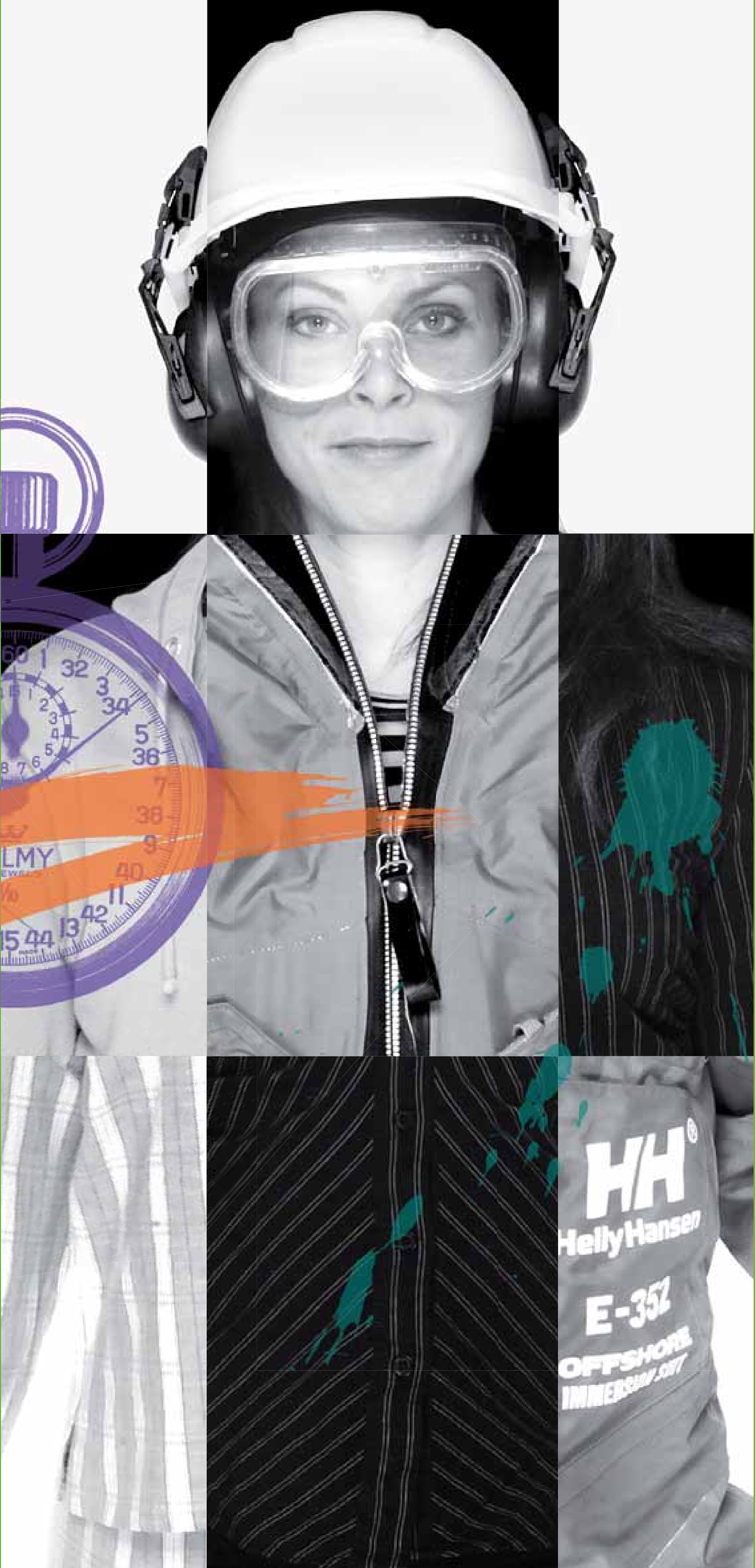

RISK LEVEL

IN THE PETROLEUM ACTIVIY

SUMMARY REPORT

TRENDS **2007**
NCS

PETROLEUM SAFETY AUTHORITY
NORWAY

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Risk Levels in the petroleum industry

Summary Report
Norwegian Continental Shelf

2007

24.4.2008

Ptil-08-03

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PETROLEUM SAFETY AUTHORITY NORWAY

Report

REPORT TITLE

Trends in Risk Levels on the Norwegian Continental Shelf
Phase 7 Summary Report 2006

CLASSIFICATION

Public	√
Publication exempted	
Limited	
Confidential	
Strictly confidential	

REPORT NUMBER

Ptil-08-03

AUTHOR/COORDINATOR

Petroleum Safety Authority Norway

ORGANISASJONAL UNIT

P-Risk levels

APPROVED BYDATE

Øyvind Tuntland
Director for Professional Competence

SUMMARY

The purpose of the work is to establish and evaluate the status and trends of risk levels in the Norwegian petroleum activitities. The trends in risk levels are illustrated through evaluation of phenomena from different angles by the use of different techniquies.

The work is based on two complementary evaluation processes:

- Register, analyse and evaluate data for defined situations of hazard and accident and the efficiency of barriers
- Perform social science studies, in this mainly through a questionnaire survey and workshops with painters and electicians.

On the basis of the data and indicators used, a generally neutral trend can be observed in 2007. This applies to key indicators relating to major accidents, including helicopter accidents, and well as the frequency of serious injuries to personnel. For major hazard indicators, there has been a long term trend that the number of incidents and near-misses is continuously being reduced, but the corresponding severity is variable.

KEYWORDS

Risk, HES, NCS

PROJECT NUMBER	NUMBER OF PAGES	EDITION
	36	

PROJECT TITLE

Trends in Risk Levels –Norwegian Continental Shelf

Foreword

Trends in risk levels in the petroleum industry are not only a matter of concern to everyone involved in the industry but are also of interest to the public at large. It was therefore a logical and important step for us to establish a structure for measuring the effect of the collective HES work in the industry. Against this background, a project was started in 1999/2000 to study trends in risk levels on the Norwegian Continental Shelf. The initial phases of the project showed that the chosen methodology lends itself to forming a picture of these trends. This activity has come to assume an important role in the industry since it contributes to a unified understanding of risk levels by the parties involved.

Our industry has a high level of competence in the field of HES. We have sought to draw on this competence by making the process an open one and inviting key resource persons from operating companies, the Civil Aviation Authority, helicopter operators, consultant firms, research and teaching institutions to contribute to the project.

Objectivity and credibility are key words if opinions on safety and the working environment are to carry any weight. The results have been presented to the Safety Forum, where both employees' and employers' organisations are represented. Comments so far have been positive and constructive and the expectation is that this work will contribute to a common platform for the improvement of safety and the working environment.

It is its use of complementary methods for measuring trends in risk levels that make the work unique. Building further on this methodological approach is an important precondition for the success of the project.

As far as we are aware, this work is also unique in that its aim is to measure risk for an entire industrial sector. We have limitations in regard to time and the information available to us. Although the project results are gradually improving in quality, they must still be applied with a degree of caution.

There are many people, both in and outside the industry, who have contributed to the work of the project. It would take too long to list them all but I should like to mention in particular the positive response we have met with in all our contacts with the parties concerned in connection with the implementation and continuing development of the work.

Stavanger, 24th April 2008

Øyvind Tuntland
Director for Professional Competence

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Part 1: Purpose and conclusions

1. Purpose and Limitations

1.1 Purpose and Limitations

The project ”Trends in Risk Levels – Norwegian Continental Shelf”, also called the risk level project, was initiated under the direction of the Norwegian Petroleum Directorate in 2000. From and including 2004, the project has been continued under the Petroleum Safety Authority as a result of that body's establishment.

From the Letter of Award 2007 (Ch. 2.2)

Performance measurement 2.1: The risk level project (RNNS) shall be continued and expanded to include the measurement of trends in HES level in both the offshore and onshore activities of the petroleum industry.

1.2 Objectives

The aim of the work is to:

- measure the impact of HES-related measures in the petroleum industry.
- help to identify areas which are critical for HES and in which priority must be given to identifying causes in order to prevent unplanned events and accidents.
- improve understanding of the possible causes of accidents and their relative significance in the context of risk, in order to create a reliable decision-making platform for the industry and authorities which will enable them to direct their efforts towards preventive safety measures and emergency preparedness planning.

The work will also help to identify potential areas for making regulatory changes and for research and development.

1.3 Important limitations

The work focuses on risk to personnel and covers major accidents, occupational accidents and working environment factors. Both qualitative and quantitative indicators are used. In the present phase, qualitative studies have been performed (offshore and onshore facilities) together with a field study comparing risk-exposed groups in the offshore and onshore contexts.

The activity is limited to factors which fall under the PSA's area of authority in regard to safety and the working environment, and all helicopter transport of personnel, in cooperation with the Civil Aviation Authority Norway and helicopter operators on the Norwegian Continental Shelf. The project covers the following areas:

- All production and mobile units on the Norwegian Continental Shelf
- Transport of personnel by helicopter between helicopter terminal and installation (point of departure to point of landing).
- The use of vessels inside the safety zone around the installations.

Eight specified onshore facilities have been included from 1.1.2006. Data acquisition started from that date and separate reports have been published in recent years containing the results and analyses for onshore facilities.

2. Conclusions

2.1 Data Quality

The evaluation of trends in risk level is dependent on many factors. For evaluations to be robust, they must be based on good data. Considerable resources have therefore been invested in guaranteeing data quality. Particular weight is attached to the prevention of underreporting. An attempt has been made to reduce the effect of any underreporting by including reporting limits for event-related indicators. Events and incidents over the lower limit will normally be visible and result in actions. Correspondingly, the project also focuses primarily on serious cases of injury to personnel. These are injuries of such a degree of severity that it would be difficult to avoid reporting them. By applying these "limit values" we believe that the possibility of underreporting is greatly curtailed and reduced to the extent that it will not change evaluations and conclusions.

2.2 The Qualitative Study

Questionnaires were first used in the work in 2001, on that occasion as a limited survey. This was repeated in 2003, 2005 and now in 2007/08. In the present phase, two qualitative studies were conducted, one targeting all personnel working on the offshore facilities and one adapted to personnel on the onshore facilities.

The questionnaire survey has previously had an estimated response percentage of about 50. If we take the reported number of manhours as indicative of how many people were working on the offshore facilities during the period in which the survey was conducted, we arrive at an estimated response percentage of about 30. A response percentage of 30 is low and partly due, we believe, to various problems connected with the distribution of the questionnaires at the heliport. Nevertheless, the response rate is sufficiently high to allow us to perform statistical analyses and split the data material into different categories. The main conclusions can be briefly summarised as follows:

- For the HES climate it is observed that the generally positive trend from 2003 and 2005continues in 2008. There is a total of 11 statements which are considered to be more positive in 2008. For example, there are more respondents this year who agree that they can influence HES factors in their own workplace, the work permit system is followed to a higher extent and emergency preparedness is evaluated as better this year than in previous years.
- Even though some statements are unchanged or has an improvement, there are seven statements with significantly lower result this year, compared to 2005. An example here is that more respondents claim that lack of maintenance has implied decreased safety.
- Respondents' experience of risk in association with different accident scenarios has increased from 2005 to 2008. This applies to a total of nine scenarios, but the change is significant for only six of them.
- With regard to the physical working environment, more respondents this year report experiencing noise and poor lighting than in the previous survey, while a smaller proportion report skin contact with chemicals and dangerous substances. More respondents see themselves as exposed to a poor indoor climate than in 2005. There are more respondents that consider the workplace to be well organised.
- Concerning the psychosocial working environment, an improvement is noted for most factors. The opportunity to influence one's own work tempo and other work-related factors has improved. Support from management and colleagues also shows an improvement and the degree of appreciation from management shows a positive trend compared with the results for 2005.
- Respondents are generally very satisfied with the quality of food and drink and other factors relating to leisure time and recreation. Their evaluation of helicopter transport, on the other hand, shows little

change and still lies at a low (negative) level. More cabin noise is reported now than in 2005. The indoor climate in the cabin is also reported as poorer than in 2005.

- Concerning sleep quality before, during and after offshore stays, there is little change between 2005 and now. However, fewer respondents report having to share a cabin with others during sleeping hours than in the previous measurement, a very positive result. Nevertheless, more respondents report experiencing noise and poor indoor climate in the cabin compared with 2005; there is a significant relationship between the incidence of shared sleeping accommodation and the experience of noise and poor indoor climate in the cabin in addition to poor sleep quality offshore, so that it is those who share sleeping accommodation who experience this to the greatest extent.
- Respondents' perception of general health is good but significantly poorer than in 2005, a result which may be due to a shift in age: the respondents in this year's survey are older than in previous years. We also find a significant increase in hearing-related complaints, tinnitus, headache and eye problems this year compared with 2005, but there are fewer incidences of allergic reactions and over-sensitivity.
- A larger proportion have been absent from work because of sickness this year than in 2005, while on the other hand fewer respondents report longterm absence and work-related absence. Women have a higher incidence of sickness absence than men but there are no age-related differences.

Concerning the results for different work areas, well service and process systems are noted as having more negative values for some of the indices relating to the HES climate, risk and physical exposure at work and sleep. Well service personnel, however, give highly positive reports on the index for social support, and both evaluations are recognisable from previous years. Those work areas with the best results on most indices for HES climate, risk, exposure and strain, and leisure time, are administration and to some extent catering. On the other hand, catering has the poorest score for physical strain, muscular, skeletal and skin complaints.

2.3 Risk Indicators

We have attempted to throw light on the risk of major accident, for example by using indicators relating to defined situations of hazard and accident (DFUs) with potential for major accident together with the total indicator measuring events with potential consequences in relation to loss of life if the event should occur. The total indicator is sensitive to individual events with large potential. For example, the picture in 2004 was marked by a few such events. In 2005 there were no events or incidents with correspondingly large potential, while in 2006 there were again a few events that made a large contribution. From Phase 6, a 3-year rolling average was introduced for the total indicator. This form of presentation will even out wide annual variations and give a better picture of trends over time, especially since the total indicator is an estimated indicator that is not an explicit expression of the level of risk.

The last time there were fatalities on the Norwegian Continental Shelf in relation to a DFU relating to major accident (a dimensioning hazard and accident event) was in 1997 in association with the helicopter accident off Brønnøysund. Most event indicators reflecting major accident potential showed an improvement or a stable level in 2007.

The event types in 2007 making the biggest contribution to the total indicator for loss of life in the case of major accidents on production installations are hydrocarbon leaks, well events and vessels on collision course.

For production installations the total indicator in 2007 shows a statistically significant reduction in relation to the previous period. The reduction is statistically significant in relation to the average for 2001-06. A statistically significant reduction can be called a real improvement.

For mobile units there are large annual variations in reported values. The total indicator for mobile units, based on 3-year rolling averages, also shows a statistically significant reduction in the last three-year period compared with the average for the period 2001-2006. On mobile units, structure-related events are those making the biggest contribution to the total indicator.

The reduction in the total indicator also reflects the reduction in the number of events in the last few years. This parallelism is not obvious, since a few events with high potential can change the total indicator.

The events with highest potential in helicopter transport are best reflected in event indicator No.1. This shows a statistically significant increase in 2007 in relation to the average for the foregoing period.

The ratio between causes of loss of life is often given as 30%/30%/40% between major accidents/occupational accidents/helicopter accidents (Vinnem, 2008).

2.3.1 Indicators Pointing to an Increase

Taking all the major accident indicators together, there is only one helicopter event indicator that points to a statistically significant increase in 2007. This increase can be partly explained by the introduction of a new type of helicopter, S92. Historical observations show that new helicopter types will have a breaking-in period of a few years. New technology should result in a decrease in the number of serious events over time.

2.3.2 Indicators Pointing to Improvement

Since 2002 there has been a reduction in the number of hydrocarbon leaks over 0.1 kg/s. 10 leaks in 2007 is clearly lower than 15 leaks in 2006. The number of leaks in 2007 is statistically significantly lower than the average in the period 2001-2006. As follow-up to the first hydrocarbon leak reduction project (the GaLeRe project) OLF established a new objective: that by 2008 there shall be maximum 10 leaks/year over 0.1 kg/s. Since this objective was achieved in 2007, the challenge is now to maintain this level or, preferably, achieve a further reduction. If we compare the leak frequency per operator, normalised by installation year, statistically significant differences are observable between operators. This difference shows that there is still clear improvement potential in the area.

