SUMMARY REPORT 2021

THE NORWEGIAN CONTINENTAL SHELF

Trends in risk level in the petroleum activity

RNNP

Foreword

Trends in the risk level in the petroleum activities concern all parties involved in the industry, as well as the general public. RNNP is an important tool for helping to establish a common picture of the trends in selected conditions that affect risk. RNNP is consequently of particular significance for interaction between the social partners within the petroleum activities, and their ownership of the process and the results are important both in terms of the implementation of the activity and the follow-up of results.

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, 31 March 2022

Finn Carlsen,
Director of professional competence, PSA

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1. Objective and limitations

1.1 Purpose

The "Trends in risk level on the Norwegian Continental Shelf" project started in the year 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. Recent developments have moved towards using several 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 work 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 in autumn 2022.

2. Conclusions

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

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. The main focus of this report is therefore trends. 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.

Data for the indicators for noise, chemical working environment and ergonomic risk factors are not reported for 2021. Unfortunately, the development of new indicators, which is taking place in collaboration with the industry, is taking longer than expected.

Ideally, it should be possible to reach a summary conclusion based on information from all the measurement instruments used. In practice, this is complicated, partly because the information used reflects HSE conditions at very different levels.

Major accidents

In 2021, there were no accidents that resulted in fatalities, hence no major accidents according to the definition of major accident used in this report. As in 2020, nor were there any exceptionally serious near misses with the potential for a large number of fatalities.

The number of near misses with major accident potential is at a stable level since 2005. This level is lower than in the period preceding 2005. In 2021, there were 37 such incidents (helicopters not included). This is at the same level as the last eight years. When the number of incidents is normalised against working hours, the frequency in 2021 is within the expected range.

Six non-ignited hydrocarbon leaks were registered in 2021 (five in 2020). All leaks were less than 1 kg/s. It is now seven years since hydrocarbon leakage exceeded 10kg/s. In 2021, there were 19 well control incidents, of which 18 are classified as level 3 well control incidents, low severity. (See the methodology report for a description of the categories for well incidents), and one is classified as serious. This is a significant numerical increase compared to 2020 (10 incidents). In 2021, three incidents of damage to structures and maritime systems that satisfy the damage criteria used in RNNP were registered. This represents a marked decrease in the number of such incidents from 2020, when there were eleven.

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 2021, the indicator (the total indicator) is lower than in 2020. This is mainly due to the fall in the number of structure-related incidents, which are weighted relatively highly in the indicator. The total indicator shows an underlying positive trend since 2005. Since particularly serious incidents are assigned relatively high weighting, the annual variation in the total indicator is large, but the positive trend illustrated by averaging is nevertheless clear. The total indicator is a composite indicator that reflects the industry's ability to influence and manage a variety of risk-related factors. The underlying positive trend in the indicator indicates that the industry has improved at managing factors that affect risk. Although an indicator based on historical figures provides relevant information on factors that affect future risk, it in no way provides sufficient information about future risk itself.

Helicopter risk accounts for a large share of the total risk exposure that employees on the NCS are subject to. The purpose of the risk indicators used in this work is to capture risks associated with incidents and to identify opportunities for improvement.

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

In the helicopter expert group's assessment of incidents in 2021, three were classified in the most serious category. The expert group assessed that, in these three incidents, there was a single remaining barrier. One was an incident in which one of the lubricating oil pumps for the main gearbox failed, causing a pressure drop in the lubricating oil. One incident was linked to an engine failure. The last was a bag that was mistakenly hung on the helicopter before departure and discovered just before take-off. If the bag had been carried up and then come loose, it could possibly have been pulled into the rotor or tail rotor, causing a crash.

Barriers

Leading indicators are used to describe robustness in withstanding incidents. 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, for many barriers, there is a positive trend that exceeds the industry's self-defined requirements. In recent years, the level has been fairly stable, with the exception of faults related to riser valves, which show an increase. This may be because the participants have become more aware of quality in respect of the testing of barriers, and that the current level is a better reflection of the true value than was the case a few years ago. It is also observed that the indicators for downhole safety valves and blowdown valves exceed the industry standard.

The maintenance data in RNNP show that, for 2021, the number of hours of backlog of preventive maintenance and the number of hours of outstanding corrective maintenance have fallen compared to 2020. Note also that the number of hours of completed preventive and corrective maintenance is higher in 2021 than in 2020.

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 2021, 172 reportable personal injuries were recorded on the NCS. 202 such injuries were reported in 2020. 27 of these injuries were classified as serious in 2021, against 28 in 2020.

Comparing the trend in the personal injury rate on the NCS in the period 2011 to 2016 with 2017 to 2021, we see that the average rate of serious personal injuries is somewhat higher in the latter period. For 2011-2016, there were an average of 0.55 injuries per million working hours, while in the subsequent period there were an average of 0.7 injuries. Although there has been a decrease in the injury rate over the past three years, the level is not down to the average for the first half of the last decade.

The questionnaire-based survey

In 2021, for the eleventh time, a comprehensive questionnaire-based survey was conducted among workers on the NCS. The survey has been conducted every other year since 2001. Even though the questionnaire is in continuous development, 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 based on working hours on facilities reported to the Petroleum Safety Authority Norway in the last half of 2021. 6,378 persons completed the form, which corresponds to 25.9% of the estimated workforce. This is higher than in 2019 (23.1%), but lower than in 2017 (31.3%).

The results as a whole show a negative development from 2019 to 2021 in terms of HSE climate, working environment factors and health complaints.

The HSE climate is generally rated more negatively in 2021 than in 2019. Of the total of 39 HSE statements in the questionnaire, 23 were rated more negatively. The change is statistically significant (sig.). When it comes to the physical, chemical and ergonomic working environment, 8 out of 13 questions were responded to more negatively in 2021 than in 2019 (sig.). For the organisational and psychosocial working environment, 16 out of 20 questions show a negative change (sig.).

Concerning health complaints, there is a negative development in 7 out of 14 of these. Sleep while offshore and before and after travelling offshore is rated as worse than in 2019.

3. Implementation

The results from RNNP are presented in annual reports. This report covers the year 2021. Work on the report was carried out mainly in the period December 2021 – March 2022.

The detailed objective for 2021 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 vessel owners: Contribute data and information about activities on the facilities
- The helicopter operators: Contribute data and information about helicopter transport activities
- HSE specialist group: (selected specialists) Evaluate the procedure, input data, viewpoints on the development, evaluate trends, propose conclusions
- Safety Forum: (multipartite) Comment on the procedure and 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, Marita Halsne, Morten Langøy, Trond Sundby, Inger Danielsen, Elisabeth Lootz, Roar Høydal, Jan Ketil Moberg, Semsudin Leto, Eivind Jåsund, Kenneth Skogen, Bente Hallan, Torbjørn Gjerde 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, Mads Lindberg, Ragnar Aarø, Espen Stemland, Margrethe R. Stavrum, Even Tysdahl, Martin Dugstad, Hans Laupsa and Marita Pytte, Safetec
- Kari Kjestveit and Astrid Schuchert, 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
- Nils-Rune Kolnes, Morten Haugseng, Egil Bjelland, CHC Helikopter Service
- Kjetil Hellesøy, Tom Idar Finnesand, Tor Bryne, Martin B. Christiansen, Bristow Norway AS

Numerous other people have also contributed to the work.

3.2 Use of risk indicators

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

- Defined situations of hazard and accident, 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
- Work 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.

Considering the definition of major accident 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 DSHAs (Defined situations of hazard and accident) 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 vessel owners. 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 shows an overview of the 21 DSHAs, and which data sources have been 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

DSHA	*Description*	*Database*
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	PSA/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 overboard	Industry
14	Work accidents	PSA
15	Work-related illness	Industry
16	Full loss of power	Industry
18	Diving accident	PSA
19	H_2S emission	Industry
20	Crane and lifting operations	PSA/Industry
21	Dropped objects	PSA/Industry

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

3.3 Developments in the activity level

Figure 3.1 and Figure 3.2 show the development, over the period from 2005 to 2021 for production and exploration activities, of the parameters used for normalisation against the activity level (all figures are relative to the year 2005, which is defined as 1.0). Appendix A to the main report (PSA, 2022a) presents the underlying data in detail.

There was a rise of 4% in working hours on production facilities in 2021 compared to 2020. For mobile facilities, there was increase of around 6% over the previous year. The number of exploration and production wells drilled rose slightly.

Production volume increased somewhat compared to 2020.

A presentation of DSHAs 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.

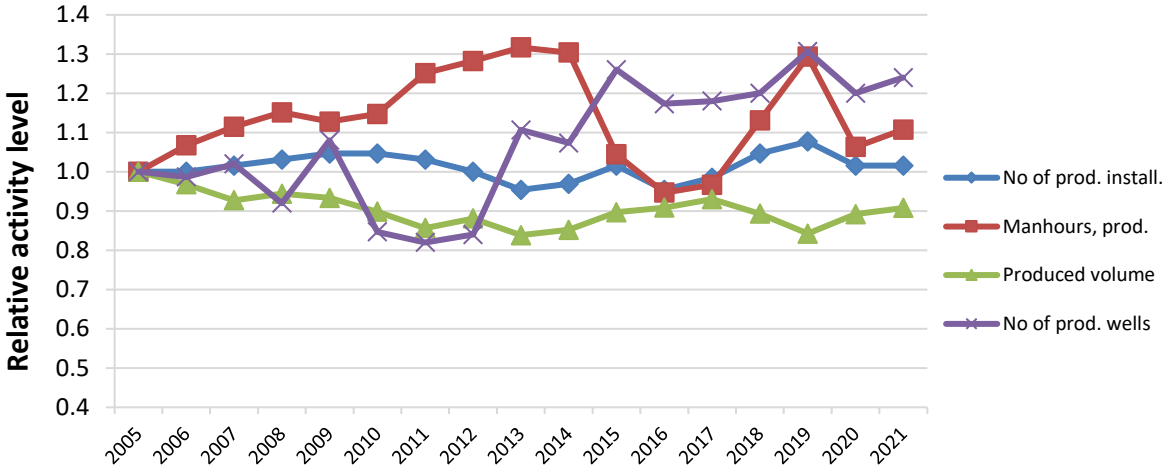

Figure 3.1 Relative trend in activity level for production facilities. Normalised against the year 2005

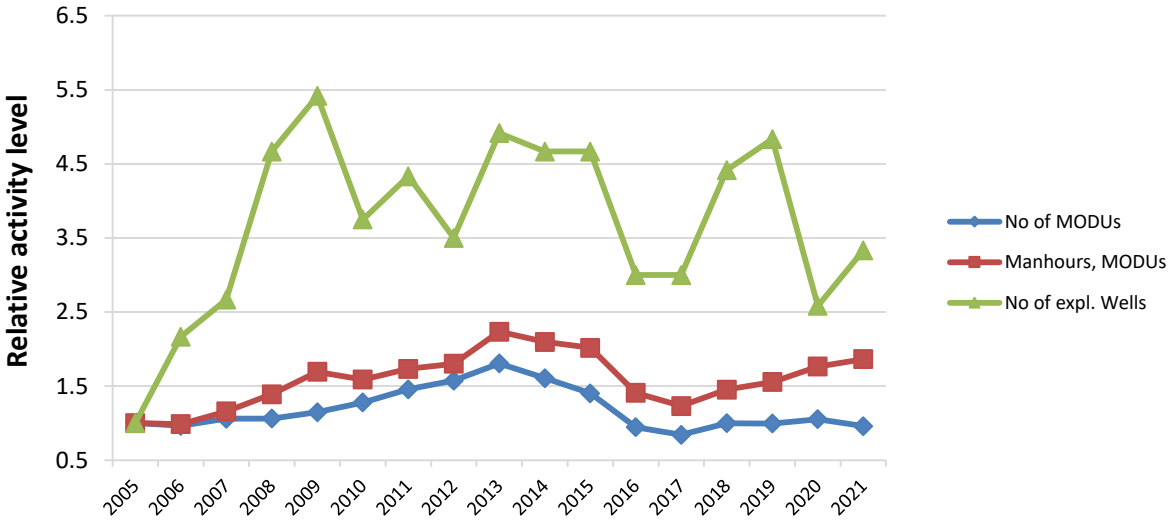

Figure 3.2 Relative trend in activity level for mobile facilities. Normalised against the year 2005

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 2021 (Norwegian and English versions)
- Main report – the Norwegian Continental Shelf for the year 2021
- Report for onshore facilities for the year 2021
- Report for acute spills to sea for the Norwegian Continental Shelf 2021, to be published in the autumn of 2022
- Methodological report, 2022

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

4. The survey

A questionnaire-based survey was conducted of employees who were offshore in the period 11 October to 21 November 2021. The survey is carried out every other year. The year's results are reported together with data from previous years. This is the eleventh time that data have been collected using this questionnaire. The general aim of the survey is to measure the employees' perception of HSE conditions in Norwegian petroleum activities. Specifically, the survey has three objectives:

- To provide a description of employees' perception of HSE conditions in the offshore industry, and map factors that are significant in respect of variations in this perception.
- To help illuminate underlying factors that may go towards explaining results from other sections of RNNP.
- To follow trends over time in respect of employees' perception of HSE conditions at their own workplace.

The questionnaire consists of four main parts:

Demographic data. This section includes questions about gender, age, nationality, education, job category, seniority, the company the person is employed by, the facility, affiliation to the facility and the company, working time arrangements, emergency preparedness functions and whether the respondent has managerial responsibilities. This section also includes questions about experiences with downsizing and reorganisation.

HSE climate at own workplace. This section consists of 39 statements relating to different factors of significance for HSE conditions: 1) personal assumptions for performing work safely, 2) characteristics of one's own and others' behaviour of significance for HSE, 3) conditions in the work situation that affect one's own behaviour.

Working environment. This section consists of 34 questions covering physical working environment factors (exposure and strain), psychosocial working environment factors (requirements for concentration and attentiveness, control over one's own work performance and social support) and job security. Four questions deal with bullying and harassment. There are also 11 questions about working hours, rest and recovery. One question about accommodation and living conditions offshore is also included in this section.

Health complaints, sickness absence and injuries. This section consists of five questions concerning sickness absence and involvement in any work accidents causing injuries, as well as 14 questions about health complaints.

A similar survey is also carried out of onshore facilities. Most of the questions are the same, but there are also certain variations. Finally, this chapter presents a comparison of the results for the offshore and onshore facility samples respectively in 2021.

4.1 Introduction

For a questionnaire-based survey where everyone in a domain is given the opportunity to respond, the composition of the participants is important for whether the responses are representative. With the information we have available, we can say that the respondents to this survey do essentially reflect the demographic composition of the employees in this industry. Although a high response rate is desirable, it is of less significance for the assessment of the survey's validity.

Between the performance of the questionnaire-based survey in RNNP 2019 and RNNP 2021, society was impacted by Covid-19. Most industries, including parts of the petroleum industry, were hit by uncertainty and layoffs. This impact was greatest in 2020, whereas in 2021 we witnessed a return of optimism and an upturn in petroleum activity. Sickness absence across society was generally high in 2020 and 2021. It is difficult to evaluate how

much and in what ways this situation has affected the results of the questionnaire-based survey in 2021.

The overall response rate (mobile and production facilities) was 25.9% in 2021, which is higher than in 2019 (22.2%). We see that the age of the sample is somewhat higher than in previous years, with the 51-60 year age group being the largest. 65% of respondents are employed by an operating company, and a similar percentage work on a production facility. Maintenance, drilling and processing are the areas of work within which most of the respondents are employed. 96.3% have permanent employment, which is stable over time, and 37.5% of respondents have managerial responsibility. 91.6% of the sample is Norwegian, which is slightly higher than in 2019.

The following provides a summary of the most important results within the various topics in the questionnaire. For further details, please see the main report.

4.2 HSE climate

The HSE climate is generally rated more negatively in 2021 than in 2019. Of the 39 HSE statements in the questionnaire, 23 have more negative assessments (sig.), and 3 have more positive assessments (sig.). The following HSE statements have the largest changes from 2019 to 2021 (all these changes are negative, except for the statement "Dangerous situations arise..." (No. 5), which was rated more positively):

- My manager is involved in the HSE work on the facility
- I feel uncomfortable pointing out breaches of safety rules and procedures
- I sometimes breach safety rules in order to get a job done quickly
- In practice, production takes priority over HSE
- Dangerous situations arise because everyone does not speak the same language
- I feel sufficiently rested when I am at work
- I have been informed of the risks associated with noise
- I think it is easy to find what I need in the governing documents (requirements and procedures)
- The company I work for takes HSE seriously
- At times, I am pressured to work in ways that threaten safety

Of the six indices, there were more negative scores compared to 2019 on the following four: Management's commitment, Colleagues' commitment, the Organisation's commitment, Conflicting goals. The biggest change was in Conflicting goals. There was no change in the indexes Cooperation and communication and Freedom to speak up.

4.3 Working environment

When it comes to the physical, chemical and ergonomic working environment, 6 out of 13 questions were responded to more negatively in 2021 than in 2019 (sig.). The biggest changes are on the following questions:

- Do you work under poor indoor conditions?
- Do you perform repeated and unilateral movements?

Both of these questions were rated more positively in 2019 than in 2017, but now in 2021 they are rated more negatively than 2017.

Sixteen out of 20 questions about the psychosocial working environment were rated significantly more negatively in 2021 than in 2019. The questions with the biggest changes are the following:

- Do you get sufficient rest/recreation between shifts?
- Is your workplace well adapted to the work tasks you perform?
- Do you get sufficient rest/recreation between work periods?
- Can you set your own work speed?
- Do you work so much overtime that it is a strain?
- Do you know exactly what is expected of you at work?

Do you feel that the cooperation climate in your work unit is encouraging and supportive?

All of these questions were rated more negatively in 2021 than in 2019. (The question "Do you know exactly what is expected of you at work?" was included for the first time in 2019).

4.4 Sleep and rest

Sleep was rated worse than in 2019. This applies while offshore, as well as before departure and after returning home. Several respondents say that they have to share a cabin while offshore. There is a difference between how employees with different shift schemes rate the quality of their sleep. In general, those who work day shifts rate their sleep most positively. More employees were awake for several hours before they went on their first shift than in 2019. There is also a difference between the shift schemes.

4.5 Health complaints, sickness absence and injuries

For seven of the 14 health complaints in question, significantly more respondents had suffered from them than in 2019. The ailments most respondents experience are pain in the neck/shoulder/arm, back pain, and knee/hip pain. Fewer (significantly) responded that they had suffered from "white fingers". There is an increase in the proportion of employees with health complaints who relate the ailment in whole or in part to their work.

Significantly more than in 2019 say that they were on sick leave during the past year. A somewhat smaller proportion were involved in accidents causing personal injury than in 2019.

4.6 Comparison between results offshore and onshore

For both samples, there is a tendency towards increasing age and seniority. The largest share of offshore respondents are >50 years old, while for onshore the 41-60 year age group dominates. There are more men than women in both samples, but the disparity is greater offshore (89% men) than onshore (79% men). The same applies to the share of managers, where offshore has 37% (stable) and onshore 29.6% (increase). Concerning terms of employment, more respondents have permanent employment offshore (96.3%) than onshore (87.7%). Onshore, approx. 60% are employed by the operator/TSP, which is a decrease, while 35% of the respondents offshore are employed by the operating company. Based on working hours, the contractors are underrepresented offshore. Approximately the same number in each sample are Norwegian (approx. 92%).

