

SUMMARY REPORT THE NORWEGIAN CONTINENTAL SHELF 2017 TRENDS IN RISK LEVEL IN THE PETROLEUM ACTIVITY



Preface

Trends in the risk level in the petroleum industry concern all parties involved in the industry, as well as the general public. Recent years' changes in the industry, which are still ongoing, have made the importance of monitoring trends in risk level even more prominent.

As a tool, RNNP has been in continuous development since it began in 1999/2000. This development takes place under the auspices of the tripartite collaboration. There has been agreement on the prudence and rationality of the selected course of development in terms of creating a basis for a shared perception of the HSE level and its trend in an industry perspective. The work has taken on an important position in the industry in that it contributes towards forming a shared understanding of the risk level. It is important that further development of RNNP safeguards its firm anchoring in the tripartite collaboration.

The petroleum industry has considerable HSE expertise. We have utilised this expertise by facilitating open processes and inviting contributions from key personnel from operating companies, helicopter operators, consultancy firms, research and teaching.

Objectivity and credibility are key for any qualified statements regarding safety and the working environment. We therefore depend on the parties having a shared understanding of the reasonableness of the methodology employed, and of the value created by the results. The parties' ownership of the process and the results are therefore important.

Many people have contributed to the performance of this work, both internally and externally. It would take too long to list all the contributors, but I particularly want to mention the positive attitude of the parties we have been in contact with in undertaking and developing the work.

Stavanger, 26 April 2018

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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, as more and more new players are being approved.

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, 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 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 2018.

2. Conclusions

The PSA seeks to measure progress in safety and the working environment using a series of indicators. This work is also important for preventing acute pollution of the environment. The basis for the evaluation is the triangulation principle, i.e. assessing developments by measuring trends in risk levels in a variety of ways.

Trends are the main focus. It must be expected that some indicators, particularly within a limited area, will at times display large annual variations. The petroleum industry should therefore focus on the positive development of long-term trends, particularly in light of Parliament's goal for the Norwegian petroleum industry to be a world leader in HSE.

There is underreporting of information concerning incidents and near-misses. In RNNP, a lower threshold is consistently used in respect of severity/the potential for which information is included in the data for the indicators. One reason for this is to reduce the impact of any underreporting, on the assumption that the degree of underreporting will be less for more serious incidents and near-misses. Although previous investigations have shown that underreporting has not changed the conclusions of the reports, it must always be taken into account that the type of information used in RNNP is subject to uncertainty.

Ideally, one should arrive at a summary conclusion on the basis of information from all the measurement instruments used. In practice, this is complicated, for example because the indicators reflect HSE conditions at levels that may be significantly different. This report particularly examines risk indicators associated with:

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

Data for the indicators for Norway's chemical working environment and ergonomic risk factors have not been reported for 2016 and 2017, since experience and assessments have shown that these indicators as designed do not give a sufficiently precise picture of the trend. In an understanding with the parties in the Safety Forum, the PSA, in collaboration with the companies' centres of expertise, has evaluated and tested alternative models for working environment indicators. It has proved difficult to come up with solutions that satisfy the requirements and wishes of the working environment domain while also meeting the technical indicator requirements of standardisation and the reduction of uncertainty. The results of this development work are expected to be submitted in 2018.

Survey questionnaire

In 2017, for the ninth time, a comprehensive questionnaire-based survey was conducted among personnel working on the Norwegian Continental Shelf (NCS). This survey has been conducted every other year since 2001.

The survey results presented in this report provide an overall picture of the employees' own assessments of the HSE climate and working environment in their workplaces. The response rate is calculated on the basis of known data about the population, such as produced working hours on facilities/installations reported to the PSA in the second half of 2017, the ratio between the number of operator and contractor employees, and other known demographic characteristics. 6,238 people completed the form, corresponding to 31.3% of the estimated workforce. This is a higher response rate than in 2015, and the number of responses is sufficient for performing statistical analyses, including at group level.

For the results as a whole, there is a negative trend from 2015 to 2017. This applies to the HSE climate, perceived risk, the working environment and health issues.

The HSE climate indicators are assessed as generally poorer in 2017 than in 2015. One pattern we observe in the results is that the respondents' assessments of their own

behaviour is less characterised by a negative trend, the index comprising statements on their own motivation and intentions remaining stable and high for the whole period from 2007 to 2017. The index comprising statements about management's prioritisation of safety had a positive trend from 2007 to 2013, but has fallen since 2013 and especially so from 2015 to 2017, and is now at its lowest level of the decade.

Overall, the perception of risk is greater than in previous measurements. 8 out of 13 risk factors are assessed significantly more negatively in 2017 than in 2015 and, as previously, the greatest risks are associated with falling objects, gas leaks and serious occupational accidents The largest (negative) change relates to the perceived risk of helicopter accidents.

The assessment of the working environment also shows that the majority of the indicators had a significantly poorer outcome in this year's measurements. This applies to the physical, chemical, ergonomic, psycho-social and organisational working environments.

Although own health and capacity for work are evenly considered as good, the results show that these factors are assessed as significantly poorer in this year's survey. There are also negative trends for 11 out of 14 health complaints.

Major accidents

No major accidents, meaning in this context accidents resulting in several fatalities, were recorded in 2017. There was one fatality in 2017, linked to a work accident.

Whereas in 2015 and 2016 there were near-misses/incidents of especial severity in view of their potential for causing major accidents, there were no such incidents in 2017.

The number of near-misses with major accident potential has shown an underlying positive trend since 2002. In 2017, there were 32 such incidents (helicopters not included). Such a low number of incidents of this type has not previously been registered in the period that RNNP covers. 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 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.

Ten non-ignited hydrocarbon leaks were registered in 2017 (12 in 2016) and 12 well-control incidents (14 in 2016). Nine of the hydrocarbon leaks were in the lowest category (0.1-1 kg/s) in 2017, while one exceeded 1 kg/s. All the well-control incidents in 2017 were in the lowest risk category.