If we compare the number of hydrocarbon leaks on the Norwegian and UK continental shelves north of 59^{o}N in the period 2002-2006 (2007 not included because UK data are unavailable), we see that the frequency on the UK Continental Shelf is about 45% lower than on the Norwegian Continental Shelf. If the comparison is limited to gas leaks, the difference is roughly 100% in the favour of the UK Continental Shelf. It should be noted that the authorities/industry on the British sector have conducted a campaign since 1999 aimed at reducing the number of hydrocarbon leaks.

On the Norwegian Continental Shelf there have been no registered cases of ignited hydrocarbon leaks (> 0.1 kg/s) since 1992 in connection with production and process facilities. The number of gas leaks > 0.1 kg/s since 1992 is probably greater than 390. It has been shown that this is significantly lower than on the UK Continental Shelf, where approximately 1.5 % of hydrocarbon leaks since 1992 have been ignited.

The indicator relating to well events in connection with production and exploration drilling shows a reduction in 2007 compared with 2006. The changes are not statistically significant. By far the majority of well events are in the category with lowest potential.

The monitoring of shipping traffic on the Continental Shelf is steadily improving. The indicator for vessel on collision course was modified in 2004 so that the number of registered cases of vessel on collision course is normalised against the number of installations monitored from the Traffic Centre at Sandsli. This indicator shows a slight but regular decrease from 2002. The change in 2007 is statistically significant. We believe that this indicator gives a good picture of the situation.

Following the implementation of new evacuation procedures on the majority of installations, there is a sharp reduction in 2007 in the probability of wave impact on deck on fixed, manned production installations.

The frequency of serious injury to personnel on production installations showed a clear increase in the last half of the 1990s. After the peak in 2000-2001 a reduction is seen. In 2005 this positive trend was broken, while in 2006 and 2007 a reduction is once more observed. The level in 2007 is statistically significantly lower than the average for the period 1997-2006. In 2007 the frequency of serious injury to personnel was 0.8 per million manhours. There were 24 cases of serious injury on production installations in 2007. The frequency for contractor personnel is higher than for operator personnel.

The frequency of serious injury to personnel on mobile units also peaked in the years 2000 and 2001. There was a marked decrease in 2002. From 2003 to 2006 inclusive, the level flattens out. In 2007 there was a decrease and the level is now at its lowest since 1997. There were 10 cases of serious injury to personnel on mobile units in 2007. The greatest decrease since 2000 is in drilling and wells. In 2007 the frequency of serious injury to personnel was 1.1 per million manhours.

2.3.3 Indicators Pointing to a Stable Level

This year we have again focused on events classified as falling objects (DFU 21). The evaluations are based on events reported to PSA. In the period 1997-2005 an average of approximately 95 events a year was reported. The corresponding figures were approximately 135 events for 2006 and 190 for 2007.

Another major accident indicator pointing to a stable level is fires unrelated to hydrocarbon leaks in process facilities.

There were three such fires in 2007, one more than in 2006. Any fire on an offshore installation is a serious event, but it is primarily fires and explosions involving hydrocarbons which have major accident potential. Other types of fire in electrical systems, utilities, flammable liquids etc. will normally take a less dramatic course, allowing several opportunities for fire-fighting. If all emergency measures fail, on the other hand, these fires can also cause considerable damage. Taking all fires on the continental shelf together, without regard to potential, an increase in the number of fires, or fire-like events, is observed in connection with electrical facilities.

We are pleased to note that we have had no events in the most serious category for structural and marine systems since 2004. The number of events on the next level remains at a high stable level and points to no particular trend. Most events are related to semi-submersible mobile units. The majority can be classified as events associated with dynamic positioning systems (DP), anchoring, fissures, internal water seeping and towing, and most events occur on mobile units. We see it as a very positive step that the Norwegian Shipowners' Association has set itself the goal of reducing the number of events on anchoring systems.

2.3.4 Indicators Pointing to No Discernible Trend

In Phase 3, indicators were established to measure the effect of barriers against major accidents. This work has been continued in the present phase. Substantial quantities of data have been acquired on barriers against major accidents, mainly relating to avoidance of the consequences of hydrocarbon leaks. Barrier indicators may be called "proactive indicators", since they tell us something about the systems' future capacity for avoiding or limiting the consequences of incidents with accident potential.

At times considerable differences are registered between operators and individual installations in relation to the unavailability of barrier elements. Although some of these differences can still be accounted for by different reporting practices and varying interpretation of the criteria for safety-critical failures, there seems to be a real difference in level between installations. This can be deduced from the large number of tests reported to the project.

Corrected for skew in the data sets, the mean percentage of barrier failures shows a relatively stable level.

This year, we have investigated whether or not there may be any connection, at installation level, between the number of hydrocarbon leaks > 0.1 kg/sec and the failure percentage of the relevant barrier functions. In the period 2001-2007, 57 % of all the installations experienced leaks. If we look at the installations with the highest mean barrier failure rate, we see that 93% of these installations have experienced leaks.

The risk indicators for noise and the chemical work environment were developed in collaboration with technical experts from the industry. Weight was attached to the need for the indicators to express risk factors as early as possible in the causal chain leading to an occupational injury or illness.

The indicator for noise is an expression of the exposure level for selected job groups and the reported data represent just under 2000 persons. For the risk of noise-related hearing impairment, 2007 shows a level which is about the same as in 2006.

This high noise level is seen most clearly in the case of painters.

It has been observed this year that most job categories are exposed to a higher level of noise than that stipulated in the HES regulations and are therefore dependent on hearing protection to prevent damage to hearing. In 2007, more than double the number of cases of hearing impairment have been reported in relation to the previous level. This underlines the need for risk-reducing measures.

With regard to the indicator for chemical work environment, some changes have been implemented in 2007 as a result of lack of robustness. The results indicate that there is still large potential for substitution of dangerous chemicals. Exposure measurement data were reported for 2007. To a great extent these figures confirm PSA's conclusions from their work with chemicals in the last few years on lack of knowledge in relation to exposure. More measurements are necessary to improve the quality of risk assessments and to ensure that appropriate and sufficient actions are taken.

2.4 Qualitative Study

Two whole-day workshops were devoted to the job categories painters and electricians. The aim of these workshops was to acquire better knowledge of risk factors for two categories of personnel working both on the onshore petroleum facilities and on the offshore installations and to highlight what steps must be taken to reduce risk for these two groups. Workshop participants represented a variety of backgrounds and disciplines from different petroleum companies, contractors, authorities and research institutions. Data from these workshops were supplemented by statistical information on the groups from various databases.

Together with available data on the incidence of illness and injury and relevant scientific studies, the results from the workshops give grounds for highlighting painters as one of the most risk-exposed groups in the petroleum industry. Painters are more exposed to a number of physical/chemical factors (ergonomics, noise, vibrations, dust and chemicals) in their work environment than other groups. Furthermore, the barriers intended to protect painters against injury and illness are primarily in the form of personal protective equipment. This personal protective equipment does not always provide fully adequate protection. Painters also have challenges associated with their general working conditions and organisational factors, including the fact that they move about more frequently between installations and other facilities, take part in maintenance campaigns and have insecure working conditions. The risk this group is exposed to can be reduced by various means, including better knowledge of the chemical area, the development of new methods of surface treatment and improvements in personal protective equipment. Better planning of maintenance operations was also emphasised as an important measure.

What characterises electricians as a group – compared with painters – is its wide internal diversity. Contractor personnel and operator personnel have a very different type of working day in terms of both job tasks and general conditions. It was pointed out at the seminar that contractor company electricians face more HES challenges than corresponding operator personnel. The contractor electricians move about between installations and other facilities and, like the painters, are involved in maintenance campaigns. Ergonomic strains and the development of muscular/skeletal complaints were put forward as the greatest risk factor for this group. The group is also exposed to noise-related hearing damage. Coordination of procedures and practice on different installations/facilities, reduction of shared sleeping accommodation and better planning of maintenance work (especially in relation to access) were put forward as important measures for this group.

2.5 General Conclusion

In 2007 there were several serious events, with the fatal accident on Saipem 7000 and the oil spillage on Statfjord A as the most serious.

In evaluating risk level, it is important to look at trends over time. Yearly changes in the indicators will occur and in such situations it is important to identify the cause of these changes, focusing particularly on systematic changes.

For 2007 it is only event indicator No.1 relating to helicopter transport that points to a significant increase. There are also key major accident indicators pointing to a decrease, including some showing a statistically significant reduction.

The total indicator for both production installations and mobile units points to a statistically significant decrease for the last three-year period. We have stated earlier that achieving an overall positive trend for the total indicator should be a clear objective, since it includes both event frequency and event potential. Sufficient alertness and a systematic, purposeful approach should contribute to the continuing reduction of risk relating to major accident. Differences in frequency between operators clearly show that there is potential for reduction in several types of events.

The frequency of serious injury to personnel again shows a positive trend on production installations, where a significant reduction has been observed in 2007. For mobile units, frequency is also reduced in 2007 but not significantly.

The positive results the gas leak reduction project can point to demonstrates that a purposeful effort bears fruit, even in the relatively short term. Directed effort is also an underlying factor for the positive trend noted for collision between vessel and installation and vessel on collision course.

The number of responses to the questionnaire survey dropped this year in relation to previous years. However, there are sufficient responses to enable us to perform statistical analyses and to split the data material into different categories.

For HES climate, it appears that the positive trend from 2003 and 2005 continues in 2008.

We have also observed this year that most job categories are exposed to a higher level of noise than the limit stipulated in the HES regulations and personnel are therefore dependent on hearing protection to prevent damage to hearing. More than double the number of hearing complaints have been registered this year in comparison with the previous level. This underlines the need for risk-reducing measures.

Part 2: Implementation and scope

3. Implementation

The current phase is a continuation of the work from previous years, completed in 2000–2006, see NPD (2001), NPD (2002), NPD (2003), PSA (2004), PSA (2005), PSA (2006) and PSA (2007). (Complete references are given in the main report and in www.PSA.no/rnnp). In this phase, we have applied the same general principles and expanded the reporting with special emphasis on the following elements:

- The social science study comprises a questionnaire survey and workshops attended by painters and electricians.
- The work of analysing and evaluating data relating to defined situations of hazard and accident has been continued, both on the installations and for helicopter transport.
- A substantial quantity of experience data has been acquired for barriers against major accidents and analysed as in phases 4–7.
- Indicators for noise and chemical work environment have been continued.
- Data from onshore facilities have been analysed and presented in a separate report.

3.1 Implementation of Phase 7 of the Project

The current phase of the work commenced in summer 2007 and involved the following participants:

- The Petroleum Safety Authority: Responsible for implementation and follow-up of the project
- Operator companies: Provide data and information on activities on the installations and contribute to the work of adapting the model for land installations, which has been included from 1.1.2006
- Civil Aviation Authority Norway: Responsible for the reporting of public data on helicopter activities and quality assurance of data, analyses and conclusions
- Helicopter operators: Provide data and information on activities in the helicopter transport sector
- HES expert group (selected specialists): Evaluate methods, databases, views on development, evaluate trends, propose conclusions
- The Safety Forum (representatives from unions, employers and authorities): Comment on project methods, procedures and results, and make recommend-dations for further work.

The Petroleum Safety Authority has had support from external experts during part of the work. The following persons were responsible for specific tasks in connection with the current phase:

- Jan Erik Vinnem, Preventor
- Odd J. Tveit
- Terje Aven, University of Stavanger
- Jorunn Seljelid, Beate R.iise Wagnild, Marina Davidian, Jon Andreas Hestad and Hanne Gøril Thomassen, Safetec

- Tommy Haugan, Geir Guttormsen, Anne Mette Bjerkan, Margit Hermundsgård, Fred Størseth and Hanne Weggeberg, SINTEF
- Brita Gjerstad, Kari Kjestveit, Jorunn-Elise Tharaldsen, Thomas Lorentzen, IRIS

The PSA working group consists of: Einar Ravnås, Øyvind Lauridsen, Sissel Østbø, Birgit Vignes, Mona Haugstøyl, Arne Kvitrud, Irene B. Dahle, Janne Lea, Hilde Nilsen, Åse Larsen, Eva Hølmebakk, Inger Danielsen, Elisabeth Lootz, Sigvart Zachariassen and Torleif Husebø.

The following persons have contributed to the work on indicators for helicopter risk:

- Evelyn Westvig, Civil Aviation Authority
- Torgny Almhjell and Rolv Georg Rasmussen, CHC Helikopter Service
- Inge Løland, Per Skalleberg, Norsk Helikopter

Various other people have contributed to the development of the project, for example in connection with the workshops.

3.2 Use of Risk Indicators

In the current phase, data have been registered for major accidents, occupational accidents and working environment factors, specifically:

- Defined situations of hazard and accident relating to major accidents, with the following main categories:
  - Uncontrolled release of hydrocarbons, fires (i.e. process leaks, well events/shallow gas, riser leaks, other fires)
  - Structural events (i.e. structural damage, collisions, threat of collision)
- Experience data relating to the performance of barriers against major accidents on the installations
- Accidents, events and significant operational disruptions in helicopter transport activities
- Occupational accidents
- Working environment factors; noise and chemical work environment
- Diver accidents
- Other DFUs with minor consequences and/or significance for emergency preparedness.

The term major accident is used at various points in these reports. There is no universally agreed definition of the term but the following definitions are often used and coincide with the definition applied in this report:

- Major accident is an accident (i.e. entails a loss) in which at least five persons may be exposed.
- Major accident is an accident caused by failure of one or more of the system's integral safety and preparedness barriers.

In the light of the definition of major accident in the Seveso II directive, the definition used in the project will rather mean a 'large accident'.

Data acquisition for the DFUs relating to major accidents is based partly on the existing Petroleum Safety Authority databases (CODAM, DDRS, etc.) but also to a considerable extent on data acquired in cooperation with the operator companies. All event data have been quality assured by e.g. checking them against the event register and other Petroleum Safety Authority databases.

Table 1 shows an overview of the 19 DFUs, and the data sources used. The industry has employed the same categories for registering data through the Synergi database.

Table 1 Overview of DFUs and data sources

DFU no.	*DFU description*	*Data sources*
1	Non-ignited hydrocarbon leaks	Data acquisition*
2	Ignited hydrocarbon leaks	Data acquisition*
3	Well kicks/loss of well control	DDRS/CDRS (PSA)
4	Fire/explosion in other areas, flammable liquids	Data acquisition*
5	Vessel on collision course	Data acquisition*
6	Drifting object	Data acquisition*
7	Collision with field-related vessel/installation/shuttle tanker	CODAM (PSA)
8	Structural damage to platform/stability/anchoring/positioning failure	CODAM (PSA) + industry
9	Leaking from subsea production systems/pipelines/risers/flowlines/loading buoys/loading hoses	CODAM (PSA)
10	Damage to subsea production equipment/pipeline systems/diving equipment caused by fishing gear	CODAM (PSA)
11	Evacuation (precautionary/emergency evacuation)	Data acquisition*
12	Helicopter crash/emergency landing on/near installation	Data acquisition*
13	Man overboard	Data acquisition*
14	Injury to personnel	PIP (PSA)
15	Occupational illness	Data acquisition*
16	Total power failure	Data acquisition*
18	Diving accident	DSYS (PSA)
19	H_2S emission	Data acquisition*
21	Falling object	Data acquisition*

* Data acquired with the cooperation of operator companies

3.3 Trends in Activity Level

Figure 1 and Figure 2 show trends over the period 1996-2007, for production and exploration activities, of the parameters used for normalisation against activity level (relative figures, year 2000 is put at 1.0).

