; introduction of new technologies, equipment or processes; and/or changes in management or staffing.

Based on your experience, you might conclude that the SPI Programme should be expanded to include a larger number of indicators in order to provide greater insights into a particular issue or address a larger scope of safety concerns.

Finally, you can incorporate the experience of others by sharing information with other enterprises that have implemented an SPI Programme. These can be other enterprises in your same industry or other industries with hazardous installations. Industry associations can help make these connections and promote overall improvements in the field of safety performance indicators.

Example Scenarios - Step Seven

CHEMICAL MANUFACTURER

1

SCENARIO 1: Based on their initial experience and the actions taken in response to the findings, the SPI team made the following decisions with respect to the MOC-focused SPI effort:

- Continue to use the outcome indicator, "number of incidents attributed to management of change as a root or intermediate cause per number of implemented changes." This appeared to work well to monitor the safety issue of concern.
- Continue to use the activities indicator, "number of times that the same change has to be resubmitted for review prior to approval." MOC reviewers consistently stated that this was a critical issue.
- Continue to use the activities indicator, "number of change requests reviewed per reviewer," but rather than track this as a simple ratio of number of requests to number of reviewers, change the metric to track this information for each individual reviewer. This would address the failure of the previous metric to identify this issue.
- Discontinue the activities indicator, "percentage of employees submitting change requests that have received MOC training." This training was made a prerequisite for all personnel submitting change requests, and additional SPI data would no longer be useful.
- Implement a new activities indicator, "do the MOC procedures address review and approval by the relevant responsible person before proceeding to the next step?" The team agreed to revisit this indicator after the procedures were updated to focus on whether the procedures resulted in review and approval by appropriate personnel.

After reviewing the results of their initial efforts, management agreed that the SPI Programme should be expanded to address two additional critical areas: contractor safety and internal (on-site) preparedness planning.

SMALL SPECIALTY CHEMICAL FORMULATOR

2

SCENARIO 2: Based on their initial experience, the SPI team proposed the following approach for the procedures-focused SPI effort:

- Continue to use the outcome indicator, "extent of the number of incidents attributed to procedures (due to, *e.g.*, procedures lacking, procedures inadequate and/or procedures not followed)." This number had shown little change over the first six months. The team hoped that the new process for updating procedures would result in a decrease in this number.
- Continue to use the three activities indicators. The issues of addressing procedures associated with all stages of a new or modified formulation had been completed and the degree to which operators were informed of new procedures remained high. Despite this, the safety and health manager reasoned that measuring these activities would ensure that they continued to operate correctly. The team was hopeful that the new process for updating procedures would result in better implementation of written procedures.
- Implement two new activities indicators: 1) "is participation of employees built into the development of procedures?" and 2) "is there a means to ensure that procedures are corrected when conflicting with other procedures or if not working properly?" These indicators would help to monitor the degree to which the new process for updating procedures was implemented.

WAREHOUSE OPERATION

3

SCENARIO 3: Based on their initial experience, the owner and shift operator agreed to the following approach for their ongoing SPI Programme:

- Continue to monitor the outcome indicator "extent hazard analyses and risk assessments are used to develop proper policies, procedures and practices to address risks." The shift operator would report on this indicator on an annual basis based on the results of the periodic evaluations to be conducted with the assistance of the professor/consultant.
- Continue to monitor the activities indicator "are all types of hazards and risks covered by suitable hazard identification and risk assessment methods?"
- Implement two new activities indicators: 1) "extent to which procedures are implemented to give feedback from hazard identification and risk assessments..." and 2) "extent to which criteria are being systematically applied for deciding on whether to undertake a risk analysis for new inventory." The warehouse would use these indicators to evaluate the areas which had been found lacking based on the initial SPIs.

Chapter 3: CHOOSING TARGETS AND INDICATORS

Introduction

<u>Purpose of this Chapter</u>: This Chapter provides a menu of possible outcome indicators and activities indicators (and related targets) to help you develop your SPI Programme. As noted in Chapter 1, this list is purposefully extensive, in order to include the range of possible subjects that could be of interest to the wide variety of enterprises that pose a risk of chemical accidents.

Thus, the lists of indicators contained in this Chapter may appear daunting and, in parts, irrelevant to your enterprise. However, using these lists in conjunction with the steps set out in Chapter 2 (and, in particular, Steps Two, Three and Four) should help you to focus on the limited number of subjects and related indicators that are most relevant to your enterprise.

The objective is to start by identifying your enterprise's key issues of concern, *i.e.*, the most critical safety-related policies, procedures and practices (including human resources and technical measures). These should be the initial focus of your SPI Programme. There are many factors which will enter into a decision on the key issues of concern including, for example: hazard identification and risk assessment; feedback from employees concerning which policies, procedures and practices are most problematic; a history of incidents within the enterprise, and in the industry more generally; and legal requirements and corporate culture.

For some enterprises, the most critical concerns may be technical issues which are addressed in section C below, along with the related procedural issues such as management of change set out in sub-section B.4. Other enterprises may find that the subjects requiring regular assessment are personnel-related and, in particular, training and contractor safety (sub-sections A.5 and B.5, respectively). Still others may find that they need to first review general safety management, as set out in section A, to ensure that there is an adequate safety culture in their enterprise. Thus, it is incumbent on each enterprise to make a determination of its key issues of concern which will be the focus of its SPI Programme.

It should be noted that many of the activities indicators are written as "yes/no" questions. However, this is not meant to dictate the metric that you should use; you will need to decide on the best metric for each of the indicators you choose. Guidance on metrics is available in Chapter 2 and in Annex I.

<u>Format</u>: The outcome and activities indicators listed in this Chapter, along with associated targets, are organised by subject, based on elements that are normally contained in safety management systems and industry's roles with respect to chemical accident prevention, preparedness and response. The Chapter is divided into six sections, each with a number of sub-sections.

For each sub-section, there are three tiers of information:

- an *introduction* summarising the subject's relevance to chemical safety, along with references to relevant paragraphs of the *Guiding Principles*;
- a *target* suggesting the overall objective that should be achieved relative to that subject; and
- *possible safety performance indicators* setting out suggestions for outcome indicator(s) and a number of activities indicators.

It should be noted that because of the way the Chapter is structured, there may be some duplication or similarity among indicators in different sub-sections.

Section A. Policies, Personnel and General Management of Safety

Safety should be an integral part of the total business activities of an enterprise. This should be reflected in the overall management instruments for the enterprise and for the individual sites.

Furthermore, safety issues should be addressed as part of the overall corporate safety, health and environment policies ("Safety Policy"), as well as in the development of safety management systems and safety goals and objectives. In this regard, management should establish a corporate safety culture that is reflected in the Safety Policy and ensures all employees are aware of their roles and responsibilities with respect to safety.

Everybody involved in the design and operation of a hazardous installation is responsible for preventing chemical incidents.[13] Top management should develop and set the Safety Policy, and exert the enterprise's commitment to safety. The more detailed procedures should be developed and implemented by line management.

The most important factor for achieving a safe workplace is the belief by all employees[14] (including management and contractors) that safety is critical. This includes the intention to act consistently with this belief, and the genuinely safe behaviour by all. Such a result is founded in the safety culture created by management in co-operation with other employees. It also requires that employees are given the tools necessary to carry out their jobs in a safe manner, in particular: training; information; and an appropriate working environment.

A basis of the management of safety is the formal system as described in administrative procedures and documents, normally called the "safety management system."

This section is designed to help enterprises to identify possible indicators to measure the coverage and quality of their safety management system, specifically those aspects of the safety management system critical to controlling hazards associated with chemical accidents. The indicators in this section also help to measure the commitment to safety in the organisation, as well as the resultant actions.

This section includes the following sub-sections:

- A.1 Overall Policies
- A.2 Safety Goals and Objectives
- A.3 Safety Leadership
- A.4 Safety Management
- A.5 Personnel
  - A.5a Management of Human Resources (including training and education)
  - A.5b Internal Communication/Information
  - A.5c Working Environment
- A.6 Safety Performance Review and Evaluation

[13] For purposes of this Document, "incident" means any event which differs from normal conditions (deviation) and which has caused or could have caused harm to health, the environment or property. Therefore, incidents include accidents (events which have caused injuries, illnesses, environmental damages, third party damage, property damage, product losses or interruption of operations) and near-misses (events without the consequences of accidents which, but for the mitigation effects of safety systems or procedures, may have developed into accidents).

[14] For purposes of this Document, employees include part-time and seasonal workers as well as contractors employed by the enterprise.

A.1 OVERALL POLICIES

A critical element of a safety culture is that there should be a clear manifestation of that culture and the long-term objectives regarding safety from the top management, supported throughout the enterprise (including the Board of Directors). This should be laid down in a Safety Policy. The Policy should provide standards and strategies designed to protect the health and safety of workers and the public, as well as the environment. The Policy should form support for the various strategies (*e.g.*, polices, procedures and practices) related to safety. The Policy should not be affected by short-term changes in the economic situation of the enterprise. The Policy is also an important instrument to convey the corporate/enterprise view on safety to external stakeholders.

See Guiding Principles document, paras.:
- 2.a.7 Clear and meaningful written statement of the Safety Policy
- 2.a.8 Consult with and involve employees
- 2.a.9 Safety Policy widely communicated
- 2.a.10 Co-operate to comply with the Safety Policy
- 2.a.12 Develop and update the safety programme conforming to the Safety Policy
- 14.a.1 Create a climate that fosters trust

TARGET
There is a comprehensive, appropriate and living Safety Policy, which is conveyed by management and understood by employees.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent to which employees (contractors and others) act in accordance with the Safety Policy.
ii) Extent to which the directors and managers take the Safety Policy into account when making decisions about health, environment, safety, personnel, financial investments and other relevant topics.

Activities Indicators

i) Is the Safety Policy conveyed to:
  - employees;
  - contractors;
  - relevant external stakeholders (suppliers, customers, public authorities, potentially affected public, etc.)?

ii) Is information concerning the Safety Policy distributed repeatedly?
iii) Has the Safety Policy been reviewed and updated according to established procedures?
iv) Does the Safety Policy include concrete commitments and clear objectives?
v) Is the Safety Policy clear that safety is a priority for the enterprise?
vi) Does the Safety Policy address all relevant issues including, *e.g.*:
  - roles and responsibilities of different employees;
  - technology and design;
  - safety management and organisations;
  - reporting and learning from incidents and other experiences;
  - the role of checks, audits and management reviews;
  - relationship to external stakeholders;
  - Responsible Care® and product stewardship;
  - a mechanism for feedback/communication from all employees and the public?

A.2 SAFETY GOALS AND OBJECTIVES

See Guiding Principles document, paras.:
- 1.4 Strive to reach the ultimate goal of zero accidents
- 2.a.2 Clearly stated and visible commitment to safety
- 2.a.12 Develop and update the safety programme

The ultimate goal for every enterprise should be to have "zero incidents." This goal provides the incentive to achieve the best possible performance and ensures continuous vigilance towards greater safety. Seeking to achieve this goal and managing safety requires a constant effort that involves establishing safety-related objectives, implementing those objectives and measuring and reviewing progress in meeting those objectives. This should be reflected in the long-term, overall Safety Policy. In order to ensure day-to-day implementation of the Policy, concrete goals and objectives should be established and agreed upon by the entire organisation.

The enterprise should have safety goals and objectives established, reviewed and revised (as appropriate) on a regular basis.

TARGET
The goals and objectives for the enterprise at each level help ensure day-to-day safety.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent to which safety goals and objectives are appropriate to the risks of the enterprise.
ii) Extent to which safety goals and objectives have been achieved.
iii) Extent to which safety goals and objectives are reviewed and updated in relation to the established procedures.
iv) Extent to which safety goals and objectives are consistent with national and international legal requirements.

Activities Indicators

i) Is there a system for establishing goals and objectives?
   - Are there goals/objectives established at different levels of the organisation? Do they follow a chain with departmental goals/objectives being part of the superior goals/objectives, etc.? Are they adjusted to be meaningful at each operational level;
   - Is there a fixed procedure for establishing goals/objectives (*e.g.*, with a formal approval body, at a specified time);
   - Are the goals/objectives in written form;
   - Are there both long-term and short-term goals;
   - Do employees participate in setting goals;
   - Does the community participate in setting goals.

ii) Are the goals/objectives appropriate to the specific circumstances?
   - Are they relevant – for the enterprise and the employee;
   - Are goals/objectives related to the hazards/risks of the installation and to the corporate Safety Policy;
   - Are they easy to understand and communicate;
   - Are they concrete and measurable;
   - Are they challenging but realistic;
   - Do they reflect the experience and views of employees;
   - Are there resources available to achieve the goals/objectives.

iii) Is there an action programme associated with every goal/objective in order to ensure implementation and follow-up?
- Are roles and responsibilities clearly expressed;
- Are timetables and resource allocations established and approved;
- Are the action programmes in writing.

iv) Are follow-up procedures in place?
- Is there a formal mechanism for this with a mandate for possible corrective actions;
- Is follow-up done at regular intervals;
- Is progress monitored and information provided to employees.

A.3 SAFETY LEADERSHIP

Management of an enterprise should ensure that there is a sound foundation, on which all work can be based, to ensure safety. There should be a true safety culture that has permeated through all levels of the enterprise. The top management commitment to safety should be such that it is experienced in the rest of the enterprise as genuine and not as "lip service" or empty words.

See Guiding Principles document, paras.:
- 2.a.2 Clearly stated and visible commitment to safety
- 2.a.3 Encourage initiative and alertness in the interest of safety
- 2.a.4 Ensure that employees are aware of their roles and responsibilities
- 2.d.29 No measures to an employee when acting in good faith
- 2.d.44 Employees to be encouraged to share their experiences
- 14.a.1 Create a climate that fosters trust

TARGET
Senior managers inspire all employees to act in a manner consistent with their Safety Policy and goals.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent managers support the Safety Policy and, therefore, act consistently to set direction and priorities and are involved in safety-related activities.
ii) Extent managers take action to correct behaviour not consistent with the Safety Policy.
iii) Extent employees at all levels follow established procedures related to safety.
iv) Extent suggestions and complaints from employees result in improvements in safety.
v) Extent employees consider management a trusted source of information on chemical risks, hazards and safety.

Activities Indicators

i) Is management actively committed to, and involved in, safety activities?
   - Is the involvement of management visible in daily operations (*e.g.*, number of visits to shop floor);
   - Do managers set good examples with respect to safety;
   - Do managers take part in the follow-up of incidents;
   - Do managers actively monitor the activity plans for safety goals and objectives;
   - Is safety (always) on the agenda of regular meetings (from board meetings to daily operational meetings);
   - Is it obvious that safety is a decisive factor in enterprise decision-making;
   - Is it obvious that safety takes priority in cases where there is a conflict between safety and operational goals;
   - Are adequate resources for safe operations allocated in general budgets as well as promptly when there is an urgent need.

ii) Do managers and supervisors have the skills and resources so that all members of their teams can work safely?
   - Is there a mechanism in place to measure skills to ensure that all members of a team work safely;
   - Are the necessary resources allocated to help ensure safety;
   - Is there an atmosphere where all employees can take actions for reasons of safety without the fear of possible negative consequences.

iii) Do employees at all levels follow established procedures related to safety?

iv) Is there a mechanism to measure employees' commitment to safety?
  - Is compliance with safety procedures monitored;
  - Do employees actively contribute to the development and implementation of safety policies and practices.

v) Is there bench-marking with other enterprises to help identify areas for improvement?

A.4 SAFETY MANAGEMENT

See Guiding Principles document, paras.:
- 2.a.12 Develop and update the safety programme
- 2.a.14 Establish a safety management system
- 2.a.15 Safety management system to address a number of areas

All enterprises should address safety management as part of their overall management (in fact, there is a clear correlation between safely-run enterprises and well-managed operations). A safety management system provides a structured approach to those arrangements needed to achieve good safety performance within an enterprise. The safety management system should be based on the Safety Policy and should define an ambition level that the enterprise considers appropriate for its business, as well as the safety concerns and requirements specific to their installations.

The primary objectives of a safety management system are to regulate formally the activities of the enterprise in order that they are carried out safely to continually improve safety performance, and to support a strong safety culture. Additional benefits of a safety management system include:

- more efficient production and maintenance with fewer operating disturbances and releases, less absenteeism, etc.;
- more efficient project management and smoother start-up by incorporating safety considerations at an early stage; and
- improved relations and increased reputation both within the enterprise (among employees and union organisations) and with external stakeholders (*e.g.*, public authorities, the general public, the community, health/medical personnel, the media, customers, other enterprises).

An effective safety management system addresses:
- *organisational structure (including the roles, responsibilities, training, education, qualifications and inter-relationship of individuals involved in work affecting safety);*
- *identification and evaluation of hazards;*
- *facilities and operational control;*
- *management of change;*
- *planning for emergencies;*
- *monitoring performance (concerning the ongoing assessment of compliance with the Safety Policy and the safety management system, and mechanisms for taking corrective action in the event of non-compliance);*
- *audit and review (addressing the periodic, systematic assessment of the Safety Policy and effectiveness and suitability of the safety management system); and*
- *accident investigation and learning from experience.*

TARGET
There is an effective safety management system that minimises risks related to chemical accidents.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent to which procedures established in the safety management system are applied by employees.

Activities Indicators

i) Is there a management system?
   - Are all risks adequately assessed;
   - Does it address ways of reducing identified risks;
   - Does it address all legal requirements, at a minimum;
   - Is it consistent with the corporate Safety Policy as well as its goals and objectives.

ii) Does the system include procedures, and is there an iterative process for continuous improvement, including:
- planning;
- implementation and operation with control and corrective actions;
- audit, management review and feedback?

iii) Are all the procedures in the system:
- clear in their requirements and ambition level;
- well-documented;
- easily identifiable;
- easily obtainable and transmitted to employees?

iv) Are roles and responsibilities of employees clearly described in safety-related documentation?
- Are the inter-relationships of personnel involved in work affecting safety clearly defined;
- Are people appointed as responsible for the safety management system.

v) Is the participation of employees to develop the safety management system secured?

vi) Are there procedures to ensure that management is aware of, and in compliance with, all legal obligations?

vii) Is there an on-going mechanism for:
- assessing compliance with the safety management system and improving safety performance;
- taking corrective action, when appropriate;
- revising the safety management system based on reviews and feedback?

A.5 PERSONNEL

A.5a Management of Human Resources (including training and education)

Management should seek to create a thriving safety-minded organisation and, in order to achieve this, management should establish systems to help ensure that:

- all employees have a clear understanding of their job tasks;
- the staffing on all levels is adequate and with the right competence for both normal circumstances and during unusual circumstances or increased workload, without over-stressing the employees;
- all employees are trained and able to use their knowledge for the safe performance of their jobs, and are competent to deal with emergencies; and
- employees are given feed-back on safety-related aspects of their jobs.

See Guiding Principles document, paras.:

- 2.d.10 Ensure sufficient staffing, generally
- 2.d.11 Ensure sufficient staffing, at all times
- 2.d.18 Safety performance essential for everyone
- 2.d.22 Personnel plans always to be consistent with operational safety requirements
- 2.d.23 Professional safety personnel available; enterprise's safety conscience
- 2.d.24 Every employee responsible
- 2.d.26 Safety Committee(s)
- 2.d.28 Safety Representatives
- 2 d 29 No measures to an employee when acting in good faith
- 2.d.30 Right to refuse to perform when believed to create a risk
- 2.d.34 Ensure all employees receive appropriate education and training
- 2.d.35 Provide training for day-to-day operations and unusual situations
- 2.d.36 Managers to have full understanding of conditions and risks
- 2.d.37 Emergency exercises with sufficient frequency
- 2.d.38 Training and education needs to be analysed regularly
- 2.d.39 Possible language problems to be addressed
- 2.d.40 Keep records of all safety-related education and training
- 2.d.45 Special care during periods of unusual conditions or stress
- 2.d.46 Special care at modifications, maintenance, shutdown/ startup
- 2.i.1 Ensure education and training of users of products

TARGET

There is appropriate staffing levels – with employees (including contractors and others) who are competent, trained and fit for their jobs – which can ensure safe handling of all hazardous substances and other hazards at the enterprise.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent employees have been trained in accordance with the planned training programme.
ii) Extent employees (including contractors and others) pass periodic assessments of competence.
iii) Extent to which the workforce performed consistent with safety objectives (*i.e.*, appropriate procedures being followed) during normal operations.
iv) Extent to which the workforce performed during emergency situations (based on tests or actual situations).
v) Extent of incidents attributed to problems related to human resources as a root or intermediate cause (*e.g.*, staffing levels, training, competency).
vi) Extent to which employees believe that they have sufficient resources (including staff, materials, resources) for safety-critical tasks.
vii) Number of safety proposals per employee (high number shows commitment).
viii) Extent employees are satisfied with the safety situation in the enterprise.

