Statement from the Norwegian Oil Industry Association (OLF)

Issue: Process Safety Performance Indicators
for Major Accident Prevention.

Event: The U.S. Chemical Safety Board's two-days hearing
to be held July 23rd – 24th,
at Hyatt Regency, 1200 Louisiana Street, Houston, Texas, US

The US Chemical Safety Board, CSB, is holding a two-day public hearing on process safety performance indicators for major accident prevention, July 23 and 24, 2012, in Houston, Texas. All panelists are asked to prepare a statement for their designated panel discussion. The CSB will post all statements on the agency website before the hearing takes place to help initiate dialogue leading up to the event.

The focus of the public hearing is on the development and use of key process safety performance indicators for major accident prevention by both industry and the regulator. The CSB has asked the Norwegian Oil Industry Association, OLF, to give a very brief description of OLF's perspective on the use of performance indicators offshore, as well as the work the association has done to advance industry's use of indicator data to improve safety.
As for the content of OLF's presentation, CSB is particularly interested in the issues described in the guidance questions presented by the CSB, cf. chapter 4.0 in this statement.

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Author: Aud Nistov
Acting director HSE & operations
Medical Docter
Specialist of Occupational Health & Environmental Medicine
Phone: +47 - 51846536
Mobile: +47- 41573182

The Norwegian Oil Industry Association (OLF)
Main Office: Vassbotnen 1, Sandnes, Norway
Mail address: P.O.Box 5481, N-4068 Stavanger, Norway
Phone: +47 – 51846500
e-mail: firmapost@olf.no
www.olf.no

1.0 Contents

2.0 Background

2.1 About OLF

The Norwegian Oil Industry Association (OLF) is a professional body and employer's association for the oil and supplier companies engaged in the field of exploration and production of oil and gas on the Norwegian Continental Shelf. OLF is a member of the Confederation of Norwegian Business and Industry (NHO). The main office is located in Stavanger and also has an office in Oslo. OLF's administration counts 39 employees. More information about our organization can be found at www.olf.no/en

OLF represents 48 oil companies and 47 supplier companies. The oil companies are either the owners of or participants in production licenses for petroleum on the Norwegian Continental Shelf (NCS). The supplier companies include well service companies, oil drilling companies, subsea contractors, catering companies, supply bases and companies within inspection, safety and security services and other services. OLF's member companies represent about 35 000 employees.

OLF's vision is to further develop a competitive oil and gas industry which enjoys respect and trust, and the association work according to the following principles:

> The OLF believes that value creation and prosperity are closely linked. Issues pursued by the OLF will also be in the best interests of the wider community. The OLF's work will be based on the following principles:
>
> - the importance of profitability for the industry
> - the principle of free competition
> - respect for people, safety and the environment
> - a high ethical standard and awareness of the industry's social responsibility

2.2 OLF goals and strategy

OLF goals 2012 – 2014 state that one of the OLF's HSE (Health & Working Environment, Safety, Security and Environment) priorities for this period is major accident risk reduction where well incidents and hydrocarbon leaks are priority areas. In order to achieve these goals, OLF has stated in the 2012 work program that to establish robust and reliable proactive major accident risk indicators is one very important activity.

2.3 OLF's project: *Deepwater Horizon* – Lessons learned and follow-up

In August 2010, OLF established a project to follow-up the *Deepwater Horizon* accident which occurred with the Macondo well in the US Gulf of Mexico (GoM) on 20 April 2010. The primary objective of this project was to gather and transfer lessons learned from the accidents in order to reduce the possibility of similar accidents occurring on the NCS. The OLF *Deepwater Horizon* project has reviewed the major investigation reports and assessed their implications for Norwegian offshore activities. A number of international activities have been pursued in response to Macondo, including those from the International association of Oil and Gas Producers (OGP), Oil and Gas UK and the American Petroleum Institute (API). OLF's project has, partly built on these initiatives and reports, issued 45 recommendations. Please find a link to the project report enclosed below: www.olf.no/dwhreport

Chapter 2.3.1 – Major hazard and safety leadership, in this report states the following:
"Safety statistics for the NCS have been improving over the past 10 years, as shown in the annual trends in risk level in the petroleum activity (RNNP) report. However, the Deepwater Horizon accident

has emphasised the need for the industry to pay greater attention to major accident prevention. Two areas have emerged as opportunities to reduce major accident risks:

- *Managing and controlling simultaneous operations (SIMOPS), within drilling, production, hot work and high risk maintenance activities*
- *Maintaining technical and operational integrity of key safety systems. A key performance indicator can be for example, backlog of maintenance of safety critical systems*

The industry is seeking more, and especially pro-active, key performance indicators to better manage these risks."

The OLF *Deepwater Horizon* project report's "Recommendation no 17" is quoted below:

> *"OLF will assess the OGP's work on process safety and key performance indicators related to asset integrity and major accident risk."*

2.4 OLF's perspective

This paper is based on the fundamental notion that Norwegian legislation is built on and developed over many years to be the performance-based regulations we have today. In Norway, offshore regulations are primarily performance-based and supplemented by prescriptive requirements through established norms and standards. The Norwegian regulations require compliance with the latest applicable regulations and updated reference standards. The regime focuses the operator's attention on its HSE performance through self-regulation and continuous improvement. This regime is built on trust and transparency. The same tradition or fundament is also applicable to the industry's perspective regarding safety performance indicators.

Furthermore, collaboration between employers, unions and government as well as worker participation are important cornerstones in the efforts to establish and develop a high level of HSE in the petroleum industry.

This paper reflects the perspective of the Norwegian petroleum industry regarding traditional thinking and basis for safety performance indicators. However, the paper does not reflect or discuss in full detail the various academic schools within safety performance indicators and must not be regarded as a comprehensive study on this issue.

3.0 Introduction

3.1 The Norwegian tripartite model

The tripartite cooperation between the industry, trade unions and governments in the oil and gas industry in Norway is unique in both a national and international perspective. Continued good cooperation between the authorities, employee and employer organizations is also a precondition for reaching the Government's goal of the Norwegian petroleum industry to be world leading in HSE. OLF is an active member on all the tripartite arenas and initiatives and works continuously to further develop the tripartite cooperation.

The Norwegian model is based partly on law and partly on collective agreements. The tri-partite model is reflected regarding arenas for cooperation on national level, sector level and on enterprise level. On enterprise level we have the Occupational Environmental Committees (regulation based), the Safety Delegates (regulation based) and the Shop Stewards. Figure 1 below illustrates the tri-partite model on the national level.