If the near-misses with major accident potential are weighted by factors that identify their inherent potential for causing fatalities in the event that they developed further, we can see that the indicator (the total indicator) is at the same level in 2017 as in 2013 and 2014. This may indicate that the increase observed in this indicator in 2015 and 2016 does not reflect a persistent change in an otherwise positive trend. 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 levels in 2015 and especially 2016 can be ascribed in part to such near-misses. The focus should therefore be on the underlying trend and any changes in it.

Helicopter risk constitutes a large share of the overall risk exposure of employees 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.

In the period in which RNNP has collected helicopter-related data, the Turøy accident in 2016 is the only helicopter accident within the scope of the survey with a fatal outcome.

In the expert group's assessment of incidents in 2017, four incidents were identified within the most serious category. Two of the incidents had no remaining barriers, and two had one remaining barrier. Three of the incidents occurred while the helicopter was at an airport/on a helideck, while one incident occurred while landing on a facility. In 2016 there were two such incidents, one of which was the Turøy accident. This indicator incorporates few incidents per year and is therefore sensitive to relatively large annual variations. It is not possible to conclude that the increase in the number of incidents from 2016 to 2017 indicates a deterioration in helicopter safety. It is important that lessons learned from such incidents are actively used to reduce risk.

Barriers

The industry is increasingly focusing on indicators that are able to describe robustness in terms of withstanding incidents – so-called leading indicators. Barrier indicators are an example of these. The barrier indicators show that there are large differences in levels between the facilities. Over time, a positive trend has been observed for some of the barriers that have been above the industry norm in recent years. With the exception of riser ESDV closure tests and DHSVs, all barriers have shown a downward or stable trend in recent years. 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 nine years. The data for the permanently placed facilities show that there are few hours of backlog in preventive maintenance, but that a number of facilities have not performed HSE-critical preventive maintenance in accordance with the players' own deadlines.

Some facilities still have a considerable number of hours of corrective maintenance unperformed. The figures show, however, a significant reduction in total corrective maintenance in 2017 compared with the preceding years. The total number of hours of outstanding HSE-critical corrective maintenance unperformed in respect of the players' own deadlines is approximately the same as in the previous year. The total number of hours of preventive and corrective maintenance performed in 2017 is around the same as in the year before.

The data for the mobile facilities shows that there is large variation in the degree of tagging and classification of systems and equipment. The data also show large variations in the backlog of preventive maintenance and in outstanding corrective maintenance. Several facilities have not performed HSE-critical preventive and corrective maintenance in accordance with the player' own deadlines.

Work accidents involving fatalities and serious personal injuries

There was one fatal accident within the PSA's area of authority on the NCS in 2017. This occurred on 7 December 2017 on Mærsk Interceptor during a maintenance operation. A raw water pump was to be lowered into position. This incident occurred in connection with lifting and installing a seawater pump. A steel sling parted, and the pump fell down. A power cable attached to the pump was pulled along in the fall and hit two people who were in the vicinity. One of them fell into the sea and died, while the other was seriously injured.

In 2017, 205 reportable personal injuries were recorded on the NCS. 189 such injuries were reported in 2016. 27 of these were classified as serious in 2017 against 17 in 2016.

From 2007 to 2013, there was a fall in the frequency of serious personal injuries; from 2014 to 2017, the frequency increased except for 2016 when there was a fall. From 2016 to 2017, there was a significant increase to 0.81 serious personal injuries per million working hours from 0.49 in 2016. The increase from 2016 to 2017 occurred on both mobile and production facilities. The change is not statistically significant viewed against the preceding 10-year period.

3. Work undertaken

The work in 2018 is a continuation of activities performed in 2000-2017; see previous reports on our website (<u>www.ptil.no/rnnp</u>). 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 survey questionnaire
- Improve the model for barrier performance in relation to major accidents
- Develop new indicators of noise, chemical working environment and ergonomic risk factors
- 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 Responsible for performance and further development of the work Authority Norway:
- Operating companies Contribute data and information about activities on the facilities. and shipowners:
- Helicopter operators: Contribute data and information about helicopter transport activities
- HSE specialist group: Evaluate the procedure, input data, viewpoints on the development, (selected specialists) evaluate trends, propose conclusions
- Safety Forum: Comment on the procedure, results and recommend further work (multipartite)
- Advisory group: Multipartite RNNP advisory group that advises the Petroleum Safety (multipartite) Authority regarding further development of the work.

The following external parties have assisted the PSA with specific assignments:

- Terje Dammen, Jorunn Seljelid, Torleif Veen, Trine Holde, Marie H. Saltnes, Trond Stillaug Johansen, Asbjørn Gilberg, Kai Roger Jensen, Ragnar Aarø, Rolf Johan Bye, Ingrid Bjørkli, Sigen Marie Hallan and Asle Fuhr, Safetec
- Kari Kjestveit, Stian Brosvik Bayer, Leif Jarle Gressgård and Anne Marthe Harstad, IRIS
- The PSA's working group consists of: Øyvind Lauridsen, Mette Vintermyr, Tore Endresen, Arne Kvitrud, Narve Oma, Morten Langøy, Trond Sundby, Hilde Nilsen, Inger Danielsen, Elisabeth Lootz, Jon Erling Heggland, Sigvart Zachariassen, Brit Gullesen, Anne Sissel Graue, Anne Mette Eide, Hans Spilde, Semsudin Leto, Eivind Jåsund, Bente Hallan, Bjørnar Heide and Torleif Husebø.

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

- Øyvind Solberg, Norwegian Oil and Gas Association, represented by LFE
- Egil Bjelland, Morten Haugseng, Nils Rune Kolnes, CHC Helikopter Service
- Martin Boie Christiansen, 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)
 - Construction-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 with significance for 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 in the PSA.

Tabell 1 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

Figur 1 and Figur 2 show the developments over the period from 2000-2017 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, 2018a) presents the underlying data in detail.

