

SUMMARY REPORT
NORWEGIAN CONTINENTAL SHELF 2019
TRENDS IN RISK LEVEL IN THE NORWEGIAN
PETROLEUM ACTIVITY

Preface

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, 2 April 2020

Finn Carlsen,
Technical Director, PSA

CONTENTS

1.	Formål og begrensninger	Feil! Bokmerke er ikke definert.
1.1	Hensikt	Feil! Bokmerke er ikke definert.
1.2	Formål	Feil! Bokmerke er ikke definert.
1.3	Sentrale begrensninger	Feil! Bokmerke er ikke definert.
2.	Konklusjoner	Feil! Bokmerke er ikke definert.
3.	Gjennomføring.....	Feil! Bokmerke er ikke definert.
3.1	Gjennomføring av arbeidet	Feil! Bokmerke er ikke definert.
3.2	Bruk av risikoindikatorer.....	Feil! Bokmerke er ikke definert.
3.3	Utviklingen av aktivitetsnivå	Feil! Bokmerke er ikke definert.
3.4	Dokumentasjon	Feil! Bokmerke er ikke definert.
4.	Spørreundersøkelsen	Feil! Bokmerke er ikke definert.
5.	Status og trender –helikopterhendelser.....	Feil! Bokmerke er ikke definert.
5.1	Aktivitetsindikatorer.....	Feil! Bokmerke er ikke definert.
5.2	Hendelsesindikatorer.....	Feil! Bokmerke er ikke definert.
6.	Status og trender – indikatorer for storulykker på innretning	Feil! Bokmerke er ikke definert.
6.1	DFUer knyttet til storulykkesrisiko	Feil! Bokmerke er ikke definert.
6.2	Risikoindikatorer for storulykker	Feil! Bokmerke er ikke definert.
6.3	Totalindikator for storulykker	Feil! Bokmerke er ikke definert.
7.	Status og trender – barrierer mot storulykker	Feil! Bokmerke er ikke definert.
7.1	Barrierer i produksjons- og prosessanleggene	Feil! Bokmerke er ikke definert.
7.2	Barrierer knyttet til maritime systemer.....	Feil! Bokmerke er ikke definert.
7.3	Vedlikeholdsstyring	Feil! Bokmerke er ikke definert.
8.	Arbeidsulykker med dødsfall og alvorlig personskade	Feil! Bokmerke er ikke definert.
9.	Andre indikatorer.....	Feil! Bokmerke er ikke definert.
9.1	DFU20 Kran- og løfteoperasjoner.....	Feil! Bokmerke er ikke definert.
9.2	DFU21 Fallende gjenstand	Feil! Bokmerke er ikke definert.
9.3	Øvrige DFUer	Feil! Bokmerke er ikke definert.
10.	Definisjoner og forkortelser.....	Feil! Bokmerke er ikke definert.
10.1	Definisjoner	Feil! Bokmerke er ikke definert.
10.2	Forkortelser	Feil! Bokmerke er ikke definert.
11.	Referanser.....	Feil! Bokmerke er ikke definert.

1. Objective and limitations

1.1 Purpose

The "Trends in risk level on the Norwegian Continental Shelf" project started in the year 1999. The background to the project was the participants' need to clarify uncertainties concerning the safety consequences of the major structural changes that the petroleum industry underwent in the late 1990s.

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, both qualitative and quantitative in nature, are used.

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 on acute spills is expected during the autumn of 2020.

2. Conclusions

Through RNNP, we seek to measure trends in safety and the working 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.

The indicators in this report are subject to continuous development. Due to deficiencies in previously used indicators relating to selected working environment factors, these are not included, in anticipation of new indicators for the area.

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. In 2019, several trends in the general picture that emerges from RNNP point to a positive development, in that the number of incidents with inherent major accident potential remains low, given the level of activity in the industry. The questionnaire data also show that the negative trends we saw from 2015 to 2017 have been reversed, in that the majority of the indices are now back on par with the results in 2015. The serious personal injury rate in 2019 is within the expected range based on the previous 10 years. This type of information has limited value with regard to future incidents. Experience shows that intensive, and continuous, attention to safety work is necessary to maintain and enhance a low risk level.

Major accidents

No major accidents, meaning accidents resulting in several fatalities, were recorded in 2019. As in 2018, nor were there any exceptionally serious near-misses/incidents. 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.

The number of near-misses with major accident potential has exhibited an underlying positive (i.e. downward) trend since 2002. In 2019, there were 38 such incidents (helicopters not included). This is slightly higher than in preceding years. Once the number of incidents is normalised against working hours however, the frequency in 2019 is significantly lower than the average for the period 2009-2018. 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. Six non-ignited hydrocarbon leaks were recorded in 2019 (seven in 2018). This is the lowest number of such incidents ever recorded. 2019 is also the first year in which no leaks above 1 kg/s were recorded. It is now six years since a hydrocarbon leak above 10 kg/s was recorded. In 2019, there were 19 well control incidents, 18 of which were in the lowest risk category, while one was classified as serious (intermediate risk category). There was a numerical increase in 2019, but once well control incidents are normalised against the number of wells drilled (drilling started), the number of well kicks per well is within the expected range in 2019. In 2019, five incidents of damage to structures and maritime systems that meet the damage criteria used in RNNP were recorded. There were six such incidents in 2018.

If the near-misses with major accident potential are weighted by factors identifying their inherent potential for causing fatalities were they to develop further, it can be seen that, in 2019, the indicator (the total indicator) is at its lowest ever level. The 2019 level is statistically significantly lower than the average for the period 2008-2018. 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. An underlying downward trend may therefore reflect the industry having improved its management of factors that affect risk. 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 risk indicators used in respect of helicopter transport are designed to capture the risk associated with relevant incidents and the effects of risk prevention activities, and to identify opportunities for improvements.

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 2019, one incident was identified that falls into the most serious incident category. The expert group assessed that, in this incident, there was only one barrier remaining. This was a technical incident relating to an engine failure, leaving a single barrier. 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.

For the first time since 2015, in 2019 there was a collision between a vessel and a facility when a supply vessel lost its course and position and drifted onto Statfjord A. The ship's masts and antennas struck the lifeboat station on Statfjord A, and the side of the ship hit one of the shafts. However, it is not considered that this incident had the potential to develop into a major accident. There was also an incident involving a drifting object (a fishing boat) in 2019.

Barriers

The industry is increasingly using indicators capable of describing robustness for withstanding incidents – so-called leading indicators. Barrier indicators are an example of these. Notably, this type of indicator describes the barriers' ability to function when called on. The barrier indicators continue to show that there are major differences in levels between the facilities. Over time, there has been a positive trend for many of the barriers to exceed the industry's self-defined requirements, but in recent years, the level has been rather stable. For most of the barrier elements, the 2019 results show them to be better than the industry's own requirements. This may mean that the focus in recent years on barrier management in the industry is also yielding results within this area.

Data on maintenance management has been collected for 11 years. The figures for the fixed facilities show that the total backlog in preventive maintenance and the backlog for HSE-critical equipment are higher in 2019 than in reporting years 2017 and 2018. In total, however, the overall number of hours of backlog is low. The backlog for HSE-critical preventive maintenance is among the higher levels reported since 2012. There was a considerable reduction in the number of hours of total outstanding corrective maintenance in 2019 compared with the previous year.

The data for mobile facilities show large variations in the backlog in preventive maintenance and in outstanding corrective maintenance. This corresponds to what we have seen in recent years. A number of facilities have not carried out HSE-critical preventive maintenance and corrective maintenance in accordance with their own deadlines.

Personal injuries and accidents

In 2019, 230 reportable personal injuries were recorded on the NCS. 196 such injuries were reported in 2018. 32 of these were classified as serious in 2019, against 25 in 2018.

Over the long term, in the period 2008-2013, there was a downward trend in the frequency of serious personal injuries. Since 2014, we see a more varied trend, and an increase from 2018 to 2019. The change is not statistically significant viewed against the preceding 10-year period.

The questionnaire-based survey

In 2019, for the tenth time, a comprehensive questionnaire-based survey was conducted among workers on the Norwegian Continental Shelf. The survey has been performed every other year since 2001. Even though the questionnaire is being continuously developed, the core of the survey remains the same. This makes the data unique and offers great opportunities for in-depth studies.

The questionnaire results presented in this report give an overall picture of the employees' own assessments of the HSE climate and the working environment in their workplace.

The response rate is calculated on the basis of working hours on facilities reported to the Petroleum Safety Authority Norway in the last half of 2019. 6,001 persons completed the form, which corresponds to 22.2% of the estimated workforce. 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. The sample is considered to be satisfactory since the response distribution correlates relatively well with other known information about the population, such as the distribution between mobile and production facilities. The demographic distribution in the sample is also relatively stable since 2017, which helps to make the surveys comparable.

The results as a whole show a positive trend from 2017 to 2019. This applies to the HSE climate, perceived risk, the working environment and health issues. The HSE climate is assessed as being significantly better in this survey than in 2017 on the majority of questions. Most results are now back to the same level as in 2015, but are still somewhat short of the level in 2013.

The statements with the most negative ratings irrespective of changes from 2017 to 2019, and which have proved problematic in the longer term, are: "Deficient maintenance has led to poorer safety", "Different facilities have different procedures and routines for the same circumstances, and this constitutes a threat to safety" and "I think it is easy to find what I need in the governing documents (requirements and procedures)". In addition, the statements: "Hazardous situations have arisen because not everyone speaks the same language" and "Increased cooperation between facility and land through the use of IT systems has led to less secure operations" are among the most negatively rated.

The question on hazard situations has changed compared with previous surveys. In 2019, the question was worded as "how often are you afraid of the following incidents?," and then 14 hazard situations were posited. The situations that employees were most often afraid of were "falling objects" and "serious work accidents". This largely correlates with the situations with which employees associated the greatest hazards in 2017.

13 questions concerned the physical, chemical and ergonomic working environment. Only one of the questions (about the frequency of sedentary work with little possibility of variation) was rated more negatively in 2019 than in 2017. Nine of the statements were rated more positively, while three were unchanged. In addition, 20 of the questions in the survey were about the psychosocial and organisational working environment. Here too, there were positive changes compared with 2017. 13 statements were rated more positively, two were unchanged, four were new questions and one was rated more negatively.

In respect of health complaints, the responses are also more positive than in 2017. Of the 14 health complaints, there are improved responses on 11, and unchanged responses on three. Health complaints relating to neck, shoulder or arm pain are the commonest, with 18.1% of respondents being quite or very troubled. The proportion of employees who have health complaints and assess these as wholly or partly related to their work situation has increased, across more or less all health complaints. The largest increases here are in tinnitus and allergic reactions.

3. Work undertaken

The results from RNNP are presented in annual reports. This report covers the year 2019. The work on the report is primarily carried out from December 2019 to April 2020.

The detailed objective for 2020 was to:

- Continue the work carried out in previous years
- Maintain and develop the total indicator method
- Conduct a questionnaire-based survey
- Improve the model for barrier performance in relation to major accidents
- Evaluate correlations in the datasets.

3.1 Performance of the work

The following participants contributed to the work on this year's report:

- 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.
- 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 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 external parties have assisted the Petroleum Safety Authority with specific assignments:

- Terje Dammen, Jorunn Seljelid, Torleif Veen, Irene Buan, Jon Andreas Rismyhr, Trond Stillaug Johansen, Jon Tolaas, Mads Lindberg, Ragnar Aarø, Kristine Nesvik, Reidun Værnes, Mahdi Ghane, Rune Haugen Larsen, Eivind Tunheim and Silje Frost Budde, Safetec
- Astrid Schuchert, Olaug Øygarden and Leif Jarle Gressgård, from NORCE.

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
- Jim Urianstad, Kjetil Heradstveit, Kjetil Hellesøy, Bristow Norway AS

Numerous other people have also contributed to the work.

3.2 Use of risk indicators

Data has been collected for hazard and accident situations relating to major accidents, occupational accidents and working environment factors, namely:

- 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
- 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.

Table 3.1 lists the 21 DFUs and the data sources used. The industry has used the same categories for registering data through databases such as Synergi.

Table 3.1 List showing the primary source of data on incidents

<i>DFU</i>	<i>Description</i>	<i>Database</i>
1	Unignited hydrocarbon leak	Industry
2	Ignited hydrocarbon leak	Industry
3	Well incidents/loss of well control	PSA
4	Fire/explosion in other areas, not hydrocarbon	Industry
5	Ship on collision course	Industry
6	Drifting object	Industry
7	Collision with field-related vessel/facility/shuttle tanker	PSA
8	Damage to a facility's structure, stability/anchoring/positioning failure	PSA + industry
9	Leak from riser, pipeline and subsea production facility*	PSA
10	Damage to riser, pipeline and subsea production facility*	PSA
11	Evacuation	Industry
12	Helicopter incidents	Industry
13	Man over board	Industry
14	Occupational accidents	PSA
15	Work-related illness	Industry
16	Full loss of power	Industry
18	Diving accident	PSA
19	H ₂ S emission	Industry
20	Crane and lifting operations	PSA/Industry
21	Falling objects	PSA/Industry

* Also includes wellstream pipeline, loading buoy and loading hose where relevant.

3.3 Developments in the activity level

Figure 3.1 and Figure 3.2 show the trends over the period 2000-2019 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, 2020a) presents the underlying data in detail.

There was an increase of 13% in working hours on production facilities in 2019 compared with 2018. For mobile facilities, there was increase of around 7% over the previous year. The number of drilled exploration and production wells also increased significantly.

Production volume fell slightly compared to 2018.

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.

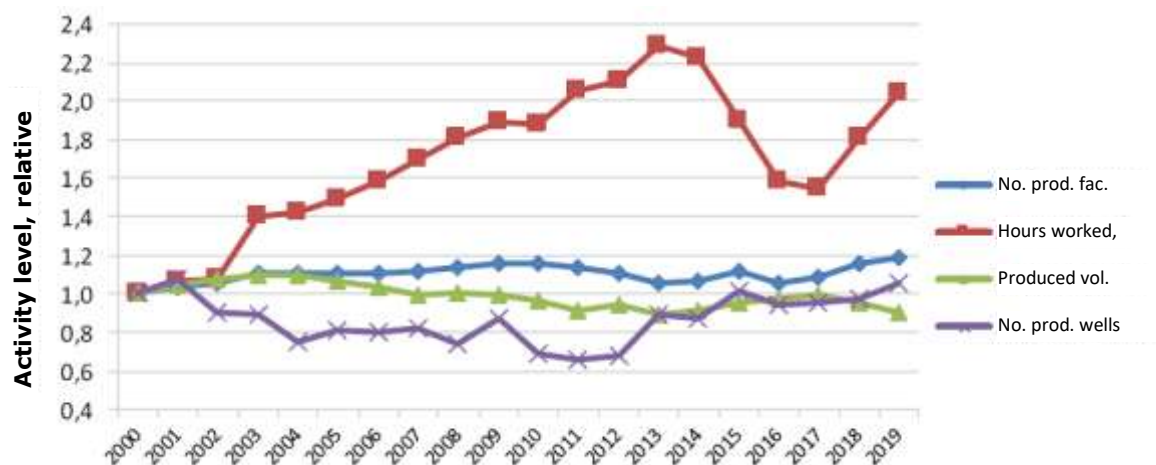


Figure 3.1 Relative trend in activity level for production facilities. Normalised against the year 2000

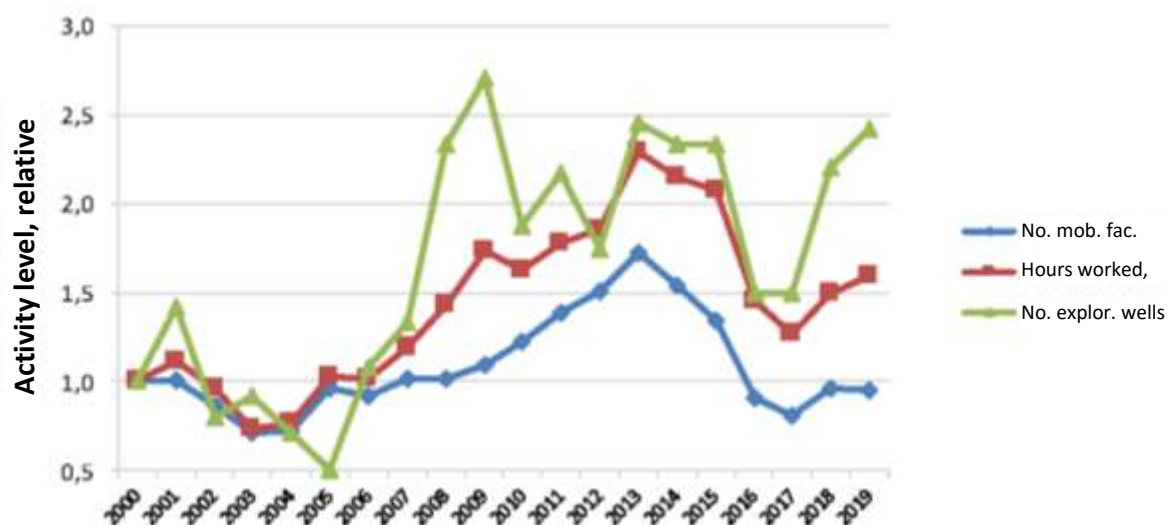


Figure 3.2 Relative trend in activity level for mobile facilities. Normalised against the year 2000

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 2019 (Norwegian and English versions)
- Main report – the Norwegian Continental Shelf for the year 2019
- Report for onshore facilities for the year 2019
- Report for acute spills to sea for the Norwegian Continental Shelf 2019, to be published in the autumn of 2020
- Methodological report, 2020

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

4. Survey questionnaire

The questionnaire was sent out between 14 October and 24 November 2019 to everyone who was offshore during this period. At an overarching level, the object of the questionnaire-based survey is to acquire knowledge about employees' perception of the state of HSE in the Norwegian petroleum activities. This is the tenth time 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, recreation conditions, working environment, health, sickness absence, sleep, rest, and working hours.

A total of 6,001 people completed the questionnaire. The response rate for this year's survey was 25.5% for mobile facilities and 20% for production facilities. For the NCS as a whole, the response rate was 22.2%. 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.

The sample is considered to be satisfactory since the response distribution correlates relatively well with other known information about the population, such as the distribution between mobile and production facilities. The demographic distribution in the sample is also relatively stable since 2017, which helps to make the surveys comparable. We can see that the distribution of areas of work has changed in line with the observed hours of work reported. We can assume that managers as a group are slightly overrepresented in the sample, and that operating company employees are also overrepresented.

