CROSSROADS OF OPPORTUNITIES

WHAT IS AN INDICATOR?
WHAT INDICATORS DO YOU USE?
DOES THE INDICATOR MEASURE WHAT IT SHOULD? PROACTIVE OR REACTIVE?
DOES THE INDICATOR PICK UP STRENGTHS AND WEAKNESSES? DOES IT CONTRIBUTE TO AN IMPROVEMENT?
DO YOU HAVE TOO MANY INDICATORS?
DOES THE INDICATOR PROVIDE USEFUL INFORMATION? DECISION SUPPORT?
IS IT UNDERSTOOD? HMM ...

INDICATOR BLUES

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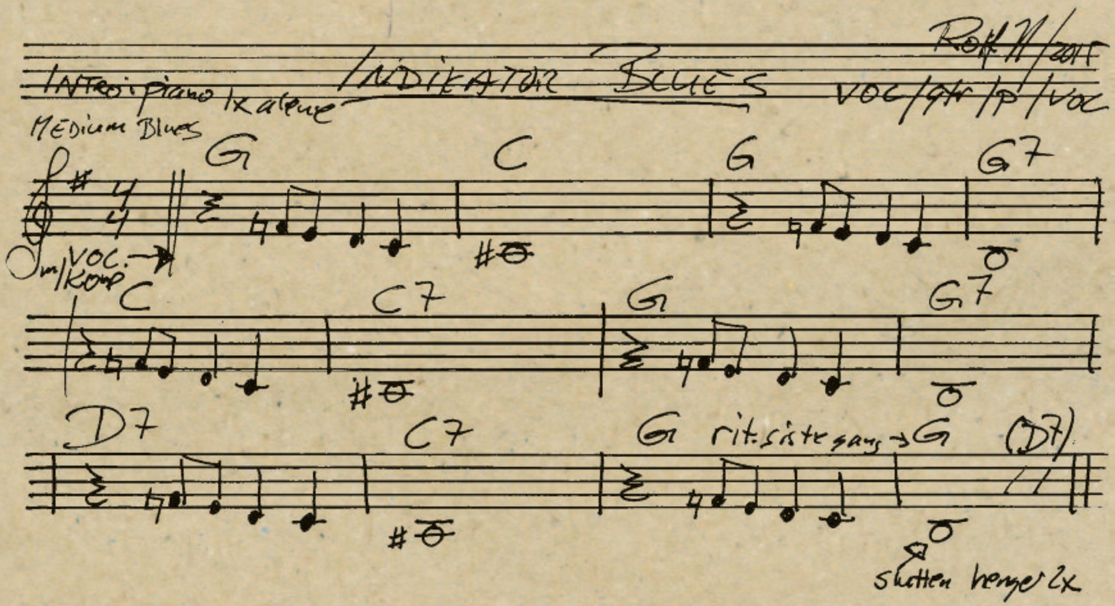
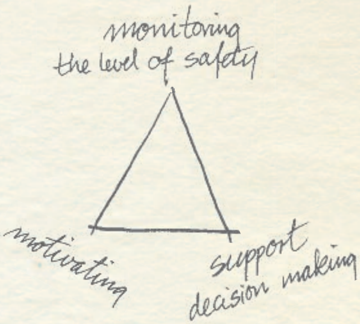


THE BLUES is a musical form often associated with melancholy. Its starting point is a simple, repeated 12-bar chord sequence. But it can have many other musical extensions, and development of the harmonic framework of the blues has been particularly noteworthy in jazz. A musician playing the blues will always work within the basic 12-bar structure, which allows them to concentrate on interpreting and conveying the message of the music in lyrics and melody.

INDICATORS normally refer to the condition, level or status of something, and are usually measurable and presented numerically. Ideal indicator systems contain information used both to define activities which prevent incidents and to measure the outcomes achieved by safety systems. Indicators have probably been emerged because humans like them. They can tell us something understandable, and provide guidance in complex and difficult areas.

THIS BOOKLET is meant to challenge, involve and encourage reflection. We seek to provide an "indicator blues", structured to encompass challenges, opportunities, conflicting goals, choices, decisions and the consequences of using indicators.



A debate on the use of indicators often occurs in the wake of major accidents. These discussions concern such issues as the nature of an indicator, what information it can or cannot provide, and how appropriate yardsticks can be developed.

Questions addressed include the distinction between reactive and proactive indicators and how to develop yardsticks which can give early and reliable information for averting major accidents.

Indicators can be used as one of several sources to monitor and assess the level of risk. They should be able to support decisions and give guidance on necessary measures for monitoring the risk level. And they should motivate management and others to take the right steps to avoid accidents.

Norway’s petroleum regulations require the responsible party to establish measurement parameters to monitor factors of significance to health, safety and the environment (HSE). Indicators must also be established for monitoring changes and trends in major accident risk and environmental risk.

These indicators are meant to be used as tools for managing risk and for keeping facilities, plants, people and the environment secure.

One challenge is the lack of general agreement on what constitutes valid, effective or reliable indicators for different aspects of HSE risk, or how these should be operationalised.

This booklet addresses the indicator concept, the difference between proactive and reactive indicators, and the interaction between indicators and human/organisational factors.

Like to know more?
Section 10 of the management regulation on measurement parameters and indicators

The aim is to present a simple overview of the way indicators can be used to monitor contributors to risk, how they can support decisions or mislead, and how they can affect organisational practice and the motivation of individuals.

