Concawe
Environmental Science for European Refining

Report

Report no.11/18

European downstream oil industry safety performance

Statistical summary of reported incidents - 2017

ISBN 978-2-87567-091-5

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Brussels
July 2018

ABSTRACT

The twenty-fourth annual report on European downstream oil industry safety performance presents work-related personal injuries for the industry's own employees and contractors and process safety performance indicators. Information was received from 40 Concawe Member Companies representing more than 96% of the European refining capacity. In 2017, there were two fatalities in the industry. While this equals the lowest number of annual fatalities recorded in 2016, we continue to consider this two too many and work to reduce this number to zero. Lost Workday Injuries rose from 501 to 577, an increase of approximately 15%. Total work hours reported increased by 7%. The number of Tier 1 and 2 process safety releases continued to decline in 2017 (total count for Manufacturing and Marketing of 287 in 2017 down from 349 in 2016).

This report is available as an Adobe pdf file on the Concawe website (www.Concawe.eu).

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EXECUTIVE SUMMARY

For 2017, information was received from 40 Concawe Member Companies, together accounting for greater than 96% of the available refining capacity in the EU-28, Norway and Switzerland. The purpose of collecting this data is twofold.

- To provide member companies with a benchmark against which to compare their performance, so that they can determine the efficacy of their safety management systems, identify shortcomings, and take corrective actions.
- To demonstrate that the responsible management of safety in the downstream oil industry results in a low level of accidents despite the hazards intrinsic to its operations.

The aggregated 2017 results for Manufacturing, Marketing and the combined downstream oil industry are shown in the table below.

Table Aggregated 2017 results for all reporting companies

All reporting companies									
Sector	**Manufacturing**			**Marketing**			**Both Sectors**		
Work Force	**OS**	**CT**	**AW**	**OS**	**CT**	**AW**	**OS**	**CT**	**AW**
Hours worked Mh	113	191	303	157	139	296	269	330	599
Fatalities	0	1	1	0	1	1	0	2	2
FAR - FA/100Mh	0.0	0.5	0.3	0.0	0.7	0.3	0.0	0.6	0.3
LWI	170	147	317	148	112	260	318	259	577
Lost time through LWI - Days	5,757	4,167	9,924	4,862	2,696	7,558	10,619	6,863	17,482
LWIF - LWI/Mh	1.5	0.8	1.0	0.9	0.8	0.9	1.2	0.8	1.0
LWIS* - Lost days/LWI	35.3	35.9	35.6	35.8	28.1	32.6	35.5	32.4	34.2
AI	357	333	690	279	160	439	636	493	1,129
AIF - AI/Mh	3.2	1.7	2.3	1.8	1.2	1.5	2.4	1.5	1.9
Distance travelled - million km							245	680	925
RA							200	280	480
RAR+ - RA/million km							0.8	0.4	0.5

* LWI severity is calculated for those LWI where lost days are reported
+ RAR is calculated for those RA where distance is reported
OS: Own staff; CT: Contractors; AW: All workers
Rounding results in Manufacturing AW hours of 303 being the sum of OS, 112.5 and CT, 190.7.

There were two fatalities reported for 2017, both were contractors, one working in Manufacturing and the other in Marketing.

Whilst this equals the number of fatalities recorded in 2016 and it equals the lowest annual number of fatalities in the industry since Concawe began collating membership data in 1993, we must continue to strive to achieve zero fatalities in our industry.

Fatalities are a relatively rare occurrence in the downstream industry. Consequently, the membership study Lost Workday Injuries (LWI) to identify further opportunities for continuous safety performance improvement. A total of 577 LWIs were reported in 2017 (501 in 2016) and 550 of these were allocated to the agreed 12 causal categories within the membership company submissions. As in previous years, a relatively small number of causal factors, including ‘Slips and Trips (same height)’, ‘Struck by’ and ‘Overexertion, Strain’ contribute to most LWIs reported.