HSE climate

For both samples, there is a negative development in the indices for HSE climate, and the changes are most evident offshore. Both samples have significant negative changes in the "Management's commitment" index. In addition, the results offshore show that there are also significant negative changes for the indices "Colleagues' commitment", "the Organisation's commitment" and "Conflicting goals". The other two indices ("Communication and cooperation" and "Freedom to speak up") do not exhibit significant changes, but these indices have the worst rating as a whole. If we compare developments in the statements individually, we find that, for offshore, there is a significant negative change in 23 out of 39 statements. The corresponding development onshore concerns four statements. Three statements offshore show significant positive developments, while one statement does the same onshore. Common to both samples are that those who have experienced reorganisation, rate the indices more poorly.

Working environment

For the physical, chemical and ergonomic working environment, there is a negative trend among employees offshore (six out of 13 questions show negative developments), and some of the results are even more negative than in 2017. For employees at onshore facilities, the results are more or less the same (or better) as in the previous measurement. For the psychosocial working environment, the results are poorer than in 2019 for both

samples. For offshore, 16 out of 21 statements are rated significantly worse than in 2019, and for several of them also lower than in 2017. At onshore facilities, there are significant negative developments for five out of 20 statements.

The proportion who states that they have been the victim of bullying is approximately the same both offshore (4.4%) and onshore (4.3%), and it is bullying from colleagues that is most prevalent. A somewhat lower proportion offshore (2.2%) answer that they have been exposed to unwanted sexual attention than is the case onshore (3.2%). For women, the proportions are 12.5% (offshore) and 8.7% (onshore). The gender difference may be due to women being more in the minority offshore than at onshore facilities.

Accommodation and sleep
There are differences in how accommodation and sleep are rated in the two samples, but the conditions are also different. Everyone working offshore must be accommodated on the facility, while only a minority of onshore employees are accommodated by the employer. The offshore employees are more satisfied with accommodation and living conditions than those accommodated onshore. Concerning sleep, this has not been as poorly rated offshore since 2007. Among those accommodated onshore, a large majority report sleeping well, and the results are better than in 2019.

Health
There is an increase in reported health complaints both offshore and onshore. Offshore, significantly more people reported being troubled by seven out of 14 health complaints, compared to 2019. Onshore, there were no significant changes, but the trend was negative. The proportion who say that the ailments are work-related has increased since 2019. For both samples, the most prevalent ailments are pain in the neck/shoulder/arm, back pain, and knee/hip pain. 5% offshore and 6.6% onshore report that they have had psychological distress in the last three months, and almost half of these report that the distress is work-related.

Self-reported sickness absence is significantly higher offshore than in 2019, while onshore there is a small (not significant) decrease. However, fewer respondents report having had sickness absence offshore (33%) than onshore (49%), which may be due to differences in the work and rotation schemes. There is also a somewhat lower proportion who report having been injured offshore (3.2%) than onshore (3.7%).

Differences between groups
Managers consistently rate HSE conditions as better than other employees rate them. The exception is that managers report having more stressful job requirements, higher workloads and more role conflicts than those without managerial responsibility. These results apply to both samples.
There is a difference between employees of operators and contractors in their assessments of HSE conditions and perceived health complaints, but this is manifested differently offshore than onshore. For both samples, the operators' employees rate the organisation's commitment most negatively and the contractor's employees are more negative in their rating of cooperation and communication. Also common to both samples are that permanent employees consistently rate HSE conditions more negatively and have more health complaints than temporary employees.

In the offshore sample, men rate four indices more negatively than women and they report having more hearing complaints. The women assess job control as poorer than men, and they report having more musculoskeletal complaints. Onshore, there are no differences between genders at the index level. In both samples, women report having had more sickness absence than men.

When it comes to the work area the respondents belong to and the correlation with results on HSE conditions, there are major differences between offshore and onshore. There are also large variations between which groups rate the different indices positively and negatively. For the type of shift arrangement offshore and perceived rest, the results are disparate, but those on fixed day shifts report being most rested and more satisfied with

the working hours schemes. It is similar onshore, where employees on continuous shifts rate relaxation and rest worse than employees on day 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 2021. 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 2005-2021. 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.

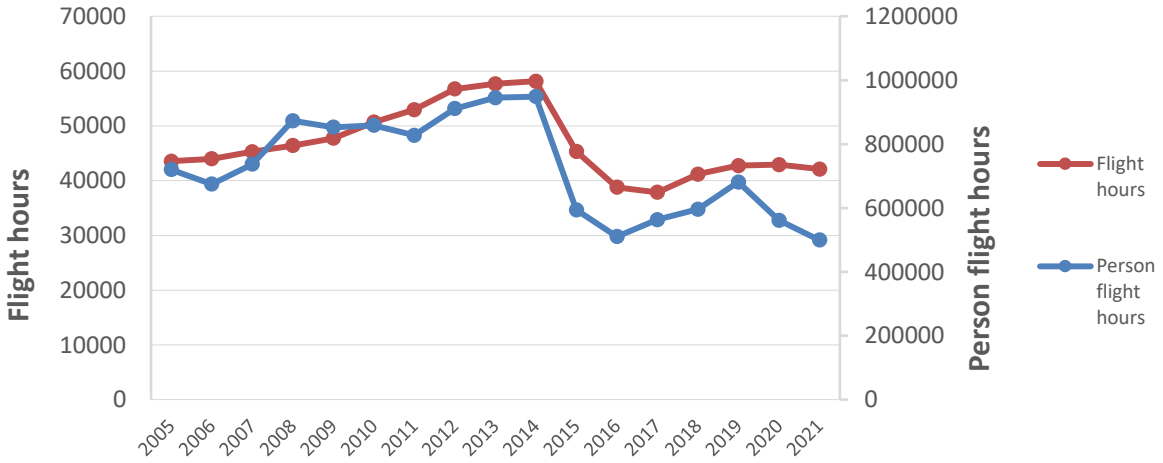

Figure 5.1 Flight hours and passenger flight hours per year, 2005-2020

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.*

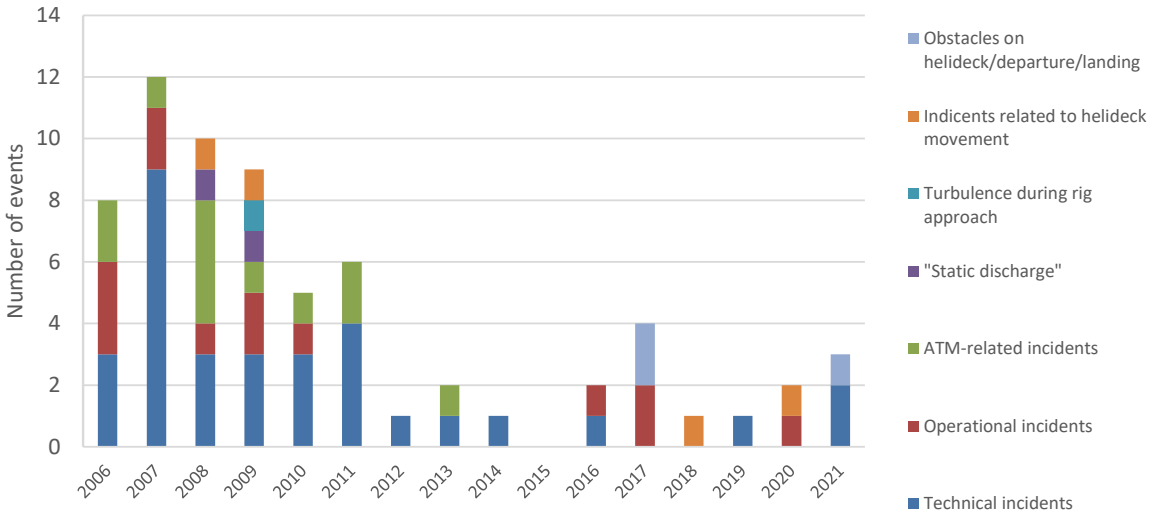

Figure 5.2 Incident indicator 1 per year by causal categories, not normalised, 2006–2021

In the expert group's assessment of incidents for 2021, there were three incidents with one remaining barrier included in incident indicator 1. One was an incident in which one of the lubricating oil pumps for the main gearbox failed, causing a pressure drop in the lubricating oil, and one incident was linked to a failed engine. The last was a bag that was mistakenly hung on a hook on the helicopter before departure and discovered just before take-off. If the bag had been carried up and then come loose, it could possibly have been pulled into the rotor or tail rotor, causing a crash.

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 (DSHA 1-10). The indicators for DSHA 12, helicopter incidents, are presented separately in chapter 4. 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 in 2015 where a wave stove in windows in an accommodation section, injuring four and killing one person, is categorised as a structural incident and is the first major accident DSHA to have caused a fatality in the period 2005-2021. The last time there were any fatalities in connection with one of these major accident DSHAs 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 1997 and 2016.

6.1 DSHAs associated with major accident risk

Figure 6.1 shows the trend in the number of reported DSHAs in the period 2005-2021. 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 2005, 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 2021, the number of reported incidents is at the same level as the previous year.

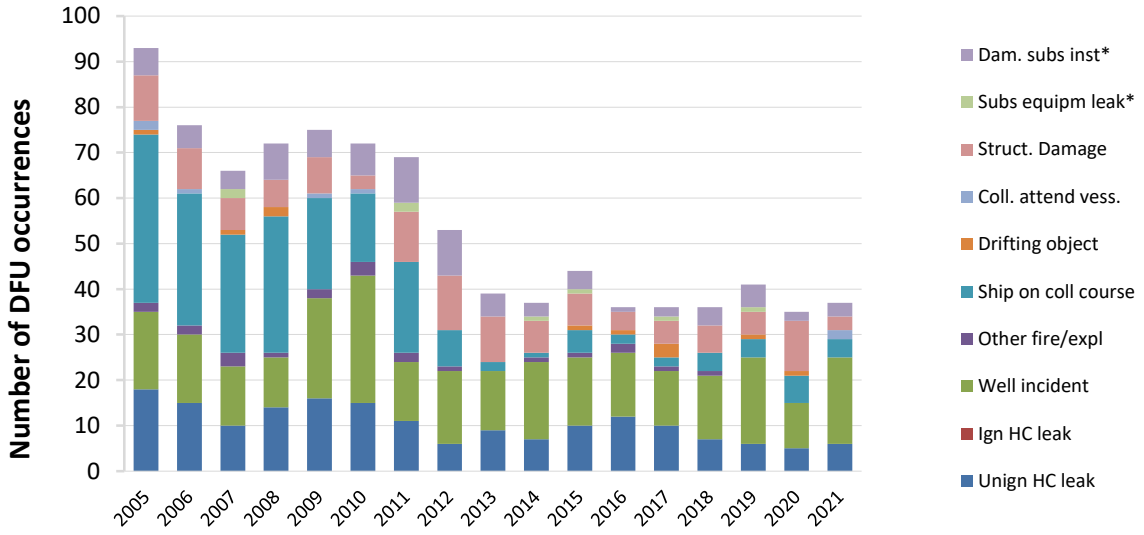

Figure 6.1 Reported DSHAs (1-10) by categories.
****Within the safety zone***

In Figure 6.1, the number of incidents is presented without normalisation relative to exposure data. Figure 6.2 shows the same overview, but now normalised against number of working hours. The level for 2021 is in the hatched area, indicating a stable level compared to the average in the previous ten-year period.

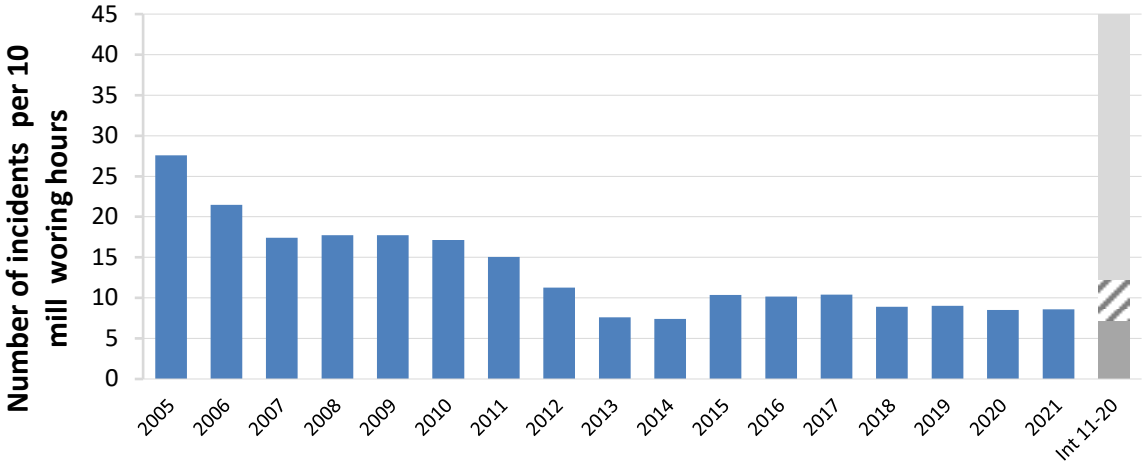

Figure 6.2 Total number of DSHA1-10 incidents normalised against working hours

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 2005-2021. Six hydrocarbon leaks were recorded in 2021, all in the category 0.1-1 kg/s.

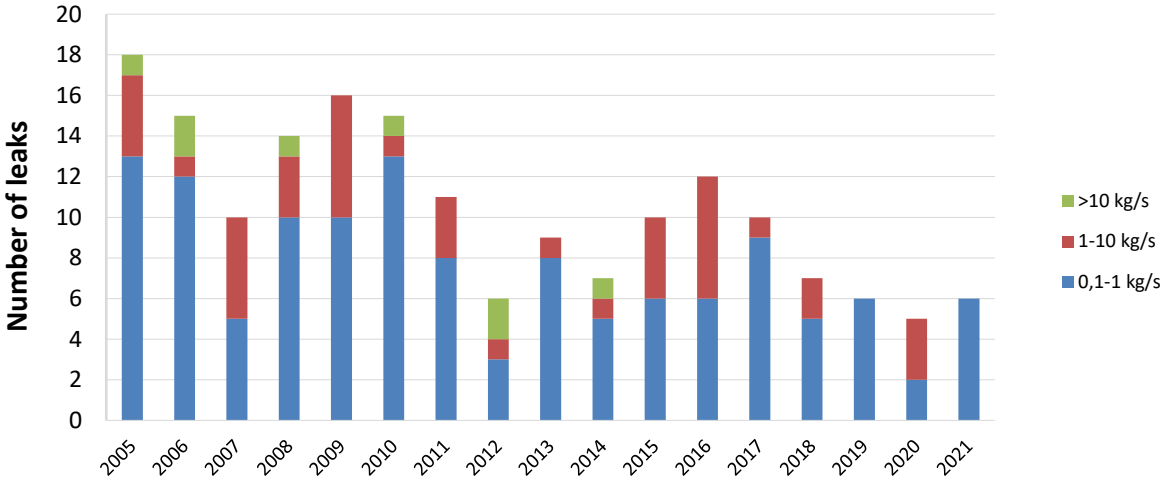

Figure 6.3 Number of hydrocarbon leaks exceeding 0.1 kg/s, 2005-2021

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 2021 is the lowest observed in the period.

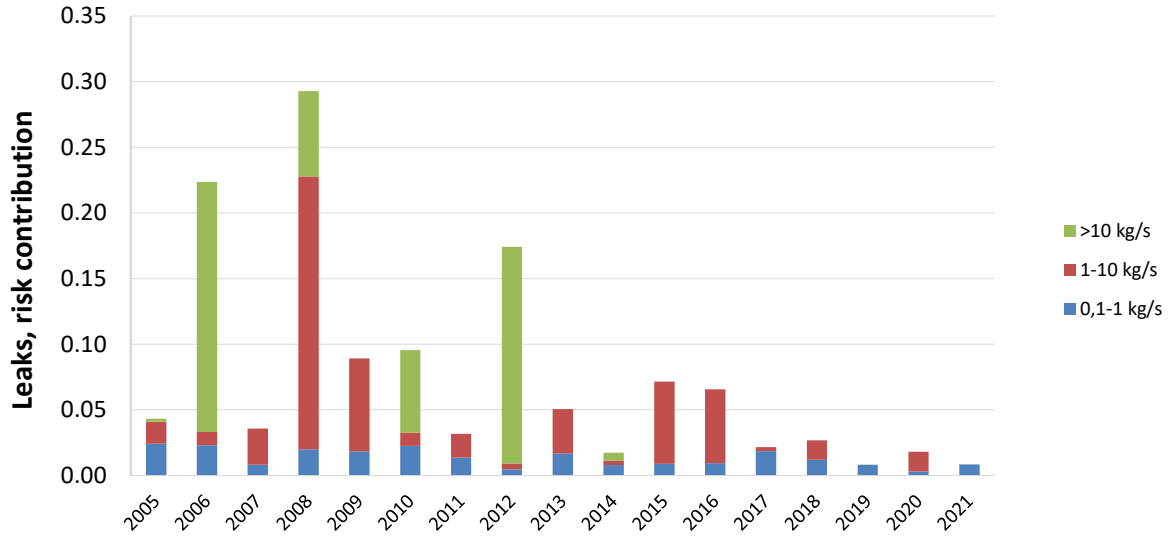

Figure 6.4 Number of hydrocarbon leaks exceeding 0.1 kg/s, 2005-2021, weighted according to risk potential

Figure 6.5 shows the trend in leaks exceeding 0.1 kg/s, normalised against working hours for production facilities. The figure shows that the number of leaks per million working hours in 2021 is within the prediction range. The change is therefore not statistically significant relative to the average for the period 2011-2020. The number of leaks has been normalised both against working hours and the number of facility years in the main report.

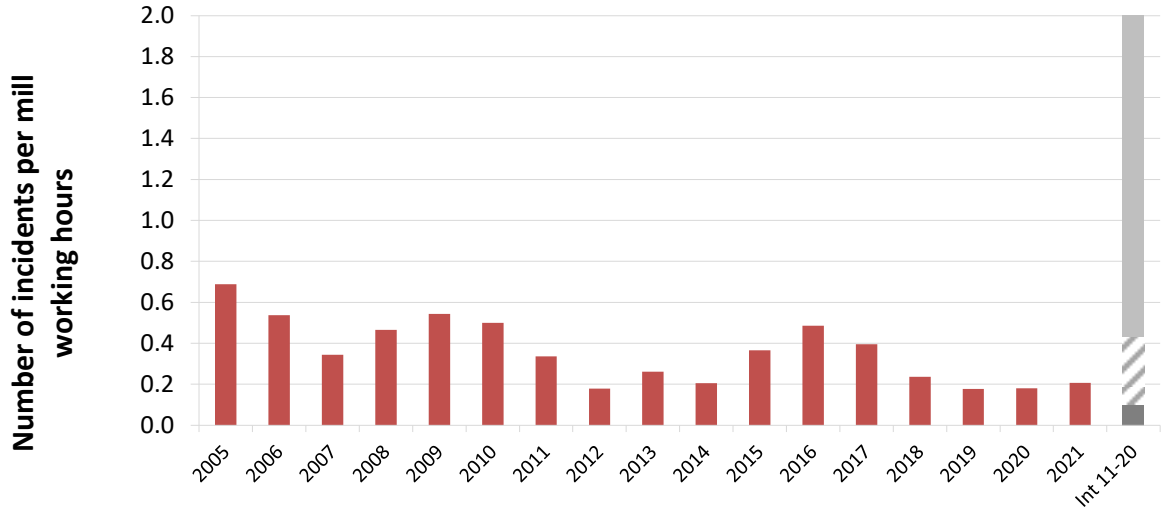

Figure 6.5 Trend, leaks, normalised against working hours

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 2021, fourteen in production drilling and five in exploration drilling. Eighteen of these were in the lowest risk category, and one was categorised as serious. Figure 6.6 shows the share of well control incidents per 100 wells drilled. The number in 2021 is somewhat higher than in 2020. 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 2018-2021, well control incidents in exploration drilling are seen to dominate again.