Figure 1: The tripartite model

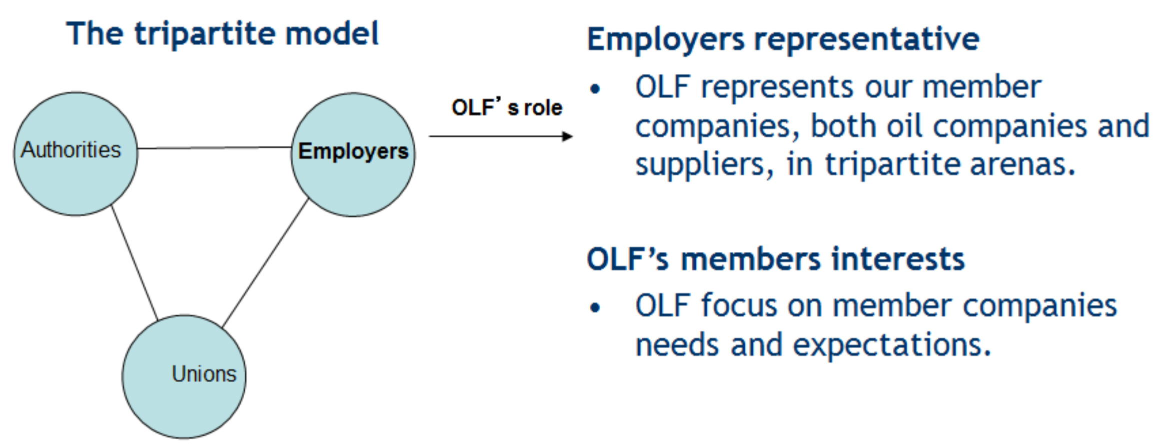


Figure 2: Examples of tripartite arenas

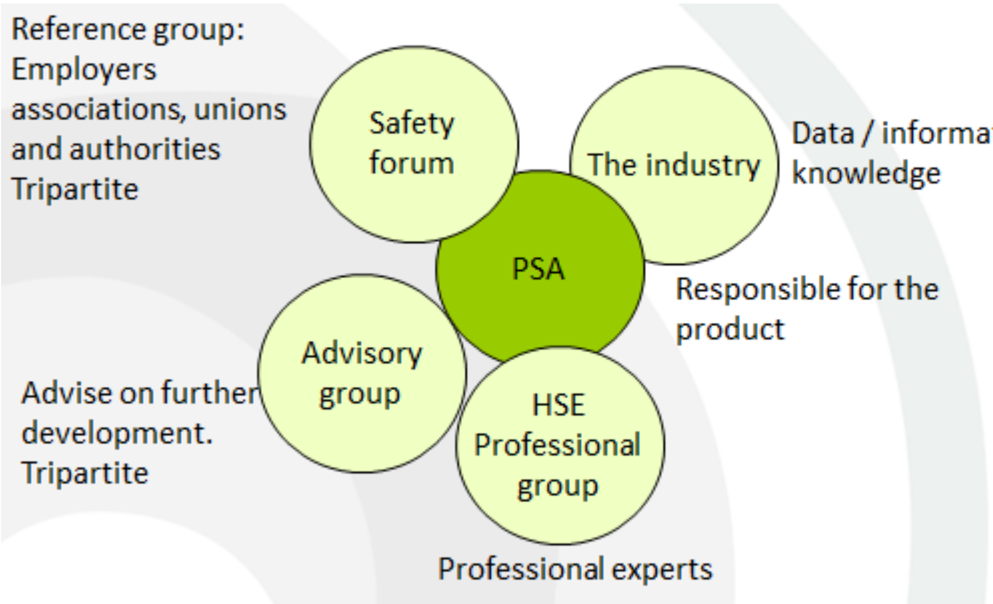
3.2 Trends in risk level - RNNP

The "Trends in risk level – Norwegian Continental Shelf" project started in the year 2000. Trends in the risk level in the petroleum industry concern all parties involved in the industry, as well as the general public. It was therefore natural and important to establish a structure for measuring the effect of the industry's overall HSE work.

RNNP as a tool has developed considerably from its inception in 1999/2000 (first report published in 2001). The development has taken place in a multipartite collaboration, where there has been agreement regarding the prudence and rationality of the selected course of development as regards forming the basis for a shared perception of the HSE level and its development in an industry perspective. The work has been awarded an important position in the industry in that it contributes toward forming a shared understanding of the risk level.

The petroleum industry has considerable HSE expertise. The Petroleum Safety Authority Norway (PSA) has attempted to utilize this expertise by facilitating open processes and inviting contributions from key personnel from both operating companies, the Civil Aviation Authority, helicopter operators, consultancies, research and teaching. Objectivity and credibility are key factors for any qualified statement regarding safety and the working environment. The work therefore depends on the parties' shared understanding of the sensibility of the applied method and that the results create value. The parties' ownership of the process and the results is therefore important. So as to further facilitate active ownership of the process, a multipartite reference group was established in 2009 to assist in the development.

Figure 3: RNNP – Participants and contributors



As shown in figure 3, OLF / the industry plays a key role in the RNNP work.

The industry has traditionally used a selection of indicators to illustrate safety development in the petroleum activities. The use of an indicator based on the frequency of lost time events has been particularly widespread. However, such indicators only cover a small part of the overall safety picture. There is a high awareness that management of major hazards is not the same as management of occupational hazards.

There has been a development in recent years where multiple indicators are used to measure trends in a few key HSE matters. The PSA, together with the industry and trade unions, wants to create a differentiated picture of trends in risk level based on information from several sides of the industry, so that we can measure the impact of the industry's overall safety work.

The objective of the “Trends in risk level in the petroleum activity”:
• Measure the impact of the industry's HSE work.
• Contribute to identify areas that are critical for HSE and where the effort to identify causes must be prioritized to prevent undesirable events and accidents.
• Increase insight in potential causes of accidents and their relative significance for the risk profile.

For further information, see the enclosed link to the “Trends in risk level in the petroleum activity – Summary report 2011 – Norwegian Continental Shelf”:
http://www.ptil.no/getfile.php/PDF/RNNP%202011/Summary_2011.pdf

3.3 OLF Key Performance Indicators

“Trends in risk level in the petroleum activity” is an annual reporting. However, OLF early identified the usefulness of having similar reporting, but more frequent, for a range of safety performance indicators. OLF has therefore since the beginning of the 2000s coordinated a monthly industry report on some key performance safety indicators. The most relevant safety performance indicators for major accident prevention are:

- hydrocarbon releases
- well incidents
- vessels on collision course.

The above mentioned safety performance indicators for major accident prevention may be defined as so-called “lagging indicators”. For some time the industry has been working with the development of “leading indicators” or “proactive safety performance indicators”. Please see chapter 4.4 for more details.

One of the goals for the future will be to agree on an industry common set of proactive safety performance indicators for major accident prevention, cf. the OLF strategy 2012 – 2014 (chapter 2.2). This is also more thoroughly debated in chapter 5.0 – the way forward.

3.4 The International Association of Oil & Gas Producers (OGP) – Safety reporting and statistics

Across the global oil & gas industry, considerable effort has been focused on the prevention of major accidents. For many years OGP has collected health and safety data. The purpose of these reports is to present the health and safety performance of the global exploration and production (E&P) industry. These allow OGP members and others to compare the E&P industry safety performance to that of previous years and benchmark their performance against other companies, different E&P activities and different regions of the world.

The key safety indicators used in the reporting are: number of fatalities, fatal accident rate, fatal incident rate, lost time injury frequency and total recordable injury rate. The report presents global results for these indicators, which are then analyzed by region, function and company. The performance of both companies and their associated contractors is reported. For further information see the link to the “OGP’s Safety & health performance indicators – 2011 data” enclosed below:
http://www.ogp.org.uk/publications/safety-performance-indicators/

In tandem with the efforts related to the traditionally collected health and safety data, in 2011 the OGP started to gather preliminary process safety data as well. As part of continuing efforts to prevent major accidents, OGP has published this recommended practice that focuses on the practical implementation of a Key Performance Indicators System linked to establishing and reporting of leading and lagging indicators. The aim: To improve process safety. A new report was therefore issued; *Process safety – recommended Practice on Key Performance Indicators* (OGP Report No. 456, November 2011). This new publication complements *Asset Integrity - the key to managing major accidents* (OGP Report No. 415, December 2008), which introduced the concept of asset integrity and its management. The recommended practice report gives readers the tools to develop a framework for managing the integrity of their operating systems.

Please find a link to OGP Report No.456 enclosed:
http://www.ogp.org.uk/publications/process-safety-recommended-practice-on-key-performance-indicators/

Publication of this new document will further inform member companies wanting to participate in this data collection and also provide a basis for industry-wide reporting. The establishment of an OGP Process Safety Subcommittee will accompany the developing data collection exercise and accelerate OGP's continued efforts in this area.

OLF is together with many of our member companies, a member of the OGP. The Norwegian industry has participated in the work done by OGP on "Process safety – recommended practice on key performance indicators". With reference to chapter 2.3 the OLF *Deepwater Horizon* project report's states in the "Recommendation no 17" that:

> *"OLF will assess the OGP's work on process safety and key performance indicators related to asset integrity and major accident risk."*

Consequently, OLF acknowledge and support the work performed by the OGP.

