2018

SUMMARY REPORT

THE NORWEGIAN CONTINENTAL SHELF 2018

TRENDS IN RISK LEVEL IN THE PETROLEUM ACTIVITY

Foreword

Trends in the risk level in the petroleum activities concern all parties involved in the industry, as well as the general public. RNNP is an important tool for helping to establish a common picture of the trends in selected conditions that affect risk. RNNP is consequently of particular importance for interaction between the social partners within the petroleum activities, which in turn makes their shared ownership of the process and the results important.

The petroleum industry has considerable HSE expertise, and this expertise is a critical success factor for an activity such as RNNP. We are therefore pleased to acknowledge the active contribution to this work of the industry participants, as well as key personnel from operating companies, vessel owners, helicopter operators, consultancies, research and teaching.

Stavanger, 10 April 2019

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Technical Director, PSA

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1. Objective and limitations

1.1 Purpose

The "Trends in risk level on the Norwegian Continental Shelf" project started in the year 2000. The Norwegian petroleum activities have gradually evolved from a developmental phase to a phase dominated by operation of petroleum facilities. There is now a strong focus on cost reductions in the industry. The player landscape is also changing.

The industry has traditionally used a selection of indicators to illustrate safety trends in the petroleum activities. Indicators based on the frequency of lost-time incidents have been particularly widespread. It is generally accepted that this only covers a small part of the overall safety picture. In recent years, the industry has used more indicators to measure trends. For the parties in the industry, it is important to establish methods for measuring the impact of the industry's overall safety work.

In this report, the Petroleum Safety Authority Norway wishes to set out a description of key factors that affect risk based on sets of information and data from the activities, in order to allow key aspects of the impact of the overall safety work in the activities to be measured.

1.2 Objective

The objective of the work is to:

- Measure the impact of the industry's HSE work.
- Contribute to identifying areas that are critical for HSE and where the effort to identify causes must be prioritised in order to prevent undesirable incidents and accidents.
- Increase insight into potential causes of accidents and their relative significance for the risk profile, to provide better decision support for the industry and authorities concerning preventive safety and emergency preparedness planning.

The work may also contribute to identifying focus areas for amending regulations, as well as research and development.

1.3 Key limitations

In this report, the spotlight is on personal risk, which here includes major accidents and occupational accidents. Reactive and proactive indicators of both a qualitative and a quantitative nature are employed.

The work is restricted to matters included in the PSA's area of authority as regards safety and the working environment. All passenger transport by helicopter is also included, in cooperation with the Civil Aviation Authority Norway and the helicopter operators on the Norwegian Continental Shelf (NCS). The following areas are covered:

- All production and mobile facilities on the NCS, including subsea facilities.
- Passenger transport by helicopter between the helicopter terminals and the facilities.
- Use of vessels within the safety zone around the facilities.

Onshore installations in the PSA's administrative area are included as of 1 January 2006. Data collection started from this date, since when separate reports have been published. Outcomes and analyses for onshore installations and the results from these installations are not included in this summary report. Since 2010, an annual report has been published, with the spotlight on acute spills to sea from offshore petroleum activities. The next report concerning acute spills is expected during the autumn of 2019.

2. Conclusions

Through RNNP, we seek to measure trends in safety, the working environment and the external environment using a series of indicators. The basis for the evaluations is the triangulation principle, i.e. assessing developments by using several instruments to measure trends in factors that affect risk.

Trends are the main focus. In an indicator-based model, it is to be expected that some indicators, particularly within areas with relatively few near-misses, will sometimes display large annual variations. A positive trend in the number of near-misses may indicate that the industry’s risk-management efforts are having an effect, but it provides no guarantee that future incidents will be avoided. Consequently, the petroleum industry, especially in the light of the Norwegian Parliament’s ambition for the Norwegian petroleum activities to be world-leading in HSE, should maintain a constant focus on the effective management of conditions that affect risk.

During 2018, a questionnaire-based survey was conducted, aimed at personnel directly involved in diving on the NCS. The questionnaire was designed through a collaboration of industry participants, STAMI (the Norwegian National Institute of Occupational Health) and the PSA.

Data for indicators for noise, chemical exposure and ergonomic risk factors are not reported for 2018 since the preparation of new indicators is taking longer than expected. As of spring 2018, industry participants are in the process of developing such indicators.

Ideally, it should be possible to reach a summary conclusion on the basis of information from all the measurement instruments used. In practice, this is complicated, for example because the information used reflects HSE conditions at levels that may be very diverse. This report particularly examines conditions associated with:

- Major accidents, including helicopter-related accidents
- Selected barriers associated with major accidents
- Serious personal injuries
- HSE climate and the working environment

Major accidents

No major accidents, meaning accidents resulting in several fatalities, were recorded in 2018. The last major accident in the industry, the Turøy helicopter crash on 29 April 2016, in which 13 people died, made its mark on the industry and clearly shows that the petroleum activities include major accident risks that require a continuous focus on effective risk management.

As in 2017, in 2018 there were no near-misses or incidents of exceptional severity in terms of their major accident potential.

The number of near-misses with major accident potential has exhibited an underlying positive (downward) trend since 2002. In 2018, there were 31 such incidents (helicopter incidents excluded). Such a low number of incidents of this type has not previously been registered in the period covered by RNNP. Once the number of incidents has been normalised against working hours, the frequency in 2018 is significantly lower than the average for the period 2008 to 2017. Statistically speaking, this means that the reduction in the period is real to a high level of probability (90%).

For most of the indicators relating to near-misses with major accident potential, fewer than five incidents per year are now recorded. With such a low number, a certain annual variation ascribable to randomness must be expected. Seven non-ignited hydrocarbon leaks were registered in 2018 (10 in 2017). This is the second-lowest number of this type of incident recorded. It is now five years since a hydrocarbon leak above 10kg/s was recorded. In 2018, there were 14 well-control incidents, 13 of which were in the lowest risk category, while one was in the medium risk category. When the number of well-control incidents is normalised against the number of wells drilled, the number of well kicks per well is within the expected range in 2018. In 2018, 6 instances of damage to structures and maritime systems that meet the damage criteria used in RNNP were registered. There were five such instances in 2017.

If the near-misses with major accident potential are weighted by factors that identify their inherent potential for causing fatalities were they to develop further, we can see that the indicator (the total indicator) in 2018 is at its lowest ever level. The 2018 level is statistically significantly lower than the average for the period 2008-2017. In line with the number of near-misses, the total indicator shows an underlying positive (falling) trend since 2000. Since particularly serious incidents are assigned a relatively high risk weighting, the annually variation in the total indicator is large, but the positive trend is obvious. The total indicator is a constructed indicator that reflects the industry's ability to influence a series of risk-related factors. Due to its nature, the indicator is sensitive to especially serious near-misses, since these are given a relatively high weighting. The focus should therefore be on the underlying trend and any changes in it.

Helicopter risk constitutes a relatively large share of the overall risk exposure of workers on the NCS. The purpose of the risk indicators used in this work is to capture the risk connected with relevant incidents and to identify opportunities for improvement.

For the period in which RNNP has collected helicopter-related data, the Turøy accident in 2016 is the only helicopter accident involving a fatality that falls within the scope of the study.

In the helicopter expert group's assessment of incidents in 2018, one incident was identified within the most serious category. The expert group assessed that there was one remaining barrier in respect of this incident. The incident concerned movements on the helideck. This indicator incorporates few incidents per year and is therefore sensitive to relatively large annual variations. It is important that lessons learned from such incidents are actively used to reduce risk.

In 2018, there was one incident linked to the use of a service operation vessel (SOV). This occurred during testing of hook-up to a normally unmanned facility. The incident caused some material damage, but its potential did not cause it to be classified as an incident in the context of RNNP.

Barriers

The industry is increasingly using indicators capable of describing robustness in terms of withstanding incidents – so-called leading indicators. Barrier indicators are an example of these. This type of indicator reveals something about the barriers' ability to function when called upon. The barrier indicators continue to show that there are major differences in levels between the facilities. Over time, for many barriers there is a positive trend that exceeds the industry's self-defined requirements. The negative trend that was observed for deluge valves and leak tests for wing and master valves in 2017 continued in 2018. For the vast majority of barrier elements, the results for 2018 are better than the industry's self-defined requirements. This may mean that the focus in recent years on barrier management in the industry is also yielding results within this area.

Maintenance management data has been collected for ten years.

The data for the *fixed facilities* shows that the overall backlog in preventive maintenance has increased from 2017 to 2018, and this includes HSE-critical backlogs. The backlog for HSE-critical preventive maintenance is among the highest levels reported since 2011.

In RNNP, we request the data for the total corrective maintenance not performed and the corrective maintenance not performed in accordance with the participants' own deadlines.

The figures show that there is a considerable number of hours of total corrective maintenance not performed at 31 December 2018, and this is a significant increase over previous years.

There is a slight increase in the number of hours of total outstanding corrective maintenance for 2018 compared with the year before. The total outstanding HSE-critical corrective maintenance is on a par with the last four years.

For the *mobile facilities*, the data shows that there is large variation in the degree of tagging and classification of their systems and equipment. Some facilities have a large proportion of tagged equipment that is not classified.

The data shows large variations in the backlog of preventive maintenance. This corresponds to what we have seen in recent years. Several facilities have not performed HSE-critical preventive maintenance in accordance with the companies' own deadlines.

The data shows variations in outstanding corrective maintenance. This corresponds to what we have seen in recent years. Several facilities have not performed HSE-critical corrective maintenance in accordance with their own deadlines.

Work accidents involving fatalities and serious personal injuries
In 2018, 193 reportable personal injuries were recorded on the NCS. 204 such injuries were reported in 2017. 25 of these were classified as serious in 2018, against 29 in 2017.

In the period 2008 to 2013, there was a decline in the serious personal injury rate. This rate varies somewhat from 2014 to 2018. From 2017 to 2018, there is a reduction from 0.9 serious personal injuries per million working hours to 0.6 in 2018. The change is not statistically significant viewed against the preceding 10-year period. The reduction from 2017 to 2018 occurred on both mobile and production facilities.

Questionnaire-based survey – diving personnel
In 2018, for the first time, diving personnel were invited to participate in the RNNP questionnaire-based survey. Most of the survey questions are the same as in the main survey, but diving personnel were also asked certain questions that concerned them alone. Since it is not possible to compare the results with those from previous surveys of the same group, we have chosen to compare them with the results from offshore personnel (2017), where possible. Due to the very disparate sample sizes, differences were not tested for statistical significance. Differences in the results should therefore be considered with a degree of caution.

The results for the diver-specific questions show that divers are more positive than their supervisors in assessing different working environment factors related to work on the NCS. The divers have the most positive attitude towards using NORSOK saturation/decompression tables. Overall, the length of saturation periods and the length of stays on board are considered the most negative (of a total of seven factors). When asked about the perceived risks of various diving-related conditions/situations, divers assess the risks as being higher than do the supervisors, for the following conditions/situations: gas cut, human/mechanical failure during diving operations (two questions), personal diving equipment (including bail-out system), fatigue and failure of automated/manual control systems (two questions). The divers were asked about their own safety behaviour during diving, and this was considered to be relatively positive.

Some of the results deal with questions and topics where it is possible to compare with offshore personnel (2017). Seven indices were constructed, summarizing the results for the HSE climate, and diving personnel had better results than offshore personnel (2017) for five of these. In respect of the working environment, the results are more inconsistent, but diving personnel have slightly better results for workload than offshore personnel (2017). Diving personnel assess the risk of various hazard and accident situations as higher than offshore personnel (2017). Concerning sleep, the experience of overall sleep quality (index of three questions) is inferior for diving personnel than for offshore personnel (2017).

Diving personnel state that they had lower sickness absence (both short-term and long-term) than offshore personnel (2017). They also report fewer health complaints, but the pattern in the most widespread complaints is similar to that of offshore personnel (2017). The assessment of own health is better than among offshore personnel (2017). It is possible that differences between the groups are due to the stricter health requirements for diving personnel than for offshore workers as a whole, but the sample is too small to support too much speculation about the results.

Field study – Perceptions of changes and safety implications in the petroleum industry

The survey results from 2015 to 2017 showed a negative trend in workers' assessment of the HSE climate, perceived risk and a series of working environment indicators. Furthermore, this negative trend could largely be attributed to groups of workers who had experienced downsizing or reorganisation. On the basis of the changes that occurred in the RNNP survey data, a qualitative study was instigated with a view to improving the industry's knowledge of what caused the changes in the results and how they can be understood and acted on.

The study was conducted as a field study, using both semi-structured interviews and participant observation at the informant's place of work. Offshore, the investigation comprised five facilities, of which three were fixed production facilities with drilling activities and two were mobile facilities. The areas covered by the study were drilling and wells (D & W) and operation and maintenance (O & M) (including scaffolding, insulation and painting).

Main findings

This qualitative study shows that employees within both O & M and D & W express uncertainty and worry over whether changes in recent years have had unintended negative impacts on risk and the working environment.

Within drilling and wells, the following factors are considered by the informants to be directly or indirectly risk-promoting:

- Cost-cutting and downsizing
- Perceived poor handling of KPIs
- Lack of facility-specific competence
- Challenges associated with management of change (MOC)
- Negative trend in collaboration between offshore and onshore
- Reduced maintenance

Within operation and maintenance, the informants consider the following factors to be directly or indirectly risk-promoting:

- Ageing and degradation of facilities
- Increased time pressure and/or workload for certain job categories
- Changes to the maintenance programmes and impaired quality of maintenance
- Replacement and downsizing of personnel and weakening of technical and facility-specific competence
- Increased decision-making authority, but reduced capacity and competence, onshore
- Undercommunication of incidents with major accident potential
- Altered contract terms for M&M suppliers

Broadly speaking, the factors that the informants describe correspond with the areas in the questionnaire-based survey with the greatest decline in 2017.

Challenges for the petroleum industry.

This study points up challenges in the sector that may have negative safety impacts.
These include:

- Reduced confidence in the interaction between different groups of participants
- Downsizing, replacement and rotation of personnel
- Use of KPIs
- Unintended consequences of changes to maintenance programmes and the organisation of maintenance

The primary challenge this represents is that it is unclear whether uncertainties and new knowledge of actual consequences of changes are adequately assessed in terms of their potential HSE implications.

3. Work undertaken

The work in 2018 is a continuation of activities performed in 2000-2017; see previous reports on our website (www.ptil.no/rnnp). The most important elements in the work were:

- The work on analysing and evaluating data concerning defined hazard and accident situations has been continued, both on the facilities and for helicopter transport.
- The questionnaire-based survey conducted for diving personnel
- Perform a qualitative study to improve the industry's knowledge of what caused the changes in the results of the questionnaire-based survey.
- Improve the model for barrier performance in relation to major accidents.
- Data from onshore installations have been analysed and presented in a separate report.
- Data on acute spills to sea and potential spills to sea are undergoing analysis, and will be presented in a separate report.
- Evaluate correlations in the datasets.

3.1 Performance of the work

The work on this year's report began in January 2018. The following organisations and people participated:

• Petroleum Safety Authority Norway:	Responsible for execution and further development of the work
• Operating companies and shipowners:	Contribute data and information about activities on the facilities.
• The helicopter operators:	Contribute data and information about helicopter transport activities
• HSE specialist group: (selected specialists)	Evaluate the procedure, input data, viewpoints on the development, evaluate trends, propose conclusions
• Safety Forum: (multipartite)	Comment on the procedure, results and recommend further work.
• Advisory group: (multipartite)	Multipartite RNNP advisory group that advises the Petroleum Safety Authority regarding further development of the work.

The following external parties have assisted the Petroleum Safety Authority with specific assignments:

- Terje Dammen, Jorunn Seljelid, Torleif Veen, Irene Buan, Trine Holde, Jon Andreas Rismyhr, Trond Stillaug Johansen, Asbjørn Lein Aalberg, Kai Roger Jensen, Ragnar Aarø, Rolf Johan Bye, Ingrid Bjørkli Nilsen, Hans Laupsa and Signe Marie Hallan, Safetec
- Kari Kjestveit, Kari Anne Holte and Stian Brosvik Bayer, NORCE Norwegian Research Centre.
- The PSA's working group consists of: Øyvind Lauridsen, Mette Vintermyr, Tore Endresen, Arne Kvitrud, Narve Oma, Morten Langøy, Trond Sundby, Inger Danielsen, Elisabeth Lootz, Roar Høydal, Jan Ketil Moberg, Audun S. Kristoffersen, Hans Spilde, Semsudin Leto, Eivind Jåsund, Kenneth Skogen, Bente Hallan and Torleif Husebø.

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

- Øyvind Solberg, John Arild Gundersen, Norwegian Oil and Gas Association, represented by LFE
- Morten Haugseng, Nils Rune Kolnes, CHC Helikopter Service
- Neal Constable, Kjetil Heradstveit, Bristow Norway AS

Numerous other people have also contributed to the work.

3.2 Use of risk indicators

Data have been collected for hazard and accident situations associated with major accidents, work accidents and working environment factors, specifically:

- Defined hazard and accident situations, with the following main categories:
  - Uncontrolled discharges of hydrocarbons, fires (i.e. process leaks, well incidents/shallow gas, riser leaks and other fires)
  - Structure-related incidents (i.e. structural damage, collisions and risk of collision)
- Test data associated with the performance of barriers against major accidents on the facilities, including data concerning well status and maintenance management
- Accidents and incidents in helicopter transport
- Occupational accidents
- Diving accidents
- Other hazard and accident situations with consequences of a lesser extent or significance for emergency preparedness.

The term 'major accident' is used in many places in the reports. There are no unambiguous definitions of the term, but the following are often used, and coincide with the base definition employed in this report:

- A major accident is an accident (i.e. entails a loss) where at least three to five people may be exposed.
- A major accident is an accident caused by failure of one or more of the system's built-in safety and emergency preparedness barriers.

Viewed in light of the major accident definition in the Seveso II Directive and in the PSA's regulations, the definition used here is closer to a 'large accident'.

Data collection for the DFUs (defined hazard and accident conditions) related to major accidents is founded in part on existing databases in the Petroleum Safety Authority (CODAM, DDRS, etc.), but also to a significant degree on data collection carried out in cooperation with the operating companies and shipowners. All incident data have been quality-assured by, for example, checking them against the incident register and other databases of the PSA.

Feil! Fant ikke referansekilden. shows an overview of the 20 DFUs, and which data sources have been used. The industry has used the same categories for registering data through databases such as Synergi.

3.3 Developments in the activity level

Figure 1 and Figure 2 show the developments over the period from 2000 to 2018 for production and exploration activities, of the parameters used for normalisation against the activity level (all figures are relative to the year 2000, which has been defined as 1.0). Appendix A to the main report (PSA, 2019a) presents the underlying data in detail.

Table 1 Overview of DFUs and data sources

DFU no.	*DFU description*	*Data sources*
1	Unignited hydrocarbon leak	Data collection*
2	Ignited hydrocarbon leak	Data collection*
3	Well incident/loss of well control	DDRS/CDRS + incident reports (PSA)
4	Fire/explosion in other areas, combustible liquid	Data collection*
5	Ship on collision course	Data collection*
6	Drifting object	Data collection*
7	Collision with field-related vessel/facility/shuttle tanker	CODAM (PSA)

DFU no.	*DFU description*	*Data sources*
8	Damage to platform structure/stability/anchoring/positioning fault	CODAM (PDA) + the industry
9	Leak from riser, pipeline and subsea production facility**	CODAM (PSA)
10	Damage to riser, pipeline and subsea production facility**	CODAM (PSA)
11	Evacuation***	Data collection*
12	Helicopter crash/emergency landing on/near facility	Data collection*
13	Man over board	Data collection*
14	Personal injury	PIP (PSA)
15	Work-related illness	Data collection*
16	Full loss of power	Data collection*
18	Diving accident	DSYS (PSA)
19	H_2S emission	Data collection*
20	Crane and lifting operations	Data collection*
21	Falling object	Data collection*

* Data collection is carried out in cooperation with the operating companies
** Also includes wellstream pipeline, loading buoy and loading hose where relevant.
*** These incidents are principally major-accident-related, but are not used in this way in the present work. Only incidents that have caused an actual evacuation (by lifeboat) are counted, i.e. not precautionary evacuations.

There was an increase of 16% in working hours on production facilities in 2018 compared with 2017. For mobile facilities, there was increase of around 18% over the previous year. The number of drilled exploration and production wells also increased significantly.

Production volume declined somewhat relative to 2017, after having shown a regular increase from the lowest level in 2013.

A presentation of DFUs or contributors to risk can sometimes vary according to whether absolute or "normalised" values are stated, depending on the normalisation parameter. In the main, normalised values are presented.

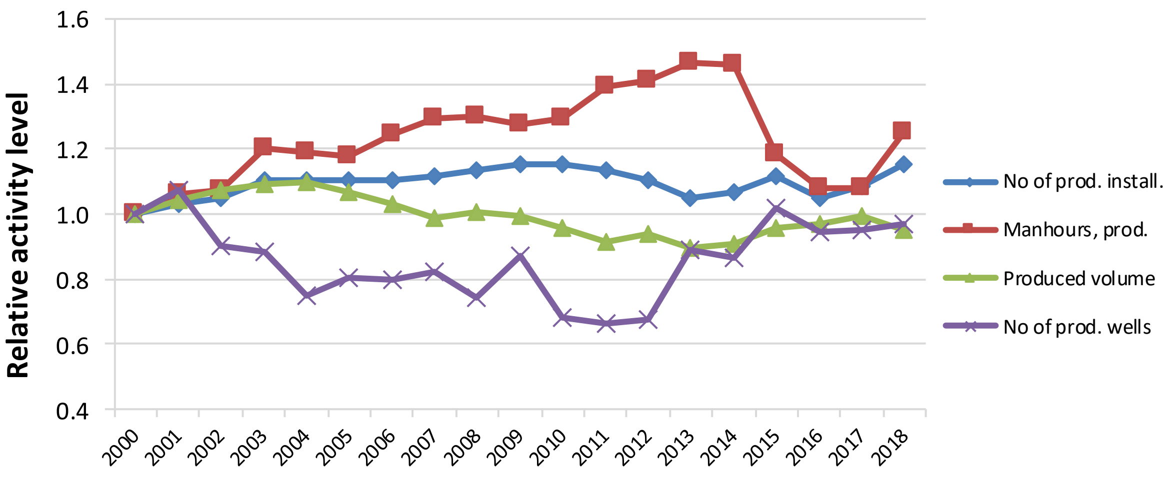


Figure 1 Relative trend in activity level for production facilities. Normalised against the year 2000

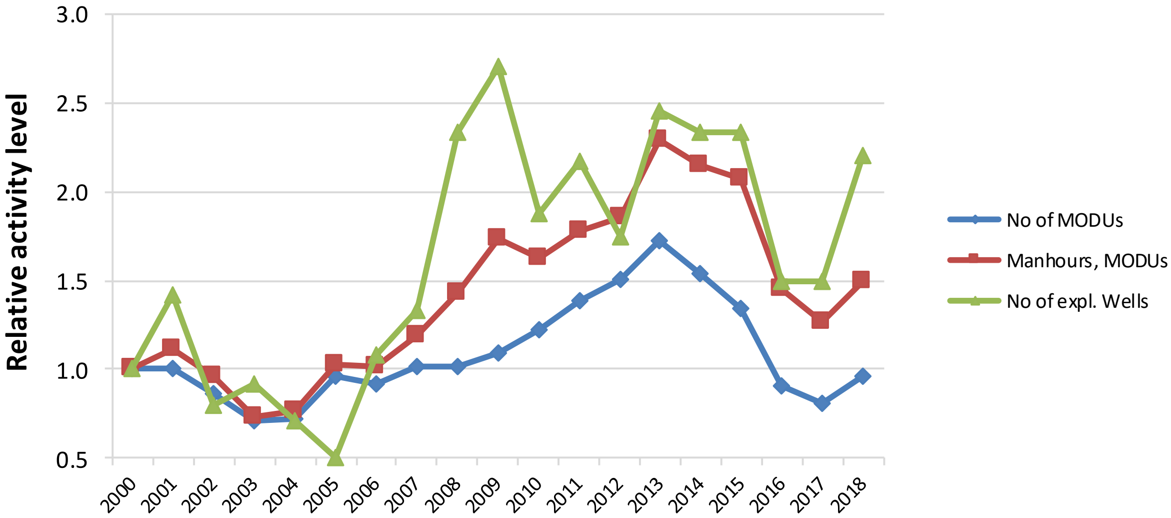


Figure 2 Relative trend in activity level for mobile facilities. Normalised against the year 2000

A corresponding activity overview for helicopter transport is shown in sub-chapter 4.1.