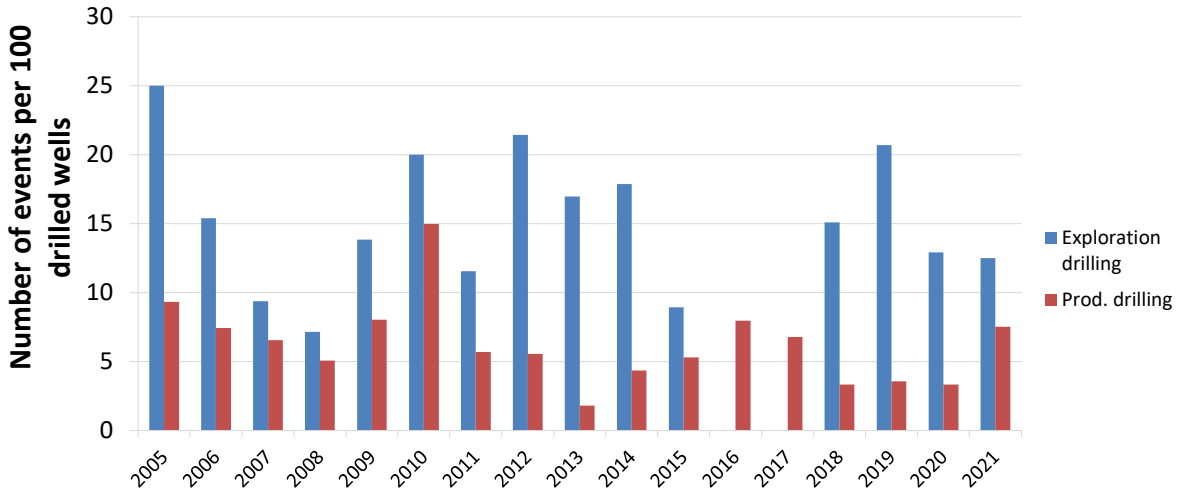

Figure 6.6 Well incidents per 100 wells drilled, for exploration and production drilling

Figure 6.7 shows the trend in weighted risk of loss of life normalised against working hours for exploration and production drilling combined. The figure shows that in 2017-2021 there was a relatively low risk associated with well control incidents on the NCS. The peaks we see in the figure are often associated with serious individual incidents that are weighted very highly compared to other incidents.

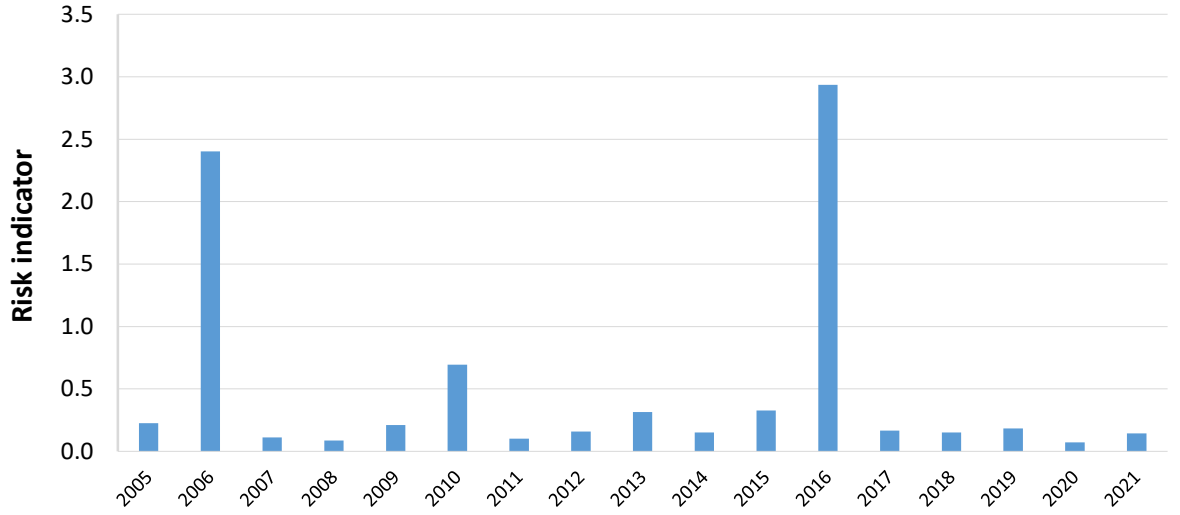

Figure 6.7 Risk indicators for well-control incidents in exploration and production drilling, 2005-2021

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.

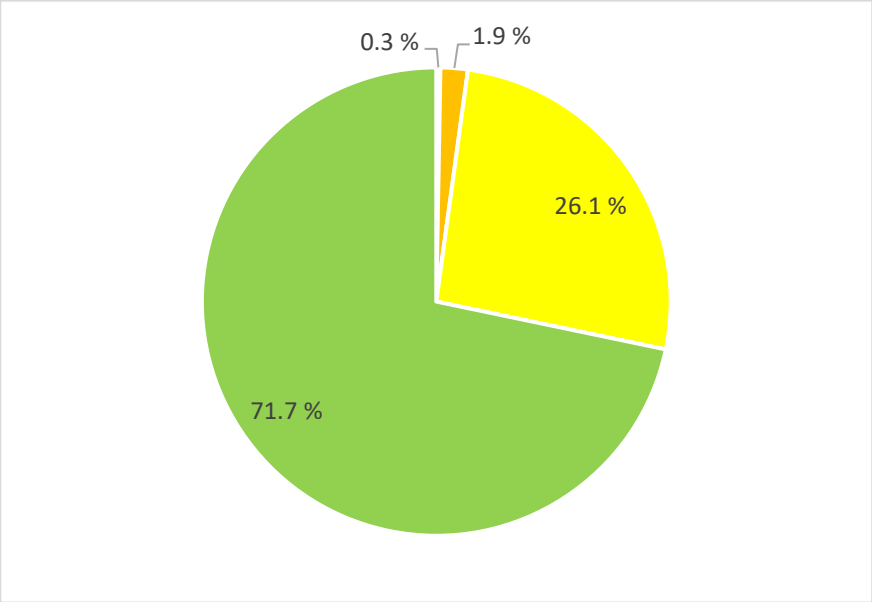

Figure 6.8 Well categories

The mapping in Figure 6.8 shows an overview of well categorisation by percentage share of a total of 2,129 wells.

The categorisation shows that around 28% 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. Six wells (0.3%) were recorded in the red category and 40 wells (1.9%) in the orange category. There are five temporary plugged wells and one production well included in the red category. In the orange category, all types of well are found. 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 556 wells (26.1%) in the yellow category.

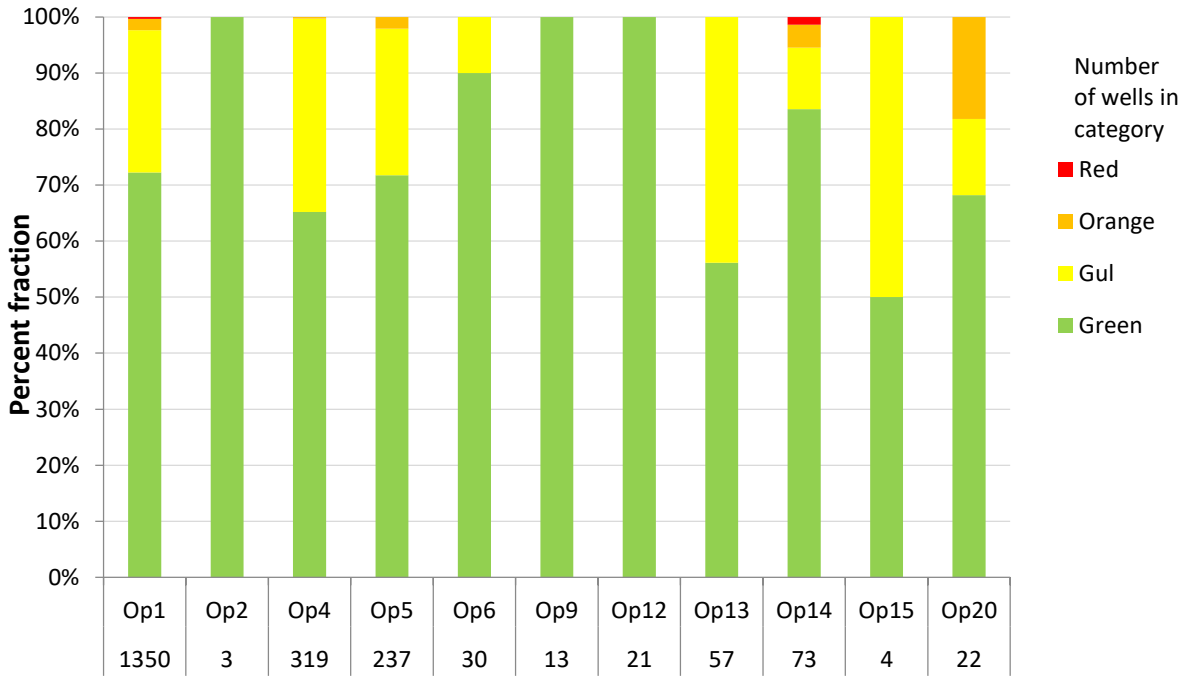

Figure 6.9 Well categorisation, by operator, 2021[1]

Figure 6.9 shows the 11 operators and wells in the integrity categories red, orange, yellow and green. There are two operators with wells in the red category (operator 1 and operator 14). Five out of eleven 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 2021, no serious leaks from risers were reported. Nor were any serious leaks from pipelines within the safety zones of surface facilities reported in 2021. A small subsea leak at a coupling was reported. This was rated at about 0.4 g/second. There was also another subsea leak that occurred when a valve was opened in connection with the flushing of pipes. Here the leak was about 25-30 L of oil.

As in previous years, there are still some leaks of chemicals such as hydraulic/barrier/control fluid and the like. Six such leaks have been reported.

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

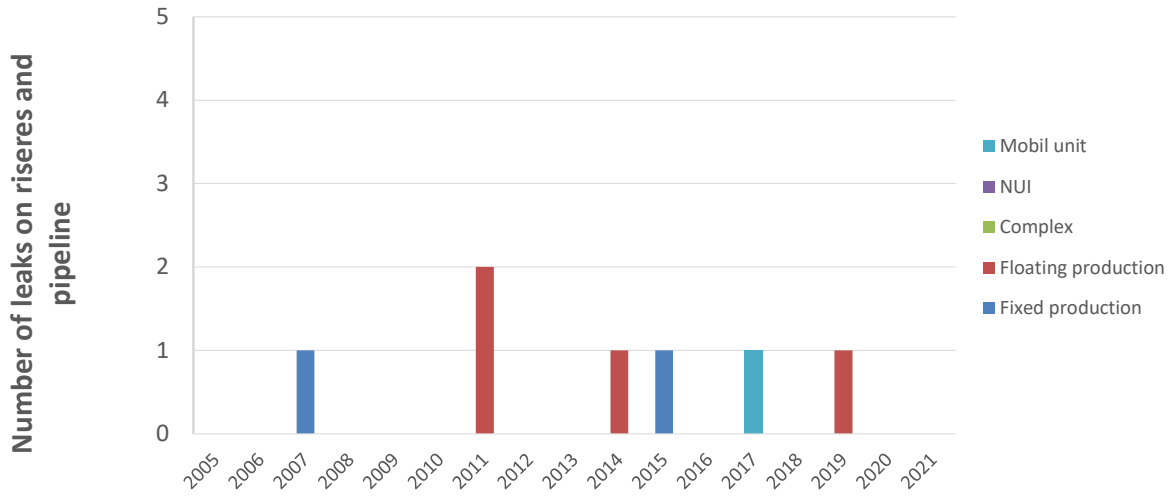

Figure 6.10 ***Number of leaks from risers & pipelines within the safety zone, 2005-2021***

In 2021, three instances of serious damage to flexible risers were reported. Flexible risers have been and remain an important contributor to risk. We have followed up this topic over a number of years and in 2021 it was the subject of several of our supervisory activities. Based on our follow-up, we have updated the overview of the seriousness of two incidents involving flexible risers in 2019, so that the total number of serious incidents for 2019 is now 5. Figure 6.11 shows the number of incidents of serious damage to risers and pipelines in the period 2005-2021. Updated information has emerged from several previous years, which means that the figure is not comparable to figures in previous reports.

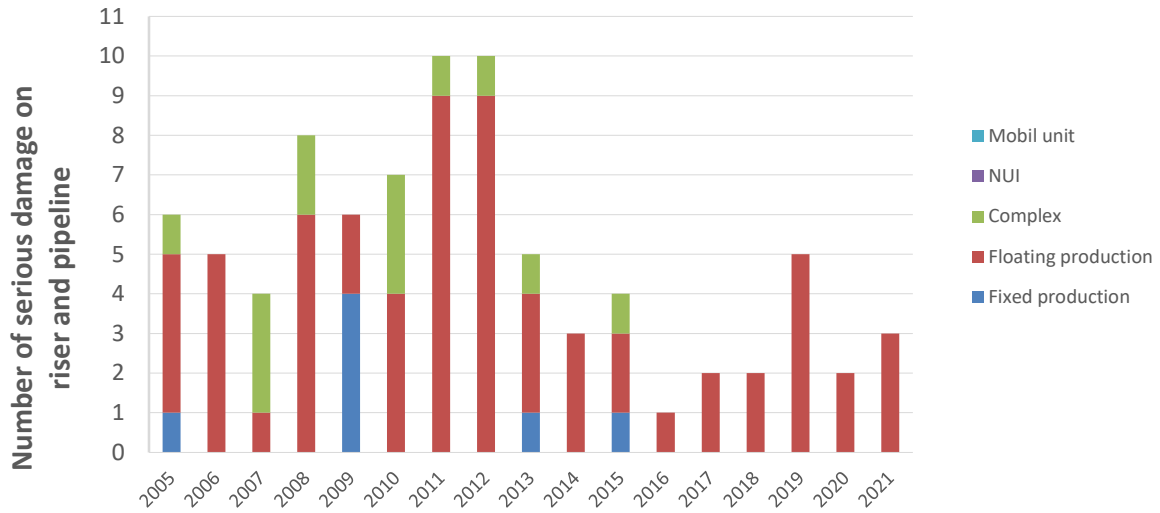

Figure 6.11 ***Number of major damage incidents to risers & pipelines within the safety zone, 2005-2021***

6.2.4 Ships on collision course, structural damage

Since 2010, only a handful of production facilities have not been monitored from a traffic centre, and a few more mobile units. Some changes have therefore been made in relation to normalisation (previously monitoring days and now installation year) and weighting for DSHA 5. For more details, see the methodology report (Petroleum Safety Authority Norway, 2022c).

The number of instances of ships on collision courses has declined substantially in recent years. In 2021, 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 zero to three per year; there were two collisions in 2021.

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. 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 correlation has been established 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 DSHA 8 from 2005-2021. In total, three incidents are included for 2021, which is the lowest reported number since 2010.

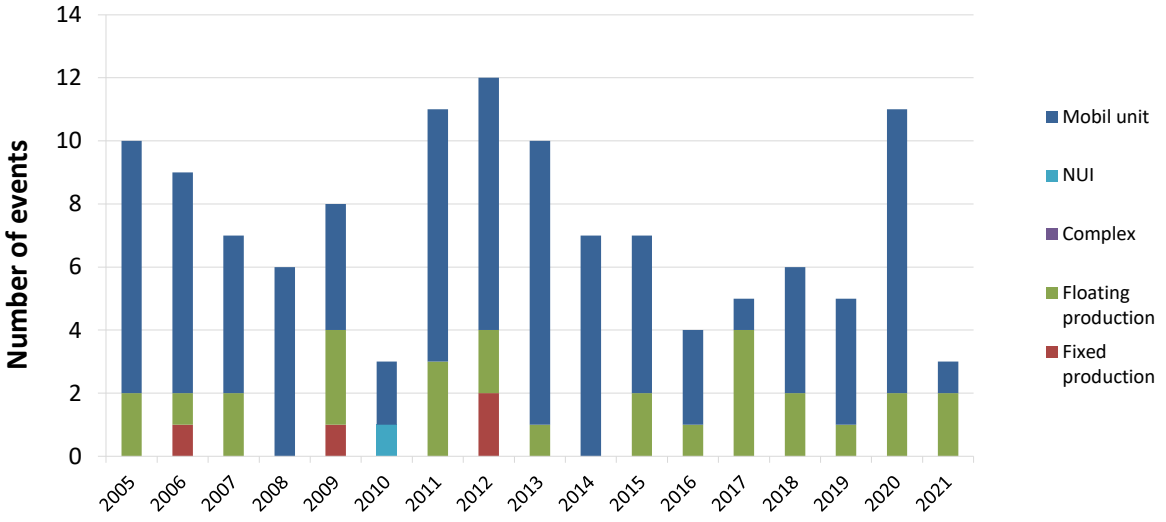

Figure 6.12 Number of reported incidents and damage events to structures and maritime systems which conform to the criteria for DSHA 8

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 serious incidents. 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 near-misses according to the potential for loss of life, and will therefore vary considerably, based on the potential of the individual incidents. The weightings were changed in 2020 to better reflect current knowledge. For more details, see the methodology report (Petroleum Safety Authority Norway, 2022c). The weightings are still fixed for different types of incidents and facility types. The largest incidents are assessed individually, in order to determine a realistic weighting based on the relevant conditions at the facility and the incident. In 2021, there were no especially serious incidents.

There are large annual variations in this indicator, mainly caused by especially serious incidents. The large 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 2005, which also applies to the value for the three-year rolling average.

Figure 6.13 shows the total indicator for production and mobile facilities. As can be seen, the value in 2021 is lower than in 2020 despite several incidents occurring in 2021. This is mainly due to the decline in structural incidents. The underlying trend, illustrated using a 3-year rolling average, shows a positive trend over time with a levelling off in recent years.