3.5 Terminology

OLF has learned that there are a multitude of different expressions to some extent, which describe (or intend to describe) the same conditions or items. OLF has experienced that there is terminology confusion when it comes to Key Performance Indicators, KPIs. The different terms;

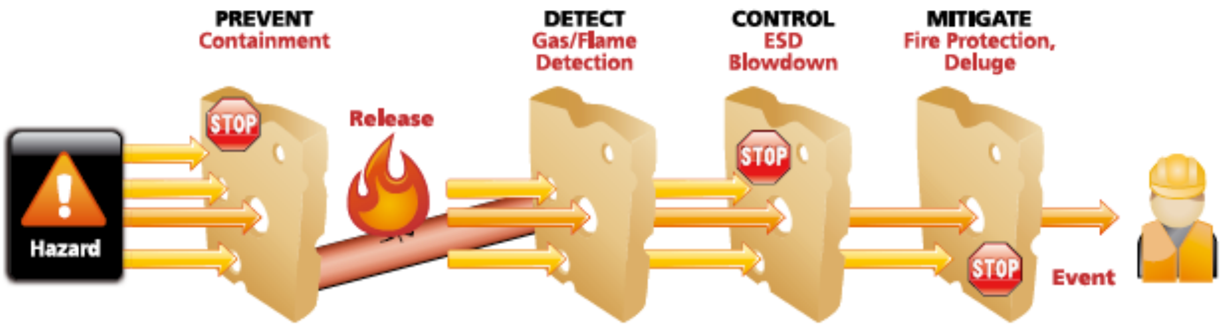
- Risk indicator
- Safety Indicator
- Major hazard risk indicator
- Asset integrity
- Process safety
- Major hazard risk

may be used somewhat interchangeably, and various stakeholders may seem to use somewhat divergent definitions. From OLF's point of view, this is an observation that one should be aware of but perhaps this is more of an academic interest than an operational issue.

In addition to the above mentioned different terms, there are different terms related to indicators such as leading, lagging, proactive, barrier, precursor, output and input.

Major incidents rarely results from a single cause but rather by multiple failures that coincide and collectively result in an exceptional event with severe consequences. This relationship between sequential failures of multiple "risk control systems" is often illustrated using the "Swiss Cheese Model" (after James Reason, 1990 and 1997). [1] This is illustrated in figure 4 below.

Figure 4: The "Swiss Cheese Model"



The same principles underpin other similar approaches such as the "Bow Tie Model" – developed by Shell and the Leiden University (Patrick Hudson et al) in cooperation [2]. This model is illustrated in figure 5 below.

Figure 5: The "Bow Tie Model"

These two models may be used to illustrate and distinguish between the two different types of KPIs: "Leading" and "lagging" indicators. Recording the number of Loss of Primary Containment (LOPC) events or actual consequences (which are the predominant cause of major process incidents in the oil and gas industry) – where one or more barriers fail simultaneously – is a "lagging indicator". The term lagging indicator may also be used to measure the number and size of holes in the barriers to assess the extent or weaknesses, defects or failures in the risk control system. Whereas monitoring the strength of barriers – by measuring the company's performance in maintaining robust risk controls – is a "leading indicator".

Lagging indicators are generally retrospective and outcome based whereas leading indicators are usually forward-looking and input based. In principle, most LOPC events will have no actual consequences but are still failures and therefore lagging outcomes, but low consequence LOPC events also provide leading information when predicting the likelihood of major incidents with serious consequences.

The following example may demonstrate the “difficulty” of “placing the knot” regarding the “Bow Tie Model”; Where is the “knot” located in the following sequence?

- Error in flange mounting after PSV replacement
- Verification not performed due to silent “deviation”
- Gas leak
- Ignition
- Failure of active fire protection
- Escalation to neighbor module
- Escape and evacuation

Another example of a type of indicator that might be either leading or lagging is a “near miss”.

Thus the term leading and lagging indicators are generally useful but the industry needs to be aware that some indicators can provide both retrospective and forward-looking insights.

However, there are some important distinctions to be made when considering risk indicators or KPIs. In which level are these indicators considered?

- National level (such as for example RNNP)?
  These indicators may give information about national trends, challenges, focus areas etc.

- Company level (benchmarking between companies)?

- Installation levels
  These indicators may provide information that can be useful regarding benchmarking between installations, or information about trends on installations

These are questions that need to be addressed when developing, proposing or working with different sets of major hazard key performance indicators.

4.0 Questions posed by the US Chemical Safety Board (CSB)

4.1 How can effective process safety performance indicators be identified and developed? (CSB's question no 1)

Through the RNNP work the following safety performance indicators have been identified and developed for the NCS;

The major hazard risk components for employees working on Norwegian offshore installations are the following:

- Major hazards during stay on the installations
- Major hazards associated with helicopter transportation of personnel, for crew change purposes every 2 weeks and any shuttling between installations

For the risk associated with major hazards on the installations, the following types of indicators have been developed through the RNNP:

- Indicators based on occurrence of incidents and near-misses (i.e. precursor events)
- Indicators based on performance of barriers that are installed in order to protect against these hazards and their consequence potential

RNNP has collected major hazard precursor data for several years. The relevant major hazards for personnel on the installations were addressed in Quantitative Risk Assessments (QRA studies), and these were one of the main sources when indicators were identified. Table 1 shows an overview of the categories of major hazard precursor events that have been included in RNNP.

Table 1: Overview of major hazards precursor event categories.

No	***Description***	***Data sources***
1	Non-ignited hydrocarbon leaks	Industry
2	Ignited hydrocarbon leaks	Industry
3	Well kicks/loss of well control	DDRS/CDRS + PSA (event reports)
4	Fire/explosion in other areas, flammable liquids	Industry
5	Vessel on collision course	Industry
6	Drifting object	Industry
7	Collision with field-related vessel/installation/shuttle tanker	PSA (CODAM)
8	Structural damage to platform/stability/anchoring/positioning failure	PSA (CODAM) + Industry
9	Leaking from subsea production systems/pipelines/risers/flowlines/loading buoys/loading hoses	PSA (CODAM)
10	Damage to subsea production equipment/pipeline systems/diving equipment caused by fishing gear	PSA (CODAM)
11	Evacuation (precautionary/emergency evacuation) *	Industry
12	Helicopter crash/emergency landing on/near installation *	Industry

*These two indicators are in principle related to major accidents, but are considered in a slightly different way in the RNNP reporting format.

RNNP has also collected barrier data for major accidents since 2002. With one small exception, only technical barrier indicators have been covered. The main focus is on barriers related to leaks in production and process facilities, where the following barrier functions are included:

- Integrity of hydrocarbon production and process facilities
- Prevent ignition
- Reduce cloud/spill
- Prevent escalation
- Prevent fatalities

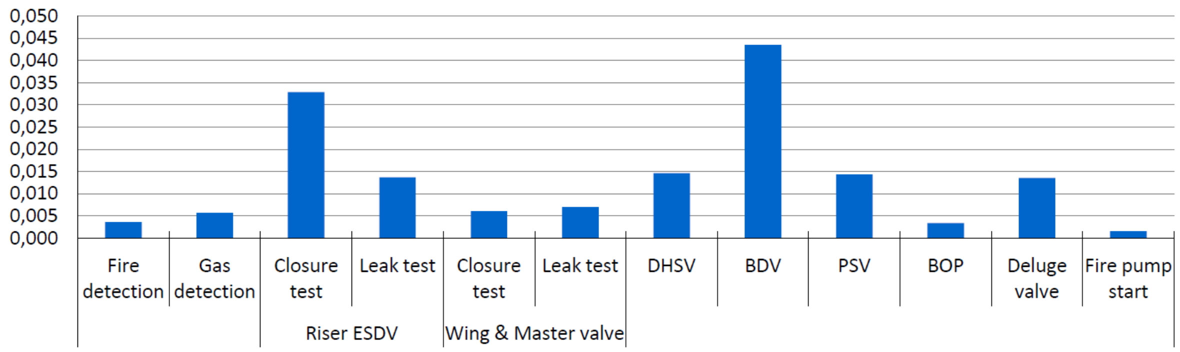
All the barrier data are reported by industry using a special reporting format for RNNP. Table 2 shows an overview of the barrier elements that are included in RNNP for the hydrocarbon related hazards.

Table 2: Overview of the major hazard barrier elements

Barrier element	
Fire detection	
Gas detection	
Riser ESDV (Emergency shutdown valves on risers/flowlines)	Closure test
	Leak test
Wing/master valves (X-mas tree valves)	Closure test
	Leak test
DHSV (Downhole safety valves)	
Pressure relief valve / Blowdown valves (BDV)	
Pressure safety valve (PSV)	
Isolation with Blowout Preventor (BOP)	
Deluge valve	
Fire pump start	

RNNP describes the relative fraction of failures for those barrier elements relating to production and process, for which test data have been acquired. These test data are based on reports from all production operators on the NCS. Figure 6 shows the mean fraction of failures for selected barrier elements 2011 (RNNP).