The number of responses (N=6,001) is high. This gives the analyses good statistical power and a sound basis for describing HSE trends over time.

4.1.1 HSE climate

Overall, the results indicate that respondents assess the HSE climate to be better in 2019 than in 2017. Of the 48 statements about HSE, 27 were rated more positively and 14 were unchanged relative to 2017. Five of the statements were new in 2019:

- "I am not adequately trained to perform my emergency preparedness tasks in case of an emergency"
- "I am thoroughly familiar with the procedures and instructions applicable to my work"
- "I have been given necessary instruction in cybersecurity for my role (e.g. training, practice and raising of awareness)"
- "My colleagues have the necessary competence to perform their jobs in a safe manner"
- "When I arrive at a new facility, there is sufficient time to get familiar with everything I need to know to do a good job".

Only two of the individual statements were rated as worse in 2019 than in 2017, namely:

- "My manager appreciates me pointing out matters of importance to HSE"
- "Communication between me and my colleagues often fails in a way that may lead to dangerous situations"

These statements did not have very low/negative scores in the first instance. For example, 6.4% partially or fully disagreed with the first of them (against 5.6% in 2017). The HSE statements with the most negative assessments (average, irrespective of change from 2017 to 2019) are:

- "Deficient maintenance has led to poorer safety" (42.4% agree fully or partially)
- "Dangerous situations arise because everyone does not speak the same language" (37.4% agree fully or partially)
- "Different facilities have different procedures and routines for the same circumstances, and this constitutes a threat to safety" (34.5% agree fully or partially)
- "I find it easy to consult governing documents (requirements and procedures)" (30.6% disagree fully or partially)
- "Increased cooperation between facility and land through the use of IT systems has led to less secure operations" (20.2% agree fully or partially)

Based on the HSE statements, seven indices have been created, addressing various HSE topics: Own safety-related behaviour, management's commitment, colleagues' commitment, the organisation's commitment, conflicting goals, cooperation and communication, and freedom to speak up. All these indices show more positive assessments in 2019 than in 2017 except HSE index 6, "cooperation and communication", which is unchanged. This index is also rated most negatively of the seven. All the indices deteriorated in rating from 2015 to 2017, and in 2019 we can see that they are approaching or are back to the 2015 level again. One index (3 colleagues' commitment) is back to the 2013 level.

4.1.2 Downsizing, reorganisation and changes

Fewer respondents have experienced reorganisation and downsizing in 2019 compared to 2017. In addition, more are confident that they will have a job as good as the one they have now in two years. As in 2017, employees who *have* been through reorganisation consider the HSE indices more negatively than those who have not.

New for the survey in 2019 is that employees were asked about the use of digital technology. More than 80% use a PC daily or for much of the day. 26% use a smartphone/tablet daily or for much of the day, while portable recording equipment, data goggles/visors, digital protective equipment and other digital aids are far more rarely used by most respondents.

The employees were also asked about changes in their working day due to new technology. 9.2% have experienced large or very large changes in forms of cooperation due to digital solutions, 14.1% due to new work tasks or processes and 13.7% due to the use of automated solutions in the preparation and performance of the work.

4.1.3 Hazard situations

The question on hazard situations has changed compared with previous surveys. In 2019, the question was worded as "how often are you afraid of the following incidents?," and then 14 hazard situations were posited. The situations that employees were most often afraid of were "falling objects" and "serious work accidents". This largely correlates with the situations with which employees associated the greatest hazards in 2017.

4.1.4 Working environment

13 questions concerned the physical, chemical and ergonomic working environment. Only one of these (questions about the frequency of sedentary work with little possibility of variation) was rated more negatively in 2019 than in 2017. Nine of the statements were rated more positively, while three were unchanged.

In addition, 20 of the questions in the survey were about the psychosocial and organisational working environment. Here too, there were positive changes compared with 2017. 13 statements were rated more positively, two were unchanged, four were new questions and one was rated more negatively. The question that is more negatively rated is "Do you work so much overtime that it is a strain?". Here, 4.2% answered "quite often, very often or always". For comparison, 3.7% responded this way in 2017.

One of the new working environment questions was "do the digital solutions you use provide the necessary support in the performance of your work tasks?". 30.2% of employees answered "never, very rarely or quite rarely" to this question.

4.1.5 Leisure

Most respondents are satisfied with the leisure conditions when they are offshore, and there are few changes compared to 2017. The food and drink quality is the only change, and this change is positive.

4.1.6 Health and sickness absence

In respect of health complaints, the responses are also more positive than in 2017. Of the 14 health complaints, there are improved responses on 11, and unchanged responses on three. Most respondents experience health complaints linked to neck/shoulder/arm pain; 18.1% are quite or very troubled. The proportion of employees who have health complaints and assess these as wholly or partly related to their work situation has increased, across more or less all health complaints. The largest increases here are in tinnitus and allergic reactions. The most common health complaints associated with the work situation are tinnitus, impaired hearing and psychological distress, where respectively 53.5%, 49.5% and 41.4% of those who have the ailments link them to the work situation. However, we see that the extent to which they link the complaints to the work situation increases the more strongly the complaint is experienced. Smaller proportions of those who are "slightly troubled" link the complaints to the work situation than those who are "very troubled".

4.1.7 Comparison between HSE assessments offshore and on land

Both offshore and on land, the proportion of women who responded to the survey compared to the proportion of men is lower in 2019 than in 2017. On land, the proportion of women (20.7%) is greater than offshore (10.1%). There are larger proportions of employees in the youngest age categories on land than offshore; only 3.2% are 25 years of age or younger among offshore employees, while 12% are in these age categories on land. The proportion in the age group 51-60 years is greater offshore (30.1%) than on land (21.2%). This age group increases slightly both offshore and on land. On land, the majority of those who responded to the survey are employed by operator companies (65.3%), while offshore the majority are employed in contractor companies (63.3%). When it comes to areas of work, maintenance is the largest group both offshore (31%) and on land (38.3%). Employees in maintenance was also the group on land that proportionally increased the most from 2017 (7.8%). Offshore, construction/modification had the largest increase (3%). Most of the employees have permanent employment both offshore (95.3%) and on land (87.6%). A fairly large proportion of those who responded to the survey have a leadership role (with or without personnel responsibilities), 37% offshore and 25.3% at onshore facilities.

In terms of working hours, there are larger proportions who work day shifts at onshore facilities in 2019 than in 2017 (75.6%). The same applies offshore (47.9%), but here the increase is not so large. 15.5% of offshore employees have worked overtime one or more times in the last year; 33% of the onshore employees have done so.

At onshore facilities, fewer respondents experienced reorganisation (55.7% did not experience it) in 2019 compared to 2017. At offshore facilities there were also fewer in this category than in 2017, but more than at onshore facilities. 38.8% of offshore employees did not experience reorganisation. Among offshore employees, 22.1% experienced very significant reorganisation, and 32.6% have experienced downsizing/layoffs. The corresponding figures on land are 10.4% and 19%.

Many of those who responded have positions of trust and/or emergency response functions. Offshore, 21.1% held one or more positions of trust and 63.4% had one or more emergency response roles. At the onshore facilities, these proportions are somewhat smaller (16.9% and 30.8%).

In general, we see an improvement in the assessment of HSE at both offshore and onshore facilities. HSE Index 1, "own safety-related behaviour", shows an improvement offshore, but no change on land. HSE Index 2, "management's commitment", has improved both offshore and on land, and onshore employees rate this index slightly better than offshore employees. This index includes a statement that has one of two significant negative changes offshore. More offshore employees disagree with "my manager appreciates me pointing out matters of importance to HSE" in 2019 than in 2017. At onshore facilities there is no change in the responses to this statement.

For HSE Index 3, "colleagues' commitment", there is also a positive change offshore and on land. Here, the responses are better than in previous years. HSE Index 4, "the organisation's commitment", is rated equally offshore and onshore, and both locations show an improvement over 2017. At the onshore facilities, they are back to the 2013 level. HSE Index 5, "conflicting goals", also has better ratings offshore and on land, returning in this case to the 2013 levels for both locations.

The seventh HSE Index, "cooperation and communication", is unchanged from 2017. One of the statements included in this index, "communication between me and my colleagues often fails in a way that may lead to dangerous situations" has a negative change from 2017 to 2019 offshore.

HSE Index 7, "freedom to speak up", has a significant improvement at both offshore and onshore facilities. The ratings are better at the onshore facilities, and for example, the statement "I experience a pressure not to report personal injuries or other incidents which may 'mess up the statistics'" is rated better at onshore facilities than offshore. When it comes to individual questions about HSE, there are a few more differences between offshore and onshore facilities that can be highlighted. At both onshore and offshore facilities, a number of respondents disagree that "in practice, production concerns take precedence over HSE concerns", but onshore facilities have better responses here than offshore.

Both onshore and offshore, those who had experienced reorganisation rated the HSE indices more negatively than those who had not experienced reorganisation. The exception was HSE Index 1, "own safety-related behaviour", at the onshore facilities. The differences were greatest offshore, in the indices "management's commitment", "conflicting objectives" and "freedom to speak up". At onshore facilities, the greatest difference was between what employees responded to the "cooperation and communication" and "freedom to speak up" indices, depending on whether they had experienced reorganization or not.

Falling objects represents the hazard situation that the largest proportions of respondents are afraid of most often, both offshore and on land. More respondents are regularly ("several times every week", "every week" or "several times a year") afraid of toxic gas/chemical pollution at onshore facilities (33.7%) than offshore ones (21.5%).

The physical, chemical and ergonomic working environment is rated better both on land and offshore in 2019 compared to 2017. Among individual conditions, the rating of sedentary work is notable. The statement "is your work static with little possibility of variation" is rated significantly more negatively offshore in 2019 than in 2017. On land, there is no change in this statement from 2017, but, among the working environment statements, it is the one that is rated most negatively.

When it comes to the psychosocial working environment, we also see generally positive changes offshore and on land. Offshore, it is only the question about onerous overtime that is significantly worse. This is also the only statement about the psychosocial working environment at onshore facilities that is unchanged from 2017; for all other statements, there are positive changes.

At onshore facilities, the proportion of employees who have health complaints is stable, with small improvements from 2017 to 2019; offshore, fewer people have health complaints.

For example, 18.1% of employees offshore are quite or very troubled by the commonest health complaint "neck/shoulder/arm pain". In 2017, the corresponding figure was 21%. At the onshore facilities, the share changed from 21.4% to 19.4%. Despite the decline in health complaints, there is a fairly large increase in the proportion of employees who relate their health complaints to their work situation. This applies both offshore and on land. For neck/shoulder/arm pain, 43% of employees at both offshore and onshore facilities perceive these to be related to their work situation. These percentages have increased by 8.4 and 10.1 percentage points respectively since 2017. At both offshore and onshore facilities, neck/shoulder/arm pain is more likely to be related to the work situation, the more strongly the complaint is perceived. That is, larger proportions of those who are very troubled by a complaint perceive it to be work-related, than those who are slightly troubled by a complaint.

As in previous years, the share of employees who have been on sick leave in the last year is higher at onshore facilities (51.7%) than offshore (23.4%).

Concerning the differences between different groups, based on gender, age, type of facility and area of work etc., there were generally more differences among groups of offshore employees than employees at onshore facilities. Offshore, all the HSE indices rate administration most positively and well service most negatively. On land, maintenance employees stand out with positive ratings in three HSE indices and one working environment index, while employees in the field of security have the most negative ratings in two HSE indices and two working environment indices.

It is not so appropriate to compare the shift arrangements at the onshore and offshore facilities, since there are more and varied arrangements offshore. What is true both offshore and on land is that those on day shifts consider they sleep better than the other shifts. Offshore, this also applies to staggered shifts and night shifts.

5. Status and trends – helicopter incidents

Cooperation with the Civil Aviation Authority and the helicopter operators on the work on risk indicators was continued in 2019. Aviation data obtained from the helicopter operators involved includes incident type, risk class, severity, type of flight, phase, helicopter type and information about departure and arrival.

5.1 Activity indicators

Figure 5.1 shows activity indicator 1 which includes volumes in the number of flight hours and the number of passenger flight hours per year in the period 2000-2019. The sharp reduction in the number of flight hours and passenger flight hours from 2014-2016 is due to the reduction in the number of hours worked on the NCS.

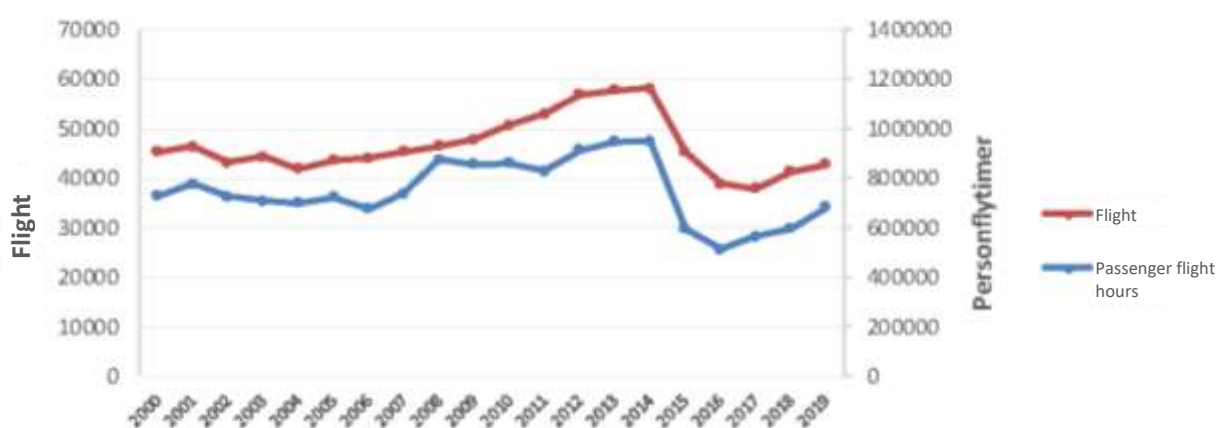


Figure 5.1 Flight hours and passenger flight hours per year, 2000-2019

The volume of helicopter flights 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 passenger flight hours fell by 47%, while the number of working hours fell by 28%. This means that fewer people were on short stays on the facilities, and that a greater proportion than before were on the facilities for a full 14 days.

5.2 Incident indicators

5.2.1 Incident indicator 1 – serious incidents and near-misses

Figure 5.2 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*.

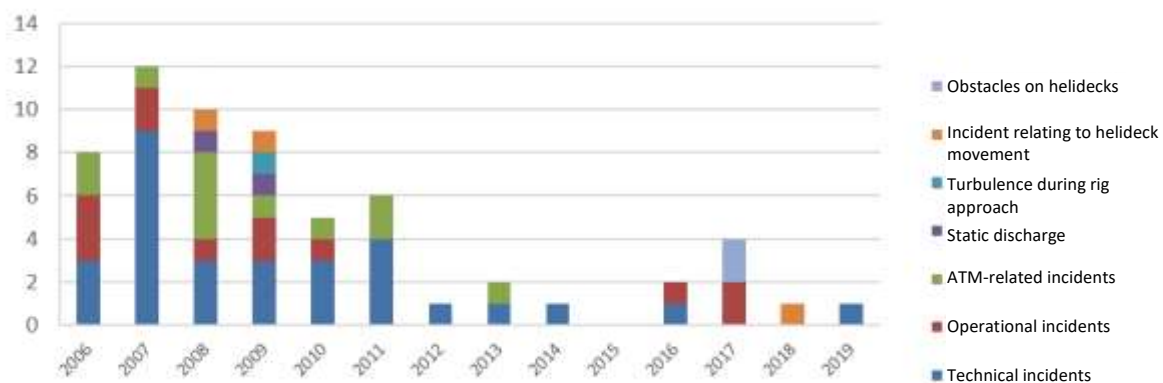


Figure 5.2 Incident indicator 1 per year by causal categories, not normalised, 2006–2019

In the expert group's assessment of incidents for 2019, there was one incident with one remaining barrier included in incident indicator 1. This was a technical incident relating to an engine failure, leaving a single barrier.

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 2000-2019. 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.

6.1 DFUs associated with major accident risk

Figure 6.1 shows the trend in the number of reported DFUs in the period 2004-2019. 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. The number of reported incidents in 2018 was the lowest recorded in the period. In 2019, however, the number of reported incidents increased, primarily due to more well control incidents.

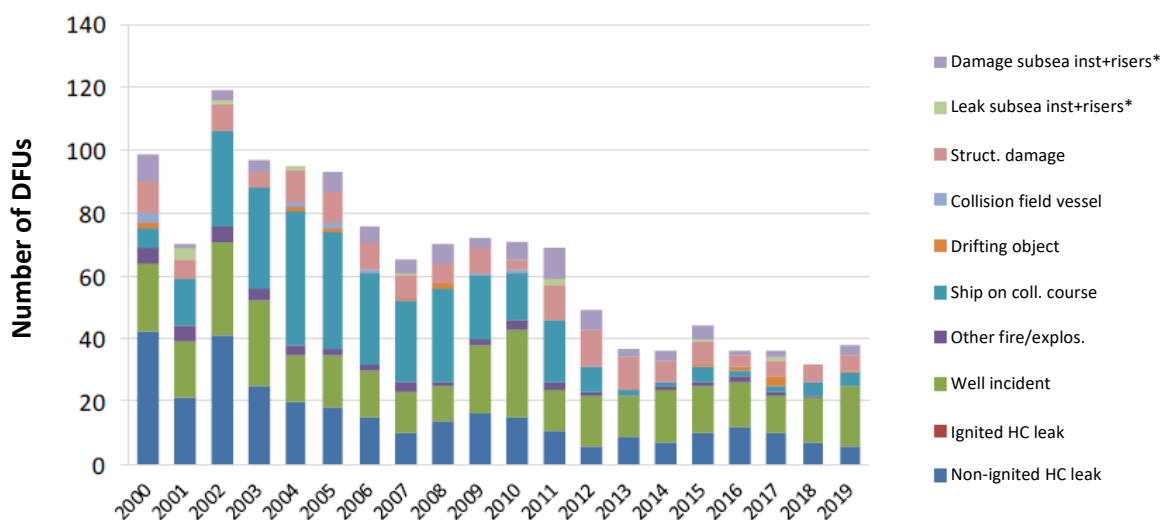


Figure 6.1 Reported DFUs (1-10) by categories.
*Within the safety zone

In Figure 6.1, the number of incidents is presented without normalisation in relation to exposure data. Figure 6.2 shows the same overview, but now normalised against number of working hours. In 2019, the value is below the hatched area, which means that the value in 2019 is significantly lower than the average in the previous ten years.