3.4 Documentation

Analyses, assessments and results are documented as follows:

- Summary report – the Norwegian Continental Shelf for the year 2018 (Norwegian and English versions)
- Main report – the Norwegian Continental Shelf for the year 2018
- Report for onshore facilities for the year 2018
- Report for acute spills to sea for the Norwegian Continental Shelf 2018, to be published in the autumn of 2019
- Methodological report, 2019

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

4. Status and trends – helicopter incidents

The cooperation with the Civil Aviation Authority and the helicopter operators was continued in 2018. Aviation data obtained from helicopter operators involved includes incident type, risk class, severity, type of flight, phase, helicopter type and information about departure and arrival. The main report (PSA, 2019a) contains additional information about the scope, constraints and definitions.

In 2016, a helicopter crashed on its way to land at Turøy in Øygarden. 13 people perished in the accident. The previous fatal helicopter accident on the NCS occurred on a flight to the Norne field in 1997.

4.1 Activity indicators

Figure 3 shows activity indicator 1 (transport service) as the number of flight hours and the number of person flight hours, and activity indicator 2 (shuttle traffic) as the number of flight hours and number of passengers per year in the period 2000-2018.

TRANSPORT SERVICE

SHUTTLE TRAFFIC

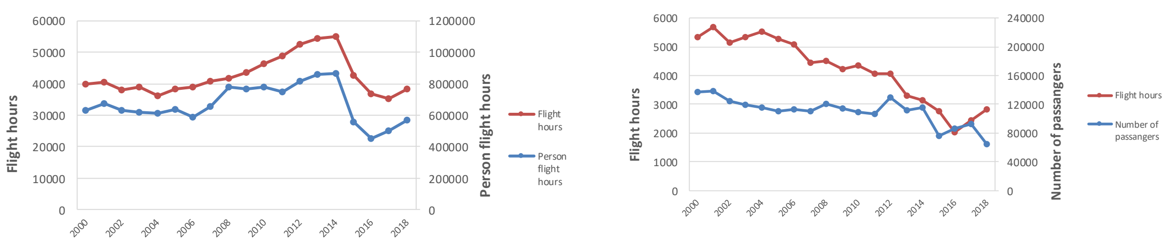


Figure 3 Flight hours and person flight hours (transport service) and number of passengers (shuttle traffic), 2000-2018

Flight hours in the transport service per year must be viewed in the context of the activity level on the NCS; see main report. From 2014 to 2016, the number of passengers fell by 40%, the number of person flight hours fell by 47%, while the number of working hours fell by 28%. In principle, there is a constant need for transport per working hour. The declines in both flight hours and person flight hours apparent in the indicator are however greater than implied by the fall in working hours.

Shuttle traffic comprises passenger transport in which the helicopter's departure and arrival relate to a single facility. The fact that the number of passengers showed only a weak fall in the period 2000-2018, while the number of flight hours more than halved is explained by the helicopters carrying more passengers on each shuttle and shuttling shorter distances and with fewer stopovers. Since 2016 there has been a rise in both transport and shuttling hours.

4.2 Incident indicators

4.2.1 Incident indicator 1 – serious incidents and near-misses

Figure 4 shows the number of incidents included in incident indicator 1. From 2009 (and subsequently for 2006, 2007 and 2008), the most serious near-misses which the companies reported were reviewed by an expert group consisting of operational and technical personnel from the helicopter operators, from the oil companies and from the PSA's project group in order to classify the incidents based on the following categories:

Little remaining safety margin against fatal accident: *No remaining barriers*
Medium remaining safety margin against fatal accident: *One remaining barrier*
Large remaining safety margin against fatal accident: *Two (or more) remaining barriers.*

In the expert group's assessment of incidents for 2018, there were two incidents with no remaining barriers and two incidents with one remaining barrier. There was one incident relating to helicopter deck movement, where the pilots were told that the helideck movements were in the green zone. After landing they discovered that the movements were outside permitted limits.

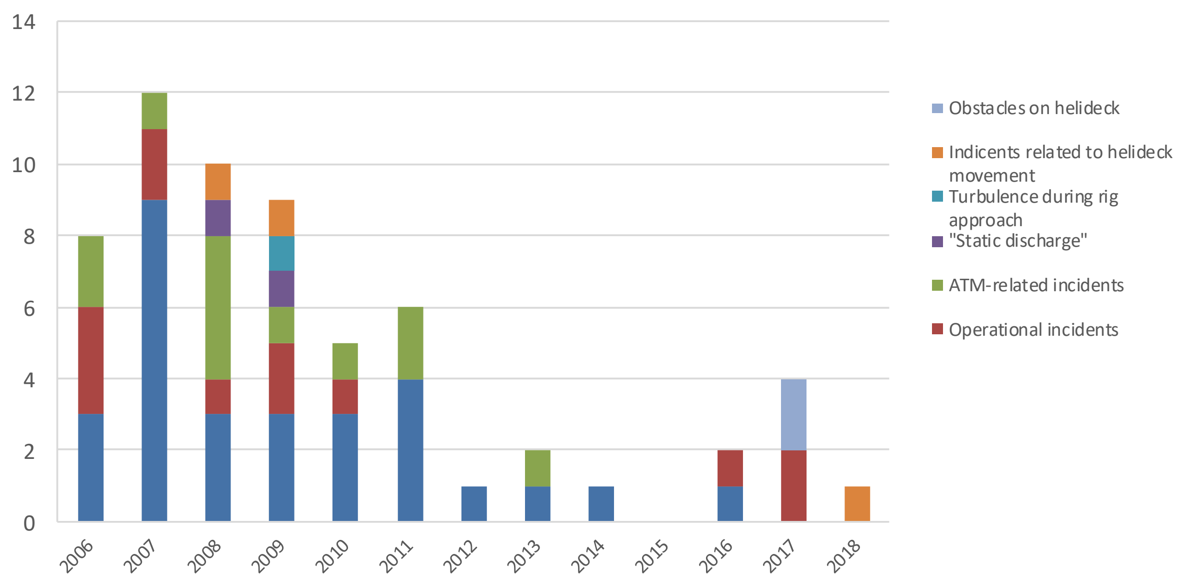


Figure 4 Incident indicator 1, incidents with little or medium remaining safety margin, 2006-2018

4.2.2 Incident indicators linked to causal categories

As of 2009, there are three incident indicators based on causal categories, with the following content:

- Incident indicator 3:
  Helideck factors:
  - Incorrect information about position of helideck
  - Incorrect/missing information
  - Equipment failure
  - Turbulence
  - Obstacles in approach/departure sectors or on deck
  - Persons in restricted sector
  - Breach of procedures
  - Other
- Incident indicator 4:
  ATM aspects (air traffic management)
- Incident indicator 5:
  Bird strikes.

As of 2018, incident indicator 5: Bird strikes is omitted. All degrees of severity beyond "no impact on safety" are included in these indicators. Figure 5 shows the number of incidents included in incident indicator 3, helideck factors. The increase in the number of incidents for helidecks in 2015 corresponds to the general increase in incidents in incident indicator 2 in that year. In all the years, there has been a preponderance of incidents on mobile facilities.

Figure 6 shows the number of incidents included in incident indicator 4, ATM aspects. Incidents included in incident indicator 4 rose sharply from 2010 to 2011, occurring in conjunction with an increased focus on deficient radio communication, which was the absolute largest single contributor to incident indicator 4 in 2011. In 2018, there were several incidents involving unidentified aircraft associated with the Trident Juncture military exercises. All the incidents in indicator 4 were classified with the lowest severity rating.

In 2018, six previous improvement suggestions were closed and three new improvement suggestions were opened:

17 *The helicopter operators and the operators on the NCS must jointly investigate opportunities to achieve continuous dataflows to the helicopter in flight, so that information about weather, turbulence, waves and movement can be communicated direct to the pilots without having to do this by radio with the potential for failure and errors that this entails.*

18 *Under the present system, the Petroleum Safety Authority Norway, the Norwegian Maritime Directorate and the Civil Aviation Authority Norway are responsible for different factors offshore that affect helicopter traffic. These supervisory authorities are responsible to different ministries and it would be desirable for collaboration between them to be closer and more formalised, to make it easier to communicate and follow up challenges that involve more than one of the parties.*

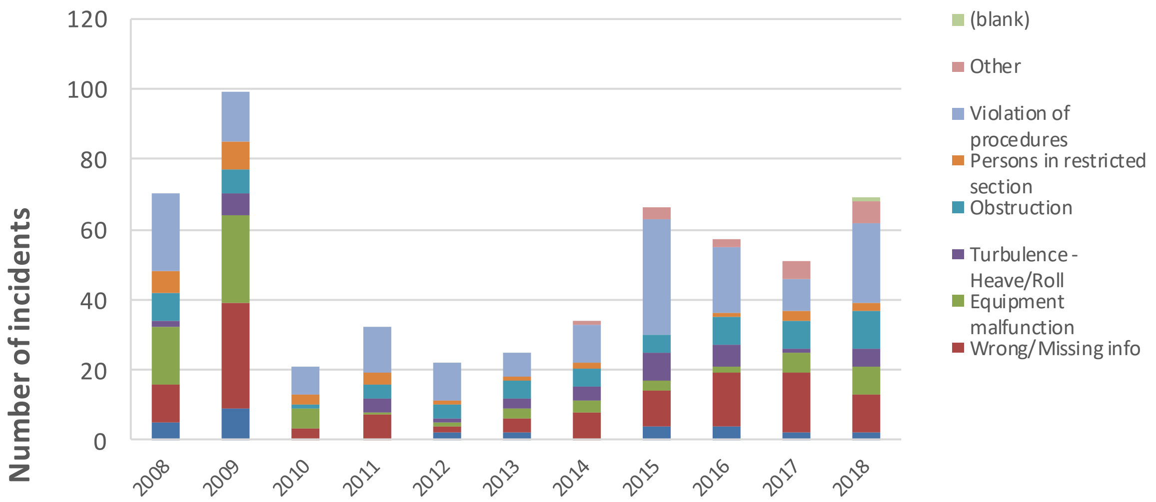


Figure 5 Helideck factors, 2008-2018

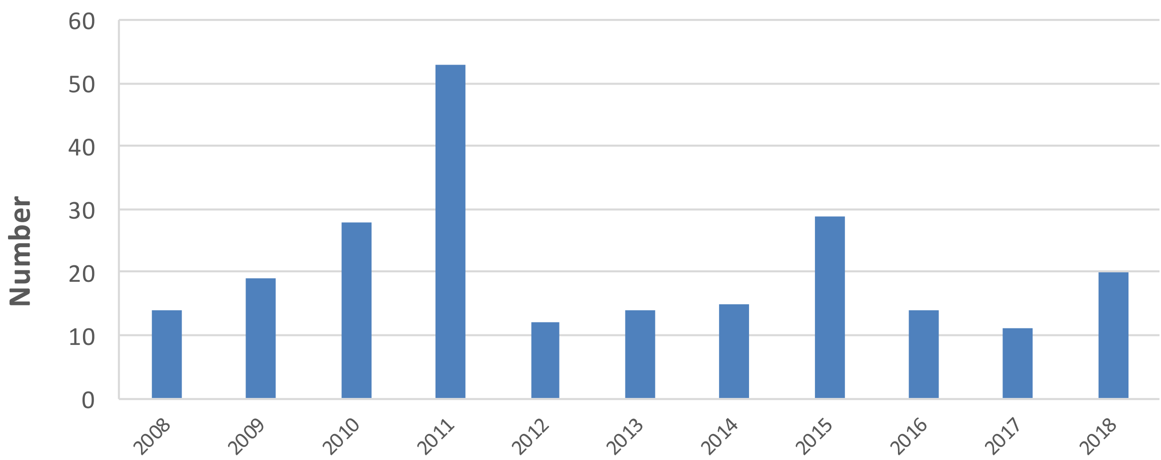


Figure 6 ATM aspects, 2008-2018

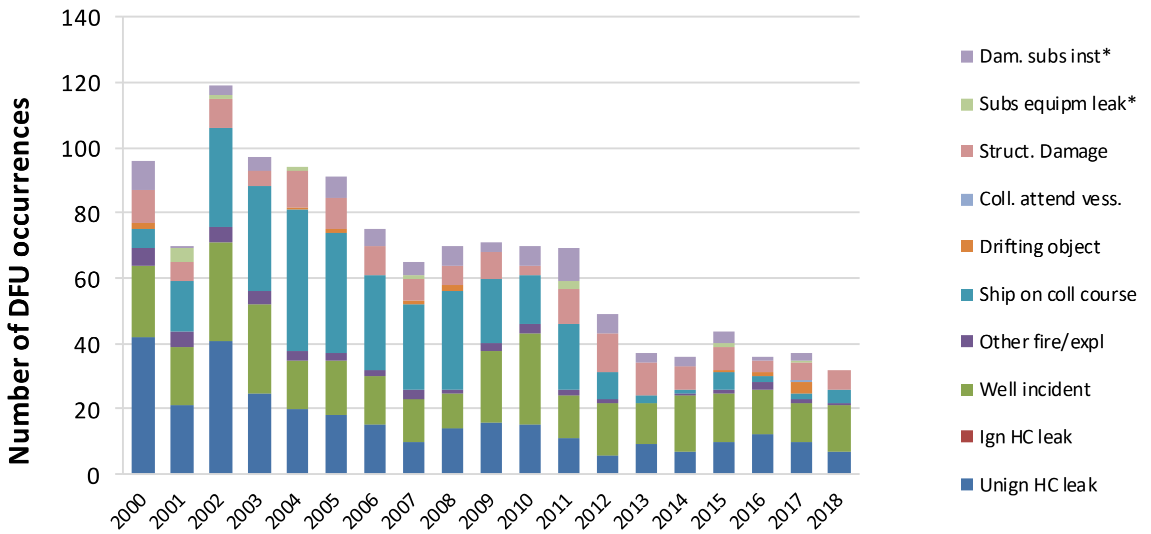
5. Status and trends – indicators for major accidents on facilities

The indicators for major accident risk from previous years have been continued, with a primary emphasis on indicators for incidents and near-misses with the potential for causing a major accident (DFU1-10). The indicators for DFU12, helicopter incidents, are presented separately in chapter 4. Barriers against major accidents are presented in chapter 6.

There have been no major accidents, per the definition used in the report, on facilities on the NCS since 1990. The serious incident on *COSL Innovator* where a wave stove in windows in an accommodation section, injuring four and killing one person, is categorised as a construction incident and is the first major accident DFU to have caused a fatality in the period 2000-2018. The last time there were any fatalities in connection with one of these major accident DFUs was in 1985, with a shallow gas blowout on the *West Vanguard* mobile facility. Added to this are the Norne and Turøy helicopter accidents in 1987 and 2016.

5.1 DFUs associated with major accident risk

Figure 7 shows the trend in the number of reported DFUs in the period 2004-2018. It is important to emphasise that this figure does not take account of the potential of near-misses in respect of loss of life. There was a rising trend in the number of incidents during the period 1996-2000, which has been discussed in previous years' reports and is therefore omitted from the figure. After an apparent peak in the number of incidents in 2002, there is a gradual reduction in the number of incidents with major accident potential. Since 2013, the number of incidents of this type has been relatively stable per year. There was a small peak in 2015, but the number of incidents in 2018 is the lowest recorded in the period.



*Within the safety zone

Figure 7 Reported DFUs (1-10) by categories

In Figure 7, the number of incidents is presented without normalisation relative to exposure data. Figure 8 shows the same overview, but now normalised against number of working hours. The 2018 level is statistically significantly lower than the average for the period 2007-2017.

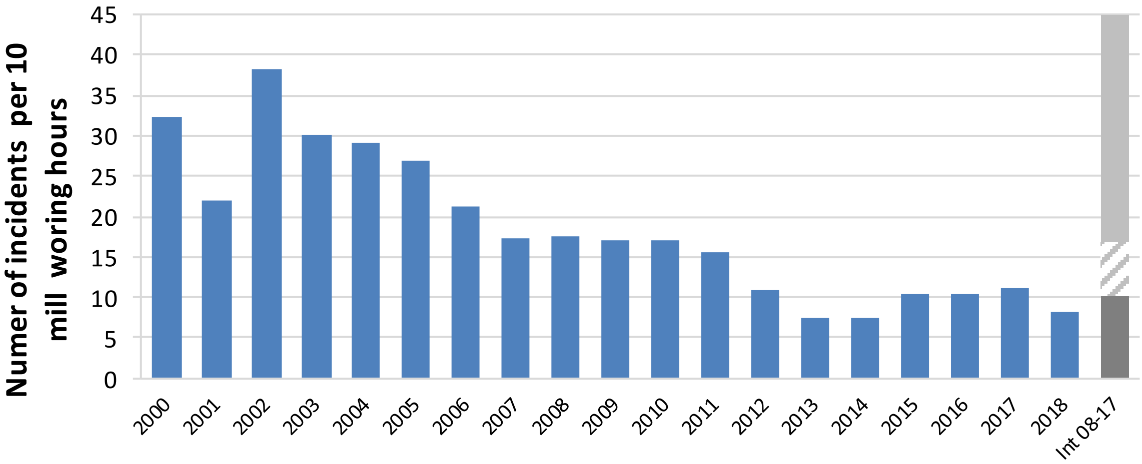


Figure 8 Total number of DFU1-10 incidents normalised against working hours

5.2 Risk indicators for major accidents

5.2.1 Hydrogen leak in the process area

Figure 9 shows the number of hydrocarbon leaks greater than 0.1 kg/s in the period 2000-2018. Seven hydrocarbon leaks greater than 0.1 kg/s were registered in 2018, of which two were in the 1-10 kg/s category, while five were in the 0.1-1 kg/s category.

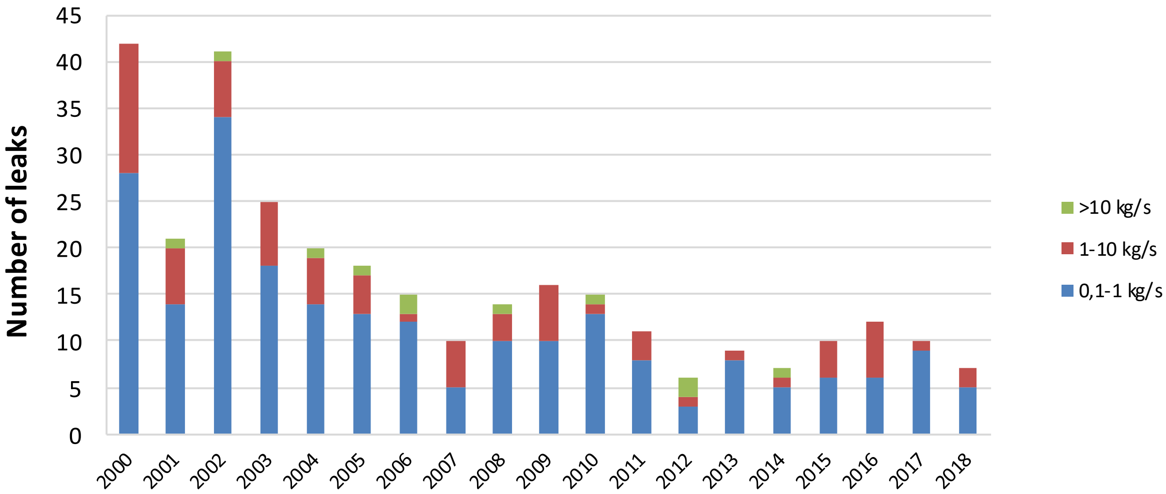


Figure 9 Number of hydrocarbon leaks exceeding 0.1 kg/s, 2000-2018

Figure 10 shows the number of leaks when these are weighted according to the risk potential they are assessed as having. In simple terms, one can say that the risk contribution of each leak is roughly proportional to the leak rate expressed in kg/s. The increase in the risk contribution in 2018 is due to one more incident in the 1-10 kg/s category than in 2017.