Figure 6: Mean fraction of failures for selected barrier elements 2011 (RNNP)



These examples from the RNNP model illustrates how the Norwegian petroleum industry together with the authorities (regulators) and the unions in cooperation have identified and developed process safety performance indicators.

4.2 What are the critical characteristics of effective indicators?

(CSB's question no 1 – a)

Several papers and studies have discussed what are the critical characteristics of effective indicators. The list below was established by Vinnem et al. (2003) [3] partly based on work by Kjellén (2000) [4]. This list is general and may apply to any risk indicators, not only to major hazards:

- Observable and quantifiable
- Sensitive to change
- Transparent and easily understood
- Robust against manipulation
- Valid

Major hazards in the offshore industry are rare events on a national level. But even major hazard precursors (hydrocarbon leaks, well kicks, ship on collision course, etc.) are rare events on a single installation. For an offshore employee the return period between occurrences of major hazard precursors may typically be in the range 10–15 years.

It must be possible to observe and measure performance by applying a recognized data collection method and scale of measurement. Usually, the indicators are expressed on a ratio scale of measurement, such as the number of hydrocarbon leaks (>0.1 kg/s) per installation year, or per 1 million man hours. It is difficult to establish a data collection method that gives reliable data, i.e. the data corresponds to the quantity we would like to observe. For example, measuring the true number of leaks is in practice often difficult. Recording of the events may be poor, and the data may be contaminated by extraneous factors. In one case in Norway some years ago, a hydrocarbon leak and a personnel injury occurred in the same event. For a long time, the injury was focused on, and the hydrocarbon leak was overlooked. It is therefore essential that the data we want to record are easily observable, so that disagreements about whether the event occurred or not can be avoided. Limiting the data collection to those events with medium and large severity will usually improve the reliability significantly.

The indicators should preferably be intuitive in the sense that what is measured is considered intuitively by the workforce to be important for the prevention of major accidents. When some years ago the number of years in the same position (e.g. as process operator) was proposed as a major hazard risk indicator, this is probably not intuitively accepted as important by many employees offshore. Yet we see proposals like this being repeated frequently. It is further preferable if the major hazard risk indicators do not require complex calculations, this is also related to intuitiveness. If the number of observations is reduced, it should correspond to an improvement. If very complex calculations are required, the confidence may be lost.

Psychological and organizational reasons could in many cases result in a too low reporting. As an example, we may think of an organizational incentive structure where absence of incidents is rewarded (for instance by a bonus scheme). There might be a risk that some incidents are not reported as the incentive structure is interpreted as rewarding the absence of reported incidents. It would be very useful if the indicators could reflect as closely as possible the hazard mechanisms. If they do, then the indicators may contribute to maintaining the awareness about the risk mechanisms. The number of hydrocarbon leaks is thus a good major hazard risk indicator, because hydrocarbon leaks are among the most hazardous incidents on offshore installations.

A risk indicator must be sensitive to change. It must allow for early warning by capturing changes in a socio-technical system that have significant effects on accident risks. Clearly, the number of occupational accidents leading to fatalities would not normally be sufficiently sensitive to change. The "good" set of indicators will reflect changes in risk as well as point to aspects where improvements should be sought. Usually the number of observations (incidents, barrier faults, etc.) for the system being considered should be in the order of a dozen or so per period.

The risk indicators must also be robust against manipulation. The point is that the indicator should not allow the organization to “look good” by for example changing reporting behavior, rather than making the necessary basic changes that reduce accident risk.

This leads us to the requirement of validity, which is a critical point in the evaluation of the quality of an indicator. Is the indicator a valid indicator for the major accident risk? Does the indicator actually measure what we intend to measure? Consider for example the indicator defined by the number of lost time injuries. Clearly, this indicator says something about accident risk, but of course, the accident risk is more than the number of lost time injuries, so we cannot use just this indicator to conclude on development in the accident risk level as a whole. The validity of a statement concerning the accident risk based on observations of the injury rate only, would thus in most cases be low. But restricting attention to this specific type of injuries, there should be no validity problem, in this respect. But still we have problem in concluding on any development in the injury risk based on the observations from the indicator. The following is a summary of the criteria discussed above:

- Combination of lagging and leading indicators
- Easily observable performance
- Intuitive indicators
- Not require complex calculations
- Not be influenced by campaigns that give conflicting signals
- Reflect hazard mechanisms
- Sensitive to change
- Show trends
- Robust to manipulation
- Validity for major hazard risk

These ten criteria should be addressed when reviewing current use of indicators or new proposals, cf. Vinnem, J.E., Safety Science 48 (2010), 770 – 787 [5].

However, finally, one should always ask a critical question: Does the indicator contribute to improvement (directly or indirectly)?

4.3 Do leading indicators provide more preventative value than lagging indicators? (CSB’s question no 1 – b)

The distinction between leading and lagging indicators has been debated for some time, for example by Kjellén: “A leading safety performance indicator is, in this interpretation, an indicator that changes before the actual risk level has changed” [6]. According to Kjellén this definition is consistent with what is commonly used in economy, but significantly different from what other researchers in safety use. Kjellén argues further that what is now typically called “leading indicators” earlier was called “proactive indicators”.

For major hazards in particular, it is important to focus on indicators that change before the actual risk level has changed. Major accidents are very rare in high reliability industries, and the last major accident in offshore operations on the NCS occurred in 1985. Even precursor events are quite rare, typically in the order of one event per installation per year. In Norway one finds it crucially important to maintain motivation and awareness that we have indicators that change before the risk level has changed. Precursor events occurrences are obviously lagging indicators, according to the RNNP definitions. The risk level has changed, at least temporarily, when a precursor event occurs.
What constitutes a leading indicator appears to be more controversial.

It is commonly accepted that “leading indicators” are clearly to be preferred over “lagging indicators”. This implies that there is more motivation in reporting performance of preventive measures, compared to performance in the sense of occurrence of near-misses and incidents.

Ale argues that no indicator for which the values are based on observations over time can be regarded as “leading indicators” [7]. According to this interpretation, none of the indicators used in the RNNP would be called “leading”, cf. chapter 4.1. The definition proposed by Kjellén, however, implies that barrier test indicators will be leading indicators, which is consistent with the view adopted in RNNP. It is argued that the performance of these barrier systems will strongly influence the likelihood that an incident in the future shall develop into a major disaster, if it occurs. The leading indicators in RNNP are indicators for barrier systems that are aimed at preventing future incidents to escalate into major accidents. This view is also shared by Swetslott who refers to indicators based on testing of barrier systems as “output” indicators, as opposed to “outcome” indicators, which are the only true lagging indicators [8].

Barrier indicators are given high priority in RNNP, due to the rare occurrence of precursor events. The main emphasis has been places on barrier elements that are associated with prevention of fire and explosion, but also structural and marine systems barriers are addressed to some extent. The RNNP has therefore included “leading” or “proactive” indicators, where this has been possible and realistic. The most relevant indicators found in RNNP considered as leading indicators are indicators based on performance of barriers that are installed in order to protect against major hazards, cf. chapter 4.1.

One of the challenges in the establishment of major hazard indicators is to define indicators that reflect the protection against major hazards in a realistic manner. Often this will need more than one indicator, for instance precursor based as well as barrier indicators. It should be noted that different sets of indicators may be relevant for a companywide presentation as opposed to presentation for an individual installation (or plant).

Barrier indicators focus on the performance of maintenance of safety critical equipment, which is an area where the PSA has expressed that some improvement should be achieved by the petroleum industry. Lagging indicators should not be disregarded completely, because they give valuable input about how the organizations have performed in the past. It is also a way to show the organization what is the result of unwanted occurrences. It is sometimes a slogan in the industry: “What is measured will be focused on”. The implication of this is that both types of indicators should be included, in order to have focus on barrier performance as well as major hazard precursors.

The overall recommendation is therefore to use both types of indicators, if possible. The main emphasis should be on leading indicators, supplemented by lagging indicators.