Activities Indicators

i) Is the distribution of roles and responsibilities for all managers and other employees with safety-related jobs clear and adequate?
- Is the split between line and staff responsibility clear;
- Are the mandates and responsibilities for specialists defined;
- Do all employees and positions have appropriate job descriptions and/or formal delegation documents that address relevant safety issues;
- Is it clear that employees are given the responsibility and means to carry out assigned tasks in a safe manner and have adequate channels to redress any concerns;
- Is the representation for the employees according to legislation and adequate (*e.g.*, in safety committees, safety representatives).

ii) Is the general competence level of the employees adequate?
- Is the basic education of the employees adequate and consistent with industry standards;
- Are there regular checks of capacity, adequacy, etc. (including, *e.g.*, alcohol/drug testing);
- Is there a procedure for employees to remove themselves, or be removed, from safety-related work when temporarily unfit for work (as determined by a manager or by the employee) without fear of possible negative consequences;
- Are employees involved in resolving safety-related problems that affect their activities.

iii) Do employees receive adequate safety-related information, and understand this information?

iv) Do employees use/apply safety information (*e.g.*, based an on independent review of day-to-day activities)?

v) Is there enough specialist competence related to safety?
- Is there an independent safety function and does it have the mandate, position and qualifications to exercise influence;
- Is there competence in all fields of safety (*e.g.*, process safety, industrial hygiene).

vi) Is there an adequate recruitment procedure?
- Are adequate job requirement profiles established;
- Is there a matching of the employees and the relevant profiles in hiring and promotions;
- Is there any checking on safety performance at hiring;
- Are there adequate controls to help ensure against hiring individuals who may be unable to carry out their tasks due to health concerns;
- Does the interview process include participation of future colleagues.

vii) Is the manning of the operations of the enterprise always adequate?
- Is it adequate during all periods of operation (including non-office hours);
- Do decisions on manning take into account that excessive overtime, excess workloads or stress could impact safety;
- Is there a procedure to help ensure that staffing is adequate during start-up, down-sizing, increasing workloads and other periods of change.

viii) Are there systems for appraisal and feed-back to employees?
- Are there formal appraisal systems that include safety performance;
- Are there opportunities for employees to participate in safety planning and development sessions (with an "open" atmosphere) and is there a procedure for implementation and feedback from such sessions;
- Are there specific incentives for good safety performance.

ix) Are there programmes for the development of the employees for job enrichment and for job rotation in order to keep the work force alert?

x) Are there procedures in place for dealing with non-compliance with safety-related procedures?

xi) Are there programmes for Behaviour-Based Safety (BBS)?

xii) Are clear, specific objectives established for training and education?
- Can these objectives be measured;
- Are the training and education objectives well-known within the organisation;
- Is there evidence that the objectives have support from the highest level of the organisation;
- Are "rewards" available for positive performance (*i.e.*, do employees' reviews recognise good safety performance).

xiii) Are there training programmes for all categories of employees? Does this include:
- induction training of all employees;
- job training for workers (initial position and major changes or promotions);
- job training/retraining for workers for normal enrichment of job;
- job training of supervisors and managers;
- specific safety training (*e.g.*, fire fighting, emergency drills, first aid);
- training of contractors;
- other categories appropriate to the circumstances of the enterprise (including training of part-time and seasonal employees).

xiv) Are there mechanisms to ensure that the scope, content and quality of the training programmes are adequate?
- Are the programmes based on the competence requirements for each job category;
- Do programmes include topics for all skills needed for the job;
- Is there participation of the employees in developing the programmes;
- Is there a mechanism for feed-back from the employees built into the programmes;
- Is the quality of the training, trainers and the training materials assessed regularly;
- Is there a formal checking of training results by an independent resource;
- Is there a review of training programmes following exercises of emergency plans and following incidents;
- Is there training in simulated operations (normal and abnormal, including emergency situations) *e.g.*, on simulators or as table-top exercises;
- Is there training based on simulations of various types of abnormal and emergency situations (especially when an installation has been running without disturbances for extended periods).

xv) Is there a mechanism to check that the training is actually performed according to the training programme, and that it achieves desired results? In this regard, are the following aspects checked and are records maintained concerning the following:
- scope (is each element addressed);
- number of employees trained;
- period of time between retraining activities;
- individual results in terms of competence of the employee being trained.

xvi) Do employees understand safety-related procedures?

xvii) Is there a training programme for outside parties who handle the enterprise's products?

A.5b Internal Communication/Information

Communication within the enterprise should be such that there is free and open, two-way exchange of information. The management should ensure that all relevant employees can provide input to, and have all the relevant information needed for, safety matters.

See Guiding Principles document, paras.:
- 2.d.19 Ensure co-operation between management and labour
- 2.d.25 Ensure effective two-way communication
- 2.d.26 Safety Committee(s)
- 2.d.27 Safety committee mechanisms at higher levels
- 2.d.33 Information to be provided to contractors and others

TARGET

Key information on safety is adequately communicated (two-way communication) and employees actively participate in the process.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent ideas and suggestions from employees related to safety within the enterprise are implemented.
ii) Extent key findings of risk assessments are communicated and known to employees.
iii) Extent there is a positive and productive atmosphere of co-operation maintained between the management and other employees.

Activities Indicators

i) Are safety issues adequately addressed in regular meetings of employees?
ii) Are there informal discussions concerning safety among all levels in the organisation?
   - Are there opportunities for employees to relate safety concerns, ideas and suggestions to those with authority to take action, on an anonymous basis if preferred;
   - Are there incentives for employees to provide input or suggestions related to safety issues.
iii) Do employees participate in groups that develop and review safety policies and procedures, and address safety issues (*e.g.*, in safety committees, works councils, management team)?
   - Is there a broad representation of managers and employees in regular meetings and working groups (project groups, safety rounds, risk analysis groups, safety audit teams) that address safety issues.
iv) Is there a mechanism for ensuring that policy-making groups are informed of safety issues and concerns, and is there a mechanism for providing feedback from these groups to employees and their representatives?
v) Is there a mechanism to ensure employees have access to all relevant safety-related information (material safety data sheets (MSDSs), safety instructions, etc.)?
vi) Is there internal publicity for safety issues (for example, on notice boards, newsletters, e-mail, targeted campaigns, incentive/award programmes)?

A.5c Working Environment

The working environment should be designed to provide good working conditions and to facilitate a safe way of acting, by taking into account the physical, psychological and mental capabilities and constraints of employees.

See Guiding Principles document, paras.:
- 2.c.4 Design to take account of human factor and be in accordance with ergonomic principles
- 2.c.6 Design to prevent or minimise the exposure of employees to hazardous substances
- 2.c.10 Appropriate level of automation and decision support systems to be provided
- 2.c.11 Computer systems to support operators
- 2.c.12 Safety systems and alarms to be designed and adapted to the capability of operators and other employees
- 2.c.16 Employees to be involved in the design of their workplace
- 2.d.8 Ensure high standard of housekeeping
- 2.d.20 Provide information to employees on the hazardous substances
- 2.d.21 Employees to be informed of, and participate in, activities concerning their work environment

TARGET
There is a good working environment which is consistent with safety objectives, including the appropriate design of workspace and man-machine interfaces, as well as good house-keeping.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Percentage of incidents attributed to design of the workplace and man-machine interface.
ii) Extent employees are satisfied with their working environment (with respect to safety).
iii) Extent to which planned safety rounds/inspections are actually implemented.
iv) Extent to which employees submit complaints about working conditions.

Activities Indicators

i) Is there a procedure for ensuring that the workspace, equipment, man-machine interface and related systems are designed in an optimum way?
- Are the workspaces designed with safety in mind (*e.g.*, do they support working according to safety procedures and not invite employees to take short-cuts or "workarounds");
- Do the emergency systems allow an operator to handle an emergency situation (*e.g.*, without being drowned with information from alarms);
- Is there a good balance between manual and instrument/computer handling and intervention;
- Is there training based on simulations of various types of abnormal and emergency situations (especially when the installation has been running without disturbances for extended periods);
- Are employees involved in the design of their workplaces and related systems;
- Is equipment easily accessible for maintenance and for regular checking or reading of instruments;
- Are computer work stations ergonomically designed (*e.g.*, light, work position, lay-out of equipment, presentation on screens).

ii) Is there a procedure for ensuring that house-keeping is good?
- Are roles and responsibilities clear;
- Is the standard checked regularly;
- Is there any incentive for the employees to follow good housekeeping practices.

iii) Are all relevant workplaces covered by safety rounds/inspections?
- Are safety rounds/inspections carried out regularly and often enough;
- Is there participation both from employees at the workplace and from safety experts;
- Are actions taken to address problems identified without unnecessary delay;
- Are all relevant aspects of safety covered.

iv) Are there procedures to control exposure of employees to hazardous substances?
- Is an inventory maintained of all possible exposures;
- Is there appropriate equipment and supplies for taking all relevant measurements;
- Are appropriate response actions taken without unnecessary delay;
- Is there efficient follow-up to identified problems or concerns.

v) Are there adequate fixed safety equipment installations (*e.g.*, safety showers) and are they maintained in good order?

vi) Are there procedures for ensuring that employees use personal protective equipment (PPE) to the extent appropriate?
- Are there clear and adequate rules which are documented and communicated;
- Do employees, in fact, use PPE in accordance with the rules;
- Are there activities that should be carried out in other ways (*e.g.*, design changes) instead of requiring PPE.

A.6 SAFETY PERFORMANCE REVIEW AND EVALUATION

Regular review and evaluation of the safety performance of an enterprise is a necessary part of managing safety. It is essential to measure the organisation's commitment to safety, to assess the achievements relative to policies and the goals set, and to recognise both good and inadequate or deteriorating standards of performance.

Performance reviews and evaluations should address, *inter alia*:

- general safety performance;
- employees' attitudes; and
- fulfilment of requirements in formal procedures.

Performance reviews and evaluations should cover both managerial and technical aspects.

See Guiding Principles document, paras.:

- 1.6 Periodically monitor and review safety performance
- 2.g.1 Monitor programmes, *e.g.*, audits
- 2.g.2 Ensure a systematic monitoring plan
- 2.g.3 Monitor by a feed-back loop, *i.e.*, plan, do, check, act
- 2.g.4 Transparency in the conduct of audits
- 2.g.5 Include representatives of the community in audits
- 2.g.6 Share information on methods and tools for inspection and audits
- 2.g.7 Use leading performance indicators
- 2.g.8 Use several levels of audits
- 2.g.9 Independent experts to monitor performance
- 2.g.10 Audits to include interviews with employees of all levels
- 2.g.11 Audit team to consist of competent and experienced members
- 2.g.12 Members of audit team to be involved in developing the audit programme
- 2.g.13 Labour and their representatives to be involved in developing the audit programme

At least part of performance reviews and evaluations should be in the form of audits, carried out by independent parties.

The results of reviews and evaluations should be fed back to management and employees, and should be used to actively correct deficiencies and to set new goals and priorities.

An SPI Programme and an audit programme can be used as complementary tools for safety performance evaluation. Furthermore, information gathered from audits can be used as an input for the SPI Programme.

TARGET
There is regular safety performance review and evaluation which measures achievements, identifies weaknesses and leads to continuous improvements.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Measurement of the trends and changes in performance including (but not limited to):
   - extent safety goals and objectives are met;
   - extent technical requirements related to safety are met (*e.g.*, based on technical reviews);
   - extent to which the enterprise achieves its established performance targets.

ii) Extent to which audits and technical reviews are completed in relation to the number planned.

iii) Extent of systematic use of safety performance indicators to measure status and progress of safety performance.

iv) Extent to which performance indicators are measured in a timely fashion.

v) Extent management takes appropriate and timely corrective action based on the recommendations of safety performance reviews, audit reports and technical reviews.

Activities Indicators

i) Is there a system in place for monitoring and measuring the effectiveness of the safety management system focusing on organisational and administrative matters? Does it include:
   - a defined scope of contents;
   - an unambiguous tool for measuring performance;
   - a fixed schedule for regular auditing;
   - inclusion of all units/departments;
   - written reports;
   - follow-up of action items;
   - broad competence participation in the audit team;
   - adequate coverage of persons interviewed at all levels;
   - adequate coverage of documents;
   - adequate check at installations.

ii) Is there a system in place for external (independent) auditing of the safety management system (focusing on organisational and administrative matters), including the same aspects as in (i)?

iii) Is there a system for technically-focused reviews of technology and process equipment by both corporate specialists and external specialists, including the same aspects as in (i)?

iv) Is there a system for comprehensive reviews of mitigation facilities by *e.g.*, external specialists, insurance companies, including the same aspects as in (i)?

v) Is there a system for regular review and follow-up by the management of all the auditing and technical reviews including:
   - penetration of reports (internal, external/audits, technical reports);
   - own spot checks;
   - formal reports (open for all stakeholders) with statements;
   - setting new objectives;
   - reviews of policies and procedures?

vi) Is there a systematic appraisal or inspection of procedures and/or systems to determine compliance with applicable standards and legislation?

vii) Is there a procedure to communicate the results of audits, inspections and similar activities to employees?

viii) Is there involvement by the members of the public in appropriate aspects of the audits?

Section B. General Procedures

Although the success of an enterprise in regard to safety is determined primarily by the safety culture (created by top management through its commitment and policy-making), there is also a strong need for supporting and re-enforcing the safety culture through the use of formal procedures and systems.

Many of the procedures would form a part of the safety management system; others may be separate. Some of them will be of an administrative nature, others of a more technical nature. This section focuses on the administrative procedures. (section C focuses on the technical issues).

Possibly the most important procedures relate to "hazard identification and risk assessment" because risk assessment is the basis for understanding risks at the installation and for establishing and implementing standards and goals for managing those risks. It is the foundation for all management of safety.

Particularly important is that hazard identification and risk assessment is carried out every time a process is modified or there is a change in management. Historical evidence suggests that procedures related to management of change is a key issue.

This section includes the following sub-sections:

B.1 Hazard Identification and Risk Assessment
B.2 Documentation
B.3 Procedures (including work permit systems)
B.4 Management of Change
B.5 Contractor Safety
B.6 Product Stewardship

B.1 HAZARD IDENTIFICATION AND RISK ASSESSMENT

All safety management should start with the identification of the hazards and the assessment of the risks at the hazardous installation. Procedures should be developed and adopted for hazard identification and risk assessment, arising from the properties and quantities of the substances produced and handled and the processes utilised in the installation, and should take into account representative and reasonable risk criteria. A step-by-step analysis of the processes will help to identify potential hazards and risks.

The procedures should be formal, systematic and written. They should reflect the need to involve specialists, the relevant employees at the installation, and the responsible managers in order to guarantee the objectivity of the hazard identification and risk assessment.

See Guiding Principles document, paras.:

- 2.a.16 Safety report to demonstrate that appropriate steps are being taken
- 2.a.17 Reports to be reviewed and updated regularly; contents of report
- 2.b.1 Undertake hazard identification and assessment
- 2.b.2 Consider choice of appropriate approach and method
- 2.b.3 Information concerning assumptions, data, and uncertainties to be provided
- 2.b.4 Strive for transparency in the assessment process
- 2.b.5 Affected stakeholders to have a role in the assessment process
- 2.b.6 All types of triggers of accidents to be considered
- 2.b.7 All types of consequences of accidents to be considered
- 2.b.8 Risk assessment to be a continuous and evolving process
- 2.b.9 Exchange information on risk assessment within the industry

TARGET
Hazards are properly identified and risks are adequately assessed.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent hazard identification and risk assessments are used to develop appropriate polices, procedures and practices to address risks.
ii) Extent risk has been reduced as a result of actions taken in light of risk assessments (in terms of, *e.g.*, number of people at risk, potential environmental impact, probability of an accident, size of risk zones).
iii) Number of incidents related to unforeseen risks (*i.e.*, not identified in risk assessments).
iv) Number of unacceptable risks that have not been adequately addressed.

Activities Indicators

i) Are there systematic procedures for hazard identification and risk assessment? Do these procedures address:
   - requirements set by the legislation;
   - criteria for deciding on whether to undertake an analysis;
   - requirements for hazard identification and risk assessments (*e.g.*, related to documentation and reporting);
   - how hazard identification and risk assessments should be done (*e.g.*, methods);
   - experience from incidents and lessons-learned;
   - consideration of the state-of-the-art/most effective methods;
   - the roles and responsibilities of those involved in undertaking hazard identification and risk assessments;
   - timing for hazard identification and risk assessments (addressing the various stages including planning, operations, and modifications of the installation);
   - actions that should be taken based on the recommendations from the risk assessments.

ii) Have installations within the enterprise completed appropriate hazard identification and risk assessments? Have these followed the established procedures?
iii) Is there a range of suitable methods for hazard identification and risk assessment that address technical matters, human factors and other aspects?
iv) Are all types of hazards and risks covered by suitable methods including:
   - safety, health and environment;
   - technical equipment, processes, storage facilities, utilities systems, projects, modifications, products, laboratory work, scale-up, etc.;
   - normal operation, start-up, shut-down, utility failures, other external disturbances, demolition, etc.;
   - human factors (at-risk behaviours identified);
   - other aspects (*e.g.*, "domino effects").
v) Is there a procedure to secure adequate resources, experience and skill to carry out the hazard identification and risk assessments?
vi) Is an incident case history record kept?
vii) Are there procedures available for calculation of probabilities of incidents occurring?
viii) Are there procedures available for calculation of consequences of selected scenarios for human health and for the environment?
ix) Have adequate barriers (*i.e.*, layers of protection) against these scenarios been identified and implemented?
x) Are there agreed criteria for risk tolerance for internal risk and external risk?
xi) Are there clear rules concerning the roles and responsibilities for participation of persons in hazard identification and risk assessments that address: leader(s) of the team; specialists; managers and other employees; and independent resources?
xii) Is there a procedure for keeping the result of hazard identification and risk assessments updated?
xiii) Is there a procedure to give feed-back from hazard identification and risk assessments in order to move towards improved safety?
xiv) Are there procedures for making relevant parts of risk assessments and consequence analyses available to public authorities and the community?

B.2 DOCUMENTATION

All enterprises should have good and orderly documentation related to safety for many reasons, including:

> **See Guiding Principles document, paras.:**
> - 2.c.11 Computer systems to provide information
> - 2.c.17 All safety-related information to be collated
> - 2.c.18 All modifications to be documented
> - 2.f.2 During changes, process documentation etc. to be supplemented
> - 2.i.10 Handover document for technology transfer to be provided

- documentation is necessary for conveying information to various persons;
- instruction-type documents are needed to specify the agreed way of performing certain activities;
- documentation gives all employees access to the agreed rules and procedures;
- documentation provides the necessary, correct engineering record of the status of installations;
- documentation concerning risk assessments and other investigations about the safety of the installations allows everyone to be informed and provides a basis for action;
- records of findings in the enterprise during operations, maintenance, modifications, etc. should be maintained and filed; and
- documentation provides a basis for improving the safety management system.

TARGET
Information is well-documented and all documentation is available.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent to which key information is documented and available.
ii) Extent documentation is maintained up-to-date (including engineering documents, operational procedures, instructions and other safety-related materials).

Activities Indicators

i) Is there complete documentation related to engineering, operational procedures, instructions and other safety related matters? Is the documentation:
  - comprehensive;
  - clearly written;
  - easily retrievable.

ii) Is there a document control system? Does this system ensure that documentation is passed along as appropriate?
iii) Does the documentation system address:
  - objective (task of the document);
  - scope (geographically, organisationally and/or the task);
  - roles and responsibilities;
  - principles and methods;
  - references?

iv) Does the documentation system conform with the requirements of the safety management system?
v) Is there a mechanism for keeping information in the documentation system and filing system updated?
  - Is this implemented on a timely basis;
  - Does this include all relevant types of information (including, for example, engineering information).

vi) Is there a document retention system?

B.3 PROCEDURES (INCLUDING WORK PERMIT SYSTEMS)

All enterprises should develop safety-related procedures which are agreed upon, circulated and adhered to. The procedures should be conveyed to employees, and training should be provided to help ensure that they are understood and followed.

See Guiding Principles document, paras.:
- 2.d.2 Ensure written and easily accessible operating procedures and instructions
- 2.d.3 Ensure procedures for prevention of fires, etc.
- 2.d.4 Ensure procedures for abnormal conditions
- 2.d.9 Ensure procedures for handover of new products, processes or equipment
- 2.e.1 Ensure procedures for maintenance and repairs

The procedures should be documented and include instructions for the safe operation of equipment, processes and storage facilities, and for other activities. The procedures should be based upon the assessment of the risks of the operations and should be one of the important elements related to the transfer of knowledge within the organisation.

TARGET
Employees carry out their tasks safely and under conditions necessary to satisfy the design intent of the installation.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent of activities which should have a written procedure or instruction, that are in fact covered by such written documentation.
ii) Extent to which relevant operators, managers and other employees know the procedures that could have an effect on safety.
iii) Extent incidents are attributed to procedures (due to, *e.g.*, procedures lacking, procedures inadequate and/or procedures not followed).
iv) Extent the work permit system is followed (*e.g.*, number of violations of the system).