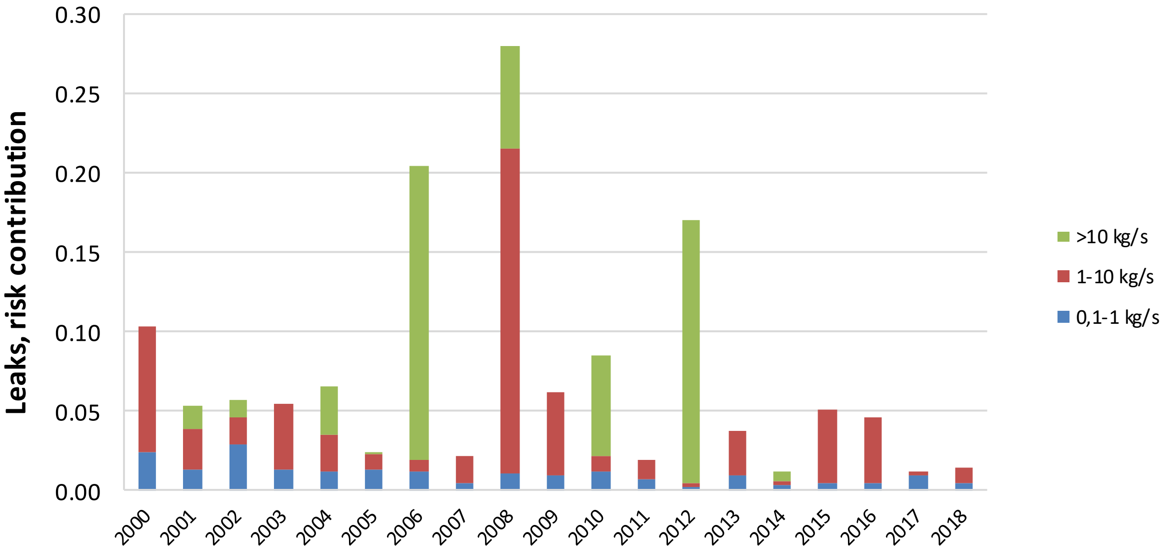


Figure 10 Number of hydrocarbon leaks exceeding 0.1 kg/s, 2000-2018, weighted according to risk potential

Figure 11 shows the trend in leaks exceeding 0.1 kg/s, normalised against working hours for production facilities. The figure illustrates the technique used throughout to assess the statistical significance (validity) of trends. Figure 11 shows that, despite the number of leaks per facility year, in 2018 this parameter lies within the prediction interval. The change is therefore not statistically significant relative to the average for the period 2008-2017. The number of leaks has been normalised both against working hours and against the number of facilities in the main report.

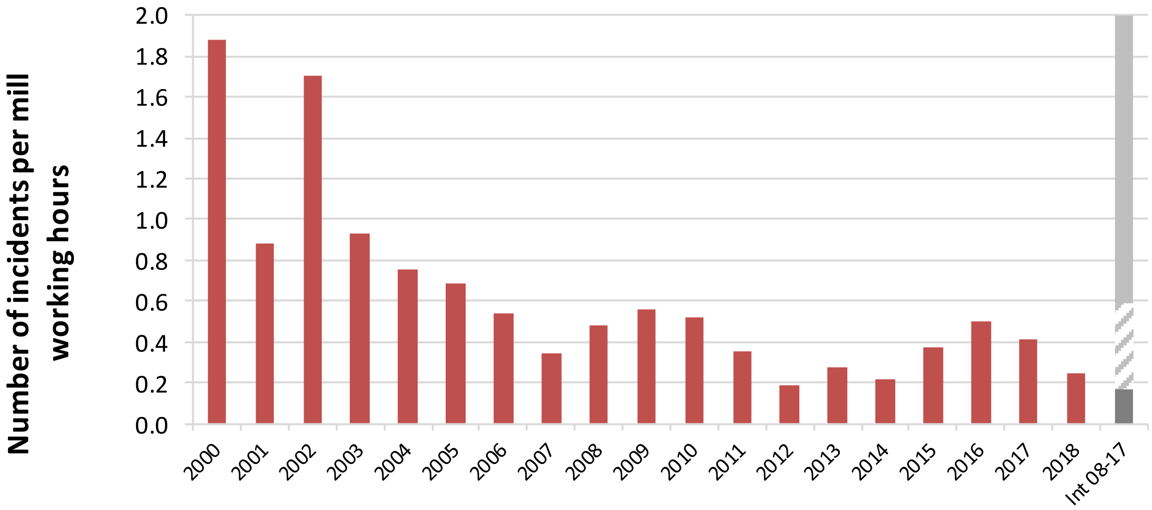


Figure 11 Trend, leaks, normalised against working hours

5.2.2 Loss of well control, blowout potential, well integrity

Figure 12 shows well control incidents broken down by exploration drilling and production drilling, normalised per 100 drilled wells.

For exploration drilling, there were major variations throughout the period. In 2016 and 2017, no well control incidents were registered in exploration drilling, whereas, in 2018, these reappeared. Usually, most incidents are associated with production drilling, but, in 2018, we observed for the first time since 2015 that most incidents came from exploration drilling.

There was an increase in the number of incidents in production drilling from 2013 to 2016, but in 2017 and 2018 the number fell from year to year. Thirteen of the well control events in 2018 are classified as being at level 3, low severity, while one event is classified as severe (level 2).

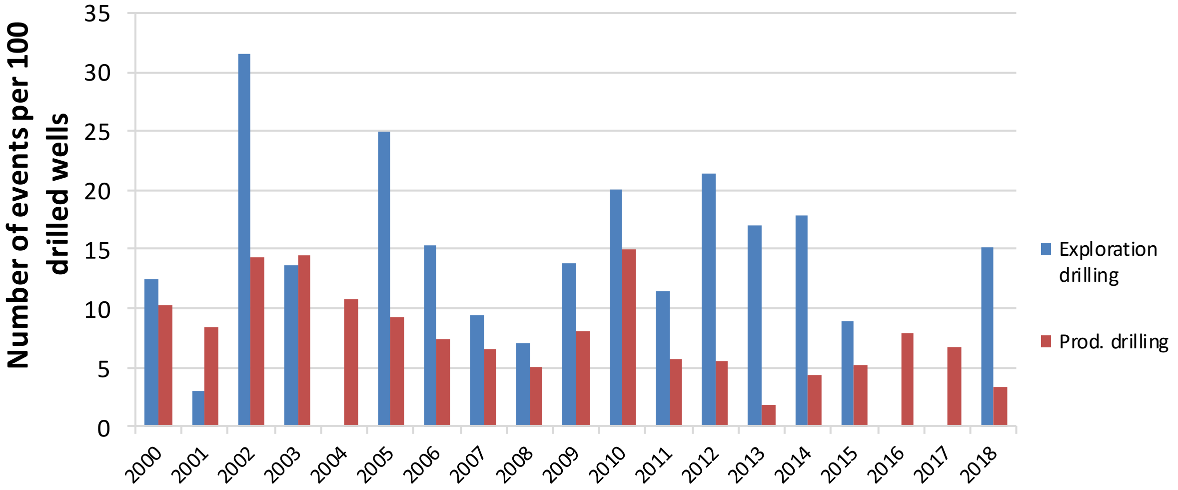


Figure 12 Well incidents per 100 wells drilled, for exploration and production drilling

Figure 13 shows the trend in weighted risk of loss of life normalised against working hours in the observation period for exploration and production drilling combined. The figure shows that, in 2018, there was a low risk associated with well-control incidents.

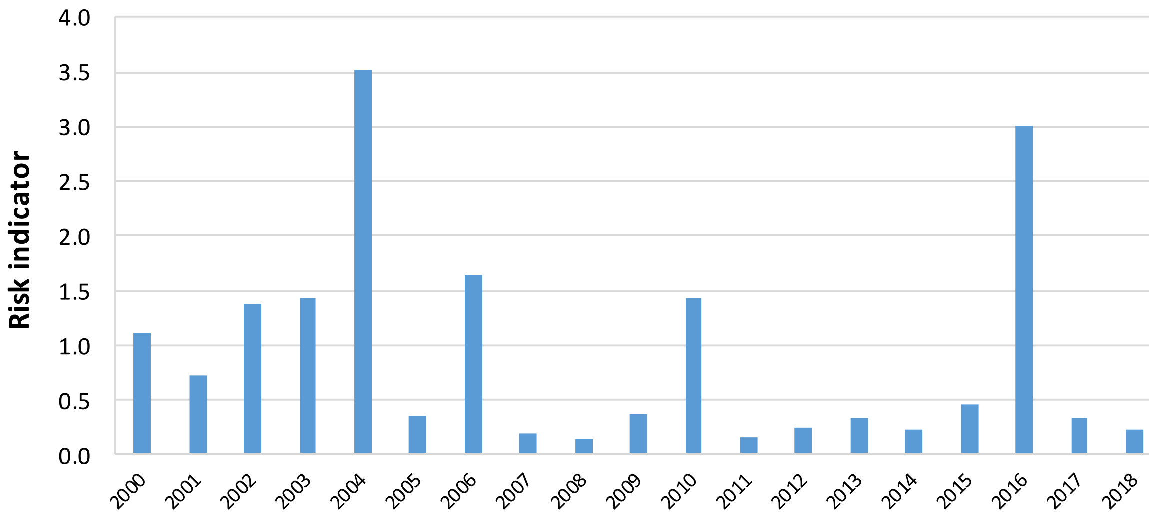


Figure 13 Risk indicators for well-control incidents in exploration and production drilling, 2000-2018

In 2007, the Well Integrity Forum (WIF) established a pilot project for key performance indicators (KPIs) for well integrity. The operating companies have reviewed all their "active" wells on the NCS, a total of 1995 wells in 2018, with the exception of exploration wells and permanently plugged wells (a total of 13 operating companies). This was first reported in accordance with WIF's list of well categories in 2008, based on current definitions and subgroups per category. WIF uses the following well categories;

Red: one barrier failed and the other is degraded/not verified or has external leaks

Orange: one barrier failed and the other is intact, or a single failure could cause a leak to surroundings

Yellow: one barrier leaks within the acceptance criteria or the barrier has been degraded, the other is intact
Green: intact well, no or insignificant integrity aspects.

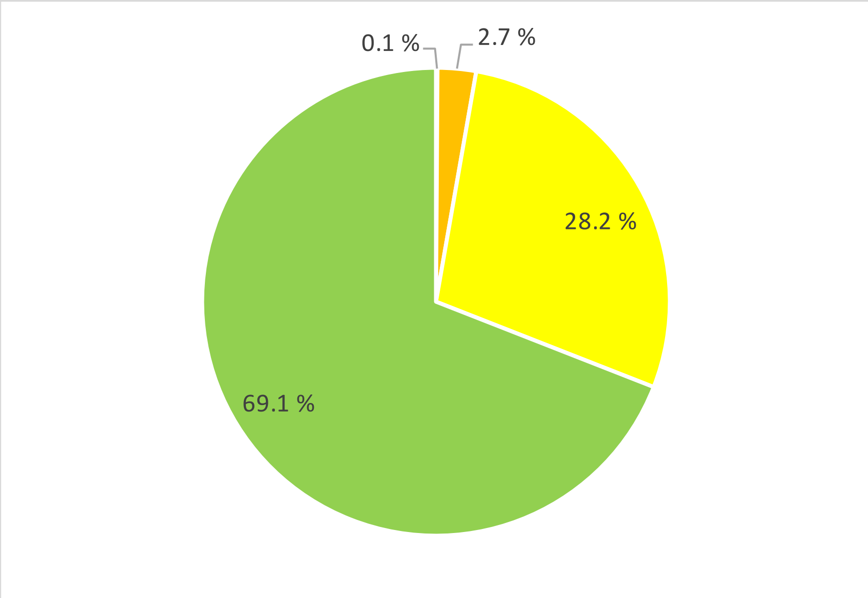


Figure 14 Well categories

The mapping shows an overview of well categories distributed according to the percentage of the total sample of 1995 wells.

The categorisation shows that around 30% of the wells included in the mapping have degrees of weakness of integrity. Wells in the red and orange categories have reduced quality in respect of the two-barrier requirement. Two wells (0.1%) were recorded in the red category and 53 wells (2.7%) in the orange category. Wells in the yellow category have reduced quality in respect of the requirement for two barriers, but the companies have compensated for this through various measures such that they are deemed to comply with the two-barrier requirement. There are 562 wells (28.2%) in the yellow category.

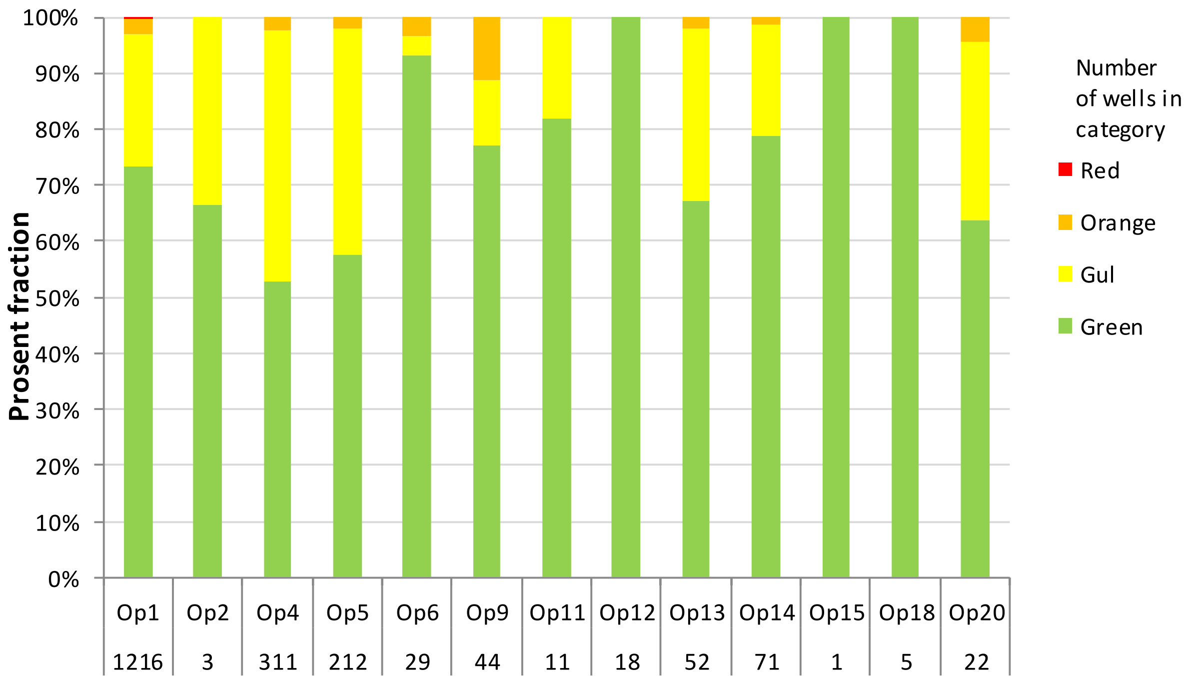


Figure 15 Development in well categories, 2009-2018

5.2.3 Leak/damage to risers, pipelines and subsea facilities

In 2018, no leaks from risers on production facilities were reported. Nor were any leaks from pipelines reported in 2018. Four leaks from subsea production facilities were reported in 2018. They were primarily located at wells and templates. Figure 16 shows an overview of the number of leaks from 2000 to 2018.

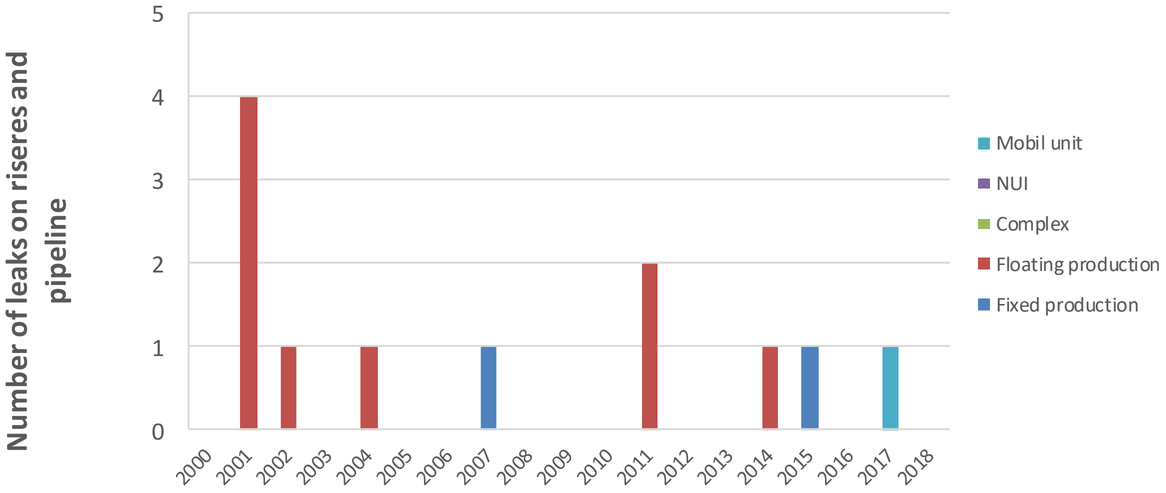


Figure 16 Number of leaks from risers & pipelines within the safety zone, 2000-2018

In 2018, there were no instances of serious damage to pipelines and risers, or to subsea facilities.

Serious damage to risers and pipelines is included in the calculation of the total indicator, but with a lower weighting than for leaks. Figure 17 shows an overview of the most serious incidents of damage within the safety zone during the period 2000-2018.

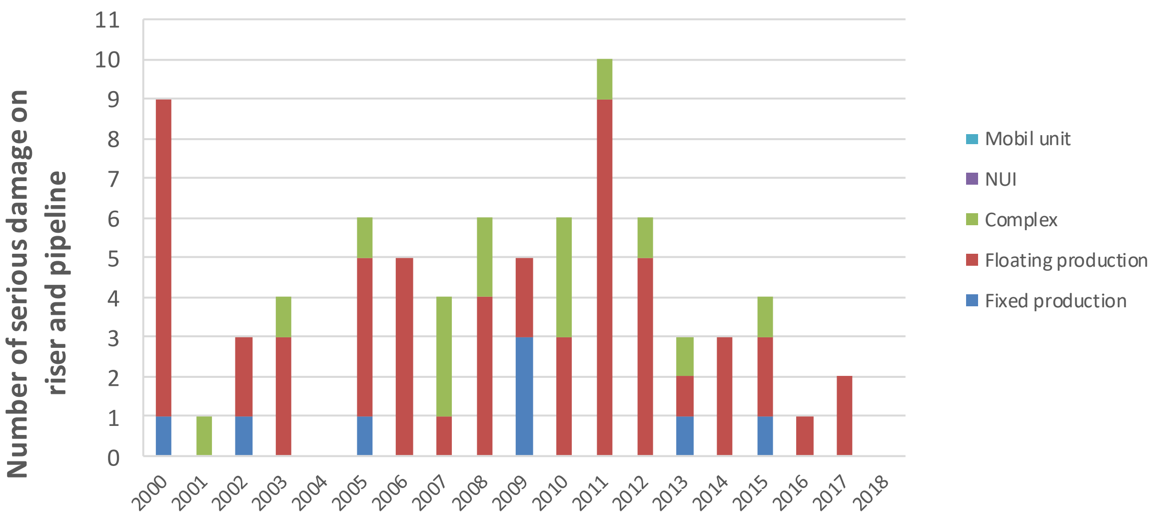


Figure 17 Number of incidents involving serious damage to risers & pipelines within the safety zone, 2000-2018

5.2.4 Ships on collision course, structural damage

There are only a few production facilities and just a few more mobile facilities where the facility itself or the standby vessel are responsible for monitoring passing ships on a potential collision course. The others are monitored from the traffic control centres at Ekofisk and Sandsli.

The indicator for ships on potential collision courses is normalised according to the number of facilities monitored from the traffic centre at Sandsli, expressed as the total number of monitoring days for all facilities monitored by Equinor Marine at Sandsli. The number of instances of ships on collision courses has declined substantially in recent years. In 2018, a total of four ships on collision courses were recorded.

As regards collisions between vessels associated with the petroleum activities and facilities on the NCS, there was an elevated level in 1999 and 2000 (15 incidents each year). Equinor in particular has worked hard to reduce such incidents, and in recent years, the number has been around two to three per year, while in 2018 there were no collisions.

Major accidents associated with structures and maritime systems are rare. Even though there have been several very serious incidents in Norway, there are too few to gauge trends. Accordingly, incidents and damage of lesser severity have been selected as measures of changes in risk. It is also assumed that there is a connection between the number of minor incidents and the most serious; see the methodology report.

The current regulations set requirements for flotels and production facilities in terms of withstanding the loss of two anchor lines without serious consequences. Loss of more than one anchor line happens from time to time. This may have major consequences, but rarely as huge as on *Ocean Vanguard* in 2004. Mobile drilling facilities are required to withstand the loss of one anchor line without undesirable consequences.

Structural damage and incidents that have been included in RNNP are primarily classified as fatigue damage, and some are storm damage. As regards cracks, only continuous structural cracks are included. No clear connection has been demonstrated between the age of the facility and the number of cracks. The number of DFU8 incidents during the period 2000-2018 is shown in Figure 18.

In 2018, six structural damage incidents were recorded. It should be noted that incidents for floating facilities for 2017 have been adjusted upwards, due to late reception of reporting in CODAM.

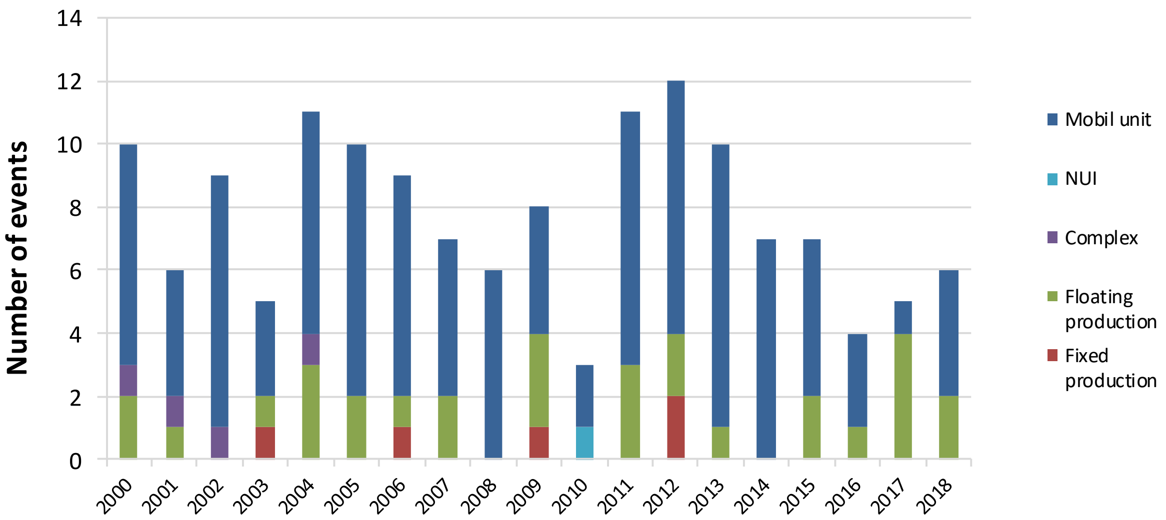


Figure 18 Number of serious incidents and incidents involving damage to structures and maritime systems which conform to the criteria for DFU8

5.3 Total indicator for major accidents

The total indicator is a calculated indicator based on incident frequency and the potential of the incidents to cause loss of life if they develop into major accidents. The total indicator is limited to incidents on board facilities, while risk associated with helicopter transport is discussed in chapter 4. It is emphasised that this indicator is only a supplement to the individual indicators, and expresses the development in risk factors related to major accidents. In other words, the indicator expresses the effects of risk management.