No pat answers are provided. Instead, the purpose is to challenge, involve and encourage reflection. Indicators can sometimes be perceived as unchallengeable. This booklet seeks to make it easier to question them and to illuminate various conditions which underpin their development and application.

INDICATOR BLUES

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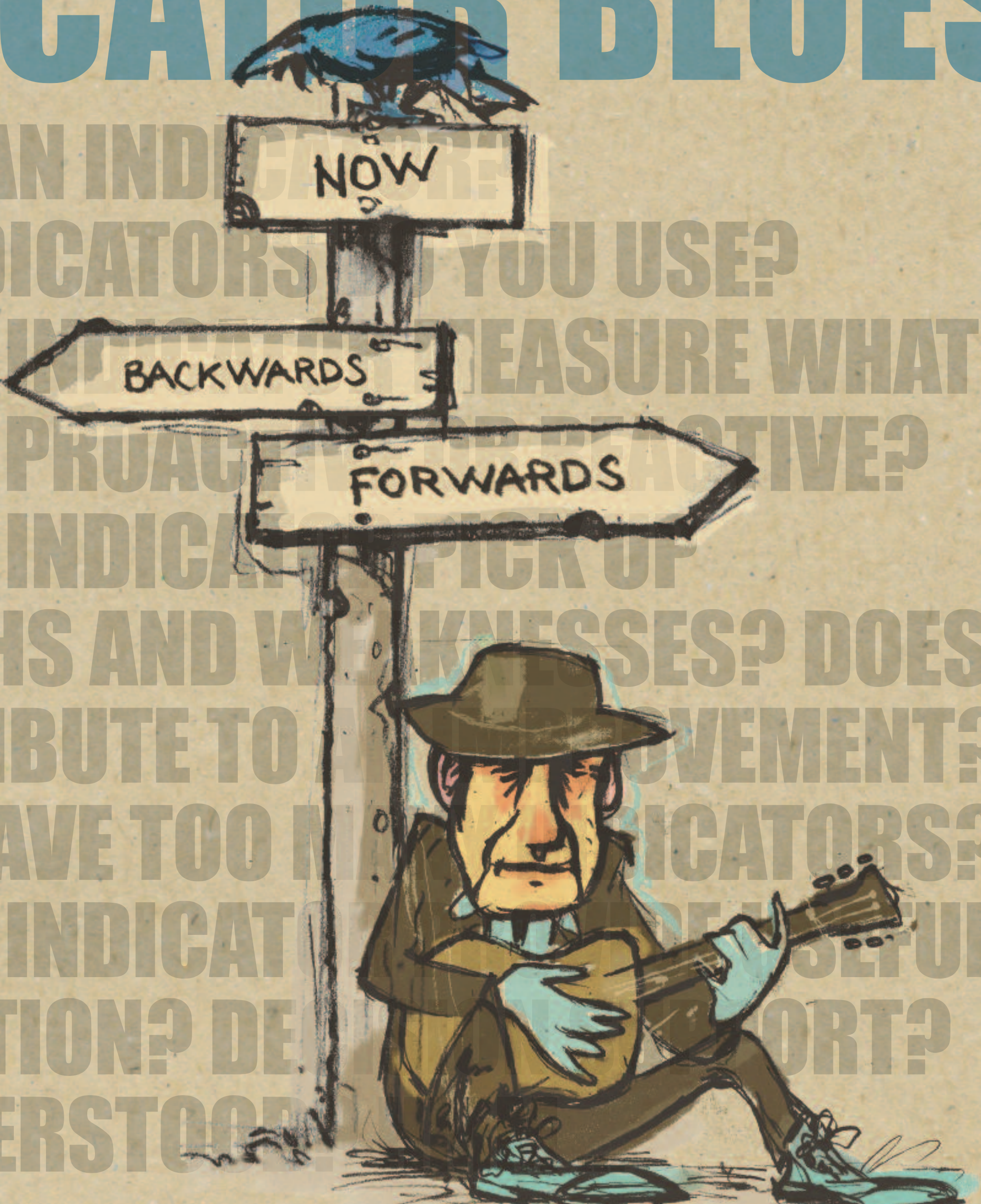


INDICATORS - IN THEORY

The guidelines to section 10 of the management regulations state that *"the indicators should be both proactive and reactive, and reflect technical, organisational and human factors"*. A proactive strategy for risk management can be defined as one which seeks to determine the boundaries of safe operation, make these visible to decision-makers, and counter conditions which shift activities closer to these limits. Proactive indicators will support the cautionary principle by providing information on the performance of key work processes, activities or barriers.

These are intended in turn to prevent future incidents, and come into play before control over the position has been lost and an undesirable incident occurs. A similar concept is the activity indicator, which measures how far important safety philosophies, procedures and practices are in place to manage risk.

Reactive indicators measure something which has happened, be it a failure, a near miss or an accident. A related concept is the outcome indicator, which measures how safety-related activities achieve the desired outcome. By definition, reactive indicators are based on measurements made after an event has taken place.