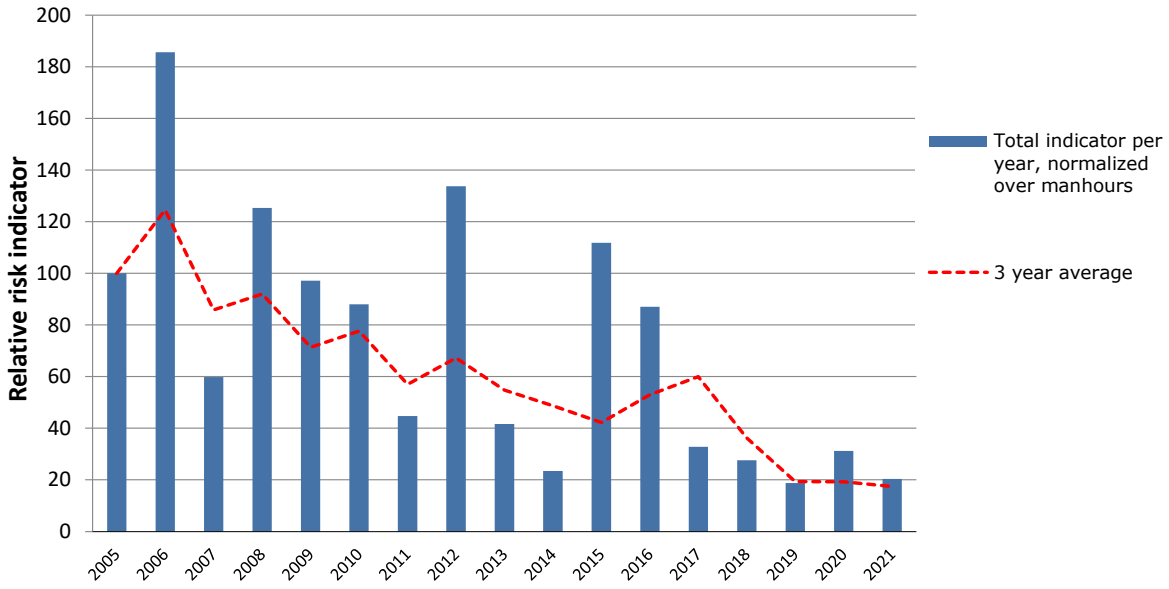

Figure 6.13 Total indicator for major accidents per year, normalised against working hours (Reference value is 100 in the year 2005, both for total indicator and three-year rolling)

The trend can be interpreted to mean that, in the period, the participants have achieved better management of factors that affect major accident risk. This can also be taken as an indication that factors that affect future risk must be kept in sharp focus and under active and continuous management.

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

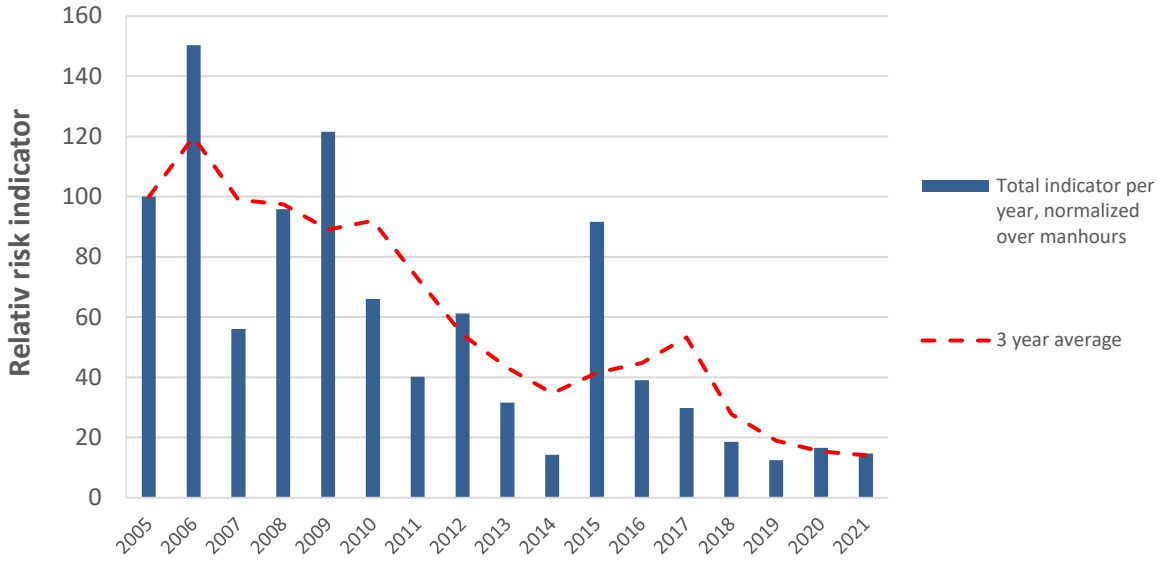

Figure 6.14 Total indicator, major accidents, production facilities, normalised against working hours, compared to three-year rolling average (Reference value is 100 in the year 2005, both for total indicator and three-year rolling)

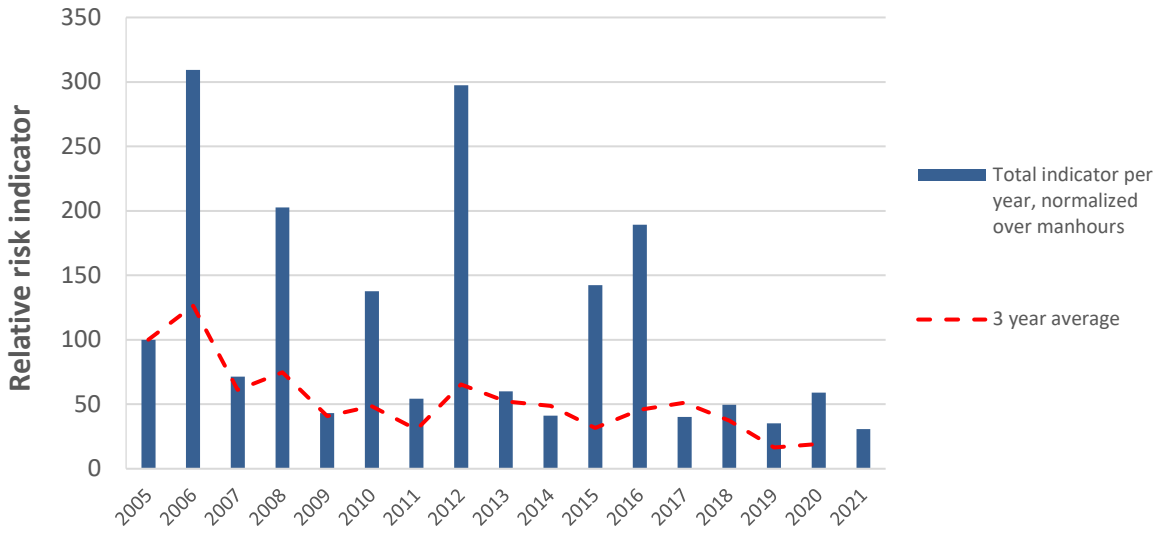

Figure 6.15 Total indicator, major accidents, mobile facilities, normalised against working hours, compared to three-year rolling average (Reference value is 100 in the year 2005, both for total indicator and three-year rolling)

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 DSHAs)
- 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 selected barrier elements associated with production and processing. The test data are based on reports from all production operators on the NCS. In addition, the associated industry norm for each barrier element is shown. Mean percentage failures for 2021 are above the industry norms for riser ESDV closure test and leak test, DHSV and BDV.

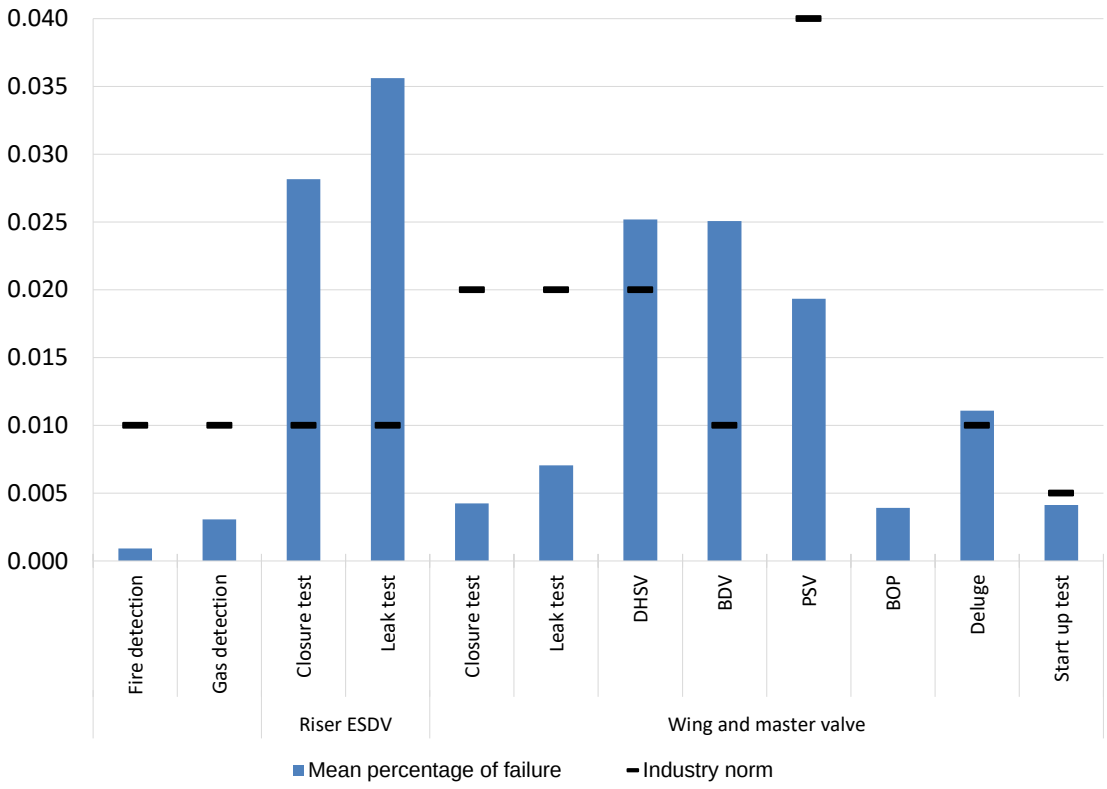

Figure 7.1 Mean percentage of failures for selected barrier elements in 2021

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 make the same contribution to the mean percentage of failures, regardless of how many tests they have.

The data show considerable variations in average levels for each of the operating companies, and for several of the barrier elements. The variations are even greater when

looking at each individual facility, as has been done for all barrier elements in the main report. Figure 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 2021, the average percentage of failures during the period 2005-2021, as well as the total number of tests carried out in 2021 (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 9 facilities are above the norm for percentage failures in 2021, while 9 are above the norm in relation to the average for the period 2005-2021.

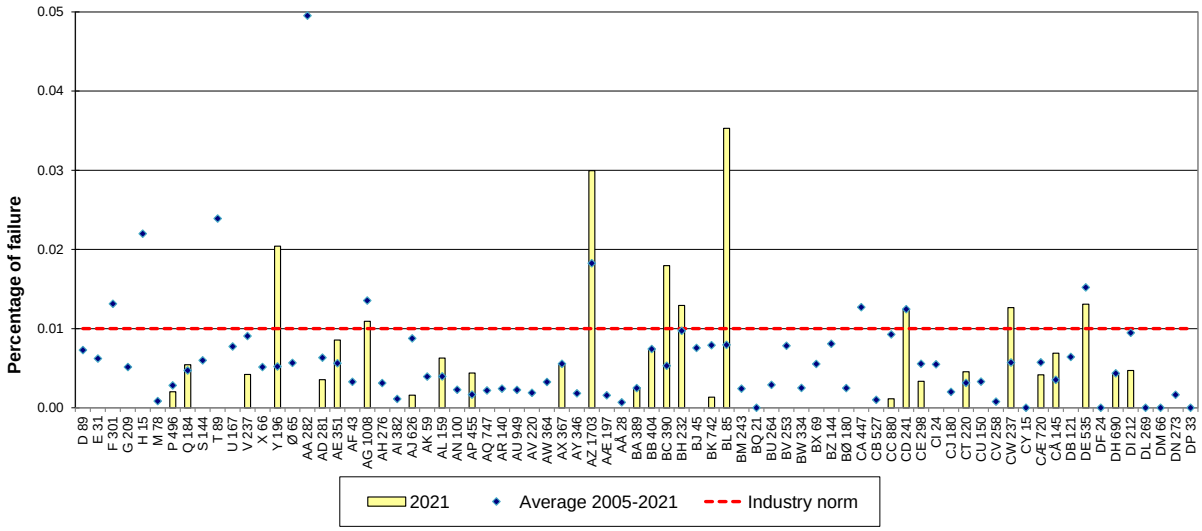

Figure 7.2 Percentage of gas detection failures

For production facilities, barrier data have now been collected for 20 years for most of the barriers, and the results show that there are large differences in level between the facilities. Figure 7.3 and Figure 7.4 compare the mean proportions of failures in three-year rolling averages from 2011 to 2021.

Figure 7.3 shows that fire detection, gas detection and start tests of fire pumps are consistently low and below the respective industry norms. Riser ESDV closure tests show falls from the start of the period up to 2015, but exhibit a slightly rising trend from 2015 to 2021, when they are well above the industry norm of 0.01. Riser ESDV leak tests have the same trend, with declines up to 2018 and then a sharp increase every year until 2021. BDV shows a downward trend from 2012 to 2015, but is stable around 0.02, which is well above the industry norm of 0.01. Deluge fluctuates around the industry norm of 0.01. In the period 2013-2015, deluge is above the industry norm, then below it in 2016-2018, and since 2019 has remained stable just above the industry norm. Fire detection and start-up test have stable low failure rates on a 3-year rolling average for the entire period 2011-2021. Both are below their respective industry norms of 0.01 and 0.005 respectively.

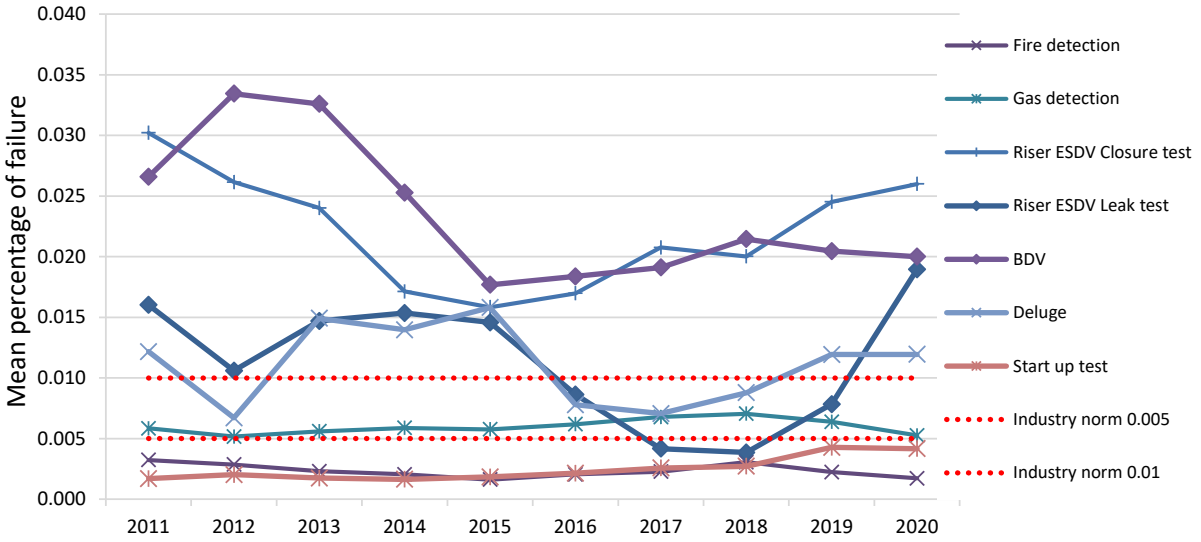

Figure 7.3 Mean percentage failures with a three-year rolling average

Figure 7.4 shows that DHSV has a rising trend from 2012 to 2017 and then flattens out towards 2021 for mean percentage failures on a three-year rolling average. DHSV has been above the industry norm of 0.02 since 2013. Other barriers remain stably below applicable industry norms. The wing and mast valve closure and leakage tests have shown a downward trend in recent years. PSV has a relatively flat trend well below the industry norm of 0.04 throughout the period 2011-2021. In general, Figure 7.3 and Figure 7.4 show that the trends for mean percentage failures on a three-year rolling average are increasing for riser ESDV closure and leak tests alike. Other barriers have a flat or slightly downward trend.

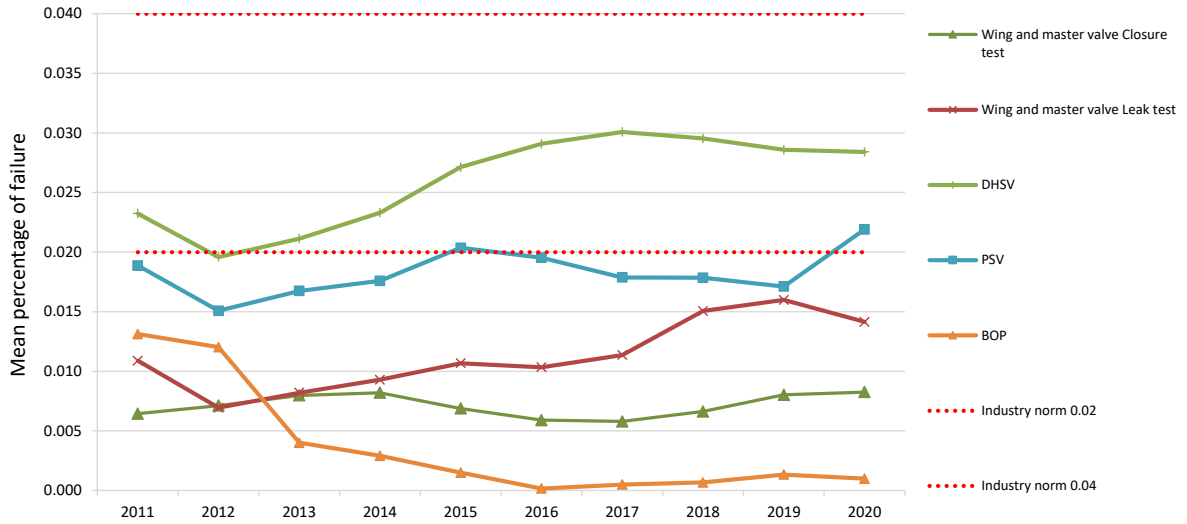

Figure 7.4 Mean percentage failures with a three-year rolling average

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 2021 and for the period 2005-2021. This can then be compared with the industry norm for safety-critical systems. Figures in bold indicate that the percentage of failures exceeds the industry norm.

The table shows that, overall, most barrier elements are below the industry norm for availability. Mean percentage failures for 2021 and mean percentage failures 2005-2021 for riser ESDV closure tests and leak tests, DHSV and BDV are above the industry norms. For deluge, the mean percentage failures for 2005-2021 are above the industry norm.

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

Barrier elements	*Number of facilities where tests were performed in 2021*	*Average, number of tests, for facilities where tests were performed in 2021*	*Number of facilities with percentage of failures in 2021 higher than the industry norm (and avg. 2005-2021 in parentheses)*[2]*	*Mean percentage failures in 2021*	*Mean percentage failures 2005-2021*	*Industry norm for availability*
Fire detection	76	499	1 (1)	0.001	0.003	0.010
Gas detection	75	291	9 (9)	0.004	0.007	0.010
Shutdown:						
· Riser ESDV	68	24	18 (37)	**0.035**	**0.020**	0.010
Closure test	68	17	12 (30)	**0.028**	**0.022**	0.010
Leak test	68	7	9 (25)	**0.036**	**0.017**	0.010
· Wing and master (Christmas tree)	81	212	7 (7)	0.006	0.010	0.020
Closure test	78	99	3 (1)	0.006	0.007	0.020
Leak test	81	117	12 (10)	0.008	0.011	0.020
· DHSV	79	79	30 (39)	**0.027**	**0.025**	0.020
Blowdown valve (BDV)	64	57	25 (46)	**0.024**	**0.022**	0.010
Pressure safety valve (PSV)	74	78	12 (6)	0.023	0.023	0.040
Isolation using BOP	23	151	-	0.002	0.013	-
Active fire safety:						
· Deluge valve	74	26	13 (26)	0.010	**0.011**	0.010
· Start test	63	76	10 (13)	0.003	0.003	0.005

7.2 Barriers associated with maritime systems

In 2021, data were collected for the following maritime barriers on mobile facilities:

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

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

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 a strong 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.