In 2009, the Safety Management Group of Concawe decided to expand the scope of industry wide safety performance indicators to address process safety, aligned to the reporting guidelines that were developed by the API [23, 24]. For 2017, 38 companies submitted Process Safety Event (PSE) data for the Manufacturing operations and 18 submitted Marketing PSE data. The 2017 PSE data represents 38 out of 39 (97% of the relevant Refining capacity) of reporting companies in Manufacturing and 97.5% of the total Manufacturing exposure hours reported. The annual reduction in Tier 1 and 2 PSE events seen since 2011 has continued in 2017.

1. INTRODUCTION TO 2017 REPORT

The collection and analysis of incident data is widely recognised by the downstream oil refining industry as an essential element of an effective safety management system.

Concawe started compiling statistical data for the European downstream oil industry in 1993 and this is the twenty-fourth report on this topic (see references of past reports in the reference list [1-23]). This report covers data collected for 2017 as well as a full historical perspective from 1993. It also includes comparative figures from other industry sectors where available. For 2017, information was received from 40 Concawe Member Companies, representing more than 96% of the European Refining capacity. From the outset, most Concawe member companies have participated so that the report has always represented a large portion of the industry and by 1995 the report represented ~93% of European refining capacity (somewhat less for distribution and retail). Over the years, the level of representation has fluctuated in line with the structural changes and mergers occurring in the industry.

The term "downstream" represents all activities of the Industry from receipt of crude oil to products sales, through refining, distribution, and retail. Not all companies operate in both the Manufacturing and Marketing areas and not all companies are able to supply all the requested data. All those who do, collect data separately for "Manufacturing" (i.e. refining) and "Marketing" (i.e. distribution, retail and "head office" staff) and this split has been applied in the report. The data is also split between company and contractor staff as contractor statistics are normally fully integrated in to the companies' safety monitoring systems. Some companies do not record road accidents separately from other incidents. All companies record own staff injuries against the Manufacturing and/or Marketing categories but this is not always the case for lost days. Contractor data is in general, less complete than company staff data. Where data are not available directly, Members are requested to present the best estimate possible.

The purpose of collecting this data is twofold.

- To provide member companies with a benchmark against which to compare their performance, so that they can determine the efficacy of their safety management systems, identify shortcomings, and take corrective actions.
- To demonstrate that the responsible management of safety in the downstream oil industry results in a low level of accidents despite the hazards intrinsic to its operations.

Several key performance indicators have been adopted by most oil companies operating in Europe as well as by other industries. Although there are differences in the way member companies collect base data these common indicators allow for an objective comparison at the industry level. The differences in precise definitions used and in local interpretation of metrics means that direct comparison of data from individual companies could lead to erroneous conclusions. For this reason, Concawe does not report individual company data but rather aggregates the data at the membership level.

In 2009 Concawe began to compile Process Safety Performance Indicator (PSPI) data. These describe the number of Process Safety Events (PSE) expressed as unintended Loss of Primary Containment (LOPC). The 2017 data represents 97% of the Manufacturing companies that reported (38 out of 39) and these companies in turn represent 97.5% of the reported exposure hours in Manufacturing. Following concerted efforts from Concawe representatives and within the membership, the number of respondents has increased in 2017. The improvement in the completeness of the data will further improve the benchmark reliability. Also for the first time in the data collection for 2017, additional

information was gathered regarding the circumstances of Tier 1 Process Safety Events. The process safety metrics for the questionnaire were submitted in line with the requirements of API RP754 (2016). This data is presented in table format in Appendix 3. Over time this will allow assessment of the main factors contributing to process safety incidents from which approaches to address incident prevention can be developed.

In 2014, the members decided to commence collecting additional information in relation to the nature of Marketing retail operations. Companies have been asked to indicate if they have no retail activity and also to describe their retail operations as either Company Owned Company Operated (COCO), Company Owned Dealer Operated (CODO), Dealer Owned Company Operated (DOCO) or Dealer Owned Dealer Operated (DODO). Concawe would like to improve the report in the data coverage for retail and transport contractors.

Table 1 summarises the number of submissions and illustrates some key aspects of the data supplied by the companies.