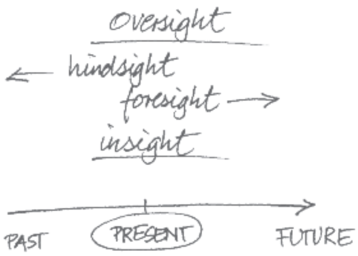
A distinction is also drawn between indicators related to process safety/major accidents and those which deal with personal safety. The first of these categories covers hazards related to activities or results with significance for all or most of a facility or a plant. Failures or accidents can cause many deaths, great damage to equipment or extensive destruction. Indicators for personal safety deal with hazards affecting people in the form of personal injury, and have little or no relationship with major accident risk.

Like to know more?
Rasmussen & Svedung (2000)
Proactive risk management in a dynamic society

Hollnagel, Woods & Leveson (2006)
Resilience engineering: Concepts and precepts

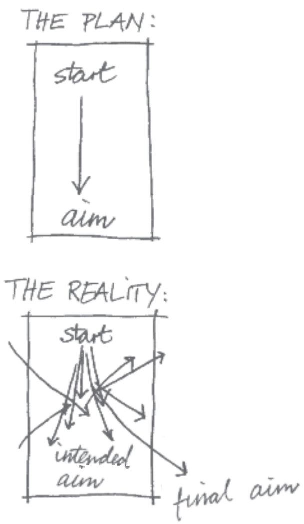
Reiman & Pietikäinen (2012)
Leading indicators of system safety – Monitoring and driving the organizational safety potential

Such yardsticks do not in themselves provide information on how well the organisation manages major accident risk or protects a facility's integrity. Using personal safety indicators and minor near misses to express major accident risk would be considered unsound by most people.



In order to monitor and influence various types of risk, organisations must know something about what could happen, what is happening and what has happened. That means knowing the past and learning from experience. They must also monitor in the present, and have managers, specialists and operators who can provide an overall view of and insights into important activities and results for safety.

At the same time, companies must seek to predict what can happen in the future. Proactive indicators involve trying to forecast what might occur, because the companies want to identify and monitor activities they think affect safety now and in the future. This means they must have a scientific basis or good reasons for assuming that given operations lead to the desired outcomes. A challenge in identifying the underlying causes of major accidents is that such relationships are very hard to determine in advance. The whole causal chain leading to an undesirable incident can normally only be identified with hindsight. And the further back you go in the chain, the weaker the link with the incident. A key issue in the debate concerns how far it is possible to identify cause and effect between proactive indicators and negative safety outcomes such as accidents.

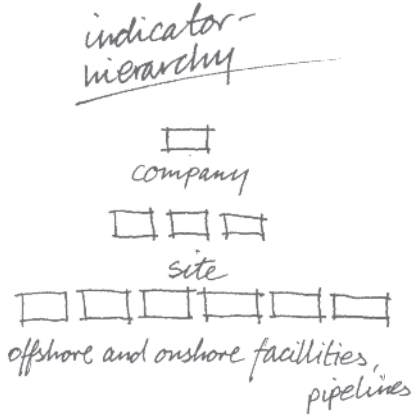


Two conditions may correlate or be sequential, but one does not necessarily give rise to the other (causality). A correlation means that A leads to B or vice versa, or that one or more third conditions (C) cause both A and B. A relationship has been found, for example, between ice cream sales and murders in New York. Does that mean people who eat ice cream become violent? This is very unlikely, and both variables proved to be influenced by a third – the weather. Both ice cream sales and criminality increase on hot days. Despite the correlation, the one did not cause the other.

Where indicators for major accident risk are concerned, experts disagree over whether causality needs to be demonstrated between yardsticks and the phenomenon they measure. The alternative view considers it sufficient to show or assume that the relationship is strong and that the numbers are large enough to be able to document trends over time.

RECOMMENDED PRACTICE, STANDARDS AND GUIDELINES

Recommended practice, standards and guidelines provide the good recipes for establishing, using and evaluating indicators in practice. They also describe models which can make it easier to understand these yardsticks.



Indicators form part of an organisation's internal control and management system, and are components in its processes for ensuring continuous improvement. When used correctly, they can allow comparisons to be made across groups, facilities, fields and players, and contribute to experience transfer and learning. They can also be used in reporting to employers, employees, the government or the general public.

Indicator hierarchies are models which can be used to evaluate levels and structures for reporting safety-related activities and results. The reporting level determines whether the indicator will apply to the whole organisation, a group of facilities, a single facility or specific activities. Within this structure, measurements from separate facilities are collated to create integrated indicators valid for a whole field or the entire organisation.

Like to know more?
API (2010) Recommended practice 754

EI (2010) Human factors performance indicators

ISO 31000 Risk management. Principles and guidelines

ISO 9001 Quality management systems

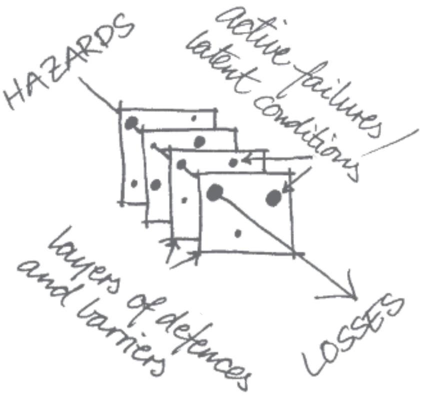
HSE (2006) Developing process safety indicators

OGP (2011) Report 456

OECD (2008) Guidance on developing safety performance indicators

Required indicators will vary between each facility or field and to meet the needs of top management within the organisation. The American Petroleum Institute (API) recommends that indicators or information selected for senior levels in the company should be representative for the whole organisation. On individual facilities, however, proactive indicators related to specific activities could be more desirable.