Activities Indicators

i) Are all operations, maintenance, laboratory, transport and other activities needing procedures covered by such (normally written) procedures?
  - Are both routine work and more infrequent or isolated cases covered;
  - Are all phases of operations covered, such as:
    - start-up;
    - normal operations (including maintenance);
    - shift change;
    - shut-down;
    - abnormal situations;
    - emergency activities;
    - security;
    - transport;
    - housekeeping;
  - Are all aspects covered such as equipment (including safety equipment) and personnel involved with processing, handling and storage of hazardous substances;
  - Are risk assessments used as a basis for the procedures;
  - Are safety instructions integrated in, or co-ordinated with, operating instructions.

ii) Is there a mechanism to ensure that the procedures are designed and written in a user-friendly way, making compliance attractive and non-compliance unattractive?
iii) Is participation of the employees built into the development of procedures?

iv) Is there a formal system for work permits, addressing:
- hot work (welding, cutting, driving vehicles, etc.);
- entry into confined spaces;
- hazardous work (*e.g.*, opening of process systems, removal of pump, instrument jobs)?

v) Are there safety procedures for critical maintenance work, such as:
- lock-out of rotating equipment;
- tag-out of equipment;
- by-passing safety-critical alarms and interlocks (including authorisation, records, limit on number of by-passed interlocks, etc.)?

vi) Are the procedures easily accessible for the users and other interested parties?

vii) Is there a document control system for the procedures?

viii) Is there a means to ensure that relevant information is passed on from one stage to another and incorporated in procedures when developing or introducing new products, processes or equipment?

ix) Is there a means to ensure that procedures are being implemented?

x) Is there a means to ensure that procedures are corrected when conflicting with other procedures or if not working properly?

xi) Is there a system to ensure that users are informed and have learned about changes in the procedures?

xii) Is there a system for regular updating of the procedures?

B.4 MANAGEMENT OF CHANGE

Based on historical evidence, inadequate reviews of changes in enterprises have resulted in accidents. The definition of what constitutes a change includes: modifications in equipment, technology or software; changes in personnel (including reducing and increasing staff size); and administrative/ managerial adjustments, including temporary modifications.

See Guiding Principles document, paras.:

- 2.f.1 Formal procedures
- 2.f.2 Hazard analysis to be reviewed and process documentation to be supplemented
- 2.f.3 Provide procedures for startup after a modification
- 2.f.4 Employees to be informed and trained about the modifications
- 2.f.5 Contractors to be included in procedures

In this regard, it should be noted that changes in the organisational structure or in manning can be triggered by economic shifts.

In order to help ensure that changes in the operations and other activities in installations with hazardous substances are carried out without increased risk, there should be structured procedures for dealing with changes. The procedures should cover the entire process, from planning to implementation and follow-up, and should include safety controls such as risk assessments, formal authorisation by competent personnel, review and follow-up, etc. It is particularly important to address the trend for new technology to go directly from the laboratory stage to commercial scale.

TARGET
Change is managed to ensure that it does not increase, or create, risks.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent technical modifications or other changes follow management of change procedures (or extent of non-compliance with management of change procedures).

ii) Number of incidents resulting from failure to manage change appropriately (*e.g.*, change in procedural process made without following the management of change policy).

iii) Percentage of change requests that are processed as “emergency changes” (*i.e.*, requiring immediate attention for safety reasons).

Activities Indicators

i) Is there a clear definition of a change (modification)?

ii) Are there procedures addressing the management of change, which cover all the necessary steps from planning to implementation and follow-up? Do the procedures address:
   - approval by the relevant responsible person before proceeding to the next step;
   - risk assessment, as appropriate;
   - clear allocations of roles and responsibilities;
   - a formal control form to steer and to keep track of the various steps in the procedure.

iii) Do the procedures apply to technical changes as well as changes of organisational or administrative character? Do they address modifications in the following areas:
   - technical, including changes in equipment and buildings (mechanical, instrumentation and control systems and other software, electrical, civil, etc.);
   - process parameters and recipes, including raw material and chemicals, utilities, etc. (*e.g.*, deviations from the approved “operating window”);
   - organisation and management;
   - personnel (manning, working times, outsourcing, etc.).

iv) Do the procedures address permanent as well as temporary modifications (including pilot projects)?

v) Do the procedures provide for a risk assessment and/or other appropriate review including pre-startup review for relevant modifications? Does this address the need for competent personnel, independent from those directly responsible for the proposed change (recognising that depending on the complexity and risk level, external expertise may be needed)?

vi) Are there clear requirements related to the updating of technical and other documentation (*e.g.*, do they require updating before a modification is implemented)?

vii) Are there clear requirements for the updating of instructions/procedures and for information and training of employees before a modification is implemented?

B.5 CONTRACTOR SAFETY

In many enterprises, contractors are hired for certain types of work affecting safety where the enterprise does not have sufficient resources or the correct specialists. The use of contractors has, in some cases, increased the risk of chemical incidents. This may be due to the fact that the contractors do not have sufficient knowledge or training in the enterprise's safety policy and procedures, or there is not sufficient co-ordination with regular staff.

A basic principle should be that all contractors receive the proper training for the installation, and should work under the same conditions as would employees, applying the enterprise's safety-related policies, procedures and practices.

TARGET
Contractors comply with the same safety requirements, policies and procedures, as employees.

See Guiding Principles document, paras.:

- 1.7 Ensure contracts incorporate provisions on roles and responsibilities
- 2.c.21 Only use contractors that can satisfy all safety requirements
- 2.d.1 Identify roles and responsibilities, including contractors
- 2.d.2 Ensure written and easily accessible operating procedures and instructions
- 2.d.15 Only use competent contractors; monitor performance
- 2.d.16 Contractors to have equivalent rights and responsibilities as staff
- 2.d.20 Ensure information to contractors on hazardous substances
- 2.d.34 Ensure education and training
- 2.d.40 Keep record of education and training
- 2.e.1 Contractors to follow all standards and procedures for maintenance and repairs
- 2.f.5 Contractors to follow all standards and procedures for modifications
- 2.h.1 Contractors to follow all standards and procedures for shutdown and decommissioning
- 17.a.7-8 Contractors to follow all standards and procedures for transport interfaces

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent contractors act in accordance with the requirements and policies of the enterprise.
ii) Number of incidents attributed to contractors or visitors as a root or contributing cause.

Activities Indicators

i) Are there procedures for the selection and hiring of contractors to help ensure safety? Do they address:
   - general requirements and check for adequate professional competence including contractors' previous performance regarding safety;
   - safety conditions included as part of the contract;
   - safeguarding that all equipment, materials and vehicles used by contractors meet relevant rules and standards and are only used by competent and, where relevant, certified individuals within the applicable limits.

ii) Are there procedures to help ensure safety in relation to contractors working on-site, including:
   - registration of each individual contractor when on site;
   - training of each individual with a check of knowledge including regular updating of training;
   - designation of a company contact person responsible for the contractor;
   - clear channels of communication with management, with encouragement for the contractor to come up with suggestions;
   - periodic inspection of contractor performance and of contractor construction sites;
   - suspension of any contractors following misconduct?

iii) Are contractors treated in the same way regarding safety as employees in all relevant aspects (safety requirements, incident reporting, etc.)?
iv) Is there a system for monitoring and giving appropriate information to contractors and visitors to the installation (recognising that different information may need to be given to different types of visitors)?

B.6 PRODUCT STEWARDSHIP

Producers have a responsibility to promote the safe management of substances they produce - from design through production and use to their final disposal or elimination (including hazardous wastes) – consistent with the principle of "product stewardship." Producers should make special efforts to help prevent incidents during the handling, transport and use of a hazardous substance by downstream users as well as to help prevent incidents during disposal.

TARGET
Hazardous substances are managed in a safe manner throughout their life-cycle.

See Guiding Principles document, paras.:
- 1.10 Ensure safe management throughout the total life cycle; assistance to downstream users
- 1.19 Means to be made available to assist enterprises with limited resources
- 2.i.1 Promote the safe management of hazardous substances throughout the total life-cycle
- 2.i.2 Actively determine whether customers can safely handle the substances
- 2.i.4 Provide means of disseminating information regarding accident prevention
- 2.i.5 Larger enterprises to assist small and medium-sized enterprises
- 2.i.6 Smaller enterprises to examine need for assistance on safety matters
- 14.c.2 Report accidents to higher level management
- 14.c.5 Report incidents for sharing of information

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent downstream users/handlers follow information on how to safely handle the enterprise's product.
ii) Extent downstream users/handlers are satisfied with the enterprise's product stewardship policies and procedures.
iii) Number of incidents reported involving the enterprise's products (by downstream users).
iv) Extent of downstream users/handlers that have had a product stewardship assessment by the producer of the hazardous substance.

Activities Indicators

i) Is there a policy regarding product stewardship and continual improvement in this respect?
ii) Is there a procedure for identification of all the relevant risks associated with the enterprise's products?
iii) Do all products containing hazardous substances have comprehensive material data safety sheets (MSDSs) and other information needed for safe handling, transport and use of the products in all relevant languages?
iv) Is there a mechanism to ensure that the relevant information reaches downstream handlers and users of the products, including:
   - distributors;
   - customers;
   - end-users;
   - transporters;
   - those responsible for disposal?
v) Are records kept of the provision, and receipt, of information by all downstream users/handlers of products?
vi) Is there a mechanism to check that downstream users/handlers of products containing hazardous substances have adequate facilities and know-how to safely and responsibly handle the products?
   - Does the enterprise (producer) undertake a product stewardship assessment of downstream users/handlers;
   - Is there a mechanism to provide training for downstream users/handlers;
   - Is there a mechanism for responding to inquiries from downstream users/handlers;
   - If downstream users/handlers are found not to be capable, is there a mechanism to resolve concerns or to refuse to sell or provide the products.
vii) Is the packaging for any products containing hazardous substances designed in such a way that the products can be handled in a safe and environmentally sound way?

viii) Is there active assistance to other enterprises (particularly small and medium-sized enterprises) related to:
- accident prevention;
- emergency preparedness;
- emergency response to accidents involving hazardous substances?

ix) Is there a system for reporting, receiving and distributing incident case histories?

x) Is the enterprise prepared to assist with expertise in case of accidents with its products during transport or during handling/use by customers or other downstream handlers/users?

Section C. Technical Issues

Sound design, engineering and construction of technical systems are prerequisites for having safe installations. Installations should then be maintained in such a way that the technical integrity is kept at an adequate level.

There should always be an aspiration for designing processes and installations so that they are inherently safe. When this is not possible, additional safety systems should be included to make the installation as safe as reasonably possible. Systems should be designed to be robust and to accept both human errors and individual component failures without creating unsafe conditions.

Design, engineering and construction of hazardous installations should always be based on recognised and proven engineering standards and codes of practice for the relevant type of equipment. The same principles apply for the associated control systems and safety systems. A basic requirement is to design and maintain everything according to all statutory requirements.

The technical systems should be designed so that there is harmony between the hardware/equipment, the control system, the computer software system and the employees at the installation.

During the design process, there should also be adequate consideration to safety in site lay-out and land-use planning matters.

This section includes the following sub-sections:

C.1 RESEARCH AND DEVELOPMENT

All types of research and development – from scientific research to industrially applied research – need to be handled with care and responsibility.

See Guiding Principles document, paras.:

- 2.c.4 Safety measures to be incorporated at the earliest conceptual and engineering design stages
- 2.d.9 Knowledge and experience from research and development to be passed on
- 2.i.14 Offer affiliates/subsidiaries access to safety-related research information
- 4.c Research/academic institutions to undertake research related to accident prevention, preparedness and response

Within industrial enterprises, the focus will be on applied research and development, especially for development of:

- chemical products;
- processes for production;
- equipment for production;
- technical protection measures for process equipment; and
- information related to the safe use of chemicals.

There is also research and development in safety proper. Industry is jointly responsible for carrying out such general safety research in order that technology and practices used are safe and sound. Individual enterprises normally do not carry out this type of research themselves, but it is paramount that they are engaged by supporting research (for example, by funding and participating in projects run by or co-ordinated by industry associations, public authorities, academia and intergovernmental organisations).

Individual enterprises should, of course, manage their safety according to the state-of-the-art with respect to safety research and development.

TARGET
Safety is improved as a result of a research and development programme with respect to, *e.g.*, production processes, procedures/methods and products manufactured.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent safety reviews (risk analyses) are performed (relative to the number of laboratory experiments).
ii) Extent of support (funding and in-kind) for external safety research.
iii) Average risk index (measure of inherent safety) of new processes that proceed to pilot/commercial scale.

Activities Indicators

i) Are there procedures for undertaking risk assessments, including the aspects of inherent safety, early in the research and development process?
ii) Are there procedures for scaling up from laboratory to pilot and to commercial scale?
iii) Are gaps in knowledge and standards identified and documented during process development and scaling up, and are there procedures for hazard assessment of any identified gaps?
iv) Is there a procedure to incorporate lessons learned from incidents into research and development?
v) Are there procedures for ensuring that research is carried out safely, and do these procedures address, *e.g.*:
   - good house-keeping;
   - limitations of hazardous materials;
   - a good working environment?

vi) Are there procedures for making safety reviews/risk analyses before laboratory experiments?
vii) Are there procedures for the safe handling of laboratory wastes?
viii) Are substances under development with still unknown properties treated as hazardous?
ix) Is there active and regular support to external research and development related to chemical safety?

C.2 DESIGN AND ENGINEERING

The safety of an installation is founded in its design and engineering. Normally, the design should be based upon proven technology and knowledge and should take into account relevant national and international standards, codes of practices and guidance standards. When new ground is broken, the uncertainties should be compensated for by other means in order to achieve an appropriate level of safety.

The selection of equipment, construction material, etc. should be based on the design parameters, applying due safety margins and considerations. When necessary, redundant systems should be included to achieve the predetermined level of safety.

The enterprise should use qualified human resources and computational techniques, together with relevant chemical and physical data, for proper calculation of the equipment and safety systems.

See Guiding Principles document, paras.:

- 2.c.4 Safety measures to be incorporated at the earliest conceptual and engineering design phases
- 2.c.6 Integrate equipment, facilities and engineering procedures to reduce the risk as far as reasonably practicable
- 2.c.7 Principles of inherently safer design to be used in an integrated approach to safety
- 2.c.8 Consider need for "add-on" protective systems
- 2.c.9 Components to be "fail-safe"
- 2.c.10 Incorporate appropriate level of automation and decision support systems
- 2.c.12 Safety systems and alarms to be designed and adapted to the capability of operators and other employees
- 2.c.13 Site lay-out to be guided by overall safety goals
- 2.c.14 Design of storage facilities to take into account the nature and extent of the hazardous substances
- 2.c.16 Employees to be involved in the design of their work place
- 2.c.17 All safety-related information to be collated
- 3.b.3 Land-use planning to take into account the cumulative risks

Design and engineering should address human aspects, both with respect to the risk of human errors and ergonomics for employees. Employees should be invited to comment and influence the design.

In all design and engineering work, there should be independent checking as well as authorisation by responsible persons before implementation. As part of this, there should be a risk identification/analysis. Bigger projects should have technical reviews.

All design and engineering should be documented, easily accessible in files and always kept up-to-date. There should be a clear strategy of "barrier thinking" in the design of a facility, using both technical and organisational/administrative barriers to achieve sufficiently safe installations.

TARGET
Hazardous installations are designed and engineered with regard to safety, including design of processes, equipment and workplaces.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent of remedial modifications needed after project completion to achieve safe and well performing equipment (can be result of, *e.g.*, risk assessment, government inspection, process review and/or employee feedback).
ii) Extent design meets current codes and standards.
iii) Number of incidents where engineering design is identified as a root or intermediate cause.
iv) Extent of negative comments from authorities when reviewing new projects.
v) Extent of satisfaction by the employees of a newly-built installation.

vi) Extent of replacement of inferior components or systems with safer ones (*e.g.*, change to closed systems or to seal-less pumps).

Activities Indicators

i) Is there a system to ensure that there is adequate competence for: process design; engineering (all relevant disciplines); and construction materials selection?

ii) Is there access to the appropriate tools (*e.g.*, for design and engineering) and reliable data (*e.g.*, related to the properties of the hazardous substances handled)?

iii) Are there procedures addressing key safety issues in the design and engineering phase including:
- use of barrier analysis;
- general ergonomic and specific man-machine (operator interface) related aspects;
- choice of the most effective technology from a safety point of view, with the aim of designing inherently safer processes;
- design of utility systems to ensure reliability in light of system demands;
- incorporation of redundancy for important safety systems;
- independent reviews;
- taking advantage of the experience of employees in the design and engineering work;
- appropriate space planning, taking into consideration the hazards identified in risk assessment and emergency planning (*e.g.*, to avoid domino effects in the event of an accident, to classify areas for flammable materials, and to take into account land-use issues);
- incorporating maintainability aspects in the design and engineering phases of a project (including modifications);
- incorporating maintenance programmes?

iv) Is there a procedure for designing safety critical systems consistent with international standards for determining the necessary safety integrity levels?

v) Is there a procedure for the design and engineering of processes and systems to address potential malfunctions (*e.g.*, to include such safety measures as pressure relief systems, fire mitigation systems and means for collecting extinguishing water)?

vi) Is there a design rule that systems and components should, in general, be designed to be “fail-safe”?

vii) Is there a clear strategy in the selection of engineering components to have a high safety standard, including incorporation of inherently safer processes and systems (*e.g.*, use of seal-less pumps, explosion proof equipment and “fire-safe valves)?

viii) Are sewer systems and other underground piping systems designed for safety?

ix) Is there a clear control strategy for the processes/activities, which is based on managing and avoiding possible risks?

x) Is there a comprehensive engineering documentation system maintained up to date that addresses, *e.g.*:
- process design specifications;
- calculations of material and energy balances;
- Piping & Instrument diagrams;
- equipment specifications;
- interlock systems?

xii) Have all areas been classified for handling of flammable material, when relevant, and all equipment installed according to requirements?

C.3 INHERENTLY SAFER PROCESSES

The concept of inherent safety means that the process, or the chemical handling activity in itself, is safe regardless of what happens. This can be attributed to the fact that:

- only non-hazardous chemicals are involved, so even if they do escape from the system no harm results;
- the quantities of any harmful chemicals are so small that no real consequence can result; or
- the process is conducted at such conditions that no serious consequence can occur.

See Guiding Principles document, paras.:

- 2.c.4 Safety measures to be incorporated at the earliest conceptual and engineering design phases
- 2.c.5 Incorporate up-to-date standards, codes of practice, etc. as a minimum ambition
- 2.c.6 Integrate equipment, facilities and engineering procedures to reduce the risk as far as reasonably practicable
- 2.c.7 Principles of inherently safer design to be used in an integrated approach to safety
- 2.c.8 Consider need for "add-on" protective systems
- 2.c.9 Components to be "fail-safe"

In reality, it is always difficult to fulfil any of these conditions completely. For example, for chemicals to combine with each other to create desirable products, reactive chemicals are normally needed which are often harmful to human health and/or the environment. However, enterprises should always strive to approach a totally inherently safe process.

If the process or activity cannot be made inherently safe, there are other ways to achieve safe conditions. For example, various types of barriers could be built around a process such as fail-safe emergency shut-down systems, and blowdown facilities and/or containments.

Another important aspect for achieving safe installations is to design them as simple and with as much error tolerance as possible. See also "Design and Engineering" on page 72.

TARGET
Safety is improved through the use of inherently safe(r) processes and equipment.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent improvements have made the facility inherently safer (which can be measured by technical methods such as index methods).

Activities Indicators

i) Is there a procedure requiring the enterprise to consider the use of more inherently safe processes or design/engineering when new projects or modifications are being planned? Does this procedure include the principles of:
   - avoiding the use of hazardous chemicals, and substituting with those less hazardous;
   - reducing inventories of hazardous substances, both in process and in storage, as much as possible;
   - selecting operating/handling conditions so as to minimise the risk (normally meaning reducing temperature and pressure).

ii) Is there a procedure to minimise the risk by providing barriers, such as:
   - designing the system to withstand the worst possible accident without losing its integrity;
   - using well-designed safety integrity systems to stop a dangerous event from occurring;
   - installing second containments to catch accidental releases;
   - using adequate safety distances to protect people from consequences?

iii) Are there decision criteria based on a life-cycle concept (and not only short-term profit)?

C.4 INDUSTRY STANDARDS

Industry, and society in general, have gathered a lot of information based on experience on what is sound and safe design, engineering and construction. Much of this has been summarised in the form of commonly accessible standards, codes of practice and guidance. These should be regarded as corner-stones in safety for industrial installations. Some of these standards should be considered as mandatory, others as recommendations.

See Guiding Principles document, para.:
- 2.c.5 Incorporate up-to-date standards, codes of practice, etc. as a minimum ambition

Furthermore, some enterprises have developed detailed standards for their internal purposes, based on their experience and their specific requirements, which are used internally for design, engineering and construction.

TARGET
Appropriate up-to-date standards are implemented, and continually upgraded, taking into account standards, codes of practice and guidance developed by industry, public authorities and other relevant bodies.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent the facility's design, engineering and construction are consistent with current standards, codes of practices and guidance.

ii) Extent of engineering disciplines covered by updated internal standards (including incorporation of most recent external standards).

iii) Extent of unauthorised deviations from internal standards discovered when reviewing projects or existing facilities (internally or by public authorities).

Activities Indicators

i) Is there a process that incorporates into internal practices all relevant national (and where relevant international) standards, codes of practice and guidance from public authorities and other bodies?
   - Is this available to, and used by, those concerned with design, engineering and construction;
   - Is there a system to ensure compliance with binding standards.

ii) Are there internal standards in the following areas:
   - engineering standards for equipment and components (*e.g.*, for piping);
   - standards for safety critical equipment (SIL determination);
   - construction standards (*e.g.*, for welding);
   - administrative standards (*e.g.*, for drawings)?

iii) Is there a procedure for modifying an internal standard, including a review and a formal approval?

iv) Is there a procedure for making exceptions to an internal standard, including a review and a formal approval?

v) Is there a procedure for maintaining and regularly auditing the internal standards?

vi) Is the enterprise actively working on revising standards for improved safety?