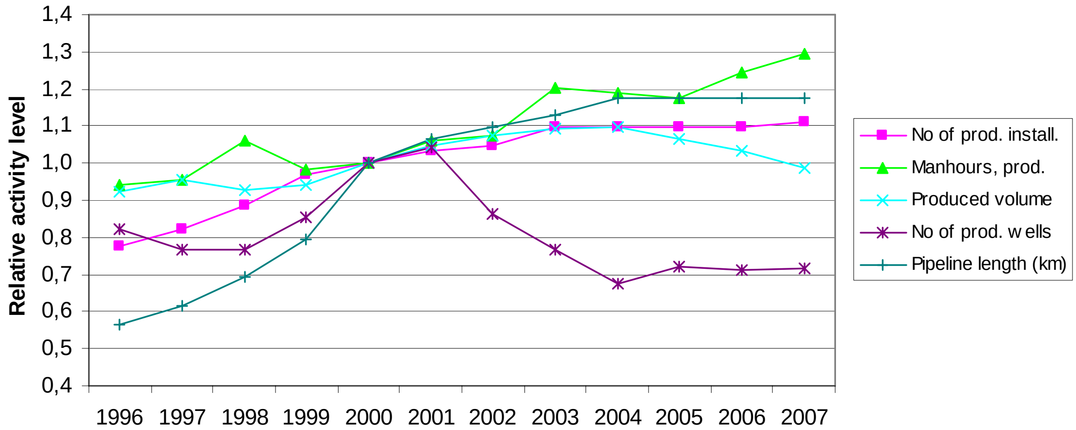

Figure 1 Trends in activity level, production

Annex A to the main report (Ptil-08-04) presents the basic data in detail. Errors in the database in earlier reports have been corrected.

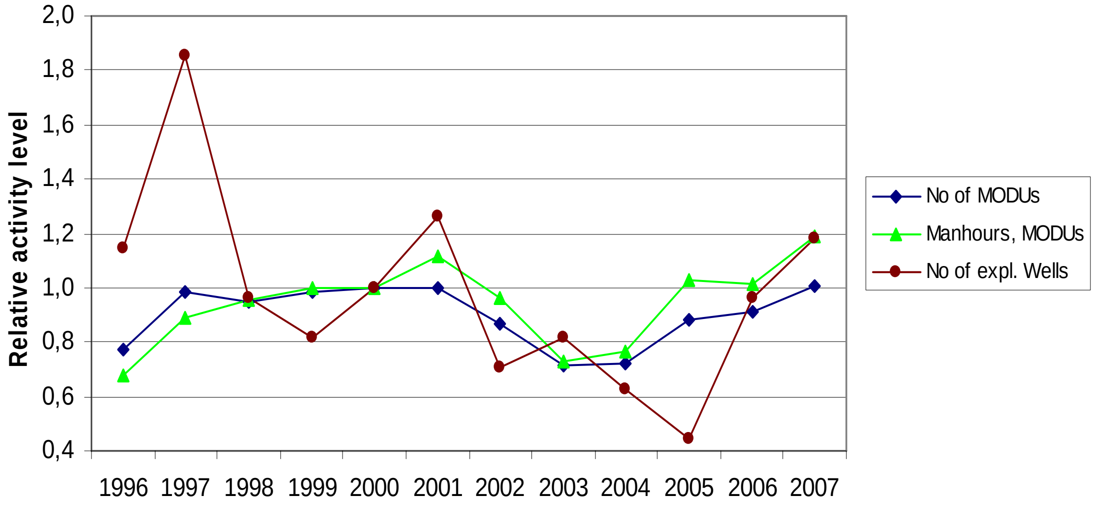

Figure 2 Trends in activity level, exploration

The changes in activity level seen in relation to the individual parameters vary, where the number of manhours on production installations has increased by 30% while the number of production wells is reduced by 30%. On mobile units the variations from year to year are even greater. Presentation of DFUs or risk may therefore differ according to whether we use absolute or "normalised" values depending on normalisation parameters. Normalised values have been presented in the main.

A corresponding activity overview for helicopter transport is shown in Subsection 7.1.

3.4 Documentation

The project's analyses, evaluations and results are documented as follows:

- Summary Report – Norwegian Continental Shelf for 2007 (Norwegian and English version)
- Project Report – Norwegian Continental Shelf for 2007
- Onshore Facilities Report for 2007

These reports can be downloaded free of charge from the Petroleum Safety Authority's website (www.PSA.no/rnnp).

4. Scope

A principal activity in the current phase was the qualitative study, conducted for the first time on both onshore and offshore facilities.

The methodology used for analysing the statistical level of risk is the same as that used in previous phases, with no significant changes. The study of serious injury to personnel in relation to occupational accidents was also performed in the same way as in previous years.

In 2002 proposed indicators for the factors noise and chemical work environment were developed. These were tested out in 2004 and have been employed subsequently, with a few changes from 2006, see Section 11.

Part 3: Results from 2007

5. Questionnaire Survey

This part of the report presents the findings from a questionnaire survey performed among personnel in the Norwegian offshore industry in the period 7th January to 15th February 2008. In general terms, the aim of the questionnaire surveyis to measure employees' perception of HES in the Norwegian offshore industry. This is the fourth time data have been acquired through use of this questionnaire. The first survey was performed in December 2001, the second in December 2003 and the third at the turn of the year 2005/2006. A corresponding survey was performed this year for the onshore facilities, of which the findings are presented in the main report for onshore facilities (Ptil-08-05). The questionnaire has been continually developed but a basic set of questions has been retained making it possible to follow trends over time.

In previous years, there has been a response percentage of about 50. In performing this year's survey, a new procedure was implemented for the distribution and collection of the questionnaires. Possibly as a result of this, a good many problems were reported to us in connection with distribution of forms at the heliport. It is our opinion that this led to a lower number of responses than expected. If we take the number of reported manhours as indicative of how many people were working on the offshore facilities in the survey period, we arrive at an estimated response percentage of about 30. A response percentage of 30 is low. Nevertheless, the number of responses, 6850, is sufficiently large to allow us to perform statistical analyses and to split the data material into different categories. By way of comparison, it can be noted that in the national living standard surveys conducted by Statistics Norway every three years less than 200 randomly selected persons represent the entire petroleum industry. The distribution of responses among different groups corresponds reasonably well on the whole with the distribution in previous years' studies and with the reported number of hours for different groups. As in previous years, there is once again a slight over-representation of operator personnel in relation to contractor personnel on production installations.

5.1 General Comments on HES Factors

For the HES climate it is observed that the generally positive trend from 2003 and 2005continues in 2008. There is a total of 11 statements which are considered to be more positive in 2008. For example, there are more respondents this year who agree that they can influence HES factors in their own workplace, the work permit system is followed to a higher extent and emergency preparedness is evaluated as better this year than in previous years. More respondents have access to the equipment they need to work in a safe manner and more agree that they have had adequate work environment training than in 2005. Still, the safety training is seen as much better than work environment training, and among the new questions on respondents' awareness of chemical exposure and associated risk, there is a relatively high percentage who rate their own knowledge in this area as low.

Seven statements have significantly poorer result this year compared to 2005. It may be noted that still more respondents consider that lack of maintenance has resulted in poorer safety. Fewer respondents now than in 2005 are of the opinion that it is easy to find relevant information in management documentation (requirements and procedures), and there are fewer who think they have had adequate training in safety. Also, stopping work when it is thought to be a danger to oneself or others is scored lower now than in 2005. Further, fewer agree that they always know who in the organisation to report to. In addition, more respondents disagree that it is easy to report occupationally-related illnesses and complaints.

The perception of risk associated with various accident scenarios has increased from 2005 to 2008. This applies to all nine scenarios but the change is significant for only six of them. The risk of collision with vessels/drifting objects and the release of toxic gases/substances/chemicals is rated as higher (poorer) than at any time since the 2001 level, while for the remaining scenarios the results remain better than in 2001.

In regard to the physical work environment, more respondents report experiencing noise and poor lighting this year than in the previous survey, while a smaller percentage report skin contact with chemicals and dangerous substances. More respondents are exposed to a poor indoors climate than in 2005. There are in 2008 more respondents who consider the workplace to be well organised.

There has been an improvement in most factors relating to the psychosocial work environment. The possibility of influencing one's own work tempo and other work-related factors has increased. Support from management and colleagues has also improved and the degree of appreciation from management shows a positive trend compared with 2005.

Respondents are generally well satisfied with the quality of food and drink and other factors in association with leisuretime and recreation. Their rating of helicopter transport on the other hand shows little change and remains at a low (negative) level. Some respondents have pointed out that the combination of survival suits and rigidly upright helicopter seats contribute to this result.

Concerning quality of sleep before, during and after offshore stays, few changes are noted from 2005 until the present. However, fewer respondents report having to share sleeping accommodation than in the previous survey, a positive result.

Nevertheless, more respondents experience noise and poor indoors climate in cabins compared with 2005, but there is a significant relationship between the incidence of shared sleeping accommodation and the perception of noise and poor indoors climate in the cabin, so that it is those who share sleeping accommodation who experience this to the greatest extent.

The perception of general health is good but significantly poorer than in 2005, which may be due to the shift in age: the respondents in this year's study are older than in previous years. We also find a significant increase in health complaints relating to hearing, tinnitus, headache and eyes compared with 2005, while there are fewer incidences of allergic reactions and oversensitivity.

There is a slight rise in the number of occupational accidents from 2005, but a slight decrease in serious injuries this year than previously (3.5 % injuries to 3.0 %). The total number of injuries reported on the questionnaire (excluding first aid) corresponds relatively well to the number of injuries reported on NAV forms, if we correct for response percentage (543 in the field study against 432 on NAV forms*). (NAV = The Norwegian Labour and Welfare Administration)*

A higher percentage report absence from work because of illness this time than in 2005, while at the same time fewer respondents report longterm absence and absence due to occupational factors. Women have a higher incidence of sickness absence than men, but there are no age-related differences.

If we look at the results for different work areas, well service and to some extent process systems are distinguished as having more negative values for several of the indices covering HES climate, risk and physical exposure at work, together with sleep and rest. Well service personnel, however, report positively on the index for social support and both these results are recognisable from previous years. Those with best results on most indices for HES climate, risk and factors associated with work/recreation are administration and to some extent catering. Concerning health indices, maintenance personnel suffer most from hearing complaints while catering personnel have fewest. Administrative personnel have fewest muscular, skeletal and skin complaints while catering personnel are most affected by these.

6. Risk Factors and General Conditions for Painters and Electricians

As part of this year's work, two whole-day workshops were held to look specifically at the job categories of painters and electricians. The aim of these workshops was to gain further knowledge of the risk factors for two categories of personnel who work on both the onshore and offshore facilities in the petroleum industry, and to highlight potential measures for reducing risk for these two groups. Painters were chosen because of the many and complex risk factors this group has in relation to their working environment and general conditions. The choice of electricians as the second job category was made primarily because there is relatively little information about electricians as a group. The two groups have different characteristics in relation to risk and basic conditions.

We know that the risk for occupational illness and injury is unequally distributed among different groups of personnel. For some categories, we know a good deal about their exposure while for others we lack information. One of the aims of the workshops was to develop an overall picture of the risk of occupational illness and injury for two categories of personnel. We have focused not only on actual exposure factors but also on the importance of general working conditions and other factors with potential impact for risk.

Participants at these workshops represented different backgrounds and disciplines from oil companies, contractor companies, authorities and research institutions. Overall, there were representatives with professional knowledge of ergonomics, noise, chemicals, psychosocial and organisational factors and those with occupational experience from the painting and electrical trades in the petroleum industry, both offshore and onshore facilities.

Prior to the workshops, information was collected about HES factors on the Norwegian Continental Shelf, with particular reference to painters and electricians, from the following PSA data sources:

- Previous field studies on risk levels from 2001, 2003 and 2005
- Reported injuries to personnel working on the Norwegian Continental Shelf
- Report on occupational illness
- Noise indicator data from the risk level report

These data were used to perform analyses which would provide background material concerning HES factors and occupational accident risk for the chosen job categories.

6.1 Painters

Painters have a high degree of exposure to various physical/chemical factors (chemicals, noise, vibrations and ergonomic strain) in their work environment. The barriers designed to provide protection against injury and illness are largely limited to individual personal protective equipment (PPE). This does not always give fully adequate protection, however, and can also cause extra strain.

Chemical exposure, noise and ergonomic strain are reported by participants as the most important risk factors for the group, as is also reflected by the distribution of diagnoses in reported cases of occupational illness. Muscular/skeletal complaints represented 50 % of these cases, skin complaints 23 % and noise-related complaints 13 %. In the 2005 field study, painters reported more than the average for other groups in the industry that they had tasks conducive to repetitive strain injuries.

Concerning organisational factors/general working conditions and the psychosocial work environment, the “nomadic” existence of many painters was emphasised. This entails challenges in relation to awareness of procedures and risk factors on the different installations or facilities and in terms of competence development in general. Their nomadic existence also makes it more difficult to put forward suggestions for improvement to the operator or owner.

A combination of nomadic existence and campaign-driven maintenance also leads to less job security and it is difficult for employer and operator/principal enterprise to assess the total exposure situation for the group. However, participants emphasised that these two factors were well-handled in the petroleum industry, particularly offshore. An important point raised at the seminar was lack of practical planning for maintenance work in both the construction and operating phase, entailing challenges in many areas including ergonomics.

Painters are also an exposed group in relation to the risk of injury, as confirmed by Register of personnel injuries for offshore personnel. Workshop participants also pointed to ultra-high pressure hosing as the task exposing painters to the highest risk of injury. The workshop results for painters, together with available data on the incidence of illness and injury and relevant scientific studies, justify putting this group forward as one of the most risk-exposed in the petroleum industry. Painters have higher exposure to several physical/chemical factors in their work environment than other categories of personnel. Painters also have challenges concerning their general working conditions and organisational factors. Despite this, the workshop participants expressed the view that painters are in many ways an under-prioritised group. According to the participants, risk for this group could have been reduced if the industry had invested more effort in competence development in relation to chemical exposure, the development of products carrying less of a health risk, the development of new materials (requiring less maintenance), better-designed personal protective equipment and new methods of surface treatment.

6.2 Electricians

Ergonomic strain and the development of muscular and skeletal complaints were emphasised as the biggest risk factor for this job category. The group is also at risk of sustaining noise-related injuries.

Concerning general working conditions/organisational factors and the psychosocial work environment, the workshop discussions revealed substantial differences between electricians engaged as operator and contractor personnel. Those electricians working for contractor companies tell of a nomadic activity in which they move about between different workplaces both offshore and onshore. This nomadic existence, in conjunction with campaign-driven maintenance work, entails challenges in relation to competence development, familiarity with the different installations, social inclusion, the opportunity for co-determination and ergonomic strain (because this type of maintenance often involves intensive, repetitive work), and makes it difficult for employer and operator/constructor to assess the total exposure picture for this group.

Electricians engaged as contractor personnel have even bigger problems than operator personnel in gaining acceptance for changes in procedures and regulations. Lack of employee co-determination on the part of contractors and the great number of rules and procedures led to decreasing respect for rules and procedures by contractor company electricians. Contractor electricians also experienced greater job insecurity than operator personnel, since they did not know which installation or facilities they would be working on in the future and at times also had to be available for work onshore.

Contractor electricians felt they were ”lower down the ladder” than operator personnel, a perception reinforced by their not having access to their own meeting areas in the same way as operator personnel and by contractor personnel often being poorer paid. Contractor electricians working offshore also had to share sleeping accommodation more than operator personnel did.

What distinguishes electricians as a group – compared with painters – are the substantial internal differences in the group. Contractor electricians have greater HES challenges than operator personnel. Coordination of procedures and practices on the different installations/facilities, reduction of shared sleeping arrangements, and better planning of maintenance work (especially in relation to physical access) were put forward as important improvement measures for this group.

7. Status and Trends – DFU12, Helicopter Events

Our cooperation with the Civil Aviation Authority and helicopter operators was continued in 2007, following much the same pattern as in previous years. Civil aviation data collected from the relevant helicopter operators cover event type, class of risk, degree of severity, type of flying, phase, helicopter type and departure/arrival details. The main report from the project (PSA, 2008) contains further information on scope, limitations and definitions.

The last major accident involving fatalities occurred in September 1997 in association with the helicopter accident off Brønnøysund. That was the last major accident on the Norwegian Continental Shelf.

In the period 2002-07 the event type "serious aviation event" was not used in reporting to the Civil Aviation Authority, but this was reintroduced from 1.7.2007. Nevertheless, this category was not applied in analysing data in the period 1999-2007. In Phase 3, three event indicators and two activity indicators were established to give the best possible picture of helicopter risk. The activity indicators show the trends in exposure to helicopter risk, and are thus more pro-active indicators. Indicators are explained in detail in the Main Report.