DFU	DFU description	Data sources
no.		
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)

Table 1Overview of DFUs and data sources

DFU	DFU description	Data sources
no.		
8	Damage to platform	CODAM (PDA) + the
	structure/stability/anchoring/positioning fault	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 ₂ S 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 a nearly unchanged total number of working hours on production facilities in 2017 compared with 2016, an increase of 0.1%. Working hours in production in 2016 and 2017 were at the lowest level since 2002. This is a marked reduction, and the total number of working hours in 2017 is around 13% below the average for the period 2000-2017. For mobile facilities, this is a fall of around 13% from the previous year. The number of drilled exploration and production wells is at the same level as in the previous year. However, the number in 2017 is relatively high, at around 8% above the average for the period 2000-2017.

Production volume increased somewhat relative to 2016, and a regular increase can be observed 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 5.1.

3.4 Documentation

Analyses, assessments and results are documented as follows:

- Summary report the Norwegian Continental Shelf for the year 2017 (Norwegian and English versions)
- Main report the Norwegian Continental Shelf for the year 2017
- Report for onshore facilities for the year 2017
- Report for acute spills to sea for the Norwegian Continental Shelf 2017, to be published in the autumn of 2018
- Methodological report, 2018

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

4. Survey questionnaire

A questionnaire-based survey was conducted of all personnel who were offshore in the period 16 October to 28 November 2017. At an overarching level, the object of the questionnaire-based survey is to acquire knowledge about employees' perception of the state of HSE in Norwegian petroleum activities. This is the ninth time that such a survey has been conducted on the NCS. The first occasion was in 2001, since when it has been conducted every other year. In parallel with this survey, a similar survey was carried out of petroleum facilities onshore. The results from the onshore facilities are presented in a separate report.

The questionnaire covered the following topics: demographics, the HSE climate, perceived accident risk, leisure conditions, working environment, capacity for work, health, sickness absence, sleep, rest, and working hours.

A total of 6,238 people completed the questionnaire. The response rate for this year's survey was 33.3% for mobile facilities and 30.5% for production facilities. For the NCS as a whole, the response rate was 31.3%. The response rate is calculated on the basis of the number of working hours which the companies have reported to the PSA. Although this is a relatively low response rate, the number of replies is nonetheless sufficiently large to permit statistical analyses and to break down the data into different groupings. Although the response rate is somewhat lower than desirable, the distribution of responses is assessed to be satisfactory since it coincides relatively well with other known information about the population, for example the distribution between mobile and production facilities. There is, however, a certain over-representation of operators' employees at the cost of contractors' employees, but the ratio between these groups is unchanged from 2015 to 2017. There is also relatively good stability in the distribution of responses for other groups from 2015 to 2017, and the trend in most of the changes has coincided well with other known information (for example, the age increase in respondents corresponds with the fact that many redundancies in the industry are made on the basis of length of service). The number of responses is large. This provides good statistical power to the analyses, and provides a good foundation for commenting on HSE trends over time.

4.1.1 HSE climate

In general, the results show a deterioration in many areas associated with the HSE climate. It can also be seen that challenging areas from previous years remain challenging. The list below shows the statements that were assessed most negatively from an HSE perspective:

- Deficient maintenance has caused poorer safety (51.3% agree fully or in part)
- Reports about accidents or dangerous situations are often "embellished" (37% agree fully or in part)
- There are different procedures and routines for the same matters on different facilities and this poses a threat to the safety (34% agree fully or in part)
- Dangerous situations arise because everyone does not speak the same language (36.3% agree fully or in part)
- In practice, production takes priority over HSE (35.5% agree fully or in part)
- There is enough manning to properly safeguarding HSE (32.3% disagree fully or in part)
- I think it is easy to find what I need in the governing documents (requirements and procedures) (33% disagree fully or in part)
- I feel sufficiently rested when I am at work (19.3% disagree fully or in part)
- The management takes input from the safety delegates seriously (13.3% disagree fully or in part)

Although the above-mentioned indicators are those assessed most negatively, we see significant negative changes in the vast majority of the HSE climate indicators from 2015

to 2017. For the negative HSE climate statements, we find that 20 out of 23 have a negative trend. Concerning positive HSE statements, we find a fall in 29 out of 32 indicators. No indicators for HSE climate had a significant positive change from 2015 to 2017.

One pattern we observe in the results is that the respondents' assessments of their own behaviour is less characterised by a negative trend, the index comprising statements on their own motivation and intentions remaining stable and high for the whole period from 2007 to 2017 (at approx. 4.7 on a scale from 1 to 5 where 5 is the best). The index comprising statements about management's prioritisation of safety had a positive trend from 2007 to 2013, but has fallen since 2013 and especially so from 2015 to 2017, and is now at its lowest level of the decade. Analyses show that employees who have experienced restructuring have more negative assessments of the HSE climate indexes that those who have not.

4.1.2 Perceived accident risk

Perceived risk overall has had a negative trend since 2015. 8 out of 13 risk factors are assessed significantly more negatively than in previous measurements. As before, the *highest evaluation* of risk is linked to falling objects, gas leaks and serious occupational accidents, while the *largest* (negative) *change* from 2015 to 2017 is in the perceived risk of a helicopter accident. Risk factors that are perceived to be rather similar to 2015 are risks of explosion, radioactive sources, collisions with ships/other vessels/drifting objects, collapse of facilities' loading-bearing structures or loss of buoyancy and falling objects.

4.1.3 Working environment

Overall, the results show a negative trend in employees' assessment of different working environment factors, in that the majority of the individual indicators have significantly changed since the previous measurement. For the physical, chemical and ergonomic/mechanical working environment, we find higher perceived exposure or stress for 12 out of 13 indicators in 2017 compared with 2015. The largest changes are in the assessment of the extent of working in cold weather-exposed areas, whether chemicals can be smelt or dust or smoke clearly seen in the air, whether heavy lifts have to be performed, and whether lifts have to be performed with the upper body twisted or bent over.