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

[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 2005.

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.

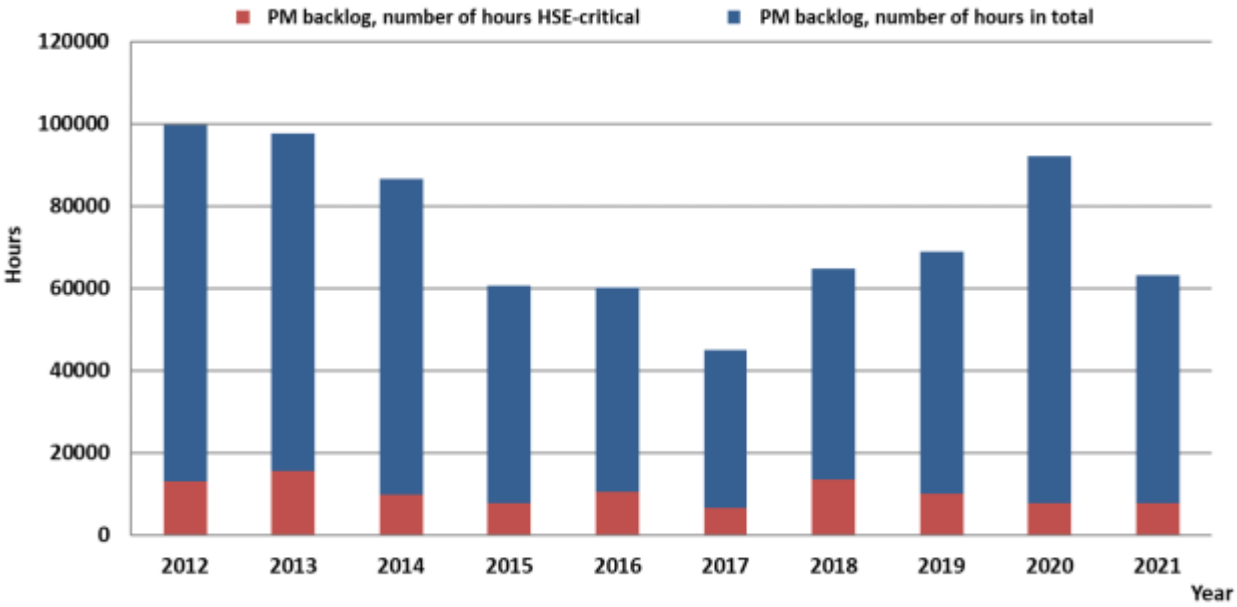

Figure 7.5 Total backlog in PM per year in the period 2012-2021 for the fixed facilities

Figure 7.5 shows the *total backlog in preventive maintenance* in the period 2012-2021 (sum of monthly averages). The figure shows that the total backlog in preventive maintenance is lower in 2021 than in 2020. The backlog in HSE-critical preventive maintenance is decreasing slightly.

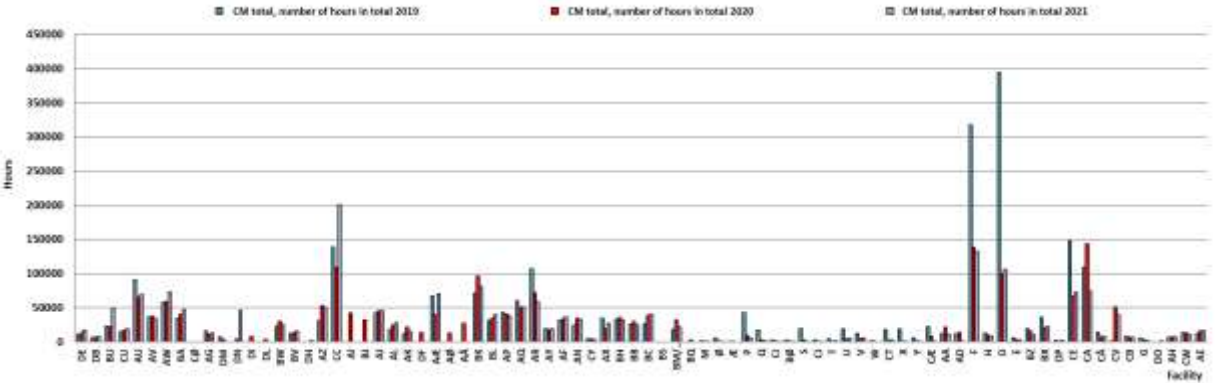

Figure 7.6 Total CM at 31.12.2021 for the fixed facilities. Two facilities have not provided data. The figure also shows data for 2019 and 2020

Figure 7.6 shows the *total corrective maintenance* for the fixed facilities identified at 31.12.2021, but not yet performed. The figure also shows the data for the reporting years 2019 and 2020. We see that some facilities have a high total number of hours of corrective maintenance not performed as at 31.12.2021. Some facilities have reduced the number of hours, but most facilities have stable figures.

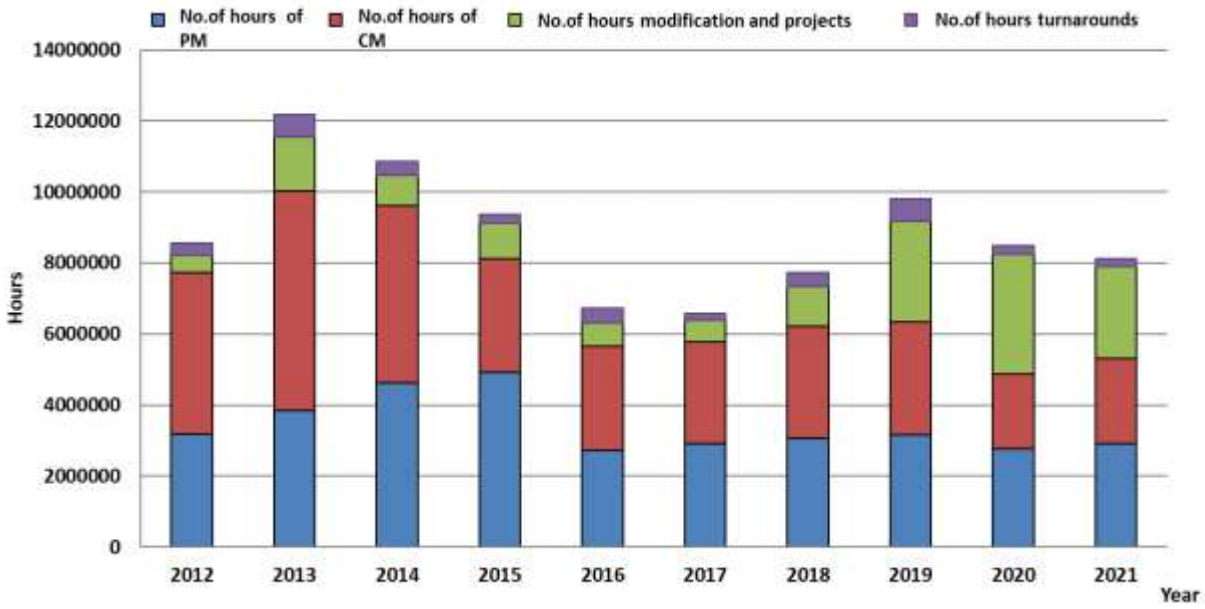

Figure 7.7 Total number of hours for performed maintenance, modifications and planned shutdowns for the fixed facilities in the period 2012-2021

Figure 7.7 shows the total number of hours for *performed maintenance, modifications and planned shutdowns* for the fixed facilities in the period 2012-2021. Figure 7.7 is especially intended to show the *distribution* of the activities. We see that the hours for preventive and corrective maintenance carried out in 2021 are approximately the same as the year before, but that the number of hours for modifications and projects has decreased somewhat compared to the previous year.

For maintenance on fixed facilities, we observe that:

- some of the facilities have not classified some of the tagged equipment
- there are large variations in the proportion of HSE-critical equipment, with some facilities having a low proportion of such equipment. The participants use virtually the same classification method
- there are few hours of backlog in preventive maintenance, but a number of facilities have not performed HSE-critical preventive maintenance in accordance with their own deadlines
- the total backlog in preventive maintenance is lower in 2021 than that reported in recent years. The backlog in HSE-critical preventive maintenance is stable
- some facilities have a high total number of hours of corrective maintenance not performed at 31.12.2021. Some facilities have reduced the number of hours, but most facilities have stable figures
- overall, there are a considerable number of hours of corrective maintenance unperformed at 31.12.2021, but the data nonetheless show a reduction from the preceding year
- there was a considerable fall in the number of hours of total outstanding corrective maintenance in 2021 compared with the previous year. The total outstanding HSE-critical corrective maintenance is similar to that in recent years
- the hours spent on the activities as a whole have decreased somewhat compared to the previous year. The number of hours of preventive maintenance performed has changed little since 2016. The number of hours on modifications and projects in 2021 has decreased compared to the previous two years
- there is a large variation in the percentage distribution by participant of performed preventive and corrective maintenance
- some operators have a significant number of hours of corrective maintenance not performed on 31.12 of the last three years compared to the corrective maintenance performed in the same period

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

- plant, systems and equipment must be tagged and classified 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 situations of hazard and accident

7.3.2 The management of maintenance of mobile facilities

Figure 7.8 shows tagged equipment for mobile facilities in the period 2018 to 2021. Some facilities have reported a significantly lower number of tagged items of equipment in 2020 and 2021 compared to the previous years.

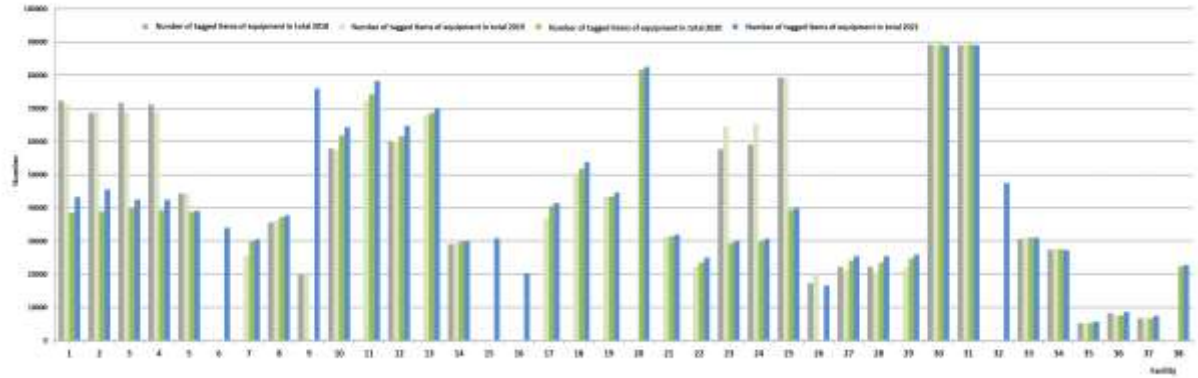

Figure 7.8 Tagged equipment for mobile facilities in the period 2018 to 2021.

Figure 7.9 shows the *backlog in preventive maintenance* in 2021.

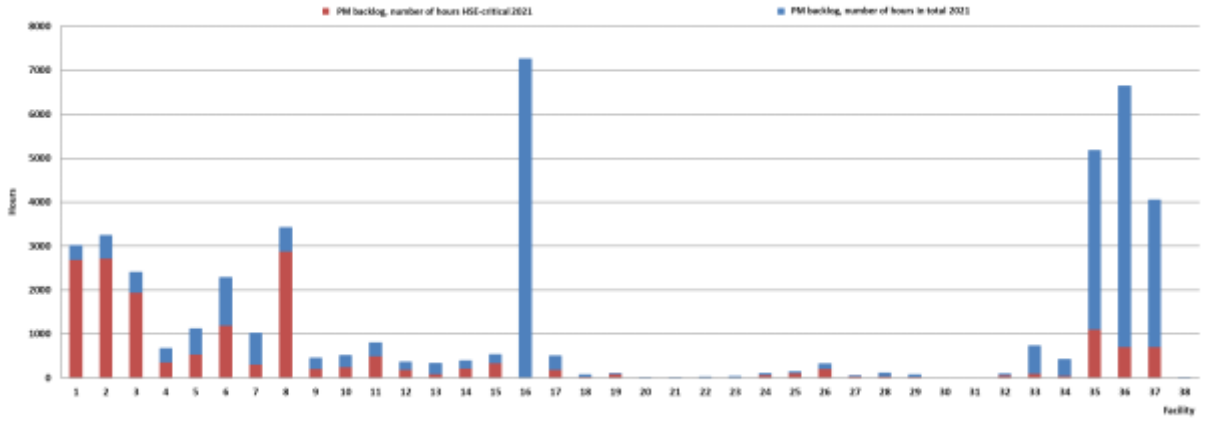

Figure 7.9 Backlog in PM for mobile facilities in 2021

There are 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 7.10 shows the *outstanding corrective maintenance* in 2021.

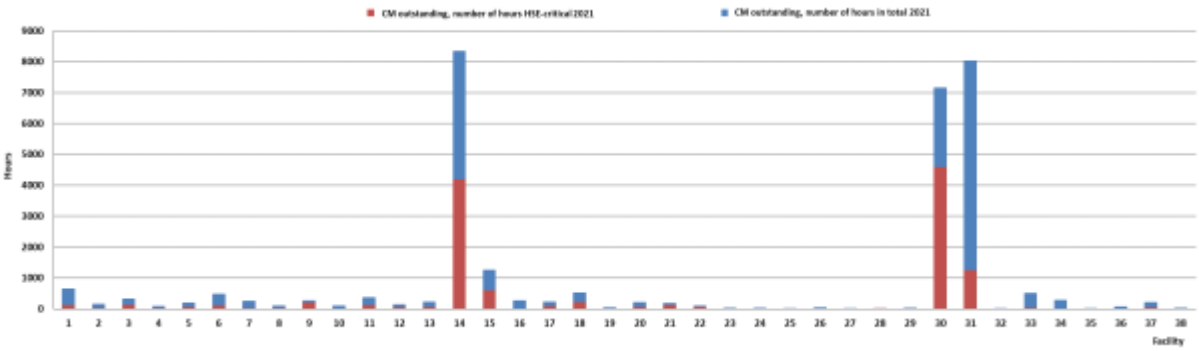

Figure 7.10 Outstanding CM for mobile facilities in 2021

There are variations in the outstanding corrective maintenance for mobile facilities. The hour total is 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 situations of hazard and accident.

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
- newer facilities generally have a higher quantity of tagged and classified equipment than older ones
- Some facilities have reported a significantly lower number of tagged items of equipment in 2020 and 2021 compared to the previous years
- wide variation in the proportion of HSE-critical equipment for the mobile facilities. Some facilities have a high proportion of HSE-critical equipment
- there are 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
- there are variations in the outstanding corrective maintenance for mobile facilities
- several facilities have not performed HSE-critical corrective maintenance in accordance with their own deadlines
- 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 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 situations of hazard and accident

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 2021. For 2021, the PSA registered 172 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 2020, 202 personal injuries were reported.

In addition, 12 injuries classified as off-work injuries and 13 first aid injuries were reported in 2021. For comparison, in 2020 there were 16 off-work injuries and 17 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 2021. 44% of the injuries were not reported to us on NAV forms in 2021. These injuries are therefore recorded based on 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.

There were 137 personal injuries on production facilities in 2021 against 147 in 2020. In the long term, there has been a positive trend in the injury rate since 2011 when the overall rate was 7.4 injuries per million working hours. In 2021, there were 4.7 injuries per million working hours. This is a fall of 0.6 injuries per million working hours from 2020. The fall is not significant.

In 2021, there were 35 personal injuries on mobile facilities, compared with 55 in 2020. The total injury rate fell from 4.1 in 2020 to 2.5 injuries per million working hours in 2021. This is the lowest level in the entire period and the decrease is significant. In the long term, mobile facilities, like production facilities, have had a positive trend, where the injury rate has decreased from 7.1 in 2011 to 2.5 in 2021.

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 rate of serious personal injuries on production facilities and mobile facilities combined. In 2021, a total of 27 serious personal injuries were reported, against 28 in 2020.

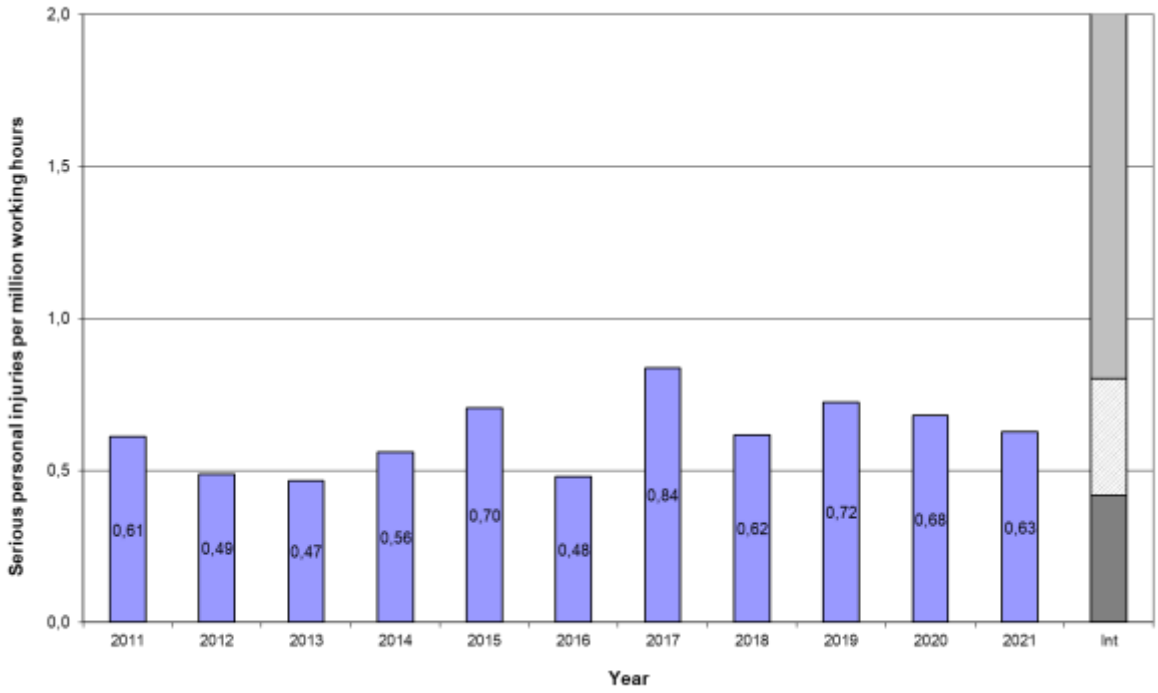

Figure 8.1 Serious personal injuries per million working hours – NCS

In the period 2011 to 2013, there was a downward trend in the personal injury rate on the NCS. 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 2020, we see a decline from 2019 and this trend continues in 2021. In 2021, the rate of serious personal injuries per million working hours is 0.6. and is within the expectation range based on the ten preceding years.

The activity level on the NCS last year rose by 1.9 million from 41.15 to 43.07 million working hours.

8.1.2 Serious personal injuries on production facilities

Figure 8.2 shows the rate of serious personal injuries on production facilities per million working hours.