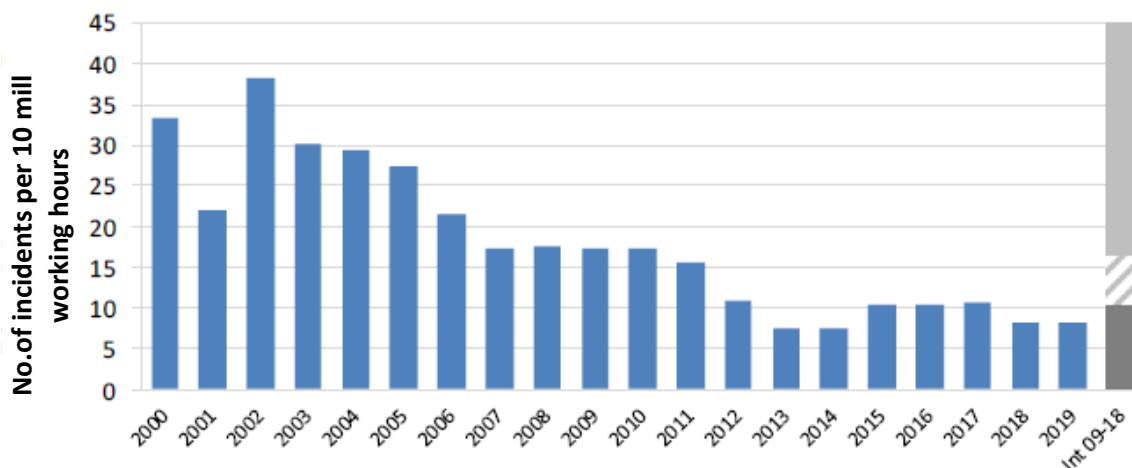


Figure 6.2 Total number of DFU1-10 incidents normalised against working hours

6.2 Risk indicators for major accidents

6.2.1 Hydrogen leak in the process area

Figure 6.3 shows the number of hydrocarbon leaks greater than 0.1 kg/s in the period 2000–2019. Six hydrocarbon leaks with a rate above 0.1 kg/s were registered in 2019, with all leaks in the category 0.1-1 kg/s.

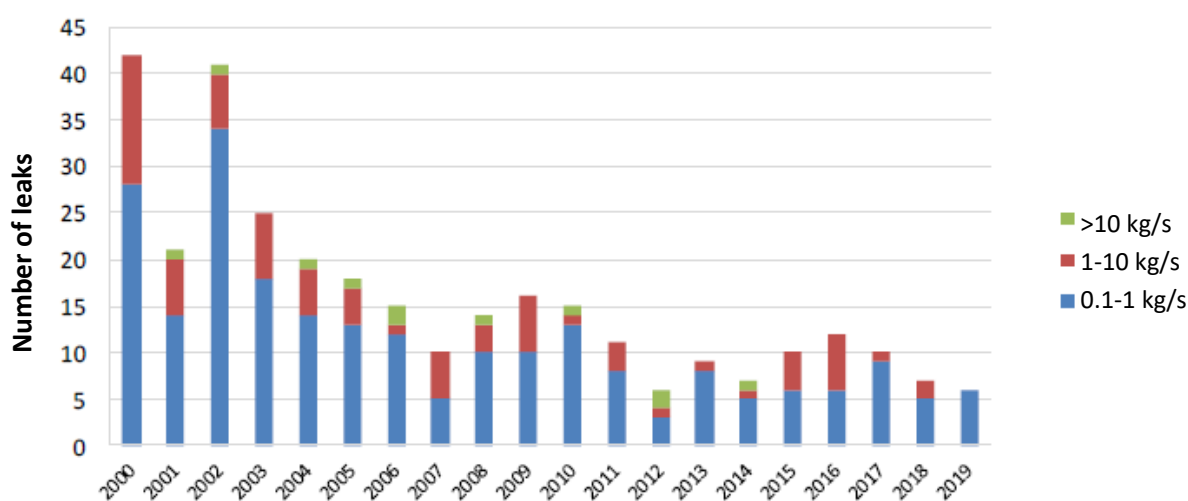


Figure 6.3 Number of hydrocarbon leaks exceeding 0.1 kg/s, 2000-2019

Figure 6.4 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 risk contribution in 2019 is the lowest observed in the period, due to few leaks overall and no leaks exceeding 1 kg/s.

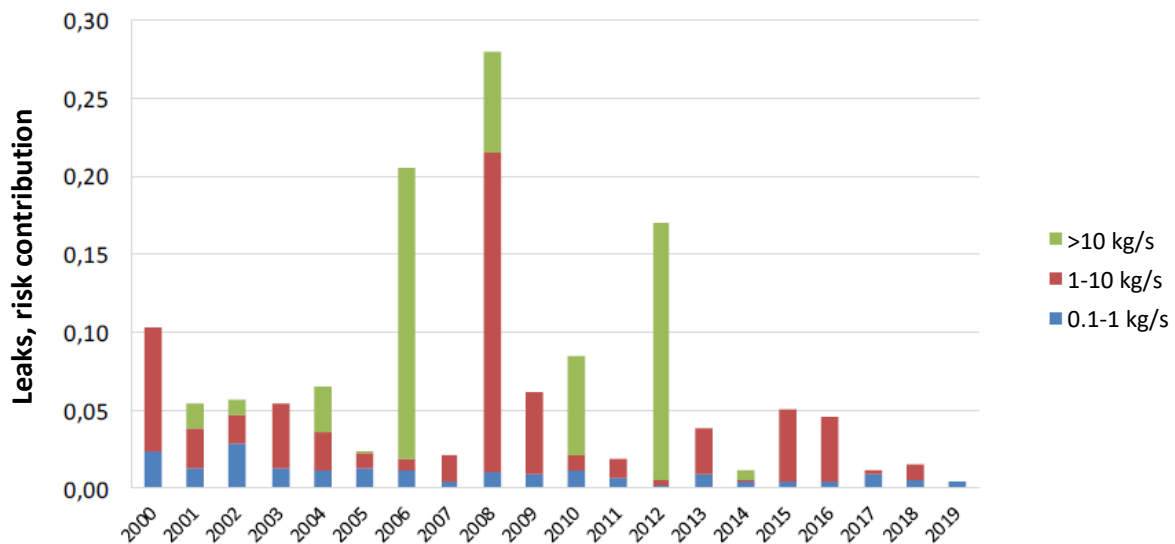


Figure 6.4 Number of hydrocarbon leaks exceeding 0.1 kg/s, 2000-2019, weighted according to risk potential

Figure 6.5 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. Furthermore, the figure shows that the number of leaks per facility year in 2019 is within the prediction range. The change is therefore not statistically significant relative to the average for the period 2008-2018. The number of leaks has been normalised both against working hours and against the number of facilities in the main report.

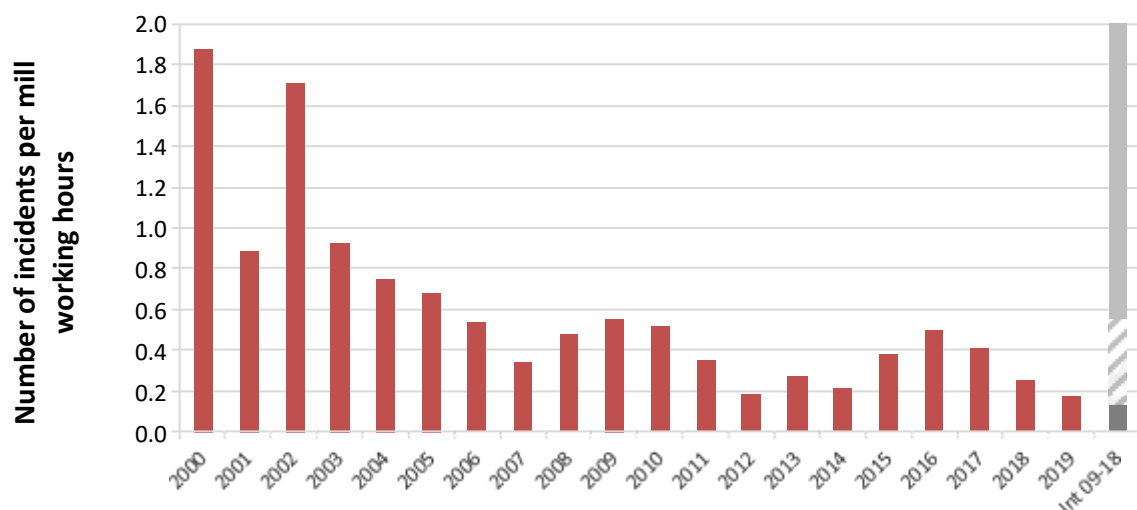


Figure 6.5 Trend, leaks, normalised against working hours

6.2.2 Loss of well control, blowout potential, well integrity

Figure 6.6 shows well control incidents broken down by exploration drilling and production drilling, normalised per 100 drilled wells.

There were 19 well control incidents in 2019, seven in production drilling and twelve in exploration drilling. Eighteen of these were in the lowest risk category, but one was in the middle category. Overall, there has been an upswing in the number of well control incidents since 2017. Figure 6.6 shows the proportion of well control incidents per 100 wells drilled. An increase in the number of incidents relating to both production drilling and exploration drilling was observed from 2018 to 2019. The number in 2019 is the highest observed since 2010. In general, the number of well control incidents per drilled well has been higher for

exploration drilling, and with greater annual variation, than for production drilling. 2016 and 2017 stood out with zero incidents in exploration drilling, while in 2018 and 2019, well control incidents for exploration drilling are seen to dominate again.

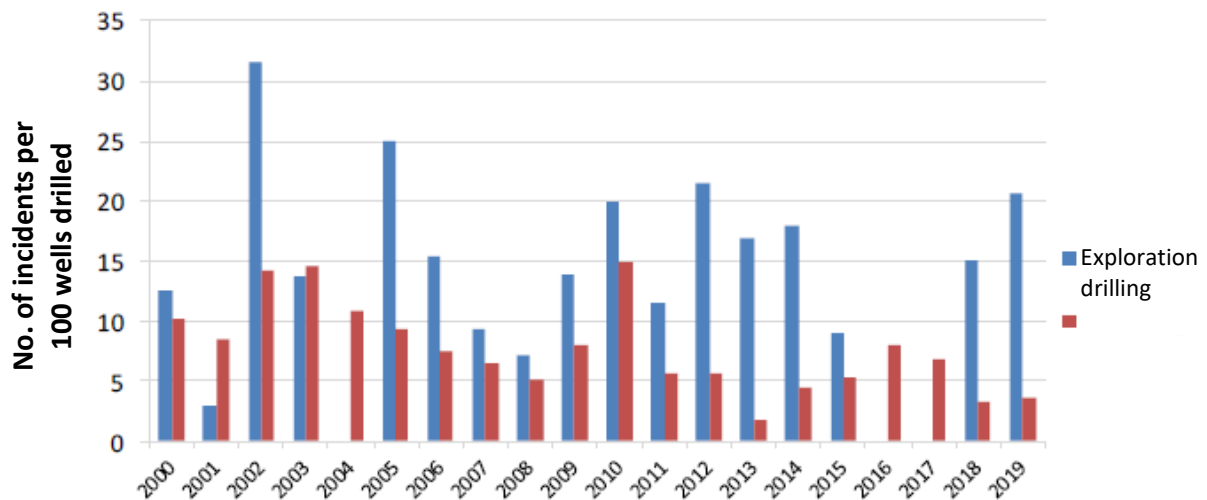


Figure 6.6 Well incidents per 100 wells drilled, for exploration and production drilling

Figure 6.7 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- 2019 there was a relatively low risk associated with well control incidents on the NCS.

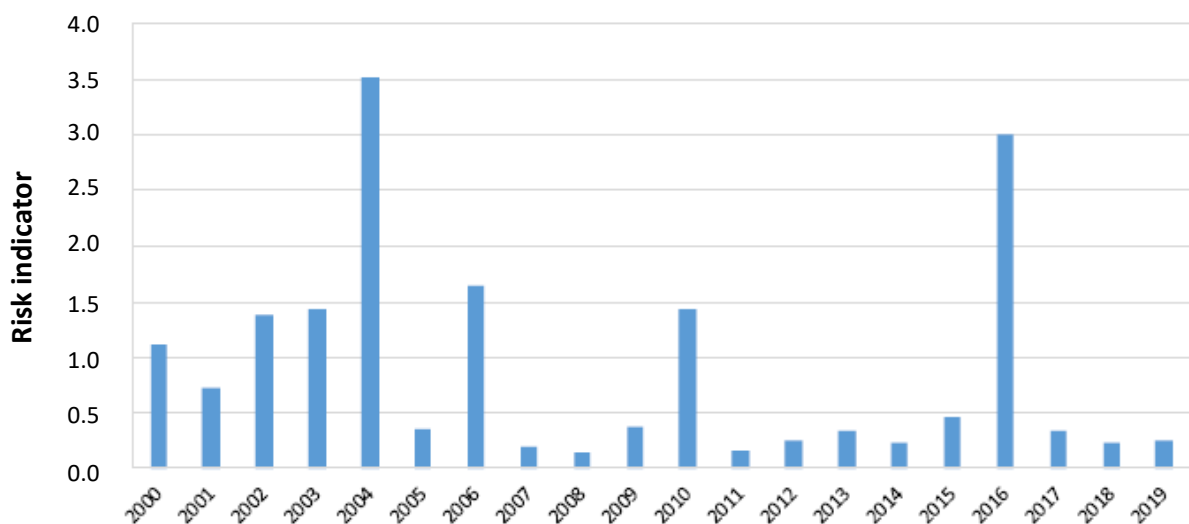


Figure 6.7 Risk indicators for well-control incidents in exploration and production drilling, 2000-2019

The Norwegian Oil and Gas Association has continued the work on well integrity issues through the Well Integrity Forum (WIF), a working group of the Drilling Managers Forum. This is a joint project for the operators on the NCS with operational production wells.

Norwegian Oil and Gas Recommended Guidelines 117 also discuss recommendations covering training, documents for transferring wells between different departments in the companies, including well barrier drawings and criteria for categorising wells.

Table 6.1 shows the criteria for categorising wells with respect to well integrity in accordance with Guidelines 117.

Table 6.1 Criteria for categorisation of wells with respect to well integrity

Category	Principle
Red	Failure of one barrier and the secondary is degraded/uncontrolled, or leak to the surface.
Orange	Failure of one barrier and the secondary is intact, or single failure that may cause leak at the surface.
Yellow	One barrier degraded, the secondary intact.
Green	Well undamaged - no or minimal non-conformity.

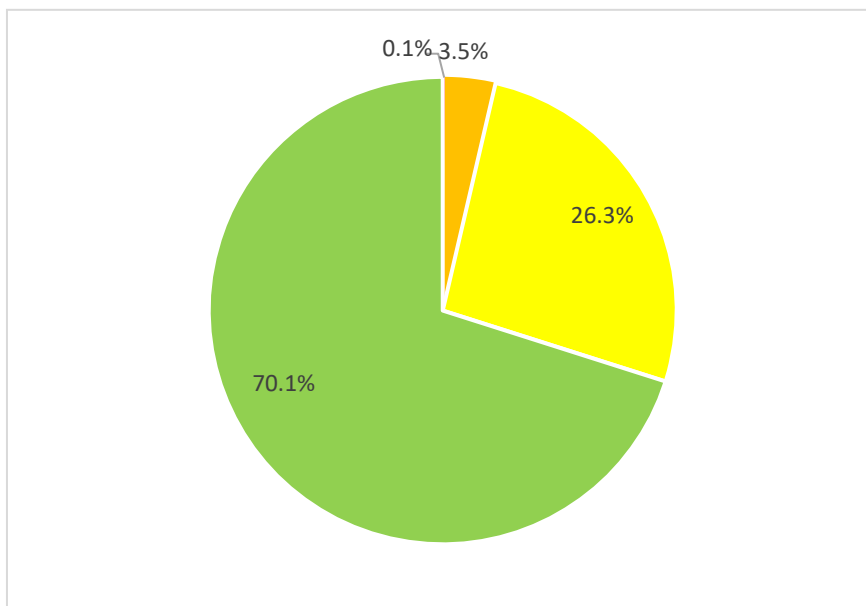


Figure 6.8 Well categories

The mapping in Figure 6.8 shows an overview of well categorisation by percentage share of total of 2,063 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. Three wells (0.1%) were recorded in the red category and 72 wells (3.5%) in the orange category. There are three temporarily plugged wells that are included in the red category. All types of well are found 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 (26.3%) in the yellow category.

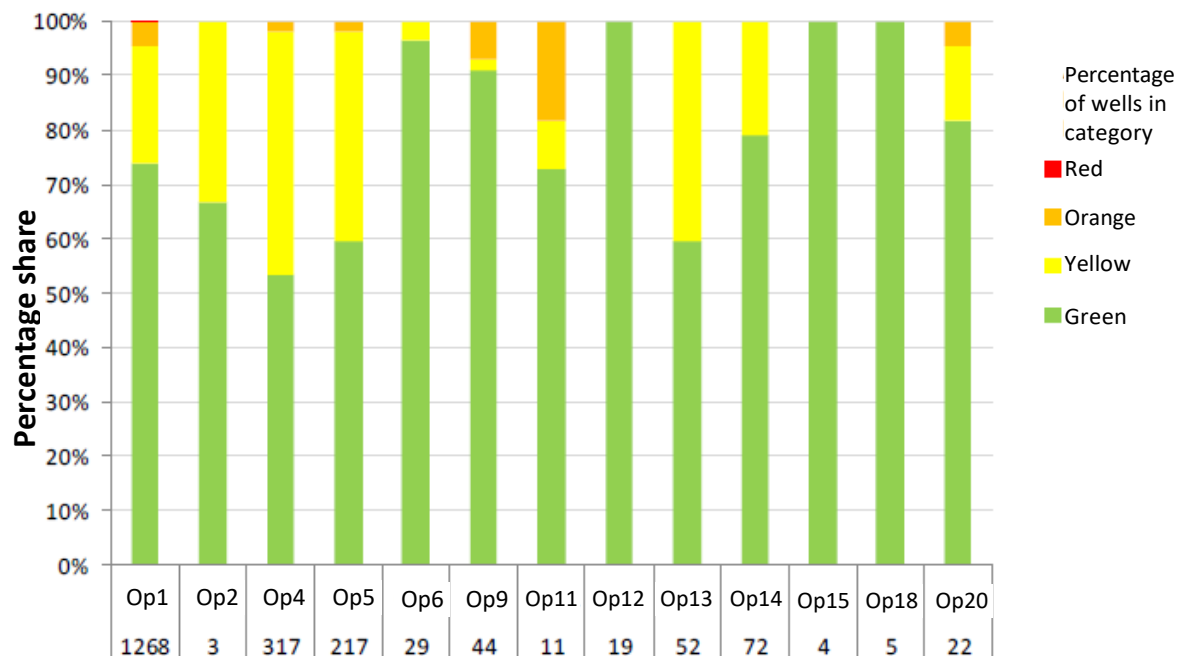


Figure 6.9 Well categorisation, by operator, 2019¹

Figure 6.9 shows the 13 operators and wells in the integrity categories red, orange, yellow and green. There is one operator that has wells in the red category (operator 1). Seven out of 13 operators have more than 75% of their wells in the green category. Three of them report all their wells in the green category.