For the psycho-social and organisational working environments, 14 out of 20 indicators show a negative change over the same period. Compared with 2015, we see that in 2017 a greater share of the respondents have more negative assessments of their opportunity for influencing decisions of importance to their work, fewer receive feedback from their immediate superior, more perceive shift arrangements as stressful, more state that the work requires so much attention that it is perceived as stressful and that they have so many tasks that it becomes difficult to concentrate on each individual one.

4.1.4 Leisure

The employees are generally satisfied with most of the circumstances relating to leisure offshore. The results show, however, a significant fall in the perception of food/refreshments, while fitness opportunities are assessed as significantly better. The results show a negative trend concerning assessments of whether the respondents sleep well a) when they are offshore, b) the last nights before travelling offshore and c) the first nights following an assignment offshore. From 2013 to 2015, there was a positive trend concerning assessments of whether cabins had to be shared. The results for 2017 are at the same level as 2015.

4.1.5 Health and sickness absence

Most of those who responded to the survey assessed their own health and capacity for work relative to mental and physical requirements as good or very good, but the average is significantly lower than in 2015. Compared with previous measurements, we find a

general increase in health problems experienced. The exceptions concern "tinnitus", "Raynaud's phenomenon (white finger)", "cardio-vascular abnormalities", which were assessed as similar to 2015. Concerning "Raynaud's phenomenon" and "cardio-vascular abnormalities", a somewhat larger proportion believe that the complaints are job-related compared with previous measurements. The largest negative change in complaints experienced is in "neck/shoulder/arm/pains" and "knee/hip pains".

The proportion reporting having had sickness absence in the last year was at the same level as in 2015, around 25%. Those working within the catering and crane/deck areas report the highest sickness absence compared with other work areas. The proportion subject to an accident involving personal injury was 4%. 84.1% of the injuries were reported to a manager/nurse, which is a fall from 2015, when 92.2% were reported.

4.1.6 Comparison of HSE assessments offshore and onshore

For most areas, it is possible to compare the responses from the offshore and onshore surveys. This applies to the parts of the survey that are essentially the same.

The samples offshore and onshore vary somewhat in terms of distribution between operator and contractor employees, gender, permanence of employment, area of work and managerial responsibility. Reporting concerning restructuring and downsizing also varies, both over time and between offshore and onshore.

Common to both onshore and offshore is that the assessment of the HSE climate, the working environment and health have shown a negative trend since the previous measurements in 2015. Although the trend is similar, the change is statistically significant for a higher number of indicators and statements among offshore employees. There was a larger number of responses from offshore (N=6,238) than onshore (N=1,267), and the differences from year to year can more easily have a significant impact in a larger sample.

In respect of HSE climate statements, for both onshore and offshore employees, there is a negative trend in statements concerning management's prioritisation of safety. This trend may be linked to restructuring and downsizing in the industry. For example, the statement "Deficient maintenance has caused poorer safety" had a marked negative trend both offshore and onshore. The same applies to "Reports about accidents or dangerous situations are often "embellished" and "There is enough manning to properly safeguarding HSE". Although the negative trend is common, there are many individual statements that are assessed differently (in number/level) by offshore and onshore employees.

Perceived risk is assessed as higher onshore than offshore when comparing the same hazard situations. The assessment of the risk of gas leak, fire, explosion, toxic emission and sabotage/terrorism is determinative for this difference.

Both offshore and onshore managers state that they have more stressful job requirements and higher workload in 2017. Non-managers report lower job control and capacity for work, higher sickness absence and a more negative response to the HSE statements than managers with or without personnel responsibilities. Common to both offshore and onshore is that women have a lower degree of control over their own work and assessed themselves as having lower capacity for work than men, while also stating that they have more musculoskeletal disorders and higher sickness absence. Men have more hearing complaints than women.

Concerning job requirements, management support and support from colleagues, we find that these are assessed similarly both offshore and onshore in 2017. We find, however, that offshore employees report more hearing complaints and musculoskeletal disorders than employees at onshore facilities, while onshore employees report a lower assessment of their own capacity for work and higher workload than employees offshore.

Reporting of short-term absence is nearly twice as high onshore as offshore, while absence greater than 14 days is higher for offshore employees. The proportion of short-term

absence is fairly stable in both categories, while long-term absence has increased from 2015 to 2017 both onshore and offshore. The proportion who relate the absence to circumstances in their work situation is somewhat higher among offshore employees than onshore employees.

5. Status and trends – helicopter incidents

The cooperation with the Civil Aviation Authority Norway and the helicopter operators was continued in 2017. 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, 2018a) 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.

5.1 Activity indicators

Figur 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 2000-2017.

TRANSPORT SERVICE

SHUTTLE TRAFFIC



Figure 3 Flight hours and person flight hours (transport service) and number of passengers (shuttle traffic), 2000-2017

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 decline in both flight hours and person flight hours that we see in the indicator is however greater than what the fall in working hours should indicate.

Shuttle traffic comprises passenger transport in which the helicopter's departure and arrival are for a single facility. The fact that the number of passengers showed only a weak fall in the period 2000-2017, 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.

5.2 Incident indicators

5.2.1 Incident indicator 1 – serious incidents and near-misses

Figur 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 2017, there were two incidents with no remaining barriers and two incidents with one remaining barrier. Three of the incidents happened when the helicopter was on the ground/deck with its rotor running and passengers onboard, and one incident related to landing on a helideck on a mobile unit. For all the incidents, it is assessed that, in the worst case, the helicopter could have toppled.

One incident involved a helicopter being parked half a metre from a pylon, without the pilots or ground personnel being aware of how close it was to the pylon. In another incident, pilot error caused rotor lift on the helicopter so that one side of the helicopter lifted from the ground before the pilots regained control.

The last two cases involved rope/jacking strap on the helideck that the pilots did not/could not see and ground personnel were not in control of, and which could have been wound into the main rotor or side rotor.