7.1 Activity Indicators

Figure 3 shows activity indicator 1 (crew-change traffic) and activity indicator 2 (shuttle traffic) in relation to the number of flight hours and the number of person flight hours a year in the period 1999-2007. For crew-change traffic there are minor variations in the course of the period, with no clear trends. There was an increase in the volume of shuttle traffic up to 2001, and thereafter a reduction in person flight hours and a stable level for flight hours.

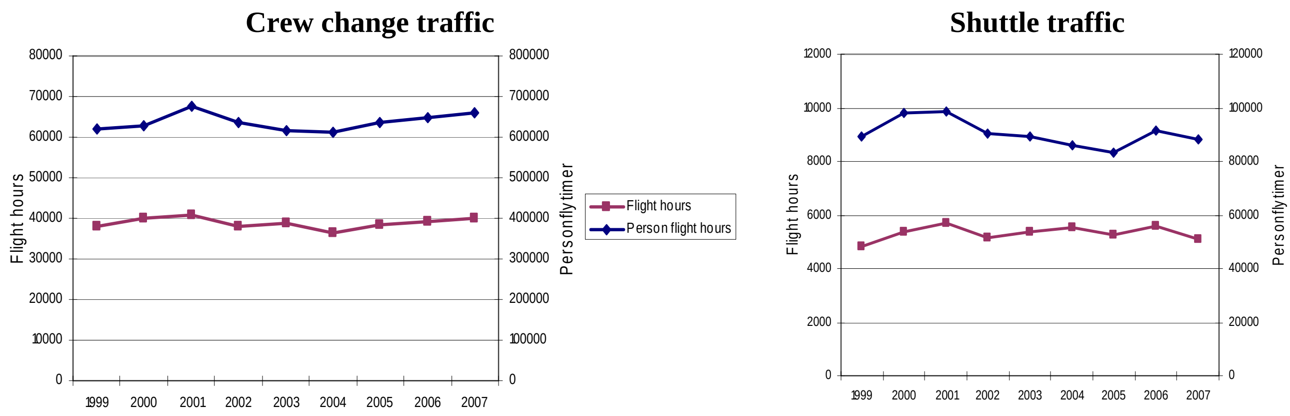

Figure 3 Volume of crew change traffic and shuttle traffic, person flight hours and flight hours, 1999-2007

Activity indicator 1, volume of crew-change traffic per year, must be seen in relation to activity level on the Norwegian Continental Shelf. In 2007 activity level (manhours) on the Norwegian Continental Shelf increa-sed by 7 %, while the number of flight hours increased by 0.3 %, and person flight hours by 1.1 %.

On a number of installations there is a shortage of space and shuttle traffic is therefore a normal part of the everyday routine. The highest percentage of shuttle traffic relates to the Ekofisk field. To a certain extent, shuttle traffic is flown using bigger helicopters than before. This may go some way towards explaining the decrease in the number of flight hours.

7.2 Event Indicators

7.2.1 Event Indicator 1

Figure 4 shows the number of events included in event indicator 1 normalised in relation to the number of million person flight hours per year. In the main report, the corresponding trend is also shown per 100 000 flight hours.

A consistently declining trend has previously been identified but the high values in 2006 and 2007 would appear to point to an increasing trend. In the Main Report, it is shown that the increase is largely due to "teething problems" with the S-92, which was brought into service in 2005. New helicopter types have increased robustness which may better prevent that incidents develop into serious events. This implies that the increase in incidents is not necessarily a unique indicator of increased risk.

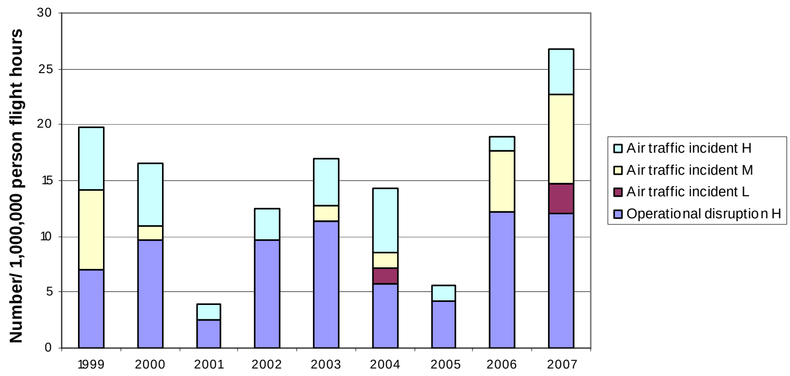

Figure 4 Event indicator 1, per 1 000 000 person flight hours, 1999-2007

7.2.2 Event Indicator 2

Figure 5 shows the number of events included in event indicator 2 normalised in relation to the number of million person flight hours in the period 1999-2004. (In the main report, the corresponding trend is also shown per 100 000 flight hours.)

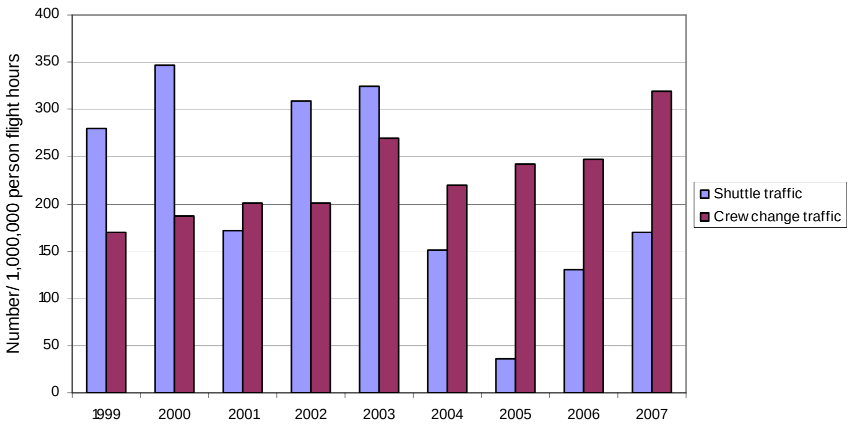

Figure 5 Event indicator 2, per 1 000 000 person flight hours, 1999-2007

There has been a slightly increasing frequency in the number of events relating to crew-change traffic throughout the period. For the number of events relating to shuttle traffic there appear to be variations around a stable level, but the number of events was low in the period 2004 – 2007. Because there are fewer events, the variations are also larger. A possible cause of the trend in 2004-2007 is the increased focus by helicopter operators on preventing events relating to shuttle traffic. One of the helicopter operators has for example introduced ”combination flying”, i.e. the pilots fly both shuttle traffic and crew-change traffic. In previous years, it was more common for permanently attached helicopters and crew to be used for shuttle traffic.

It is evident that there are considerably more events relating to crew-change traffic than to shuttle traffic. Normalisation of events in relation to volume of activity has generally resulted in a higher frequency of events, with a corresponding degree of severity, for shuttle traffic than for crew-change traffic, which may be an indication that risk is higher in the case of shuttle traffic. After 2003, the ratio has been completely the reverse, as it also was in 2001 if not so clearly. Once again, the introduction of S-92 has been a contributory factor in the last 2-3 years.

7.2.3 Event Indicator 3

Event indicator 3 shows (see Subsection 6.4.3 in the Main Report) the same events as in event indicator 1, with the addition of events in the ”parked” phase, i.e. events identified while the helicopter is standing on the helideck. These events are not considered to have major accident potential.

Events on the helideck increased, particularly in 2002, when OLF issued new guidelines for helideck personnel. With sharper focus on “correct” procedure on the helideck in relation to pilots, observance of these guidelines may be behind the increase in the number of reported events in the parked phase in 2002-2003. After 2003 the number has remained fairly constant, with 3-4 events a year. In 2007 only 2 parked phase events were noted. There is therefore reason to believe that the measures have had an effect.

8. Status and Trends – Indicators for Major Accidents on Installations

The indicators for major accident risk developed in earlier phases have been continued, with the main emphasis on indicators for events and incidents with potential for major accident. Indicators for major accident risk are discussed in Section 7.

There have been no major accidents, by the project’s definition, on installations on the Norwegian Continental Shelf in the last 15 years. None of the DFUs for major accident risk on the installation have involved fatalities in the period. The last time there were fatalities in association with one of these major accident DFUs was in 1985, with the shallow gas blowout on the rig "West Vanguard", see also page 16 in connection with the helicopter accident off Brønnøysund. Nor have there been any cases of ignited hydrocarbon leak from process systems since 1992, apart from the occasional minor leak with no potential for major accident.

The most important individual indicators for production and mobile units are discussed in Subsection 8.2. The other DFUs are discussed in the Main Report. The indicator for total risk is discussed in Subsection 8.3.

8.1 DFUs related to Major Accident Risk

Figure 6 shows the trend in the number of reported DFUs on installations in the period 1996-2007. It is important to emphasise that these DFUs vary widely in their contribution to risk.

The average level after 2000 is higher than the average for the period 1996-99. The level after 2002 shows a constant decrease and in 2007 was on a level for the period 1996-99. In particular, DFU5 (vessel on collision course) has been underreported in previous years, in our view. This applies to a lesser extent to the DFUs relating to hydrocarbon leaks and loss of well control. Figure 6 shows that these are dominant in number up to 2003, but the percentage falls to below 50 % from and including 2004. The increase in DFU5 (vessel on collision course) in Figure 6 is not a reliable indication of trends in risk level (see the discussion in Subsection 8.2.3).

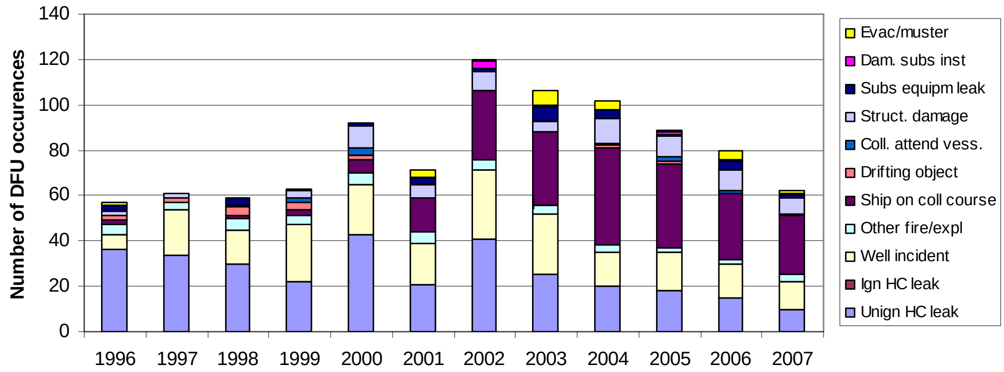

Figure 6 All reported DFUs distributed by category

8.2 Risk Indicators for Major Accidents

8.2.1 Hydrocarbon Leaks in the Process Area

Figure 7 shows the total number of leaks over 0.1 kg/s in the period 1996-2006. Up to 1999 there was a falling trend, followed by considerable variation from year to year. There was a substantial drop after 2002, but the number of leaks > 1 kg/s did not decrease to the same extent in the period 2003-05. In 2006 the number of leaks greater than 1 kg/s also shows a decrease, but two of the leaks were larger than 10 kg/s. In 2007 there were no leaks over 10 kg/s but the number of leaks over 1 kg/s has increased from 3 to 4 in relation to 2006. Hydrocarbon leaks are still classified by leak rate in broad bands as shown in Figure 7. In the Main Report a finer classification is also shown for the period 2001-07. The number of leaks in 2007 (10) is half the level for the period 2003-05 (21 a year on average). 10 leaks a year was OLF's objective for the end of 2008.

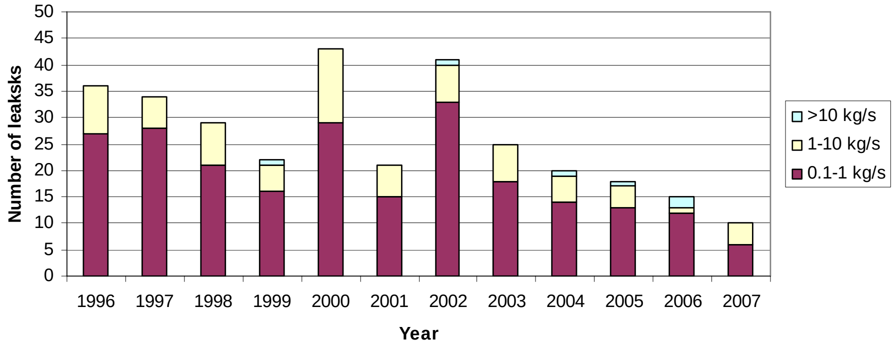

Figure 7 Number of hydrocarbon leaks exceeding 0.1 kg/s, 1996-2007

Figure 8 shows the trend for leaks over 0.1 kg/s, normalised against installation year, for all types of production installation. The figure illustrates the technique used throughout the project for evaluating the statistical significance (robustness) of trends. Figure 8 shows that the reduction in the number of leaks per installation year is statistically significant in 2007, in relation to the average for the period 2001-06. This is shown by the fact that the height of the column for 2007 falls in the lowest, dark grey field (see Subsection 2.3.5 of the Pilot Project Report). Leaks are discussed in the Main Report, normalised against both manhours and number of installations.

There are considerable variations between operators in regard to the frequency of leaks over 0.1 kg/s, indicating that there is clear potential for improvement. This is substantiated by Figure 9 which shows the average leak frequency per installation year for operators on the Norwegian Continental Shelf. In previous years, the figure has been presented for the entire period 1996 until the present. If the period is limited to the last five years, it can be seen that it is the same operators who still have the highest frequencies but they are no longer much higher than any of the other companies.

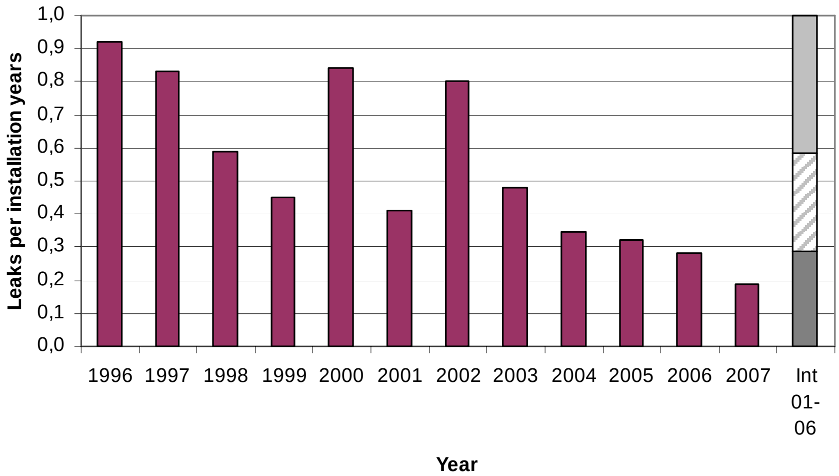

Figure 8 Trend, leaks, normalised against installation year, all production installations

A systematic comparison has been made for gas, condensate and oil leaks on the UK and the Norwegian Continental Shelf in the areas north of Sleipner (59 °N), where the installations on both shelves are of generally corresponding scope and complexity. It should be noted that the UK Health and Safety Executive reporting period runs until 31.3. each year. The last period for which data are available is 1.4.2006-31.3.2007 (called "2006" in the figures). If the value for 2007 appears to be 0 for the UK Continental Shelf, this is because the value is missing.