The total indicator weights the contributions from the observations of the individual DFUs according to the potential for loss of life (see the pilot project report), and will therefore vary considerably, based on the potential of the individual incidents. Figure 20 shows the indicator for production facilities with annual values and three-year rolling average. The large annual variations are reduced when viewing the three-year rolling average, which clarifies the long-term trend. Working hours are used for normalising against activity level. The level of the normalised value was set at 100 in the year 2000, which also applies to the value for the three-year rolling average.

Figure 19 shows that the total indicator for 2018 is the lowest for the entire period.

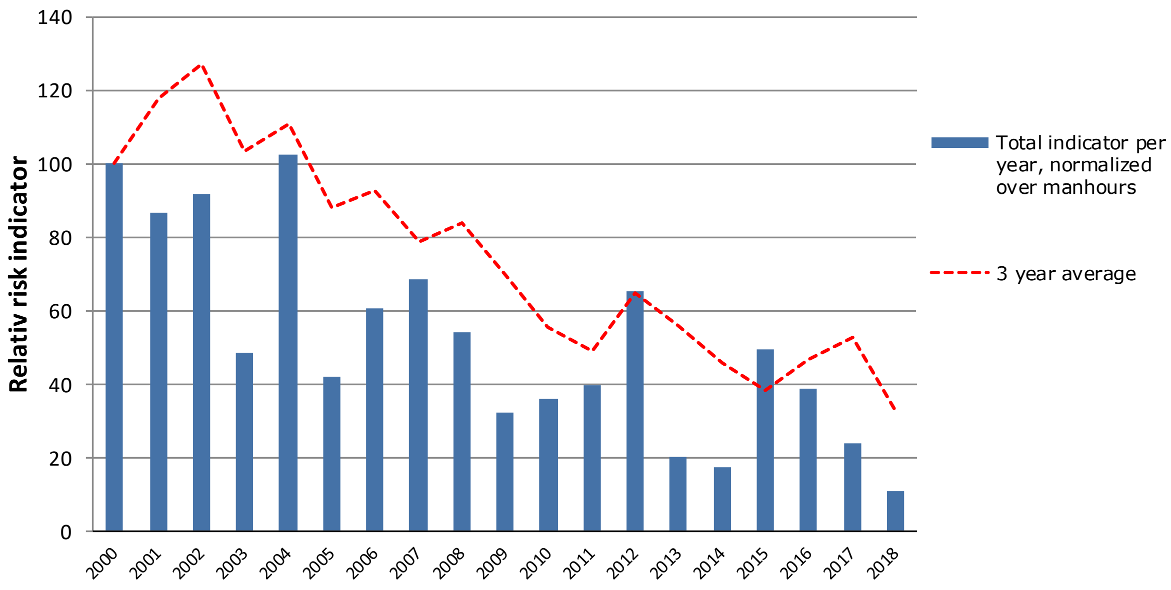


Figure 19 Total indicator for major accidents per year, normalised against working hours, annual values and three-year rolling average (the reference value is 100 for year 2000, for both the total indicator and three-year rolling average)

The three-year rolling average clearly shows a positive trend in the period from 2002. The trend can be interpreted to mean that, in the period, the participants have achieved better management of factors that affect major accident risk. The annual values show larger variations, which are mainly due to especially serious incidents. This can also be taken as an indication that factors that affect future risk must be given keen focus and active management.

Figures 20 and 21 show the total indicator for production facilities and mobile facilities respectively.

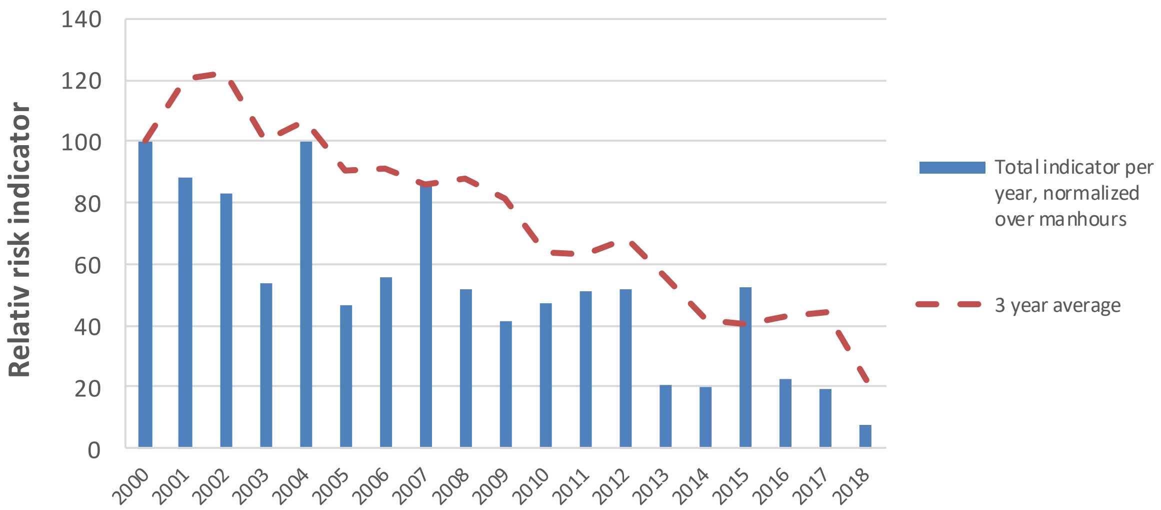


Figure 20 ***Total indicator, production facilities normalised against working hours, annual values and three-year rolling average (the reference value is 100 for year 2000, for both the total indicator and three-year rolling average)***

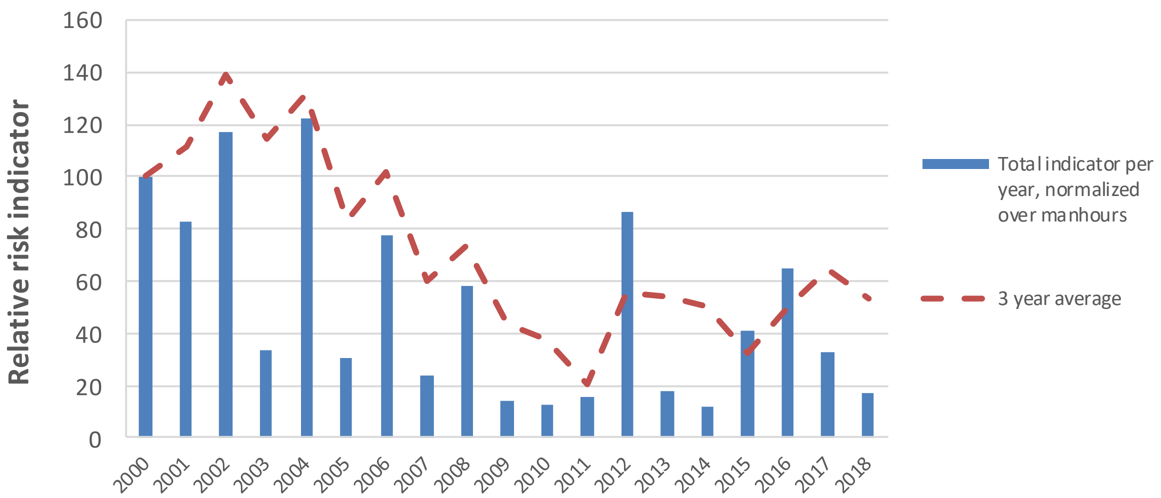


Figure 21 ***Total indicator, mobile facilities normalised against working hours, annual values and three-year rolling average (the reference value is 100 for year 2000, for both the total indicator and three-year rolling average)***

6. Status and trends – barriers against major accidents

Reporting and analysis of data concerning barriers has been continued from preceding years without significant adjustments. As previously, the companies report test data from routine periodic testing of selected barrier elements.

6.1 Barriers in the production and process facilities

There is primary emphasis on barriers relating to leaks from the production and process facilities, including the following barrier functions:

- Integrity of hydrocarbon production and process facilities (covered to a considerable degree by the DFUs)
- Prevent ignition
- Reduce clouds/releases
- Prevent escalation
- Prevent any fatalities

The different barriers consist of several interacting barrier elements. For example, a leak must be detected before isolation of ignition sources and emergency shutdown (ESD) is implemented.

Figure 22 shows the proportion of failures for the barrier elements associated with production and processing. The test data are based on reports from all production operators on the NCS. In addition, the associated industry norm for each barrier element is shown.

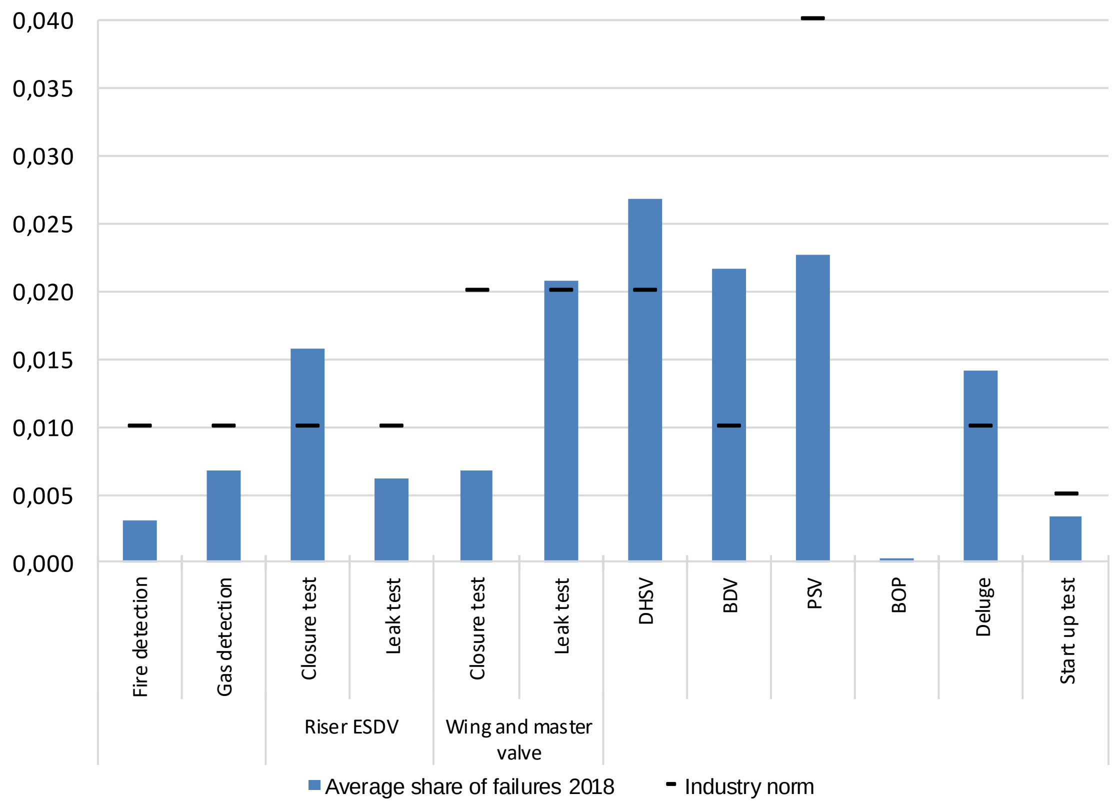


Figure 22 Mean percentage of failures for selected barrier elements in 2018

The main report shows both the "mean percentage of failures" (Figure 22), i.e. the percentage of failures for each facility individually, averaged for all facilities, and the "overall percentage of failures", i.e. the sum of all failures on all reporting facilities, divided by the sum of all tests for all reporting facilities. All facilities have the same contribution to the mean percentage of failures, regardless of how many tests they have.

The data show considerable variations in average levels for each of the operating companies, and for several of the barrier elements. The variations are even greater when looking at each individual facility, as has been done for all barrier elements in the main report. Figure 23 shows an example of such a comparison for gas detection (all types of gas detectors). Each individual facility is assigned a letter code, and the figure shows the percentage of failures in 2018, the average percentage of failures during the period 2002-2018, as well as the total number of tests carried out in 2018 (as text on the X axis, along with the facility code).

The industry norm for gas detection is 0.01. Figure 23 shows that 11 facilities are above the norm for percentage failures in 2018, while 9 are above the norm in relation to the average for the period 2002-2018.

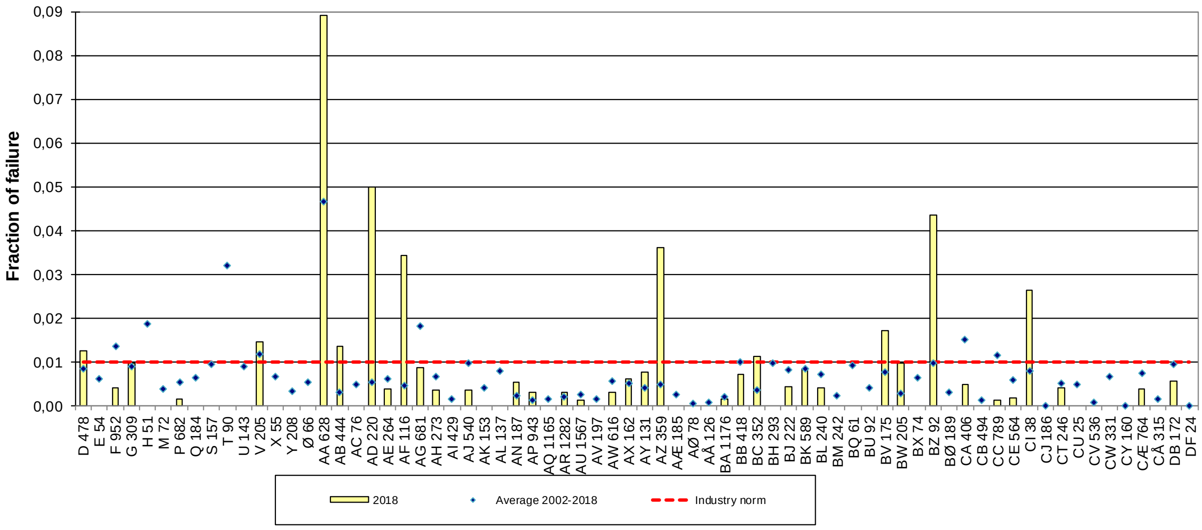


Figure 23   Percentage of gas detection failures

For production facilities, barrier data have now been collected for 17 years for most of the barriers, and the results show that there are large differences in level between the facilities. Figure 24 and Figure 25 compare the mean proportions of failures in three-year rolling averages from 2011 to 2018.

Figure 24 shows that fire detection, gas detection and start tests of fire pumps are consistently low and below the respective industry norms. Riser ESDV closure tests and BDV show falls from the start of the period up to 2015, but both exhibit a slightly rising trend from 2015 to 2018. Both are well above the industry norm of 0.01. The riser ESDV leak test and deluge show the opposite trend with a rise in the middle of the period and a fall after 2015. From 2016, both the riser ESDV leak test and the deluge are below the industry norm of 0.01.

Figure 25 shows that DHSV has a rising trend from 2012 to 2017 and flattens out in 2018. From 2013, it is above the industry norm of 0.02. Other barriers remain stably below applicable industry norms. The wing and master valve leak test has however a rising trend from 2012 to 2018. For the industry as a whole, a flat trend is apparent for most of the barriers in recent years. The wing and master valve leak test, BDV and deluge are the barrier elements showing the greatest change and, for these, the trend for the proportion of failures is rising.

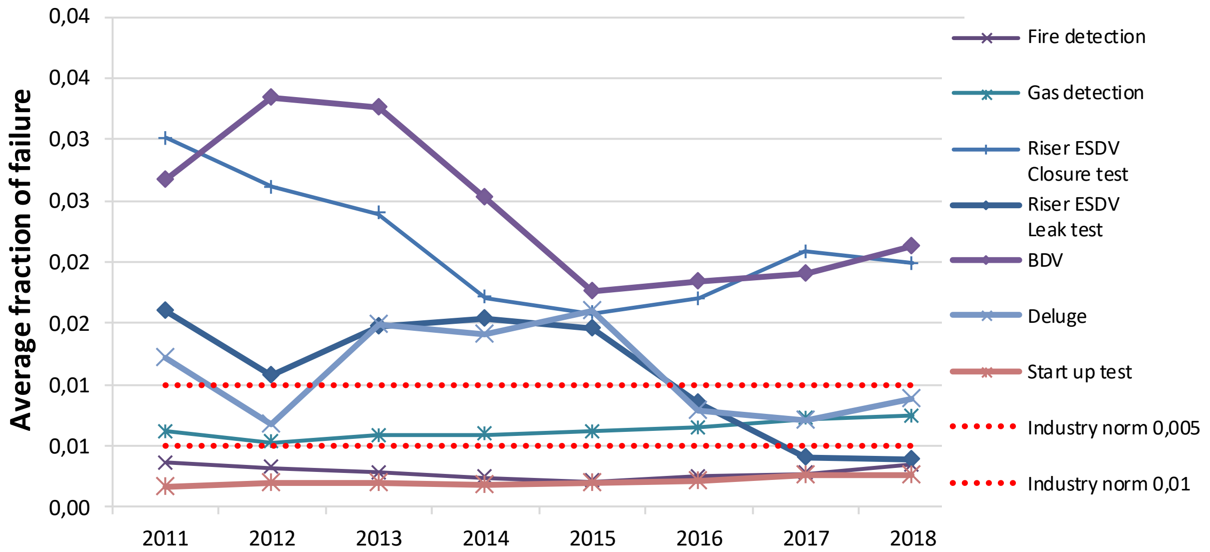


Figure 24 Mean percentage failures with a three-year rolling average

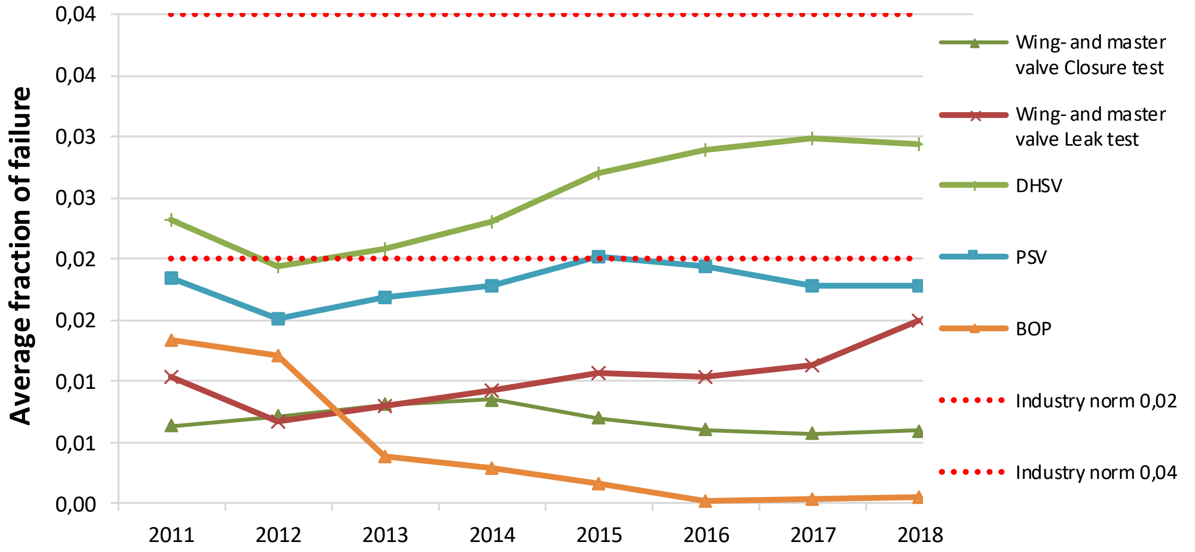


Figure 25 Mean percentage failures with a three-year rolling average

Feil! Fant ikke referansekilden. shows how many facilities have carried out tests for each barrier element, the total number of tests, the average number of tests for the facilities that have carried out tests, the overall percentage of failures and the mean percentage of failures for 2018 and for the period 2002-2018. This can then be compared with the industry norm for safety-critical systems. Figures in bold indicate that the percentage of failures exceeds the industry norm.

The table shows that, overall, most barrier elements are below or about on a par with the industry norm for availability. The average proportion of failures for 2018 and the average proportion of failures for 2002-2018 for riser ESDV closure tests, DHSVs, BDVs and deluge valves are above the industry norms. The riser ESDV leak tests are above the industry norms for the average proportion of failures for 2002-2018.

Table 2 General calculations and comparison with industry norms for barrier elements

Barrier elements	*Number of facilities where tests were performed in 2018*	*Average, number of tests, for facilities where tests were performed in 2018*	*Number of facilities with percentage failures in 2018 greater than the industry norm*	*Number of facilities with average percentage failures 2002-2018 greater than the industry norm*[1]*	*Total percentage failures in 2018*	*Mean percentage failures in 2018*	*Total percentage failures 2002-2018*	*Mean percentage failures 2002-2018*	*Industry norm for availability*
Fire detection	69	583	5	3	0,003	0,003	0,003	0,004	0,01
Gas detection	70	345	11	9	0,007	0,007	0,007	0,008	0,01
Shutdown:									
· Riser ESDV	60	26	13	29	**0,013**	0,009	**0,016**	**0,018**	0,01
Closure test	60	18	11	25	**0,018**	**0,016**	**0,014**	**0,019**	0,01
Leak test	60	8	2	15	0,004	0,006	**0,012**	**0,013**	0,01
· Wing and master (Christmas tree)	76	224	11	8	0,011	0,017	0,008	0,011	0,02
Closure test	73	109	4	3	0,006	0,007	0,006	0,007	0,02
Leak test	76	118	18	11	0,015	**0,021**	0,010	0,012	0,02
· DHSV	76	79	35	37	**0,040**	**0,027**	**0,027**	**0,024**	0,02
Blowdown valve (BDV)	62	61	25	43	**0,021**	**0,022**	**0,021**	**0,022**	0,01
Pressure safety valve (PSV)	67	136	8	12	0,016	0,023	0,029	0,024	0,04
Isolation using BOP	19	146			0,000	0,000	0,014	0,015	*[2]
Active fire safety:									
· Deluge valve	67	31	17	23	**0,014**	**0,014**	0,009	**0,011**	0,01
· Start test	58	92	7	12	0,002	0,003	0,003	0,003	0,005

6.2 Barriers associated with maritime systems

In 2018, data were collected for the following maritime barriers on mobile facilities:

- Watertight doors
- Valves in the ballast system
- Deck height (air gap) for jack-up facilities
- GM and KG margin values for floaters. The KG margin values have been collected as of 2015.

Data collection was carried out for both production and mobile facilities. There are considerable variations in the number of tests per facility, from daily tests to twice per year.

[1] For *closure tests* and *leak tests* for riser ESDVs and wing and master valves, the average is from 2007, for PSVs and BDVs, the average is from 2004.
[2] For isolation using BOP, there is no comparable industry norm, since this is not considered to be appropriate. It is recommend to follow up failure in this barrier using trend analysis.