Figure 4 Incident indicator 1, incidents with little or medium remaining safety margin, 2006–2017

5.2.2 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.

All degrees of severity beyond "no impact on safety" are included in these indicators. Figur 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.

Figur 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. The largest contributor in 2017 relates to misunderstandings between air traffic services and pilots, especially in relation to directional or altitude changes and taxiing before departure and after landing.

In 2017, six previous improvement suggestions were closed and three new improvement suggestions were opened.

- 14. Improved requirements are to be introduced for the marking of helidecks and obstructions on the facilities, including flare stacks, with lights. The lights' design and intensity shall be specified so as to ensure that the obstructions are clearly visible in all light conditions.
- 15. WiFi/4G is to be installed on all helidecks, so that the EFB (Electronic Flight Bag) can be updated with the latest information on weather, waves and other conditions.
- 16. The oil company to which the mobile facility is contracted is to be given increased responsibility for ensuring that the helideck is inspected by an approved company, that personnel have adequate training and that the helideck manual is complied with.



Figure 5 Helideck factors, 2008–2017



Figure 6 ATM aspects, 2008-2017

6. 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 5. Barriers against major accidents are presented in chapter 7.

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 2000-2017. 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.

The fatal accident on Mærsk Interceptor in which a man fell overboard is assessed as a work accident.

6.1 DFUs associated with major accident risk

Figur 7 shows the trend in the number of reported DFUs in the period 2004-2017. It is important to emphasise that this figure does not take account of the potential of nearmisses 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 was 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 2017 is the lowest recorded in the period.



*Within the safety zone Figure 7 Reported DFUs (1-10) by categories

In Figur 7, the number of incidents is presented without normalisation relative to exposure data. Figur 8 shows the same overview, but now normalised against number of working hours. The 2017 level is statistically significantly lower than the average for the period 2007-2016.



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

6.2 Risk indicators for major accidents

6.2.1 Hydrogen leaks in the process area

Figur 9 shows the number of hydrocarbon leaks greater than 0.1 kg/s in the period 2000-2017. Ten hydrocarbons leaks were recorded in 2017, one in the category 1-10 kg/s and nine in the category 0.1-1 kg/s.



Figur 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 relatively low risk contribution in 2017 derives from there being only one incident in the category 1-10 kg/s, where the leak was at the lower end, at a rate of 1 kg/s.



Figure 10 Number of hydrocarbon leaks exceeding 0.1 kg/s, 2000-2017, weighted according to risk potential

Figur 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. Figur 11 shows that, despite the number of leaks per facility year, in 2017 this parameter lies within the prediction interval. The change is therefore not statistically significant relative to the average for the period 2007-2016. 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

6.2.2 Loss of well control, blowout potential, well integrity

Figur 12 shows the occurrence of 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 within exploration drilling.

There was an increase in the number of incidents in production drilling from 2013 to 2016, before a reduction in 2017 from the preceding year. All the 12 well-control incidents in 2017 are classified as level 3, low severity.



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

Figur 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 2017 there was a low risk associated with well-control incidents.



drilling, 2000-2017

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 1961 wells in 2017, 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 with external leaks Orange: one barrier failed and the other is intact, or a single failure could cause a leak to the surroundings Yellow: one barrier leaks within the acceptance criteria or the barrier has been degraded, the other is intact





Figure 14 Well categories

The mapping shows an overview of well categories distributed according to the percentage of the total sample of 1961 wells.

The categorisation shows that 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. Three wells (0.2%) were recorded in the red category and 43 wells (2.2%) 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 542 wells (27.6%) in the yellow category.

There was an increase in the percentage of wells in the top three categories from 28.5% in 2016 to 30% in 2017. The development in the different categories is shown in Figur 15.



Figure 15 Development in well categories, 2009-2017

6.2.3 Leak/damage to risers, pipelines and subsea facilities

In 2017, no leaks from risers to production facilities were reported. Nor were any leaks from pipelines reported in 2017. For subsea facilities, one hydrocarbon leak was reported as well as a number of minor spills of hydraulic fluid and some small hydrocarbon leaks. The hydrocarbon leak occurred while a mobile facility was present, so it is classified as an incident on a mobile facility. Figur 16 shows an overview of the number of leaks from 2000 to 2017.



Figure 16 Number of leaks from risers & pipelines within the safety zone, 2000-2017

There were two incidents of serious damage to pipelines and risers in 2017. There was no serious damage 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. Figur 17 shows an overview of the most serious incidents of damage within the safety zone during the period 2000-2017.



Figure 17 Number of incidents involving serious damage to risers & pipelines within the safety zone, 2000-2017

6.2.4 Ship 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 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 Statoil Marine at Sandsli. The number of instances of ships on collision courses has declined substantially in recent years. In 2017, a total of two 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). Statoil 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 2017 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 great 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 2000-2017 is shown in Figur 18.

In 2017, one structural damage incident was recorded. The fall in the number of incidents is connected to an extent with the large decline in the number of mobile facilities on the NCS.



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

6.3 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. Figur 20 shows the indicator for production facilities with annual values, in addition to a three-year rolling average. The large variations from year to year are reduced when viewing the three-year rolling average, thereby clarifying the underlying 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.

Figur 19 shows that the total indicator in 2017 is lower than in 2016, and at the same level as in 2013 and 2014.



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 annual 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)

7. 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.

7.1 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/emissions
- 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) are implemented.

Figur 22 shows the proportion of failures for the barrier elements on production facilities. 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 2017

The main report shows both the "mean percentage of failures" (Figur 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. Figur 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 2017, the average percentage of failures during the period 2002-2017, as well as the total number of tests carried out in 2017 (as text on the X axis, along with the facility code).

The industry norm for gas detection is 0.01. Figur 23 shows that 18 facilities are above the norm for percentage failures in 2017, while 15 are above the norm in relation to the average for the period 2002-2017.