Table 1 Number of companies submitting data for 2017

No of companies	**Manufacturing**[b]			**Marketing**		
	Own staff	Contractors	All workers	Own staff	Contractors	All workers
Submission	39	39		27	19	
Including						
Lost days	32	32		14	16	
All injuries	36	36		18	17	
Road accidents[a]	10	6		8	9	
Distance travelled	15	7		17	11	
Process Safety[c]			38			18
Retail Operations						
No retail						5
COCO						13
CODO						9
DOCO						2
DODO						10

a) Several Companies do not report their Road accidents and related exposure hours separately. These incidents are included in their overall statistics in cases where relevant criteria (LWI, AI) are met.

b) One reporting member reported no refining activities in 2017 so in total there were 40 company submissions.

c) In 2017, further investigation of all zero records for Process Safety events especially in Marketing has resulted in greater confidence in the data submitted. Consequently, the Marketing Sector's contribution to Process Safety statistics has risen from 14 in 2016 to 18 in 2017.

2. 2017 PERSONAL SAFETY PERFORMANCE RESULTS

The aggregated 2017 results for Manufacturing, Marketing and the combined downstream industry are shown in **Table 2**.

Table 2 Aggregated 2017 results for all reporting companies

All reporting companies									
Sector	**Manufacturing**			**Marketing**			**Both Sectors**		
Work Force	**OS**	**CT**	**AW**	**OS**	**CT**	**AW**	**OS**	**CT**	**AW**
Hours worked Mh	113	191	303	157	139	296	269	330	599
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* LWIS is calculated for those LWI where number of lost days are reported
+ RAR is calculated for those RA where distance is reported
OS: Own staff; CT: Contractors; AW: All workers
Rounding results in Manufacturing AW hours of 303 being the sum of OS, 112.5 and CT, 190.7.

2.1. 2017 FATALITIES

There were two fatalities reported for 2017 (the same number of fatalities as recorded in 2016). Both were contractors, one working in Manufacturing and the other in Marketing. The fatality in Manufacturing was caused by a fall from height during maintenance work on a fixed roof storage tank. Without proper use of the safety belt, the Injured Person jumped from the roof of the tank to the equipment platform instead of using stairs or ramps. The fatality in Marketing occurred when an out of control car struck a worker at high speed on the forecourt of a highway filling station.

In addition to Fatalities, Concawe membership also study Lost Workday Injuries (LWI) to identify further opportunities for continuous safety performance improvement.

2.2. 2017 LOST WORKDAY INJURIES

In 2017, there was an overall increase in Lost Workday Injury Frequency (LWIF) from 2016 performance. The LWIF went from 0.90 LWI/Mh in 2016 to 0.96 LWI/Mh in 2017 across all workers. The increases were observed in Manufacturing (Own Staff 1.24 to 1.51, Contractors 0.67 to 0.77) while Marketing (Own Staff 0.94 to 0.95, Contractors 0.86 to 0.81) remained steadier. Refer to Appendix 2 for the details.

For comparison purposes the LTIF (frequency of LWIs + Fatalities) has been calculated for each category of workers, compared with the LWIF and presented in **Table 3** below.

Table 3 Comparison of LWIF and LTIF in 2017

	LWIF	LTIF
All workers	0.96	0.97
Manufacturing Staff	1.51	1.51
Manufacturing Contractors	0.77	0.78
Marketing Staff	0.95	0.95
Marketing Contractors	0.81	0.81

There is very little difference between the two measures when the number of fatalities is small relative to the number of LWI.

It has long been accepted that to achieve a sustainable zero-fatality safety performance a company must continually work to reduce lower level safety incidents (such as lost workday injuries, restricted workday injuries, medical treatment cases, first aid cases and near misses). Although lower level incidents such as slips and trips can result in relatively minor consequences, the actual root causes behind both minor and major incidents generally prove to be very similar.

The effective investigation of all incidents (near miss, minor and major) to obtain a full understanding of their root causes is therefore essential for the creation of a supportive safety culture and the fostering of the right organisational behaviours necessary to achieve zero incidents or accidents in operations.