6.3 Maintenance management

Defective or deficient maintenance has often proved to be a contributory cause of major accidents. The major accident potential means that safety work in general and the maintenance of safety-critical equipment in particular have been given much emphasis in the petroleum industry. One aim of such maintenance management is to identify critical functions and ensure that safety-critical barriers work when required.

Since 2010, we have collected data from industry participants in order to monitor trends in selected indicators. By gaining an overview of the present situation and trends over time, the industry and the authorities can more easily prioritise areas in the work going forward.

The individual participant is responsible for regulatory compliance and ensuring systematic HSE efforts, so as to reduce the risk of unwanted incidents and major accidents.

6.3.1 The management of maintenance of fixed facilities

The main report shows more graphs of participants' maintenance management figures than are reproduced here.

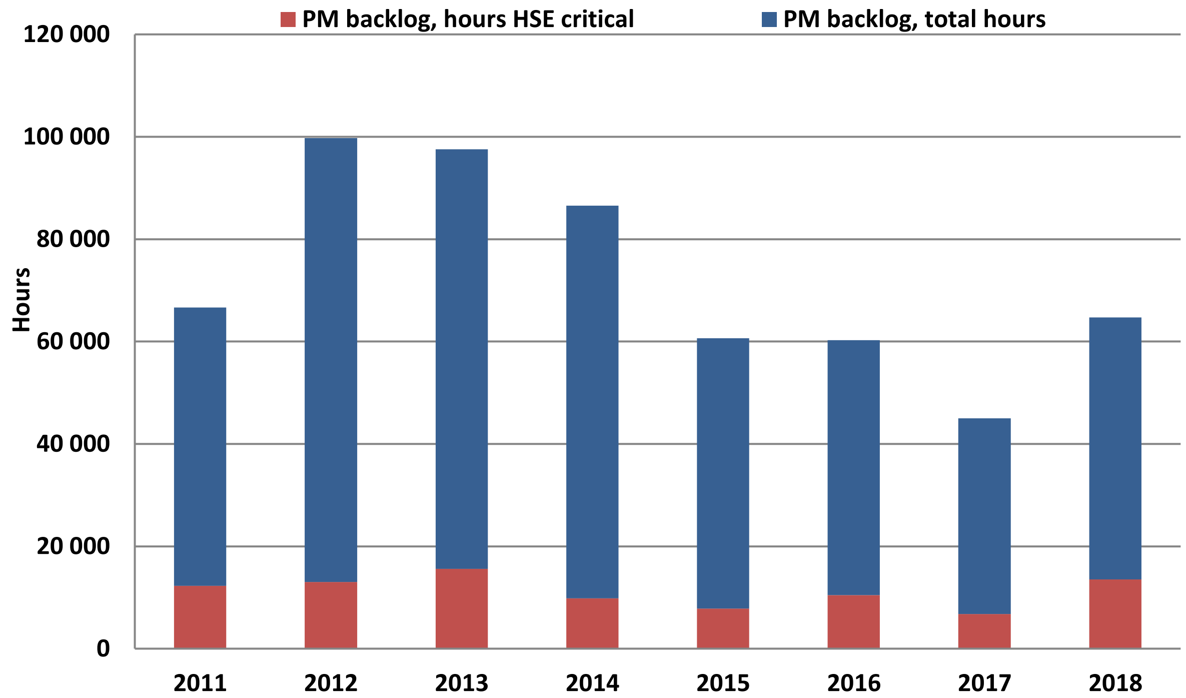


Figure 26 Total backlog in PM per year in the period 2011-2018 for the fixed facilities

Figure 26 shows the total backlog in preventive maintenance in the period 2011-2018 (sum of monthly averages). The total backlog in preventive maintenance and the backlog for HSE-critical equipment are higher in 2018 than in reporting year 2017. The backlog for HSE-critical preventive maintenance is among the highest levels reported since 2011.

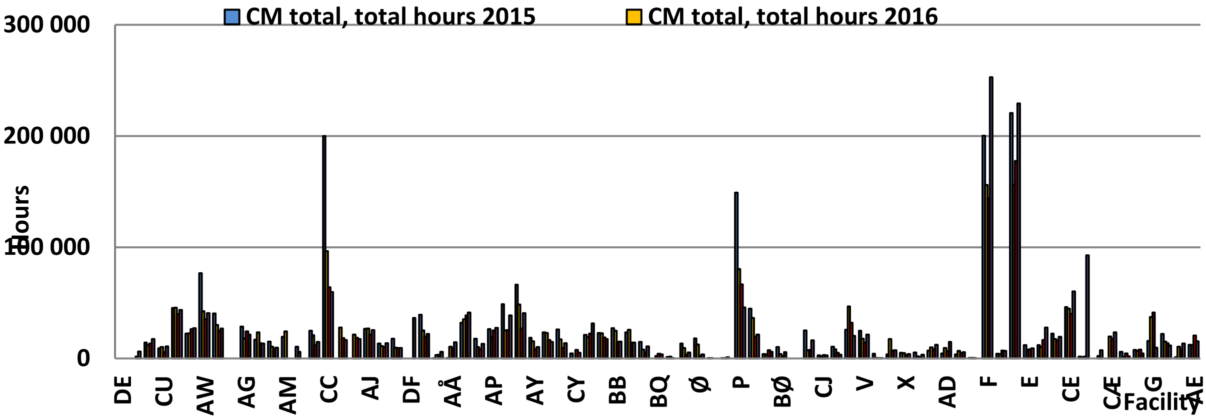


Figure 27 Total CM at 31/12/2018 for the fixed facilities. The figure also shows data for 2015 and 2017

Figure 27 shows the *total corrective maintenance* identified at 31/12/2018, but not yet performed.

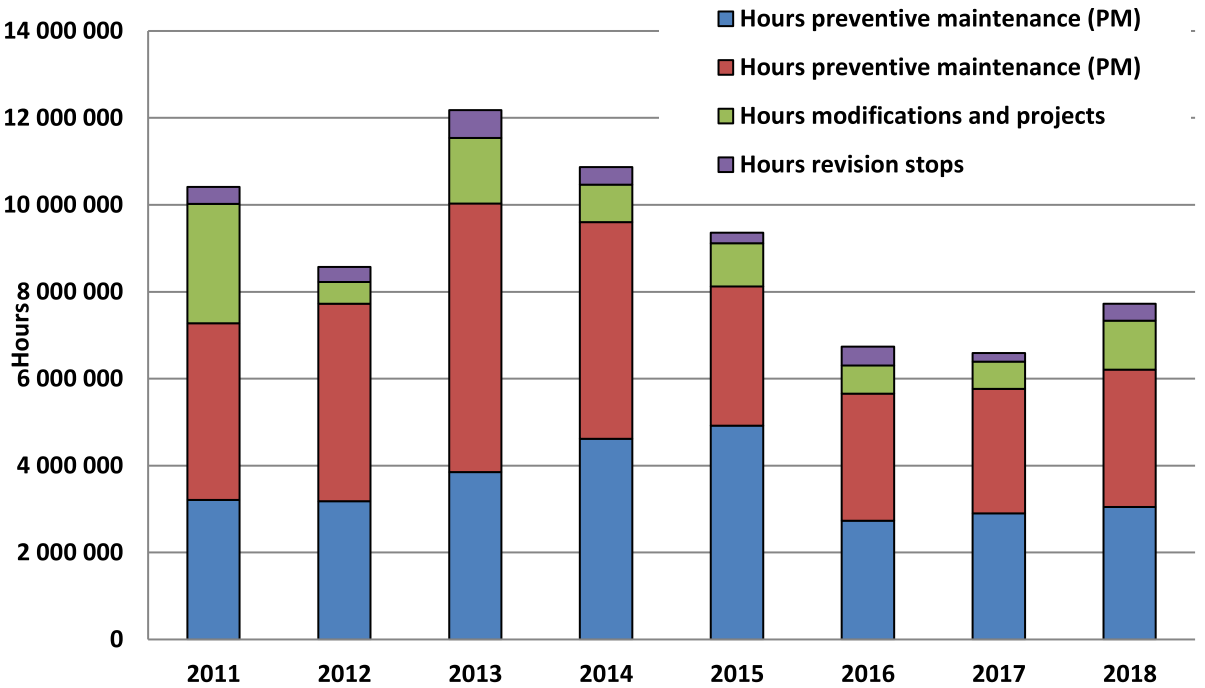


Figure 28 Total number of hours for performed maintenance, modifications and planned shutdowns for the fixed facilities in the period 2011-2018

Figure 28 shows the total number of hours for *performed maintenance, modifications and planned shutdowns* for the fixed facilities in the period 2011-2018. The figure is especially intended to show the *distribution* of the activities. We can see that the hours for the preventive and corrective maintenance carried out in 2018 are slightly higher than in the previous year. We can also see that the number of hours for modifications and projects has almost doubled.

In the main report, we observe that:

- some of the tagged equipment is not classified
- there are large variations in the proportion of HSE-critical equipment, with some facilities have a low proportion. This is in spite of the fact that the participants use virtually the same classification method
- there are few hours of backlog in preventive maintenance, but a number of facilities have not performed HSE-critical preventive maintenance in accordance with their own deadlines

- the total backlog in preventive maintenance and the backlog for the HSE-critical equipment are slightly higher than in the year before. The backlog for HSE-critical preventive maintenance is among the highest levels reported since 2011
- some facilities still have a considerable number of hours of corrective maintenance unperformed, but the number of hours is significantly reduced compared with the preceding years
- overall, there are a considerable number of hours of corrective maintenance unperformed, but there is still a significant reduction compared with the preceding years
- there is a small increase in the total outstanding corrective maintenance compared with the preceding year
- the total outstanding HSE-critical corrective maintenance is similar to that in recent years
- the hours for performed preventive and corrective maintenance are somewhat higher than in the previous year, and the number of hours for modifications and projects has nearly doubled
- there is a large variation in the percentage distribution by participant of performed preventive and corrective maintenance. A number of participants aim to reduce their corrective maintenance

These observations must viewed in the context of the regulatory requirements, notably that

- plant, systems and equipment must be tagged and classified so as to facilitate safe operation and prudent maintenance, including maintaining the performance of the barriers
- the activity level on the facility must take account of the status of maintenance performance. Status is this context includes the backlog of preventive maintenance and the outstanding corrective maintenance
- the significance of unperformed maintenance must be assessed both individually and in combination. The assessment is crucial for determining the extent to which unperformed maintenance entails increased risk
- backlogs in the HSE-critical preventive maintenance may contribute to increased uncertainty with regard to technical condition, and hence increased risk
- corrective maintenance of HSE-critical equipment should not exceed the defined deadlines, since the HSE-critical equipment is intended to inhibit or restrict the defined hazard and accident situations

6.3.2 The management of maintenance of mobile facilities

Figure 29 shows the *backlog in preventive maintenance* in 2018 (monthly average).

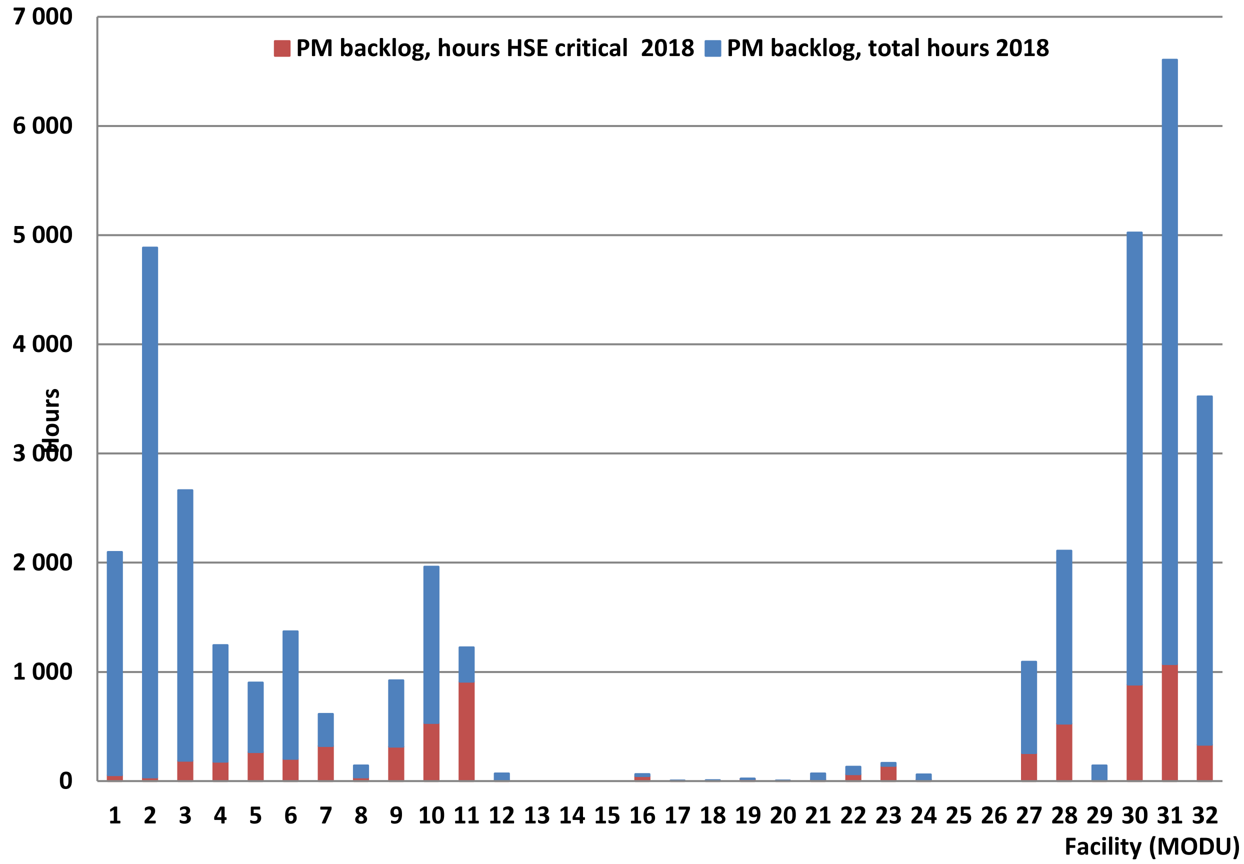


Figure 29 Backlog in PM for mobile facilities in 2018

There are large variations in the backlog of preventive maintenance for mobile facilities. Several facilities have not performed preventive maintenance of HSE-critical equipment in accordance with the companies' own deadlines. This may contribute to increased uncertainty with regard to technical condition, and hence increased risk.

Maintenance is of great importance for maintaining critical functions and ensuring that HSE-critical equipment functions when required.

Figure 30 shows *outstanding corrective maintenance* in 2018 (monthly average).

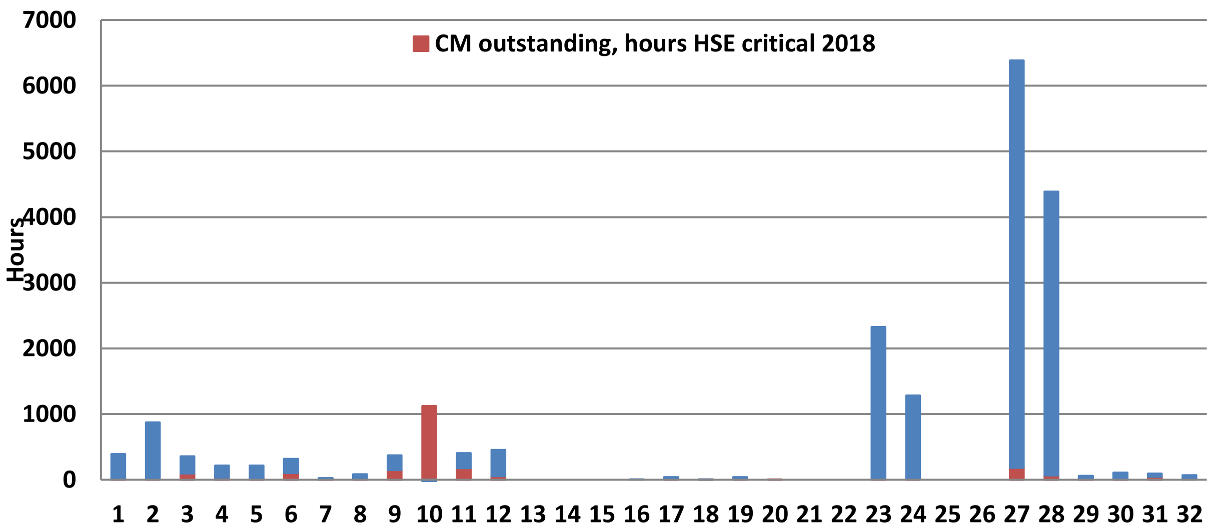


Figure 30 Outstanding CM for mobile facilities in 2018

There are large variations in the outstanding corrective maintenance for mobile facilities. Several facilities have not performed corrective maintenance of HSE-critical equipment in accordance with the companies' own deadlines.

Maintenance of this type of equipment should not exceed the defined deadlines since HSE-critical equipment is intended to inhibit or restrict the defined hazard and accident situations.

On several occasions, we have emphasised the importance of participants assessing the significance of outstanding corrective maintenance, both as individual items and collectively. The assessment is crucial for determining the extent to which outstanding maintenance entails increased risk.

In the main report, we observe that:

- there is large variation in the degree of tagging and classification of the facilities' systems and equipment. Jack-up facilities have a large proportion of tagged equipment that is not classified
- in general, newer facilities have a higher quantity of tagged and classified equipment than older ones
- there is a lot of variation in the proportion of HSE-critical equipment. Some facilities have a low proportion. The participants use virtually the same classification method
- there are large variations in the backlog of preventive maintenance. This corresponds to what we have seen in recent years
- several facilities have not performed HSE-critical preventive maintenance in accordance with defined deadlines. This may contribute to increased uncertainty with regard to technical condition, and hence increased risk
- there are variations in the outstanding corrective maintenance. This corresponds to what we have seen in recent years. Some facilities have not performed HSE-critical corrective maintenance in accordance with their own deadlines
- there is a large variation in the percentage distribution between the performed preventative and corrective maintenance per participant

These observations must be seen in the context of the regulatory requirements, notably that

- plant, systems and equipment must be tagged and classified so as to facilitate safe operation and prudent maintenance, including maintaining the performance of the barriers
- the activity level on the facility must take account of the status of maintenance performance. Status is this context includes the backlog of preventive maintenance and the outstanding corrective maintenance
- the significance of unperformed maintenance must be assessed both individually and in combination. The assessment is crucial for determining the extent to which unperformed maintenance entails increased risk
- backlogs in the HSE-critical preventive maintenance may contribute to increased uncertainty with regard to technical condition, and hence increased risk
- corrective maintenance of HSE-critical equipment should not exceed the defined deadlines, since the HSE-critical equipment is intended to inhibit or restrict the defined hazard and accident situations

7. Work accidents involving fatalities and serious personal injuries

There were no fatal accidents within the PSA's area of authority on the NCS in 2018. In 2018, 193 reportable personal injuries were recorded on the NCS. 204 such injuries were reported in 2017. 25 of these were classified as serious in 2018, against 29 in 2017.

In addition, 35 injuries classified as off-work injuries and 28 first aid injuries were reported in 2018. For comparison, in 2017 there were 22 off-work injuries and 30 first aid injuries. First-aid injuries and off-work injuries are not included in figures.

In recent years, we have seen a reduction in the number of injuries reported on the NAV (Norwegian Labour and Welfare Administration) forms, and this trend continued in 2018. 28% of the injuries were not reported to us on the NAV forms. These injuries are therefore recorded on the basis of information received in connection with the quality assurance of the data. The injuries not reported on NAV forms include two classified as serious. In order to clear up deficient reporting, in 2018 a request was made to relevant employers in which we asked for missing NAV forms for injuries that occurred in 2017. The status as at March 2019 is that we are still lacking NAV forms for the year 2017 for 11% of the injuries notified/reported to us.

The frequency of reportable personal injuries per million working hours on production facilities went from 7.1 in 2017 to 5.3 in 2018. There were 150 personal injuries on production facilities in 2018 against 171 in 2017. Over the long term, there has been a fall in the frequency of reportable personal injuries per million working hours. The number of working hours rose by 3.9 million from 2017 to 2018.

In 2018, there were 43 personal injuries on mobile facilities, compared with 33 in 2017. On mobile facilities, the frequency of reportable personal injuries went from 3.5 injuries per million working hours in 2017 to 3.9 in 2018. Over the long term, as with production facilities, mobile facilities have shown a positive trend, and the frequency in 2018 is below one half that of the level in 2008. The number of working hours rose from 9.3 million in 2017 to 11.0 million in 2018.

7.1 Serious personal injuries

Figure 31 shows the frequency of serious personal injuries on production facilities and mobile facilities combined. In 2018, a total of 25 serious personal injuries were reported, against 29 in 2017. There were no fatal accidents on the NCS in 2018. The last fatal accident occurred in 2017.

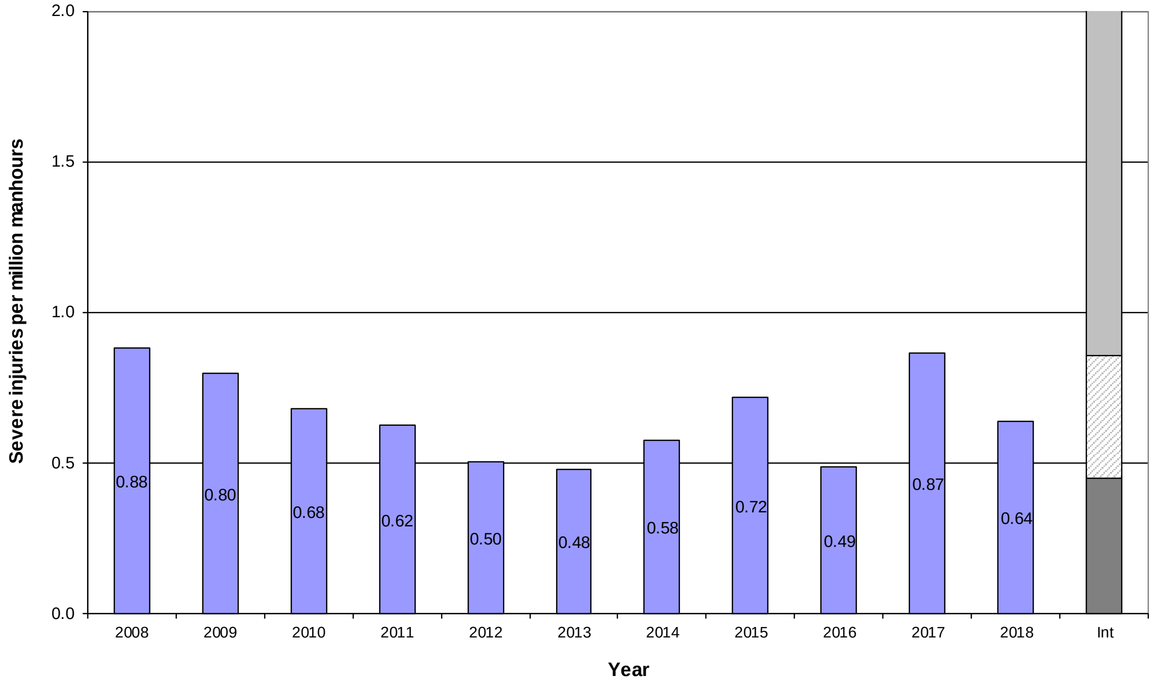


Figure 31 Serious personal injuries per million working hours – NCS

From 2017 to 2018, there was a fall in the frequency of serious personal injuries per million working hours from 0.9 to 0.6. However, even in 2018, the frequency is within the expected level based on the ten preceding years. In the period 2008-2013, there was a steady downward trend in the serious personal injury rate. After 2014, the trend is more varied. The activity level on the NCS last year fell by 5.6 million to 39.1 million working hours.