Figure 23 Percentage of gas detection failures

For production facilities, barrier data have now been collected for 16 years for most of the barriers, and the results show that there are large differences in level between the facilities. For the industry as a whole, a positive trend has been observed for some of the barriers that have been above the industry norm in recent years.

This is apparent from Figur 24 and Figur 25 which show mean failures using a three-year rolling average for the different barriers. Riser ESDV leak tests and deluge valves were below the industry norm of 0.01 in 2016 and show a further fall in 2017. Mean percentage failures on a three-year rolling average for riser ESDV leak tests fell in the period 2011-2015, but saw a weak increase from 2015 to 2017. BDVs show a fall from 2012 to 2015 and are at around the same level in 2016 and 2017, but are still above the industry norm. DHSVs, however, show a rising trend from 2012 to 2017. Other barriers remain stably below applicable industry norms. This may mean that the focus in recent years on barrier management in the industry is also yielding results within this area.



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



Tabell 2 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 2017 and for the period 2002-2017. This can then be compared with the industry norm for safetycritical systems. Figures in **bold** indicate that the percentage of failures, at industry level, 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. As in the previous year's RNNP report, the mean percentage of failures for 2017 and the mean percentage of failures for 2002-2017 for riser ESDVs, DHSVs and blowdown valves (BDVs) are above the industry norm. The same applies to the mean percentage of failures for 2002-2017 for deluge valves and riser ESDV leak tests.

Barrier elements	Number of facilities where tests were performe d in 2017	Average, number of tests, for facilities where tests were performe d in 2017	Number of facilities with percentag e failures in 2017 greater than the industry norm	Number of facilities with average percentag e failures 2002- 2017 greater than the industry norm* ¹	Total percent age failures in 2017	Mean percent age failures in 2017	Total percent age failures 2002- 2017	Mean percent age failures 2002- 2017	Industry norm for availability
Fire detection	71	572	6	4	0.002	0.003	0.003	0.004	0.01
Gas detection	71	333	18	14	0.008	0.008	0.007	0.008	0.01
Shutdown:									
· Riser ESDV	61	21	12	30	0.011	0.015	0.014	0.018	0.01
Closure test	59	14	10	23	0.012	0.024	0.012	0.020	0.01
Leak test	58	8	2	17	0.008	0.002	0.013	0.013	0.01
 Wing and master (Christmas tree) 	73	232	11	7	0.011	0.012	0.008	0.010	0.02
Closure test	68	120	6	3	0.008	0.006	0.006	0.007	0.02
Leak test	73	121	13	8	0.014	0.014	0.010	0.011	0.02
· DHSV	73	83	37	34	0.042	0.030	0.027	0.024	0.02
Blowdown valve (BDV)	62	57	26	41	0.023	0.024	0.021	0.022	0.01
Pressure safety valve (PSV)	70	123	8	11	0.015	0.012	0.030	0.024	0.04
Isolation using BOP	20	138			0.001	0.001	0.005	0.016	* 2
Active fire safety:									
· Deluge valve	70	30	8	22	0.006	0.008	0.009	0.011	0.01
· Start test	61	118	9	14	0.002	0.003	0.003	0.003	0.005

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

7.2 Barriers associated with maritime systems

In 2017, 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 values for floating facilities at year-end.
- KG values are also collected during the year, but will not be used until next 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.

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.

7.3 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 the players 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 player is responsible for regulatory compliance and ensuring systematic HSE efforts, so as to reduce the risk of unwanted incidents and major accidents.

7.3.1 The management of maintenance of permanentely placed facilities

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



Figure 26 Total backlog in PM per year in the period 2011-2017 for the permanently placed facilities

Figur 26 shows the total backlog in preventive maintenance in the period 2011-2017 (sum of monthly averages). The total backlog in preventive maintenance and the backlog for HSE-critical equipment are somewhat smaller in 2017 than in reporting year 2016.



Figure 27 Total CM at 31/12/2017 for the permanently placed facilities. The figure also shows data for 2015 and 2016

Figur 27 shows the *total corrective maintenance* identified at 31 December2017, but not yet performed. Some facilities have a considerable number of hours of corrective maintenance unperformed.



Figure 28 Total number of hours for performed maintenance, modifications and planned shutdowns for the permanently placed facilities in the period 2011-2017

Figur 28 shows the total number of hours for *performed maintenance, modifications and planned shutdowns* for the permanently placed facilities in the period 2011-2017. The figure is especially intended to show the *distribution* of the activities. We can see that the hours of preventive and corrective maintenance performed in 2017 are on a par with the year before.

In the main report, we observe that:

- there is a regular increase in tagged and classified equipment in the period 2011-2017.
 A large part of this increase is due to the influx of new facilities, but some have also been removed from the survey
- some of the tagged equipment is not classified, and this proportion is approximately as large as the year before
- there is notable variation in the proportion of HSE-critical equipment

- there are few hours of backlog in preventive maintenance, but a number of facilities have not performed HSE-critical preventive maintenance in accordance with the players' own defined deadlines
- the total backlog in preventive maintenance and the backlog for HSE-critical equipment are somewhat smaller in 2017 than in 2016
- some facilities have a considerable number of hours of corrective maintenance unperformed as at 31 December 2017
- some operators have a considerable number of hours of corrective maintenance unperformed at 31 December 2017, but the numbers are significantly reduced compared with the previous years
- the number of hours of total outstanding HSE-critical corrective maintenance is on a par with the year before
- the number of hours of preventive and corrective maintenance performed in 2017 is around the same as in 2016

These observations must be seen in the context of the regulatory requirements. This means

- installations, 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 overall. 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 it is the HSE-critical equipment that is intended to inhibit or restrict the defined hazard and accident situations

7.3.2 The management of maintenance of mobile facilities

Figur 29 shows *the backlog in preventive maintenance* in 2017 (monthly average). 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 players' 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 29 Backlog in PM for mobile facilities in 2017

Figur 30 shows *outstanding corrective maintenance* in 2017 (monthly average). 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 players' own deadlines.