From 2011, 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 2017, the rate has varied from year to year, but all years have had a higher rate than in 2013. From 2018 to 2020 we see a slight increase, but in 2021 this trend reverses. The rate of serious personal injuries per million working hours fell from 0.8 in 2020 to 0.6 in 2021. The rate in 2021 is within the expected level based on the ten preceding years.

On production facilities, there were 19 serious injuries in 2021 compared with 22 in 2020. The number of working hours increased by 1.16 million in 2021, from 27.8 million in 2020 to 28.9 million in 2021.

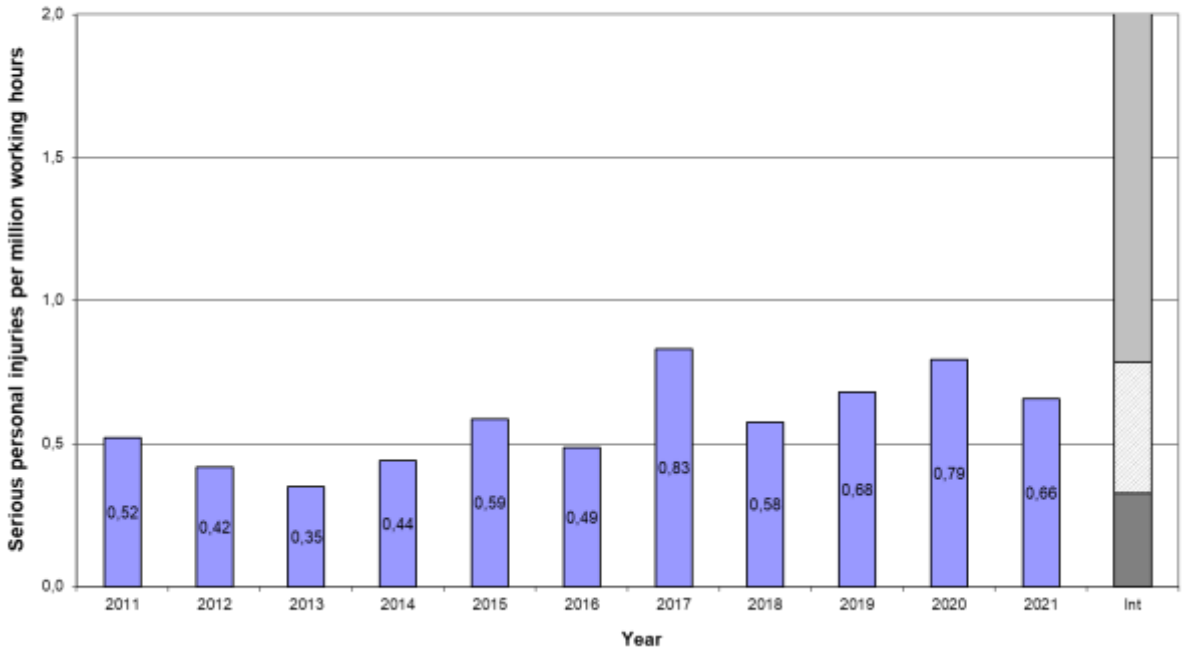

Figure 8.2 Serious personal injuries on production facilities per million working hours

8.1.1 Serious personal injuries on mobile facilities

Figure 8.3 shows the rate of serious personal injuries per million working hours on mobile facilities.

The rate in 2021 was 0.57 and it has increased compared to the level in 2020 when it was at its lowest level in the period, with 0.45 serious personal injuries per million working hours. The injury rate is therefore within the range of expected values based on the preceding ten years. In the period 2011 to 2020, the years 2016 and 2020 are distinctly positive; otherwise the level at the end of the period has varied.

The hourly rate reported for the mobile facilities in 2021 is 14.1 million, while there were 13.4 million hours in 2020 (+0.8). The number of serious injuries is eight in 2021 compared with six in 2020.

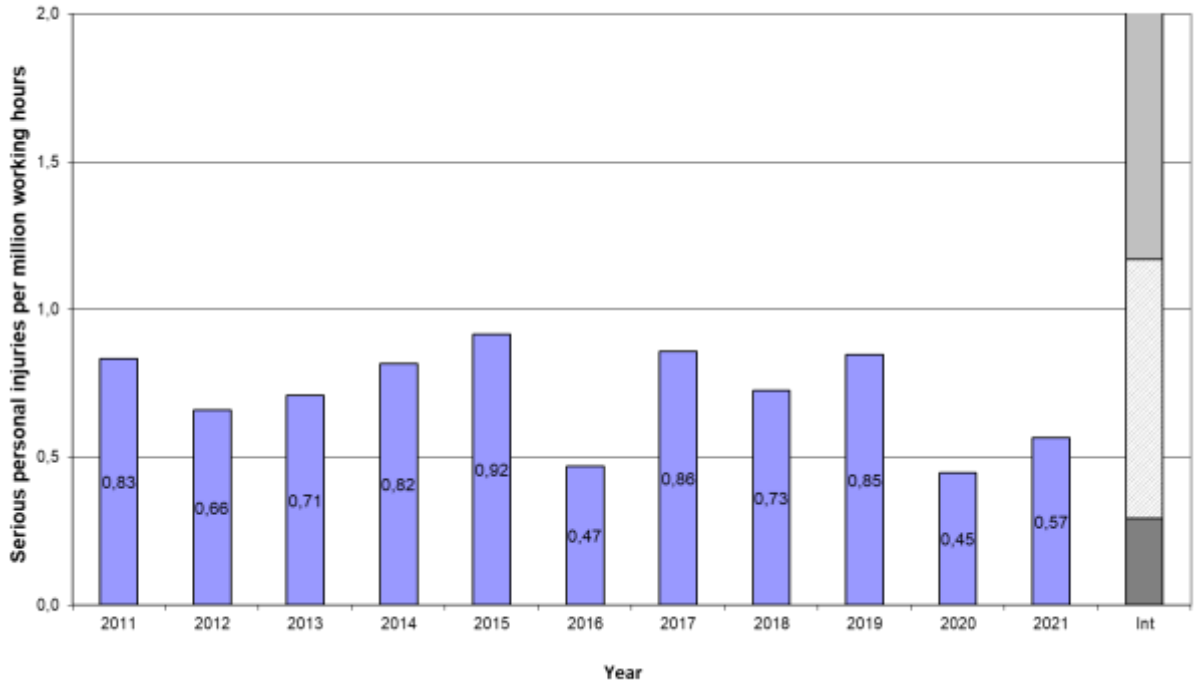

Figure 8.3 Serious personal injuries per million working hours, mobile facilities

9. Other indicators

9.1 DSHA 20 Crane and lifting operations

DSHA 20 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 dropped objects. DSHA 20 was created and presented for the first time in the 2015 report. The time series now consists of data for the period 2013-2021. The analysis looks at both the nine 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 absolute number of reported incidents for fixed facilities in 2021 has risen somewhat compared to 2020. Normalised against working hours there has also been an increase, and, for the period 2018-2021, the normalised number of incidents shows an increasing trend (see Figure 9.1).
- In 2021, there is an increase from 2020 in incidents related to Lifting in the drilling module (both absolute and normalized) and Other lifting activities. The number of incidents related to Lifting by offshore crane has decreased somewhat since 2020 (see Figure 9.2, Figure 9.3, Figure 9.5 and Figure 9.6).
- Looking at incidents without personal injury, but with the potential for injury, in 2021 there was a significant increase in the number of incidents with one person exposed, compared to 2020, and the level was higher than in all previous years, with the exception of 2019. At the same time, there has been a decrease in the number of incidents with two people exposed compared to 2020 (see Figure 9.4).

Mobile facilities

- The number of reported incidents for mobile facilities (both absolute and normalised) has been steadily rising since 2017 and the number of incidents in 2020 was the highest recorded in the whole period 2013-2021. In 2021, the absolute number of incidents was 73, compared to 72 incidents in 2020, but, normalized, the number fell back slightly (see Figure 9.1 and Figure 9.2).
- Breaking incidents down by type of lifting activity, there was an increase from 2018 especially in incidents relating to Lifting in drilling modules, and the increase is in both absolute and normalised results; the number of incidents in 2021 is the highest ever in the reporting period. There was also an increase in the number of incidents related to Lifting in the drilling module when normalized against the number of wells drilled (see Figure 9.5 and Figure 9.6).
- Looking at incidents without personal injury, but with the potential for injury, in 2021 there was a significant increase in the number of incidents with several people exposed, producing the highest number in the period 2013-2021, with the exception of 2013 (see Figure 9.4).

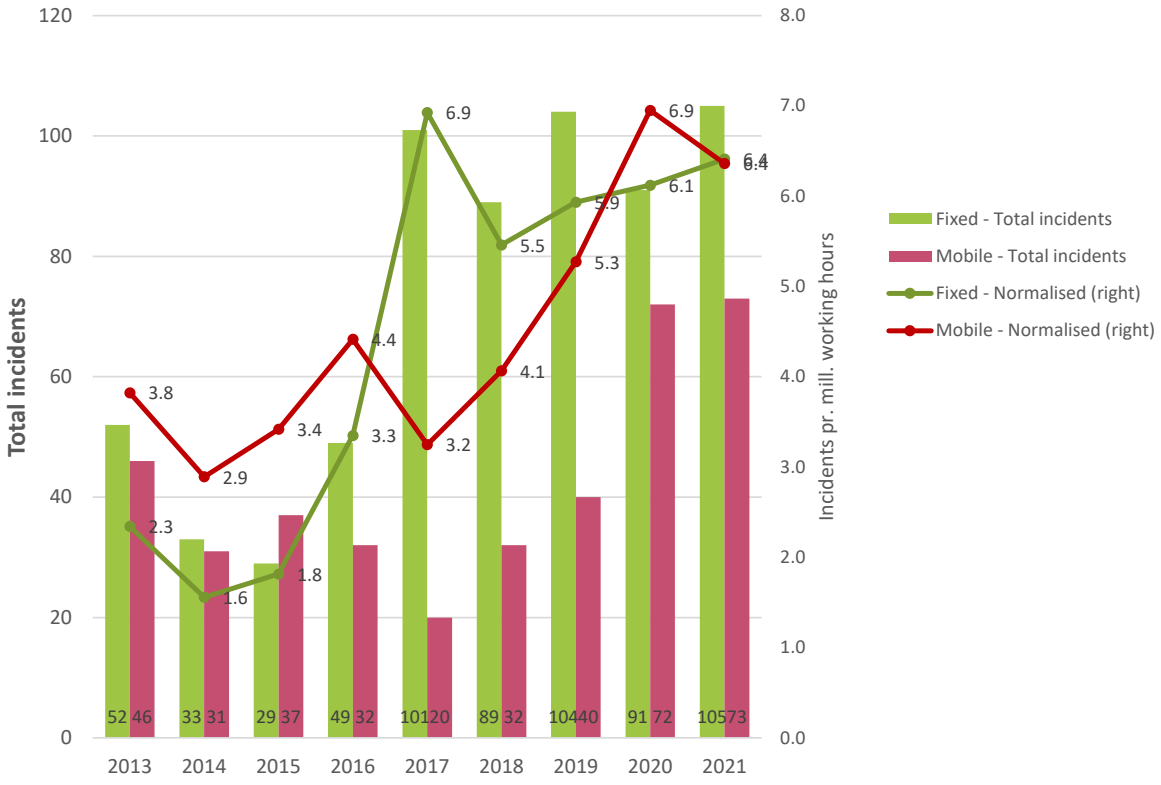

Figure 9.1 Number of reported incidents for crane and lifting operations in the period 2013-2021 for fixed and mobile facilities – absolute numbers and numbers normalised against millions of working hours relating to drilling and well operations and to construction and maintenance, per type of facility.

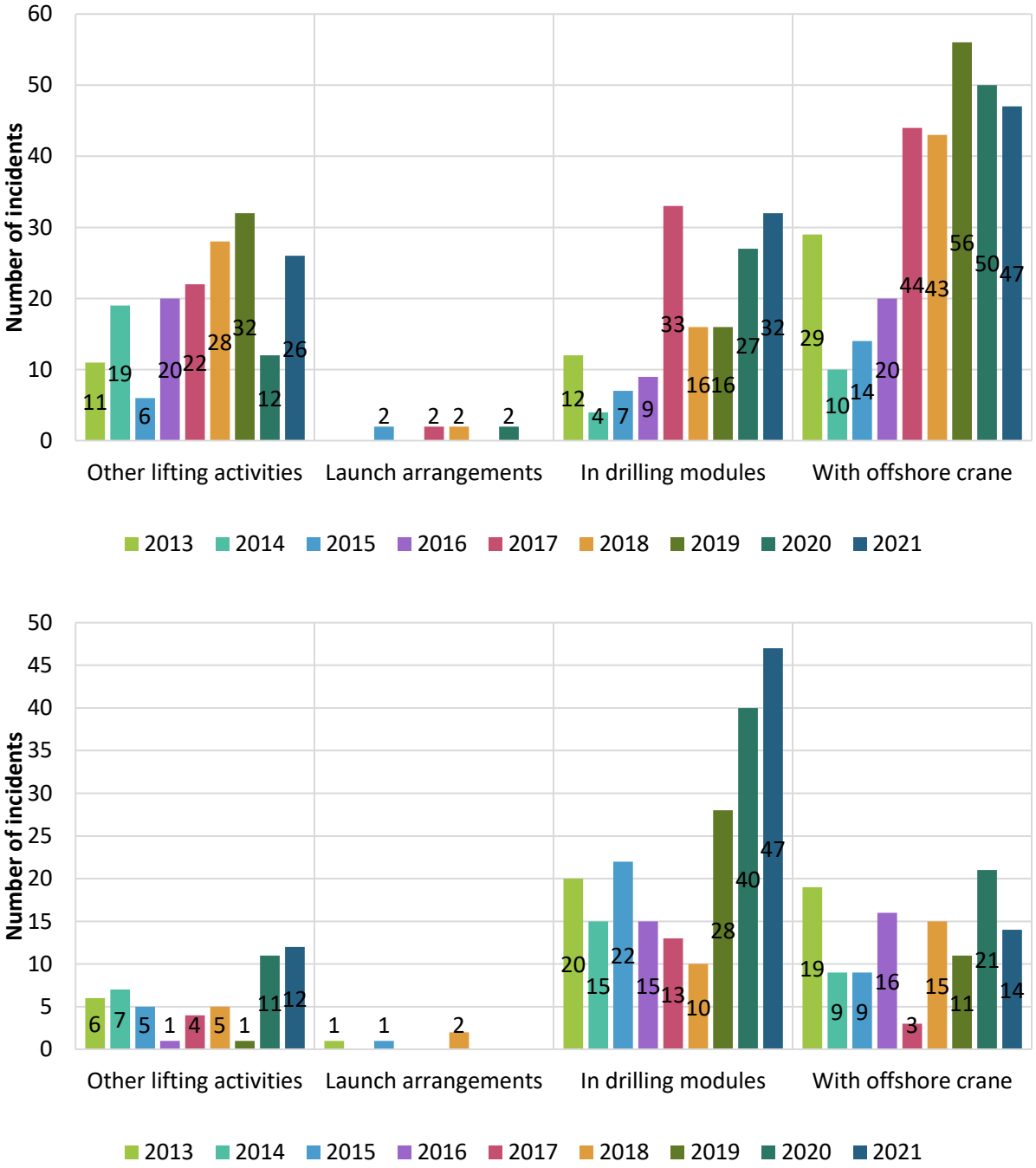

Figure 9.2 Number of incidents per year for the different types of lifting activities for the period 2013-2021, shown for fixed (top) and mobile (bottom) facilities.

Figure 9.3 Number of reported incidents relating to lifting using offshore cranes for the period 2013-2021 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.

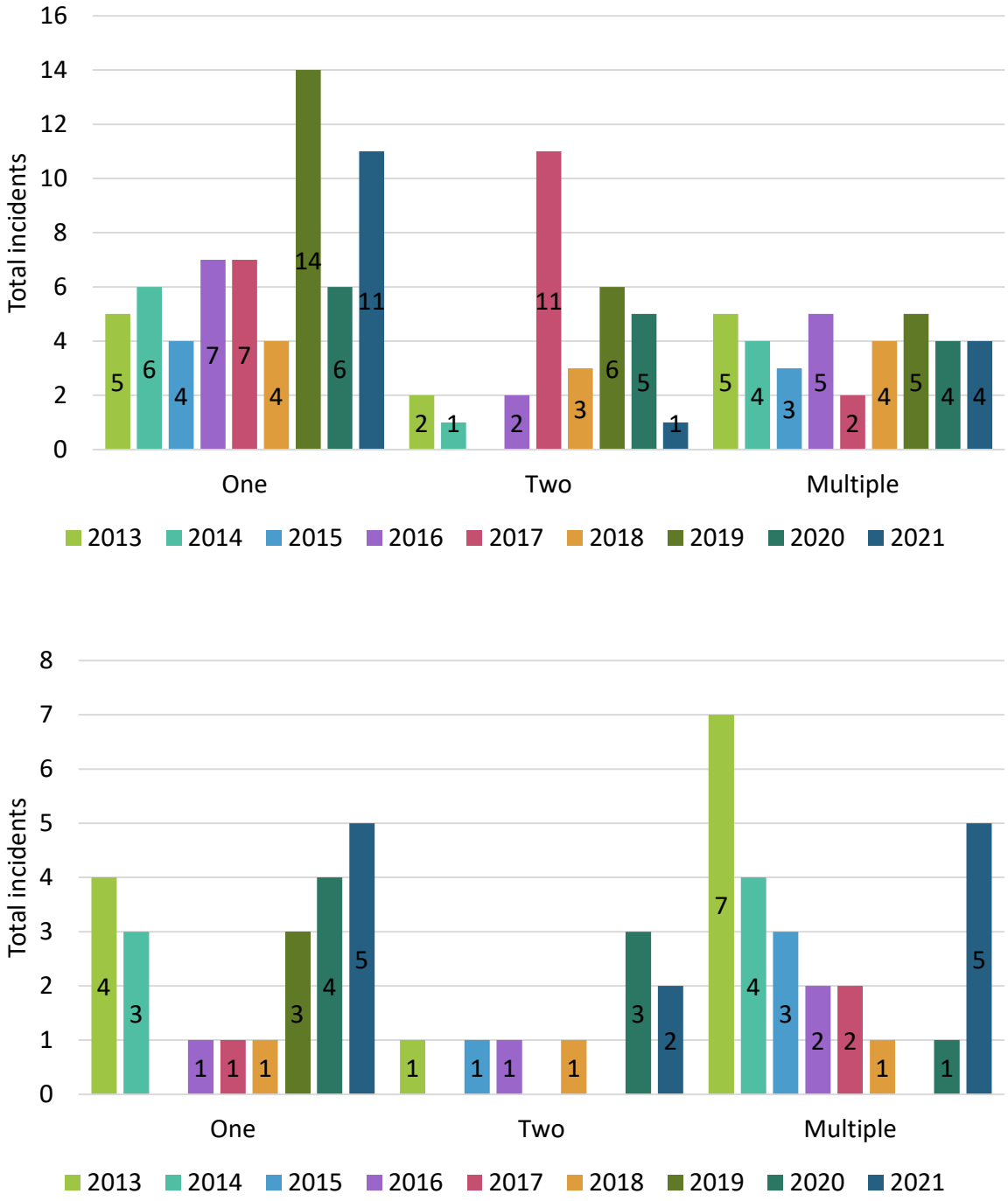

Figure 9.4 Number of incidents (without personal injury) with persons exposed to the incident, for fixed (top) and mobile (bottom) facilities, for the period 2013 to 2021