7.1.1 Serious personal injuries on production facilities

Figure 32 shows the frequency of serious personal injuries on production facilities per million working hours. From 2009, there was a downward trend until 2013. In 2013, the injury rate on production facilities was at its lowest level (0.4). With the exception of 2016, the trend increased in subsequent years before the injury level again pointed downwards in 2018. The injury rate fell from 0.9 in 2017 to 0.6 in 2018. However, in 2018 the frequency is within the expected level based on the ten preceding years. On production facilities, there were 17 serious personal injuries in 2018 against 21 in 2017. The reduction from 2017 to 2018 was primarily within drilling and wells, where the frequency went from 1.6 to 0.7 serious personal injuries per million working hours.

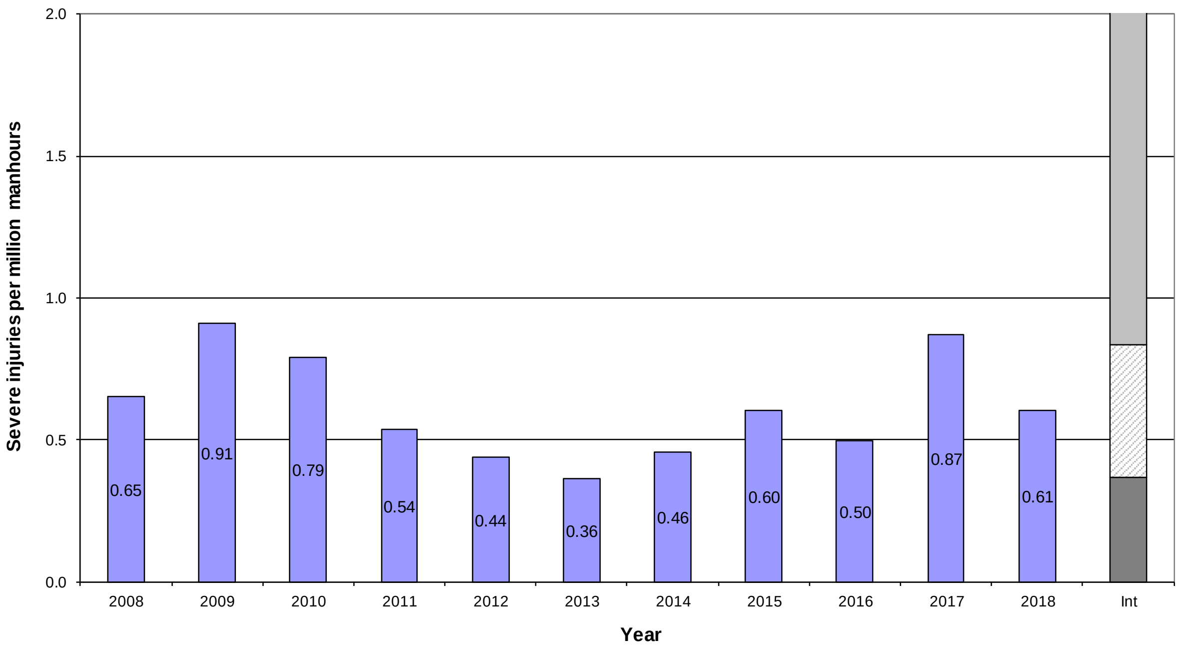


Figure 32 Serious personal injuries on production facilities per million working hours

7.1.2 Serious personal injuries on mobile facilities

Figure 33 shows the frequency of serious personal injuries per million working hours on mobile facilities. Over the long term, since 2008, we can see a very positive trend and observe the lowest level ever in 2010 (0.4). From 2012, we once again see a rising trend in the following years, but in 2016 there is a marked reduction in the rate of serious personal injuries. In 2017, we have a temporary upswing, before it falls again in 2018. There is a fall of 0.2 serious personal injuries per million working hours, from 0.9 in 2017 to 0.7 in 2018. The injury rate is therefore within the expected values based on the preceding ten years. The reduction from 2017 to 2018 on mobile facilities was within drilling/wells (from 1.3 to 0.5).

The number of hours reported for mobile facilities in 2018 rose by around 1.7 million, from 9.3 million in 2017 to 11.0 million in 2018. The number of serious personal injuries was 8 in both 2017 and 2018.

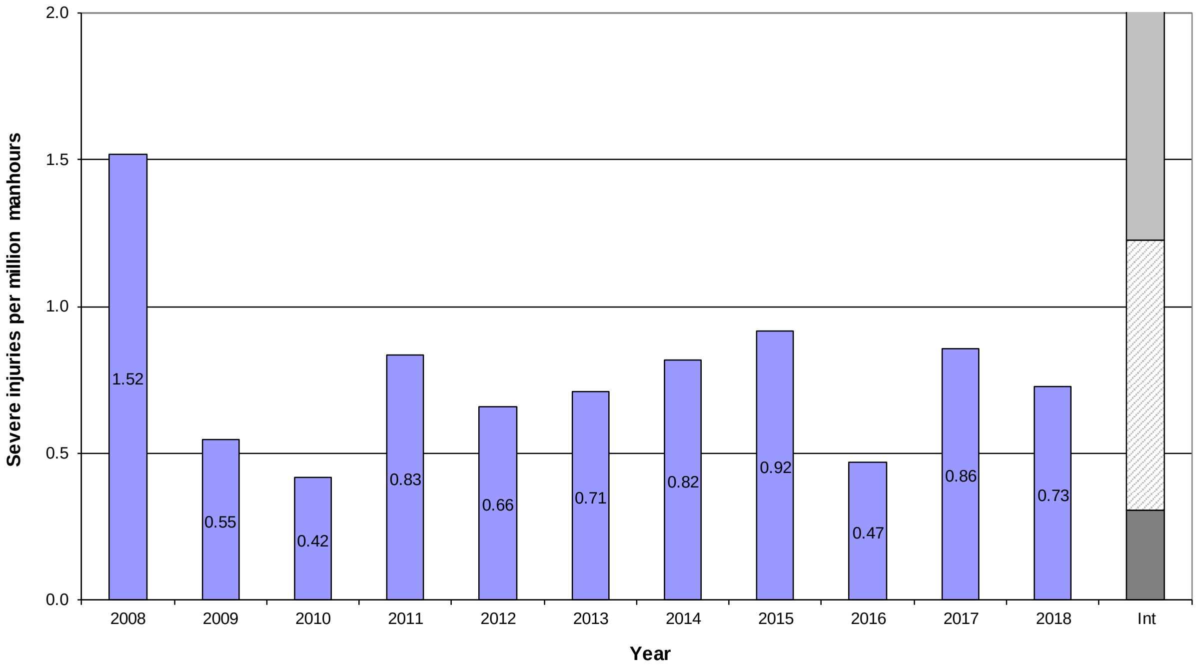


Figure 33 Serious personal injuries per million working hours, mobile facilities

8. Field study – Perceptions of changes and safety implications in the petroleum industry

8.1 Background and context of the study

Since 2001, a questionnaire-based survey has been conducted for the RNNP report every other year. The primary goal of the survey is to measure the employees' perception of the state of HSE in Norwegian petroleum activities (PSA, 2017).

The questionnaire-based survey has three objectives:

- To provide a description of employees' perception of the state of HSE in the offshore industry, and map factors that are significant in respect of variations in this perception.
- To help shed light on the underlying conditions that may be involved in explaining results from other parts of RNNP.
- To follow trends over time in respect of employees' perception of HSE conditions at their own workplace.

The PSA has noted that from 2013, through 2015, and especially up to 2017, the results of the questionnaire-based survey as a whole have exhibited a negative trend. This applies to the HSE climate, perceived risk, the working environment and health issues.

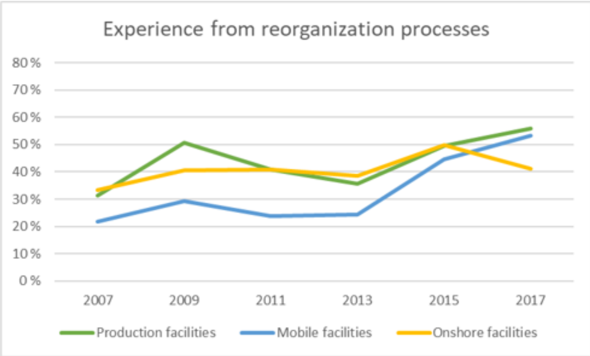
At the same time, the number of incidents with major accident potential shows a positive (falling) trend from 2002, and the 2017 figure is the lowest in the period covered by RNNP. When the number of incidents is normalised against working hours, the frequency in 2017 is significantly lower than the average in the period 2007-2016.

For serious work accidents, the picture is rather different, with a fall from 2007 to 2013, a rise from 2014 to 2015, a fall in 2016 and a rise again in 2017.

The petroleum industry has been through a period of relatively major restructuring in the wake of the fall in oil prices in 2013/2014. Data from Statistics Norway show that employment in the oil industry and industries supplying services to the oil industry fell by a full 25,000 from 2013 to 2015 (Statistics Norway, 2019). According to the Engen Committee, there are signs of growing safety challenges and collaboration between the social partners is under pressure, but the safety level in the industry in general is high (Engen Committee, 2018). A recent study from Proactima (2018) further demonstrates a correlation between cost reductions and the risk of undesirable incidents, with the quality of the actual change and restructuring process as the decisive element.

The PSA's own analysis of the questionnaire-based survey suggests that the negative trend in the safety indicators emerging from the survey is attributable above all to the group of employees who have experienced downsizing or reorganization. The survey for 2017 shows that a large proportion of offshore employees have experienced restructuring and downsizing processes (see Figure 34), especially in 2015 and 2017[3].

[3] The question is "Have there been downsizing or redundancies at your workplace in the last year?". The questionnaire-based survey is conducted at the end of the year (Nov-Dec).



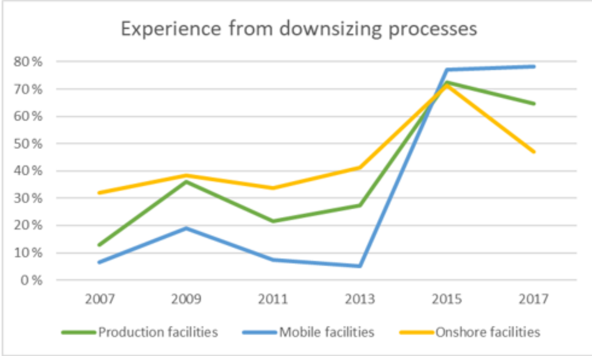


Figure 34 Proportion of respondents stating that they have experienced downsizing and/or restructuring last year (data from RNNP.no)

The background to and rationale for an indepth study are precisely these divergent results in RNNP for 2017, between the major accident indicators, serious personal injuries and the questionnaire-based survey, as well as the general challenges that the industry faces or has faced in relation to change and restructuring. The study aims to investigate more deeply the themes touched on in the questionnaire, using a large number of interviews with petroleum industry employees, both offshore and onshore. The aim is to better understand what lies behind this negative trend in the respondents' replies, but also to bring out any positive changes.

8.2 Statement of the issue

The PSA wanted an answer to the following research question:

The PSA seeks to understand why the respondents have answered negatively to HSE topics in the questionnaire. Emphasis shall be given to specific experiences and practices of informants, describe the subjective (emic[4]) perspective and investigate whether the answers indicate safety-related problems.

The study shall provide specific examples to underpin why the respondents answer as they do. The researchers shall capture both positive and challenging aspects of these themes.

8.3 Methodology

The study approaches the issue by utilizing a combination of semi-structured interviews, open interviews, and participant observation. The problem requires qualitative methods and an interpretive approach (Wadel, 1996) based on "thick" descriptions of the themes being addressed. Through such an approach, the researchers try to understand the informants' perspective (the so-called *emic* approach) in relation to work tasks, relationships with colleagues and managers and change processes in the organisations they belong to.

To gain access to the most valid data possible, without placing excessive constraints on what the informants say, researchers conducted a combination of *semi-structured* and *open/ethnographic interviews* (Spradley, 1979) at the informants' workplaces. Both types of interview included group interviews/discussions. All the interviews were audio-recorded, and the informants were able to give their informed consent[5].

[4] In this context, "emic" means investigating an organisational culture *from within*, as experienced by the employees. Its counterpart is "etic", from outside, which involves a more theoretical procedure.
[5] The informants were given the following information concerning confidentiality and privacy: Participation is voluntary. No notes or recordings will be given to the PSA or operator/company. The notes do not use the names of facilities or individuals. No operators, facilities or individuals are identified in the report. The data will be deleted at

The *semi-structured* interviews consisted of a combination of single-person interviews and group interviews. The group interviews provide an insight into topics where a certain consensus prevails, as well as topics where there are disagreements. The semi-structured interviews were in two parts. The first part was completely open and was based on the informants' stories and accounts about what it was and is like to work at this facility/installation and in the industry in recent years. The aim is to obtain unfiltered accounts of what preoccupies the informants. The second part dealt directly with the results from the questionnaire-based survey of 2017 for the sector as a whole, where the researchers asked for possible clarifications and reflections based on the informants' views of the results. The questions used as a basis for the discussions were the questions concerning the HSE climate that were assessed most negatively in 2017 (PSA, 2017):

- Deficient maintenance has led to poorer safety
- Reports on accidents or hazardous situations are often sanitised
- Different facilities have different procedures and routines for the same circumstances, and this constitutes a threat to safety
- Hazardous situations have arisen because not everyone speaks the same language
- In practice, production takes priority over HSE
- There is enough manning to properly safeguard HSE
- I find it easy to consult governing documents
- I feel sufficiently rested when I am at work
- Input from the safety delegates is taken seriously by the management

Open/ethnographic interviews at the informants' workplace involve short visits/fieldwork ("rapid ethnography") on board the facilities/installations. In addition to carrying out semi-structured interviews, the researchers are able to participate in more informal conversations that take place on board, for example, in coffee bars and rest rooms. The thing that differentiates a purely informal discussion from an open interview is that the interlocutor knows that we are researchers performing a job at the workplace. The primary function of these interviews is for the researchers to gain an insight into the main points of discussion among the employees.

The researchers also took part in operations occurring on the facility/installation through *participant observation*.

8.3.1 Sample and limitations

The sampling criteria employed were founded on the idea of having a broad data sample. To accommodate this requirement, it was decided that the overall sample of facilities should meet the following criteria:

- Breadth of operators
- Different types of facility, including onshore installations, permanent production facilities and mobile facilities
- Facilities/installations with respectively low or high scores reported on the questionnaire-based survey (measured against the arithmetical mean)
- Facilities/installations where many respondents reported restructuring and/or downsizing and facilities where these were not reported (measured as a percentage of respondents)

The choice fell on three production facilities with active drilling and well activities, two mobile facilities with active drilling and well activities, and two onshore installations. Each offshore facility was visited for 4 days, while the onshore installations were visited for 2 days. The facilities had an age range from 4 years to more than 30 years. All three

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the end of the project. You can withdraw your consent at any time. The study follows guidelines from the Norwegian Data Protection Authority and the Norwegian Centre for Research Data.

production platforms were over 25 years old. For the onshore installations, one was a refinery and the other a terminal.

Safetec informed the companies about the areas of work and personnel categories (from Platform Manager to operatives at the sharp end) they wanted for interviews and relevant meetings/activities for observation, and the companies themselves chose interviewees accordingly. Around 10-20% of the interviews were agreed on during the visits. The interviews lasted for 1 hour (+/-30 min). As shown in Table 3, there were 102 participants in 81 interviews in total in the study.

Table 3 Number of informants and interviews in the study

Area	**Number of informants (interview)**
Drilling contractor and well service	38 (33)
Operation and maintenance excl. SIP[6]	64 (40)[7]
SIP	10 (8)
Total	**102 (total 81 interviews)**
Of which onshore installations	16
Of which offshore	65

8.4 Main findings and key challenges for the petroleum industry

In this chapter, the main findings relating to the issue are presented, followed by challenges that the petroleum industry should work on in its ongoing improvement activities within risk management and HSE.

8.4.1 Main findings

The main issue in this investigation was to provide a possible explanation for why the respondents to the RNNP questionnaire-based survey for 2017 answered more negatively on questions concerning HSE than in previous surveys.

If one compares individual results of the questionnaire-based surveys (2015 and 2017) with the perceptions and assessments of their own organisation from this study's informants, the negative changes appear to be meaningful. This indicates that the survey questions largely measure what they are meant to and that the content validity at an overarching level can be considered good. A comparison of individual informants' perceptions, across facilities, companies and job positions shows a large degree of convergence of perceptions, indicating that the questions also measure relatively precisely what they are intended to. However, there are indications that certain questions can, to some extent, also measure conditions that they are not intended to measure, which weakens the content validity. These are factors, for example, that may concern dissatisfaction and various other reactions to the perception of the change processes. The study shows that it is primarily perceptions of the consequences of the changes that underlie the differing results of the survey between 2015 and 2017.

Over recent years, a number of organisational changes have been implemented in respect of cost savings and efficient operation in the petroleum industry. The study shows that offshore employees in both operation & maintenance (O & M) and drilling & wells (D & W) express *uncertainty* and *worry* over whether changes implemented in recent years have had a negative impact on risk and the working environment. Factors addressed by employees in this context, and which are considered to directly influence accident risk include:

[6] Two of the interviews were group interviews with safety representatives, with 7 and 8 participants respectively.
[7] 16 of these interviews are from onshore installations.

- ageing and degradation of the facilities over time (O & M only)
- changes in maintenance philosophy, maintenance programmes and scope of maintenance
- quality of equipment (D & W only)
- the likelihood of impaired risk understanding, misjudgments and mistakes

In addition, the informants describe what they believe to be *indirect* effects of change and which are considered to have negative safety implications. Unintended effects described include:

- impaired competence (technical and facility specific offshore)
- impaired quality of maintenance
- increased time pressure and/or workload for certain job categories
- Reduced capacity and competence in support centres onshore
- undercommunication of risk

8.4.2 Challenges for the petroleum industry

This study points up challenges in the sector that may have negative safety impacts. These include:

- Reduced confidence in the interaction between different groups of participants
- Downsizing, replacement and rotation of personnel
- Use of KPIs
- Unintended consequences of changes to maintenance programmes and the organisation of maintenance

The primary challenge this represents is that it is unclear whether uncertainties and new knowledge of actual consequences of changes are adequately assessed in terms of their potential HSE implications.

Reduced trust in the interaction between different groups of participants
The study indicates that *trust* between some groupings is impaired in situations where information sharing is essential for safe operations. The safety literature shows that trust is a phenomenon that affects the safety climate and safe work practices of an organisation (see, for example, Jones and Jones, 2011; Luria, 2010; Burns et al., 2006; and Conchie et al., 2006). This study shows that challenges linked to trust emerge in particular in the relationships between operators and subcontractors, and in the relationships between offshore personnel and support centres onshore. Tensions related to the interaction between onshore and offshore have been a familiar and recurrent theme within the industry. The study suggests, however, that perceived challenges with this organisational interface have been reinforced as a result of the perception of weakened facility-specific competence, weakened technical support (both within O & M and D & W), and changes in decision-making authority and the decision-makers involved. Although there has been a strategy within the industry over the years to transfer tasks from offshore to onshore, this study indicates that offshore workers are finding that more planning activity and more administrative tasks have been transferred from onshore to offshore. At the same time, it is asserted that decision-making authority is increasingly being transferred onshore. Within drilling, it is particularly stressed that the technical support from onshore concerning drilling operations has been weakened. Unintended consequences of this change are posited to include:

- A bigger workload for offshore managers
- Reduced opportunities for hands-on management
- Poorer information base and understanding in support of decision-making

Downsizing, replacement and rotation of personnel
Downsizing processes, replacement and rotation of personnel have been direct measures or the consequences of measures in the change processes of recent years. The survey

shows that offshore employees are experiencing the following unintended consequences of these changes:

- Impaired facility-specific competence, with associated increased risk of misjudgments and mistakes
- Impaired technical competence within the onshore organisation, with associated increased risk of misjudgments
- Increased workload and time pressure for individual groups, with associated increased likelihood of mistakes
- Lesser coordinated and aligned work practices in relation to certain manual work tasks, with associated increased risk of misunderstandings and mistakes. This is a circumstance that is specifically addressed within D & W, with reference to manual work on drill floors.

Use of KPIs

The use of Key Performance Indicators and the unintended consequences thereof, especially within drilling, has been a recurring theme in this study. One key feature is that the informants have pointed out some significant differences between how the operating companies and individual managers use and publish KPI results in respect of day-to-day operations. According to the informants, an emphasis on progress in the operation and on poorer KPI results compared with other drill teams and drilling suppliers, promotes a focus on progress that may compromise the focus on HSE-related conditions. Unintended consequences under discussion are:

- Impaired operational management and risk assessments and the risk of misjudgments during operations that may represent a hazard for well incidents. This is an aspect that may emerge both when changing drilling schedules, and in respect of drillers' assessments during drilling operations.
- Increased likelihood of mistakes (specifically slips & lapses) among roughnecks that may pose an increased risk of work accidents
- Risk of damage to equipment and falling objects as a consequence of more restricted time for maintenance
- Increased workload for individual groups that could result in an increased probability of strain injuries

Experience from investigations shows that failing operational management, time efficiency and production requirements are often underlying causes of incidents (Tharaldsen, 2013). Findings in this study indicate that the industry faces a challenge as to how KPIs are used and published in relation to day-to-day operations, and the extent to which the KPI results are actually applied to reflection and learning in terms of developing "best practice". The survey indicates that there are variations in practice between operators and individual managers.