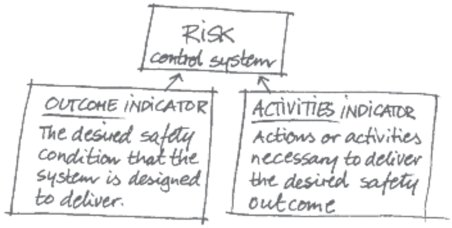
Creating reactive indicators is easier, since these reflect actual near misses or accidents. Proactive versions, on the other hand, address conditions further back in the causal chain. So developing good proactive indicators can be difficult. Complex causality makes it hard to form a full picture of activities and conditions which influence the system's condition. In an effort to understand the role of indicators in the course of an accident, a number of guidelines have tried to relate them to the *"Swiss cheese" model*. It is important to appreciate that this approach can involve both a simplification of the original model and a constraint on the indicator concept.



The model assumes that an organisation builds up successive layers of defence against accidents. Comprising both barriers and safeguards, these are visualised as slices of cheese. Each defensive "slice" may incorporate flaws, which are in constant motion. An incident can only occur if these "holes" align while an accident trajectory passes through. The holes in the cheese can be active or latent failures. While the active type is short-lived, latent conditions represent long-term faults in the system – such as unanticipated hazards which have not been defended against.

Like to know more?
Reason (2008)
The Human Contribution

Efforts have been made to position indicators in the Swiss cheese model, where the proactive type measures the performance of the slices and reactive ones gauge the holes – in other words, unsafe acts or latent conditions. This has been criticised for making the concepts less clear, because proactive usually relates to something which precedes a loss of control or an undesirable incident. The alternative way of viewing indicators in this model is to say that those on the cheese slices and holes are proactive as long as they precede an incident. Reactive indicators are measures made after the event.



Britain's Health and Safety Executive (HSE) recommends that both a proactive and a reactive indicator should be established for each risk control system or barrier function. Interaction between these two yardsticks will either confirm that the system is functioning as it should or sound a warning that problems are developing. The same recommendation has been given by the Organisation for Economic Cooperation and Development (OECD). It says that each activity (or proactive) indicator should have an associated outcome (or reactive) one. Describing indicators as part of a continuous improvement process, with information which can be used both proactively and reactively, is a common denominator of recommended practice, standards and guidelines.

Although indicators can be viewed in relation to barriers activated in the shift from normal operation towards failures, hazards and accidents, the concept is actually more extensive. It will cover a number of activities found in normal operation but not reflected in barrier models. Good indicator systems should also be able to pick up weak signals or early warnings of weaknesses and failures which might lead to accidents.

INDICATOR BLUES

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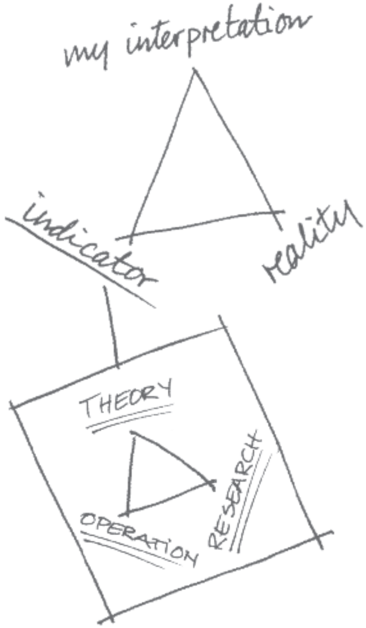

Many scientific requirements exist for good measurements. One is that indicators should be *valid*. This means they must relate to and measure what is to be measured – such as major accident risk. Documenting what *effect* using the indicator has or how it affects major accident risk is also required. And it must be *reliable* and unaffected by accidental factors. This means, for example, that results must be the same even if different people conduct the measurements related to the relevant indicator. That has nothing to do with whether the indicator is valid, but whether it is affected by uncontrolled variables or circumstances. A thermometer can measure temperature reliably, for instance. But if a calibration error means it reads 10°C too much, its results will not be valid in deciding whether you have a fever. Similarly, a watch can be correctly set and run steadily. But if the time setting changes each time your wrist moves too sharply, it will not be reliable.

Indicators must also be *sensitive* to changes in what they measure. In other words, they must respond to variations in risk. A thermometer which only worked in 10-degree steps would not be sensitive enough to measure a fever. Furthermore, indicators need to be *representative* and address factors relevant to major accident risk. And finally they should not be vulnerable to *manipulation*. This means it must not be possible to affect the figures or assessments on which the indicator rests unless an actual change has occurred in what is to be measured.

Little systematic empirical research exists for indicators in the petroleum sector, and documented correlations between these and major accidents are lacking (uncertainty about validity).

Major accident risk and safety are complex phenomena in a constant state of change. It is still not possible to predict the interaction between all the factors which may lead to accidents. One challenge is that the further back you go in a causal chain, the harder it becomes to identify correlations (validity) which lead to an accident, for example. So concentrating on validity can overlook early warnings or signals of failure.