C.5 STORAGE OF HAZARDOUS SUBSTANCES (SPECIAL CONSIDERATIONS)

Storage of hazardous substances presents special risks or concerns that warrant specific guidance, in addition to that addressed to all hazardous installations.

See Guiding Principles document, paras.:
- 2.c.14 Design of storage facilities to take into account the nature and extent of the hazardous substances
- 2.d.6 Procedures to be established at storage facilities, *e.g.*, to prevent product degradation

Large amounts of hazardous chemicals are often kept in storage. Releases of products could lead to fires and other accidents with major consequences. Therefore, special precautions should be taken to avoid loss of containment.

Among important aspects when storing hazardous substances are:

- maintaining proper information about the substances and products stored;
- proper marking and labeling;
- segregation of incompatible chemicals;
- limitation of volumes, to the extent it improves safety;
- proper storage conditions;
- proper location;
- secondary containment in case of a release;
- adequate fire and explosion protection (with special care for fireworks and other explosives);
- awareness of possible combustion products;
- availability and use of appropriate personal protective equipment;
- safe transport and loading/unloading operations.

TARGET
Hazardous substances are stored in a safe manner, in order to avoid any loss of containment and other risks of accidents.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Level of risk at the hazardous installation based on, *e.g.*, extent of hazardous material stored.
ii) Extent products are stored according to good practices, including *e.g.*:
   - extent tanks or warehouses containing hazardous substances have secondary containment;
   - extent tanks containing hazardous substances have overfilling protection systems;
   - capacity of storage facility/warehouse to contain contaminated fire water.

Activities Indicators

i) Are the following basic requirements fulfilled:
   - relevant information on all hazardous substances available;
   - proper labelling on all packaging and tanks;
   - adequate security measures taken?
ii) Is there a procedure for storage of various hazardous substances, including a sound policy on:
   - minimising the amount of stored hazardous substances;
   - securing a high quality storage facility (both in terms of the conditions of the facility and the quality of handling substances at the facility);
   - keeping certain substances which are incompatible segregated from each other;
   - limiting the amount per storage unit;

- proper storage (*e.g.*, limiting the height of storing bulk chemicals and small packaged chemicals);
- having adequate containment for spills;
- installing adequate fire protection facilities;
- co-ordination of transfers to/from the storage?

iii) Are all areas for loading and unloading hazardous chemicals appropriately equipped with facilities for containment of spills?

iv) Are all areas with the possibility of a fire, and with the possibility of having contaminated extinguishing water, constructed to contain the water and route it to a place where it can be controlled?

v) Are all storage areas located as to avoid the possibility for an accident to spread to other areas ("domino effects")?

C.6 MAINTAINING INTEGRITY/MAINTENANCE

Installations should be maintained in such a way that an adequate safety level is kept continuously. The integrity of installations should be kept at the intent of the original design. A long-term maintenance policy should be established for this purpose. The focus should be on preventive maintenance, based on measuring the condition of the equipment and of relevant systems.

Practical maintenance programmes should cover all sorts of important equipment (pressure vessels, piping, rotating equipment, instrumentation, safety systems, etc.), with regular tests and overhauls. Particularly important is the checking of special safety devices.

See Guiding Principles document, paras.:

- 2.c.18 Ensure quality assurance during the construction phase
- 2.c.19 Safety checks to be carried out at commissioning and start-up
- 2.c.20 Purchase equipment only from reputable suppliers; inspect equipment for safety
- 2.c.21 Only use contractors that can satisfy all safety requirements
- 2.e.1 Ensure programmes for the regular maintenance, inspection and testing of equipment
- 2.e.2 Ensure regular inspection and maintenance of emergency alarms and equipment

Maintenance work must be carried out under strict controls in order not to provoke hazards.

See also "Contractor Safety" on page 65.

TARGET
Integrity of equipment and facilities are maintained in order to avoid any loss of containment and other risks.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent of maintenance back-log for safety critical items (*i.e.*, actions not complete by "due dates").
ii) Extent of safety devices (*e.g.*, safety trips, pressure relief devices) that do not function properly when tested.
iii) Extent of testing of safety devices carried out versus testing planned.
iv) Extent of preventive maintenance versus corrective maintenance.
v) Number of unplanned shut-downs attributable to inferior maintenance.
vi) Number of incidents attributable to inferior maintenance.

Activities Indicators

i) Are there procedures to cover the safe construction of facilities by:
   - having inspection programmes to check the fulfilment of all standards;
   - using only reputable suppliers of equipment;
   - using only reputable contractors for installation?

ii) Is there a system for preventive maintenance with regular measurements of the condition of equipment? Does it include, *e.g.*:
   - tightness test of equipment and piping systems;
   - visual inspection of equipment;
   - lubrication and greasing of equipment;
   - vibration measurement of rotating equipment;
   - thickness measurement of vessels, tanks and piping (corrosion/erosion)?

iii) Is there a system for testing of safety systems (interlock systems, overfilling protection, critical alarms, emergency shut-down, fire protection systems including such things as emergency power and water supply and sprinkling, safety showers, etc.)? Does it address, *e.g.*:
- documentation on control method, test interval, responsibility;
- feed-back to revise the need for testing depending on the results.

iv) Is there a procedure for identifying and logging needs for repair and control of equipment?

v) Is there a system for follow-up and documentation of maintenance work? Is this used for analysis of performance and reliability of the equipment?

vi) Is there a procedure for checking that installations are maintained according to the specified engineering documentation, following all the mandatory requirements and additional internal requirements?

Section D. External Co-operation

Handling of chemicals is often very complex and involves great responsibility for all parties concerned. Therefore, all parties are dependent on each other for information on how to best handle the chemicals and for concrete assistance in emergency situations, etc.

The importance of good co-operation between all parties concerned is obvious. Enterprises should therefore strive for co-operation with: public authorities; the public and other stakeholders, including academia; and other industrial enterprises (directly or within trade associations).

Key issues for success in this area are:

- openness, pro-activeness and responsiveness;
- ability to create confidence; and
- exchange of knowledge, experience and accident/incident data.

This section includes the following sub-sections:

D.1 Co-operation with Public Authorities
D.2 Co-operation with the Public and Other Stakeholders (including academia)
D.3 Co-operation with Other Enterprises

D.1 CO-OPERATION WITH PUBLIC AUTHORITIES

Good co-operation with public authorities (based upon mutual trust, openness and responsiveness) is a prerequisite for smooth and successful safety at an enterprise. Good personal relationships between the respective individuals are also critical for successful handling of safety matters.

To facilitate this co-operation, information – of both long-term and short-term nature including information on reportable incidents – should be provided promptly to the authorities. Well-informed authorities are an asset for an enterprise.

See Guiding Principles document, paras.:

- 1.2 Prevention of accidents is the concern of all stakeholders
- 1.8 Management to co-operate with the public authorities to assist them in meeting their responsibilities
- 2.c.1 Co-operation with public authorities in land use planning
- 2.c.2 A scale plan to be developed for proposed new installations
- 2.c.3 Co-operation in developing means to reduce risks at existing installations

One specific subject related to co-operation with public authorities is land-use planning, an important strategic process for maintaining sufficiently safe conditions around hazardous installations. The main responsibility for this activity lies with the public authorities. However, enterprises have a vital role when selecting a proposed site for a new hazardous installation or when proposing major modifications to an existing site. The enterprise is also responsible for providing the information needed for land-use planning decisions by delivering risk assessments and other relevant input.

See also "Design and Engineering" on page 72 and "Hazard Identification and Risk Assessment" on page 58.

TARGET
There is effective and constructive co-operation with public authorities, based upon open communication, pro-active engagement and mutual confidence, leading to shared goals.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent public authorities have confidence in the safety policies and procedures at the enterprise. Evidence of this could be, *e.g.*, the authorities providing greater flexibility to the enterprise to show compliance with legislation, or the authorities performing only limited inspections (*e.g.*, US Occupational Safety and Health Administration's "star system").

ii) Reduction in numbers of questions about safety from the authorities.

Activities Indicators

i) Is there a specific policy/procedure for co-operation and communication with the authorities? Are people specifically appointed for this task?

ii) Are there well-established and trustful channels for communication with the (national) public authorities, both formal and informal?
   - Are there regular planning and information meetings;
   - Is there a means to easily get advice from authority contact(s);
   - Is there actual, regular communication with public authorities.

iii) Are there well-established and trustful channels for communication with the local authorities and community organisations, both formal and informal?
   - Are there regular planning and information meetings;
   - Is there a means to easily get advice from local authority and community contact(s);
   - Is there actual, regular communication with local authorities and community organisations.

iv) Is there a means for ensuring compliance with public authorities' requirements and requests?

v) Is there an effective land-use planning process, including:
- knowledge in the organisation and its key people of the external requirements;
- an inventory of all the risks posed by the enterprise on people and the environment;
- procedures for contacts with public authorities and the public early in projects;
- procedures for basing land-use planning on risk assessment including consequence analyses;
- procedures for including land-use planning aspects when making modifications to the on-site facilities?

D.2 CO-OPERATION WITH THE PUBLIC AND OTHER STAKEHOLDERS (INCLUDING ACADEMIA)

Creating and maintaining good and confident relationships with the public and other stakeholders is essential to ensuring confidence in the safety of the enterprise. Among these stakeholders are representatives of the community, hospitals and other health/medical services, schools, nursing homes, environmental groups and the media.

See Guiding Principles document, paras.:
- 1.2 Prevention of accidents is the concern of all stakeholders
- 2.a.11 The Safety Policy to be made available to the public
- 2.g.4 Improve transparency in audits, including making publicly available the relevant policies, programmes and outcomes
- 7.11 Industry, public authorities and the public to discuss the type of information to be made available to the public
- 7.12 Employees to act as safety ambassadors within their community

Co-operation with external stakeholders is not always an easy task and can only be reached if the enterprise acts in an open and pro-active manner, maintaining a continuous dialogue with interested parties. Information should be shared concerning the chemicals and chemical processes at the enterprise, including the safety measures used to prevent chemical accidents/incidents. Top management should demonstrate to the public their personal interest and commitment to safety issues. This can be done in a variety of ways, for example, by appearing in media (newspapers, radio), participating in public meetings, etc. A strong, co-operative relationship with the media can facilitate these exchanges.

The employees of the enterprise should be well-informed so that they could act as ambassadors for the enterprise in their relations with friends and other members of the community.

Communication with the public is normally a requirement in the legislation of most countries.

TARGET
There is co-operation with members of the public and other stakeholders in order to achieve public confidence that the enterprise is operating safely, based on open and trustful communication and provision of information on risks.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent the public is informed about the risks of chemical accidents in their communities.
ii) Extent of trusted two-way communication between industry and the media on safety issues, both formal and informal.
iii) Extent the public, environmental groups and other community-based organisations trust the information provided by industry.
iv) Number of complaints from the public regarding safety performance of the enterprise.

Activities Indicators

i) Are there specific policies/procedures for communicating with the community/public (including citizens' committees) and other stakeholders?
   - Are there employees responsible, and specifically trained, for this task;
   - Is information provided to the public and other stakeholders in a format that is easily understood by the average citizen and by journalists;
   - Is there co-operation with authorities and local officials when communicating with the public;
   - Does the enterprise participate in the community advisory panel (if there is one);
   - Is there active participation of the top management in the process of communication with the public.

ii) Is there a system for maintaining an ongoing dialogue with all the relevant people/groups in the neighbourhood (including, for example, housing areas, schools, hospitals and other health/medical services, nursing homes, commercial centres)?
   - Does it involve direct communication with the public (through, for example, a local council/committee for co-operation in safety questions, regular "open house" arrangements and/or seminars on the hazards and risks in the facility);
   - Does it include regular reporting of incidents, etc.;
   - Are there readily accessible lines for telephone and e-mail for the public to communicate with the enterprise.

iii) Is there a mechanism for checking that information has been well-received and understood?

iv) Is there a system for handling inquiries and complaints concerning safety issues from the public?
   - Is it a formal system with documentation;
   - Is feed-back given efficiently, as soon as possible, by a specially appointed person;
   - Does it include additional feedback after preventive actions have been taken.

v) Is there a procedure to provide the media relevant and quick information (especially in the event of an incident)?

vi) Is there a well-developed system for communication and co-operation with the suppliers to the enterprise?

vii) Is there a well-developed system for communication and co-operation with the customers of the enterprise?

viii) Is there a system for supporting and funding external research on safety?

ix) Is there a system for giving training to key members of the public on the safety programme of the enterprise? Does it include training for:
   - local schools;
   - hospitals and other health/medical facilities that might be involved in the event of an accident;
   - nursing homes in the area;
   - neighbouring commercial enterprises.

D.3 CO-OPERATION WITH OTHER ENTERPRISES

It is important for enterprises to co-operate in the interest of safety. Experience with safety-related issues should be shared in order that problems encountered by one enterprise are not repeated in other enterprises. Those that could benefit from co-operation (*e.g.*, through sharing of information and experience) include: enterprises within the same geographical area; those within the same sector of the industry; those using similar types of manufacturing processes and/or using the same type of chemicals; and/or those with a producer-user relationship.

See Guiding Principles document, paras.:
- 2.i.3 Enterprises to co-operate with others in their region
- 2.i.4 Industry/trade associations and other organisations to disseminate information related to accident prevention
- 2.i.5 Larger enterprises to assist small and medium-sized enterprises
- 2.i.6 Smaller enterprises to examine need for assistance on safety matters
- 2.g.6 Industry to share information on the methodologies and tools used for inspections and audits
- 2.g.14 Industry to create a system for improving the exchange of information and experience of auditing

The benefits from co-operation are many, *e.g.*:

- learning from each other in general, especially with respect to avoiding accidents;
- setting a general level of safety performance;
- spreading knowledge of the state-of-the-art;
- offering assistance to small and medium-sized enterprises (SMEs);
- creating joint efforts and funding to address major concerns;
- co-operating in conversations with relevant authorities; and
- improving chemical accident preparedness and response.

TARGET
There is co-operation and sharing of experience with other relevant enterprises.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent of participation in industry associations and programmes (local geographical, trade, professional, etc.) that address safety-related issues.

ii) Extent of participation in local networks that address safety-related issues.

Activities Indicators

i) Is there a system for sharing information on safety-related experiences (*e.g.*, accidents/near-misses):
- within the enterprise; and
- with other enterprises?

ii) Does the enterprise actively co-operate with other enterprises in avoiding domino effects?

iii) Is there participation in co-operative work with respect to, *e.g.*:
- setting up common safety objectives for the industry;
- working with risk acceptance criteria;
- systems for sharing information on accidents/near-misses;
- systems for offering assistance to SMEs?

iv) Does the enterprise participate regularly in conferences/workshops related to chemical safety?

v) Does the enterprise participate in industry, professional and trade associations (local, regional, etc.)?

vi) Does the enterprise participate in local co-operation groups related to safety?

Section E. Emergency Preparedness and Response

Despite all the efforts to avoid accidents, there must be preparedness to deal with the possibility of emergencies and accidents. This is a responsibility of the enterprise, of public authorities and of communities/the public.

Therefore, emergency plans should be developed, including both an enterprise-internal plan (on-site emergency plan) which is generally the responsibility of the enterprise, and an external plan (off-site emergency plan) which is generally the responsibility of the public authorities. These two plans should be co-ordinated with each other in order to be able to efficiently and properly deal with possible accidents.

Criteria for when to call in the external emergency response resources should be agreed between the enterprise and the relevant public authority.

A key point in emergency planning is the regular training of people in the implementation of the plans.

Close co-operation between enterprises and public authorities is necessary both in establishing the plans and in related training. There should also be co-operation with the public and other stakeholders. The enterprise has a key role in facilitating such co-operation.

This section includes the following sub-sections:

- E.1 Internal (on-site) Preparedness Planning
- E.2 Facilitating External (off-site) Preparedness Planning
- E.3 Co-operation Among Industrial Enterprises

E.1 INTERNAL (ON-SITE) PREPAREDNESS PLANNING

The enterprise should prepare an on-site emergency plan for how to handle an emergency internally and with internal resources.

This plan should be based on possible accident scenarios identified as a result of the hazard identification and risk assessments. The plan should address subjects such as the internal emergency organisation, mitigation resources, alarming systems, emergency response centres, evacuation, information, when to request external response resources, etc.

TARGET
Adverse effects of chemical accidents are effectively mitigated.

See Guiding Principles document, paras.:

- 5.a.1 Public authorities and the industry to establish emergency planning activities
- 5.a.2 Programmes to elaborate possible scenarios, and an identification of potential risks and zones likely to be affected
- 5.a.3 Planning to include potential health and environmental consequences and to identify actions
- 5.a.4 Planning to take into account potentially complicating factors
- 5.a.12 Emergency plans to be tested, reviewed and updated
- 5.a.13 Assessment to be made of existing skills, equipment and other resources available, and compared to what might be needed
- 5.a.17 Systems and procedures for detection of an accident to be in place
- 5.a.18 Methods to inform the public about warning systems and how to act in case of emergency
- 5.a.19 Spokespeople to be carefully chosen and trained
- 5.b.1 Industry to have an adequate on-site emergency plan
- 5.b.2 On-site emergency plan to have roles and responsibilities, and chain-of-command, defined
- 5.b.3 All employees to be made fully aware of provisions in plan
- 5.b.4 Visitors to be provided with information on what to do in an emergency
- 8.1 Systems to alert response personnel to be in place
- 8.2 Parties responsible for emergency response to be invited in the planning process
- 8.4 Spokespeople to have the necessary knowledge, skills, authority and credibility
- 9.1 On-site emergency plan to be activated in the event of an accident
- 9.2 In case the emergency cannot be handled by on-site resources, the local emergency response authorities to be alerted
- 9.3 Plans to contain criteria for when public authorities to be called in

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) The number of elements in the plan which work correctly when tested.
ii) The number of problems identified during testing or implementation of the on-site plan.
iii) Extent to which the on-site plan has been tested (in relation to any testing plans).
iv) Extent of employee competence in responding to unexpected events (*e.g.*, when an incident occurs, or during testing procedures).

Activities Indicators

i) Is there an adequate on-site emergency preparedness plan?
   - Is it based on a thorough identification of possible accident scenarios, covering the whole range from small and likely to major and unlikely scenarios;
   - Does it consider external hazards;
   - Does it include an emergency organisation with clearly defined roles for all personnel involved, and with a clear hierarchy of responsibility;
   - Does it address preparedness for accidents with off-site impacts;
   - Are the internal resources of the emergency organisation adequate for carrying out its tasks, at any time of the day or the year;
   - Is the system for calling in personnel adequate at all times.

ii) Is there regular training and exercise of the on-site plan?
   - Does it involve all the relevant forces in the community on a regular basis;
   - Does it cover all employees (*e.g.*, on all shifts) on a regular basis;
   - Is training performed during non-office hours to test the on-call system;
   - Are "dry runs" performed;
   - Are table-top exercises carried out.

iii) Are all employees, contractors and other personnel at the site informed about the on-site plan and trained for appropriate response actions?

iv) Is there an internal emergency force for the immediate mitigation of emergencies?
   - Is it adequately trained for its tasks;
   - Does it have adequate (and regularly tested) equipment.

v) Is there an adequate system for alarming within the enterprise in an emergency situation, including:
   - alarming from the field to the response resources without delay;
   - alerting all personnel within the enterprise by (*e.g.*, by sounding alarms and/or visually by lights)?

vi) Is there a system (and criteria) for external alarming of, *e.g.*:
   - external response resources;
   - the community (the public in the vicinity of the enterprise) when applicable?

vii) Is there adequate provision for an emergency control centre within the enterprise which includes:
   - communications equipment, which will always be operable;
   - relevant plans and drawings of systems on the site;
   - call lists, personnel lists, etc.;
   - an alternate centre in case the normal should become inoperable?

viii) Are there well-marked and clear evacuation routes leading to defined assembly points for personnel in case of an evacuation?

ix) Is there a counting and reporting system for reporting missing people, covering all people on the site at the time of the emergency?

x) Are there clear criteria in the emergency plan on when to trigger the off-site emergency plan? Has this been agreed with the authorities?

xi) Is the responsibility for communication with external parties clarified (*e.g.*, company spokespeople)? Is the appointed person(s) trained for this purpose?

xii) Is there a procedure for review and updating of the emergency plan? Does it address review and updating:
   - on a regular basis;
   - after training of the plan.

E.2 FACILITATING EXTERNAL (OFF-SITE) PREPAREDNESS PLANNING

In case of a significant emergency at a hazardous installation, there will be a need to use the resources of the community for mitigation, rescue, hospitalisation, information, evacuation and possibly other activities. For this to work in a real situation, thorough co-operative planning and training must be done in advance.

Public authorities have primary responsibility for off-site planning, and it is the responsibility of the enterprise to facilitate this as much as possible with relevant input and co-operation.

TARGET
Support is given to public authorities and others in the development and implementation of off-site preparedness plans.