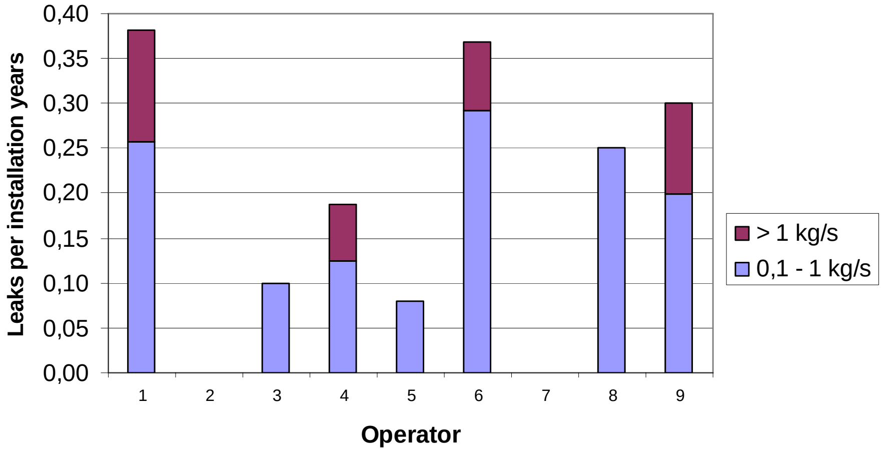

Figure 9 Average leak frequency per installation year, 2003-07

Figure 10 shows a comparison between the Norwegian and the UK Continental Shelf, in which both gas/two-phase leaks and oil leaks are included, normalised against installation year, for the two national shelves north of 59°N. The figure applies to the period 2002-06. The data included in the figure are limited to process facilities in which oil leaks have occurred. During this period there has been in addition approximately 1 leak per year in the shaft in association with storage cells in the northern sector of the UK Continental Shelf, plus 1 leak every second year in connection with tank operations on production or storage vessels. There have been no corresponding leaks in the period on Norwegian production installations. The latter leaks have not been taken into calculation in the figure.

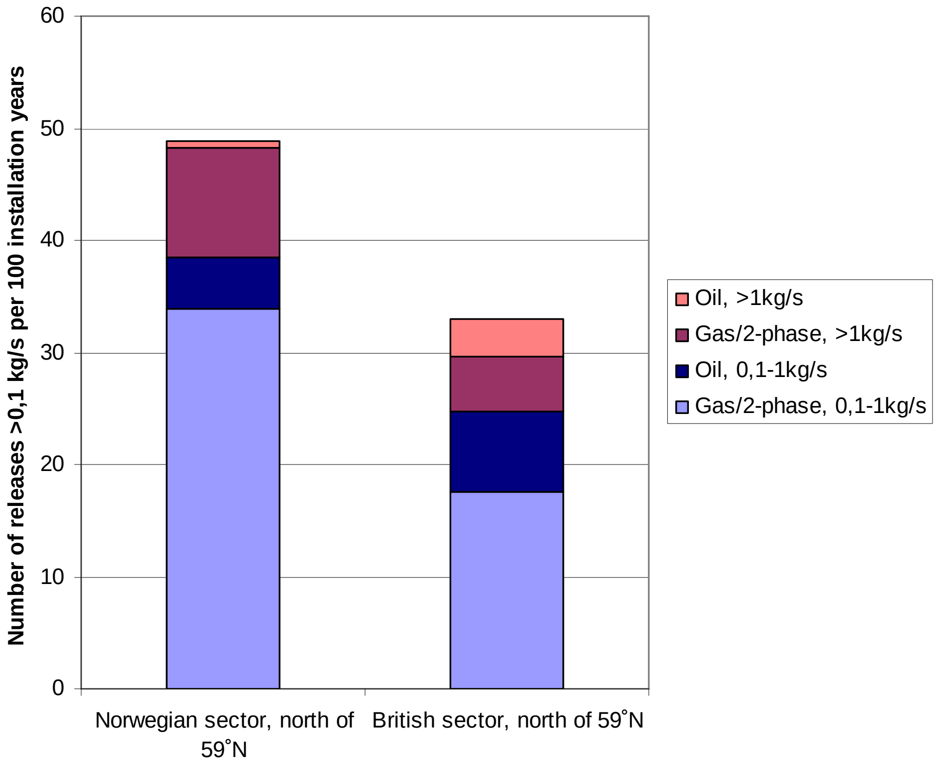

Figure 10 Comparison of gas/two-phase and oil leaks on the Norwegian and the UK Continental Shelf per 100 installation years

On the Norwegian Continental Shelf no cases of ignited hydrocarbon leaks (> 0.1 kg/s) have been registered since 1992. The number of hydrocarbon leaks > 0.1 kg/s since 1992 is probably about 390. It has been shown that the percentage of ignited leaks is significantly lower than on the UK Continental Shelf, where approximately 1.5 % of gas and two-phase leaks since 1992 have been ignited.

8.2.2 Loss of Well Control, Blowout Potential

Figure 11 shows the incidence of well events and shallow gas events distributed by exploration drilling and production drilling, normalised per 100 drilled wells. Both exploration drilling and production drilling are shown collectively and with a common scale, for purposes of comparison.

For exploration drilling there have been large variations throughout the period, perhaps around a stable average on a level with that at the beginning of the period, 1996. Production drilling showed a consistently increasing trend up to 2003, with minor variations. In the period from 2004 there has been a decrease, but this is not statistically significant. Taken together, well event frequency is higher for exploration drilling than for production drilling, with the exception of 2001, 2003 and 2004, where the ratio was reversed. By far the majority of well events fall into the category of regular, i.e. events with minor potential. In 2007 there were three events involving serious shallow gas, which has the highest risk potential.

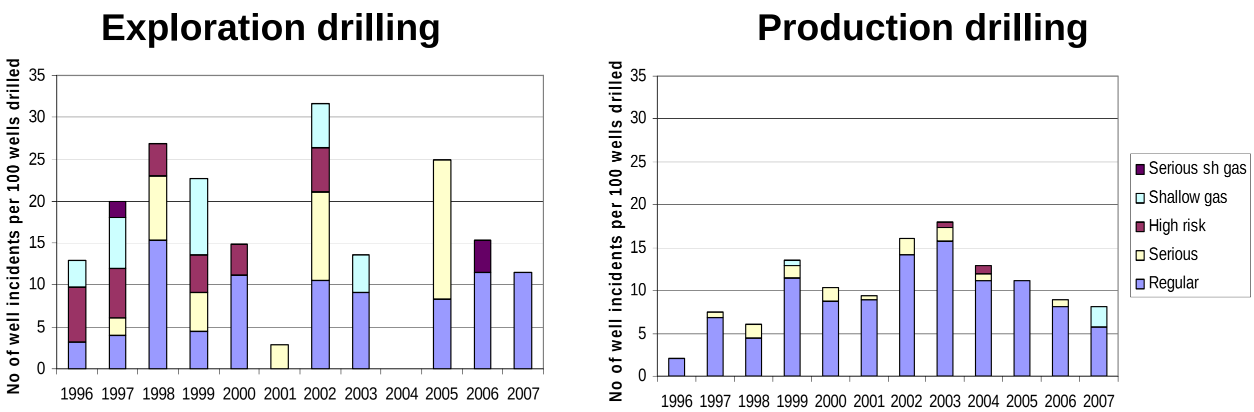

Figure 11 Well events according to degree of severity per 100 wells drilled, for exploration and production drilling

8.2.3 Vessel on Collision Course, Structural Damage

In the period before 1999 there was probably considerable underreporting of occurrences of vessel on collision course, because this is not detectable on radar. In the period after 1999, there has been a substantial increase in the number of vessels reported on possible collision course. The number of installations monitored from Statoil's Traffic Centre at Sandsli rose substantially in the period 1999-2003, and has continued to increase but not so sharply. There are also indications that there is still a degree of underreporting of vessels on possible collision course, when monitoring does not take place from a traffic centre such as Statoil's centre at Sandsli and the one on Ekofisk.

In Phase 5 a new indicator for DFU5 was introduced, by which the number of vessels reported on possible collision course was normalised in relation to the number of installations monitored from the traffic centre at Sandsli. With the new indicator there has been a decrease since 2002. Figure 12 shows the trend for the new indicator from 1999, showing that there are limited variations after 2000. Installations B-7 and H-11 on the Norpipe pipeline to Emden are not included in Figure 12.

The level for 2007 is lower than in the entire period 2000-06, and the reduction is statistically significant. The picture is almost identical if we normalise in relation to manhours.

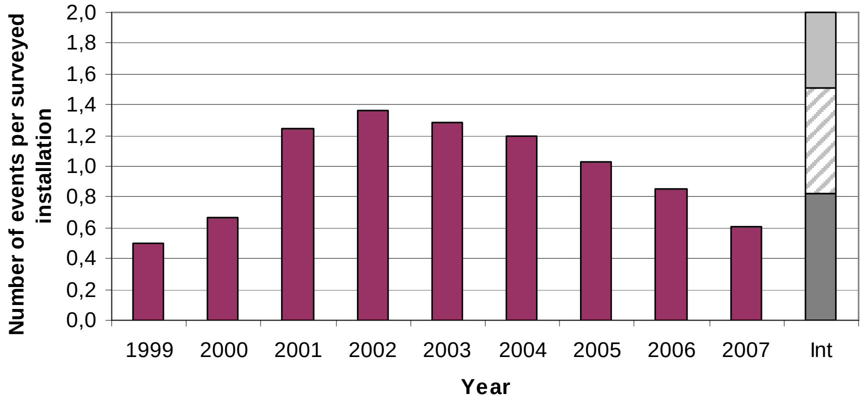

Figure 12 Number of "vessel on collision course" events in relation to the number of installations monitored from Sandsli TTS

Up to 2002 the number of "major" events and cases of structural damage and damage to marine systems increased, according to their classification in PSA's CODAM database, especially for mobile units. After 2002 the number of events may appear to fluctuate round a stable level. Starting from Phase 6, DFU8 events have been divided into two categories, where a small number of the most serious events are separated out and given a higher weighting. There have been no such events in the period 2005-07, with the failure of two anchor lines on Ocean Vanguard in 2004 being the last event in this category.

It is becoming more common to have dynamic positioning systems (DP) on both vessels and installations. A high percentage of the collisions that have occurred between vessels and installations have been due to failures of, or faulty use of, DP systems. In the period from 2000 there has been on average two such events per year, with one event in 2007.

The prevailing regulations stipulate requirements for flotels and production installations whereby they must be able to tolerate the loss of two lines without serious consequences. The loss of more than one anchor line occurs from time to time and can have large consequences but rarely on such a scale as the event on Ocean Vanguard in 2004. Mobile drilling units are only required to tolerate the loss of one anchor line without unplanned consequences. Figure 13 shows the number of events after 1996.

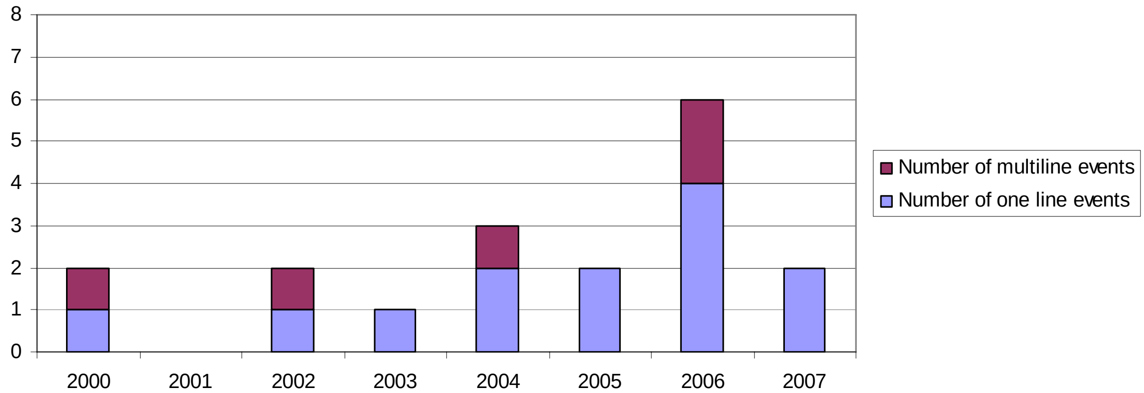

Figure 13 The number of anchor lines with loss of load capacity, 2000-2007, included in DFU8

8.3 Total Indicator for Major Accidents

The total indicator presented here applies to major accident risk on the installation, while the risk relating to helicopter transport was discussed in Section 7. The model developed in the pilot project for calculating a total indicator reflecting DFUs' potential for generating major accidents has been continued in the present phase. We would emphasise that this indicator is only a supplement to the individual indicators and that it is not an explicit expression of risk.

The total indicator weights contributions from observations of the individual DFUs in relation to their potential for loss of life (see the Pilot Project Report), and will therefore vary to a substantial degree from observations of the individual DFUs. Figure 14 shows how these indicators were presented from and including Phase 6, with 3-year rolling averages. In this way, it is possible to avoid large jumps from year to year, thus making the longterm trend clearer.

Manhours are used as the common parameter for normalisation against activity level. The level is put at 100 in year 2000. Figure 14 shows the trend of the total indicator for all production installations.

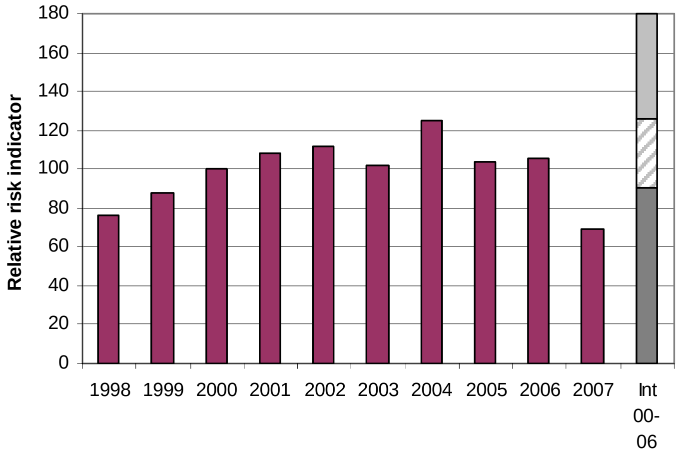

Figure 14 Total indicator, production installations, normalised against manhours, 3-year rolling averages

(Value put at 100 in year 2000)

The main impression given by the figure is that of a relatively stable level for the period, with a possible reduction over the last 3-4 years.

Figure 15 shows the indicator for major accident risk for floating production units. As already noted, it was especially the gas blowout on Snorre A that made a large contribution in 2004, together with the gas leak on Visund in 2006. Both events affect the value in 2006 (which is the average for the period 2004-06). The corresponding figure for production installations shows a stable level for the whole period, with reduction in 2006 and 2007.

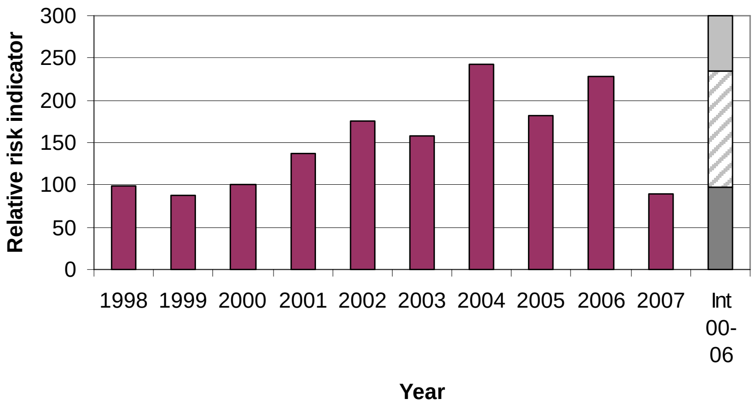

Figure 15 Total indicator, floating production units only, normalised against manhours

(Value put at 100 in year 2000)

Figure 16 shows the trend for the total indicator for mobile units, with 3-year rolling averages. The 2007 value is on a par with that for 2005 and the value in 2006 represents a slight increase. There is nevertheless an overall downward trend over the entire period.

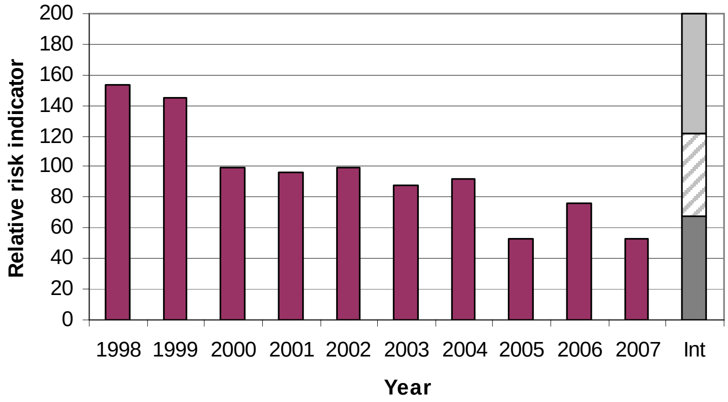

Figure 16 Total indicator, mobile units, normalised against manhours

(Value put at 100 in year 2000)

The figure shows only the total value for the indicator. The values for floating production units is substantially influenced by well events/shallow gas blowouts and particularly in the years 2000-2002, and to an even greater extent, by structural damage. In 2007 there have been no incidents in the most serious category.