Oversimplifying the indicator system in order to satisfy scientific standards risks ending up with results which cannot be transferred to the much more complex real world. That can be viewed as a choice between taking the right route, with scientifically acceptable but perhaps impractical indicators, or trying to find a useful path. It will be more difficult in the latter case to demonstrate that the indicators correlate with major accidents or have the desired effect. But the activities and results underlying them are considered likely to be important for safety. Scientists debate whether it is enough to be convinced that some activities affect safety – through expert assessment, for example – or whether a causal relationship must be proven.

British philosopher Carveth Read wrote in 1898: “It is better to be vaguely right than exactly wrong”. This can serve as a reminder that it is better in safety work to be on the safe side, and that important information is not only numerical. The counterargument would be that failing to observe scientific standards risks constructing safety systems which are potentially counterproductive and fail to manage risk. The challenge is to strike a good balance between these extremes.

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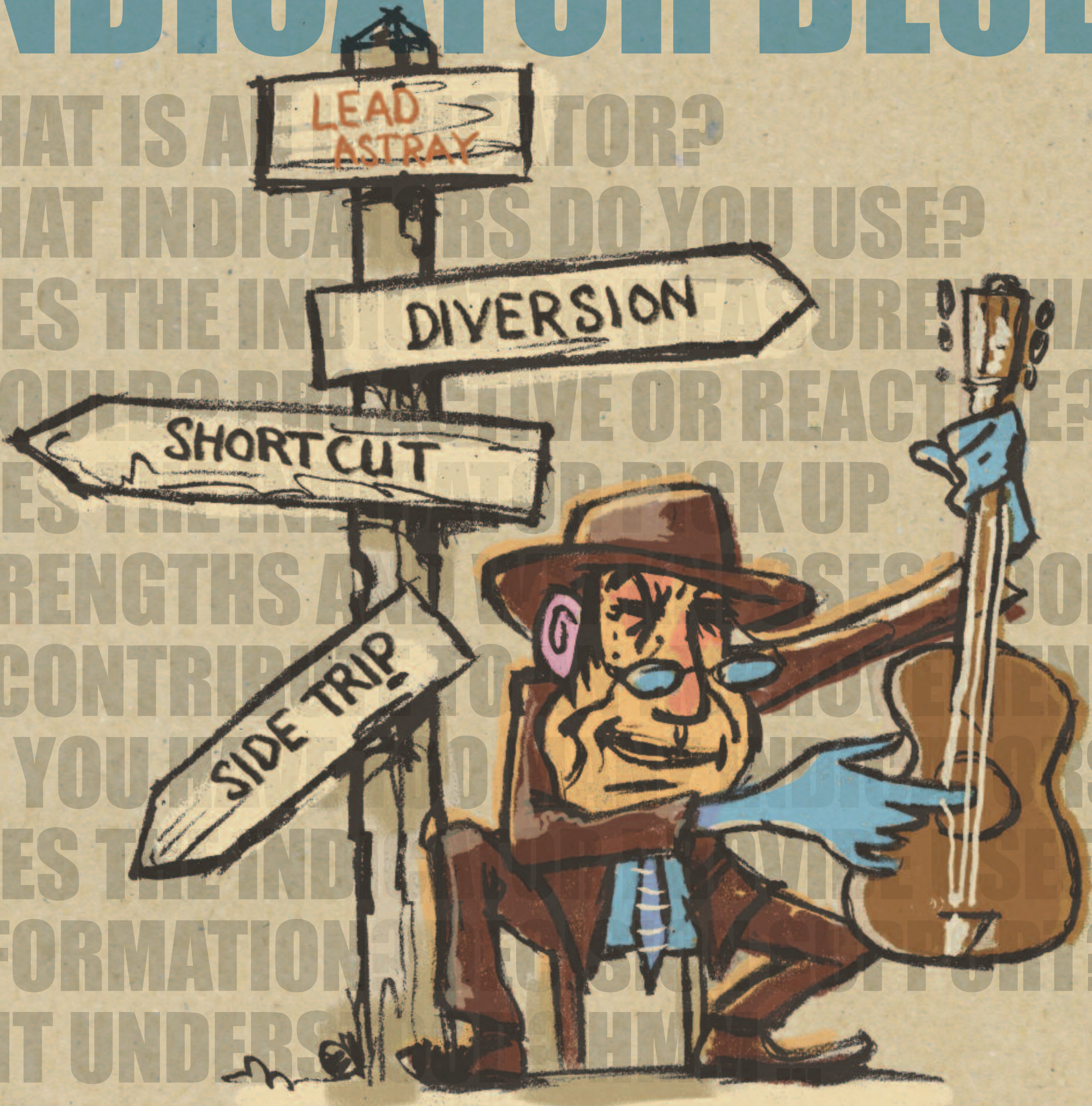

GONE ASTRAY

Envisage the following circumstances. This year's trends in risk level (RNNP) report from the PSA is ready for publication. The media and selected guests have been called in to hear the findings. These include a steady downward trend over recent years in the risk indicators for major accidents, which is now lower than ever. The next day's media headlines read: "Risk of major accidents lower than ever".

This might be a reasonable conclusion for people without expert knowledge of the RNNP indicators to reach. One question which ought to be asked is whether reactive indicators for major accident risk – which measure what has happened – can be used to predict the future.

Safety research has demonstrated that people have a tendency to equate proactive and reactive indicators. To some extent, the latter reflect the outcome of important activities to enhance safety. This means reactive indicators are also relevant in the future, assuming the activities involved do not change. That depends, too, on other important operating parameters staying unchanged. These include financial or political conditions, regulatory requirements or standards, management priorities and contractual terms.