See Guiding Principles document, paras.:

- 5.a.8 Co-operation between industry and response personnel essential
- 5.a.9 Industry, public authorities and health/medical organisations to co-operate
- 5.a.10 Emergency plans to identify the roles and responsibilities of all parties concerned
- 5.a.12 Emergency plans to be tested, reviewed and updated
- 5.a.13 Assessment to be made of existing skills, equipment and other resources available, and compared with what might be needed
- 5.a.14 All parties to ensure that all types of resources needed are available
- 5.b.8 Industry to work with public authorities in developing off-site emergency plans
- 5.b.9 Industry to co-operate with public authorities to ensure the public have appropriate information
- 5.b.10 Enterprises in the same geographic area to co-ordinate their on-site emergency plans

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicator

i) Extent and quality of support to public authorities and others involved in off-site preparedness planning.

Activities Indicators

The following indicators reflect the activities that should be undertaken by the enterprise, although the formal responsibility for off-site planning will be with the public authorities:

i) Is there a joint group (involving industry, community and public authorities) for undertaking off-site planning?
ii) Are the responsibilities for the enterprise, the public authorities and other stakeholders (including the public) in an emergency clarified in detail?
iii) Is the off-site emergency plan based on possible risk scenarios identified in hazard identification and risk assessments as well as on other relevant considerations?
iv) Has the enterprise provided adequate information to public authorities (including, for example, response personnel, health/medical facilities, environmental authorities, etc.) and to other enterprises that may be affected in case of accidents including, *e.g.*:
   - data on the chemicals;
   - information on volumes of chemicals as well as storage and process conditions;
   - information on possible by-products and combustion products that could be formed in an emergency.
v) Are there regular visits from the public authorities to familiarise them with the installations?
vi) Is there regular training of the on-site emergency plan with participation of the external (public) resources?
vii) Is there assistance in setting up of on-site plans for other enterprises that may be affected in case of accidents?
viii) Are the combined resources from the enterprise and the community adequate to deal with all the foreseeable scenarios?
   - Is there a procedure for calling in assistance from outside the community, when needed.

E.3 CO-OPERATION AMONG INDUSTRIAL ENTERPRISES

In case of an accident that is too big or difficult for the affected enterprise to handle, the resources of enterprises located close-by or enterprises with special qualifications to assist should be used to mitigate the emergency.

See Guiding Principles document, paras.:
- 5.a.14 All parties to ensure that all types of resources needed are available
- 5.b.10 Enterprises in the same geographic area to co-ordinate their on-site emergency plans

There are also possibilities to co-ordinate on a more general level between enterprises dealing with similar facilities and products.

Aspects to consider include:

- sharing of equipment locally;
- sharing of personnel, information and expertise for mitigation on a local level; and
- joint personnel, resources and equipment for mitigation of transport accidents.

There are also other subjects that could be part of co-ordination and co-operation, *e.g.*, guarding against outside threats, awareness of possible domino effects.

The initiative to co-ordinate and optimise resources could either come from the enterprises themselves, but would normally be co-ordinated by some community organisation or public authority.

Training and exercises related to anticipated joint efforts are essential.

TARGET
There is effective co-operation and co-ordination among industrial enterprises to improve emergency planning and response.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicator

i) Extent other enterprises provide support during a response or exercise.

Activities Indicators

i) Are there procedures for co-ordination/co-operation in case of emergencies, on a local, regional and/or national level? Does it include the issue of possible domino effects, when relevant?
ii) Do the procedures include sharing of equipment and personnel for mitigation?
iii) Do the procedures address fixed installations and transport of hazardous substances?

Section F. Accident/Near-Miss Reporting and Investigation

Learning from incidents and other experience is absolutely fundamental for improving safety at hazardous installations. Therefore, enterprises should have a functioning system for reporting incidents, and for action and follow-up based on experience.

There should also be systems on a national level requiring enterprises to report more serious incidents for further handling by authorities/trade associations. Efforts should be made to facilitate sharing incident case history information among enterprises, both nationally and internationally.

This section includes the following sub-sections:

- F.1 Reporting of Accidents, Near-Misses and Other "Learning Experiences"
- F.2 Investigations
- F.3 Follow-up (including application of lessons learned and sharing of information)

F.1 REPORTING OF ACCIDENTS, NEAR-MISSES AND OTHER "LEARNING EXPERIENCES"

Each enterprise should have a system for internal reporting and dealing with all events which deviate from normal conditions and which could have adverse effects on safety, health, the environment or property (called "incidents" for purposes of this Document). This is the basis from which enterprises can learn from experience to avoid repeating similar dangerous occurrences.

Events which actually lead to measurable consequences – damage to people, the environment or property – should all be reported and handled promptly and efficiently. It would obviously be the goal to have as few as possible of these kind of events (accidents).

See Guiding Principles document, paras.:

- 1.9 Management to encourage and facilitate the reporting of all incidents
- 2.d.31 Employees to report to management any situations deviating from normal
- 2.d.42 Particular attention to be given to "human factors"
- 14.a.1 Create a climate that fosters trust, especially for reporting incidents
- 14.c.1 Industry to comply with all procedures for reporting accidents to public authorities
- 14.c.2 Local management to report to higher management all significant incidents
- 14.c.3 Safety culture to promote the reporting of all incidents
- 14.c.4 Information on incidents to be provided also to trade associations

Events which do not lead to any measurable consequences, but which could have resulted in consequences, had the circumstances been different – "near-misses" or other "learning experiences" – should also be reported and handled in a similar way. The objective should also be to minimise such events; however, efforts should be made to have as many of them as possible reported in order to learn from experience. This is of particular concern because there is a tendency not to report events when there are no consequences.

It could be an advantage for the enterprise's reporting scheme to have two categories: events with measurable consequences; and those without consequences. While the principle of learning the maximum from each event to avoid a recurrence should be the same, consideration should be given to having separate reporting systems for:

- serious accidents (including those with fatalities or major environmental impact), Lost Time Incidents (LTIs), accidents with significant environmental impact and accidents involving first aid or other medical treatment; and
- "near-misses" (deviations with no or little consequences) and other "learning experiences."

TARGET
Accidents, near-misses and other "learning experiences" are reported in order to improve safety.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent relevant incidents (accidents and near-misses) are reported.
ii) Rate of recordable incidents (measured by categories such as loss of primary containment, fires, explosions).
iii) Number of days since last recordable incident.
iv) Extent lessons are identified as the results of incidents (accidents and near-misses) and influence change.
v) Rate of incidents causing environmental or property damage.
vi) Number of automatic emergency shut downs.
vii) Number of abnormal releases from continuous (or normal) emissions.
viii) Rates of incidents related to occupational injuries or occupational illnesses [using, for example, lost time incident (LTI) rates, lost work day rates, severity rates, recordable incident rates or medical treatment cases].

Activities Indicators

i) Is there a comprehensive system for reporting incidents and other "learning experiences"?
  - Are there definitions for "reportable events";
  - Are all types of incidents and other learning experiences involving hazardous substances covered (including serious accidents, LTIs, medical treatment, environmental impact, near-misses and other learning experiences);
  - Does the reporting system include all incidents related to the activities of the enterprise including actions of contractors and transporters;
  - Are there clear responsibilities for co-ordination and maintenance of the system.

ii) Are there clear, documented procedures for reporting, with well-defined roles and responsibilities, and clear directions and reporting forms?
  - Does this include reporting to third parties (*e.g.*, national authorities, local authorities including emergency response personnel, trade associations);
  - Are relevant parts of accident reports available to the public.

iii) Are all employees encouraged by the management to report and discuss incidents?
  - Is there an open atmosphere, without fear of punishment;
  - Are there incentives for reporting;
  - Is there a history of employees willing to report their mistakes;
  - Are there opportunities to discuss incidents, and ways to avoid similar situations in the future;
  - Is there a formal mechanism for responding to employee reports, including taking action and giving feed-back to the individual;
  - Is there a mechanism to share lessons learned throughout the enterprise, and the industry.

iv) Is the reporting system regularly reviewed to ensure that it is functioning as intended?
  - Is there a mechanism for assessing or measuring that reporting and follow-up actually leads to increased safety awareness;
  - Are the findings of the review utilised to improve the reporting system.

F.2 INVESTIGATIONS

See Guiding Principles document, paras.:
- 15.a.1 Industry to investigate all incidents
- 15.a.2 Protocols to be established for conducting root cause investigations
- 15.a.3 A team to be established for accident investigations
- 15.a.4 Investigations to take account of various types of information/evidence
- 15.a.5 Comprehensive investigation reports to be prepared
- 15.a.6 Recommendations from investigations to be specific
- 15.a.7 Ensure adequate follow-up to investigations
- 15.a.8 Consider the use of third parties in certain cases
- 15.a.10 Following an investigation, provide a review of the investigation process
- 15.b.1 Ensure prompt investigation and thorough analysis of all incidents
- 15.b.2 Industry to be committed to doing root cause investigations

It is important that accidents involving hazardous substances and other relevant incidents be promptly investigated after they have been reported. The objective of the investigations should be to determine the root and contributing cause(s) in order to avoid similar problems in the future. This goes beyond the immediate cause of the accident (*e.g.*, the operator failed to follow proper procedures). The root cause analysis seeks to determine the underlying reason for the failure (such as the operator was not well-trained or had insufficient information, there was insufficient staff, there was extreme stress on the operator or the design of the facility made it difficult for the operator to follow procedures). The same goes for analysing technical, organisations and human causes.

Procedures should be in place for the investigation and analysis of incidents. A system should also be established for analysing the result of the investigation and taking corrective action, as appropriate. The extent of the investigation should be related to the seriousness of the incident and the value of the incident for learning lessons.

Information from investigations should be shared within the enterprise and throughout the industry.

TARGET
Root causes and contributing causes are identified through investigations of accidents, near-misses and other unexpected events.

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent that incidents (accidents and near-misses) are investigated in accordance with established procedures.
ii) Extent of events where the investigators identify root and contributing cause(s).

Activities Indicators

i) Is there a system/procedure for investigation and analysis of incidents, with the following key features:
   - identification of roles and responsibilities of those involved in the investigations (ensuring that appropriate experts and staff are involved, including employees concerned with the event);
   - clear statement of criteria for determining which incidents should be subject to investigation, and at what level;
   - clear criteria for appointing investigating teams when relevant (with impartial members);
   - criteria for when external resources should be called in, *e.g.*, representatives of the community;
   - procedures for carrying out the investigation (including how to gather evidence from witnesses, documentation, technical reviews and other sources);
   - procedures for analysing evidence;

- procedures for determining and analysing root causes, together with contributing causes;
- procedures for developing conclusions and recommendations;
- procedures for analysing whether the interface with external planners, responders and the public functioned as expected?

ii) Is the analysis of an incident supplemented by a potential problem analysis of similar situations in other parts of the enterprise?

F.3 FOLLOW-UP (INCLUDING APPLICATION OF LESSONS LEARNED AND SHARING OF INFORMATION)

After incidents have been investigated and root causes found, appropriate corrective actions should be taken, as well as other follow-up activities such as dissemination of information and experience.

In this regard, two separate categories for follow-up actions should be distinguished: one for each individual incident; and another for a collected number of incidents over a longer period (*e.g.*, a year).

In addition to investigations of individual incidents, it is essential to carry out an overall analysis of all the incidents that happen within an enterprise in order to identify common underlying causes and trends. Based on statistics and trend analyses of incidents over a period of time, it will be possible to find systematic problems, leading to efficient programmes and measures for corrective actions.

See Guiding Principles document, paras.:
- 14.a.1 Create a climate that fosters trust
- 14.c.5 Co-ordinate reporting by industry at national and international level
- 15.a.7 Ensure adequate follow-up to investigations
- 15.a.11 Provide efforts to promote sharing of the lessons learned
- 15.a.12 Information from investigation reports to be shared among stakeholders
- 15.a.13 Make efforts to share methodologies used in investigations
- 15.a.14 Make efforts to develop an agreed framework for preparing investigation reports

TARGET
Effective corrective actions are taken as the result of lessons learned from accidents, near-misses and other "learning experiences."

POSSIBLE SAFETY PERFORMANCE INDICATORS:

Outcome Indicators

i) Extent all relevant recommendations from investigations are implemented.
ii) Amount of time needed for implementation of recommendations from investigations.
iii) Extent of recurrence of accidents with the same or similar causes.
iv) Extent that trend analyses reflect safety improvements, based on elimination of root and contributing causes of incidents.

Activities Indicators

i) Is there a procedure for taking corrective actions as the result of individual incidents? Does this procedure address:
   - identification of roles and responsibilities for action;
   - when and how to take action;
   - the need to consider technical and managerial actions.

ii) Is there a system for follow-up of incident investigations and related recommendations? Does this procedure address:
   - identification of roles and responsibilities for taking action;
   - timely implementation of recommendations/establishment of deadlines;
   - documented follow-up to determine whether recommendations have been followed, action(s) have been taken and the reason(s) for such action(s).

iii) Is there a procedure for preparing statistical reports and trend analyses to identify common or systemic problems (such as weaknesses in training, inadequate procedures, maintenance problems or inadequate technology)?
   - Is there a procedure for taking corrective actions as a result of such studies.

iv) Is there a system for aggregated analysis of reported incidents, addressing *e.g.*:
- type of incidents involved (amount of chemical released, notification time, response time, extent of injuries);
- why numbers are going up or down?

v) Is there an efficient and effective system for disseminating the results of accident investigations, statistical reports and trend analyses? Does this provide for dissemination:
- inside the enterprise to all concerned;
- to other enterprises within the industry;
- to stakeholders outside the enterprise (including, *e.g.*, public authorities, media, community, the public).

vi) Do the results of investigations result in appropriate modifications to on and off-site emergency plans, response operations and other preparedness and accident prevention activities.

ANNEX I: Further Guidance on Developing SPI Metrics

Introduction

This Annex provides detailed guidance on the selection of metrics when choosing outcome and activities indicators for an SPI Programme. It should be used in conjunction with Steps Three and Four of Chapter 2 (*How to Develop an SPI Programme*).

Outcome and activities indicators consist of two inter-related parts: *what* is being measured (*e.g.*, staff competence) and *how* it is being measured (*e.g.*, number of staff scoring above 75% on a competency test). The "metric" associated with an indicator is focused on the question of *how* the indicator is being measured. For this *Guidance*, a *metric* is defined as a system of measurement used to quantify safety performance for *outcome* and/or *activities* indicators.

This Annex contains definitions related to: indicator subjects; data collection methods; data types (measurement levels); and categories of metrics. The definitions are followed by four tables that will help you to choose a metric for an indicator, depending on your answers to the following questions: what is being measured; how will the data be collected; what type of data best fits your needs; and what category of metric best fits your needs? The logic for using the sets of definitions and tables for choosing a metric is set out in Figure 3 (Steps for Selecting a Metric) and Figure 4 (How to Use this Annex) on the following pages. Figure 3 provides an overview of the questions that a user should ask and address and the steps for selecting a metric. Figure 4 provides additional detail on how to use the information in the Annex to complete these steps.

FIGURE 3 - STEPS FOR SELECTING A METRIC

The purpose of this Figure is to help you select a metric for a particular outcome or activities indicator by determining four relevant elements: the subject of your indicator; the data collection method; the type of date you will collect; and the category of metric that is appropriate.

Before you start, try to answer these questions:

- Who will use the indicator?
- How will the indicator be used to make decisions?
- How can the outcome/activities be measured?
- What potentially useful data are already collected by the enterprise?

Answer the questions below, referring to the Step-by-Step guidance in Chapter 2 and the definitions on pages 104 through 107. Use your answers to the questions along with Table 1 and the appropriate version of Table 2 (2A, 2B or 2C) to complete the blue boxes and choose a metric for your outcome or activities indicator.

What is being measured?
(*e.g.*, people, organisations, systems/processes, physical plant/processes, hazard/risk)

- Identify the subject of the SPI.
- Refer to **Indicator Subjects - Definitions**, page 104.

INDICATOR SUBJECT:

How will the data be collected?
(*e.g.*, testing, surveys, interviews, observations, instruments, combined methods)

- If generating new data for the SPI, identify data collection methods that fit the measurement culture of the enterprise.
- If using existing data for the SPI, identify data collection methods associated with the existing data.
- Refer to **Data Collection Methods - Definitions**, page 105.

DATA COLLECTION METHOD:

→

What type of data best fits your needs?
(*i.e.*, binary measures, categories, ordered measures, ratio measures, interval measures)

- Based on your answers to "what is being measured?" and "how will the data be collected?" review **Table 1**, page 108 and identify the data type that best meets your needs.
- Refer to **Data Types (Measurement Levels) - Definitions** page 106.

DATA TYPE:

→

What category of metric best fits your needs – descriptive, threshold or trended?
What table (2A, 2B or 2C) represents that category?

- Identify the category of metric that seems to best fit your needs – descriptive, threshold or trended.
- Refer to **Categories of Metrics - Definitions**, page 107.
- Identify the metrics selection table, **2A (Descriptive)**, page 110, **2B (Threshold)**, page 111 or **2C (Trended)**, page 112, associated with the general type of metric that you identify.

CATEGORY OF METRIC:

TABLE 2A, 2B OR 2C:

→

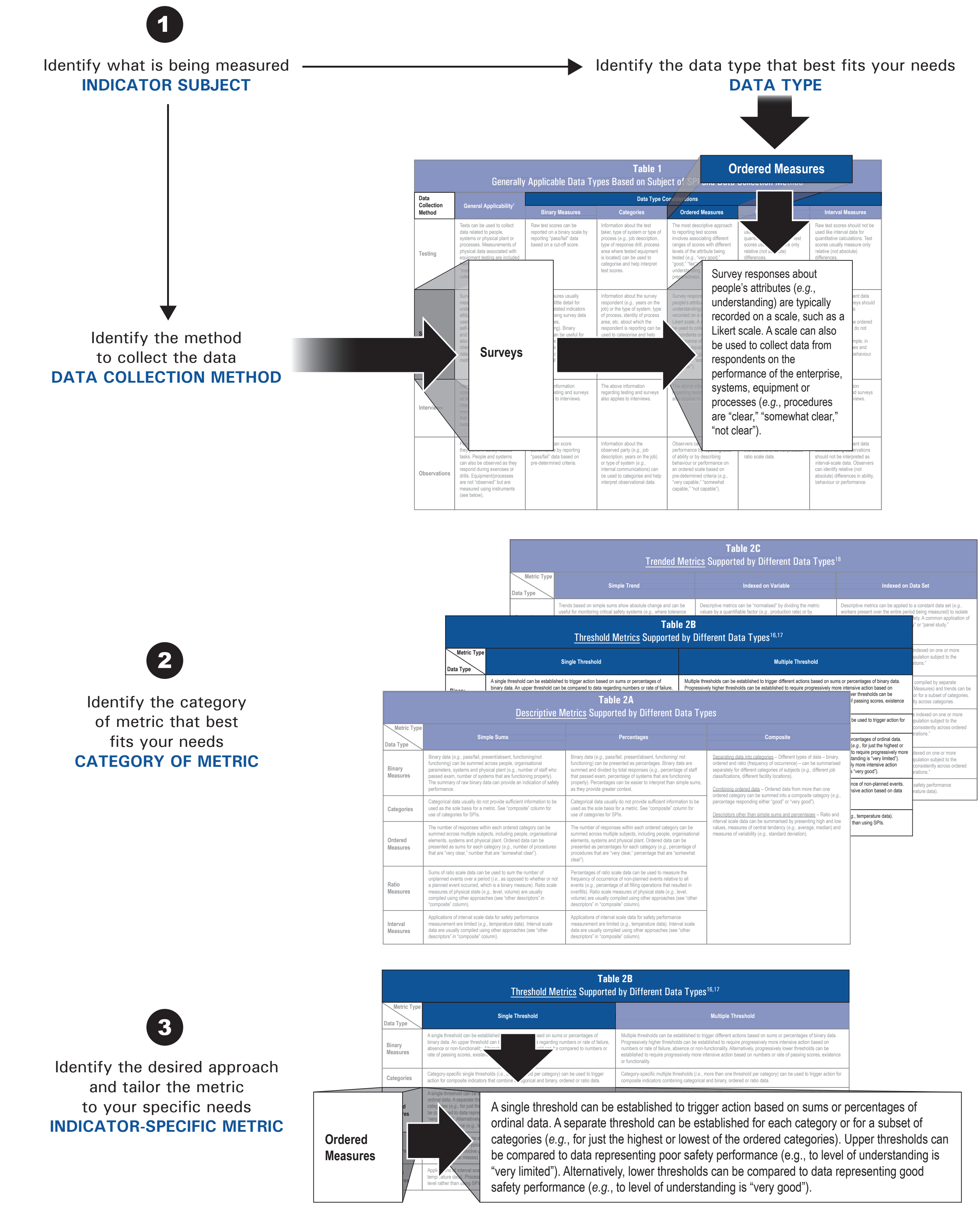
What is the best metric for your application?

- Find the entry in the metrics selection table (**Table 2A**, **2B** or **2C**) that corresponds to the data type identified using **Table 1**.
- Review the entry, identify the desired approach and develop the details for the metric to best meet your needs.

INDICATOR-SPECIFIC METRIC:

FIGURE 4 - HOW TO USE THIS ANNEX

The following is an example of how this Annex can be used to identify the best metric for your application. This example identifies a situation where a simple threshold metric will be used for an outcome/activities indicator that will rely on survey data. This example is for illustration only. Other metrics, appropriate to your specific circumstance, can be selected using a similar approach.



Indicator Subjects - Definitions

For purposes of defining metrics, safety performance indicators can generally be organised into five categories: people, organisations, systems/processes, physical plant/processes and hazard and risk measures.