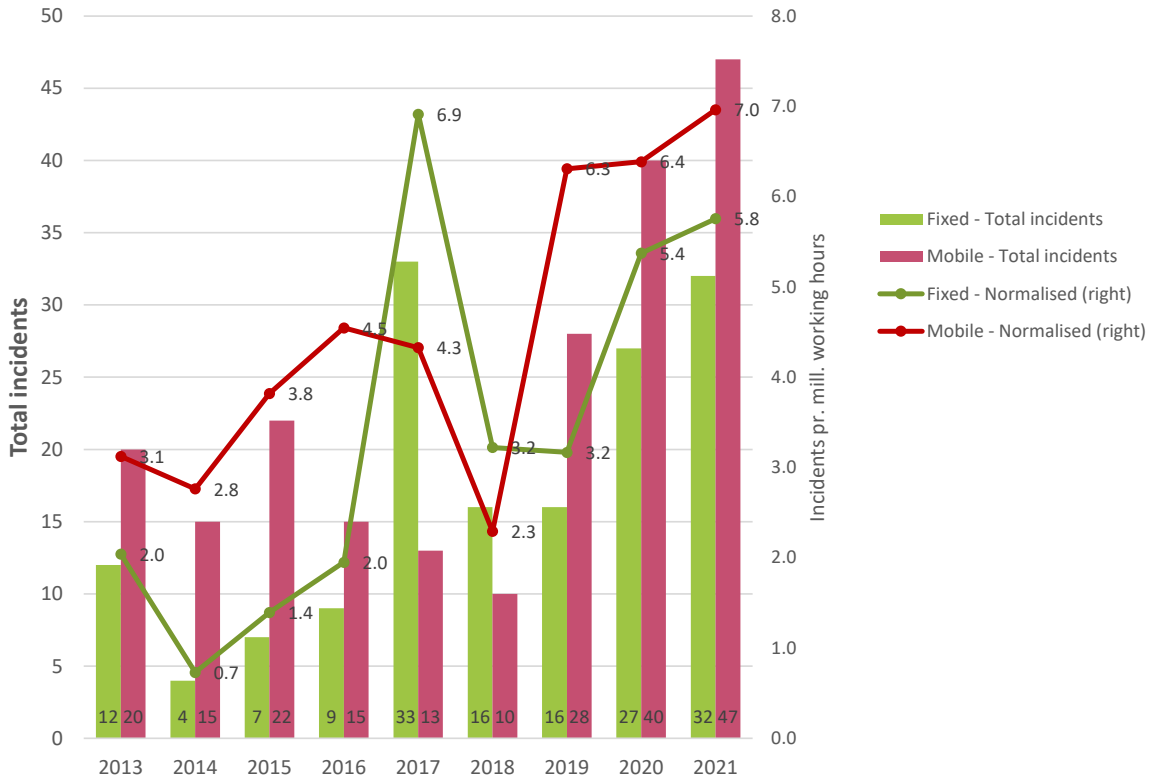

Figure 9.5 Number of incidents relating to lifting in the drilling module for the period 2013-2021 shown for fixed and mobile facilities – absolute numbers and numbers normalised against million working hours relating (exclusively) to drilling and well operations, per type of facility

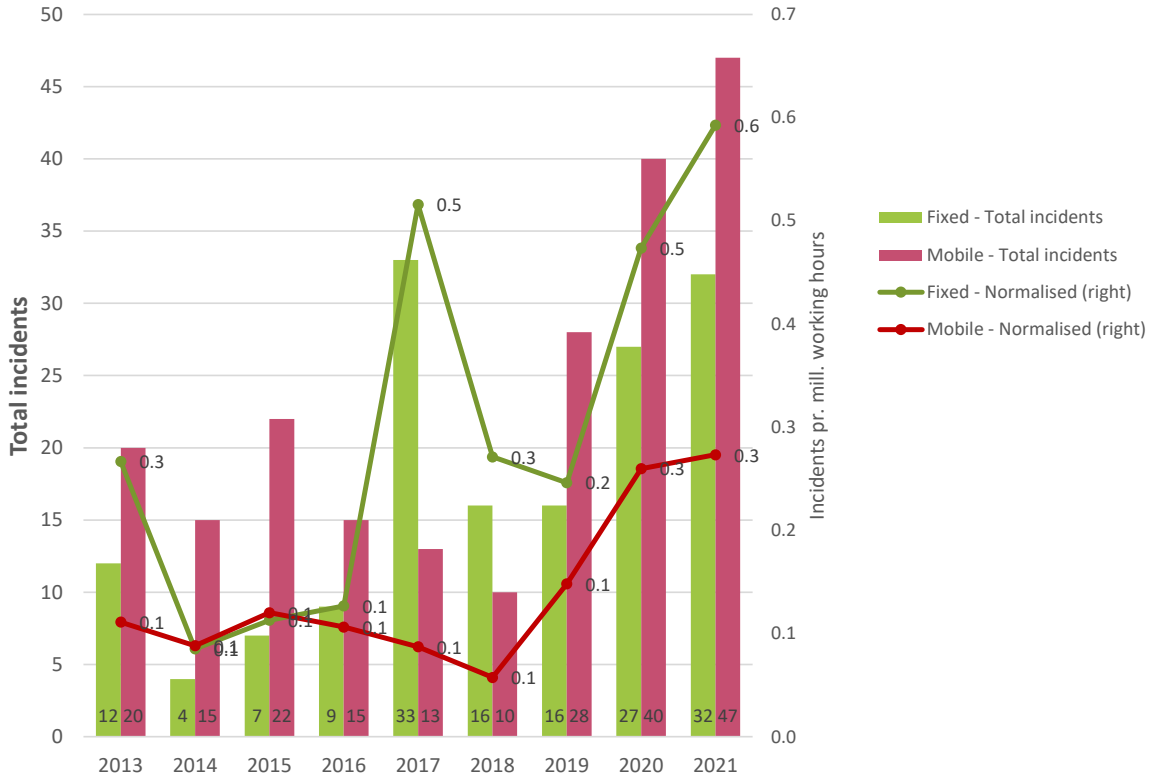

Figure 9.6 Number of incidents relating to lifting in the drilling module for the period 2013-2021 shown for fixed and mobile facilities – absolute numbers and numbers normalised against the number of drilled wells (exploration and production wells)

9.2 DSHA 21 Dropped objects

DSHA 21 Dropped 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 DSHA 20.

As of the 2015 report, for offshore facilities, a new DSHA 20, Crane and lifting operations, was introduced which has caused changes in DSHA 21 Dropped objects. The time series now consists of data for the period 2013-2021. The analysis looks at both the nine 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 in 2021. The normalized number of incidents (against the total number of hours worked) is lower than in 2020 (see Figure 9.7).
- A significant decrease was observed in 2020 in the number of incidents that resulted in personal injuries, totalling 5 on fixed facilities in 2020 compared with 11 in 2019. In both 2018 and 2019, the number was more than twice as high as in the years 2013-2017. In 2021, the number was closer to the levels before 2018, with a total of 6 incidents (see Figure 9.8).
- For drilling areas, there was a very significant increase in the number of incidents >40 J from 2018 to 2019; a threefold increase. In 2020, this fell back to the same level as in 2018, and was at about the same level in 2021 (see Figure 9.10 for >40 J, as well as Figure 9.9 for <40 J).
- For scaffolding, there was an increase in the number of dropped objects for both <40 J and >40 J from 2020 to 2021. Normalised against the number of hours worked relevant to structures and maintenance, there was an increase in incidents <40 J, and a decrease in incidents >40 J (see Figure 9.11 Number of incidents, <40 J to the left, and >40 J to the right, on fixed facilities during scaffolding assembly and disassembly. Blue dotted lines show number of incidents normalized to number of working hours with construction and maintenance in the period 2013-2021.).
- For incidents without personal injury, but with the potential for injury, there is a negative trend in 2019, in that the proportion of incidents with exposed personnel (two persons and several persons) increased compared to 2018. This reversed with a sharp decline in 2020, and has remained at the same level in 2021 (see Figure 9.12).
- The potential for injury is relatively stable when looking at the total number of incidents involving exposed personnel in 2021 versus 2020. Since the activity level has increased, this is a positive trend normalized against the total number of hours worked (see Figure 9.12).

Mobile facilities

- In 2018, *mobile facilities* saw an increase in reported incidents after a number of years of a weak downward trend. The year 2021 is slightly lower than 2018, 2019 and 2020 in the absolute number of incidents. The number of incidents normalised against working hours has decreased significantly from 2019 to 2021 (see Figure 9.7).
- For drilling areas, there was a decrease in the absolute number of incidents for both <40 J and >40 J from 2020 to 2021. The number of incidents normalised against working hours has decreased significantly from 2019 to 2021. The fall is primarily related to work processes in operations in the drilling area. However, the decrease

in the normalized number may be due to a change in the data collection for the number of hours worked; despite a decrease in the number of wells drilled from 2019 to 2020, the number of hours worked increased. Developments have therefore also been normalised against the number of wells drilled. This shows a decrease in normalised numbers from 2020 to 2021 for both <40 J and >40 J (see Figure 9.13, Figure 9.14, Figure 9.15 and Figure 9.16).

- The share of dropped objects >40 J in the drilling areas on mobile facilities has decreased in recent years, but is up slightly again in 2021. The number of dropped objects with a high energy classification decreased from 2020, which is a positive development (see Figure 9.17).

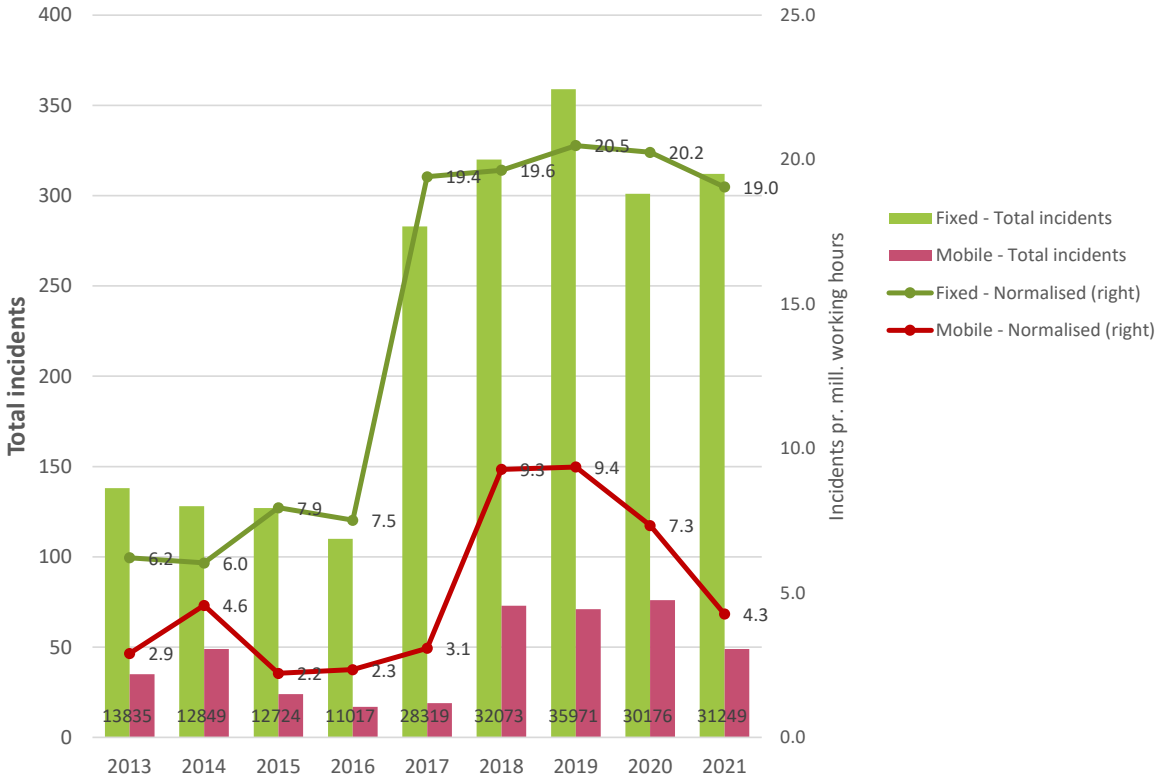

Figure 9.7 Number of incidents, and number incidents per million work hours with dropped objects. The incidents are separated for fixed and mobile facilities, in the period 2013-2021.

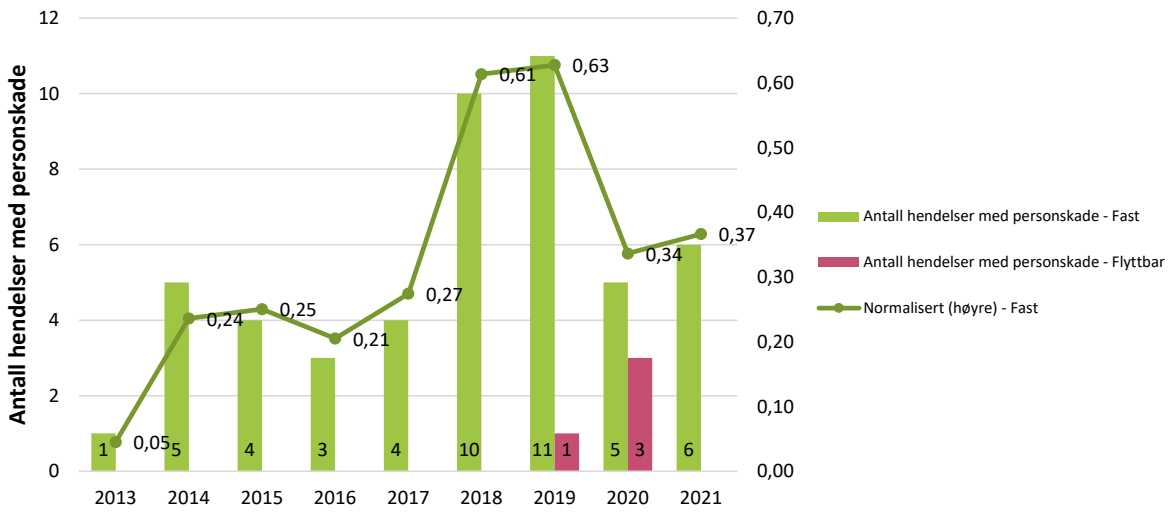

Figure 9.8 Number of incidents with dropped objects causing personal injury, in the period 2013-2021. For fixed facilities, the number of incidents normalised against total number of work hours is shown. Only four of the incidents happened on mobile facilities.

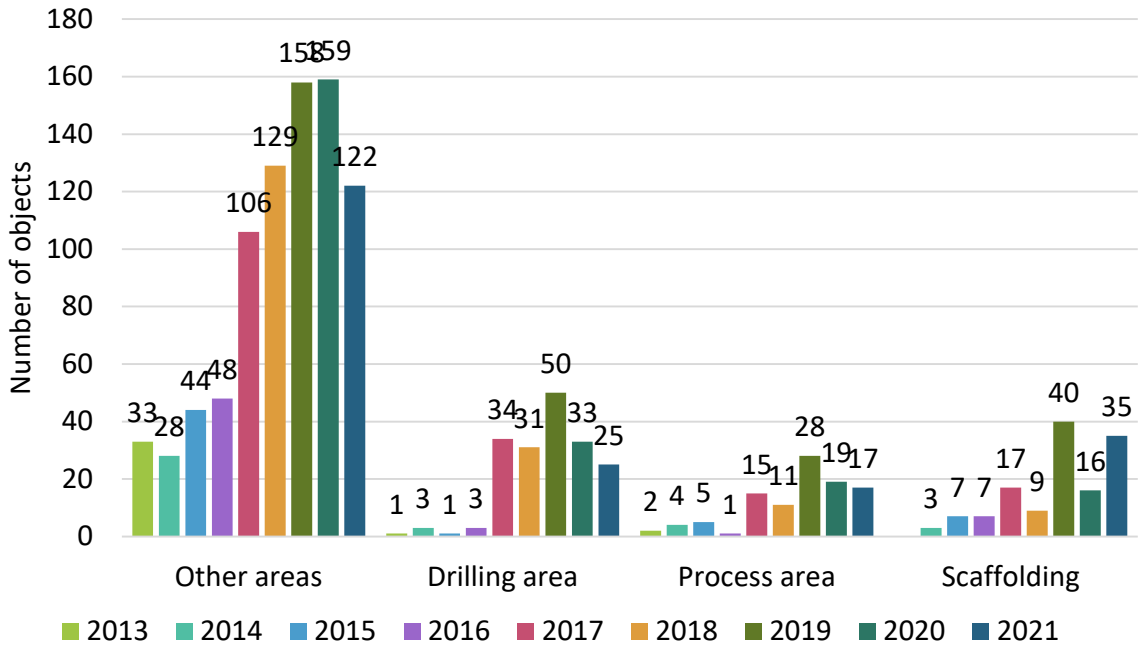

Figure 9.9 Total number of dropped objects for fixed facilities with energy <40 J. Incidents are separated among main categories of work types for the period 2013-2021.

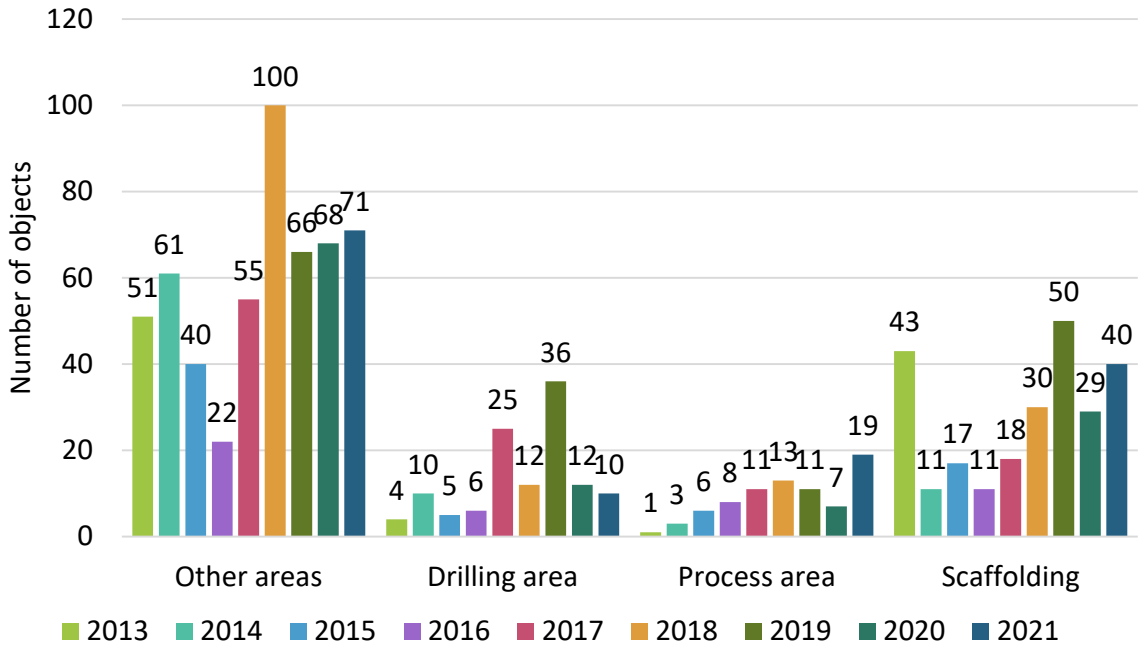

Figure 9.10 Total number of dropped objects for fixed facilities with energy >40 J. Incidents are separated among main categories for work types in the period 2013-2021.