Like the government, employer organisations and unions in Norway are concerned to ensure that systematic efforts to improve HSE never end. At the same time, many major changes are afoot in the Norwegian petroleum sector. Oil prices are low, and most operators and contractors on the Norwegian continental shelf (NCS) agree that costs must come down. The industry is downsizing and pursuing efficiency and restructuring processes, while company plans for maintenance and modification are changing. Such processes can have positive results. But risk may be affected by a transitional period of this kind, with changing operating parameters and conditions. The question is whether the indicators for major accident risk are still credible and valid measures of the present level of risk. Are conditions under control?

Using indicators can lead you astray. A key challenge arises when they are incorporated in a performance management system using incentives of various kinds to achieve specific targets. Incentives or sanctions tied to indicators could encourage a desire to manage these rather than the phenomena they are meant to monitor.

Among other applications, indicators are intended to influence or amend the way individuals and groups in organisations act, think and feel about important conditions for safety. This could seem a rather unusual way to think about such yardsticks, but it follows logically from their purpose. Most indicators will eventually require decision-makers and others to act or make changes on the basis of the information provided in order for the yardsticks to be effective.

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EFFECT AND AFFECT

A blowout, explosion and fire occurred on the Deepwater Horizon rig drilling on the Macondo well in the Gulf of Mexico on 20 April 2010. Eleven people died, a number of others were seriously injured and the unit sank after two days. More than four million barrels of oil flowed freely from the well before the leak was plugged after 87 days.

In the wake of this disaster, its causes have been related in part to the interpretation, use and effects of indicators at individual, group and organisational levels.

MENTAL SHORTCUTS AND BIASES

Although attention was also being paid to safety before the Macondo accident, major accident risk had been measured using indicators for personal safety. Investigations have shown that the latter fail to provide a relevant picture of major accident risk. The indicators being measured attracted attention. Several reports found that people were more concerned to manage through personal safety indicators. This could have created false confidence that the major accident risk was low.

For better or worse, indicators are ideal for people's mental apparatus. This is because the brain constantly seeks to create causes and effects. These are stored as mental recipes or heuristics – simplifications of reality which help to find suitable, but often incomplete, answers to difficult questions and to take decisions. Two different systems for information processing can be distinguished in the brain, with the first automatic and swift, requiring little involvement and beyond conscious control. The second system is mentally demanding and involves consciously focusing attention, solving problems and comparing information.

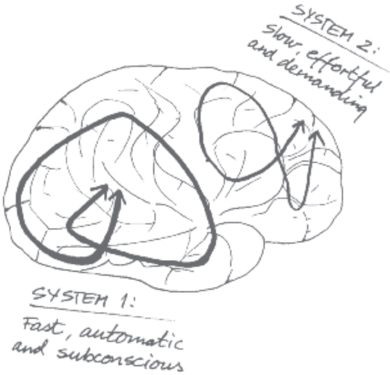
Like to know more?
Hopkins (2012)
Disastrous Decisions

Kahneman (2011)
Thinking fast and slow

PSA
A book about learning

Størseth, Hauge & Tinmannsvik (2014)
Safety barriers: Organizational potential and forces of psychology

A basic feature of brainwork and System 2 is a desire to minimise the use of mental energy. If pre-processed information – such as indicators – is easily available, it will often be utilised even when invalid. Two common mental shortcuts, known as availability and representative heuristics respectively, involve exaggerating the probability of something occurring.The first type utilises the ease with which examples of specific incidents can be recalled, while the second is based on how typical something appears – as when two conditions occur close together in time or resemble each other.



Mental shortcuts can lead to systematic biases. One conclusion after the Macondo incident was that personnel had systematically misinterpreted vital danger signals when establishing a well barrier (the cement job). They had also taken unfortunate decisions to skip measurements which could have determined the quality of the cement job, and ignored or misinterpreted the results of a well integrity test which suggested something was wrong. A common example is “confirmation bias”, where people select information which confirms what they expect to see happen and ignore contradictory data.

Transferred to the petroleum industry, this means accepting the possibility that indicators are being used for unsuitable conditions or as an invalid decision base. Understanding indicators depends on where individuals are going to use them. So it is important to question how far they could contribute to bias. If hydrocarbon leaks have occurred over many years, are they therefore expected to happen next year? With major changes taking place in the industry, is it possible to remain confident about what the indicators show?

How can non-measureable safety-critical conditions be managed? And are there differences between the way indicators are interpreted by specialists on the one hand and understood by management, media and offshore workers on the other?

MOTIVATION

People are motivated by jobs which are specific, measurable, attainable, relevant and time-bound, which they master and which they achieved good results with earlier. Indicators have many of these properties. They are specific and measurable, reflect something in the real world, and cover a defined period. They provide fully processed information, often in visual form, and invite the brain to do what it does best – draw quick, automatic and simplified conclusions about reality.

If the indicators are good, judicious and accurate, utilising them can be useful. But should they be detailed and difficult to grasp, people can quickly be misled. Indicators can also be useful and appropriate from an expert's perspective, while decision-makers and others may fail to appreciate important shortcomings in the information they provide and generalise this to areas where it is no longer valid.