9. Status - Barriers against Major Accidents

The reporting and analysis of barrier data have been continued in the present phase, with no significant adjustments from the foregoing phases, except that tests of isolation valves have been distinguished in "closing tests" (to check that the valve closes within a specified time) and "leak Tests" (to check that the valve has an internal leak rate, if relevant, under a specific value). As before, the companies report availability/reliability in the form of test data from periodic testing of selected barrier elements. The terminology used is largely concurrent with that proposed by the Barrier Working Group in Working Together for Safety (SfS).

9.1 Barriers in the Process Area

The main focus is on barriers relating to leaks in the process area, where the following barrier functions are included:

- Barrier function to maintain the integrity of process facilities (covered to a large extent by DFU1)
- Barrier function to prevent ignition
- Barrier function to reduce cloud/spill
- Barrier function to prevent escalation
- Barrier function to prevent fatalities.

The different barriers consist of various coordinated barrier systems (or elements). For example, a leak must be detected before any isolation of ignition sources and emergency shutdown (NAS/ESD) can be implemented.

Figure 17 shows the relative fraction of failures for those barrier elements for which test data have been acquired. These test data are based on reports from all production operators on the Norwegian Continental Shelf. Reporting for most barrier elements in the present phase has been stabilised. For some elements, better routines for data acquisition have been introduced, particularly in regard to BOP.

In general it may be said that the fraction of failures is on the same level as the industry's availability requirements for new installations, but the highest values in the figure are above this level. Trends for the fraction of failures have also been evaluated. Overall, there is no uniform picture, the most characteristic feature being a constant level with minor variations. The exception concerns data from muster drills, where the total number of drills and the proportion meeting efficiency requirements (VSKTB) remain more or less unchanged from year to year. Those with the lowest fraction are consistently those with the most stringent efficiency requirements. The installations with a low proportion of drills meeting the requirements are the same from year to year.

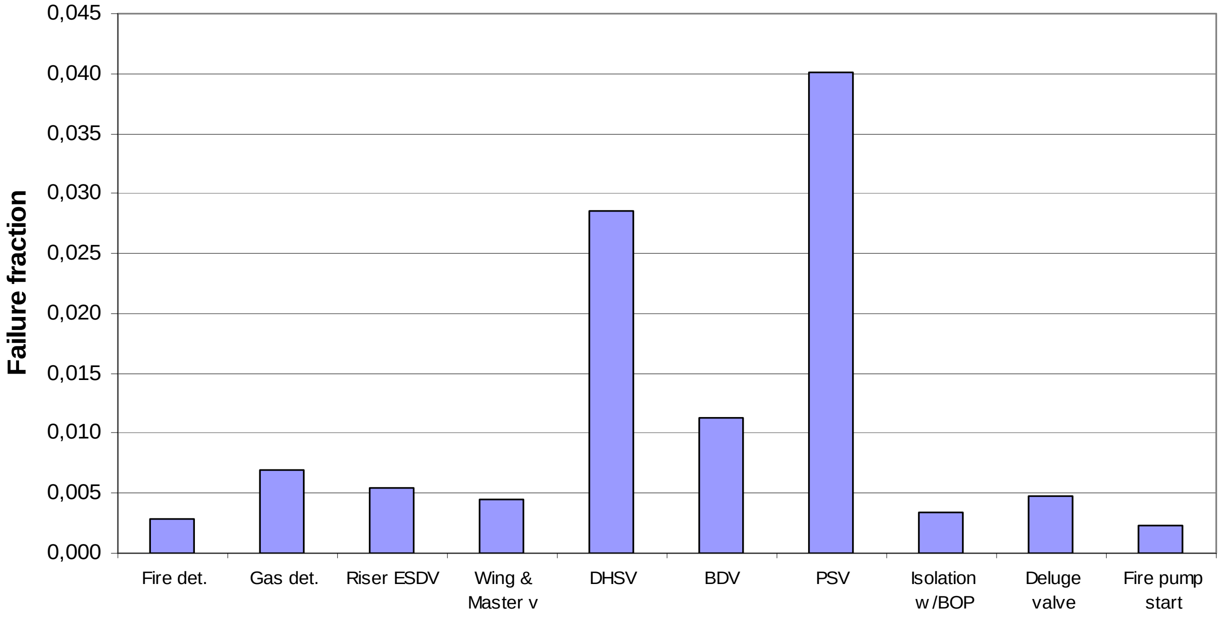

Figure 17 Relative number of faults for selected barrier elements, 2007

Figure 17 shows the ”total fraction of failures”, i.e. the sum of all failures on all installations which have reported them, divided by the sum of all tests for all installations reporting them. Figure 18 shows the ”mean fraction of failures”, i.e. the fraction of failures for each installation separately and then the mean for all installations. Again we see here the differences between closing tests and leak tests shown for riser ESDVs and the wellhead wing and master valves.

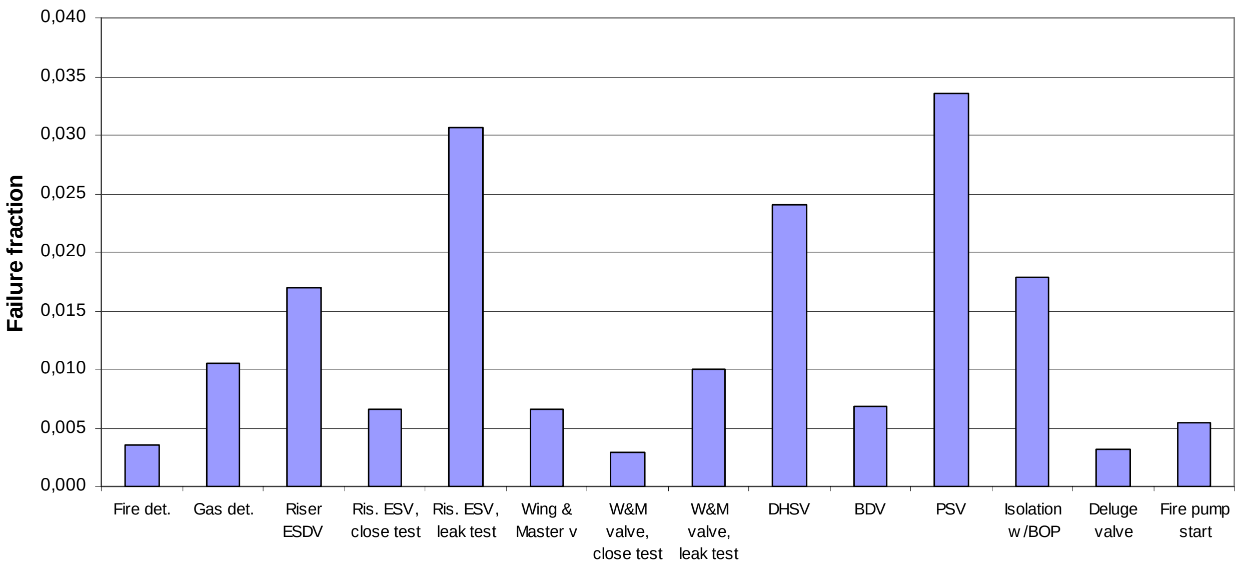

Figure 18 Mean fraction of failures for selected barrier elements, 2007

In the current phase, an expanded analysis has been performed to identify those installations which over a period of time have consistently higher fractions of test failures for many barrier elements and this result has also been studied in relation to the number of leaks over 0.1 kg/s on the same installations. A corresponding analysis was performed in 2007 and the results show a corresponding consistency in these two years.

9.2 Barriers relating to Marine Systems

The acquisition of barrier data from and including Phase 7 has been expanded to include a few selected barrier elements relating to marine systems:

- Watertight doors
- Ballast system valves
- Anchoring system
    - The number of situations where a brake has been knocked out
    - The number of situations where the second brake has also failed
- Time without acceptable signals from three reference systems or fewer than two reference systems following different principles (applies only to mobile units)

Data have been acquired for both floating production units and other mobile units. Most of the relevant installations have reported data. For production installations there was in 2006 a failure rate in connection with testing of watertight doors and ballast system valves corresponding to 1.5-2 %, while the values for 2007 have decreased to under 0.5%. No failures relating to anchoring systems for these installations have been reported. For mobile units the number of tests and percentage failures vary considerably between units. Average values are partly lower than for floating production units in relation to testing of watertight doors and ballast system valves, but there are units with failures on every third test. Figure 13 shows the number of anchor lines that have failed.

9.3 Barriers against Structural Failure

One of the most important barriers against structural damage is the clearance designed between decks and the highest anticipated wave height (the hundred-year wave). A modelling of the risk of wave impact on deck based on data for anticipated subsidence, shows that there is increasing probability of wave impact on deck, both for manned installations and for installations evacuated in hurricane conditions. In terms of risk to personnel, it has been calculated how many decks are expected to be hit by a hundred-year wave (Figure 19). Only installations expected to be manned during the hundred-year wave have been included. Values have been normalised to 100 in year 2000. The improvement in the curves for personnel risk between 1985 and 1986 is due to the jack-up operation on Ekofisk. The change between 1995 and 1996 is due to the introduction of evacuation procedures, to be implemented when hurricane conditions are forecast, for the most exposed installation on Ekofisk. The change from 2004 to 2005 is due to the introduction of evacuation routines on Valhall. The subsequent decrease is due to an increasing number of installations with evacuation procedures. The index is normalised against reference year 2000, put at 100. A rising index is an expression of higher risk. Following the incidences of wave impact on deck on several installations in 2006, we have worked with the relevant operators to improve evacuation criteria through de-manning at an earlier stage.

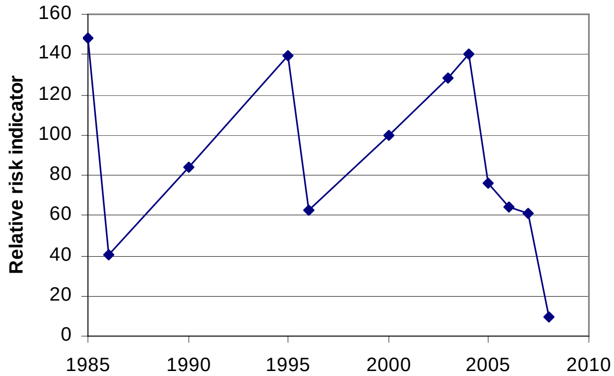

Figure 19 Indicator for risk to personnel for wave impact on deck, 1985-2010

Chapter 10 of the Facilities Regulations requires main safety functions, including main bearing structures, to be able to withstand loads with an annual probability of 10^{-4}. Some main bearing structures on older installations cannot satisfy this requirement. We have now interpreted the main safety function requirement as meaning that the loss of main safety functions must not occur as a result of loads with greater than 10^{-4} /year probability while there are personnel on board. With this interpretation, it is our view that the activities meet safety conditions both individually and collectively. The implementation of this interpretation and new procedures have led to substantially improved safety for protection against wave impact on deck while the installations remain manned.

10. Occupational Accidents with Serious Injury to Personnel

In 2007 there was an accident resulting in one fatality while Saipem 7000 was lifting a seabed separator module into place on the Tordis Field, operated by Statoil. The casualty was probably struck by a hydraulic hose when it suddenly tautened, resulting in the person being knocked or pushed over the railings. He fell into the water from the winching platform approximately 30 metres above sea level and drowned. The previous fatal accident occurred in 2002.

For 2007 PSA has registered 432 cases of injury to personnel on petroleum industry installations on the Norwegian Continental Shelf meeting the criteria of fatality, absence from the next shift or medical treatment. In 2006, 385 cases of injury were reported. In addition, 40 cases classified as leisuretime injuries and 162 cases given first aid treatment were reported in 2007. In 2006, by comparison, there were 60 cases of leisuretime injuries and 192 cases requiring first aid. Injuries sustained during leisuretime or treated by first aid are not included in figures and tables.

On production installations in the period 1997 to 2000 there were minor changes in the total frequency of injuries. From 2000 to 2004 there was a clear and consistent decrease from 26.4 to 11.3 per million manhours in 2004. Since 2004 total injury frequency has remained generally unchanged and in 2007 it was 11.2. In 2007 there were 326 cases of injury on production installations.

On mobile units, as for production installations, there were minor changes in the period 1997 to 2000. From 2000 injury frequency declined steadily from 33.7 to 11.7 in 2004, where it remained generally unchanged until 2007 and was then 12.3 per million manhours. Injury frequency in the period 2004 to 2007 is on the same level for mobile units and production installations. In 2007 there were 106 cases of injury on mobile units as against 82 in 2006.

10.1 Serious Occupational Accidents, Production Installations

Figure 20 shows the frequency of serious injury to personnel per million manhours on production installations. The level of frequency shows a falling trend from 2000 to 2004. From 2006 to 2007 there were marginal changes in frequency from 0.86 in 2006 to 0.83 in 2007. On production installations there were 24 cases of serious injury to personnel, the same as in 2006. The number of manhours has increased from 27.9 million to 29.0 million in 2007, with a consequent slight reduction in normalised frequency in 2007.

10.2 Serious Occupational Accidents, Mobile Units

The frequency in 2007 is 1.1 (see Figure 21) against an average for the previous ten years of 2.1. We have had a marked fall in recent years from the peak in 2000 and 2001. From 2002 up to and including 2006 there were only slight changes in the frequency of injuries. In 2007 there was a marked reduction from 1.9 to 1.1. However, the injury frequency rate still lies within the expected value based on the previous 10 years but in the lower band of the interval.

10.3 Comparison of Accident Statistics between the British and the Norwegian Continental Shelf

PSA and the UK Health and Safety Executive (HSE) publish a half-yearly joint report containing a comparison of statistics for injuries to personnel on offshore installations. The classification criteria appeared at first to be almost identical but on closer scrutiny some differences were discernible. With a view to improving the basis of comparison, we have had discussions with the UK authorities and have subsequently adopted common criteria for classification of serious injury to personnel and corresponding areas of activity.