6.2.3 Leak/damage to risers, pipelines and subsea facilities

In 2019, no serious leaks from risers were reported. Nor were any serious leaks from pipelines within the safety zones of surface facilities reported in 2019. Outside the safety zones of surface facilities, three incidents of leaks from pipelines were reported. One of these was a gas pipe, while the other two were water injection pipes.

No hydrocarbon leaks from subsea production facilities were reported in 2019, but some spills of hydraulic fluid and chemicals were reported, mainly relating to valve operations.

¹ The number of wells included for each operator is stated under Op1, Op2, etc.

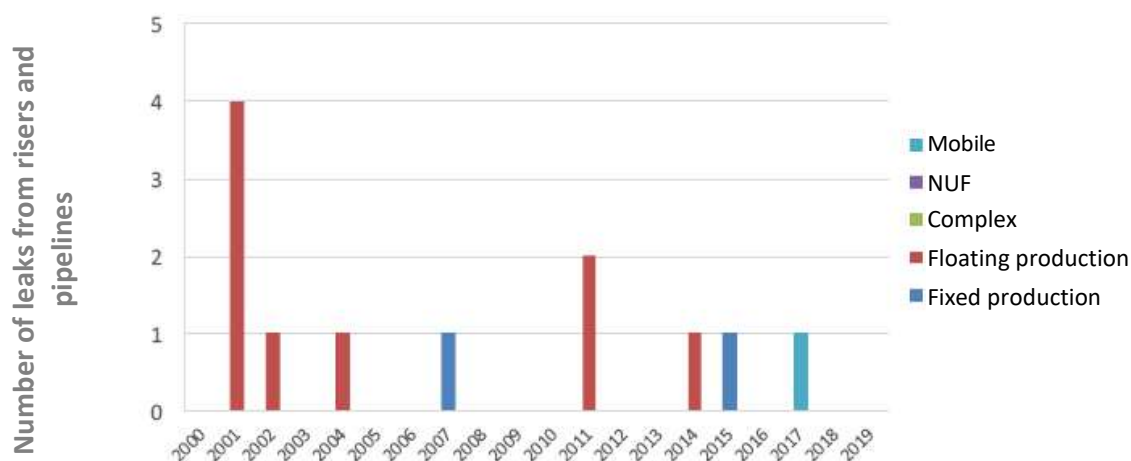


Figure 6.10 *Number of leaks from risers & pipelines within the safety zone, 2000-2019*

In 2019, three instances of serious damage to pipelines and risers were reported. All three concerned flexible risers and associated auxiliary equipment. One riser came loose from its attachment and fell to the seabed. The cause was a combination of corrosion and wear to its armouring. The riser was not in operation when this occurred. In the other two cases, the damage was to the risers' auxiliary equipment. In one case, a bend stiffener came loose from the attachment and slipped down the pipe, while, in the other, the anchoring of a Mid Water Arch broke.

Serious damage to risers and pipelines is included in the calculation of the total indicator, but with a lower weighting than for leaks. Figure 6.11 shows an overview of the most serious damage to risers and pipelines in the period 2000-2019.

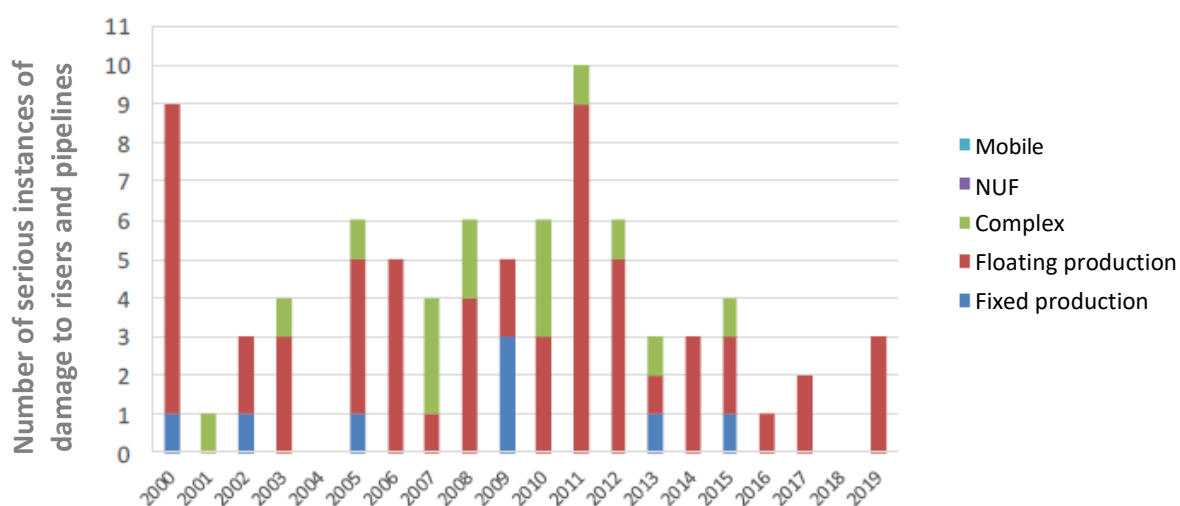


Figure 6.11 *Number of major damage incidents to risers & pipelines within the safety zone, 2000-2019*

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 2019, 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; there was one collision in 2019. The collision in 2019 is not considered to have had major accident potential.

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. Figure 6.12 shows the number of reported incidents and damage events to structures and maritime systems which conform to the criteria for DFU8 in the period 2000-2019. In total, five incidents are included for 2019.

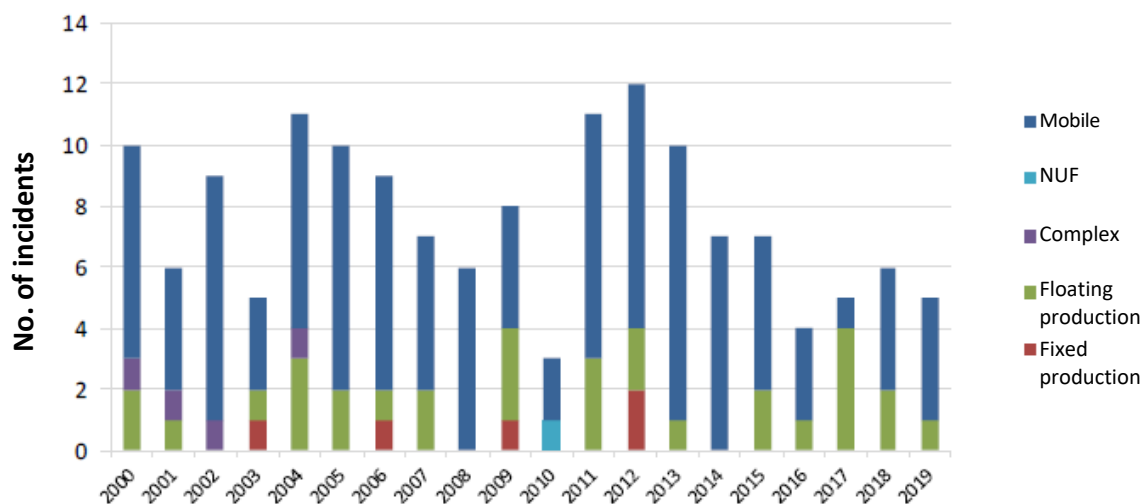


Figure 6.12 Number of reported incidents and damage events to structures and maritime systems which conform to the criteria for DFU8

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 restricted to incidents on board facilities. 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, and will therefore vary considerably, based on the potential of the individual incidents. Figure 6.14 shows the indicator for production facilities with annual values, in addition to a 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 6.13 shows the difference between annual values and three-year average values. Such a smoothing of the annual values is made to clarify any underlying trend.

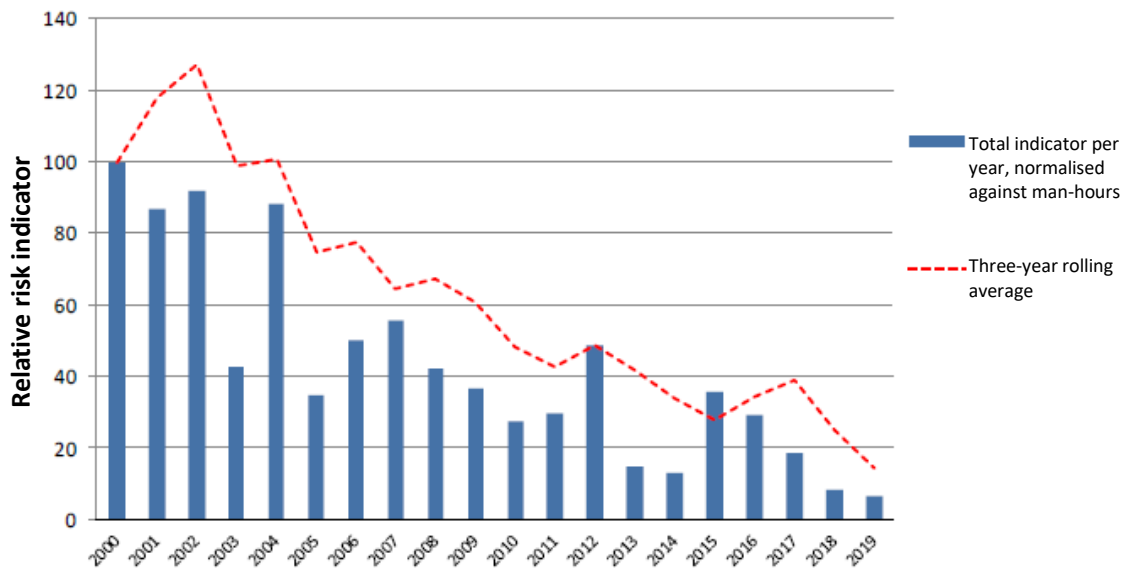


Figure 6.13 Total indicator for major accidents per year, normalised against working hours (Reference value is 100 in the year 2000, both for total indicator and three-year rolling)

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 columns 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.

Figure 6.14 and Figure 6.15 show the total indicator for production facilities and mobile facilities.

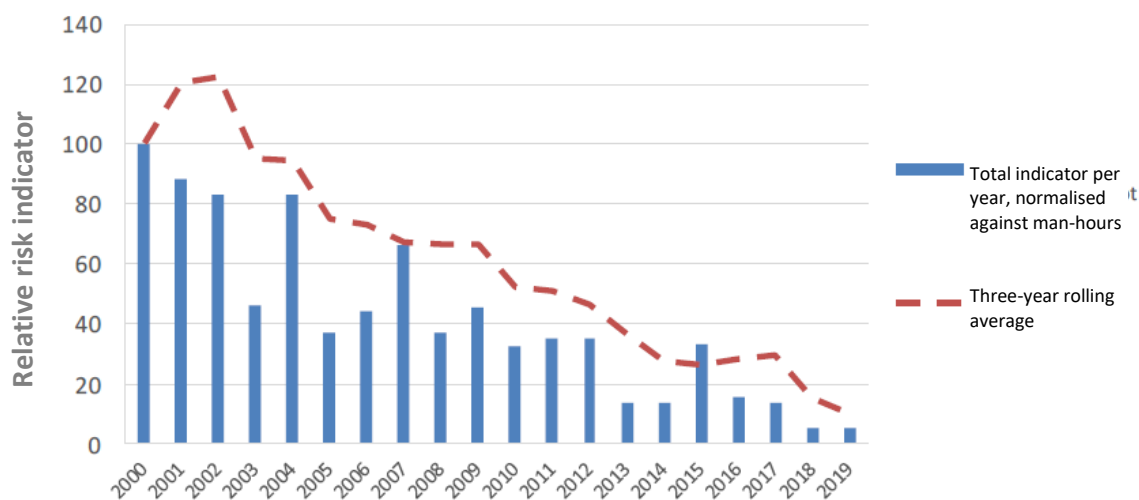


Figure 6.14 Total indicator, major accidents, production facilities, normalised against working hours, compared to three-year rolling average (Reference value is 100 in the year 2000, both for total indicator and three-year rolling)

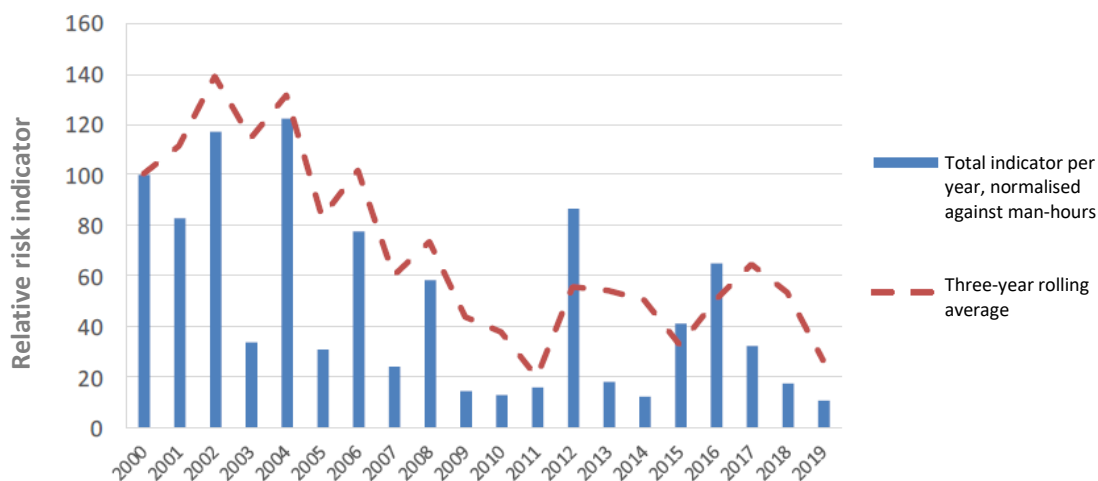


Figure 6.15 Total indicator, major accidents, mobile facilities, normalised against working hours, compared to three-year rolling average (Reference value is 100 in the year 2000, both for total indicator and three-year rolling)

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) is implemented.

Figure 7.1 shows the proportion of failures for the barrier elements related to production and process. 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.

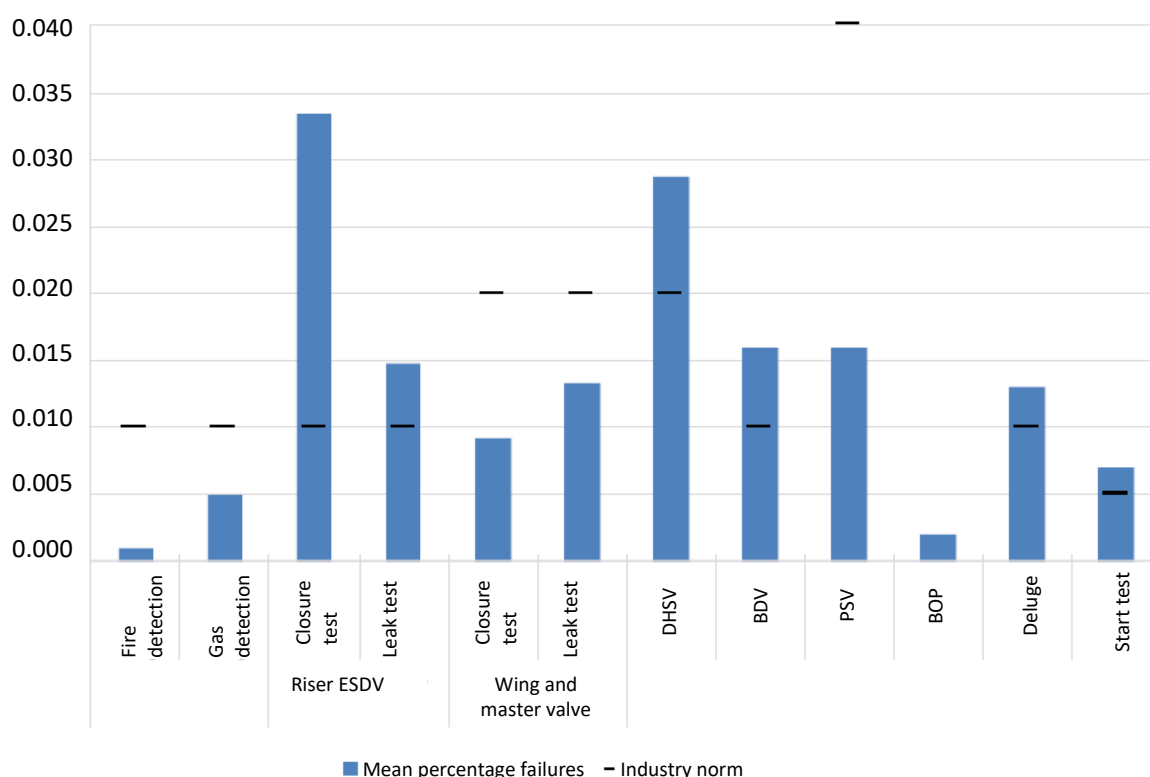


Figure 7.1 Mean percentage of failures for selected barrier elements in 2019

The main report shows both the “mean percentage of failures” (Figure 7.1), 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 one looks at each individual facility, as has been done for all barrier elements in the main report. Figure

7.2 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 2019, the average percentage of failures during the period 2002-2019, 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 7.2 shows that 7 facilities are above the norm for the proportion of failures in 2019, while 8 are above the norm when taking the average in the period 2002-2019.