Table 4 Causes of LWIs in 2017

	LWI 2017				
Causes	Causes	Manufacturing	Marketing	Combined	%
Road accident	Road accident	8	8	16	2.9%
Height/Falls	Falls from height	27	16	43	7.8%
	Staff hit by falling objects	7	10	17	3.1%
	Slips & trips (same height)	104	97	201	36.5%
Burn/ electrical	Explosion or burns	17	8	25	4.5%
	Exposure electrical	1	4	5	0.9%
Confined space	Confined Space	1	0	1	0.2%
Other causes	Assault or violent act	2	9	11	2.0%
	Water related, drowning	0	0	0	0.0%
	Cut, puncture, scrape	18	17	35	6.4%
	Struck by	32	41	73	13.3%
	Exposure, noise, chemical, biological, vibration	18	8	26	4.7%
	Caught in, under or between	14	7	21	3.8%
	Overexertion, strain	32	20	52	9.5%
	Pressure release	4	0	4	0.7%
	Other	13	7	20	3.6%
	Total	298	252	550	100.0%

Note: Not allocated, 27 LWIs: 19 LWIs for Manufacturing and 8 LWIs for Marketing.

Table 4 indicates a relatively small number of causal factors contribute to most LWIs reported. Slips and Trips (same height), Struck by and Overexertion, Strain account for 59% of all LWIs reported in 2017.

Table 5 provides the causes of LWI in 2017 as a percentage of total incidents in each sector, Manufacturing and Marketing. A similar pattern is evident in both sectors with the same five causal factors (Slips and Trips; Struck by; Overexertion, Strain; Falls from Height; and Cut, Puncture, Scrape) contributing to 71% of Manufacturing LWIs and 76% of Marketing LWIs. Slight differences between the sectors then emerge between less frequent LWI causes.

Concentrating on the most frequent causes of these incidents offers the opportunity to address prevention of Lost Workday Injury across both sectors.

Table 5 Causes of LWIs in 2017 split Manufacturing vs. Marketing.

LWI 2017					
Causes		Manufacturing		Marketing	
		Number of incidents	Percentage of total incidents	Number of incidents	Percentage of total incidents
Road accident	Road accident	8	2.7%	8	3.2%
Height/Falls	Falls from height	27	9.1%	16	6.3%
	Staff hit by falling objects	7	2.3%	10	4.0%
	Slips & trips (same height)	104	34.9%	97	38.5%
Burn/ electrical	Explosion or burns	17	5.7%	8	3.2%
	Exposure electrical	1	0.3%	4	2%
Confined space	Confined Space	1	0.3%	0	0%
Other causes	Assault or violent act	2	1%	9	3.6%
	Water related, drowning	0	0%	0	0%
	Cut, puncture, scrape	18	6.0%	17	6.7%
	Struck by	32	10.7%	41	16.3%
	Exposure, noise, chemical, biological, vibration	18	6.0%	8	3.2%
	Caught in, under or between	14	4.7%	7	2.8%
	Overexertion, strain	32	10.7%	20	7.9%
	Pressure release	4	1.3%	0	0.0%
	Other	13	4.4%	7	2.8%
	Total	298	100%	252	100%

Note: Not allocated, 27 LWIs: 19 LWIs, Manufacturing, 8 LWIs, Marketing.

Table 6 shows the Lost Workday Injury frequency statistics broken down in to quartiles. This demonstrates a wide range of variability in performance between the top performing members (Quartile 1 – Q1) and the bottom performing members (Quartile 4 – Q4). Further analysis of the data over many years shows that the variability is consistently between member companies and not within one or more member company's year to year submissions. For the most part these differences do not change much over the years. This reflects genuine levels of performance achieved by different member companies.