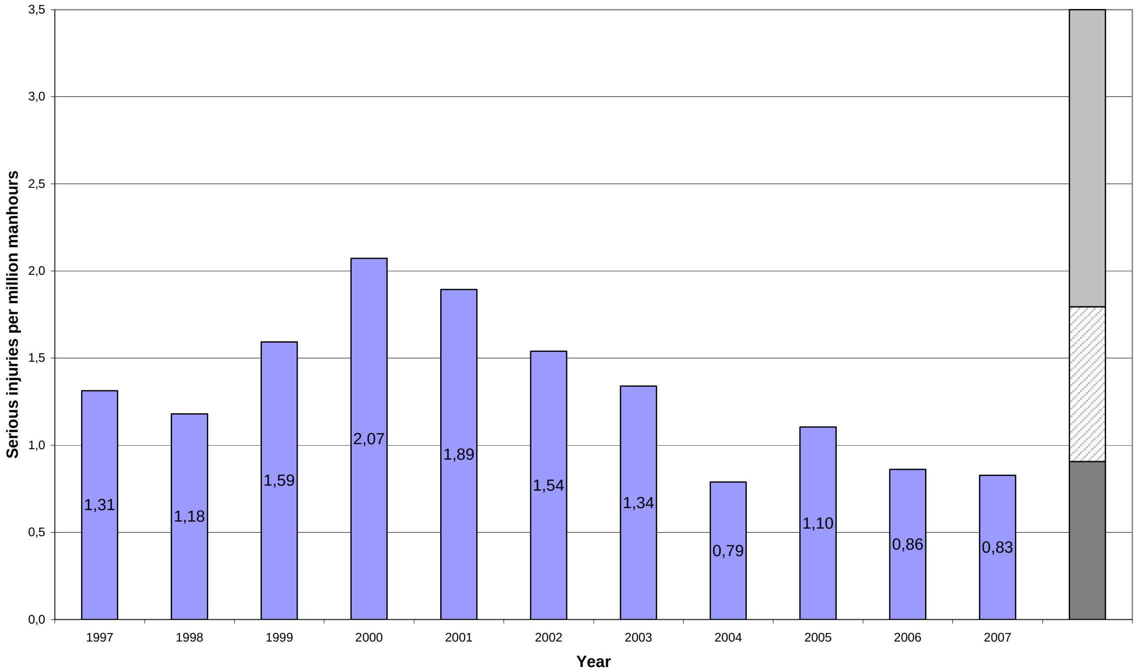

Figure 20 Serious injuries to personnel on production installations related to manhours

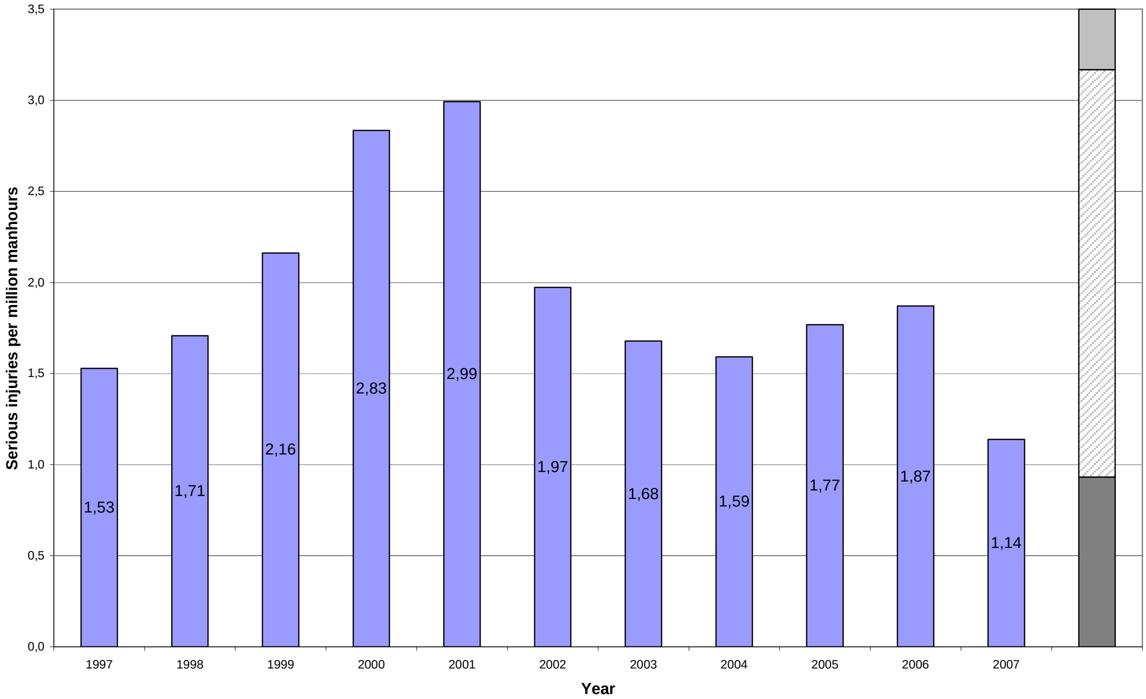

Figure 21 Serious injuries to personnel per million manhours, mobile units

The average frequency of cases resulting in death and serious injury for the period 2001 up to and including the first half of 2007 shows that there have been 1.03 injuries per million manhours on the Norwegian side and 1.10 on the UK Continental Shelf. The difference is hardly significant. On the other hand there is a greater difference in the frequency of fatal accidents in the same period. The average frequency of fatalities on the UK Continental Shelf is 3.78 per 100 million manhours against 0.94 on the Norwegian Continental Shelf, this difference being significant. On the UK Continental Shelf there were 12 fatalities in the period in question against 2 on the Norwegian Continental Shelf (the fatality on the Norwegian Continental Shelf in 2007 occurred in the second half of the year.

11. Risk Indicators – Noise and Chemical Work Environment

Risk indicators for noise and chemical work environment were developed in cooperation with expert personnel from the industry. Importance was attached to the need for the indicators to reveal risk factors as early as possible in the causal chain leading to occupational accident or illness.

With few exceptions, data have been registered from all installations on the Norwegian Continental Shelf, for mobile and production installations. In regard to noise, the data set shows that there is common understanding of the reporting criteria and the indicator would seem to give a meaningful picture of the situation. It also seems to be sensitive to change. For the chemical work environment the situation is different. Some of the reporting reflects divergent understanding of the reporting criteria. This means that the indicator is not as robust as one might wish. Changes have therefore been introduced in reporting procedure for 2007.

Comments from the companies have been generally positive. The indicators have attracted commitment and management attention and an improvement is noted in the prioritisation of risk reduction. In establishing the indicators, it was an important aim that they should support good processes in the companies. There is a high level of activity in the industry directed towards the development and implementation of methods and tools for risk assessment and management in relation to noise and the chemical work environment.

It is important to emphasise that the indicators represent a collection of a rough and simplified set of data aimed at providing companies with a tool allowing them to monitor and influence trends for their installations and compare these with those of other companies in the industry. This set of basic data in itself is not enough to satisfy statutory requirements in relation to noise and the chemical work environment in individual companies. It is also worth noting that the risk indicator for noise does not cover all groups with a high level of exposure.

11.1 Noise with Potential for Impairing Hearing

The indicator for noise exposure covers 11 pre-defined job categories. Data have been reported for a total of 1854 persons, somewhat fewer than for previous years. The average noise indicator for the 1854 persons included in the study is 90.4. This is a slight improvement from the 2006 level (90.6). The distribution over different job categories and groups of installations is shown in Figure 22 (further details in the Main Report, PSA, 2008). The results show an improvement on 20 of total 59 installations, an increase in relation to 2006. The figures additionally show a deterioration for some installations, with 1 installation in particular showing a negative trend where the indicator increases by more than 10 units compared with 2006. The cause of this deterioration is an increase in level in the job category painters on this installation.

There are only seven installations where no detailed risk evaluation for certain job groups has been made, but some installations have made detailed evaluations for only 1-2 job categories and here actual noise exposure has been reported in relation to the individual job categories. In most cases, there is little deviation between the noise indicator and real exposure over 12 hours expressed in decibels A. This is a useful verification of the indicator's robustness.

If we assume that the noise indicator reflects real noise exposure, most job categories covered by this study have a level of noise exposure exceeding 83dBA which is the limit stipulated in the Facilities Regulations Section 22. However, taking into consideration the use of hearing protection as reported by the companies, the majority of job categories are seen to have a level of noise exposure within the required limit. Even if we apply a conservative estimate for the noise suppression effect of the hearing protection, this does not mean that the situation is satisfactory. Hearing protection has clear limitations as a preventive measure. Persistently high reporting of hearing damage indicates that this is not an effective barrier. The average noise indicator with hearing protection for the 1854 persons included in the study is 79.2, a slight improvement from the 2006 level.

The indicator also calculates uncertainty in the result and the 95 % percentile for indicator value. This means that personnel with noise exposure are under a level of exposure corresponding to this with 95 % probability. The 95 % percentile lies typically 6-8 dA (occasionally up to 10 dBA) higher than the average values shown in the graph.

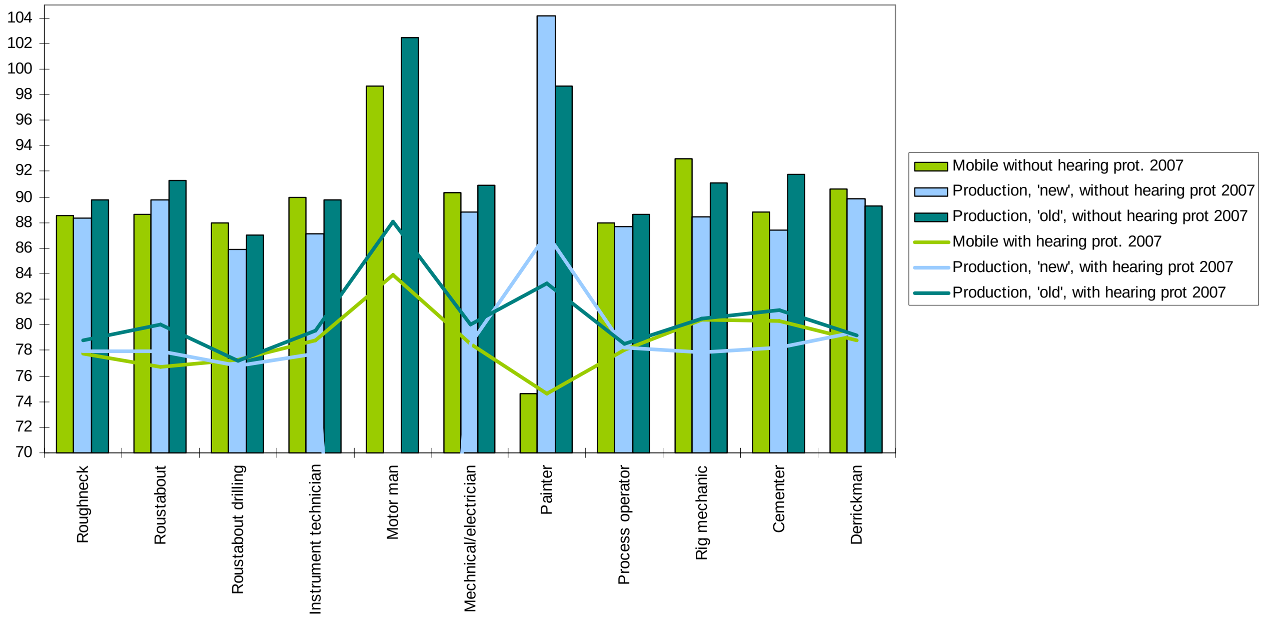

Figure 22 Average exposure to noise by job category and installation type, 2007

The noise indicator for the job categories painters and machinist is markedly higher than for other groups and for these categories the noise indicator including hearing protection is also relatively high.

For all job categories with the exception of painters, the noise indicator is lower on “new” installations than on “older” ones.

Only ten installations have reported the implementation of technical measures which together have led to a reduction in noise exposure by respectively 1 dB, 6 installations with a reduction of 3 dB, 5 installations with a reduction of 5dB and 2 installations with a reduction of 8 dB for certain job categories.

Reporting confirms that a number of companies have formalised and implemented schemes for limiting working hours. Of 59 installations there are only 10 (8 mobile and 2 fixed) which have not introduced such schemes for certain groups. As for 2005 and 2006 there is still potential for improvement in this area on mobile units. Although it can be difficult to verify that this type of measure is effective, there are examples that may indicate that this is the case. Schemes of this kind can entail operational disadvantages and may in themselves serve to encourage the introduction of technical measures.

Despite the fact that the indicators point to high exposure, there are still some installations which have not established plans for risk reduction measures, cf. Figure 23. This picture shows a more positive trend than in 2006, while at the same time there is greater attention to the need for plans to be risk based. The exception here is mobile units where a decrease can be noted. Improvement potential has been registered in relation to implementing measures in accordance with established plans. This applies in particular to older production installations and to mobile units where under 50% of planned measures have been implemented.

595 cases of noise-related injuries were reported to the PSA for 2007, more than double in relation to the previous level. This increase is partly due to the fact that not all companies have established adequate practices for regular reporting and that there has been a tidying-up job in 2007. The high figure for 2007 should accordingly have been spread over a longer period. There may be other reasons for the increase but work done by the petroleum industry in relating noise injuries to exposure level on the installation indicates that approximately half the registered incidences of hearing damage are due to occupational exposure. If we also take into account that there is considerable underreporting, particularly in the contractor segment of the industry, and that there are probably selection mechanisms at work serving to hide injuries, we are facing a relatively extensive scope of injuries.

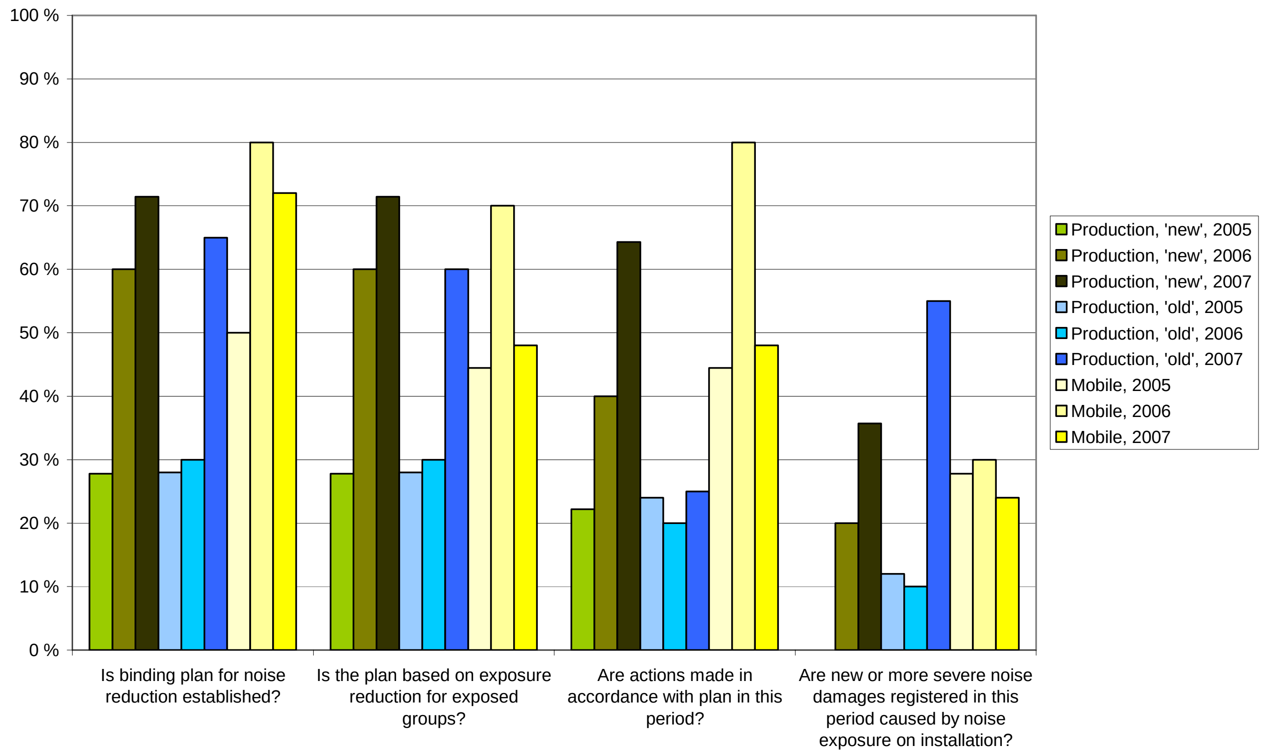

Figure 23 Planned risk reducing measures

On the whole, it seems clear that large groups of personnel in the offshore petroleum industry are exposed to excessive levels of noise and that the risk of developing noise-related hearing damage is not inconsiderable. PSA's experience through contacts with the industry, executive work and audits indicates that there is extensive potential for noise-reducing measures.

11.2 Chemical Work Environment

There has been a change in the set of indicators for the chemical work environment. Because of its lack of robustness, the indicator covering rough and detailed risk assessment has not been included in 2007. It has not been possible to achieve common understanding of reporting criteria and the indicator has therefore proved incapable of reflecting the real situation with sufficient accuracy. In 2008 PSA will work together with the different parties to develop new indicators. The indicator for the chemical spectrum's risk profile has been retained unchanged. A new feature in 2007 is reporting of the number of exposure measurements performed in the present year, i.e. exposure measurements forming the basis for analysis of exposure and health risk to personnel.

Data reported for 2007 show that there is still considerable variation between companies in regard to the number of chemicals in use (Figure 24). To some extent this reflects the type of installation and activities on board. Drilling operations have particular weight here. The number of chemicals varies from 116 to 872, with an arithmetical mean of 412. For chemicals carrying high risk potential, the number varies from 5 to 155, while the mean value is 69. There is a systematic co-variation, installations using most chemicals also having most chemicals with high risk potential.

For production installations a slight increase in the total number of chemicals is noted in relation to previous years. For chemicals with high risk potential there are 24 installations showing an increase and 16 installations showing a reduction or remaining at the same level. For mobile units the trend is more positive. A majority of these installations shows that the number of chemicals has fallen and there is a corresponding reduction of chemicals with high risk potential, Figure 25 and Figure 26.