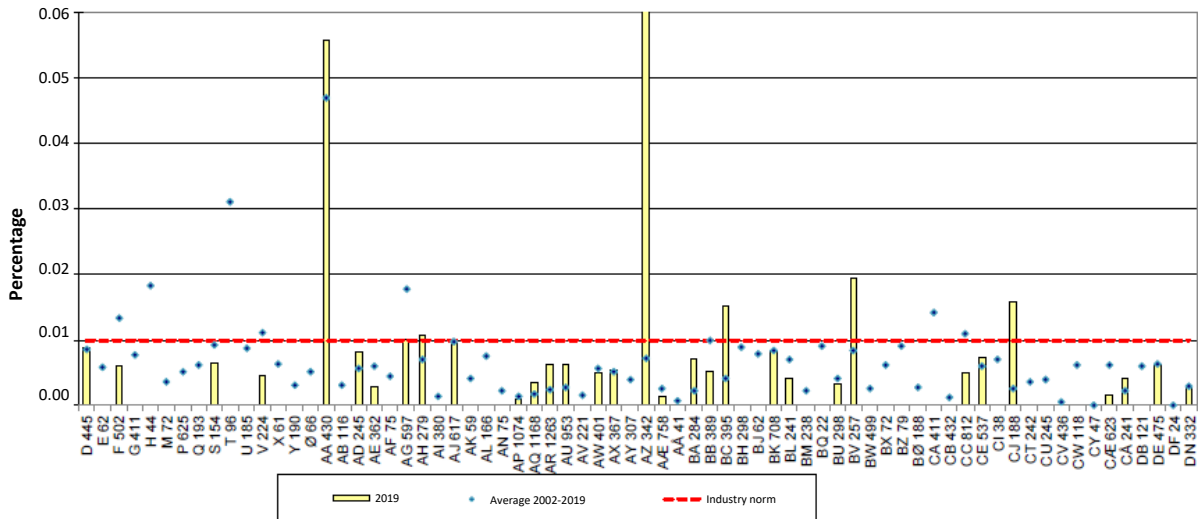


Figure 7.2 Percentage of gas detection failures

For production facilities, barrier data have now been collected for 18 years for most of the barriers, and the results show that there are large differences in level between the facilities. In Figure 7.3 and Figure 7.4, the mean percentage failures for three-year rolling averages are compared from 2011 to 2019.

Figure 7.3 shows that fire detection, gas detection and start tests of fire pumps are consistently low and below the respective industry norms. The riser ESDV closure test and BDV show a fall from the start of the period until 2015. The riser ESDV closure test increases from 2015 to 2019. BDV appears to flatten out after 2015. Both are well above the industry norm of 0.01. The riser ESDV leak test and deluge show a rise in the middle of the period and a fall from 2015 to 2017. Both rise slightly in 2019. Deluge is above the industry norm of 0.01 in 2019.

Figure 7.4 shows that DHSV has a rising trend from 2012 to 2017, before flattening out in 2018-2019. 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 2019. For the industry as a whole, a flat trend is apparent for most of the barriers in recent years. The riser ESDV closure and leak test and deluge are the barrier elements showing the greatest change and, for these, the trend in the proportion of failures is rising.

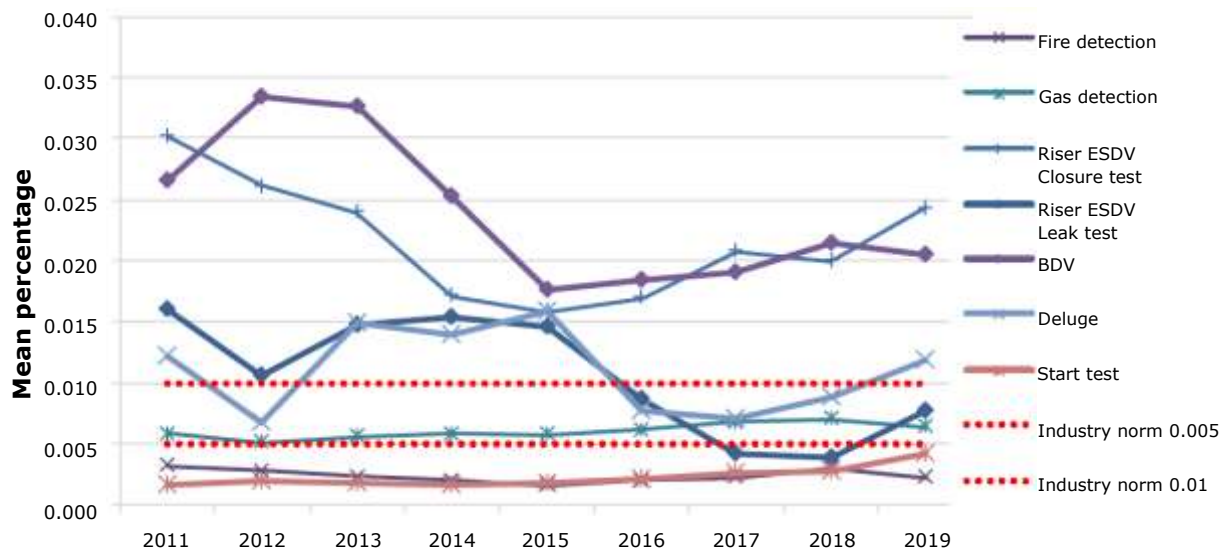


Figure 7.3 Mean percentage failures with a three-year rolling average

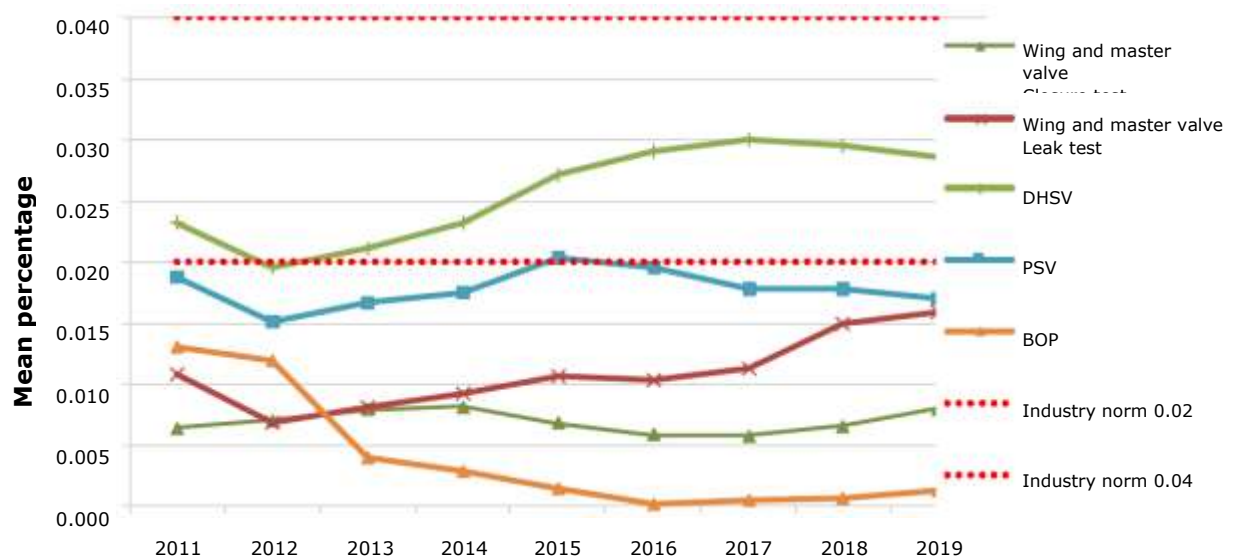


Figure 7.4 Mean percentage failures with a three-year rolling average

Table 7.1 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 2019 and for the period 2002-2019. 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, many barrier elements are below or about on a par with the industry norm for availability. Mean percentage failures for 2019 and mean percentage failures 2002-2019 for riser ESDV closure test and leak test, DHSV, BDV and deluge are above the industry norm. Start test is above the industry norm for mean percentage failures for 2019.

Table 7.1 General calculations and comparison with industry norms for barrier elements

Barrier element is	Number of facilities where tests were performed in 2019	Average, number of tests, for facilities where tests were performed in 2019	Number of facilities with percentage failures in 2019 greater than the industry norm	Number of facilities with average percentage failures 2002-2019 greater than the industry norm ^{*2}	Total percent age failures in 2019	Mean percent age failures in 2019	Total percent age failures 2002-2019	Mean percent age failures 2002-2019	Industry norm for availability
Fire detection	70	610	2	3	0.001	0.001	0.003	0.003	0.010
Gas detection	70	328	7	8	0.006	0.005	0.007	0.008	0.010
Shutdown:									
• Riser ESDV	64	21	10	33	0.011	0.026	0.015	0.018	0.010
• Closure test	64	14	6	27	0.010	0.033	0.013	0.020	0.010
• Leak test	59	8	5	17	0.013	0.015	0.012	0.013	0.010
• Wing and master (Christmas tree)	80	207	9	8	0.009	0.011	0.011	0.011	0.020
• Closure test	78	101	7	5	0.006	0.009	0.007	0.007	0.020
• Leak test	78	115	13	11	0.012	0.013	0.012	0.012	0.020
• DHSV	80	71	35	38	0.040	0.029	0.028	0.025	0.020
Blowdown valve (BDV)	63	60	21	45	0.012	0.016	0.020	0.021	0.010
Pressure safety valve (PSV)	71	102	11	10	0.021	0.016	0.029	0.023	0.040
Isolation using BOP	20	172	4	19	0.002	0.002	0.013	0.015	^{*3}
Active									
Fire protection:									
• Deluge valve	69	29	12	23	0.008	0.013	0.009	0.011	0.010
• Start test	62	92	17	15	0.002	0.007	0.003	0.003	0.005

7.2 Barriers associated with maritime systems

In 2019, 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.

² 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.

³ For isolation using BOP, there is no comparable industry norm, since it is not considered appropriate. It is recommended to follow up failures in this barrier using trend analyses.

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 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.

7.3.1 The management of maintenance of fixed facilities

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

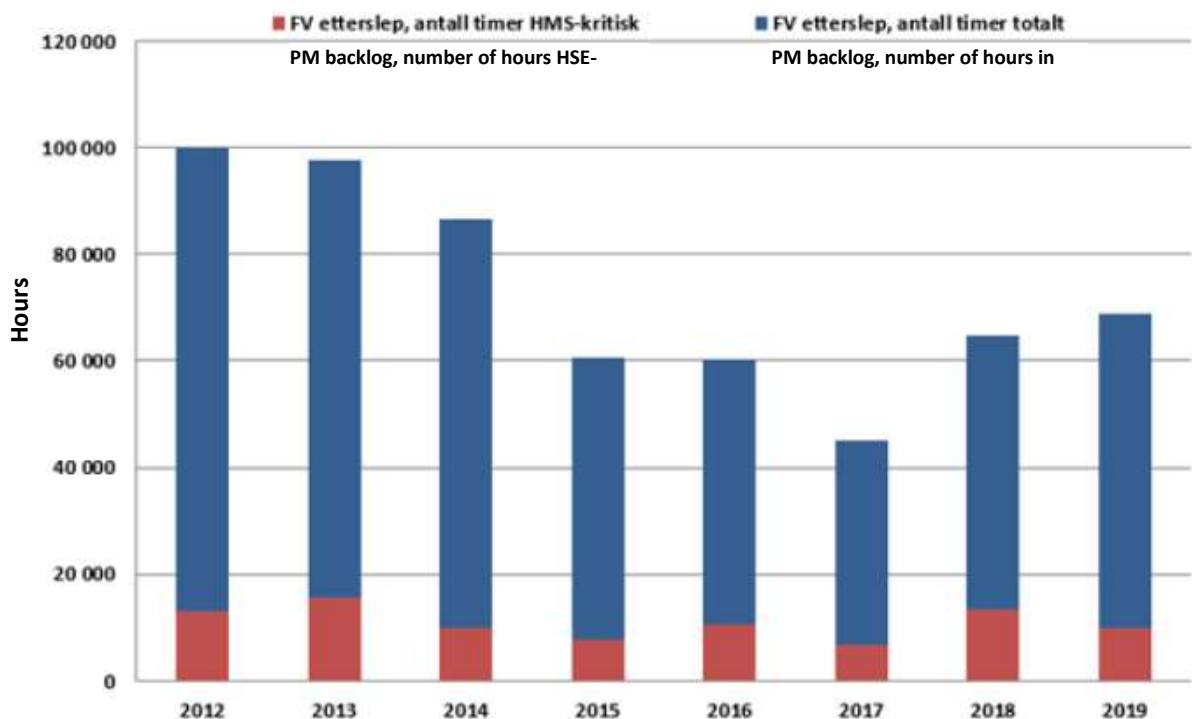


Figure 7.5 Total backlog in PM per year in the period 2011-2019 for the fixed facilities

Figure 7.5 shows that the total backlog in preventive maintenance is higher in 2019 than for the reporting years from 2015 to 2018. The backlog in HSE-critical preventive maintenance is more or less similar to that reported since 2012.

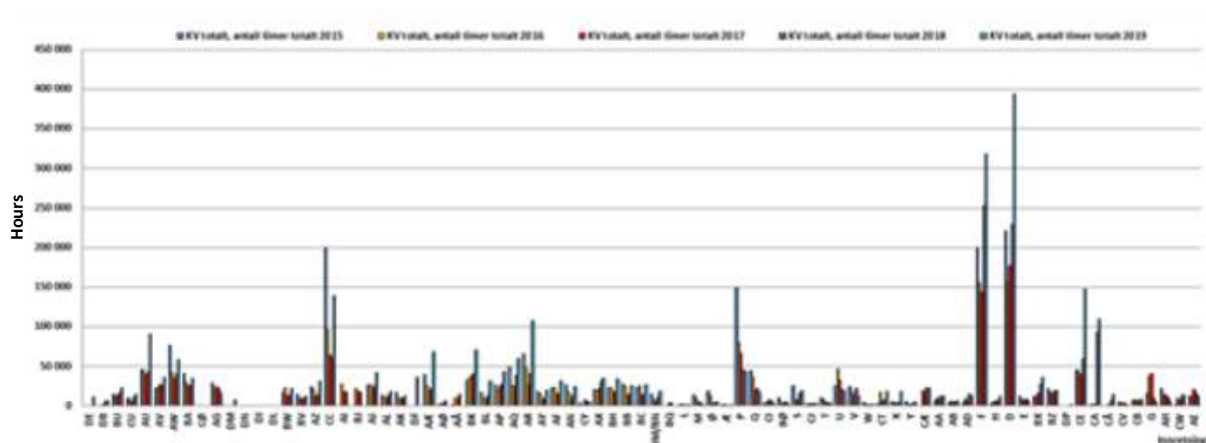


Figure 7.6 Total CM at 31/12/2019 for the fixed facilities. The figure also shows data for 2015 to 2018

Figure 7.6 shows the *total corrective maintenance* identified at 31/12/2019, but not yet performed. The figure shows that some facilities have a significant number of hours of corrective maintenance that have not been carried out as of 31/12/2019, and for some the hour count is significantly higher than in previous years. Most facilities have stable figures.

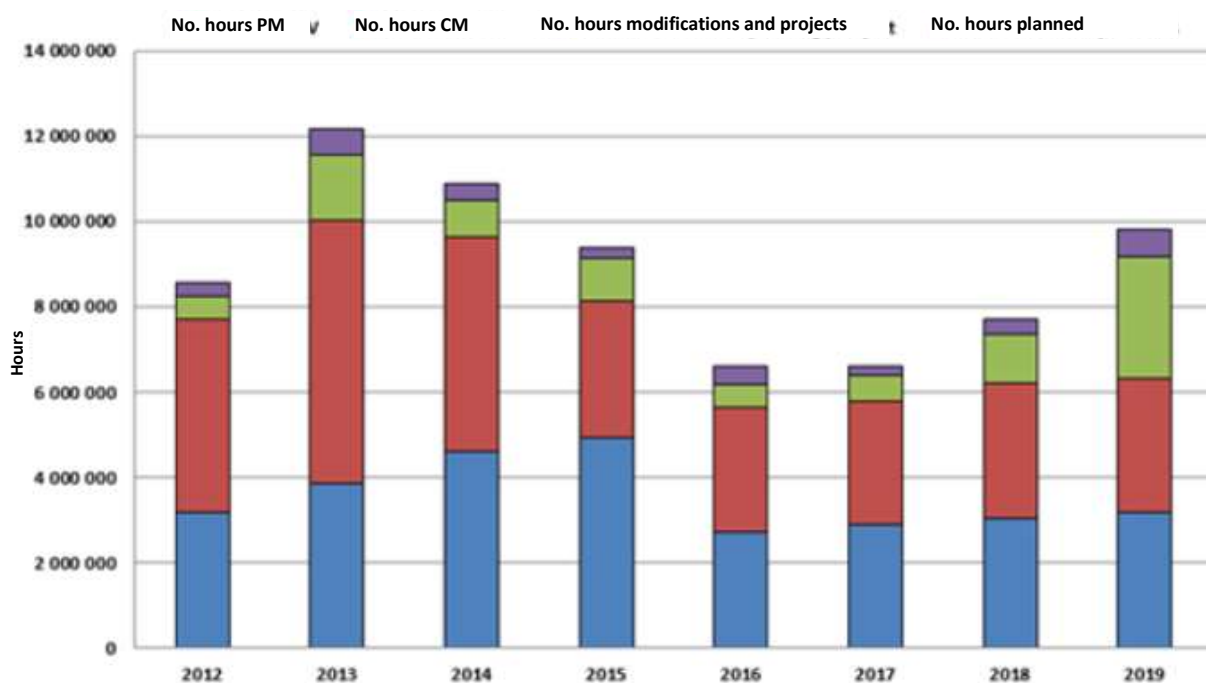


Figure 7.7 Total number of hours for performed maintenance, modifications and planned shutdowns for the fixed facilities in the period 2012-2019

Figure 7.7 shows the total number of hours for performed maintenance, modifications and planned shutdowns for the fixed facilities in the period 2012-2019. 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 2019 are slightly higher than in the previous year. We can also see that the number of hours for modifications and projects has increased.