Table 6 2017 LWIF quartile distribution ranges and average values for each quartile range

	Quartiles														
LWIF	Manufacturing			Marketing			Total own staff			Total contractors			Total downstream		
	low	high	average	low	high	average	low	high	average	low	high	average	low	high	average
Q1	0.00	0.56	0.21	0.00	0.00	0.00	0.00	0.32	0.07	0.00	0.36	0.11	0.00	0.53	0.23
Q2	0.56	1.26	0.92	0.00	0.36	0.22	0.32	0.96	0.62	0.36	0.91	0.62	0.53	1.09	0.87
Q3	1.26	2.21	1.64	0.36	1.45	0.87	0.96	2.39	1.47	0.91	2.35	1.28	1.09	1.90	1.38
Q4	2.21	22.71	7.05	1.45	19.78	5.82	2.39	15.08	7.34	2.35	32.47	7.21	1.90	22.71	7.21

The quartile distribution ranges and average values for each quartile for the 2017 All Injury Frequency (AIF) are shown in **Table 7**. The average performance indicator figures for the industry conceal a wide range of individual values between reporting companies.

Table 7 2017 AIF quartile distribution ranges and average values for each quartile range

	Quartiles														
AIF	Manufacturing			Marketing			Total own staff			Total contractors			Total downstream		
	low	high	average	low	high	average	low	high	average	low	high	average	low	high	average
Q1	0.00	1.31	0.75	0.00	0.00	0.00	0.00	0.72	0.42	0.00	1.01	0.44	0.00	0.98	0.61
Q2	1.31	2.17	1.78	0.00	0.72	0.54	0.72	2.01	1.28	1.01	2.13	1.40	0.98	2.04	1.43
Q3	2.17	4.99	3.37	0.72	2.01	1.25	2.01	4.81	2.96	2.13	4.69	3.04	2.04	4.75	3.12
Q4	4.99	25.80	10.49	2.01	25.44	8.09	4.81	22.77	10.90	4.69	32.47	9.87	4.75	25.80	10.05

2.3. PERFORMANCE TRENDS 2008 TO 2017

Performance indicators are particularly useful for identifying trends and patterns when considered over time. The historical trends for the European downstream oil industry over the past ten years are summarised in this section. Ten years has been chosen as a period reasonably representative of actual operating conditions and practices in place within the industry. For a full historical perspective, back to 1993, additional data tables are provided in **Appendix 2**.

Table 8 Fatalities by sector 2008-2017

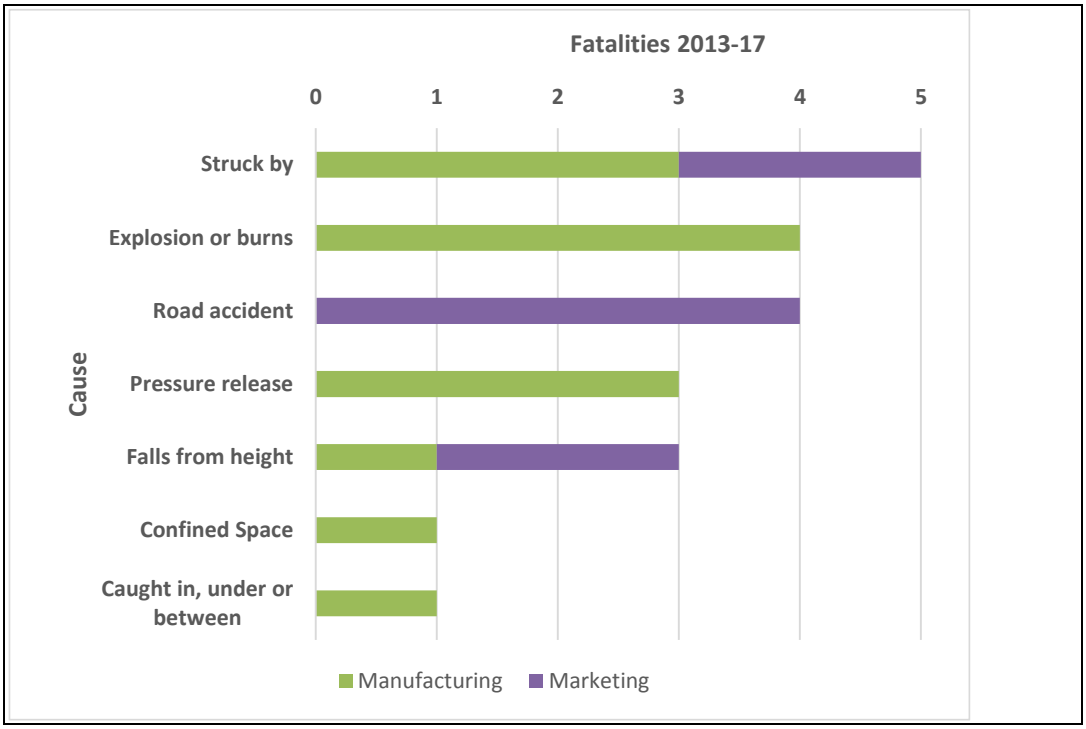
Fatalities over 10 years by sector			
Year	Manufacturing	Marketing	Total
2008	5	6	11
2009	9	2	11
2010	11	3	14
2011	10	1	11
2012	4	6	10
2013	4	2	6
2014	6	1	7
2015	4	3	7
2016	2	0	2
2017	1	1	2
Total	56	25	81