4.4 Please describe the work OLF is doing to develop, implement, and promote the use of process safety indicators for major accident prevention offshore. (CSB’s question no 2)

The RNNP work depends on the parties' shared understanding of the risk level on the NCS, cf. chapter 3.2, 3.3 and 4.1. A common understanding creates value. The stakeholders' (workforce representatives, employers, authorities and others) ownership of the process and the results is therefore important.

The RNNP reference group is Safety Forum. Safety Forum is the central arena for cooperation among the parties in the industry and the authorities as regards health, safety and environment in the petroleum activities on the Norwegian shelf and on land. Safety Forum was established in 2001 to initiate, discuss and follow up relevant safety, emergency preparedness and working environment issues in the petroleum industry, both offshore and at land facilities, in a tripartite perspective. As pointed out, OLF (the industry) is one of the major stakeholders within this reference group.

The following member organizations are represented in the Safety Forum:

- The Norwegian Petroleum Safety Authorities (PSA)
- **Norwegian Oil Industry Association (OLF)**
- The Federation of Norwegian Industries
- The Norwegian Shipowners' Association
- The Norwegian Union of Energy Workers (SAFE)
- Lederne
- The Norwegian Union of Marine Engineers (DSO)
- Industry Energy (IE)
- The Norwegian Confederation of Trade Unions (LO)
- The Norwegian United Federation of Trade Unions

The Safety Forum is an arena for consultation and follow-up of a number of key projects and processes, including the risk level project. The Safety Forum has a strategic agenda in which the major accident perspective, working environment risk, tri-partite collaboration and participation, capacity, competence and regulatory enforcement and finally mutual sharing of knowledge and information within the industry, have priority.

Safety Forum is also a partner and consultation body for the Norwegian national assembly; "Stortinget" and its White Papers on health, safety and environment in the petroleum activities. For further information about the safety Forum, see the link enclosed below:
http://www.ptil.no/safety-forum/category167.html

As to further facilitate active ownership of the RNNP work and process, a multipartite reference group was established in 2009 to assist in the risk level project development. OLF plays a key role in this reference group.

RNNP's data acquisition for the major hazard precursor events is based on considerable amounts of data acquired from the operator and shipping companies operating on the NCS in close cooperation with PSA regarding their established databases. Consequently, the industry play a major role in the RNNP project, including developing, implementing and promoting the use of process safety indicators for major accident prevention.

OLF has also since the beginning of the 2000s coordinated a monthly industry report on some key performance safety indicators. The most relevant OLF safety performance indicators for major accident prevention are:

- hydrocarbon releases
- well incidents
- vessels on collision course.

These indicators and the underlying documentation (company internal reports including the following information per incident: Company, installation, a short description of the incident and consequences, causal category, causal description and the estimated energy) are reported on a monthly basis and this KPI reporting constitutes a permanent agenda item on every meeting in the OLF's Board, OLF's Operations Committee and OLF's HSE Managers Forum.

Figure 7 show examples of the monthly reporting of some of the safety performance indicators presented and discussed at the meetings in the OLF's Board, OLF's Operations Committee and OLF's HSE Managers Forum.

Figure 7: OLF monthly HSE reporting "Scorecard"

	End 2008	End 2009	End 2010	End 2011	End May 2012	Target 2012	Target 2013	Target 2014	Comments
Ambitions:									
Hydrocarbon leaks by 25 %	14	15 (13)	14 (12)	11 (11)	1 (4)	10	9	8	Gas leaks over 0,1 kg/s
Well incidents by 25 %	11	22 (10)	28 (9)	12 (7)	4 (4)	11	9	9	
Number of ships on collision course 25%	31	20	15	12	2 (4)	10	9	9	
Serious personnel injuries by 25 %	35	32 (28)	28 (23)	26 (17)	2 (10)	23	21	19	No fatalities in 2008. One fatality in 2009. No fatalities in 2010. No fatalities in 2011.
Personnel injuries by 25 %	294	231 (245)	239 (196)	268 (147)	126 (103)	246	224	201	
Dropped objects by 25 %	167	192 (139)	158 (111)	309 (84) *) 104 (84) **)	76 (39)	95	86	78	*) Reported according to the non-RNNP-harmonized reporting. **) Adjusted according to RNNP-reporting.

In addition, the industry has for some time been working to further develop industry major risk "leading indicators" or "proactive safety performance indicators". OLF therefore took an initiative and organized a workshop in December 2011 on leading key performance indicators (KPIs) for asset integrity and process safety. The objective was to utilize an industry forum to exchange ideas on KPIs that can be used to prevent major accidents. The proactive KPIs may help in detecting early signals in relation to the increased risk for major accidents so that interventions can take place before an accident occurs. It is intended that this workshop will be the first in a series of several that have the theme KPIs on the agenda.

The theme of the first OLF workshop was "Leading Key Performance Indicators related to Asset Integrity and Process Safety".

The program is shown below:

08:30 – 09:00	Registration
09:00 – 09:15	Welcome and Introduction, Aud Nistov - *OLF*
09:15 – 10:00	Lagging and Leading Key Performance Indicators (KPIs) Definitions and How are they uses within our industry, Jan Erik Vinnem - *OLF/Preventor*
10:00 – 10:30	Purpose and Definitions for the OLF HSE KPI Reporting, Camilla Hesstvedt - *OLF/Acona*
10:30 – 10:45	Break
10:45 – 11:45	OGP's Safety Reporting and Statistics, Kirsty Walker - Schlumberger/*Chair of the International Association of Oil and Gas Producers (OGP)'s Safety Data Subcommittee*
11:45 – 12:15	Leading KPIs based on the Norwegian Petroleum Safety Authorities (PSA)'s Risk Level in the Norwegian Petroleum Activity (RNNP), Torleif Husebø - *PSA*

12:15 – 13:00	Lunch
13:00 – 13:30	Industrial experience in the use of leading KPIs, Jan Vidar Markmanrud – *Lundin Norway AS*
13:30 – 14:15	“TIMP” (system for styring av teknisk integritet), Ingbjørn Refsdal - *Statoil*
14:15 – 14:45	Monitoring major accident risk, Bodil Alteren and Marius Aardal - *Det norske*
14:45 – 15:45	Discussions
15:45 – 16:00	Summary and Conclusions, Aud Nistov – *OLF*

Please find a link to the presentations from this seminar enclosed below:
http://www.olf.no/no/Var-virksomhet/HMS-og-Drift/Arrangemener/Workshop-Leading-KPIs/

The presentations given by the different OLF member companies at the seminar illustrate that much attention and a lot of work is devoted to the identification and development of effective process safety performance indicators for major accident prevention. However, OLF will not take the liberty and go into details regarding the various company internal indicators that were presented at the workshop. The OLF goal for the future will be to agree on an industry common set of proactive safety performance indicators for major accident prevention, cf. the OLF strategy 2012 – 2014, cf. chapter 2.2, 3.3 and 5.0.

4.5 In its report on the Deepwater Horizon incident, OLF identified the potential use of a company’s maintenance backlog for safety critical systems as a leading indicator. Is OLF gathering industry data on this indicator and analyzing that data for trends/benchmarking? Can that indicator be normalized? (CSB’s question no 3)

In the OLF’s report: “Deepwater Horizon – Lessons learned and follow-up”, it is proposed to recommend the potential use of a company’s maintenance backlog for safety critical systems as a leading indicator (cf. chapter 2.3 in this statement);

> *“Safety statistics for the NCS have been improving over the past 10 years, as shown in the annual trends in risk level in the petroleum activity (RNNP) report. However, the Deepwater Horizon accident has emphasised the need for the industry to pay greater attention to major accident prevention. Two areas have emerged as opportunities to reduce major accident risks:*
>
> - *Managing and controlling simultaneous operations (SIMOPS), within drilling, production, hot work and high risk maintenance activities*
> - *Maintaining technical and operational integrity of key safety systems. A key performance indicator can be for example, backlog of maintenance of safety critical systems*
>
> *The industry is seeking more, and especially pro-active, key performance indicators to better manage these risks.”*

There are often wishes to establish indicators also for operational barriers, but there are, however, few success stories known in this field as far as OLF has been able to ascertain. Many companies use volume of backlog of preventative or corrective maintenance, often limited to maintenance of safety critical barrier elements. It is beyond doubt that this is an important parameter, but it should be regarded with caution being used or considered as a barrier indicator as such. The importance of the extent of backlog is to some extent parallel with competence level. Absence of backlog or the presence of high competence levels are both essential prerequisites of a good safety management system, but none of these elements are sufficient to ensure a low failure fraction or error free operation. The level of backlog may therefore be an important indicator in addition to other indicators, but not an alternative to failure fractions of barrier elements as presented above.