For maintenance on fixed facilities, 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 of preventive maintenance, but several facilities have no performed HSE-critical preventive maintenance in accordance with their own deadlines
- the total backlog in preventive maintenance is higher in 2019 than for the reporting years from 2015 to 2018. The backlog in HSE-critical preventive maintenance is more or less similar to that reported since 2012
- some facilities have a significant number of hours of corrective maintenance that have not been carried out as of 31/12/2019, and for some the hour count is significantly higher than in previous years. Some facilities have reduced the number of hours. Most facilities have stable figures and low counts
- there is overall a considerable number of hours of corrective maintenance not performed as at 31/12/2019. The figures for 2019 also show a significant increase compared with the years before
- there was a considerable reduction in the number of hours of total outstanding corrective maintenance in 2019 compared with the previous year. The total outstanding HSE-critical corrective maintenance is on a par with the last three years
- the hours for the preventive and corrective maintenance carried out in 2019 are slightly higher than in the previous year. We can also see that the number of hours for modifications and projects has increased
- there is a large variation in the percentage distribution by participant of performed preventive and corrective maintenance.

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 in 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.

7.3.2 The management of maintenance of mobile facilities

Figure 7.8 shows the *backlog in preventive maintenance* in 2019.

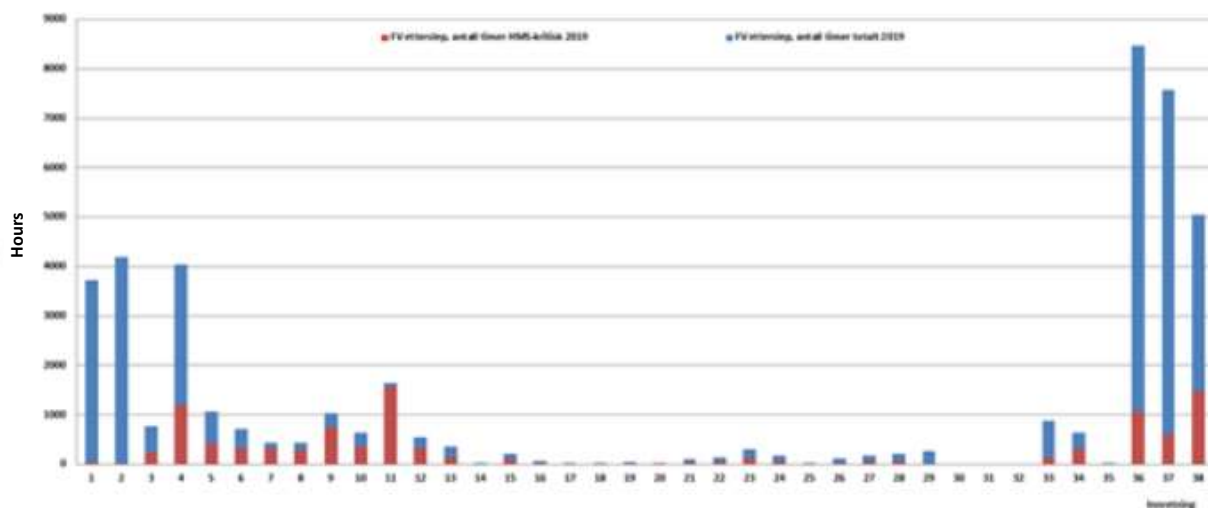


Figure 7.8 Backlog in PM for mobile facilities in 2019

There are large variations in the backlog of preventive maintenance for mobile facilities. 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.

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

Figure 7.9 shows the *outstanding corrective maintenance* in 2019.

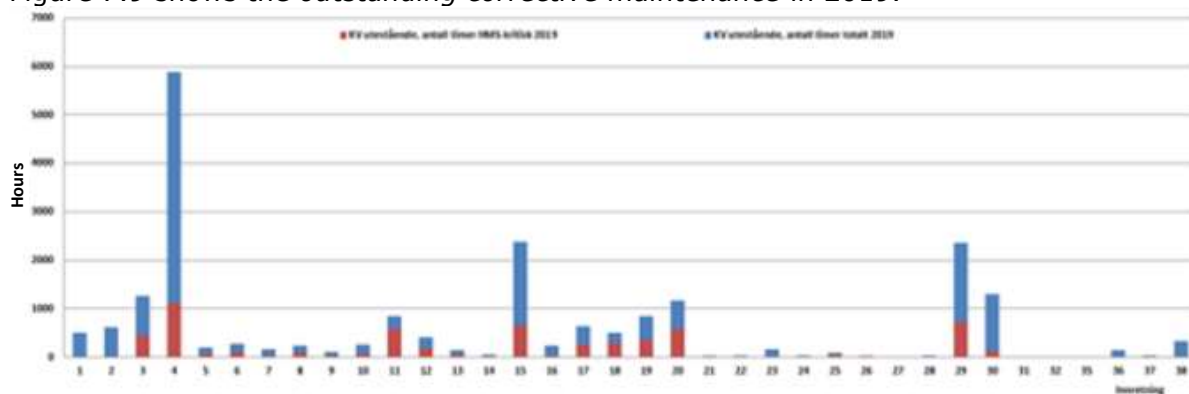


Figure 7.9 Outstanding CM for mobile facilities in 2019

There are large variations in the outstanding corrective maintenance for mobile facilities. This corresponds to what we have seen in recent years. The hour total is however relatively low. Several facilities have not performed HSE-critical corrective maintenance in accordance with their 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.

We note 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

- 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 for mobile facilities. This corresponds to what we have seen in recent years. The hour total is however relatively low. Several 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 in 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.

8. Work accidents involving fatalities and serious personal injuries

There were no fatalities within the Petroleum Safety Authority Norway's area of authority on the NCS in 2019. For 2019, the PSA registered 230 personal injuries on facilities in the petroleum activities on the NCS that fulfil the criteria of fatality, absence into the next shift or medical treatment. In 2018, 196 personal injuries were reported.

In addition, 20 injuries classified as off-work injuries and 22 first aid injuries were reported in 2019. For comparison, in 2018 there were 35 off-work injuries and 31 first aid injuries. First aid injuries and off-work injuries are not included in figures or tables.

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 2019. 40% of the injuries were 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 ten classified as serious. The injuries concern both contractors' and operators' employees. In order to clear up the lack of reporting, in 2018 an inquiry was addressed to the relevant employers where there was a lack of NAV forms for injuries that occurred in 2017. As at February 2020, the status is that, for the year 2017, we are lacking NAV forms for 11%. The corresponding figures for 2018 are that 28% of injuries notified/reported to us still lack NAV forms. Two of these are classified as serious.

There were 181 personal injuries on production facilities in 2019 against 153 in 2018. In the long term, there has been a positive trend in the injury rate since 2009 when the overall rate was 8.4 injuries per million working hours. In 2019, there were 5.3 injuries per million working hours. This is about the same level as in 2018.

In 2019, there were 49 personal injuries on mobile facilities, compared with 43 in 2018. The total injury rate rose from 3.9 in 2018 to 4.2 injuries per million working hours in 2019. In the long term, mobile facilities, like production facilities, have had a positive trend, where the injury rate has decreased from 6.9 in 2009 to 4.2 in 2019.

8.1.1 Serious personal injuries

Serious personal injuries are defined in the guidelines to the Management Regulations Section 31, which definition is used as the basis for classifying serious personal injuries.

Figure 8.1 shows the frequency of serious personal injuries on production facilities and mobile facilities combined. In 2019, a total of 32 serious personal injuries were reported, against 25 in 2018.

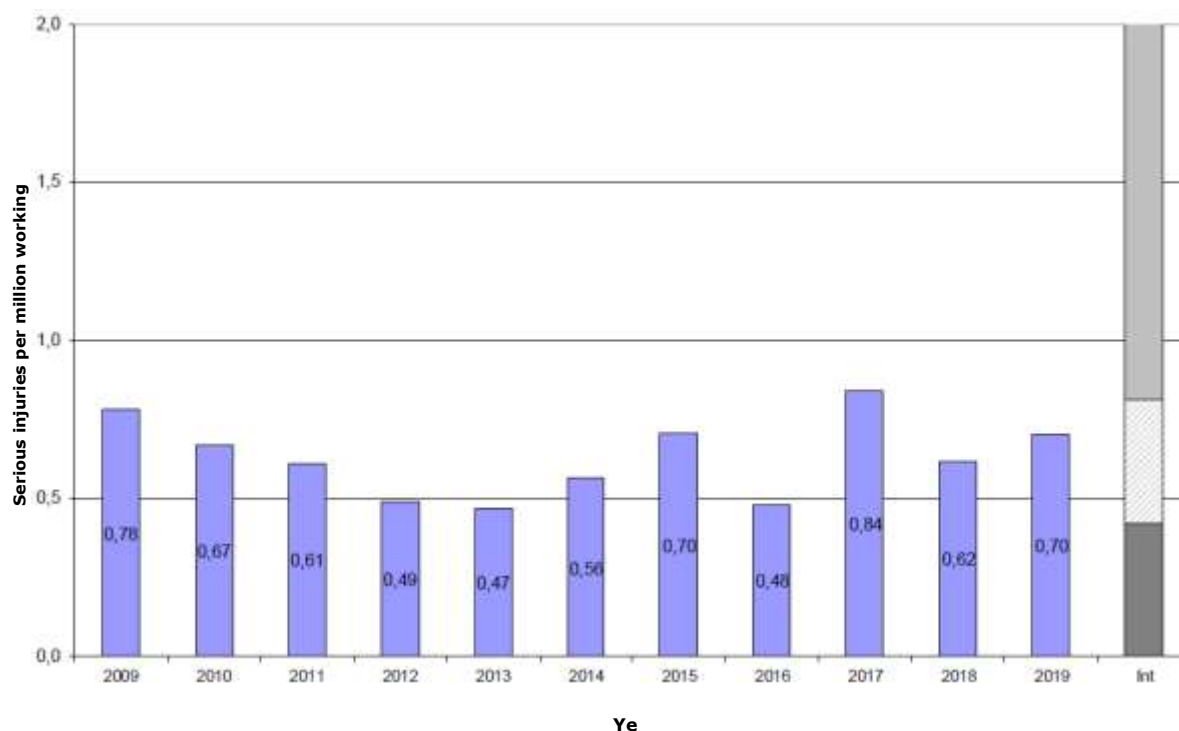


Figure 8.1 Serious personal injuries per million working hours – NCS

In the period 2009 to 2013 there was a downward trend. From 2014 the trend was more varied, with the rate of serious injuries per million working hours varying from 0.5 in 2016 to 0.8 in 2017. In 2019, there was an increase over 2018, from 0.6 to 0.7. In 2019 the rate is within the expected level based on the ten preceding years.

The activity level on the NCS last year rose by 5.2 million to 45.7 million working hours.

8.1.2 Serious personal injuries on production facilities

Figure 8.2 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. In the period 2014 to 2019, the frequency has varied from year to year, but all years have had a higher frequency than in 2013. From 2018 to 2019, there was a small increase in the rate of serious injuries per million working hours, from 0.58 to 0.65. The rate in 2019 is within the expected level based on the ten preceding years.

On production facilities, there were 22 serious injuries in 2019 compared with 17 in 2018. The number of working hours increased from 28.1 million in 2018 to 33.9 million in 2019 (+5.9 million).

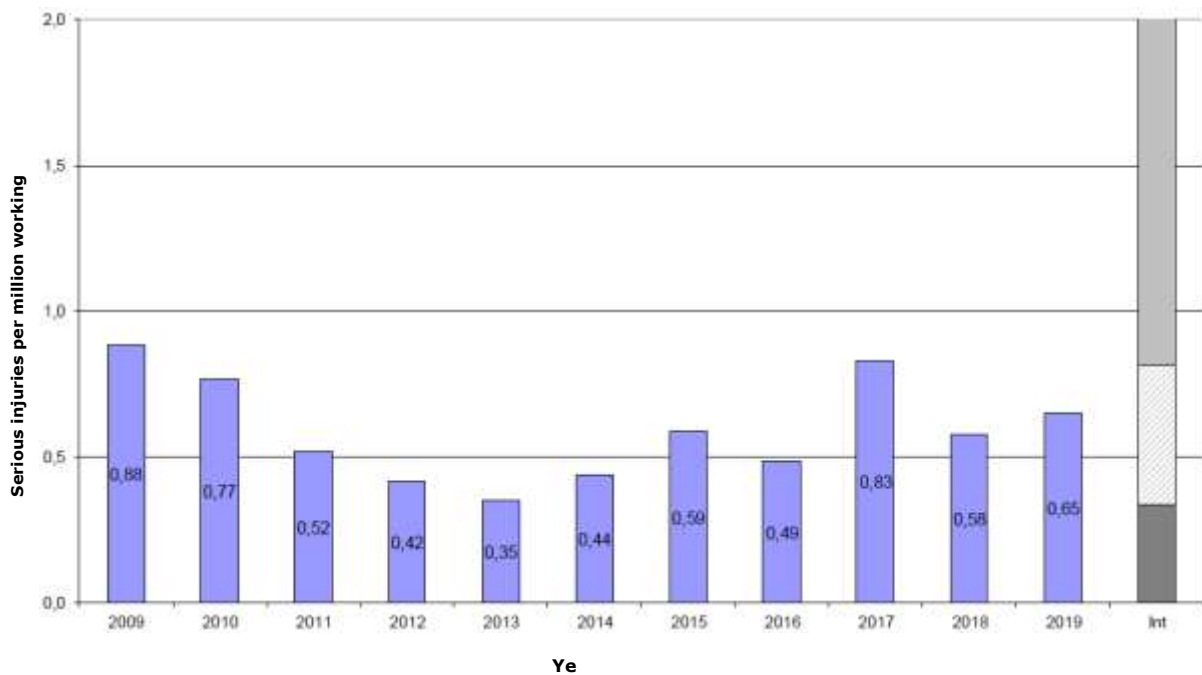


Figure 8.2 Serious personal injuries on production facilities per million working hours

8.1.3 Serious personal injuries on mobile facilities

Figure 8.3 shows the frequency of serious personal injuries per million working hours on mobile facilities. The rate in 2019 has risen slightly compared with 2018 and is now at about the same level as in 2017. The injury rate is therefore within the expected values based on the preceding ten years. In the whole period, in 3 out of 11 years, the rate stands out positively relative to the average⁴. These were 2009, 2010 and 2016. The remaining eight years fluctuate around the average and there is not a trend towards improvement in the period.

The hourly rate reported for the mobile facilities in 2019 is 11.8 million, while there were 11.0 million hours in 2018. The number of serious injuries is ten in 2019 compared with eight in 2018.

⁴ The frequencies in 2009 and 2010 were lower than the expected value based on the then preceding ten-year periods. 2016 was within the expected range.

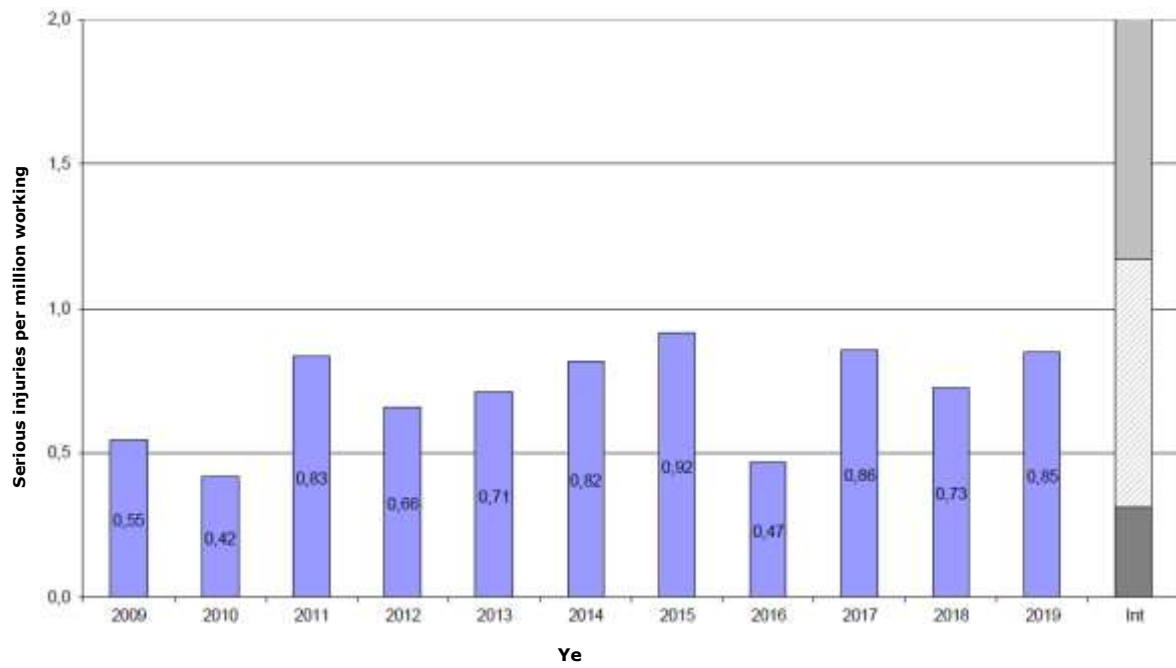


Figure 8.3 Serious personal injuries per million working hours, mobile facilities

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. The time series now consists of data for the period 2013-2019. The analysis looks at both the six years combined and a comparison between the years, as appropriate.

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 increased slightly, and in 2019 is higher than any previous year. The normalised number of incidents based on working hours also shows an increase from 2018 to 2019 (see Figure 9.1).
- Incidents involving the use of offshore cranes rose from 2018, and in 2019 were higher than any previous year. This is true in terms of both absolute and normalised numbers (see Figure 9.2 and Figure 9.3).
- Looking at incidents without personal injury, but with the potential for injury, the number of incidents with exposed personnel (one person and several persons) is clearly increasing, and for incidents with one person exposed it has increased sharply (see Figure 9.4).
- In 2018, there was a positive trend that might indicate better planning of lifting operations with fewer exposed persons when an incident occurs. This trend is clearly broken in 2019, with reference to the preceding point (see Figure 9.4).

Mobile facilities

- The number of reported incidents for mobile facilities (both absolute and normalised) increased from 2017 to 2018, and rose further in 2019. The normalised number of incidents in 2019 is higher than all previous years (see Figure 9.1).
- Breaking incidents down by type of lifting activity, there was an increase over 2018 especially in incidents relating to lifting in drilling modules, and the increase is significant, both in absolute and normalised numbers. The largest contributors to the increase in 2019 are other lifting equipment and fixed slewing and/or telescoping cranes contributing 36% each (see Figure 9.5).