Unintended consequences of changes to maintenance programmes and the organisation of maintenance

The study shows that the quality and scope of maintenance are a key topic for offshore workers. Inferior quality of maintenance that can both have operational and safety implications is attributed to unintended consequences of changes in maintenance programs and the organisation of maintenance. Factors that offshore workers think may have negative consequences for the quality of maintenance include:

- Less time for performing individual preventive maintenance jobs due to changes in maintenance programmes
- Changes to contract terms for M & M contractors
- Greater emphasis on progress in drilling operations, and less time for routine maintenance (lubrication of equipment, drop-check etc.)

Main challenge for the petroleum industry

The informants' perceptions and considerations, with reference to the information processing perspective on major accidents (see Rosness et al., 2004; Turner, 1978; Turner and Pidgeon, 1997) and general decision-making theory (March, 1994), actualise the question of how industry participants manage and evaluate multiple – partially simultaneous – independent change initiatives, with regard to risk.

Over recent years, a number of organisational changes have been introduced with a view to cost savings. This study has detected a number of factors that indicate that these changes have had certain unintended consequences that offshore workers believe could have negative implications for HSE. The study also indicates that there may be interaction effects between some of the initiatives that may have negative HSE implications.

For the industry as a whole, the adoption of many initiatives in a relatively short space of time will represent a challenge in respect of maintaining a full overview of any changes to the risk picture. This imposes requirements on appropriate methods and processes for managing risk. The study shows that the companies and industry should review and assess whether:

1. all organisational changes described by the informants have been risk-assessed
2. a comprehensive risk assessment of all change initiatives has been made, notably in respect of potential interaction effects
3. questions concerning uncertainty linked to possible consequences of the initiatives are included in the assessments
4. new knowledge about the actual consequences of the changes has been evaluated in respect of updates to risk assessments

9. Questionnaire-based survey – Divers in the petroleum industry

A questionnaire-based survey was conducted among personnel on diving vessels during the period 1 January to 31 December 2018 (we refer to this as the "diver survey" below). This is the first time that diving personnel have been invited to participate in the questionnaire-based survey in RNNP. An equivalent survey has been performed nine times on the NCS and six times at onshore petroleum installations. At an overarching level, the aim of the survey in RNNP is to acquire knowledge about the employees' perception of the HSE status in the Norwegian petroleum activities.

Most of the questions in the diver survey are the same as in the main survey, but diving personnel also received certain questions that applied to them alone. Besides the diver-specific questions, the questionnaire includes the following topics: demographics, the HSE climate, experience of accident risk, recreation conditions, working environment, ability to work, health, sickness absence, sleep, rest, and working hours.

115 individuals responded to the diver survey. Although this is a small number of people, it is estimated that they comprise around 33% of the population in question. Based on their stated position on board, 64% of the respondents are defined as divers (saturation/surface), 26% are supervisors (diving-related), and 10% held a different position. Well over half of those who answered the diving survey had 1-2 diving periods on the NCS during the last 12 months. 80% had 1-9 periods. 45% of divers/supervisors stated that they mainly work on the UK shelf, and 22% work mostly on the NCS.

Since it is not possible to compare the sample or results for diving personnel with previous years, we have opted to compare the results with those from the offshore personnel survey (2017), where possible. Due to the very disparate sample sizes (there were 6,238 persons in the offshore survey in 2017), differences between the two groups were not tested for statistical significance. Differences in the results should therefore be considered with a degree of caution.

There are major differences in the composition of the samples (those that responded) for offshore (2017) and diving personnel (2018). Predefined categories make it difficult to talk about average age, but the diving personnel's ages are more centred in the 31-50 years categories, while the majority of offshore personnel (2017) are in higher age categories (41-60 years). There are almost no young persons (< 25 years) among the diving personnel. Very few diving personnel have permanent employment (5%), which is the complete opposite of offshore personnel (2017). Two-thirds of those who responded to the diving survey are British and only one-tenth are Norwegian. In the offshore survey (2017), nine out of ten respondents were Norwegian. Among diving personnel, 37% said that they had worked on the same vessel in the last 12 months. Among offshore personnel (2017), 80% replied that they worked on the same facility on every or nearly every tour of duty.

9.1 Diving-related topics

Divers and supervisors have assessed seven different working environment factors relating to work on the NCS. The results show that divers are more positive than their supervisors towards these factors. There is a particularly large difference in the assessment of the use of NORSOK saturation/decompression tables, and 84% of the divers consider their use to be "quite/very advantageous". Regardless of job category, the length of the saturation period and the duration of the stay on board were assessed most negatively.

When asked about the perceived risks of various diving-related conditions/situations, divers assess the risks as being higher than do the supervisors, for the following conditions/situations: gas cut, human/mechanical failure during diving operations (two questions), personal diving equipment (including bail-out system), fatigue and failure of automated/manual control systems (two questions).

The divers (not their supervisors) were also asked about their own safety behaviour when diving, and this was assessed relatively positively. 80% responded that they "quite/very rarely or never" were worried about their own safety during diving, and 82% responded similarly to disagree that they worked with supervisors or support personnel whom they deemed incompetent. To the question "Did time pressure make it hard to follow operational procedures?", 37% responded "sometimes", while 7% thought this was "quite/very often or always" the case. Operational procedures were largely assessed to be relevant to the divers' specific tasks, but 46% replied that they "quite/very rarely or never" reported deviations from planned procedures.

9.2 HSE climate

The questions concerning the HSE climate are largely the same as for offshore personnel (2017), but certain questions were changed and some removed. Through the use of indices (several questions aggregated), only comparisons of identical sizes are made. Differences between groups refer to the differences in average responses, when given on a five-part scale. The main report presents tables that show the actual values and whether these can be interpreted as "good" or "bad" results from a broader perspective.

Seven indices have been constructed that summarize the results for the HSE climate, and diving personnel have better results than offshore personnel (2017) for five of these. The indices that (without comparison) were considered the most positive/advantageous by the diving personnel were "Own safety behaviour", "The Organisation's commitment" and "Colleagues' commitment". The indices "Cooperation and communication" and "Freedom to speak up" received the least positive/advantageous assessment.

At individual question level, the largest difference between the two groups relates to the following assertions:

- I think it is easy to find what I need in the governing documents (requirements and procedures)
- Deficient maintenance has led to poorer safety
- There is enough manning to properly safeguard HSE
- In practice, production takes priority over HSE
- The health, working environment and safety laws and regulations are not good enough
- I experience a pressure not to report personal injuries or other incidents which may "mess up the statistics"

To all six of these statements, diving personnel replied more positively than offshore personnel (2017). Among statements that diving personnel responded to more negatively than offshore personnel (2017) are the following:

- Lack of cooperation between operators and contractors often lead to dangerous situations
- Being too preoccupied with HSE can be a disadvantage to your career
- I have been informed of the risks associated with noise
- I know which chemicals I may be exposed to

9.3 Perceived accident risk

Diving personnel assessed the risk of ten comparable hazard and accident situations to be higher than did offshore personnel (2017). There is an especially large difference regarding the following situations: helicopter accident, collisions with ships/vessels/floating objects, explosion and collapse of the vessel's load-bearing structures or loss of buoyancy, where divers perceive the greatest risk. The highest risks were assessed for the two diving-specific situations of "Dynamic positioning failure (DP failure)" and "Contamination/emissions/discharge of toxic gases/substances/chemicals".

9.4 Working environment

Diving personnel have assessed the conditions of the working environment as both better and worse than for offshore personnel (2017). For the physical, chemical and ergonomic work environments, the results for diving personnel are better on questions of noise, lighting, skin contact with oil/drilling mud/chemicals, indoor climate and sedentary work. Conversely, diving personnel state that they are more often obliged to perform heavy lifting than offshore personnel (2017). Concerning the psychosocial and organisational work environment, diving personnel state that they more frequently receive assistance/support and get feedback from their immediate superior compared to offshore personnel (2017). Training in the use and support of IT systems is assessed more positively by diving personnel, but access to IT systems is inferior to offshore (2017). Diving personnel have somewhat better results for workload (index).

9.5 Leisure

Diving personnel are uniformly satisfied with their leisure conditions (food/beverage, exercise, other recreational facilities). They are slightly more dissatisfied with cabin conditions than offshore personnel (2017). Chamber conditions (diver-specific question) are viewed more positively than cabin conditions. In respect of sleep, the perception of overall sleep quality (index) is lower for diving personnel than for offshore personnel (2017). In respect of individual questions, however, sleep quality “when offshore” (on the vessel) is assessed quite similarly as for offshore personnel (2017), even though diving personnel must more often share cabins when sleeping. The main difference is that diving personnel more rarely sleep well before and after a tour of duty than offshore personnel (2017).

9.6 Health and sickness absence

Sickness absence (both short-term and long-term) was stated to be lower for diving personnel than for offshore personnel (2017). Diving personnel also say that they have fewer health problems, but the pattern in the commonest complaints is similar to offshore personnel (2017). That is to say that pain in the neck/shoulders/arm, back pain and ringing in the ears/tinnitus are the most prevalent. Of the diver-specific health ailments, fatigue and joint pain are most prevalent. Diving personnel assess their own health as better than do offshore personnel (2017). It might be posited that the differences between the groups are due to diving personnel having stricter health requirements than offshore personnel overall, but the sample is too small to speculate too much on the basis of these results.

11. Other indicators

11.1 DFU20 Crane and lifting operations

DFU20 crane and lifting operations includes incidents involving lifting equipment and its use which led to, or could have led to, personal injury or harm to equipment or the environment. It includes incidents both involving and not involving falling objects. DFU20 was created and presented for the first time in the 2015 report. At that time, the operators were asked to report incidents back to 2013, so that the time series now comprises data for the period 2013-2018. The analysis looks at both the six years combined and a comparison between the years, as appropriate.

There is a new feature in this year's report: the operators were asked to categorise the types of crane/lifting equipment into a further main category**,** gantry and overhead cranes, in addition to offshore cranes, lifting in the drilling module and subcontracting arrangements. Types of crane/lifting equipment that do not fall into any of these four categories come under "Other lifting equipment" and for these the operators were asked to specify a subcategory.

The main findings, which are also shown using the figures and a table below, are:

Fixed facilities

- The number of reported incidents for *fixed facilities* in 2018 (both absolute and normalised) fell slightly from 2017, but is still far higher than for the years prior to 2017 (see Figure 35).
- In 2017, there was a large increase in the number of incidents and, in last year's report, it was investigated whether this increase could be related to increased reporting of incidents with low energy potential. The conclusion was that this did not explain the rise; there were large increases in both the absolute and normalised number of incidents, including for the higher energy classes. Consequently, in this year's report, the same breakdown in analysis of incidents into low and high energy classes was not performed.
- Over time, see Figure 35, we have seen a decrease in the number of reported incidents (both absolute and normalised) from 2013 to 2014, then a steady increase in the period 2014-2016, a large increase for the year 2017 – and then falling somewhat in 2018.
- The reduction in the number of incidents from 2017 to 2018 (both absolute and normalised) is mainly due to fewer lifting-related incidents in the drilling module; see Figure 36.
- There were 43 incidents involving personal injuries in the period 2013-2018; see Table 4. Three of these incidents are in 2018.
- With the exception of 2014, the normalised number of incidents involving personal injuries for fixed facilities has shown a steady increase from 2013 to 2017; see Figure 37. This trend was broken in 2018 and both the absolute and normalised number of incidents involving personal injuries fell for fixed facilities.
- The trend in the proportion of incidents with personnel exposed, and consequently with a potential for injury, is clearly downward; see Figure 38. This may indicate better planning of lifting operations leading to fewer workers exposed if an incident occurs.

Mobile facilities

- The number of reported incidents for *mobile facilities* (both absolute and normalised) has risen from 2017 to 2018, and is back at the 2016 level (see Figure 35).

- The observed absolute and normalised number of incidents shows, with the exception of 2016, the same trend over time (see Figure 35): a fall in the number of reported incidents from 2013 to 2014, then an increase in 2015. In 2016, the absolute number decreases slightly while the normalised number rises further from 2015. From 2016 to 2017, both the absolute and the normalised number of incidents are reduced slightly, and then, in 2018, climb back to the 2016 level.
- The increase from 2017 to 2018 is mainly due to an increase for lifting using offshore cranes; see Figure 39.
- There were 24 incidents involving personal injuries in the period 2013-2018; see Table 4. Three of these incidents are in 2018.
- With the exception of 2015, both the absolute and normalised numbers of incidents involving personal injuries have had a steady decline from 2013 to 2017; see Figure 37. In 2018, there is an increase in both the absolute and normalised numbers of incidents involving personal injuries, and it is at a level slightly above the level in 2016, but lower than in the years before this.
- Incidents relating to drilling have shown a decrease in absolute numbers for the entire period from 2015; see Figure 36. The same applies to the normalised number of incidents, but the fall started a year later and is observed from 2016.
- As for fixed facilities, the trend in the proportion of incidents where personnel are exposed, and which consequently have a potential for injury, is clearly downwards; see Figure 38. This may indicate better planning of lifting operations leading to fewer workers exposed if an incident occurs.

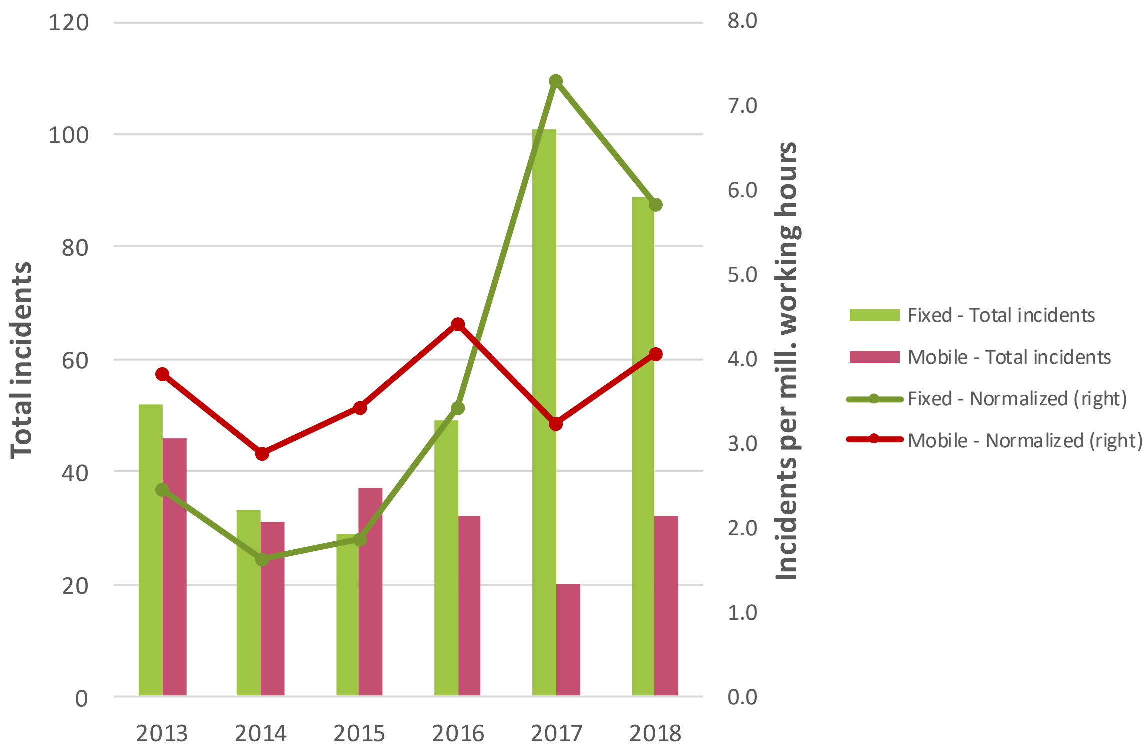

Figure 35 Number of reported incidents for crane and lifting operations in the period 2013-2018 for fixed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relating to drilling and well operations and to construction and maintenance, per type of facility

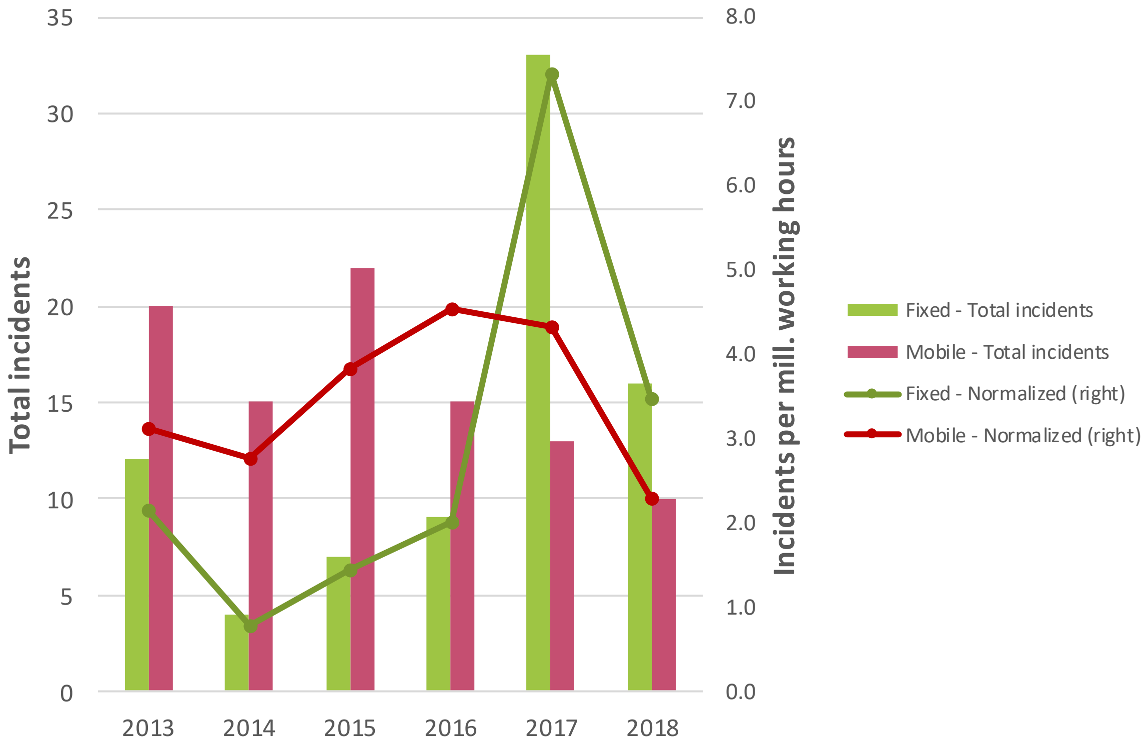

Figure 36 ***Number of incidents relating to lifting in the drilling module for the period 2013-2018 shown for fixed and mobile facilities – absolute numbers and numbers normalized against million working hours relating (exclusively) to drilling and well operations, per type of facility***

Table 4 ***Total number of reported incidents, and incidents involving personal injuries by facility type***

År	*Total number reported incidents*	*Number of incidents with personal injuries*	
		Fixed facilities	*Mobile facilities*
2013	98	9	7
2014	64	7	5
2015	66	7	6
2016	81	8	2
2017	121	9	1
2018	121	3	3

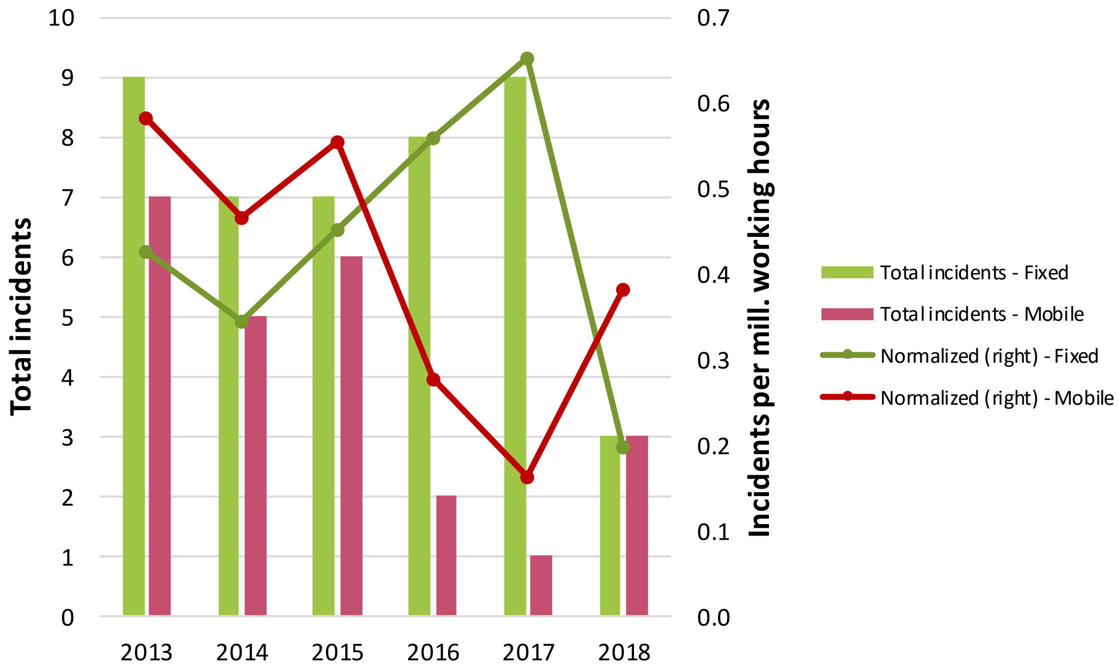

Figure 37 Number of incidents involving personal injuries for crane and lifting operations in the period 2013-2018 for fixed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relating to drilling and well operations and to construction and maintenance, per type of facility