Barrier indicators in the RNNP work are based on periodic test of barrier elements as part of preventative maintenance schemes, using ‘man made’ activation signals or stimuli (such as test gas releases). This type of test must not be confused with barrier testing which is sometimes used by the industry as an additional recording, when the actual performance of barrier elements is recorded during a precursor event, such as a gas leak. The second type of test is principally not achieved without increase in risk, and should not be considered relevant basis of a leading indicator. But the tests that are part of preventative maintenance are carried out without any coupling to increased risk, should be considered leading indicator according to the definition stated by Kjellén.

In addition, in 2006, the PSA started the project Maintenance as an instrument to prevent major accidents; maintenance status and challenges in this context. The goal was, among other things, to update the status of maintenance management in the petroleum activities as regards to what significance maintenance has for prevention of major accidents.

The indicators for maintenance management focus on *the decision basis for maintenance management*, i.e. labeling (”tagging”) systems and equipment on the facilities, classification of what is labeled, and what percentage of this is classified critical as regards consideration for health, safety and the environment (”HSE critical”). In addition, the *status of performed maintenance* is included, i.e. the hours spent on preventive and corrective maintenance lag, and the hours spent on outstanding corrective maintenance; also with consideration for HSE-critical equipment and systems.

The reporting classes in the introductory phases were as follows:

Decision basis for maintenance management:

- Number labeled ("tagged") equipment in total
- Number of "tags" classified
- Number of "tags" classified as HSE-critical

Status of performed maintenance:

- Preventive maintenance lag, number of total hours
- Preventive maintenance lag, number of hours HSE-critical
- Corrective maintenance outstanding, number of total hours
- Corrective maintenance outstanding, number of hours HSE-critical

It may be difficult to identify strong correlations between a company’s maintenance backlog and an increased major hazard risk. This also implies to the industrial level. Therefore, apart from the above described ongoing work under the direction of RNNP and the work being performed in the individual companies, OLF has for the time being not established an industry initiative or has a special focus on the potential use of a company’s maintenance backlog for safety critical systems as a leading indicator. However, OLF will in the future consider to further look into the matter together with the RNNP project and various academic institutions.

4.6 What other leading or key performance indicators are being explored by OLF and its members? Can they be normalized across industry? (CSB’s question no 4)

Reference is made to the previous chapters; 4.1, 4.3, 4.4 and 4.5 regarding which leading or key performance indicators are being explored by OLF and its members.

Regarding normalization of precursor indicators; All the precursor based indicators that have been presented are normalized as well as not normalized. It could first of all be noted that the trends are virtually identical between the two sets of curves, because the volume of normalization data does not change abruptly; changes are gradual and over several years. The following normalization parameters are used for the major hazard indicators:

- Man hours
- Number of installation years
- Number of wells drilled (for drilling associated hazards)

- Number of helicopter flight hours/person flight hours (for helicopter associated hazards)

Man hours are used as the primary parameter for normalization. This implies that for instance the overall indicator has the dimension of FAR values, although this is not used actively in the discussions. Man hours constitute an important parameter for several hazard mechanisms. Several of the hazard types are correlated with activity levels, thus making man hours a natural choice. But man hours are not very suitable for equipment malfunctions.

Number of installation years is also used extensively, although this does not give any discrimination between more complex and less complex installations.

It has been suggested that production volume could be used as an indication of complexity, but production volume is mainly a function of reservoir characteristics, and thus not a good indicator for complexity. Production volume is therefore only established on a national level, but is also available on an installation level.

It has been considered that the number of leak sources (such as valves, flanges, welds and instruments) might be more suitable. Such information is available in QRA studies, but has been found to be very demanding to establish on a general basis.

Weight of processing modules has been used in one study as an approximation of complexity. Iit was found that weight of these modules and number of leak points correlated reasonably well for those installations where both sets of data were available (Vinnem et al., submitted for publication) [9].

As part of the ongoing “OLF hydrocarbon leak reduction project”, OLF has performed an analysis of causes of hydrocarbon leaks occurring in the four year period of 2008 – 2011; “Analysis of causes of hydrocarbon leaks in 2008 – 2011” [10]. The work has been based on submission of investigation reports (and similar) from all relevant companies. The scope of the work has been limited to analysis of causes of hydrocarbon leaks. In this work, we have presented the hydrocarbon leaks normalized with installation year, leak frequency, number of leak sources (as an estimate of complexity) and finally number of operations (work permits issued for work in the process areas of the installations). A normalization like this has provided us with a better insight considering root causes and underlying causes to hydrocarbon leaks on the NCS.

4.7 Does OLF share its members’ indicator data with other members in some fashion (anonymous or otherwise)? Does OLF publish or plan to publish any indicator data? (CSB’s question no 5)

As previously mentioned in chapter 3.3, OLF early identified the usefulness of reporting a range of safety performance indicators on an industry level, that is; Reporting on an industry level and at a higher frequency than RNNP (which is an annual report). However, a monthly reporting must be simplified considerably compared to an annual RNNP reporting.

OLF has therefore since the beginning of the 2000s coordinated a monthly industry report on some key performance safety indicators.

The most relevant OLF safety performance indicators for major accident prevention are:

- hydrocarbon releases
- well incidents
- vessels on collision course.

These indicators and the underlying documentation (company internal reports including the following information per incident: Company, installation, a short description of the incident and consequences, causal category, causal description and the estimated energy) are reported on a monthly basis. This information is shared between the operators through a monthly report that is made available to all the OLF members on the OLF member web pages.

In addition, these indicators and the underlying documentation constitute a permanent agenda item for discussion and experience transfer and exchange on every meeting in the OLF's Board, OLF's Operations Committee and OLF's HSE Managers Forum, cf. chapter 4.4.

4.8 How does OLF use PSA's RNNP report and data to influence safety improvements from its industry members? (CSB's question no 6)

The RNNP work is highly valued by the OLF (the industry) as the project depends on the parties' shared understanding of the risk level on NCS. A common understanding creates value. The stakeholders' (workforce representatives, employers, authorities and others) ownership of the process and the results is therefore important. OLF is one on the major contributors to RNNP and the RNNP report and the annual launching of this report is considered one of the important events by the Norwegian petroleum industry stakeholders.

Consequently, the RNNP report is being used by the industry and the individual companies for different purposes such as benchmarking, experience transfer, basis for improvement projects and safety campaigns etc. OLF would like to present the following example:

"OLF's project hydrocarbon leaks reduction"
The risk trend showed an alarming increase of hydrocarbon leaks on the Norwegian sector until the beginning of the 2000s. The top was reached in 2000 when the total number of hydrocarbon leaks >0.1 kg/second counted 42. This was the trigger for the OLF to establish a project with the scope to reduce the number of hydrocarbon leaks on the NCS. OLF had a goal to reduce the number of hydrocarbon leaks with a leak rate > 0.1 kg/second by 50% based on the period 2000-2002 by the end of 2005. This target was reached in 2005. However, OLF / the industry considered (and still do) the occurrence of hydrocarbon leaks as one of the main risk hazards to major accidents, and a new target was set; that is reducing the average number of leaks > 0.1 kg/second per year to 10 during the three year period 2006 - 2008. This target was reached already in 2007. However, the RNNP showed that the observed positive trend was not stable and the number of hydrocarbon leaks in 2008 counted 14. The OLF goal and strategy 2009 – 2011 stated that the number of hydrocarbon leaks with a leak rate > 0.1 kg/second should be reduced by 25% based on the 2008 results. This target was met by the end of 2011. However, the Norwegian petroleum industry consider this result as unsatisfactory, and this triggered another OLF project with an identical scope as previous projects, but set up with a different methodology. The new objective for the 2012 – 2014 periode is that the number of hydrocarbon leaks with a leak rate > 0.1 kg/second should be reduced by 25% based on the 2011 results. So far in 2012 we have observed 1 hydrocarbon leak with a leak rate of > 0.1 kg/second. The results so far in 2012 are promising, cf. figure 5 and 6 in chapter 4.4.