Over the past ten years there has been a steady reduction in the number of fatalities recorded in the European downstream oil industry with the improvement seen in both the Manufacturing and Marketing Sectors. While this represents continuing improvement in the management of safety risks within the downstream oil industry, further focus is required to achieve and sustain our objective of zero fatalities.

In 2013, the membership agreed to adopt 16 cause categories to describe both fatalities and Lost Workday Injury (LWI) in an attempt to learn more from the actual incidents. These causal categories allow for better benchmarking and alignment with other industry organisations, particularly the IOGP that represents the upstream sector of the oil and gas industry. The Concawe categorization of causes for fatalities and LWIs are further explained in **Appendix 1**.

Figure 1 summarizes the causes of all fatalities which were allocated a cause by the participating company in the period 2013 to 2017.

Figure 1 Number of fatalities by cause 2013-2017



Since Concawe moved to reporting fatalities against the same 16 causes as Lost Workday Injury in 2013, 'Struck by' (five fatalities), 'Explosions or Burns' (four fatalities) and 'Road Accidents' (four fatalities) have been the largest contributors to fatalities in the industry. Together, the three causes account for approximately 62% of the fatalities experienced in the industry since 2013. Three fatalities in this period have not been allocated to a cause category.

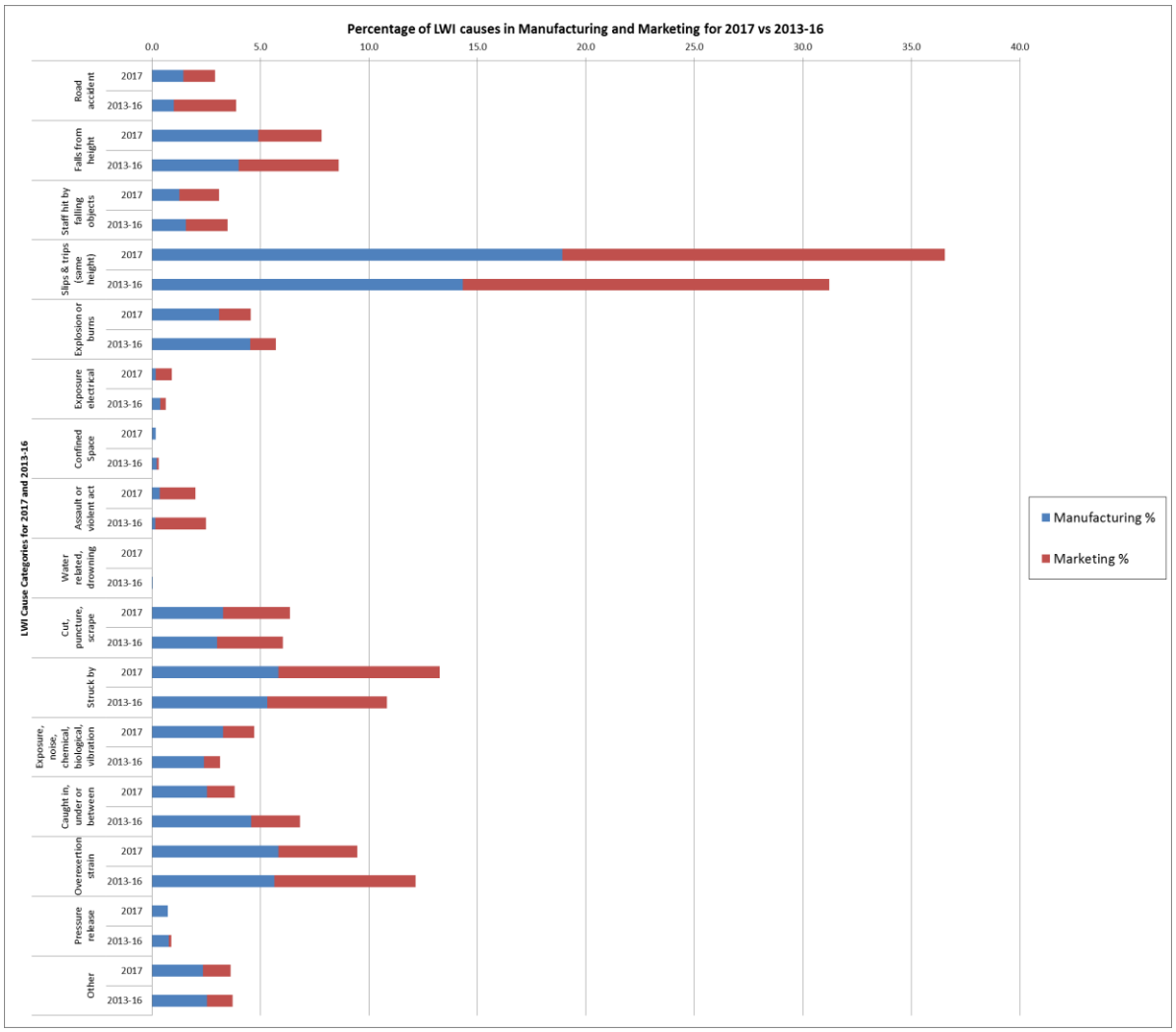
Until 2013, Concawe compiled fatality data against broad causal categories that could change year to year. Expanding this to 16 distinct categories provided for greater transparency of cause and better benchmarking, but risked losing information on longer term trends. However, by revisiting pre-2013 data, a reasonably consistent pattern can be seen.