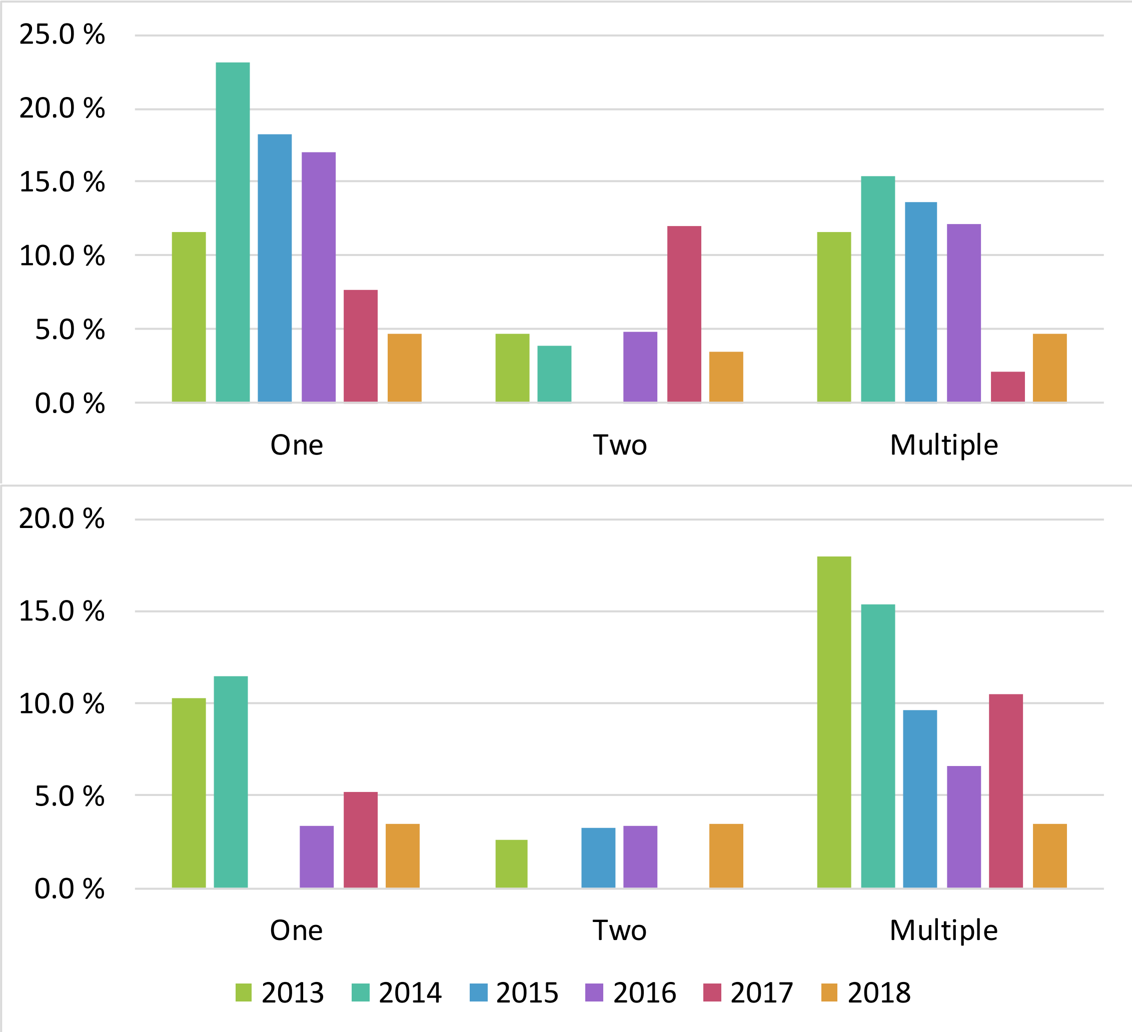

Figure 38 Relative number of incidents (without personal injury) with persons exposed to the incident, for fixed (top) and mobile (bottom) facilities, for the period 2013-2018

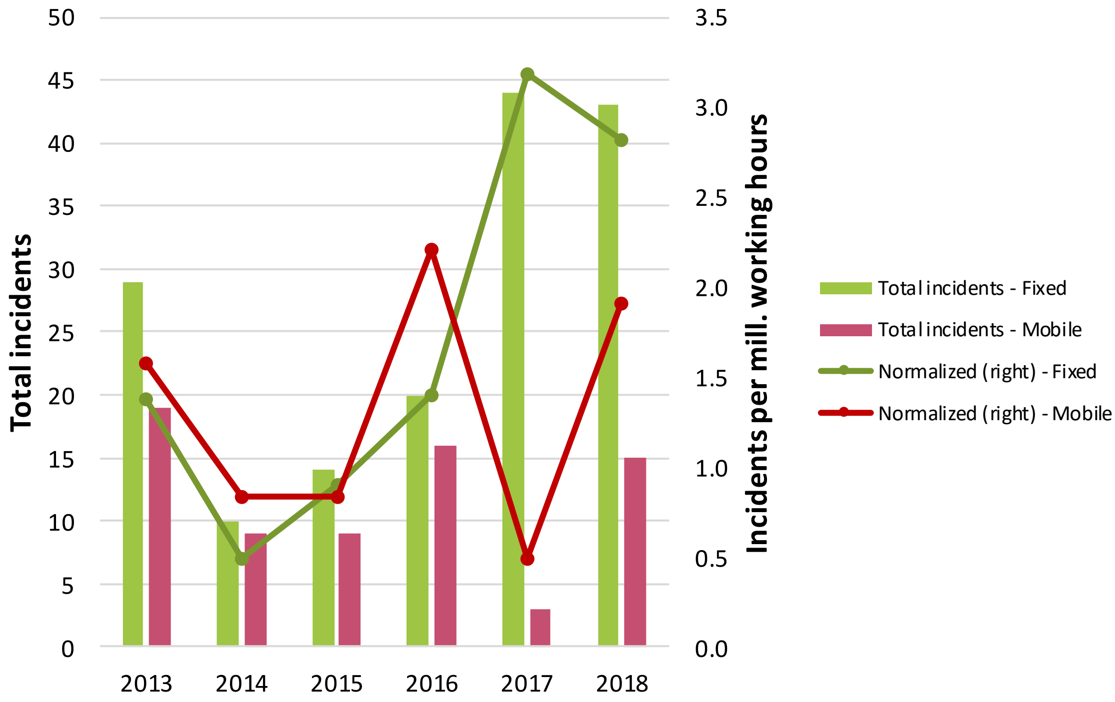

Figure 39 Number of incidents relating to lifting using offshore cranes for the period 2013-2018 shown for fixed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relating to drilling and well operations and to construction and maintenance, per type of facility

11.2 DFU21 Falling objects

DFU21 Falling objects comprises all incidents where an object falls within a facility's safety zone, either on deck or into the sea, with the potential for becoming an accident, and which does not involve crane and lifting equipment and the use thereof. Incidents linked to crane and lifting equipment and the use thereof are presented in DFU20.

As of the 2015 report, for offshore facilities, a new DFU20, Crane and lifting operations, was introduced which has caused changes in DFU21 Falling objects. The time series now consists of data for the period 2013-2018. The analysis looks at both the six years combined and a comparison between the years, as appropriate.

Please also see 11.1 DFU20 Crane and lifting operations for a description of new features in 2018 and key aspects of the report. The same description applies to DFU21 as to DFU20.

The most important findings, which are also shown in the figures below, are:

Fixed facilities

- For the *fixed facilities*, a weak annual decline in the number of reported incidents is observed in the period 2013-2016, while in 2017 there was a significant increase to more than twice the previous year. For 2018 we see a further increase in reported incidents, but with a slightly weaker rise when normalized "per million working hours". The increase in 2018 may possibly be due to a generally higher activity level on the NCS
- There were 27 incidents involving personal injuries in the period 2013-2018. It should be noted that ten of these incidents are from 2018, which equates to a doubling compared with the previous five years.
- There are probably a number of reasons for the large increase in reported incidents in 2017 and 2018. In respect of reporting as of 2017, the PSA has specified the following:

    - all falling objects shall be reported regardless of whether the object falls within or outside a barriered area.
    - no lower limit for fall energy or deduction for height of a person shall be used.
- The largest percentage increase from 2017 to 2018 is for incidents over > 40 J, with an increase from 109 to 147 incidents. The trend is the same when adjusted for millions of working hours.
    - The increase in the number of incidents in energy class > 40 J concerns mainly work processes relating to Scaffolding and Other areas.
    - There is a relatively large increase from 2017 to 2018 in the number of incidents in energy class C (100-1000 J), which increase from 59 to 74 incidents.

- Three incidents with potential for HC leaks were recorded in 2018. All of these occurred on fixed facilities.

Mobile facilities

- For *mobile facilities*, since 2014 a fall has been seen in the number of reported incidents. For 2018, this trend is broken, and there is a significant increase in the number of reported incidents from 2017 to 2018. Looking at the number of incidents per million working hours reveals this same pattern, of a decrease from 2014 onwards being broken by an increase in 2018.
- The increase in incidents in 2018 relates primarily to work processes in the drilling areas both for incidents > 40 J and incidents < 40 J.
- There were no incidents involving personal injuries in the period 2013-2018.

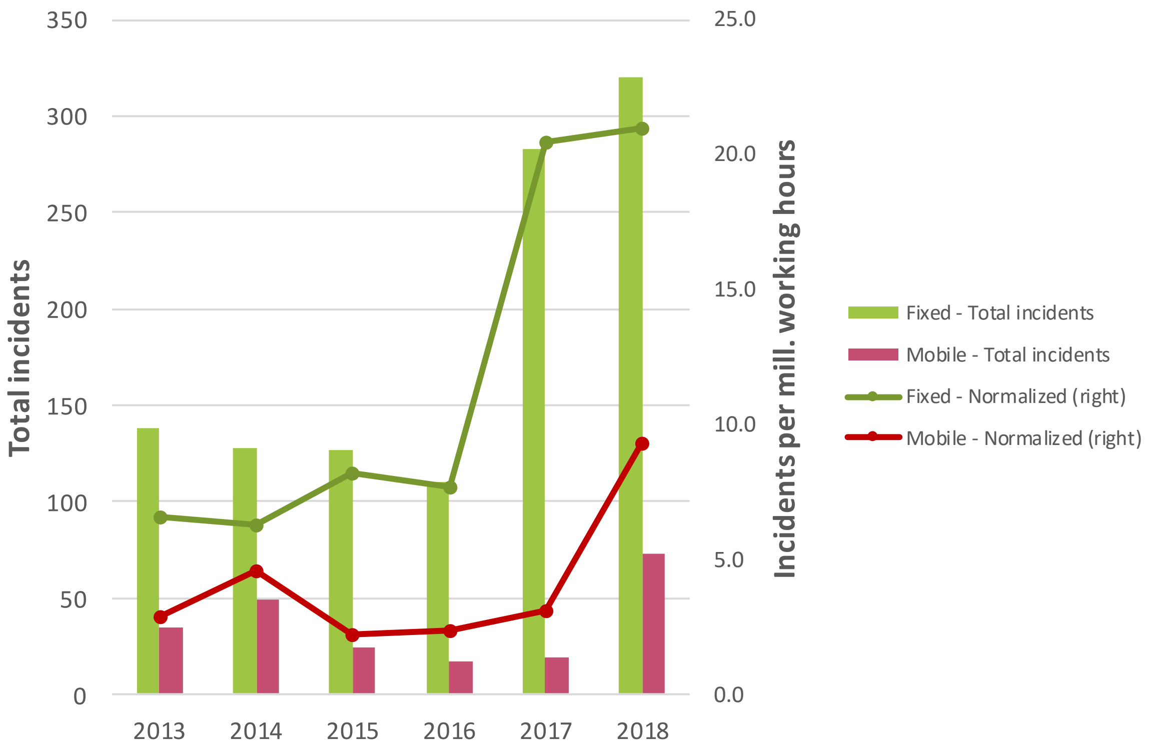

Figure 40 Number of incidents and incidents per million working hours classified as falling objects, by fixed and mobile facilities, in the period 2013-2018

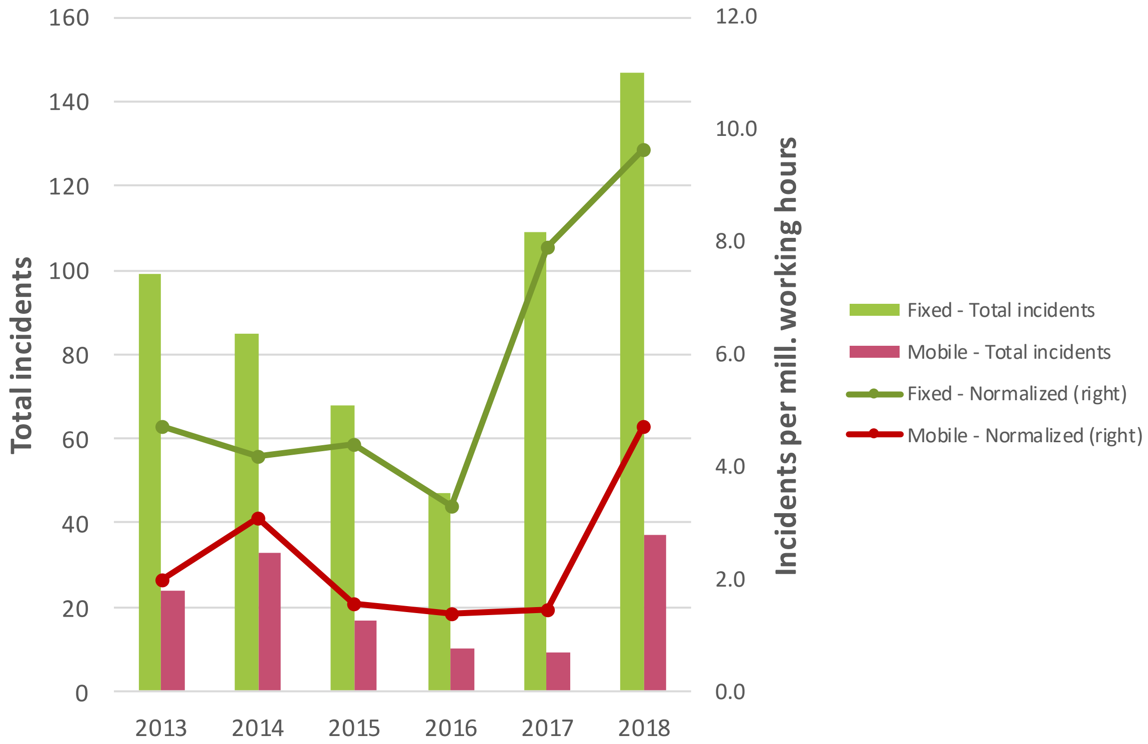

Figure 41 ***Number of incidents and incidents per million working hours classified as falling objects > 40 J, by fixed and mobile facilities, in the period 2013-2018***

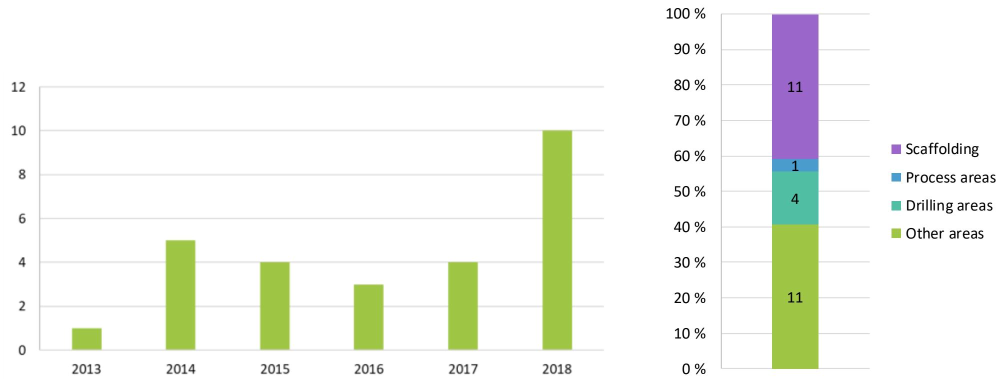

Figure 42 ***Total number of falling object incidents causing personal injury, in the period 2013-2018 (left). Also broken down by main category of work process (number of incidents given in the column) (right). All incidents were on fixed facilities.***

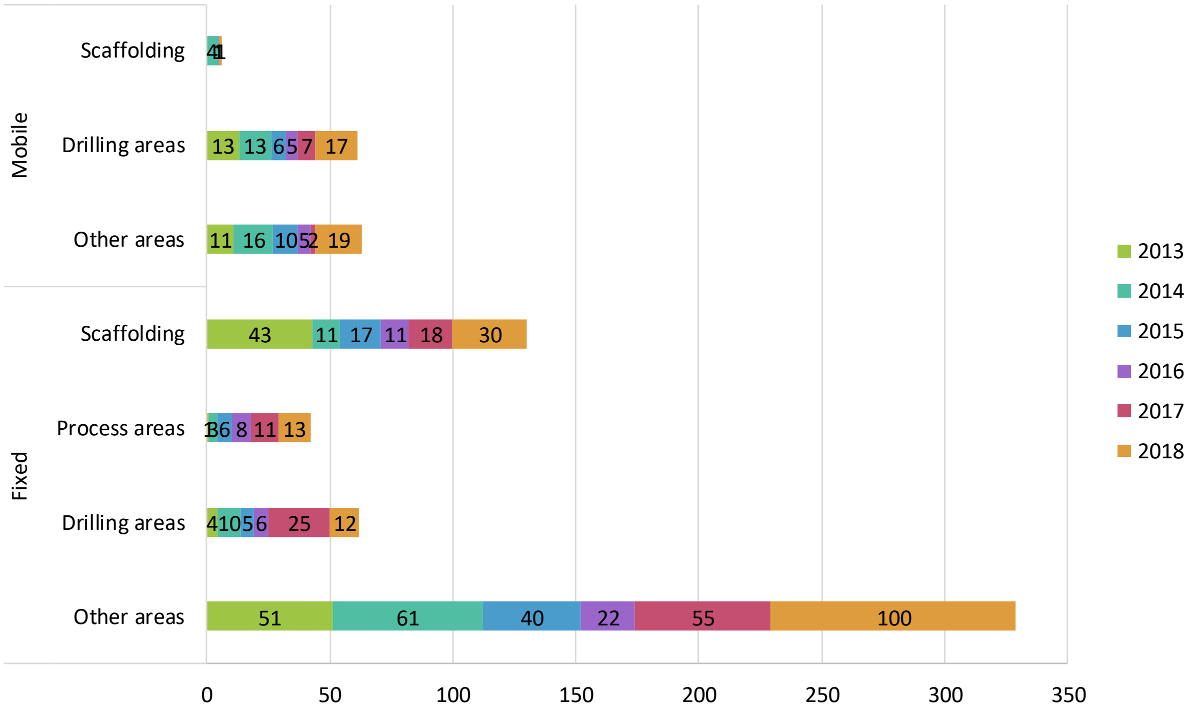

Figure 43 Total number of incidents > 40 J broken down by fixed and mobile facilities and main categories of work processes (number of incidents per year is given in the columns), for the period 2013-2018

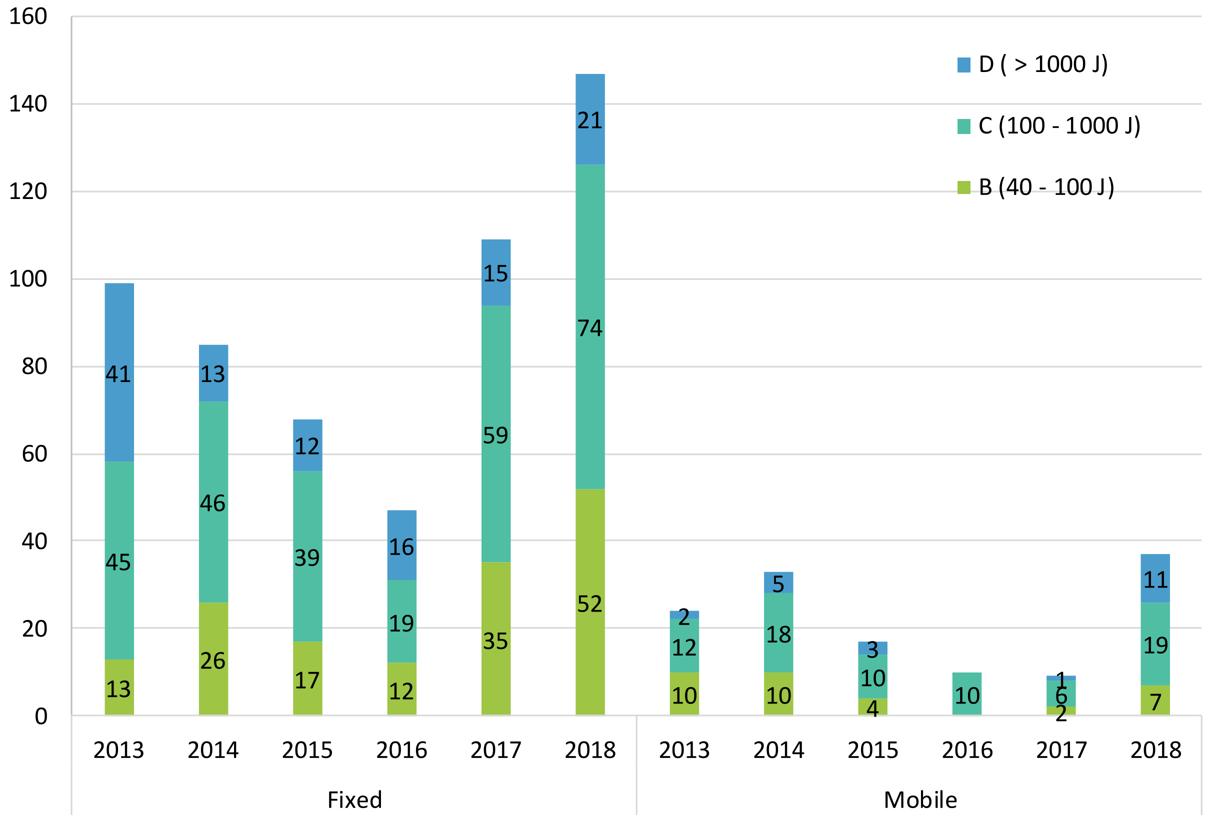

Figure 44 Number of objects by energy classes > 40 J, for fixed and mobile facilities, for the period 2013-2018

11.3 Other DFUs

The main report presents data for incidents that have been reported to the Petroleum Safety Authority Norway, as well as for other DFUs without major accident potential, such as DFU11, 13, 16 and 19, see **Feil! Fant ikke referansekilden.**.

12. Definitions and abbreviations

12.1 Definitions

See sub-chapters 1.10.1 - 1.10.3, as well as 5.2, in the main report.

12.2 Abbreviations

For a detailed list of abbreviations, see PSA, 2018a. The most important abbreviations in this report are:

CODAM	Database for damage to structures and subsea facilities
BDV	Blowdown valve
BOP	Blowout Preventer
BORA	Barrier and operational risk analysis
DDRS/CDRS	Database for drilling and well operations
DFU	Defined hazard and accident situations
DHSV	Downhole safety valve
DSYS	The PSA's database of personal injuries and hours of exposure during diving activities
ESDV	Emergency shutdown valve
PM	Preventive maintenance
GM	Metacentre height of floating facilities
HSE	Health, safety and environment
KG	The distance from the keel to the centre of gravity on floating facilities
KPI	Key Performance Indicator
CM	Corrective maintenance
PSA	Petroleum Safety Authority Norway
RNNP	Trend in risk level in the Norwegian petroleum activity
WIF	Well Integrity Forum

13. References

Detailed reference lists can be found in the main reports:

PSA, 2019a. Risk level in the petroleum activity – Norwegian Continental Shelf, Main report, 10.04.2019
PSA, 2019b. Risk level in the petroleum activity – onshore installations, 10.04.2019
PSA, 2019c. Risk level in the petroleum activity – Methodology report, 10.04.2019