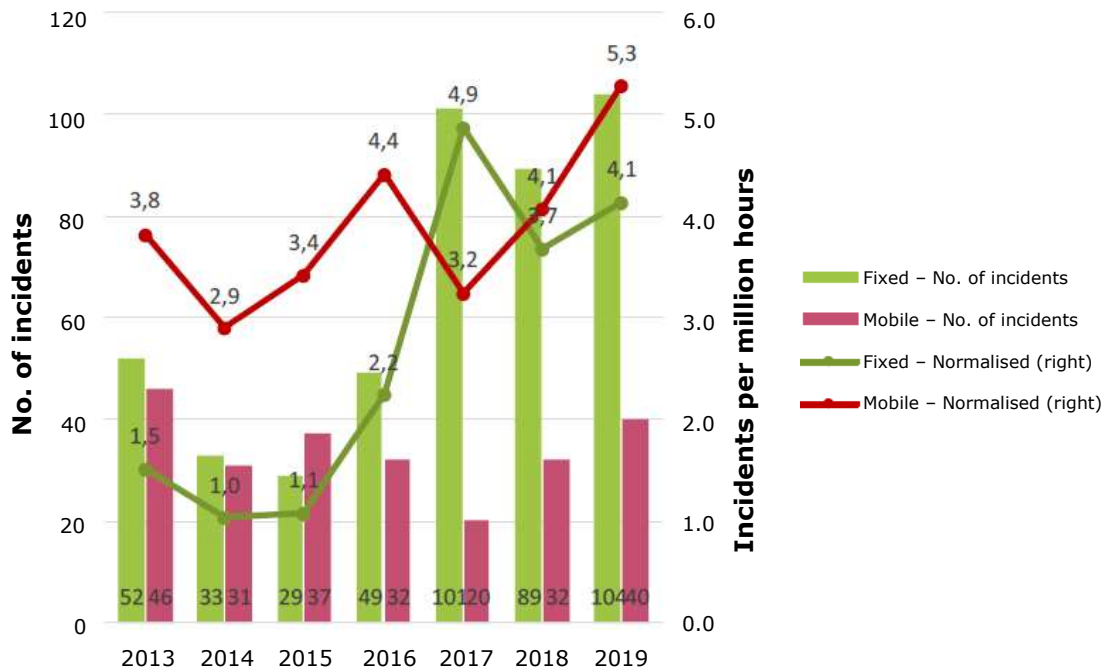


Figure 9.1 Number of reported incidents for crane and lifting operations in the period 2013-2019 for fixed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relating to drilling and well operations and to construction and maintenance, per type of facility

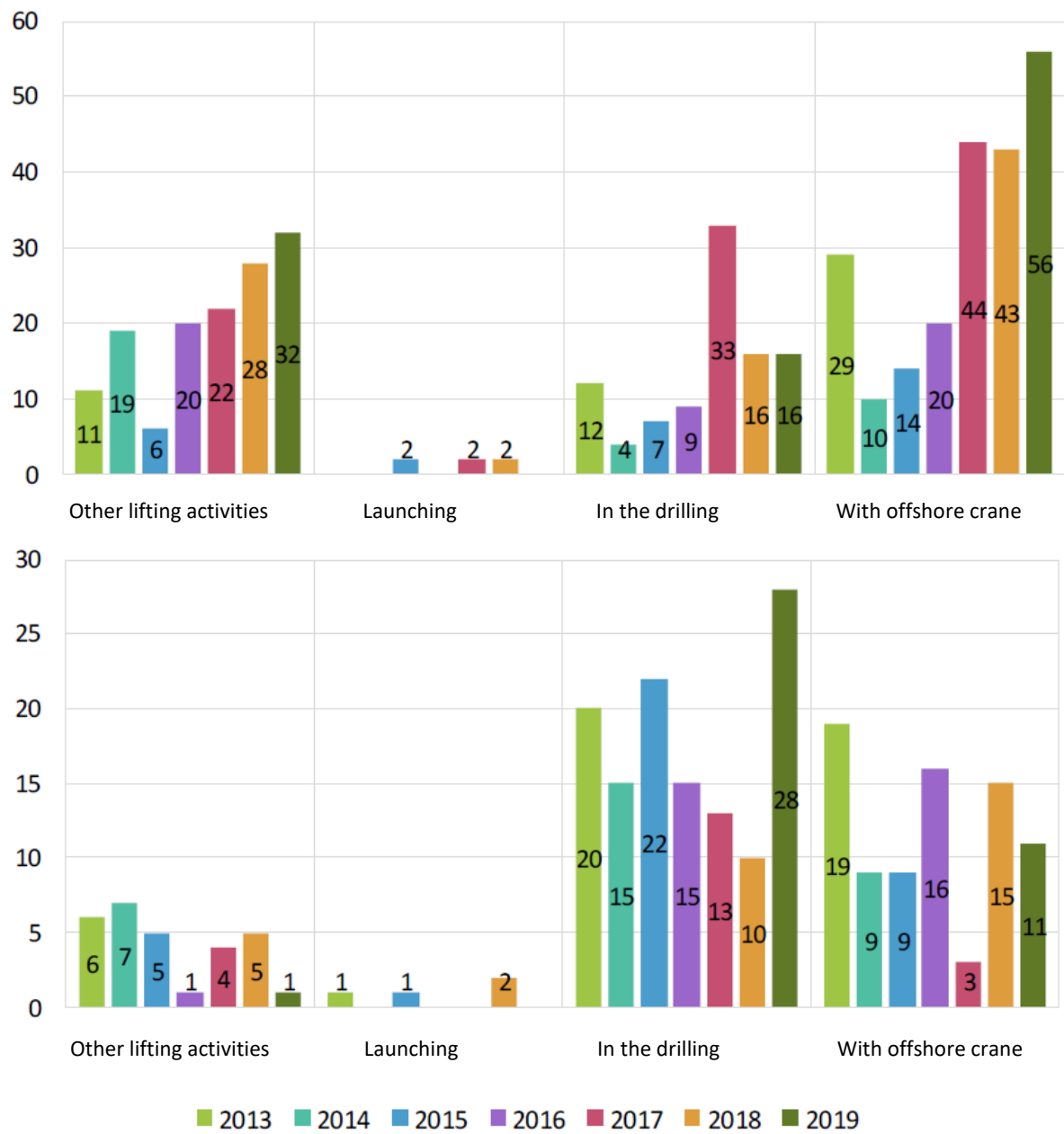


Figure 9.2 Number of incidents per year for the different types of lifting activities for the period 2013-2019, shown for fixed (top) and mobile (bottom) facilities

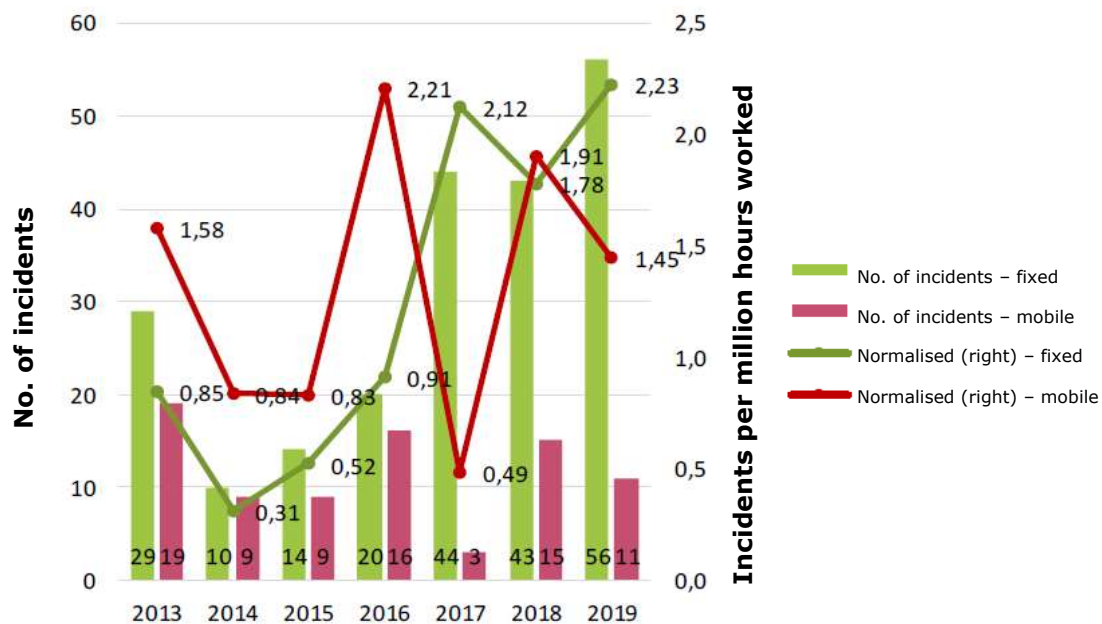


Figure 9.3 Number of incidents relating to lifting using offshore cranes for the period 2013-2019 shown for fixed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relating to drilling and well operations and to construction and maintenance, per type of facility

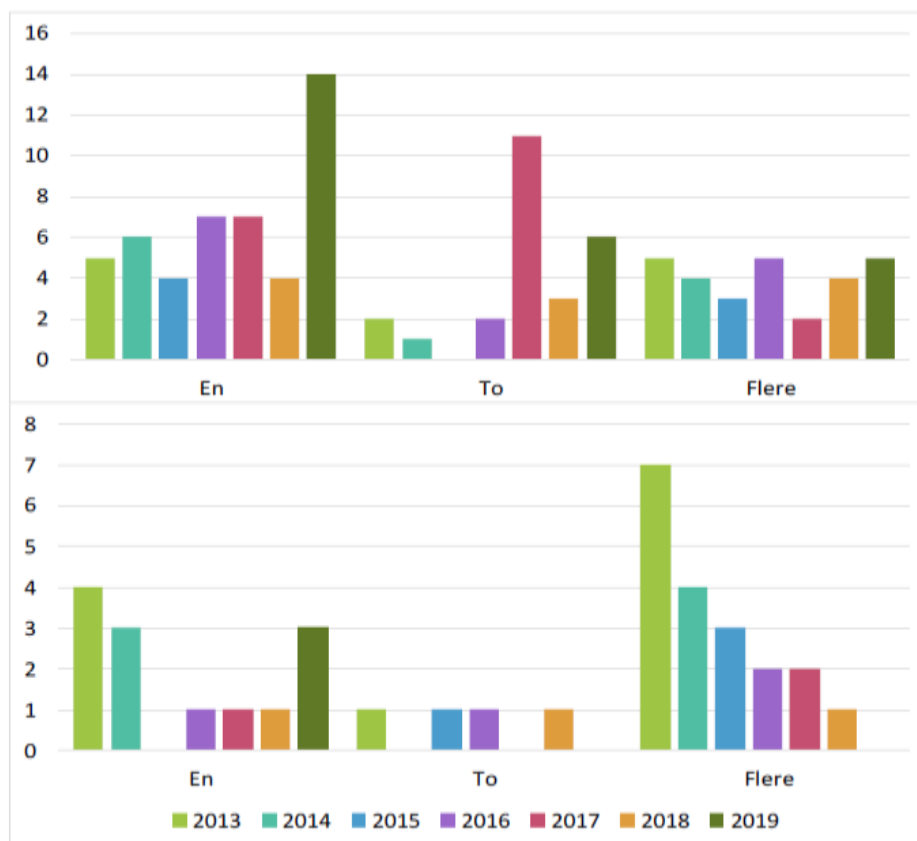


Figure 9.4 Relative number of incidents (without personal injury) with persons exposed to the incident, for fixed (top) and mobile (bottom) facilities, for the period 2013-2019

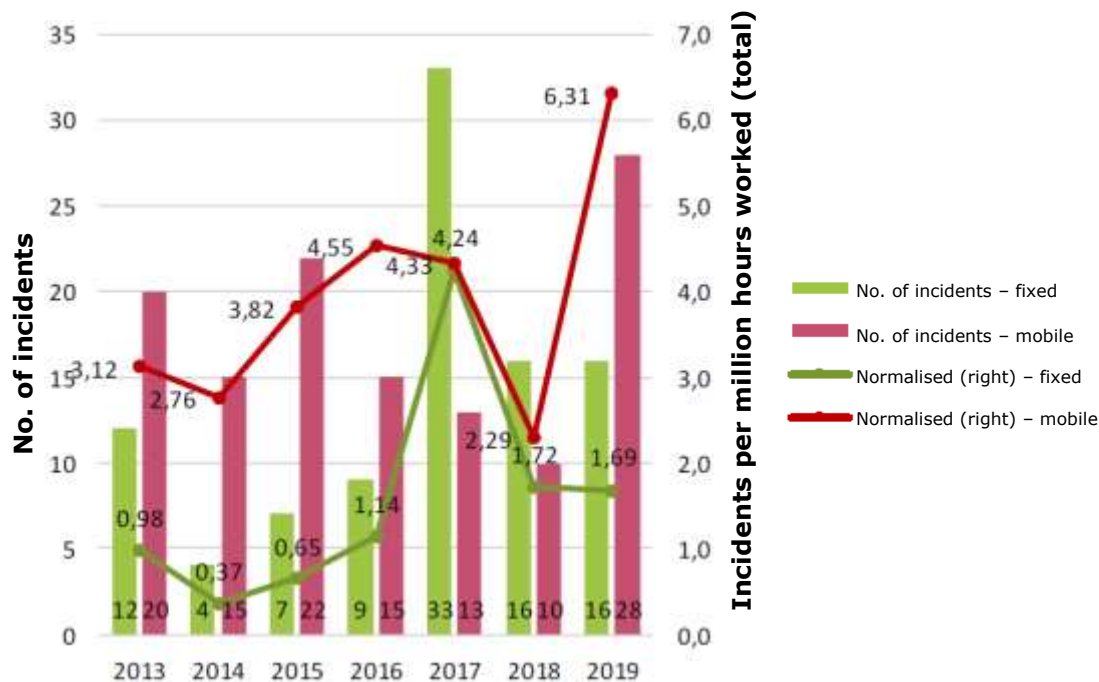


Figure 9.5 Number of incidents relating to lifting in the drilling module for the period 2013-2019 shown for fixed and mobile facilities – absolute numbers and numbers normalised against million working hours relating (exclusively) to drilling and well operations, per type of facility

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, 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 2013-2019. The analysis looks at both the six years combined and a comparison between the years, as appropriate.

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

Fixed facilities

- The number of reported incidents for fixed facilities increased slightly, and in 2019 is higher than any previous year. The normalised number of incidents is at almost the same level in 2019 as in 2018 (see Figure 9.6).
- In 2019, the highest number of incidents involving injuries was observed in the entire observation period, a total of 11 on fixed facilities in 2019 compared with 10 in 2018. In both 2018 and 2019, the number is more than twice as high as the years 2013-2017 (see Figure 9.7).
- For drilling areas, there is a very significant increase in the number of incidents >40 J from 2018 to 2019; a threefold increase. There is also an increase in the number of incidents <40 J. The increase is primarily related to work processes in operations and operations in the drilling area (see Figure 9.8).
- For scaffolding, there is a significant increase for both incidents <40 J and >40 J from 2018 to 2019. For incidents >40 J, this comes on top of an increase from 2017 to 2018 (see Figure 9.8).

- For scaffolding, in 2019 there is also an increase in the number of incidents related to assembly/dismantling and use of scaffolding, for incidents with both energy classes <40 J and >40 J. The normalised data (events per million working hours relevant for construction and maintenance) shows the same trend for both energy categories (see Figure 9.9).
- For incidents without personal injury, but with the potential for injury, there is a negative trend, in that the proportion of incidents with exposed personnel (two persons and several persons) increases compared to 2018 (see Figure 9.10).
- In 2018, a positive trend was observed that could indicate better planning of lifting operations leading to fewer persons exposed when an incident occurs. This trend is clearly broken in 2019, with reference to the preceding point (see Figure 9.10).
- The injury potential shows an increase in the number of objects in all energy classes >40 J in 2019 (see Figure 9.11).

Mobile facilities

- In 2018, *mobile facilities* saw an increase in reported incidents after a number of years of a weak downward trend. 2019 is on a par with 2018. This applies to both absolute and normalised quantities (see Figure 9.6).
- For drilling areas, there is a significant increase in the number of incidents for both <40 J and >40 J compared with 2018. This comes on top of an already strong increase from 2017 to 2018, and applies to both absolute and normalised numbers of incidents. The increase is primarily related to work processes in operations in the drilling area (see Figure 9.12).

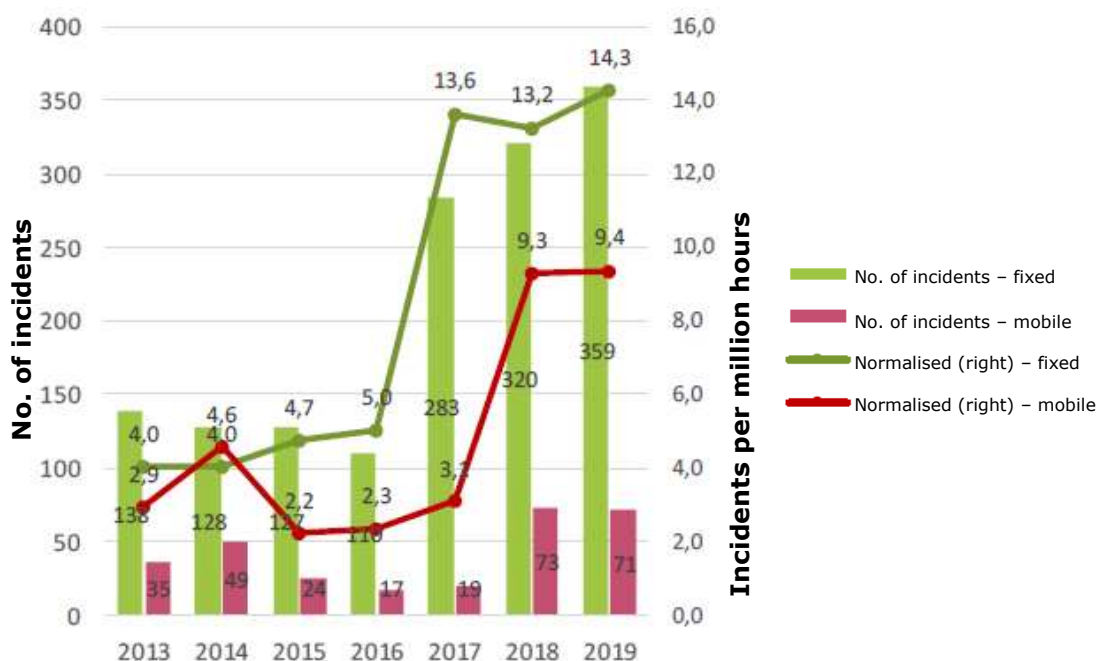


Figure 9.6 Number of incidents and incidents per million working hours classified as falling objects, by fixed and mobile facilities, in the period 2013-2019

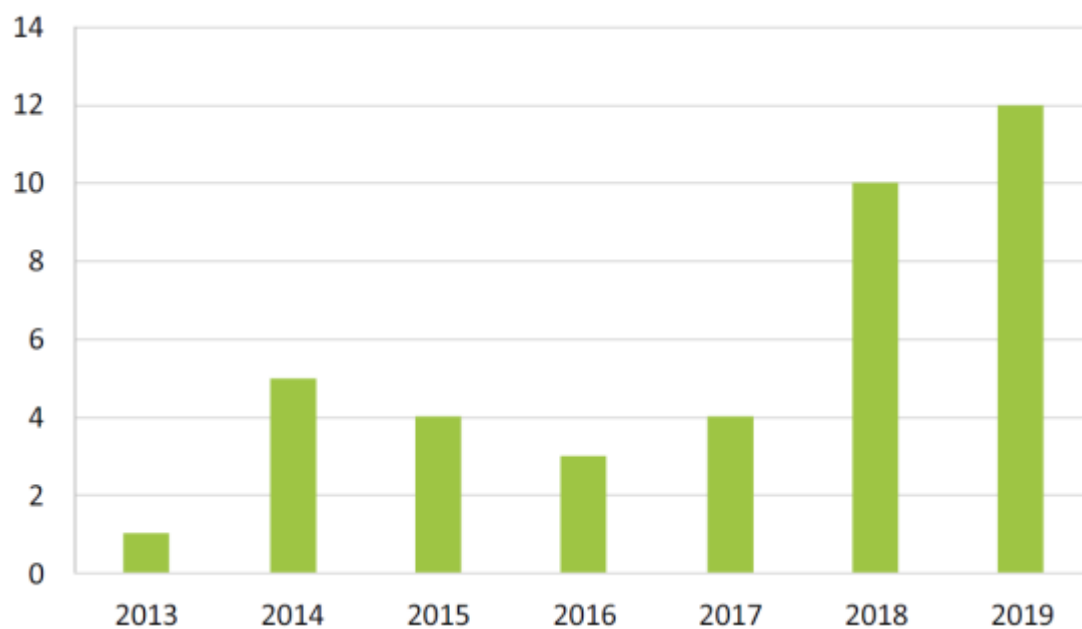


Figure 9.7 Total number of falling object incidents causing personal injury, in the period 2013-2019. With only one exception, in 2019, all such incidents were on fixed facilities.