Motivation deals with the internal and external forces which initiate action and determine its direction, intensity and duration. These are factors which allow problems to be solved in specific ways, and which determine the commitment people make to their work. A distinction is generally made between intrinsic and extrinsic motivation, with the first referring to the way work is experienced as intrinsically meaningful and rewarding. The feeling of being able to influence your own work, perform well and master the jobs you do will strengthen this *intrinsic motivation*. That can be reinforced by an indicator which helps to give you a better understanding of the significance of your work for what the indicator measures, and which you feel you can influence.

Costs were under tight scrutiny in the Macondo organisation, where drilling was not doing well on efficiency indicators. It was among the 10 worst in terms of days per 10 000 feet drilled, and for the non-productive time indicator. Performance-based bonus schemes for management were governed by drilling efficiency, and attention in personal evaluations normally concentrated on costs and performance. Some possible effects of this included the choice of cheaper and faster well solutions and the dropping of safety-critical tests which called for longer rig time. Similarly, well tests which should have been carried out during exploration drilling were hopped over and left to the people who would be completing the well for production.

Extrinsic motivation refers to sources of behaviour which are governed by outside rewards, and which relate to results rather than the work itself. Performance pay and indicator-based bonuses are examples of this, but others could be praise and positive feedback. Aims can include promoting learning, concentrating attention and motivating safety improvements. Research shows that performance pay for individuals is generally positive with simple and boring jobs, boosting commitment and results, but negative for more complex and interesting work. Absence of rewards can also be perceived as punishment, and doing away with them may reduce motivation to below the level before the system was first introduced. Moreover, although external rewards influence commitment, they do not increase employee knowledge, skills or ability to perform well. If financial reward systems related to indicators are nevertheless to be adopted at the individual level,

Like to know more?
Janis (1971)
Groupthink

some questions need to be asked. These include what is actually being rewarded, does this present possible downsides, and is anything being achieved with external rewards which could not be attained in other ways?

"THAT'S THE WAY WE DO THINGS HERE"

Humans are specialists at interacting with each other. In addition to norms and values, groups form shared perceptions of the things they feel help them to perform tasks. Colleagues and managers teach new members of the group the right way to perceive, think and feel in relation to the problems and jobs to be tackled. These are building blocks in the organisational culture, and provide strong guidance on decision-making, problem-solving and ways to act for individuals and groups. On the other hand, external factors and operating parameters will affect an organisation's culture. When parameters come under pressure, a robust HSE culture can play a key role as a protective buffer to ensure that a high priority is given to safety.

After test results indicated a leak in the Macondo well, a theory (known as a bladder effect) was propounded to explain that the well was safe despite the poor results. In addition to drilling personnel from the contractor, the team involved included two representatives from the operator company. The culture among the drilling crew has been described as close-knit, with able professionals who took a proprietorial attitude to each well and were used to being in charge. Strong group pressure was also observed, where powerful sanctions were imposed against people asking "unintelligent" questions. While the operator employees were initially sceptical to the bladder effect, one of them soon came round to the theory and the other then also agreed.

Following the disaster, one of the operator personnel said that he felt the others found it laughable that he was doubtful about the theory.

What happened within this group has subsequently been related to the concepts of “normalising” danger signals and of “groupthink”. Normalisation involves redefining or interpreting failures or faults in such a way that they are eventually regarded as acceptable. Group thinking describes a type of problem-solving where the search for agreement overrides a realistic assessment of alternative approaches or interpretations.

In the wake of an undesirable incident, it can be difficult to grasp the position the players found themselves in before the event occurred and the outcome was known. The tendency is to disregard other possible outcomes. Instead of the uncertainty faced by players ahead of an unexpected event being appreciated, they get blamed for failing to understand what is obvious with hindsight. Nevertheless, complex systems fail in complex ways. Looking at how indicators affect individuals or groups is not enough. Attention must be paid to the way indicators shape organisational frameworks, which in turn affect employees.

CONFLICTING GOALS AND ORGANISATIONAL FRAMEWORKS

Robust organisations must be able to balance conflicting demands between production or efficiency needs and safety requirements, for instance. A number of decisions were taken ahead of the Macondo accident to save time or money without their consequences for safety being adequately assessed. Downsizing and cutbacks, concentrating on doing the job faster and cheaper, and incentives which rewarded this, are among the conditions subsequently subject to criticism. Important tools intended to identify potential problems and the consequences of hazards concentrated only on possible negative effects for time and costs, and took no account of safety impacts. Pressure on costs drove decisions in the direction of removing organisational redundancy, which also affected safety. It led in part to insufficient staffing and lack of training.