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

On several occasions, we have emphasised the importance of the players 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.



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Figure 30 Outstanding CM for mobile facilities in 2017

In the main report, we observe that:

- there is large variation in the degree of tagging and classification of the facilities' systems and equipment. Some 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 are large variations in the backlog of preventive maintenance
- there are large variations in the outstanding corrective maintenance
- some facilities have not performed HSE-critical preventive maintenance in accordance with the players' own deadlines
- some facilities have not performed HSE-critical corrective maintenance in accordance with the players' own deadlines

These observations must be seen in the context of the regulatory requirements. This means

- installation, 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 overall. 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
- 8. Work accidents involving fatalities and serious personal injuries

There was one fatal accident within the PSA's area of authority on the NCS in 2017. This occurred on 7 December 2017 on Mærsk Interceptor during a maintenance operation The incident occurred in connection with lifting and installing a seawater pump. A steel sling parted, and the pump fell down. A power cable attached to the pump was pulled along in the fall and hit two people who were in the vicinity. One of them fell into the sea and died, while the other was seriously injured.

In 2017, 205 reportable personal injuries were recorded on the NCS. 189 such injuries were reported in 2016. 27 of these were classified as serious in 2017 against 17 in 2016.

In addition, 22 injuries classified as off-work injuries and 25 first-aid injuries were reported in 2017. For comparison, in 2016 there were 25 off-work injuries and 28 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 reported incidents on NAV forms and, even through there is an improvement from 2016, 25% of injuries are still not reported to us on 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 one classified as serious. In order to clear up deficient reporting, in 2017 a request was made to relevant employers in which we asked for missing NAV forms for injuries that occurred in 2016.

The frequency of reportable personal injuries per million working hours on production facilities went from 6.0 in 2016 to 7.0 in 2017. There were 170 personal injuries on production facilities in 2017 against 144 in 2016. 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 was unchanged from 2016 to 2017 at 24.1 million.

In 2017, there were 35 personal injuries on mobile facilities, compared with 45 in 2016. On mobile facilities, the frequency of reportable personal injuries went from 4.2 injuries per million working hours in 2016 to 3.8 in 2017. This is the lowest recorded rate for the entire period. Over the long term, as with production facilities, mobile facilities have shown a positive trend, and the frequency in 2017 is under one third that of the level in 2007. The number of working hours fell from 10.7 million in 2016 to 9.3 million in 2017.

8.1 Serious personal injuries

Figur 31 shows the frequency of serious personal injuries on production facilities and mobile facilities combined. In 2017, a total of 27 serious personal injuries were reported against 17 in 2016. In 2017, the serious personal injuries included one fatality.



Figure 31 Serious personal injuries per million working hours – NCS

From 2016 to 2017, there was an upturn in the frequency of serious personal injuries per million working hours from 0.5 to 0.8. The change from 2016 to 2017 is significant. However, even in 2017, the frequency is within the expected level based on the ten preceding years. In the period 2007 to 2013, there was a downward trend in the serious personal injury rate. The injury rate in 2013 was at its lowest level. With the exception of 2016, when we had a large reduction, we see a rising trend in the frequency of serious personal injuries since 2013. The activity level on the NCS last year fell by 1.3 million to 33.5 million working hours.

8.1.1 Serious personal injuries on production facilities

Figur 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 in subsequent years rose. The injury rate in 2017 is 0.8 and we need to go back to 2010 to find a similar figure. However, in 2017 the frequency is within the expected level based on the ten preceding years. On production facilities, there were 19 serious personal injuries in 2017 against 12 in 2016. The increase from 2016 to 2017 was primarily within drilling and wells, where the frequency went from 0.4 to 1.6 serious personal injuries per million working hours.



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

8.1.2 Serious personal injuries on mobile facilities

Figur 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). In 2011, the rate doubled, and then fell somewhat in 2012. From 2013, 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 had an increase from 0.5 in 2016 to 0.9 serious personal injuries per million working hours. The injury rate is within the expected values based on the preceding ten years. The increase from 2016 to 2017 on mobile facilities was in both drilling/wells (from 0.9 to 1.3) and operation/maintenance (from 0.5 to 1.3). As previously mentioned, there was one fatality in 2017 on a mobile facility. The person worked within maintenance.

The number of hours reported for mobile facilities in 2017 fell by around 1.4 million, from 10.7 million in 2016 to 9.3 million in 2017. The number of serious personal injuries in 2017 was eight, against five in 2016.



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

9. Other indicators

9.1 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 2013-2017. The analysis looks at both the five years combined and a comparison between the years, as appropriate.

In this year's report, the categorisation of the two lowest energy classes has been changed by increasing the difference between the lowest and next lowest energy class from 10 J to 40 J. Other key aspects in this year's report are:

- There is a distinction between permanently placed and mobile facilities where the data supports this.
- **Normalisation of the data** has been used so that account of the activity level is taken when data are compared between the years.

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

Permanently placed facilities

- For *permanently placed facilities*, a fall is observed in the number of reported incidents (Figur 34) (both absolute and normalised) from 2013 to 2014, but there was then a regular increase in the period 2014-2016, and a large increase in the number of reported incidents for 2017.
 - The increase is primarily associated with lifting equipment in drilling areas, where the number of incidents tripled relative to 2016, and offshore cranes, where the number of incidents doubled (Figur 35).
 - The number of incidents in the highest energy class, D, was five times higher in 2017 than 2016, and the number of incidents in class C doubled (Figur 36).
- There were 40 incidents involving personal injuries in the period 2013-2017 (Figur 37 and Tabell 3). Nine of the incidents were in 2017.
- There are probably a number of reasons for the large increase in reported incidents in 2017. It is assumed to be partially, but not exclusively, related to reporting routines:
 - with effect from reporting for 2017, the PSA has made the following clarifications:
 - 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.
 - It was expected that the number of incidents of low energy potential would increase as a result of the clarification for reporting in 2017. Special attention has been paid to the trend in incidents without falling objects and to incidents with energy potential greater than 40 J (Figur 38).
 - The trend incidents without falling objects shows a <u>decline</u> from 2016 to 2017.
 - The trend in incidents with falling objects with an energy potential
 > 40 J shows <u>large increase</u> from 2016 to 2017 in the number of

incidents in total and per million working hours, from 12 to 41 incidents.

o It seems clear that this observed increase is a genuine one.