Figure 8: Number of hydrocarbon leaks on the NCS in the period 1996 – 2011 (annual reporting)

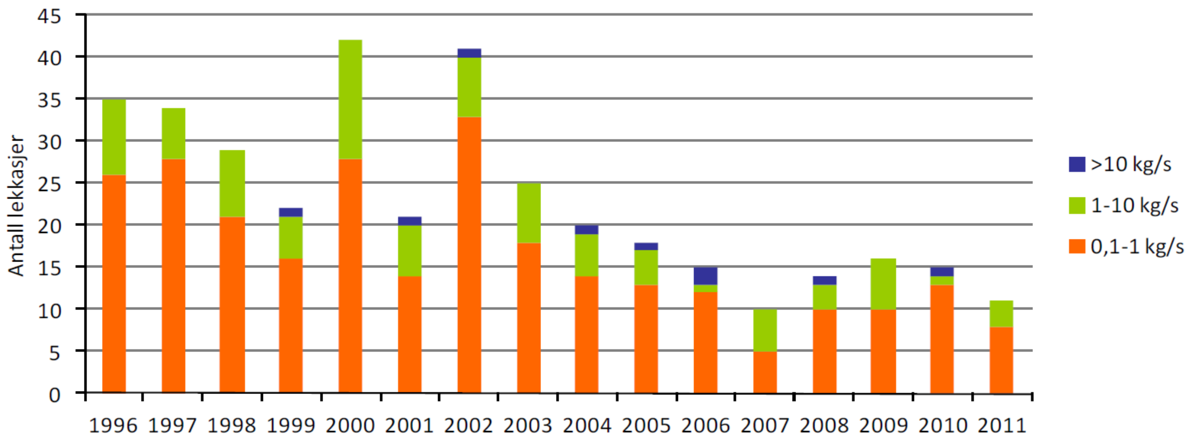
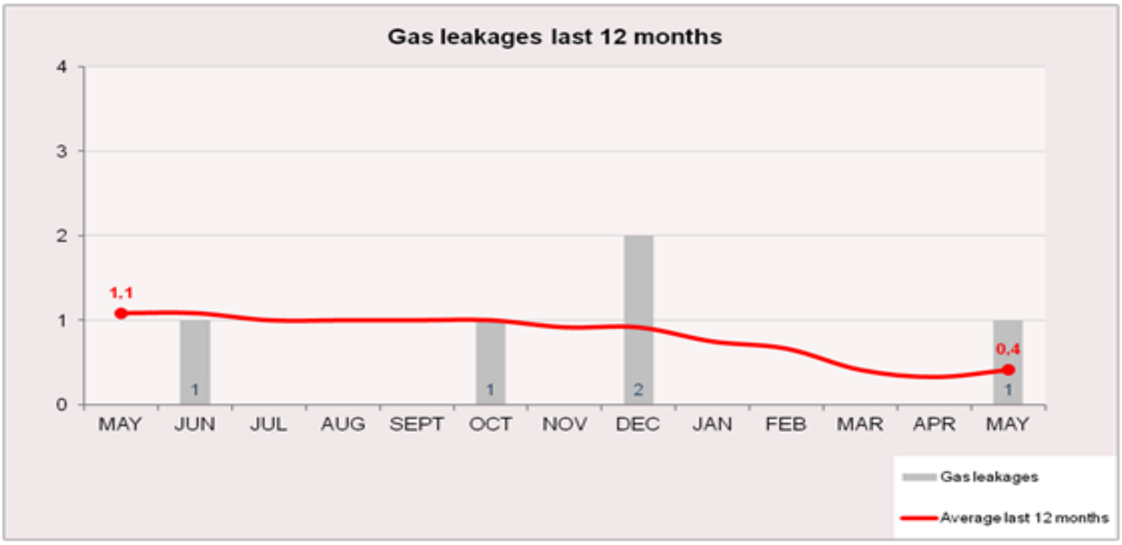


Figure 9: OLF's monthly reporting of hydrocarbon leaks > 0,1 kg/second (2012 May report)



The example in figure 8 and 9 shows how OLF uses RNNP to "monitor" major hazard risks on the NCS.

4.9 Does the Norwegian regulator play an important role in driving safety improvements offshore? Please describe. (CSB's question no 7)

It is OLF's view that the Norwegian Petroleum Safety Authority, PSA, plays an important and central role in increasing the safety level in the Norwegian petroleum industry. First and foremost, PSA has a role as a supervisory body with the following mandate:

> *"We are the regulatory authority for technical and operational safety, including emergency preparedness, and for the working environment.*
> *Our regulatory role covers all phases of the industry, from planning and design through construction and operation to possible ultimate removal.*
> *"Safety" covers a broad range in our terminology and embraces three categories of loss – human life, health and welfare, the natural environment, and financial investment and operational regularity."*

The PSA is responsible for developing and enforcing regulations which govern safety and working environment in the petroleum activities on the Norwegian continental shelf and associated land facilities. The regulations assume that the activities maintain prudent health, environmental and safety standards. They are developed to be a good tool for the industry and for the authorities' supervision. Therefore, the regulations contain a large degree of functional requirements where standards and norms specify the regulations' level of prudence. In this manner, the challenges that follow from continuous change processes in a complex industry are met.

The PSA has identified priority areas ("Trend in risk level" – RNNP is a key player in this respect) where action will have the biggest impact, and where special attention is needed if Norway is to fulfill its ambition of being a world leader in petroleum-related HSE (as stated in the recent Stortinget – White Paper on HSE). PSA can encourage the industry to engage or establish improvement projects on an industry level or company level and thus may represent an important promoter for HSE work.

Collaboration between employers, unions and government as well as worker participation are important cornerstones in the efforts to establish and develop a high level of HSE in the petroleum industry.

Furthermore, the Norwegian regulation is built on the principles of trust and transparency. PSA also plays an important role in terms of data collection. PSA can encourage voluntary participation in reporting arrangements, or may by regulations require industry to report on various data sets. PSA has the mandate and authority to manage this information in such a way that HSE information or HSE knowledge that might represent distortion of competition, or that might influence the marked in any way, remains anonymous.

4.10 Additional potential questions to consider (cf. letter from CSB)

4.10.1 How should indicators be used to drive performance and prevent major accident events ?

Please see chapter 4.8 for examples from the Norwegian petroleum industry.

One of the objectives of the work performed related to the indicators for major hazards in the Risk Level initiative by PSA, has been to inspire individual companies to develop their own scheme of major hazard indicators.

Performance indicators for personnel risk have traditionally been focused on occupational accidents, and less on major accidents. Major accidents are rare events even on a national scale, and certainly for an operator with relatively few installations. Even major hazard precursors (such as hydrocarbon leaks of critical size) are relatively seldom occurrences for an operator with relatively few installations.

When companies have focused on indicators for occupational hazards, this presumably reflects the assumption that there is a strong correlation between occupational hazards and major hazards. This was found to be one of the problems in the Texas City refinery accident (The Report of the BP US Refineries Independent Safety Review Panel, 2007) [11]. The investigation found that this invalid assumption was one of the factors leading to conditions that would allow such an accident to occur.

Some companies have been forerunners in this regard in the Norwegian offshore petroleum operations, and have established major hazard indicators for internal company follow-up. For example, one company (Thomassen and Sørum, 2002) [12] has established several indicators and has developed an information system in order to focus the awareness of management on such aspects.

It is essential that companies develop their internal major hazard indicator schemes, for individual installations as well as companywide operations. The background from RNNP gives a starting point in order to propose such schemes.

OLF will promote discussions on how such schemes may be outlined, based on experience with schemes for major hazard indicators for some companies. Further on, chapter 4.4 describes different activities with the intention to drive performance and prevent major accident events in the Norwegian petroleum industry.

4.10.2 Does the operator or contractor understand what actions can be taken to improve performance ?

The "Trends in risk level – Norwegian Continental Shelf" (RNNP) – presents a differentiated picture of trends in risk level based information from several sides of the industry with the intention to measure the impact of the industry's overall safety work. The annual reports provide an excellent background material for the operators and contractors regarding improvements projects related to safety performance.