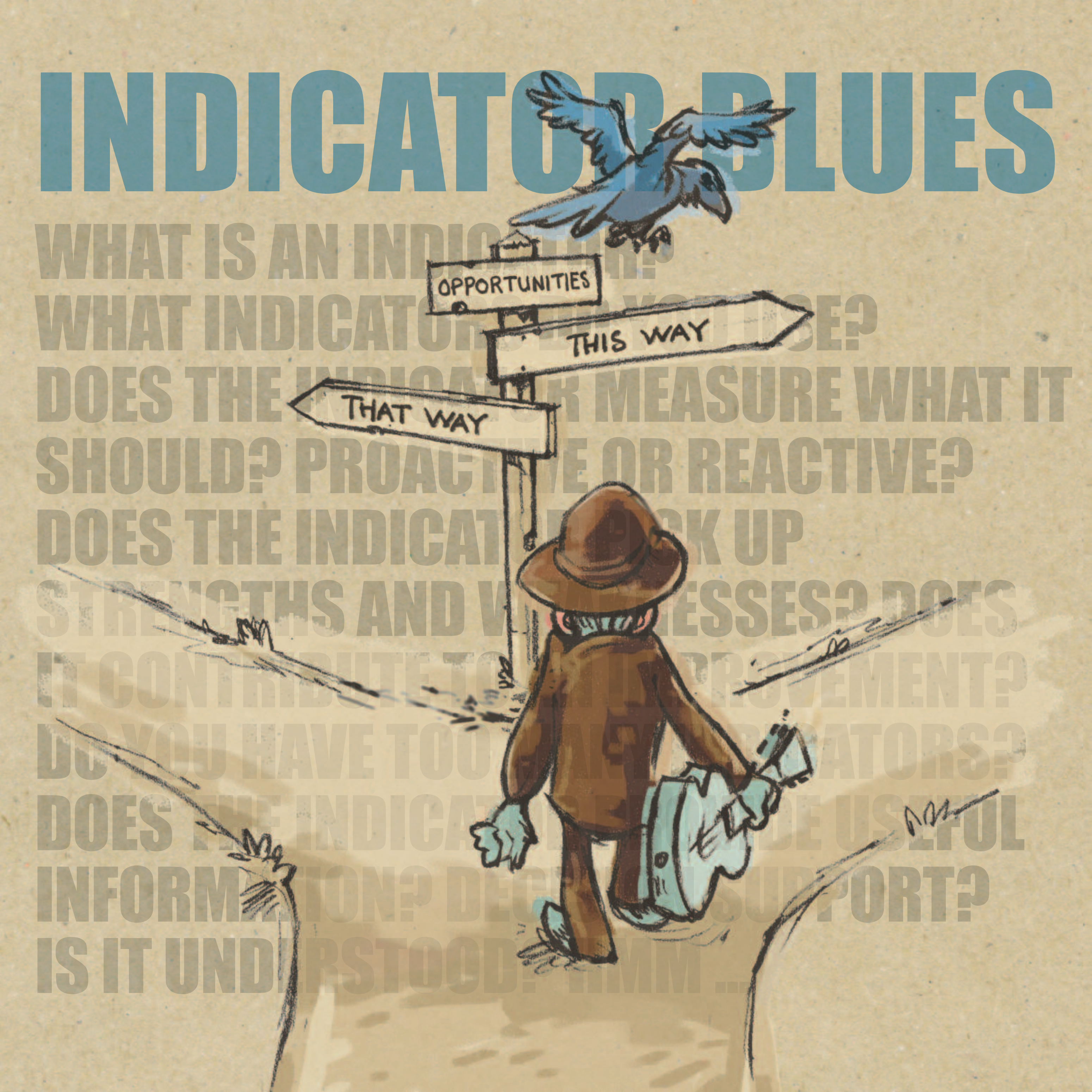
The following familiar challenges related to indicators used to provide base information for major accident risk were identified after the accident.

- Excessive weight is given to indicators for accident trends (historical performance) when assessing accident risk (future performance).

- Great weight is given to indicators for accident trends (such as work accidents) despite their limited relevance for assessing major accident risk.

- Information relevant for assessment in conjunction with accident trends is available but not used, particularly if accidents show a declining tendency.

- Important information on accident risk or uncertainty is filtered away.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IS IT UNDERSTOOD? HMM ...
OPPORTUNITIES
THIS WAY
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OVERVIEW OF INDICATORS

Countless conditions can form part of a chain of events which may collectively represent an HSE risk. Many of these will be unknown. Establishing indicators for conditions further back in the chain is difficult, partly because it can be hard to determine such relationships. But choosing to ignore them risks missing weak but early and important warning signals. Where the consequences can be serious, "it is better to be vaguely right than exactly wrong". Staying on the safe side is also crucial to the way the PSA as the regulator wants the industry to relate to risk.

Scientists and international guidelines distinguish between indicators related specifically to risk and those assumed to have such a relationship. The same applies to the effects of using the indicators. Proving that exerting influence on an indicator in a positive direction helps to enhance safety is difficult, but good reasons may exist for assuming that it does. Another way of saying this is that indicators for activities, desired outcomes and safety systems can be based on what technical experts, operating personnel management and union representatives agree on and believe are important for handling risk. Worker participation, dialogue and collaboration increase the chance that activities and results enshrined in the indicators are understood and motivate personnel in the desired direction which are important and coveted outcomes.

Indicators have probably emerged because humans like them. They can tell us something understandable, and provide guidance in complex and difficult areas. As in the blues, indicators involve challenges, opportunities, choices and consequences. Good ones present challenges for the industry to tackle.

This represents a positive effect if it prompts increased attention on areas which all sides believe are important for HSE, and which the industry can demonstrate progress with. Nobody wants indicators to be more important in themselves than the aspects they are intended to say something about – such as occupational health, the safety of facilities and plants, and environmental protection. Using indicators must be beneficial.

Norway has a performance-based (functional) regulatory regime, which gives companies freedom to choose recommended solutions or recognised alternatives. But this freedom is accompanied by an expectation from government that the industry conducts thorough follow-up of its own activities. Indicators will also provide a simplified presentation of reality, with its degrees of uncertainty. They therefore are and must remain only one of many tools for managing risk.

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