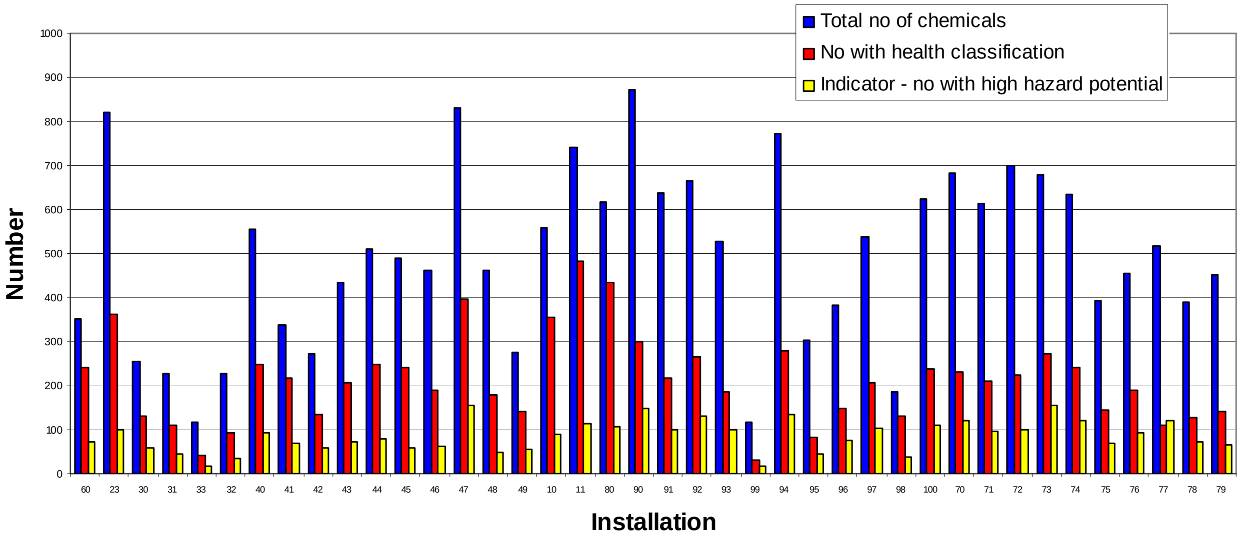

Figure 24 Indicator for the chemical spectrum's hazard profile – production installations

23 out of 40 production installations report that they have performed altogether 341 exposure measurements. 262 measurements or 77 % were performed by 2 companies. There are 17 installations which have not performed exposure measurements. On mobile units a total of 14 exposure measurements were conducted on 7 out of 26 installations.

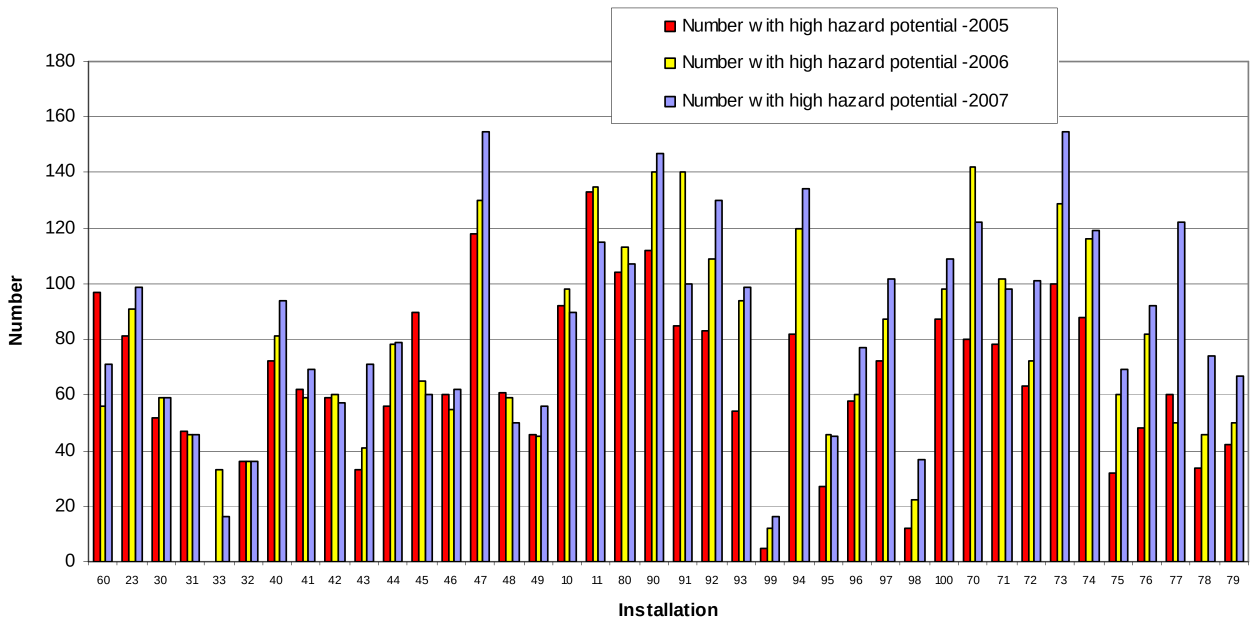

Figure 25 Trends in the indicator for the chemical spectrum's hazard profile 2005-07, production installations

In 2007 there were altogether 253 reported cases of substitution, bringing health benefits, against 252 in 2006. This is a low level in comparison with previous years. Most substitutions were effected on installations with a high number of chemicals in this period.

65 cases of occupational skin complaints, mainly due to chemical exposure, were reported in 2007 against 61 cases in 2006.

For both production and mobile units, reports show great variation in the total number of chemicals in use. Some of this variation can be ascribed to type of installation and activities but there is considerable potential for reducing the number of chemicals in use.

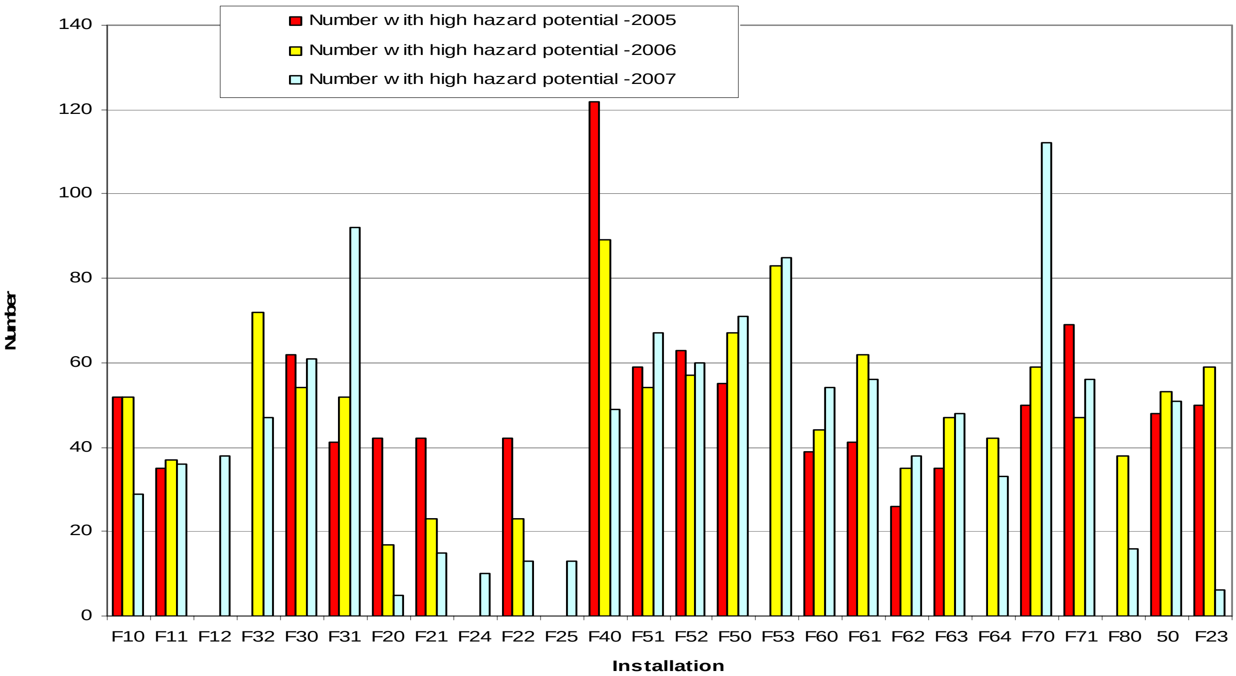

Figure 26 Trends in the indicator for the chemical spectrum's hazard profile 2005-07, mobile units

While mobile units can present a positive trend concerning the number of the most hazardous chemicals, the trend for production installations is slightly negative. In the last two years, the number of substitutions bringing health benefits has been substantially lower than in preceding years. Substitutions have not been sufficient to prevent an increase in the number of hazardous chemicals in use.

Close attention has been paid to the use of chemicals in the petroleum industry in recent years and in spring 2007, after a comprehensive review of industry practice, the Petroleum Safety Authority concluded that companies have serious deficiencies in regard to proper risk assessment and that analyses are insufficiently based on measurements. The figures reported by the companies for measurement activities show that only two companies perform measurements to any extent (measurement series), and that for a majority of installations no measurements were made in 2007. The reported figures go a long way towards confirming PSA's earlier conclusions. More measurements are necessary in order to enhance the quality of risk assessments and to ensure that appropriate and adequate measures are implemented.

12. Other Indicators

12.1 DFU21 Falling Object

253 events were reported to the project for 2007, approximately the average for the period 2002-06: 256. 180 events were predicted for 2007, against an average of 99 predicted events in the period 1997-2006. This marked increase is due to the project's focus on falling object events since Phase 3, together with the fact that no lower limit has been set for reportable events. The figures are not comparable and cannot be used to establish trends.

A falling object can result in injury to personnel, material damage, production stop or a combination of these. In 2002 there were two fatalities (17.4.2002 on Byford Dolphin and 1.11.2002 on Gyda) and 18 cases of injury registered relating to falling objects. In 2003 seven cases of injury were registered, nine in 2004, two in 2005, while in 2006 the number of reported cases rose to 13, and further to 14 in 2007. Data have been reported for two indicators from and including Phase 3 of the project:

- The frequency of falling objects for different work processes (drilling, crane operations, process and other)
- The frequency of falling objects for different energy classes (indicator for showing the potential of a falling object for damage to equipment and structures and injury to personnel).

The evaluation of barriers relating to falling objects is based on investigation reports. The terminology often used in relation to barriers etc. in these contexts differs a little from terminology used in other connections. In Section 9 we distinguish between barriers, barrier functions, barrier elements and controllable factors. In official investigations it is common to use a single concept: "barrier", with the following wide interpretation: "all systematic, physical and administrative forms of protection found in the organisation and the individual workplace to prevent the occurrence of, or to limit the consequences of, failures and erroneous actions". Examples of barriers using this interpretation are rules and safety systems, procedures, guidelines etc.

With a view to identifying barrier failures, we have studied 93 of the 267 events (34.8 %) in 2002, 131 of the 254 events (51.6 %) in 2003, 90 of the 279 events (32 %) in 2004, 175 of the 282 events (62 %) in 2005 and 198 of the 318 events (62 %) in 2007. The evaluations are based on reported barrier failures and a study of investigation reports.

An overview of barrier failures for falling objects in the period 2002-2007 is shown in Figure 27. The dominant causes of events in 2007 are the following:

- Working practice/individual factor
- Work organisation
- Work environment
- Company management/platform organisation
- Ergonomics – poor technique

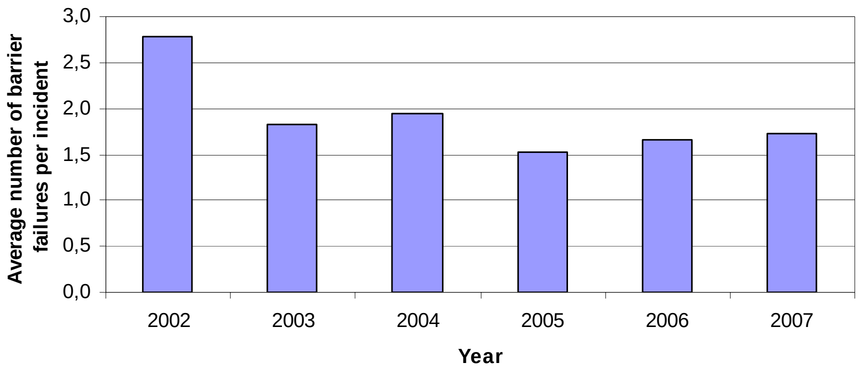

Figure 27 Overview of barrier failures in relation to DFU21 falling object, 2002-2007

"Working practice/individual factor" covers failure to follow procedure or deviation from procedure, lack of preparation and individual checking, and individual factors such as fatigue, illness, motivation etc. This showed a marked increase in 2006 but in 2007 is back on a level with the other years. There is reason to believe that the high number in 2006 is mainly due to the difficulty of classifying barrier failures clearly. This applies particularly to barrier failures reported through the project, and where no formal investigation has taken place.

"Work organisation" covers lack of planning, lack of preparation, insufficient time for preparation and implementation etc.

"Company management/platform organisation" refers to e.g. lack of maintenance programmes, quality assurance programmes and test programmes, lack of experience transfer or risk analysis, etc. "Work environment" refers to inadequate lighting or poor visibility, inadequate cleaning, cramped or stressful working conditions, uncomfortable temperature or humidity, strong wind or high waves or high sound level. In 2007 many events were reported giving strong wind as a cause of the occurrence.

"Ergonomics – poor technique" refers to poor (written) instructions/lack of instructions, poor marking/lack of marking of components, poor accessibility, poor ergonomics or design. The highest percentage of events in this category can be related to technical design.

12.2 Other DFUs

In the Main Report we present data events reported to the PSA, and for the following remaining DFUs, which do not have major accident potential:

- DFU10 Damage to subsea production facilities/pipeline systems/diving equipment caused by fishing gear
- DFU11 Evacuation (precautionary/emergency evacuation)
- DFU13 Man overboard
- DFU16 Total blackout
- DFU18 Diving accident
- DFU19 H_2S release

For the first two DFUs and DFU18 data are accessible from 1996, from 1990 for DFU13, for the other DFUs from 2001 onwards only.

13. Recommendations for Further Work

The basis for the next phase of the project, which will take place in the period medio 2008 – medio 2009 and include data for 2008, will be the work completed in the present phase. The methods used in the project are subject to constant review with the aim of continued application. Special activities in the next phase will include the following:

- Seek to implement indicators for the external environment
- Extend barrier indicators to cover maintenance-related factors

14. Definitions and Abbreviations

14.1 Definitions

See Subsections 1.9.1 - 1.9.3 and 6.2 in the Main Report.

14.2 Abbreviations

For a detailed list of abbreviations see PSA, 2007: Trends in Risk Levels on the Norwegian Continental Shelf, Report from current phase 24.4.2008. The most important abbreviations used in this report are as follows:

CODAM	Database for damage to structures and subsea installations
DDRS/CDRS	Database for drilling and well operations
DFU	Defined situations of hazard and accident
DSYS	Database for injuries and exposure time in diving activities
FAR	Fatal Accident Rate (see Subsection 1.9.3 in the Phase 7 report)
HCLIP	HC Leak and Ignition Project [database]

HES	Health, environment and safety
HPHT	High pressure, high temperature [wells]
MTO	Man, Technology and Organisation
NPD	The Norwegian Petroleum Directorate
PIP	Database for injuries and manhours on production and mobile units
PLL	Potential Loss of Life (see Subsection 1.9.3 in the Phase 7 report)
PSA	The Petroleum Safety Authority
SfS	Working together for Safety
SFT	Pollution Control Authority
VSKTB	The activity's specific requirements for preparedness (efficiency requirements)

15. References

For a detailed reference list, see the following:

Ptil-08-04. Risk Levels in the petroleum activity, Main report, Norwegian Continental Shelf, 2007, 24.4.2008

Ptil-08-05. Risk Levels in the petroleum activity, Onshore Facilities, 2007, 24.4.2008