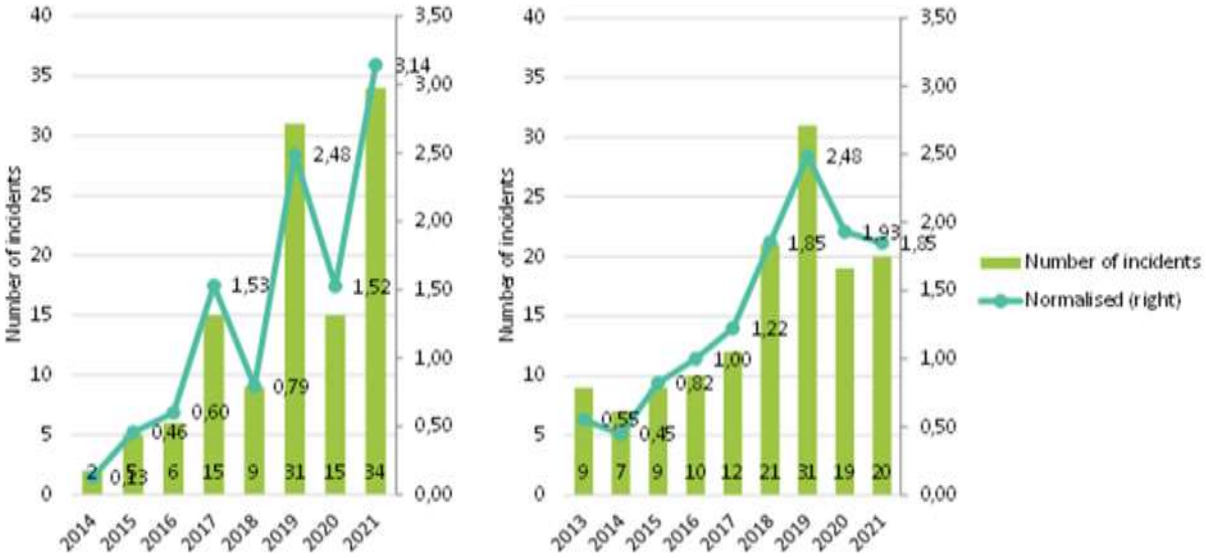

Figure 9.11 Number of incidents, <40 J to the left, and >40 J to the right, on fixed facilities during scaffolding assembly and disassembly. Blue dotted lines show number of incidents normalized to number of working hours with construction and maintenance in the period 2013-2021.

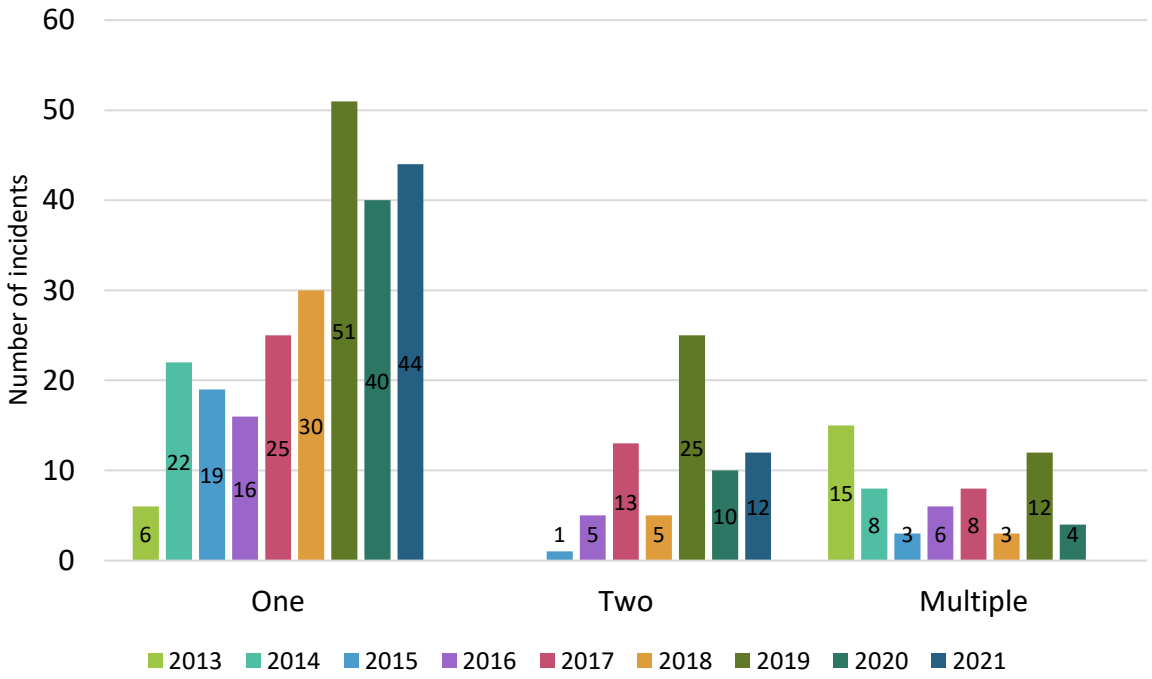

Figure 9.12 Number of incidents (without personal injury) with exposed personnel on fixed facilities.

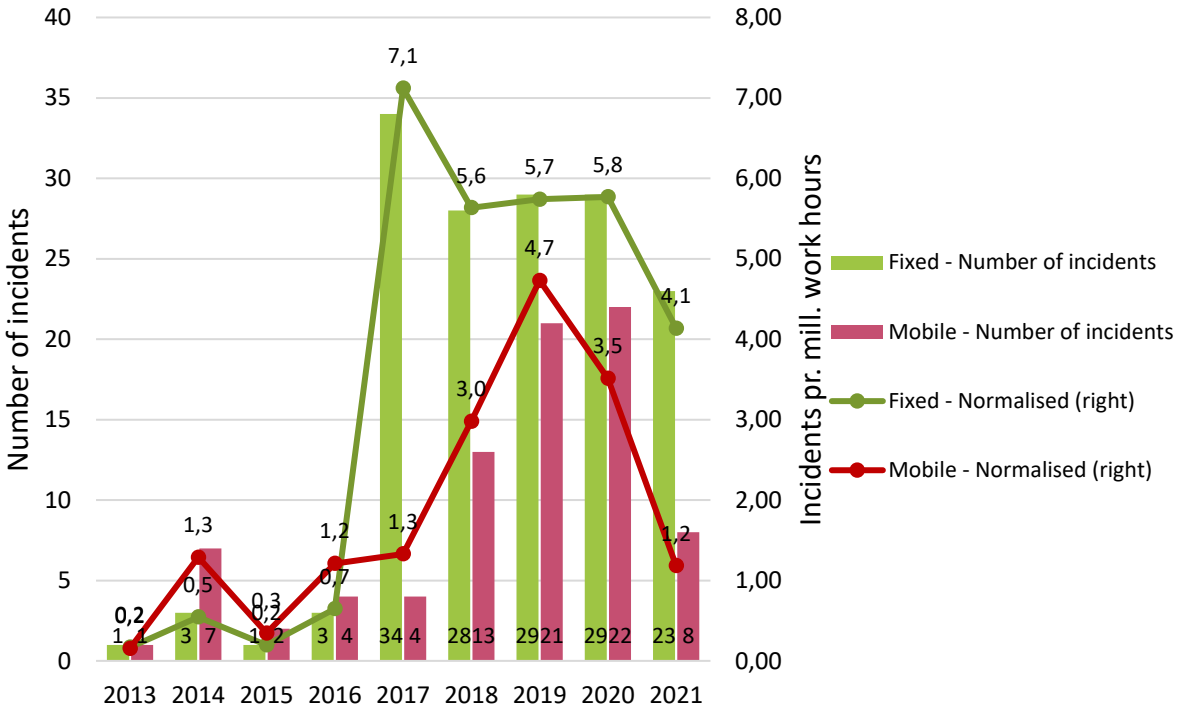

Figure 9.13 Number of incidents in drilling areas with energy <40 J, among fixed and mobile facilities, as well as normalised against number of work hours of drilling operations in the period 2013-2021.

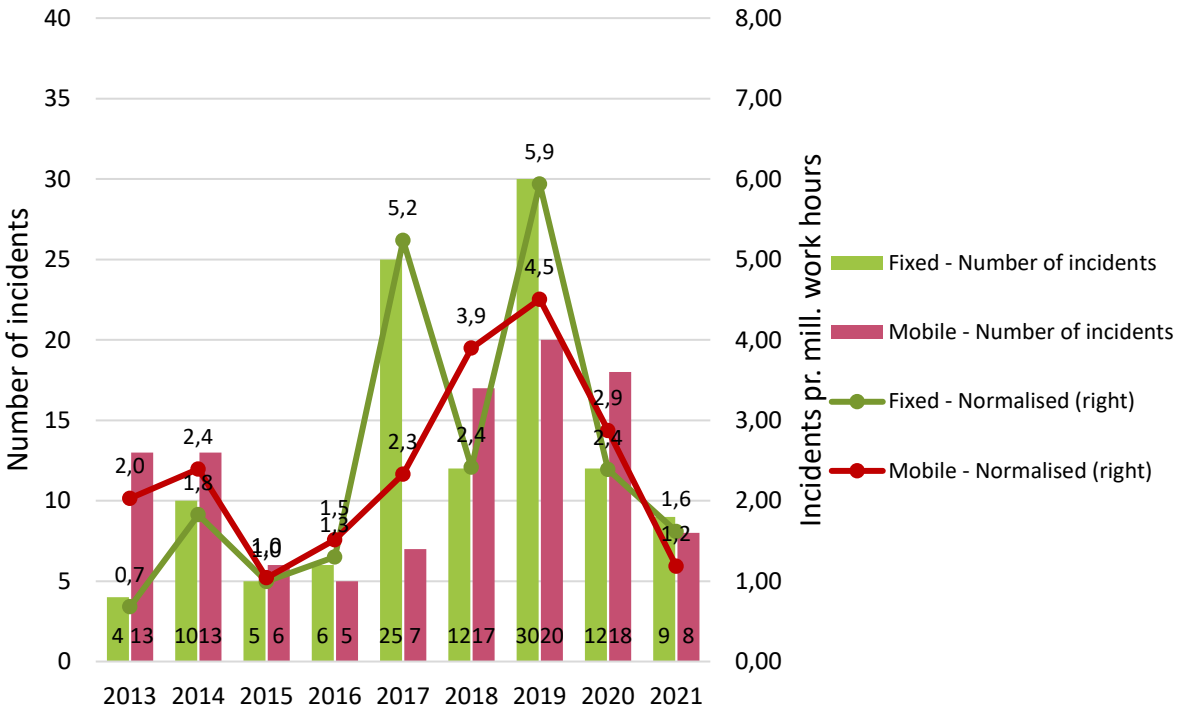

Figure 9.14 Number of incidents in drilling areas with energy <40 J, among fixed and mobile facilities, as well as normalised against number of work hours of drilling operations in the period 2013-2021.

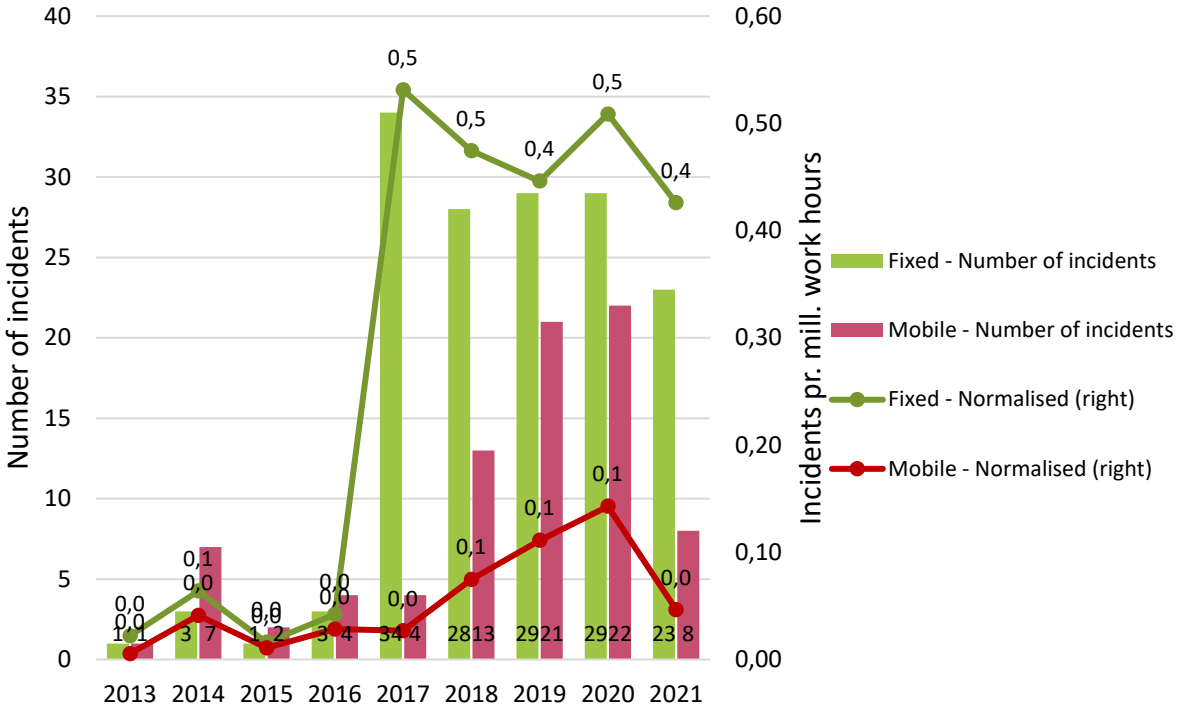

Figure 9.15 Number of incidents in drilling areas with energy <40 J, among fixed and mobile facilities, as well as normalised against number of wells drilled in the period 2013-2021.

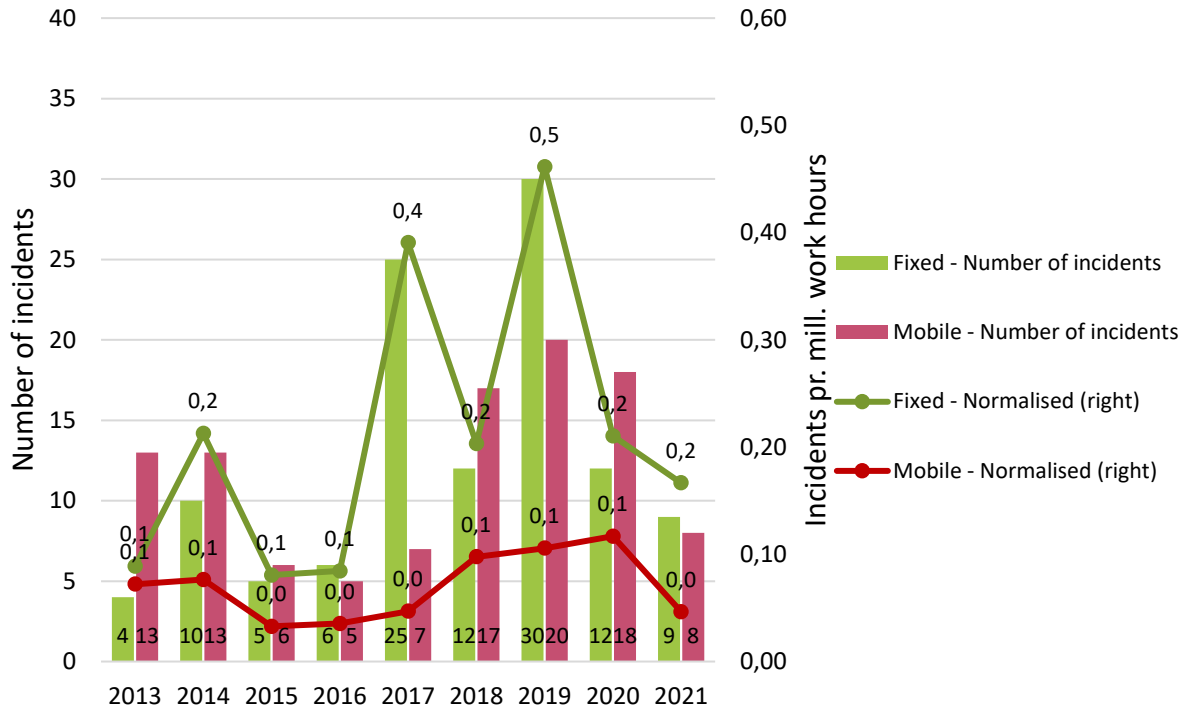

Figure 9.16 Number of incidents in drilling areas with energy >40 J, among fixed and mobile facilities, as well as normalised against number of wells drilled in the period 2013-2021.

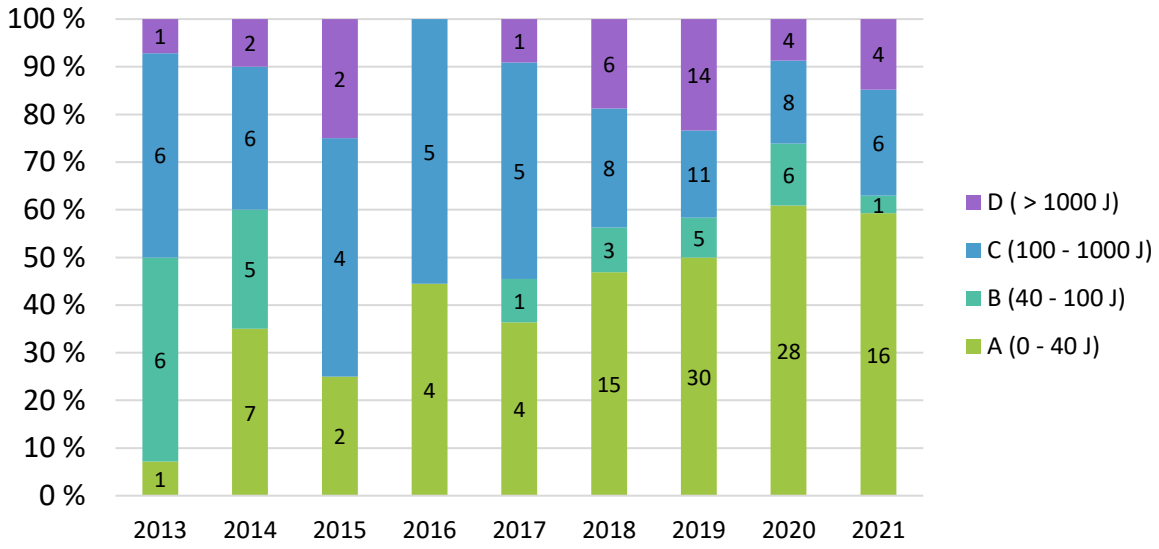

Figure 9.17 Number of dropped objects distributed among energy categories in drilling areas at mobile facilities in the period 2013-2021.

9.3 Other DSHAs

The main report presents data for incidents that have been reported to the Petroleum Safety Authority Norway, as well as for other DSHAs without major accident potential, such as DSHA 11, 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, 2022a. 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
DSHA	Defined situations of hazard and accident
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:

Ptil, 2022a. Risk level in the petroleum activity – Norwegian Continental Shelf, Main report, 31.03.2022
Ptil, 2022b. Risk level in the petroleum activity – onshore installations, 31.03.2022
Ptil, 2022c. Risk level in the petroleum activity – Methodology report, 31.03.2022