Mobile facilities

- For *mobile facilities*, there was a fall in the number of reported incidents from 2013 to 2014, and then an increase in 2015 (Figur 34). In 2016 and 2017, the absolute number has fallen, but the normalised number increased regularly in the period 2014-2016, and there was a fall in line with the fall in the absolute number from 2016 to 2017.
- There were 21 incidents involving personal injuries in the period 2013-2017 (Figur 37 and Tabell 3). One of these incidents was in 2017, and it led to a fatality and a serious injury. The accident occurred during work on the installation of a new raw water pump on the Mærsk Interceptor facility.





Figure 34 Number of reported incidents for crane and lifting operations in the period 2013-2017 for permanently placed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relative to drilling and well operations and to construction and maintenance, per type of facility.





Figure 35 Number of incidents per year for the different types of lifting equipment for the period 2013-2017, for permanently placed and mobile facilities





Figure 36 Number of incidents per year linked to crane and lifting operations that have caused falling objects, broken down by energy class and by permanently placed and mobile facilities (the number of incidents is given in the columns)







Table 3	Total number of reported incidents, and incidents involving personal injuries
by facility	type

Year	Total number of reported incidents	Number of incidents involving personal injuries			
		permanently placed facilities	Mobile facilities		
2013	98	9	7		
2014	64	7	5		
2015	66	7	6		
2016	81	8	2		
2017	121	9	1		



Figure 38 Number of reported incidents <u>without falling objects</u> (on the left) and classified as <u>falling objects > 40 J</u> (on the right) for crane and lifting operations in the period 2013-2017 for permanently placed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relative to drilling and well operations and to construction and maintenance, per type of facility.

9.2 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, a new DFU20, Crane and lifting operations, was introduced for offshore facilities, which has caused changes in DFU21 Falling objects. The time series now consists of data for the period 2013-2017. The analysis looks at both the five years combined and a comparison between the years, as appropriate.

Please also see 9.1 DFU20 Crane and lifting operations for a description of new features in 2017 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:

Permanently placed facilities

- For *permanently placed facilities*, an annual fall is observed in the number of reported incidents (Figur 39) in the period 2013-2016, while there is a large increase in the number of reported incidents for 2017, both in absolute numbers and normalised per million working hours.
- There were 17 incidents involving personal injuries in the period 2013-2017 (Figur 41). Four of the incidents were in 2017.
- There are probably a number of reasons for the large increase in reported incidents in 2017. It is assumed to be partially, but not exclusively, related to reporting routines:

- all falling objects shall be reported regardless of whether the fall within or outside a barriered area.
- no lower limit for fall energy or deduction for height of a person shall be used.
- It was expected that the number of incidents of low energy potential would increase as a result of the clarification for reporting in 2017, which the analysis confirms. The analysis (Figur 40) also shows, however, that the same picture is obtained if the incidents with energy class < 40 J are removed from the data, i.e. a large increase from 2016 to 2017 in the number of incidents in total and per million working hours.
 - The increase in the number of incidents in energy class > 40 J relate primarily to work processes in drilling areas (Figur 42).
 - A relatively large increase in the number of incidents in energy classes B and C is observed from 2016 to 2017 (Figur 43):
 - Energy class B (40-100 J) increases from 12 to 35 incidents.
 - Energy class C (100-1,000 J) increases from 19 to 59 incidents.
- It seems clear that this observed increase is a genuine one.

Mobile facilities

- For *mobile facilities*, there was an increase in the number of reported incidents from 2013 to 2014 (Figur 39), but a fall can be observed in the last three years. Looking at the number of incidents per million working hours, there is a weak increase for mobile facilities since 2015, despite a fall in the absolute number of incidents.
- There were no incidents involving personal injuries in the period 2013-2017.





Figure 39 Number of incidents and incidents per million working hours classified as falling objects, broken down by permanently placed and mobile facilities, in the period 2013-2017, normalised against millions of working hours, relating to drilling and well operations and to construction and maintenance.



Figure 40 Number of incidents and incidents per million working hours classified as falling objects > 40 J, broken down by permanently placed and mobile facilities, in the period 2013-2017, normalised against millions of working hours, relating to drilling and well operations and to construction and maintenance.



Figure 41 Total number of falling object incidents causing personal injury, in the period 2013-2017. (left). Also broken down by main category of work process, number of incidents given in the column (right). All incidents were on permanently placed facilities.





Figure 42 Total number of incidents > 40 J broken down by permanently placed and mobile facilities and main categories of work processes (number of incidents is given in the columns), for the period 2013-2017



Figure 43 Number of objects by energy classes > 40 J, for permanently placed and mobile facilities, for the period 2013-2017

9.3 Other DFUs

The main report presents data for incidents that have been reported to the PSA, as well as for other DFUs without major accident potential, such as DFU11, 13, 16 and 19, see Tabell 1.

10. Definitions and abbreviations

10.1 Definitions

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

10.2 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
СМ	Corrective maintenance
PSA	Petroleum Safety Authority Norway
RNNP	Trend in risk level in the Norwegian petroleum activity
WIF	Well Integrity Forum

11. References

Detailed reference lists can be found in the main reports:

PSA, 2018a. Trends in the risk level on the Norwegian Continental Shelf, Main report, 26/04/2018

PSA, 2018b. Trends in the risk level – onshore facilities in the Norwegian petroleum activities, 26/04/2018

PSA, 2018c. Trends in the risk level on the Norwegian Continental Shelf, Methodological report, 26/04/2018