People: Indicators can measure people's attributes, such as understanding, values, attitudes, capabilities and behaviour. People subject to SPIs could include labour and management personnel, such as equipment operators, safety personnel, senior managers and contractors. Examples of SPIs that measure people's attributes include:

- Level of knowledge of procedures by affected operators, managers and other employees;
- Extent employees are satisfied with their safety situation;
- Extent employees use appropriate safety equipment.

Organisations: Indicators can be used to measure an organisation's attributes. Analogous to people, organisations can demonstrate values, attitudes, capabilities and behaviours, which will be reflected in organisational design and operations. However, measuring organisations is a fundamentally different task than measuring people, which has implications for the types of metrics that are most applicable. Examples of SPIs that measure organisational attributes include:

- Extent employees are given opportunities to participate in safety management decisions;
- Extent management is involved in safety activities;
- Extent to which responsibilities for safety management system are assigned.

Systems/Processes: Indicators can also be used to measure attributes of organisational systems and processes, such as their presence, functionality and effectiveness. This category could be viewed as a subset of the above "organisations" category; however, because safety management systems are central to safety performance, it is useful to treat systems separately for the purpose of focusing the metrics selection process. Examples of SPIs that measure organisational systems and processes include:

- Extent to which planned safety rounds/inspections are actually implemented;
- Extent technical modifications are carried out according to management of change procedures;
- Clarity of control strategy for hazardous materials processes/activities.

Physical Plant/Processes: Indicators can be used to measure the state or condition of the physical plant, physical processes and the workplace and surrounding environments. These could include physical measurements (*e.g.*, temperature, pressure or level), equipment counts (*e.g.*, number of operational sprinkler heads) and hazardous material quantities or concentrations. Examples of SPIs that measure the state/condition of physical plant and processes include:

- Measurements of exposure at work places;
- Capacity for containment of contaminated water;
- Extent of safety devices that do not function properly when tested.

Hazard and Risk Measures: SPIs are also used to monitor progress in attaining more complex measures of safety such as hazard or risk. These are more complex expressions of a physical state or condition. Examples of SPIs that address more complex measures of safety include:

- Extent of inherently safer processes in the enterprise;
- Reduction of chemical risks at hazardous installations;
- Extent to which safety goals and objectives have been achieved.

Note that for some indicators, it will be unclear which of these categories applies. For example, the indicator "extent to which employees are involved in the design of their workspaces" could reflect employee attitudes (subject: people) or Organisational opportunities (subject: organisations). When answering the question, "*what is being measured*?" it is important that you clearly define what the data will reflect. From this, you can find an appropriate metric.

Data Collection Methods - Definitions

When defining an SPI, it is important to identify what data are available already or could be obtained to support the indicator. For enterprises that already have data that will support an indicator, defining them by data type will help select the appropriate metric. For enterprises that will need to collect new data to support an indicator, the collection method will influence applicable data types which, in turn, will influence the types of metrics that can be used. The following are common data collection methods used in the context of performance indicators:

Testing: Testing is a procedure whereby people, systems or physical plant/processes are subject to stimuli and conclusions are drawn based on an objective evaluation of responses. For example, people can be given tests to evaluate their understanding of a safety process, emergency response systems can be tested using incident exercises, and equipment can be tested at a range of temperatures and pressures. Testing data can be reported in terms of raw test scores, test scores described on a scale (*e.g.*, below average, average, above average) or as pass/fail.

Surveys: Whereas tests require that test administrators draw conclusions based on responses, surveys ask respondents to directly self-report. A test may ask the taker a series of questions to gauge their understanding of a safety process, while a survey may ask the respondent to directly characterise their level of understanding (*e.g.*, very good, good, fair, poor). Survey data are best reported on a scale, such as a "Likert scale."

Interviews: Interviews can be used to obtain the same types of data as testing and surveys. For example, rather than administer a written test, employees can be asked a series of questions in an interview format. Although interviews can be more time-intensive and can require a greater level of expertise, they allow for immediate follow-up questions that can help an organisation better understand responses and obtain information needed to remedy a safety situation.

Observations: Observations involve watching people as they perform normal safety-related tasks or as they respond to incidents or incident exercises. Observations can include elements of testing, where the observer "grades" subjects on pre-determined criteria. In addition, like surveys, observations allow the observer to note information that may not be captured in a limited set of test questions but that may be important to understand the overall setting and the appropriate response to remedy a safety situation. For the purpose of this guidance, physical "tests" (*e.g.*, observing an operator to perform a set of actions) are included under the category of "observations" rather than "testing."

Instruments: Instrumentation can be used to capture information about physical systems, such as temperature, pressure, flow rate, etc. Instrument-based data collection tools are similar to observation tools in that they collect information in the context of operations. Unlike observations, instrumentation is limited to a pre-determined range of instruments and measurements and cannot capture qualitative information about context.

Combined Methods: The above methods can be combined into a complementary data collection strategy. For example, survey questions can be included in a written test to gather data for scoring and to complement self-reported data. Interviews can be conducted following tests and surveys to gather information to better understand responses and address safety concerns. When combining methods, care should be exercised to handle different data types in a way that does not violate their validity (*e.g.*, to avoid using survey data reported on a scale as part of a test scoring approach).

Data Types (Measurement Levels) - Definitions

Different data types, or measurement levels, provide different kinds of information and can be manipulated in different ways. Data type can be the function of existing data that will be used for an SPI or can be selected based on the subject of the SPI and the data collection tool. Data type will affect the types of metric that can be used for an SPI. Performance measures typically rely on the followings data types, or measurement levels:

Binary Measures: Binary measures can have one of two values, such as “yes/no,” “pass/fail,” or “functional/not functional.” Binary measures are less descriptive than other types of measures, but they can be used to provide a simple, clear message. They can be useful for compiling more complex safety data into a summary message for senior managers.

Categories: Categories can be used to describe different kinds of equipment, different job functions, etc., where the categories do not reflect a specific order (*e.g.*, the order in which categories are displayed does not indicate that one category is valued more highly than the next). Categorical data by itself is not useful for performance indicators. However, using categories to help interpret other types of data can provide useful insights. For example, if labourers, shift managers and safety personnel are all asked the same question (*e.g.*, do you feel that this is a safe workplace?), categories can be used to separate the responses and identify differences among different types of workers. This can help focus subsequent safety improvement efforts.

Ordered Measures: Ordered measures (also know as “ordinal measures”) are used to order or rank data on a scale, such as a “Likert scale.” Ordered data are grouped in categories that are both mutually exclusive and cover all possible values. Ordered data are useful for safety measurements that are harder to quantify, such as “level of understanding” or “competence.” With ordered data, the difference between one category and the next (*e.g.*, the difference between “good” and “very good”) is not constant, and approaches that assign “scores” to different categories should be avoided or used with caution.

Ratio Measures: Ratio measures are used for data that can be expressed using common units (*e.g.*, meters, years) where there is a true zero value. When data meet these requirements, meaningful ratios can be calculated (*e.g.*, a depth of 2 meters is twice as deep as a depth of 1 meter; therefore, depth can be expressed as a ratio measure). Note that temperature does not have a true zero (*e.g.*, 40°C is not twice as hot as 20°C), so not all data expressed using common units are ratio data (see “interval measures,” below). Ratio measures are generally applicable for indicators measuring safety performance of physical plant and processes rather than personnel or organisational systems. Ratio measures include physical measurements, such as pressure, level, quantity and chemical concentration.

Interval Measures: Interval measures are similar to ratio measures except that they do not have a true zero. Equal differences on an interval scale represent numerically equal differences in dimension. For example, a 2°C difference between 46°C and 48°C is the same as that between 24°C and 26°C. However, because interval scale measurements have no true zero value, ratios of interval data are not valid (*e.g.*, 40°C is not twice as hot as 20°C). Interval measures are most commonly used for temperature data.

Categories of Metrics - Definitions

The following categories of metrics are useful for both outcome and activities indictors. These descriptions are intended to provide a starting point for considering alternative metrics for an individual indicator. These are not exclusive; there are other categories of metrics that may be more appropriate for specific circumstances.

Descriptive Metrics: A descriptive metric illustrates a condition measured at a certain point in time. Descriptive metrics can be used by themselves but, more typically for SPIs, they serve as the basis for threshold or trended metrics (see below). Descriptive metrics include:

- Simple sums – Simple sums are raw tallies of numbers (*e.g.*, number of employees who passed a training assessment exam, number of incidents).
- Percentages – Percentages are simple sums divided by totals or normalised on a population (*e.g.*, percentage of employees who passed a training assessment exam, percentage of incidents attributed to a poor working environment as a root or intermediate cause).
- Composite – Composite metrics are descriptive metrics that involve more complex calculations using raw data or a combination of data types (*e.g.*, a simple sum can be presented in two categories, such as number of operators vs. number of safety managers who passed a training assessment exam).

Threshold Metrics: A threshold metric compares data developed using a descriptive metric to one or more specified "thresholds" or tolerances. The thresholds/tolerances are designed to highlight the need for action to address a critical issue. Threshold metrics include:

- Single threshold – A single threshold metric compares results developed using a descriptive metric to a single tolerance level. When the tolerance level is exceeded, this indicates that a specified action should be taken.
- Multiple threshold – A multiple threshold metric highlights the need for different types of actions based on different tolerance levels. For example, a first tolerance level could indicate the need for a review of procedures; whereas, a second (higher) level could indicate the need to also take specific actions.

Trended Metrics: A trended metric compiles data from a descriptive metric and shows the change in the descriptive metric value over time. Trended metrics can present results in raw form (*e.g.*, bar chart showing annual number of reported incidents), as absolute or relative change (*e.g.*, annual difference in number of near-misses over time) or rate of change (*e.g.*, percentage decrease in number of near-misses from previous year). Trends can include simple changes in values over time or can index the data to capture the influence of outside factors and isolate safety performance, for example:

- Simple trend – Simple trends present the output from descriptive metrics at different points in time to show changes in safety results over time. Simple trends are not manipulated to account for outside influences on the safety result.
- Indexed on a variable – To account for outside factors, metrics can be indexed on one or more variables that affect, but are not affected by, safety. For example, a sharp decrease in production could be solely responsible for fewer incidents. To isolate the influence of safety performance, an indicator of incident frequency could be indexed on production rates.
- Indexed on a data set – Metrics can also be indexed on a common data set. For example, where there is employee turn-over, changes in attitude could reflect changes in the employee population. To isolate the influence of safety-related activities on employee attitudes, an unchanging set of employees could be monitored over time (*i.e.*, a longitudinal survey).

Nested Metrics: Nested metrics are two or more of the above types of metrics used to present the same safety-related data for different purposes. For example, one metric may provide point-in-time results for comparison with tolerances (*e.g.*, to highlight specific deviations from safety expectations) and another metric may compile information in a condensed format for senior managers (*e.g.*, number of deviations from expectations within a given period).

Table 1
Generally Applicable Data Types Based on Subject of SPI and Data Collection Method

Data Collection Method	General Applicability[15]	Data Type Considerations				
		Binary Measures	Categories	Ordered Measures	Ratio Measures	Interval Measures
Testing	Tests can be used to collect data related to people, systems or physical plant or processes. Measurements of physical data associated with equipment testing are included below under the "instrumentation" data collection method.	Raw test scores can be reported on a binary scale by reporting "pass/fail" data based on a cut-off score.	Information about the test taker, type of system or type of process (*e.g.*, job description, type of response drill, process area where tested equipment is located) can be used to categorise and help interpret test scores.	The most descriptive approach to reporting test scores involves associating different ranges of scores with different levels of the attribute being tested (*e.g.*, "very good," "good," "fair"), level of understanding, or level of preparedness, etc.	Raw test scores should not be used like ratio data for quantitative calculations. Test scores usually measure only relative (not absolute) differences.	Raw test scores should not be used like interval data for quantitative calculations. Test scores usually measure only relative (not absolute) differences.
Surveys	Surveys can be used to measure people's understanding, values and attitudes. They can also be used to ask people to self-report on their behaviour and capabilities. Surveys can also be used to collect observation or instrumentation data (see "combined methods," below).	Binary measures usually provide too little detail for personnel-related indicators measured using survey data (*e.g.*, attitudes, understanding). Binary measures can be useful for collecting "yes/no" data on whether critical systems, procedures or equipment are in place and/or working as intended.	Information about the survey respondent (*e.g.*, years on the job) or the type of system, type of process, identity of process area, etc. about which the respondent is reporting can be used to categorise and help interpret survey data.	Survey responses about people's attributes (*e.g.*, understanding) are typically recorded on a scale, such as a Likert scale. A scale can also be used to collect data from respondents on the performance of the enterprise, systems, equipment or processes (*e.g.*, procedures are "clear," "somewhat clear," "not clear").	Surveys, as defined in this document, do not produce ratio scale data. They can be used as a mechanism to collect ratio scale data that is generated using other methods (see combined methods, below).	Ordered measurement data collected using surveys should not be interpreted as interval-scale data. Differences from one ordered category to another do not represent constant differences, for example, in understanding, values and attitudes, ability or behaviour.
Interviews	Interviews can be used to obtain the same types of data as testing and surveys. Interviews also allow for immediate follow-up questions that can help an organisation better understand responses.	The above information regarding testing and surveys also applies to interviews.	The above information regarding testing and surveys also applies to interviews.	The above information regarding testing and surveys also applies to interviews.	The above information regarding testing and surveys also applies to interviews.	The above information regarding testing and surveys also applies to interviews.
Observations	People can be observed as they perform safety-related tasks. People and systems can also be observed as they respond during exercises or drills. Equipment/processes are not "observed" but are measured using instruments (see below).	Observers can score performance by reporting "pass/fail" data based on pre-determined criteria.	Information about the observed party (*e.g.*, job description, years on the job) or type of system (*e.g.*, internal communications) can be used to categorise and help interpret observational data.	Observers can score performance by reporting level of ability or by describing behaviour or performance on an ordered scale based on pre-determined criteria (*e.g.*, "very capable," "somewhat capable," "not capable").	Observations, as defined in this document, do not produce ratio scale data.	Ordered measurement data collected using observations should not be interpreted as interval-scale data. Observers can identify relative (not absolute) differences in ability, behaviour or performance.

Table 1 (continued)
Generally Applicable Data Types Based on Subject of SPI and Data Collection Method

Data Collection Method	General Applicability[15]	Data Type Considerations				
		Binary Measures	Categories	Ordered Measures	Ratio Measures	Interval Measures
Instruments	Instrumentation can be used to capture information about physical systems, such as temperature, pressure, flow rate, etc.	Binary scale data can be used to collect data on equipment performance (*e.g.*, whether controls worked properly or not).	Information about the equipment or process being measured (*e.g.*, identity of process area) can be used to categorise and help interpret instrument-derived data.	Raw instrument data can be combined and associated with different levels of the attribute being tested (*e.g.*, high, medium or low frequency of failure).	Most raw instrument-derived data can be directly reported as ratio scale data or can be manipulated and reported using common mathematical and statistical techniques.	Interval scale measures can be used to report raw temperature data, dates, etc.
Combined Methods	• Survey questions can be included in tests (and *vice versa*) to provide both test score and self-reported data. When using a combined approach, survey responses reported on an ordered scale should not be assigned a value for test scoring but, rather, should be compiled and reported separately. • Physical (observed) and written tests can be combined to measure people's capabilities under normal operational situations and under different incident scenarios (*e.g.*, using incident exercises). Data can be compiled in a composite test score. • Observations can be used in conjunction with survey and test data to as a check on the ability of the test to measure the attribute (*e.g.*, competence in performing a task) and/or to check survey responses (*e.g.*, self-described capabilities). • Interviews can be used following tests, surveys and observations to better understand responses and develop approaches for addressing potential safety issues. • Surveys can be used as an instrument to collect observational and instrument-derived data. Surveys can be distributed to personnel who gather the necessary information and return the surveys to a central location for compilation. In this case, the survey is not the primary collection method. Information presented above regarding the primary method should be used to evaluate metric options.					

[15] See "Data Collection Methods – Definitions" on page 105 for further discussion of general applicability.

Table 2A
Descriptive Metrics Supported by Different Data Types

Metric Type / Data Type	Simple Sums	Percentages	Composite
Binary Measures	Binary data (*e.g.*, pass/fail, present/absent, functioning/not functioning) can be summed across people, organisational parameters, systems and physical plant (*e.g.*, number of staff who passed exam, number of systems that are functioning properly). The summary of raw binary data can provide an indication of safety performance.	Binary data (*e.g.*, pass/fail, present/absent, functioning/ not functioning) can be presented as percentages. Binary data are summed and divided by total responses (*e.g.*, percentage of staff that passed exam, percentage of systems that are functioning properly). Percentages can be easier to interpret than simple sums, as they provide greater context.	Separating data into categories – Different types of data – binary, ordered and ratio (frequency of occurrence) – can be summarised separately for different categories of subjects (*e.g.*, different job classifications, different facility locations). Combining ordered data – Ordered data from more than one ordered category can be summed into a composite category (*e.g.*, percentage responding either “good” or “very good”). Descriptors other than simple sums and percentages – Ratio and interval scale data can be summarised by presenting high and low values, measures of central tendency (*e.g.*, average, median) and measures of variability (*e.g.*, standard deviation).
Categories	Categorical data usually do not provide sufficient information to be used as the sole basis for a metric. See “composite” column for use of categories for SPIs.	Categorical data usually do not provide sufficient information to be used as the sole basis for a metric. See “composite” column for use of categories for SPIs.	
Ordered Measures	The number of responses within each ordered category can be summed across multiple subjects, including people, organisational elements, systems and physical plant. Ordered data can be presented as sums for each category (*e.g.*, number of procedures that are “very clear,” number that are “somewhat clear”).	The number of responses within each ordered category can be summed across multiple subjects, including people, organisational elements, systems and physical plant. Ordered data can be presented as percentages for each category (*e.g.*, percentage of procedures that are “very clear,” percentage that are “somewhat clear”).	
Ratio Measures	Sums of ratio scale data can be used to sum the number of unplanned events over a period (*i.e.*, as opposed to whether or not a planned event occurred, which is a binary measure). Ratio scale measures of physical state (*e.g.*, level, volume) are usually compiled using other approaches (see “other descriptors” in “composite” column).	Percentages of ratio scale data can be used to measure the frequency of occurrence of non-planned events relative to all events (*e.g.*, percentage of all filling operations that resulted in overfills). Ratio scale measures of physical state (*e.g.*, level, volume) are usually compiled using other approaches (see “other descriptors” in “composite” column).	
Interval Measures	Applications of interval scale data for safety performance measurement are limited (*e.g.*, temperature data). Interval scale data are usually compiled using other approaches (see “other descriptors” in “composite” column).	Applications of interval scale data for safety performance measurement are limited (*e.g.*, temperature data). Interval scale data are usually compiled using other approaches (see “other descriptors” in “composite” column).	

Table 2B
Threshold Metrics Supported by Different Data Types[16,17]

Data Type \ Metric Type	Single Threshold	Multiple Threshold
Binary Measures	A single threshold can be established to trigger action based on sums or percentages of binary data. An upper threshold can be compared to data regarding numbers or rate of failure, absence or non-functionality. Alternatively, a lower threshold can be compared to numbers or rate of passing scores, existence or functionality.	Multiple thresholds can be established to trigger different actions based on sums or percentages of binary data. Progressively higher thresholds can be established to require progressively more intensive action based on numbers or rate of failure, absence or non-functionality. Alternatively, progressively lower thresholds can be established to require progressively more intensive action based on numbers or rate of passing scores, existence or functionality.
Categories	Category-specific single thresholds (*i.e.*, one threshold per category) can be used to trigger action for composite indicators that combine categorical and binary, ordered or ratio data.	Category-specific multiple thresholds (*i.e.*, more than one threshold per category) can be used to trigger action for composite indicators combining categorical and binary, ordered or ratio data.
Ordered Measures	A single threshold can be established to trigger action based on sums or percentages of ordinal data. A separate threshold can be established for each category or for a subset of categories (*e.g.*, for just the highest or lowest of the ordered categories). Upper thresholds can be compared to data representing poor safety performance (*e.g.*, to level of understanding is "very limited"). Alternatively, lower thresholds can be compared to data representing good safety performance (*e.g.*, to level of understanding is "very good").	Multiple thresholds can be established to trigger different actions based on sums or percentages of ordinal data. Multiple thresholds can be established for each category or for a subset of categories (*e.g.*, for just the highest or lowest of the ordered categories). Progressively higher thresholds can be established to require progressively more intensive action based on data representing poor performance (*e.g.*, to level of understanding is "very limited"). Alternatively, progressively lower thresholds can be established to require progressively more intensive action based on data representing good safety performance (*e.g.*, to level of understanding is "very good").
Ratio Measures	A single threshold can be established to trigger action based on frequency of occurrence of non-planned events. Typically, thresholds involving ratio scale data measuring frequency of occurrence would involve use of upper thresholds representing poor safety performance (*e.g.*, frequency of near-misses).	Multiple thresholds can be established to trigger action based on frequency of occurrence of non-planned events. Progressively higher thresholds can be established to require progressively more intensive action based on data representing poor safety performance (*e.g.*, frequency of near-misses).
Interval Measures	Applications of interval scale data for safety performance measurement are limited (*e.g.*, temperature data). Process-specific tolerance upsets are usually addressed at an operational level rather than using SPIs.	Applications of interval scale data for safety performance measurement are limited (*e.g.*, temperature data). Process-specific tolerance upsets are usually addressed at an operational level rather than using SPIs.