4.10.3 Do the indicators being measured provide sufficient data to drive incremental improvements ?

Please see the previous chapters.

4.10.4 How do you know that a particular indicator is predictive of a major accident event ? In other words, are the indicators measured demonstrably predictive of risk ? If so, how ? If not, why not ?

The following ten criteria should be addressed when reviewing current use of indicators or new proposals, cf. chapter 4.2:

- Combination of lagging and leading indicators
- Easily observable performance
- Intuitive indicators
- Not require complex calculations
- Not be influenced by campaigns that give conflicting signals
- Reflect hazard mechanisms
- Sensitive to change
- Show trends
- Robust to manipulation
- Validity for major hazard risk

However, one of the challenges in the establishment of major hazard indicators is to define indicators that reflect the protection against major hazards in a realistic manner. Often this will need more than one indicator, for instance precursor based as well as barrier indicators. It should be noted that different sets of indicators may be relevant for a companywide presentation as opposed to presentation for an individual installation (or plant), cf. chapter 4.3.

4.10.5 Ideally, what is the role of regulators in the collection and use of indicators for major accident prevention ?

Please see chapter 4.9.

5.0 The way forward

The main purpose of major hazard risk indicators is to maintain high awareness, motivation and emphasis on prevention against major hazards. Major accidents, and even major accident precursors are so rare events, that it is easy for an organization to loose focus and concentrate solely on prevention of occupational accidents. It is therefore essential that the indicators that are used by the industry have a certain volume of data, and some fluctuations regularly, in order to create the basis for maintaining high awareness and motivation.

Major hazard indicators should be a mix between lagging and leading indicators, and need to have a certain volume of data, in order to have reliable predictions and some fluctuations that can help to maintain focus. Major hazard precursors typically occur with an average frequency of once per installation per year. This is insufficient as a basis for incident based indicators on an installation level.

If it is accepted that a certain volume of data is required, then barrier indicators, which have been labeled leading indicators, are to be preferred over lagging indicators, especially on an individual installation level. Quite an extensive data collection scheme may be required in order to have sufficient number of faults registered for the most reliable installations. If the data collection scheme is more limited, the number of faults during testing of barrier systems may be almost as few as the number of major hazard precursors, and thus quite insufficient.

OLF proposes that occurrence of hydrocarbon leaks with a significant flow-rate should also be an important indicator even though it is a lagging indicator, because of the strong emphasis on prevention of such occurrences. The flow-rate limit should be set at the value which may cause uncontrolled escalation of the accident, in case of failure of consequence reducing barrier systems, for modern offshore installations this limit is often considered to be typically 0.1 kg/s flow-rate. Minor leaks, such as below 0.1 kg/s, should not be used as an indicator of more severe leaks. The reason is the fundamental difference in causes of minor leaks as opposed to the larger leaks.

This document defines 10 criteria, cf. chapter 4.2, that major hazard risk indicators should be assessed against, and a mixture of precursor and barrier indicators will be able to satisfy these criteria if the data collection schemes are set up with care. At the present time, these proposals are limited to technical barrier elements. Operational barrier elements may be an extension in the future.

It may be difficult to identify strong correlations between a company's maintenance backlog and an increased major hazard risk. This also implies to the industrial level. Therefore, apart from the above described ongoing work under the direction of RNNP and the work being performed in the individual companies, OLF has for the time being not established an industry initiative or has a special focus on the potential use of a company's maintenance backlog for safety critical systems as a leading indicator. However, OLF will in the future consider to review the matter together with the RNNP project and various academic institutions.

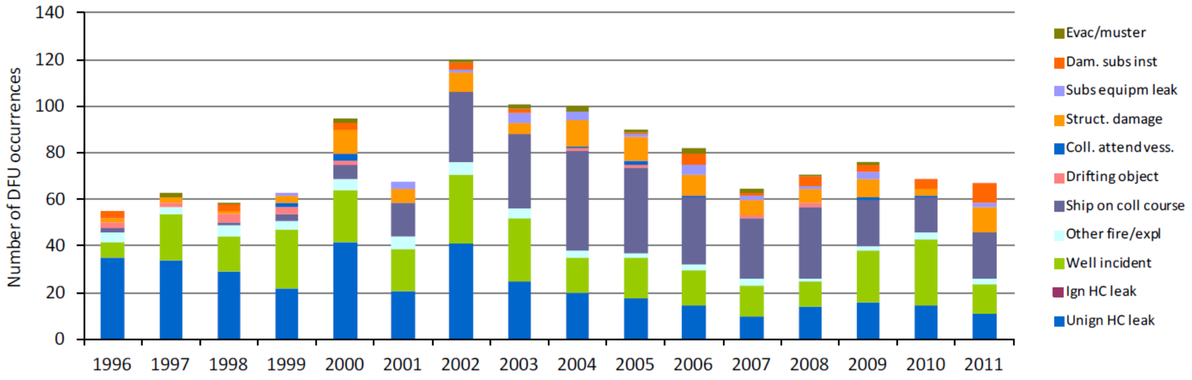
Another issue for future work could be to elaborate and discuss High Reliability Organizations (HRO) principles with regards to safety performance indicators development.

Figure 10 show the development in the number of reported Defined hazard and accident situations (DFU) during the period 1996–2011. It is important to emphasize that these DFUs have very different contributions to risk.

From and including 2000, the number of incidents has been substantially higher than in the period 1996–1999, with some variations. After 2002, there has been a reduction in the number of events up to 2007. No further reductions have been identified after 2007, and there have been only minor variations around a stable level of about 70 incidents per year.

There has been a decline in the number of incidents involving hydrocarbon systems during the period from 2002–2007; from wells, process systems and pipelines/risers. In these categories, there were 72 events in 2002, while there were 25 events in 2007 and 26 events in 2008. These are the lowest levels ever reported in this work. Significant increases were once again registered in 2009 and 2010; 41 and 43 events, respectively. For 2011, the number of events involving hydrocarbons has been reduced to 26. This is mainly due to fewer well events, which have been halved compared with 2010.

Figure 10: Development in the number of reported DFU during the period 1996–2011



This picture illustrates that there are still issues and challenges on the Norwegian Continental Shelf regarding major accident prevention. OLF will therefore continue the work on identifying and developing process safety performance indicators for major accident prevention, both through RNNP in cooperation with the regulators and the employee representatives, through member company initiatives and through independent OLF projects. OLF will work to develop and establish reliable monthly safety performance indicators, both leading and lagging, to further be able to monitor trends and at an early stage implement improvement projects in HSE critical areas identified through the safety performance indicators.

OLF sees a need for further work on developing excellent process safety performance indicators for major accident prevention both on the industrial level, cross-border and especially in cooperation with other organizations, such as CSB and OGP. OLF is positive to contribute to this kind of collaboration.

The OLF goal for the future will be to agree on an extended industry common set of safety performance indicators for major accident prevention, both leading and lagging, cf. the OLF strategy 2012 – 2014, cf. chapter 2.2 and 3.3.

If major hazard indicators can assist in maintaining high awareness, this may be an important element in preventing major accidents.

6.0 Abbreviations

OLF – the Norwegian Oil Industry Association
NHO – Confederation of Norwegian Business and Industry
NCS – Norwegian Continental Shelf
HSE – Health & Working Environment, Safety, Security and Environment
GoM – Gulf of Mexico
OGP – International association of Oil and Gas Producers
API – American Petroleum Institute
RNNP – Trends in risk level in the petroleum activity
KPI – Key performance indicator
E&P – Exploration and production
LOPC – Loss of Primary Containment
QRA – Quantitative Risk Assessments
DDRS/CDRS – Database for drilling and well operations
PSA – the Norwegian Petroleum Safety Authority
CODAM – Database for damage to structures and subsea facilities
ESDV – Emergency shutdown valves on risers/flowlines
DHSV – Downhole safety valves)
BDV – Pressure relief valve
PSV – Safety valve
BOP – Blowout preventor
CSB – U.S. Chemical Safety Board
DFU – Defined hazard and accident situations
HRO – High Reliability Organizations

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