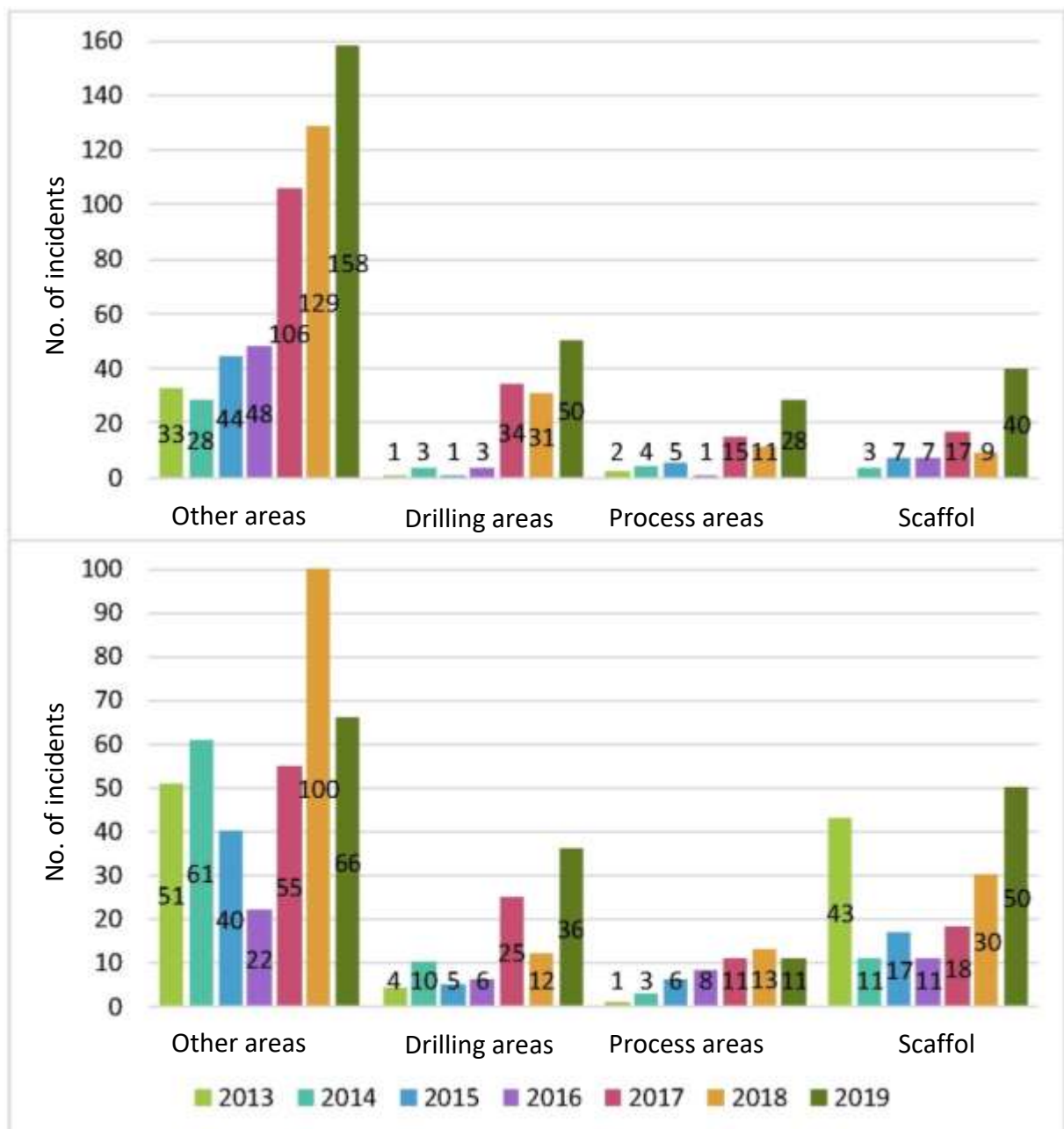


Figure 9.8 The total number of incidents for fixed facilities, differentiating <40 J (top) and >40 J (bottom) – by main categories of work processes (number of events per year specified in the columns), for the period 2013-2019

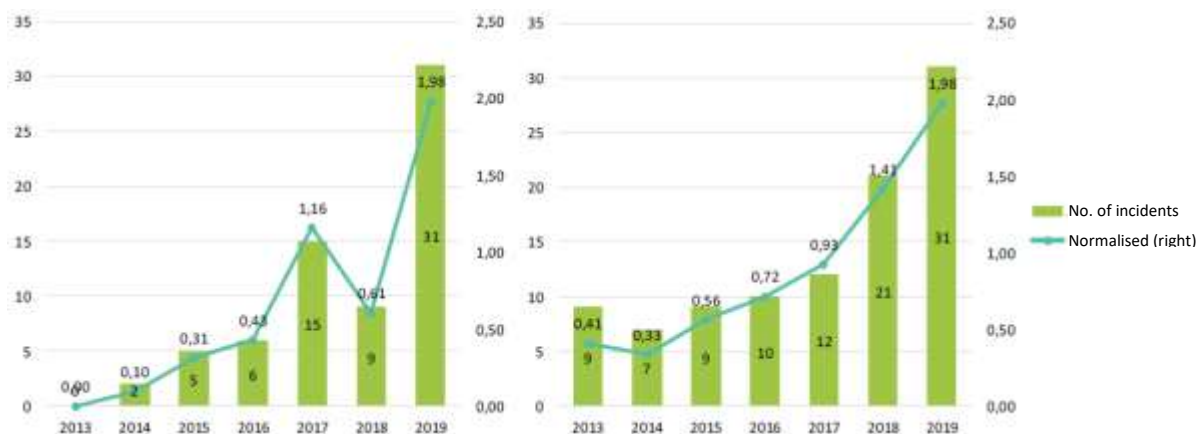


Figure 9.9 Number of incidents, <40 J on the left and >40 J on the right, on fixed facilities relating to erection/dismantling and use of scaffolding, as well as normalised against working hours for construction and maintenance, for the period 2013-2019

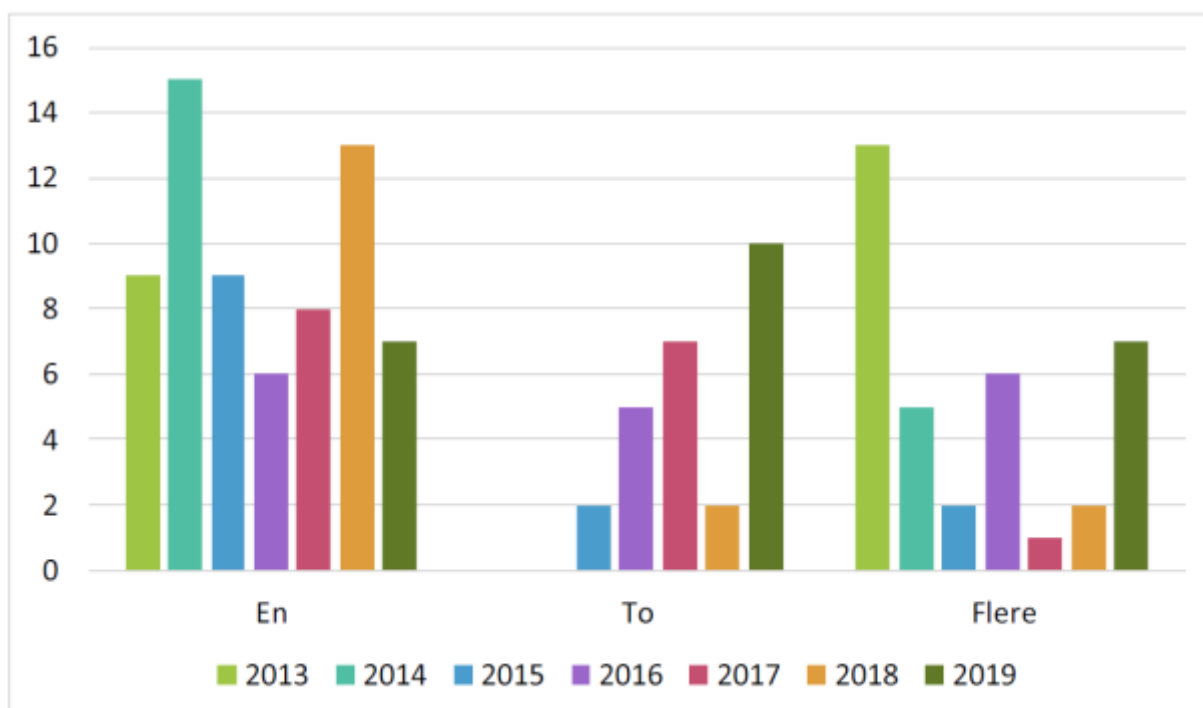


Figure 9.10 Absolute number of incidents (without personal injury) with persons exposed to an incident >40 J on fixed facilities

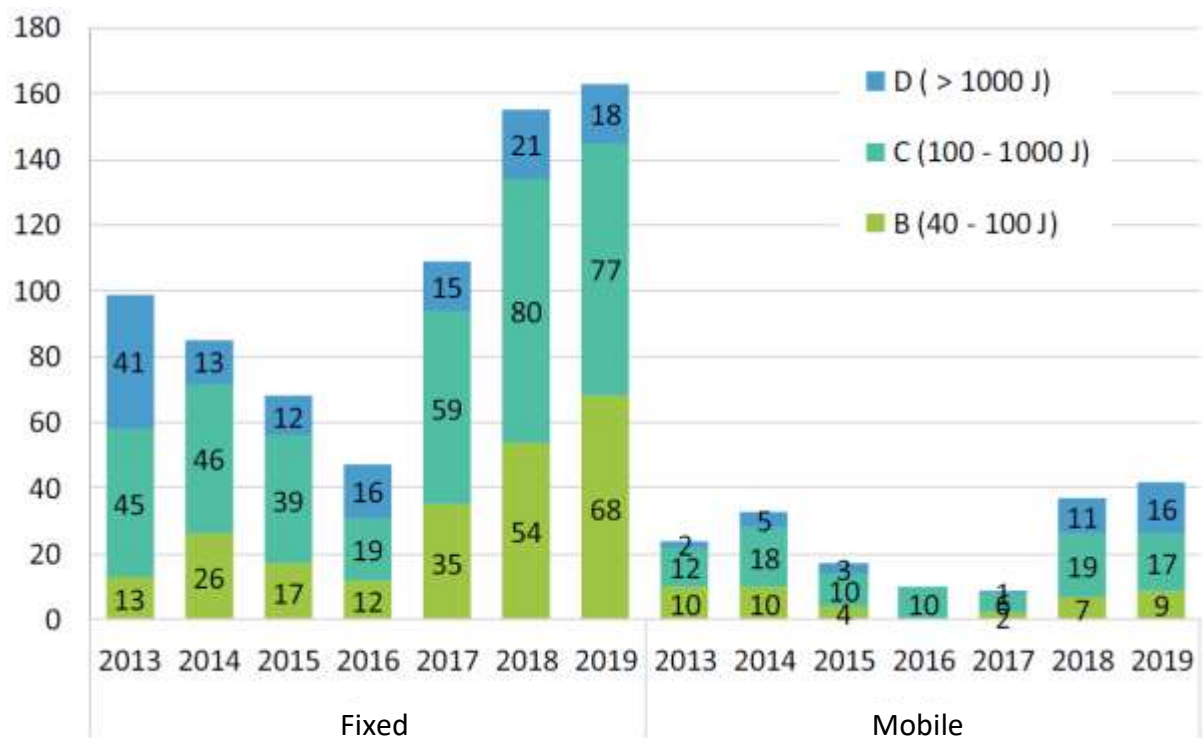


Figure 9.11 Number of objects by energy classes > 40 J, for fixed and mobile facilities, for the period 2013-2019

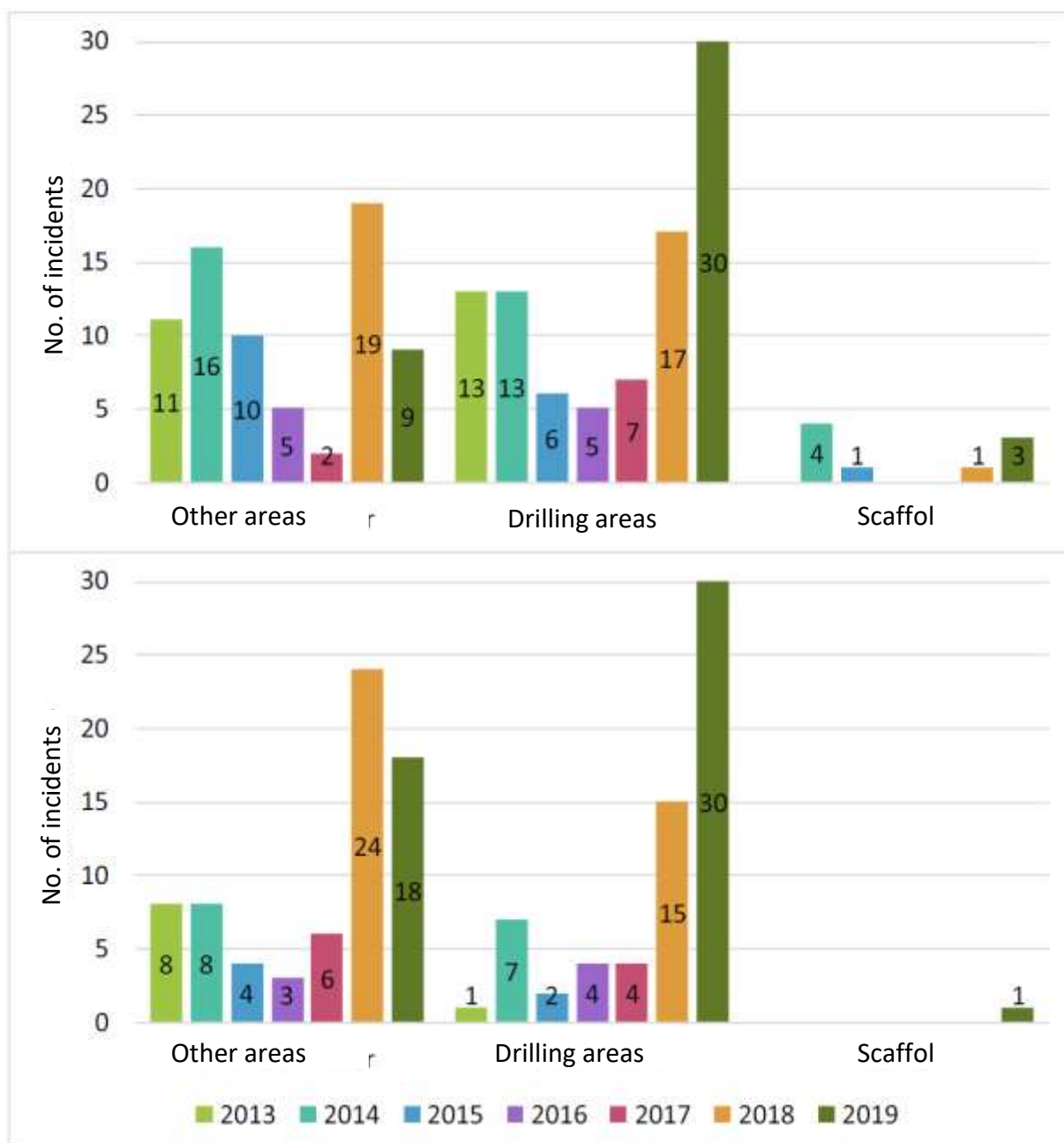


Figure 9.12 The total number of incidents for mobile facilities, differentiating <40 J (top) and >40 J (bottom) – by main categories of work processes (number of events per year specified in the columns), for the period 2013-2019

9.3 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.

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 detailed list of abbreviations, see PSA, 2020a. 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

11. References

Detailed reference lists can be found in the main reports:

PSA, 2020a. Risk level in the petroleum activity – Norwegian Continental Shelf,
Main report, 02.04.2020

PSA, 2020b. Risk level in the petroleum activity – onshore installations,
02.04.2020

PSA, 2020c. Risk level in the petroleum activity – Methodology report,
02.04.2020