[16] Threshold metrics compare data developed using descriptive metrics to one or more specified thresholds or tolerances. Refer to Table 2A for discussion of descriptive metrics supported by different data types.

[17] Thresholds based on simple sums would not change with changes in totals. For example, if the threshold is two system failures per quarter, this will not change regardless of whether you have ten systems or one hundred systems that are tested. Thresholds based on simple sums can be useful for critical safety systems (*e.g.*, where the tolerance for failure is low). Thresholds based on percentages can adjust with changes in the population. For example, a threshold of 2% system failure rate will adjust to changes in the number of systems tested. Thresholds based on percentages are useful for measuring overall performance where totals (*e.g.*, number of staff, number of production runs) frequently change.

Table 2C
Trended Metrics Supported by Different Data Types[18]

Data Type \ Metric Type	Simple Trend	Indexed on Variable	Indexed on Data Set
General Considerations	Trends based on simple sums show absolute change and can be useful for monitoring critical safety systems (*e.g.*, where tolerance for failure of a single system is low). Trends based on percentage metrics adjust with changes in totals. Population variations should be considered when interpreting and reporting trends based on percentages.	Descriptive metrics can be "normalised" by dividing the metric values by a quantifiable factor (*e.g.*, production rate) or by separating values into different categories for categorical factors (*e.g.*, season). Metrics normalised in this way could then be trended.	Descriptive metrics can be applied to a constant data set (*e.g.*, workers present over the entire period being measured) to isolate trends associated with changes in safety. A common application of this approach is a "longitudinal survey" or "panel study."
Binary Measures	Simple sums, percentages or composite metrics involving binary data can be collected at different points in time, and metric values from different points in time can be compared to show safety performance trends. See also "general considerations."	Metrics based on binary data can be indexed on one or more variables that effect but are not affected by safety, such as production rate, season, etc. See also "general considerations."	Metrics based on binary data can be indexed on one or more variables that effect the underlying population subject to the indicator. See also "general considerations."
Categories	Binary, ordered and ratio data can be compiled by separate categories (see Table 2A, Composite Measures) and trends can be reported for all categories separately or for a subset of categories.	Binary, ordered and ratio data can be compiled by separate categories (see Table 2A, Composite Measures) and trends can be reported for all categories separately or for a subset of categories. Indexing should be applied consistently across categories.	Binary, ordered and ratio data can be compiled by separate categories (see Table 2A, Composite Measures) and trends can be reported for all categories separately or for a subset of categories. Indexing should be applied consistently across categories.
Ordered Measures	Simple sums, percentages or composite metrics involving ordered data can be collected at different points in time, and metric values from different points in time can be compared to show safety performance trends. See also "general considerations."	Metrics based on ordered data can be indexed on one or more variables that effect but are not affected by safety, such as production rate, season, etc. Indexing should be applied consistently across ordered categories. See also "general considerations."	Metrics based on ordered data can be indexed on one or more variables that effect the underlying population subject to the indicator. Indexing should be applied consistently across ordered categories. See also "general considerations."
Ratio Measures	Frequency of occurrence of non-planned events can be trended for established units of time (*e.g.*, weekly, monthly) to show changes in safety performance. See also "general considerations."	Metrics based on ratio data can be indexed on one or more variables that effect but are not affected by safety, such as production rate, season, etc. See also "general considerations."	Metrics based on ratio data can be indexed on one or more variables that effect the underlying population subject to the indicator. Indexing should be applied consistently across ordered categories. See also "general considerations."
Interval Measures	Applications of interval scale data for safety performance measurement are limited (*e.g.*, temperature data).	Applications of interval scale data for safety performance measurement are limited (*e.g.*, temperature data).	Applications of interval scale data for safety performance measurement are limited (*e.g.*, temperature data).

[18] Threshold metrics compare data developed using descriptive metrics to one or more specified thresholds or tolerances. Refer to Table 2A for discussion of descriptive metrics supported by different data types.

ANNEX II: Summary of Targets (from Chapter 3)

SECTION A: Policies, Personnel and General Management of Safety

A.1 Overall Policies

TARGET: There is a comprehensive, appropriate and living Safety Policy, which is conveyed by management and understood by employees.

A.2 Safety Goals and Objectives

TARGET: The goals and objectives for the enterprise at each level help ensure day-to-day safety.

A.3 Safety Leadership

TARGET: Senior managers inspire all employees to act in a manner consistent with their Safety Policy and goals.

A.4 Safety Management

TARGET: There is an effective safety management system that minimises risks related to chemical accidents.

A.5 Personnel

A.5a Management of Human Resources (including training and education)

TARGET: There are appropriate staffing levels – with employees (including contractors and others) who are competent, trained and fit for their jobs – which can ensure safe handling of all hazardous substances and other hazards at the enterprise.

A.5b Internal Communication/Information

TARGET: Key information on safety is adequately communicated (two-way communication) and employees actively participate in the process.

A.5c Working Environment

TARGET: There is a good working environment which is consistent with safety objectives, including the appropriate design of workspace and man-machine interfaces, as well as good house-keeping.

A.6 Safety Performance Review and Evaluation

TARGET: There is regular safety performance review and evaluation which measures achievements, identifies weaknesses and leads to continuous improvements.

SECTION B: General Procedures

B.1 Hazard Identification and Risk Assessment

TARGET: Hazards are properly identified and risks are adequately assessed.

B.2 Documentation

TARGET: Information is well-documented and all documentation is available.

B.3 Procedures (including work permit systems)

TARGET: Employees carry out their tasks safely and under conditions necessary to satisfy the design intent of the installation.

B.4 Management of Change

TARGET: Change is managed to ensure that it does not increase, or create, risks.

B.5 Contractor Safety

TARGET: Contractors comply with the same safety requirements, policies and procedures, as employees.

B.6 Product Stewardship

TARGET: Hazardous substances are managed in a safe manner throughout their life-cycle.

SECTION C: Technical Issues

C.1 Research and Development

TARGET: Safety is improved as a result of a research and development programme with respect to, *e.g.*, production processes, procedures/methods and products manufactured.

C.2 Design and Engineering

TARGET: Hazardous installations are designed and engineered with regard to safety, including design of processes, equipment and workplaces.

C.3 Inherently Safer Processes

TARGET: Safety is improved through the use of inherently safe(r) processes and equipment.

C.4 Industry Standards

TARGET: Appropriate up-to-date standards are implemented and continually upgraded, taking into account standards, codes of practice and guidance developed by industry, public authorities and other relevant bodies.

C.5 Storage of Hazardous Substances (special considerations)

TARGET: Hazardous substances are stored in a safe manner, in order to avoid any loss of containment and other risks of accidents.

C.6 Maintaining Integrity/Maintenance

TARGET: Integrity of equipment and facilities are maintained in order to avoid any loss of containment and other risks.

SECTION D: External Co-operation

D.1 Co-operation with Public Authorities

TARGET: There is effective and constructive co-operation with public authorities, based upon open communication, pro-active engagement and mutual confidence, leading to shared goals.

D.2 Co-operation with the Public and Other Stakeholders (including academia)

TARGET: There is co-operation with members of the public and other stakeholders in order to achieve public confidence that the enterprise is operating safely, based on open and trustful communication and provision of information on risks.

D.3 Co-operation with Other Enterprises

TARGET: There is co-operation and sharing of experience with other relevant enterprises.

SECTION E: Emergency Preparedness and Response

E.1 Internal (on-site) Preparedness Planning

TARGET: Adverse effects of chemical accidents are effectively mitigated.

E.2 Facilitating External (off-site) Preparedness Planning

TARGET: Support is given to public authorities and others in the development and implementation of off-site preparedness plans.

E.3 Co-operation Among Industrial Enterprises

TARGET: There is effective co-operation and co-ordination among industrial enterprises to improve emergency planning and response.

SECTION F: Accident/Near-Miss Reporting and Investigation

F.1 Reporting of Accidents, Near-misses and Other "Learning Experiences"

TARGET: Accidents, near-misses and other "learning experiences" are reported in order to improve safety.

F.2 Investigations

TARGET: Root causes and contributing causes are identified through investigations of accidents, near-misses and other unexpected events.

F.3 Follow-up (including application of lessons learned and sharing of information)

TARGET: Effective corrective actions are taken as the result of lessons learned from accidents, near-misses and other "learning experiences."

The "Golden Rules" were a new addition to the 2nd edition of the *Guiding Principles*. The objective of these is to highlight in several pages the primary roles and responsibilities of the major stakeholders with respect to chemical accident prevention, preparedness and response. It should be recognised that these represent best practice, *i.e.*, objectives to be achieved over time. They are not one-time actions but rather require ongoing vigilance.

The Golden Rules are not meant to be a complete overview of the *Guiding Principles*; nor do they address the full range of issues discussed in this *Guidance*. In order to fully understand the points made in these Golden Rules, it is important to refer to the entire text of the *Guiding Principles*.

Role of All Stakeholders

- **Make chemical risk reduction and accident prevention, as well as effective emergency preparedness and response, priorities in order to protect health, the environment and property.**
  While the risks of accidents are in the communities where hazardous installations are located, requiring efforts by stakeholders at the local level, there are also responsibilities for stakeholders at regional, national and international levels.

- **Communicate and co-operate with other stakeholders on all aspects of accident prevention, preparedness and response.**
  Communication and co-operation should be based on a policy of openness, as well as the shared objective of reducing the likelihood of accidents and mitigating the adverse affects of any accidents that occur. One important aspect is that the potentially affected public should receive information needed to support prevention and preparedness objectives, and should have the opportunity to participate in decision-making related to hazardous installations, as appropriate.

Role of Industry (including management and labour)

Management

- **Know the hazards and risks at installations where there are hazardous substances.**
  All enterprises that produce, use, store or otherwise handle hazardous substances should undertake, in co-operation with other stakeholders, the hazard identification and risk assessment(s) needed for a complete understanding of the risks to employees, the public, the environment and property in the event of an accident. Hazard identification and risk assessments should be undertaken from the earliest stages of design and construction, throughout operation and maintenance, and should address the possibilities of human or technological failures, as well as releases resulting from natural disasters or deliberate acts (such as terrorism, sabotage, vandalism or theft). Such assessments should be repeated periodically and whenever there are significant modifications to the installation.

- **Promote a "safety culture" that is known and accepted throughout the enterprise.**
  The safety culture, reflected in an enterprise's Safety Policy, consists of both an attitude that safety is a priority (*e.g.*, accidents are preventable) and an appropriate infrastructure (*e.g.*, policies and procedures). To be effective, a safety culture requires visible top-level commitment to safety in the enterprise, and the support and participation of all employees[19] and their representatives.

[19] For purposes of this publication, "employee" is defined as any individual(s) working at, or on behalf of, a hazardous installation. This includes both management and labour, as well as (sub)contractors.

- **Establish safety management systems and monitor/review their implementation.**
  Safety management systems for hazardous installations include using appropriate technology and processes, as well as establishing an effective organisational structure (*e.g.*, operational procedures and practices, effective education and training programmes, appropriate levels of well-trained staff, and allocation of necessary resources). These all contribute to the reduction of hazards and risks. In order to ensure the adequacy of safety management systems, it is critical to have appropriate and effective review schemes to monitor the systems (including policies, procedures and practices).

- **Utilise "inherently safer technology" principles in designing and operating hazardous installations.**
  This should help reduce the likelihood of accidents and minimise the consequences of accidents that occur. For example, installations should take into account the following, to the extent that they would reduce risks: minimising to the extent practicable the quantity of hazardous substances used; replacing hazardous substances with less hazardous ones; reducing operating pressures and/or temperatures; improving inventory control; and using simpler processes. This could be complemented by the use of back-up systems.

- **Be especially diligent in managing change.**
  Any significant changes (including changes in process technology, staffing and procedures), as well as maintenance/repairs, start-up and shut-down operations, increase the risk of an accident. It is therefore particularly important to be aware of this and to take appropriate safety measures when significant changes are planned – before they are implemented.

- **Prepare for any accidents that might occur.**
  It is important to recognise that it is not possible to totally eliminate the risk of an accident. Therefore, it is critical to have appropriate preparedness planning in order to minimise the likelihood and extent of any adverse effects on health, the environment or property. This includes both on-site preparedness planning and contributing to off-site planning (including provision of information to the potentially affected public).

- **Assist others to carry out their respective roles and responsibilities.**
  To this end, management should co-operate with all employees and their representatives, public authorities, local communities and other members of the public. In addition, management should strive to assist other enterprises (including suppliers and customers) to meet appropriate safety standards. For example, producers of hazardous substances should implement an effective Product Stewardship programme.

- **Seek continuous improvement.**
  Although it is not possible to eliminate all risks of accidents at hazardous installations, the goal should be to find improvements in technology, management systems and staff skills in order to move closer toward the ultimate objective of zero accidents. In this regard, management should seek to learn from past experiences with accidents and near-misses, both within their own enterprises and at other enterprises.

Labour

- **Act in accordance with the enterprise's safety culture, safety procedures and training.**
  In the discharge of their responsibilities, labour should comply with all the procedures and practices relating to accident prevention, preparedness and response, in accordance with the training and instructions given by their employer. All employees (including contractors) should report to their supervisor any situation that they believe could present a significant risk.

- **Make every effort to be informed, and to provide information and feedback to management.**
  It is important for all employees, including contractors, to understand the risks in the enterprise where they work, and to understand how to avoid creating or increasing the levels of risk. Labour should, to the extent possible, provide feedback to management concerning safety-related matters. In this regard, labour and their representatives should work together with management in the development and implementation of

safety management systems, including procedures for ensuring adequate education and training/retraining of employees. Labour and their representatives should also have the opportunity to participate in monitoring and investigations by the employer, or by the competent authority, in connection with measures aimed at preventing, preparing for and responding to chemical accidents.

- **Be proactive in helping to inform and educate your community.**
  Fully informed and involved employees at a hazardous installation can act as important safety ambassadors within their community.

Role of Public Authorities

- **Seek to develop, enforce and continuously improve policies, regulations and practices.**
  It is important for public authorities[20] to establish policies, regulations and practices, and have mechanisms in place to ensure their enforcement. Public authorities should also regularly review and update, as appropriate, policies, regulations and practices. In this regard, public authorities should keep informed of, and take into account, relevant developments. These include changes in technology, business practices and levels of risks in their communities, as well as experience in implementing existing laws and accident case histories. Public authorities should involve other stakeholders in the review and updating process.

- **Provide leadership to motivate all stakeholders to fulfil their roles and responsibilities.**
  Within their own sphere of responsibility and influence, all relevant public authorities should seek to motivate other stakeholders to recognise the importance of accident prevention, preparedness and response, and to take the appropriate steps to minimise the risks of accidents and to mitigate the effects of any accidents that occur. In this regard, the authorities should establish and enforce appropriate regulatory regimes, promote voluntary initiatives and establish mechanisms to facilitate education and information exchange.

- **Monitor the industry to help ensure that risks are properly addressed.**
  Public authorities should establish mechanisms for monitoring hazardous installations to help ensure that all relevant laws and regulations are being followed, and that the elements of a safety management system are in place and are functioning properly, taking into account the nature of the risks at the installations (including the possibilities of deliberate releases). Public authorities can also take these opportunities to share experience with relevant employees of the installations.

- **Help ensure that there is effective communication and co-operation among stakeholders.**
  Information is a critical component of safety programmes. Public authorities have an important role in ensuring that appropriate information is provided to, and received by, all relevant stakeholders. Public authorities have a special role in facilitating education of the public concerning chemical risks in their community so that members of the public are reassured that safety measures are in place, that they understand what to do in the event of an accident, and that they can effectively participate in relevant decision-making processes. Public authorities are also in a position to facilitate the sharing of experience (within and across borders).

- **Promote inter-agency co-ordination.**
  Chemical accident prevention, preparedness and response is, by nature, an inter-disciplinary activity involving authorities in different sectors and at different levels. To help ensure effective prevention, preparedness and response, and efficient use of resources, it is important that all relevant agencies co-ordinate their activities.

[20] For purposes of this publication, "public authorities" are defined to include national, regional and local authorities responsible for any aspect of chemical accident prevention, preparedness and response. This would include, *inter alia*, agencies involved in environmental protection, public health, occupational safety, industry and emergency response/civil protection.

- **Know the risks within your sphere of responsibility, and plan appropriately.**
  Public authorities are responsible for off-site emergency planning, taking into account the relevant on-site plans. This should be done in co-ordination with other stakeholders. In addition, public authorities should ensure that the resources necessary for response (*e.g.*, expertise, information, equipment, medical facilities, finances) are available.

- **Mitigate the effects of accidents through appropriate response measures.**
  Public authorities (often at the local level) have primary responsibility for ensuring response to accidents that have off-site consequences, to help reduce deaths and injuries, and to protect the environment and property.

- **Establish appropriate and coherent land-use planning policies and arrangements.**
  Land-use planning (*i.e.*, establishing and implementing both general zoning as well as specific siting of hazardous installations and other developments) can help to ensure that installations are appropriately located, with respect to protection of health, environment and property, in the event of an accident. Land-use planning policies and arrangements can also prevent the inappropriate placing of new developments near hazardous installations (*e.g.*, to avoid the construction of new residential, commercial or public buildings within certain distances of hazardous installations). Land-use planning policies and arrangements should also control inappropriate changes to existing installations (*e.g.*, new facilities or processes within the installation). They should also allow for the possibility of requiring changes to existing installations and buildings to meet current safety standards.

Role of Other Stakeholders (*e.g.*, communities/public)

- **Be aware of the risks in your community and know what to do in the event of an accident.**
  Members of communities near hazardous installations, and others that might be affected in the event of an accident, should make sure that they understand the risks they face and what to do in the event of an accident to mitigate possible adverse effects on health, the environment and property (*e.g.*, understand the warning signals, and what actions are appropriate). This involves reading and maintaining any information they receive, sharing this information with others in their household and seeking additional information as appropriate.

- **Participate in decision-making relating to hazardous installations.**
  The laws in many communities provide opportunities for members of the public to participate in decision-making related to hazardous installations, for example by commenting on proposed regulations or zoning decisions, or providing input for procedures concerning licensing or siting of specific installations. Members of the public should take advantage of these opportunities to present the perspective of the community. They should work towards ensuring that such opportunities exist, whenever appropriate, and that the public has the information necessary for effective participation.

- **Co-operate with local authorities, and industry, in emergency planning and response.**
  Representatives of the community should take advantage of opportunities to provide input into the emergency planning process, both with respect to on-site and off-site plans. In addition, members of the public should co-operate with any tests or exercises of emergency plans, following directions and providing feedback, as appropriate.

ANNEX IV: Explanation of Terms

The terms set out below are explained for the purposes of the *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response*, as well as this *Guidance on SPI* only, and should not be taken as generally agreed definitions or as terms that have been harmonised between countries and organisations. To the extent possible, common definitions of these terms are used.

Accident or chemical accident
Any unplanned event involving hazardous substances that causes, or is liable to cause, harm to health, the environment or property. This excludes any long-term events (such as chronic pollution).

Activities Indicators
See "Indicators."

Affiliates
Enterprises in which another enterprise has minority voting rights and no effective operational control.

Audit
A systematic examination of a hazardous installation to help verify conformance with regulations, standards, guidelines and/or internal policies. This includes the resultant report(s) but not subsequent follow-up activities. Audits can include examinations performed either by, or on behalf of, management of a hazardous installation (self or internal audit), or an examination by an independent third party (external audit).

Chemical accident
See "Accident."

Chemical industry
Enterprises that produce, formulate and/or sell chemical substances (including basic and specialty chemicals, consumer care products, agrochemicals, petrochemicals and pharmaceuticals).

Community(ies)
Individuals living/working near hazardous installations who may be affected in the event of a chemical accident.

Contractors
Includes all contractors and subcontractors.

Consequence
Result of a specific event.

Emergency preparedness plan (or) emergency plan
A formal written plan which, on the basis of identified potential accidents together with their consequences, describes how such accidents and their consequences should be handled, either on-site or off-site.

Employee
Any individual(s) working at, or on behalf of, a hazardous installation. This includes both management and labour, as well as (sub)contractors.

Enterprise
A company or corporation (including transnational corporations) that has operations involving production, processing, handling, storage, use and/or disposal of hazardous substances.

Ergonomics
A discipline concerned with designing plant, equipment, operation and work environments so that they match human capabilities.

Hazard
An inherent property of a substance, agent, source of energy or situation having the potential of causing undesirable consequences.

Hazard analysis
Identification of individual hazards of a system, determination of the mechanisms by which they could give rise to undesired events and evaluation of the consequences of these events on health (including public health), environment and property.

Hazardous installation
A fixed industrial plant/site at which hazardous substances are produced, processed, handled, stored, used or disposed of in such a form and quantity that there is a risk of an accident involving hazardous substance(s) that could cause serious harm to human health or damage to the environment, including property.

Hazardous substance
An element, compound, mixture or preparation which, by virtue of its chemical, physical or (eco)toxicological properties, constitutes a hazard. Hazardous substances also include substances not normally considered hazardous but which, under specific circumstances (*e.g.*, fire, runaway reactions), react with other substances or operating conditions (temperature, pressure) to generate hazardous substances.

Human factors
Human factors involve designing machines, operations and work environments so that they match human capabilities, limitations and needs (and, therefore, is broader than concerns related to the man-machine interface). It is based on the study of people in the work environment (operators, managers, maintenance staff and others) and of factors that generally influence humans in their relationship with the technical installation (including the individual, the organisation and the technology).

Human performance
All aspects of human action relevant to the safe operation of a hazardous installation, in all phases of the installation from conception and design, through operation, maintenance, decommissioning and shutdown.

Incidents
Accidents and/or near-misses.

Indicators
Indicators is used in this Document to mean observable measures that provide insights into a concept – safety – that is difficult to measure directly. This *Guidance* includes two types of safety performance indicators: "outcome indicators" and "activities indicators":

Outcome indicators are designed to help assess whether safety-related actions are achieving their desired results and whether such measures are, in fact, leading to less likelihood of an accident occurring and/or less adverse impact on human health, the environment and/or property from an accident. They are reactive, intended to measure the impact of actions that were taken to manage safety and are similar to what is called "lagging indicators" in other documents. Outcome indicators often measure change in safety performance over time, or failure of performance. Thus, outcome indicators tell you *whether* you have achieved a desired result (or when a desired safety result has failed). But, unlike activities indicators, do not tell you *why* the result was achieved or why it was not.

Activities indicators are designed to help identify whether enterprises/organisations are taking actions believed necessary to lower risks (*e.g.*, the types of actions described in the *Guiding Principles*). Activities indicators are a pro-active measure, and are similar to what are called "leading indicators" in other documents. Activities indicators often measure safety performance against a tolerance level that shows deviations from safety expectations at a specific point in time. When used in this way, activities indicators highlight the need for action to address the effectiveness of a critical safety measure when a tolerance level is exceeded.

Thus, activities indicators provide enterprises with a means of checking, on a regular and systematic basis, whether they are implementing their priority actions in the way they were intended. Activities indicators can help explain why a result (*e.g.*, measured by an outcome indicator) has been achieved or not.

Information
Facts or data or other knowledge which can be provided by any means including, for example, electronic, print, audio or visual.

Inspection
A control performed by public authorities. There may be (an)other party(ies) involved in the inspection, acting on behalf of the authorities. An inspection includes the resultant report(s) but not subsequent follow-up activities.

Interface
See “Transport interface.”

Labour
Any individual(s) working at, or on behalf of, a hazardous installation who are not part of management. This includes (sub)contractors.

Land-use planning
Consists of various procedures to achieve both general zoning/physical planning, as well as case-by-case decision-making concerning the siting of an installation or of other developments.

Likert Scale
A type of survey question where respondents are asked to rate attributes on an ordered scale (*e.g.*, extent employees follow procedures, where options could range from “never” to “always” with gradations in between such as “not very often,” “somewhat often,” and “very often”). Questions for use with Likert scales often posed in terms of the level at which respondents agree or disagree with a statement (*e.g.*, extent agree or disagree with the statement “employees follow procedures,” where possible responses range from “strongly disagree” to “strongly agree”). Labels associated with different responses should represent more-or-less evenly spaced gradations.

Local authorities
Government bodies at local level (*e.g.*, city, county, province). For purposes of this document, these include bodies responsible for public health, rescue and fire services, police, worker safety, environment, etc.

Management
Any individual(s) or legal entity (public or private) having decision-making responsibility for the enterprise, including owners and managers.

Metric
A system of measurement used to quantify safety performance for *outcome* and *activities* indicators.

Monitor (or) monitoring
Use of checks, inspections, tours, visits, sampling and measurements, surveys, reviews or audits to measure compliance with relevant laws, regulations, standards, codes, procedures and/or practices; includes activities of public authorities, industry and independent bodies.

Near-miss
Any unplanned event which, but for the mitigation effects of safety systems or procedures, could have caused harm to health, the environment or property, or could have involved a loss of containment possibly giving rise to adverse effects involving hazardous substances.

Outcome Indicators
See "Indicators."

Pipeline
A tube, usually cylindrical, through which a hazardous substance flows from one point to another. For purposes of this publication, pipelines include any ancillary facilities such as pumping and compression stations.

Port area
The land and sea area established by legislation. (Note: some port areas may overlap. Legal requirements should take account of this possibility.)

Port authority
Any person or body of persons empowered to exercise effective control in a port area.

Probability
The likelihood that a considered occurrence will take place.

Producer(s) (chemical)
Enterprises that manufacture or formulate chemical products (including basic and specialty chemicals, consumer care products, agrochemicals, petrochemicals and pharmaceuticals).

Product Stewardship
A system of managing products through all stages of their life cycle, including customer use and disposal (with the objective of continuously improving safety for health and the environment).

Public authorities
Government bodies at national, regional, local and international level.

Reasonably practicable
All which is possible, subject to the qualification that the costs of the measures involved are not grossly disproportionate to the value of the benefits obtained from these measures.

Risk
The combination of a consequence and the probability of its occurrence.

Risk assessment
The informed value judgment of the significance of a risk, identified by a risk analysis, taking into account any relevant criteria.

Risk communication
The sharing of information, or dialogue, among stakeholders about issues related to chemical accident prevention, preparedness and response including, *e.g.*: health and environmental risks and their significance; policies and strategies aimed at managing the risks and preventing accidents; and actions to be taken to mitigate the effects of an accident. For purposes of this document, risk communication includes dialogue and sharing of information among the public, public authorities, industry and other stakeholders.

Risk management
Actions taken to achieve or improve the safety of an installation and its operation.

Root cause(s)
The prime reason(s) that lead(s) to an unsafe act or condition and result(s) in an accident or near-misses. In other words, a root cause is a cause that, if eliminated, would prevent the scenario from progressing to an accident. Root causes could include, for example, deficiencies in management systems that lead to faulty design or maintenance, or that lead to inadequate staffing.

Safety management system
The part of an enterprise's general management system that includes the organisational structure, responsibilities, practices, procedures, processes and resources for determining and implementing a chemical accident prevention policy. The safety management system normally addresses a number of issues including, but not limited to: organisation and personnel; identification and evaluation of hazards and risks; operational control; management of change; planning for emergencies; monitoring performance; audit and review.

Safety performance indicators
See "Indicators."

Safety report
The written presentation of technical, management and operational information concerning the hazards of a hazardous installation and their control in support of a justification for the safety of the installation.

Stakeholder
Any individual, group or organisation that is involved, interested in, or potentially affected by chemical accident prevention, preparedness and response. A description of stakeholders groups is included on in the Introduction to this publication under "Scope."

Storage facilities
Warehouses, tank farms and other facilities where hazardous substances are held.

Subsidiaries
Enterprises in which another enterprise has majority voting rights and/or effective operational control.

Transboundary accident
An accident involving hazardous substances that occurs in one jurisdiction and causes adverse health or environmental consequences (effects), or has the potential to cause such consequences, in another jurisdiction (within a country or across national boundaries).

Transport interface
Fixed (identified) areas where hazardous substances (dangerous goods) are transferred from one transport mode to another (*e.g.*, road to rail, or ship to pipeline); transferred within one transport mode from one piece of equipment to another (*e.g.*, from one truck to another); transferred from a transport mode to a fixed installation or from the installation to a transport mode; or stored temporarily during transfer between transport modes or equipment. Thus, transport interfaces involve, for example, loading and unloading operations, transfer facilities, temporary holding or keeping of hazardous substances during cargo transfer (*e.g.*, warehousing), and handling of damaged vehicles or spilled goods. Examples include: railroad marshalling yards, port areas, receiving/loading docks at hazardous installations, terminals for roads and for intermodal transport between road and rail, airports and transfer facilities at fixed installations.

Warehouse keeper
The person responsible for a storage facility, whether on the site of a hazardous installation or off-site.

ANNEX V: Selected References

This Annex provides a list of publications that might be of interest to the readers of this *Guidance on Developing Safety Performance Indicators*. This list is NOT intended to be comprehensive; rather, it was developed from suggestions by the OECD Working Group on Chemical Accidents and the Group of Experts on SPI. The purpose was to make reference to publications that are relevant, may provide further guidance on developing SPI programmes and that are easily available to the public.

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Costigan, A. and Gardner, D. (2000) *Measuring Performance in OHS: An Investigation into the Use of Positive Performance Indicators*. Journal of Occupational Health and Safety. Australia. Vol. 16, #1. pp. 55-64.

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www.chaspi.info-exchange.com

Health and Safety Executive (UK) and Chemical Industries Association, (2006) *Developing Process Safety Indicators: A step-by-step guide for chemical and major hazard industries*, HGN 254, ISBN 0717661806.

Hopkins, Andrew (2000) *Lessons from Longford: The Esso Gas Plant Explosion.*

Hurst, N.W., Young, S., Donald, I., Gibson, H., Muyselaar, A. (1996) *Measures of Safety Management Performance and Attitudes to Safety at Major Hazard Sites*. Journal of Loss Prevention in the Process Industries, Vol. 9 No. 2, pp. 161-172.

International Labour Office (2001) *Guidelines on Occupational Safety and Health Management Systems*, ILO-OSH 2001.

International Programme on Chemical Safety, Inter-Organization Programme for the Sound Management of Chemicals and World Health Organization Collaborating Centre for an International Clearing House for Major Chemical Incidents (University of Wales Institute) (1999), *Public Health and Chemical Incidents: Guidance for National and Regional Policy Makers in the Public/Environmental Health Roles*, ISBN 1-9027724-10-0.

Kaplan, Robert, S. and Norton, David, P. (1996) *Translating Strategy into Action: The Balanced Scoreboard*. Harvard Business School Press.

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Major Industrial Accidents Council of Canada (MIACC) (1998) *Community Self-assessment Tool, Partnership toward Safer Communities, a MIACC initiative*.

Marono, M, Correa, M.A., Sola, R. (1998) *Strategy for the Development of Operational Safety Indicators in the Chemical Industry*. Proceedings of the 9th International Symposium on Loss Prevention and Safety Promotion in the Process Industries.

Martorell, S., Sanchez, A., Munoz, A., Pitarch, J.L., Serradell, V. and Roldan, J. (1999) *The Use of Maintenance Indicators to Evaluate the Effects of Maintenance Programs on NPP Performance and Safety. Reliability engineering and system Safety*. Elsevier Science Ltd. Vol. 65, #2. pp. 85-94.

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Organisation for Economic Co-operation and Development (OECD) (2003) *Guiding Principles for Chemical Accident Prevention, Preparedness and Response* (2nd edition).

Ritwik, U. (2000) *Ways to measure your HSE program*. Hydrocarbon processing. pp. 84B-84I.

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Skjong, Rolf (1995) *Questionnaire on Risk Management of Ageing Process Plants*. Det Norske Veritas (DNV). European Process Safety Center (EPSC). 19 pages.

Stricoff, R., Scott (2000) *Safety Performance Measurement: Identifying Prospective Indicators with High Validity*. Professional Safety. Park Ridge. Vol. 45, #1. pp. 36-39.

Taylor, J.R. (1998) *Measuring the Effectiveness and Impact of Process Safety Management*. Proceedings of the 9th International Symposium on Loss Prevention and Safety Promotion in the Process Industries.

United Kingdom Business Link, Health and Safety Performance Indicator. Practical advice and a self-assessment tool for small and medium-sized business.
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www.epa.gov/ceppo/p-tech.htm

Van Steen, J.F.J. and Brascamp, M.H. (1995) *On the Measurement of Safety Performance*. Loss Prevention and Safety Promotion in the Process Industries, Vol. 1. pp. 57-69.

Virginia Tech (Department of Urban Affairs and Planning), in conjunction with the US Environmental Protection Agency (2001) *Checking Your Success - A Guide to Developing Indicators for Community Based Environmental Projects.*
www.uap.vt.edu/checkyoursuccess

Voyer, Pierre (2000) *Tableaux de bord de gestion et indicateurs de performance*, 2ème édition. Presses de l'Université du Québec. 446 pages.

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Annex VI: Background

This *Guidance on Developing Safety Performance Indicators* has been prepared as part of the OECD Chemical Accidents Programme, under the auspices of the expert group established to manage the Programme, the Working Group on Chemical Accidents (WGCA).

This publication was produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC).

The OECD

The Organisation for Economic Co-operation and Development is an intergovernmental organisation in which representatives of 30 industrialised countries (from Europe, North America and the Pacific) and the European Commission meet to co-ordinate and harmonise policies, discuss issues of mutual concern and work together to respond to international concerns. Much of OECD's work is carried out by more than 200 specialised Committees and subsidiary groups made up of member country delegates. Observers from several countries with special status at the OECD, international organisations and non-governmental organisations (including representatives from industry and labour) attend many of the OECD's workshops and other meetings. Committees and subsidiary groups are served by the OECD Secretariat, located in Paris, France, which is organised into Directorates and Divisions.

The Chemical Accidents Programme

The work of the OECD related to chemical accident prevention, preparedness and response is carried out by the Working Group on Chemical Accidents, with Secretariat support from the Environment, Health and Safety Division of the Environment Directorate.[21] The general objectives of the Programme include: exchange of information and experience; analysis of specific issues of mutual concern in member countries; and development of guidance materials. As a contribution to these objectives, approximately 20 workshops and special sessions have been held since 1989.

One of the major outputs of this Programme is the *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response* (2nd ed. 2003). The *Guiding Principles* set out general guidance for the safe planning and operation of facilities where there are hazardous substances in order to prevent accidents and, recognising that chemical accidents may nonetheless occur, to mitigate adverse effects through effective emergency preparedness, land-use planning and accident response. The *Guiding Principles* address all stakeholders including industry (management and other employees at hazardous installations), public authorities and members of the community/ public. The *Guiding Principles* build on the results of the workshops, as well as the collective experience of a diverse group of experts from many countries and organisations, in order to establish "best practices."

For further information concerning the Chemical Accidents Programme, as well as a list of the guidance materials and other publications prepared as part of this Programme, see: www.oecd.org/env/accidents.

The work of the WGCA has been undertaken in close co-operation with other international organisations. A number of these organisations, including the International Labour Office (ILO), the International Maritime Organization (IMO), the United Nations Environment Programme (UNEP), the UN Economic Commission for Europe (UNECE), the World Health Organization (WHO) and the United Nations Office for the Coordination of Humanitarian Affairs (through the Joint UNEP/OCHA Environment Unit), are very active in the area of chemical accident prevention, preparedness and response and have prepared guidance materials on related subjects.

[21] The Environment, Health and Safety Division publishes free-of-charge documents in ten different series: Testing and Assessment; Good Laboratory Practice and Compliance Monitoring; Pesticides and Biocides; Risk Management; Harmonisation of Regulatory Oversight in Biotechnology; Safety of Novel Foods and Feeds; Chemical Accidents; Pollutant Release and Transfer Registers; Emission Scenario Documents; and the Safety of Manufactured Nanomaterials. More information about the Environment, Health and Safety Programme and EHS publications is available on the OECD's World Wide Web site (http://www.oecd.org/ehs).

Preparation of the *Guidance on Developing Safety Performance Indicators (SPI)*

This *Guidance on SPI* has been prepared as a companion to the *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response* (2nd ed). The Working Group agreed that it would be valuable to develop guidance to facilitate implementation of the *Guiding Principles*, and to help stakeholders assess whether actions taken to enhance chemical safety in fact lead to improvements over time.

To help in the preparation of the *Guidance on SPI*, the WGCA established a Group of Experts, with representatives of member and observer countries, industry, labour, non-governmental organisations and other international organisations. Experts from Sweden, the US and Canada agreed to be the lead authors of the three parts of the *Guidance* (*i.e.*, addressing industry, public authorities and communities/public respectively). A list of participants in this Group can be found on the Acknowledgements page.

The Working Group specified that the Group of Experts should develop guidance, rather than precise indicators, to allow flexibility in application, and stated that the guidance should address both measures of activities/organisation of work and measures of outcome/impact.

The Group of Experts began its work by collecting as much experience as possible on SPI and related activities. The first version of the *Guidance on SPI* was completed in 2003. The WGCA agreed that this should be published as an "interim" document because it presented an innovative approach to measuring safety performance. At the same time, the WGCA established a pilot programme to get volunteers from industry, public authorities and communities to test the *Guidance on SPI* and provide feedback.

During the course of the pilot programme, feedback was received from 11 participants (four companies, three federal government agencies and four local authorities and emergency response organisations). These participants provided very constructive comments that led to significant changes from the 2003 version of the *Guidance on SPI*.

Following the Pilot Programme, a small Group of Experts was convened to review the comments received, as well as to consider related developments, and to revise the *Guidance on SPI* accordingly. The Group of Experts agreed that a number of changes should be made to the 2003 *Guidance*, with the most important being:

- the addition of Chapter 2, setting out the steps for implementing an SPI Programme (building on the experience in the United Kingdom);
- the creation of two separate publications: one for industry and one for public authorities and communities/public;
- the drafting of a separate chapter for emergency response personnel, as a subset of public authorities; and
- the development of additional guidance on the use of metrics.

The bulk of the 2003 version is now contained in Chapter 3, which was amended to take into account experience gained during the Pilot Programme and additional feedback.

In addition to the text of this *Guidance on SPI*, there will be a searchable, more inter-active version available on-line at www.oecd.org/env/accidents.

Other OECD Publications Related to Chemical Accident Prevention, Preparedness and Response

Report of the OECD Workshop on Strategies for Transporting Dangerous Goods by Road: Safety and Environmental Protection (1993)

Health Aspects of Chemical Accidents: Guidance on Chemical Accident Awareness, Preparedness and Response for Health Professionals and Emergency Responders (1994) [prepared as a joint publication with IPCS, UNEP-IE and WHO-ECEH]

Guidance Concerning Health Aspects of Chemical Accidents. *For Use in the Establishment of Programmes and Policies Related to Prevention of, Preparedness for, and Response to Accidents Involving Hazardous Substances* (1996)

Report of the OECD Workshop on Small and Medium-sized Enterprises in Relation to Chemical Accident Prevention, Preparedness and Response (1995)

Guidance Concerning Chemical Safety in Port Areas. *Guidance for the Establishment of Programmes and Policies Related to Prevention of, Preparedness for, and Response to Accidents Involving Hazardous Substances. Prepared as a Joint Effort of the OECD and the International Maritime Organisation (IMO)* (1996)

OECD Series on Chemical Accidents:

No. 1, Report of the OECD Workshop on Risk Assessment and Risk Communication in the Context of Chemical Accident Prevention, Preparedness and Response (1997)

No. 2, Report of the OECD Workshop on Pipelines (Prevention of, Preparation for, and Response to Releases of Hazardous Substances (1997)

No. 3, International Assistance Activities Related to Chemical Accident Prevention, Preparedness and Response: Follow-up to the Joint OECD and UN/ECE Workshop to Promote Assistance for the Implementation of Chemical Accident Programmes (1997)

No. 4, Report of the OECD Workshop on Human Performance in Chemical Process Safety: Operating Safety in the Context of Chemical Accident Prevention, Preparedness and Response (1999)

No. 5, Report of the OECD Workshop on New Developments in Chemical Emergency Preparedness and Response, Lappeenranta, Finland, November 1998 (2001)

No. 6, Report of the OECD Expert Meeting on Acute Exposure Guideline Levels (AEGLs) (2001)

No. 7, Report of the Special Session on Environmental Consequences of Chemical Accidents (2002)

No. 8, Report of the OECD Workshop on Audits and Inspections Related to Chemical Accident, Prevention, Preparedness and Response (2002)

No. 9, Report of the OECD Workshop on Integrated Management of Safety, Health, Environment and Quality, Seoul, Korea, 26-29 June 2001 (2002)

Internet Publication, Report of CCPS/OECD Conference and Workshop on Chemical Accidents Investigations (2002)

Special Publication, International Directory of Emergency Response Centres for Chemical Accidents (2002, revision of 1st edition published in 1992)

No. 10, Guiding Principles for Chemical Accident Prevention, Preparedness and Response: Guidance for Industry (including Management and Labour), Public Authorities, Communities and other Stakeholders (2003, revision of 1st edition published in 1992)

No. 11, Guidance on Safety Performance Indicators, A Companion to the OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response: Guidance for Industry, Public Authorities and Communities for developing SPI Programmes related to Chemical Accident Prevention, Preparedness and Response (Interim Publication scheduled to be tested in 2003-2004 and revised in 2005) (2003)

No. 12, Report of the Workshop on Communication Related to Chemical Releases Caused by Deliberate Acts, Rome, Italy, 25-27 June 2003 (2004)

No. 13, Report of the OECD Workshop on Sharing Experience in the Training of Engineers in Risk Management, Montreal, Canada, 21-24 October 2003 (2004)

No. 14, Report of the OECD Workshop on Lessons Learned from Chemical Accidents and Incidents, Karlskoga, Sweden, 21-23 September 2004 (2005)

No. 15, Integrated Management Systems (IMS)-Potential Safety Benefits Achievable from Integrated Management of Safety, Health, Environment and Quality (SHE&Q) (2005)

No. 16, Report of the OECD-EC Workshop on Risk Assessment Practices for Hazardous Substances Involved in Accidental Releases, 16-18 October 2006, Varese, Italy (2007)

No. 17, Report of Survey on the Use of Safety Documents in the Control of Major Accident Hazards (2008)