While road accidents are the largest single cause of fatalities 2008-17 (20%), they have declined as an overall percentage of all fatalities compared to 1998-2007 when they represented 48% of all fatalities. No fatal road accidents have been recorded in 2016 and 2017.

Burn/Electrical causes accounted for 16% of fatalities over 2008-17 and Falls from Height account for 12% of fatalities over the same period. Fire related causes also account for 11% of fatalities in the period 1998 to 2007. Concawe data collected over 2008-17 describes 47% of fatalities as resulting from operations, maintenance and construction.

LWI causal data has only been available since 2013. A summary of the LWI results from 2013 to 2017 is shown in **Table A2-6 (Appendix 2)** and in **Figure 2**.

***Figure 2*:** LWI causes in Manufacturing and Marketing in 2017 compared with period 2013-2016



Since Concawe began collecting LWI data against the 16 causal categories in 2013 a pattern has been emerging in the data. As in fatalities, a limited number of causes contribute to most LWIs. In 2017, 73% of LWIs were caused by the following, Slips & Trips (same height) 37%, Struck by 13%, Overexertion, Strain 9%, Falls from Height 8% and Cut, Puncture, Scrape 6%. This pattern is broadly consistent year to year and similar across both Manufacturing and Marketing.

While there is no direct correlation between causes of LWI and fatalities (Figure 3), the data suggest that focus on reducing LWI in three areas could have the potential to address the causes of the majority of fatal incidents reported in recent years.
These areas are:

- Process Safety to address Explosion, Burns and Pressure Release related incidents
- Operational safety focused on Struck by and Working at Height
- Road Safety

Figure 3 LWI and Fatalities causal data for 2013-2017

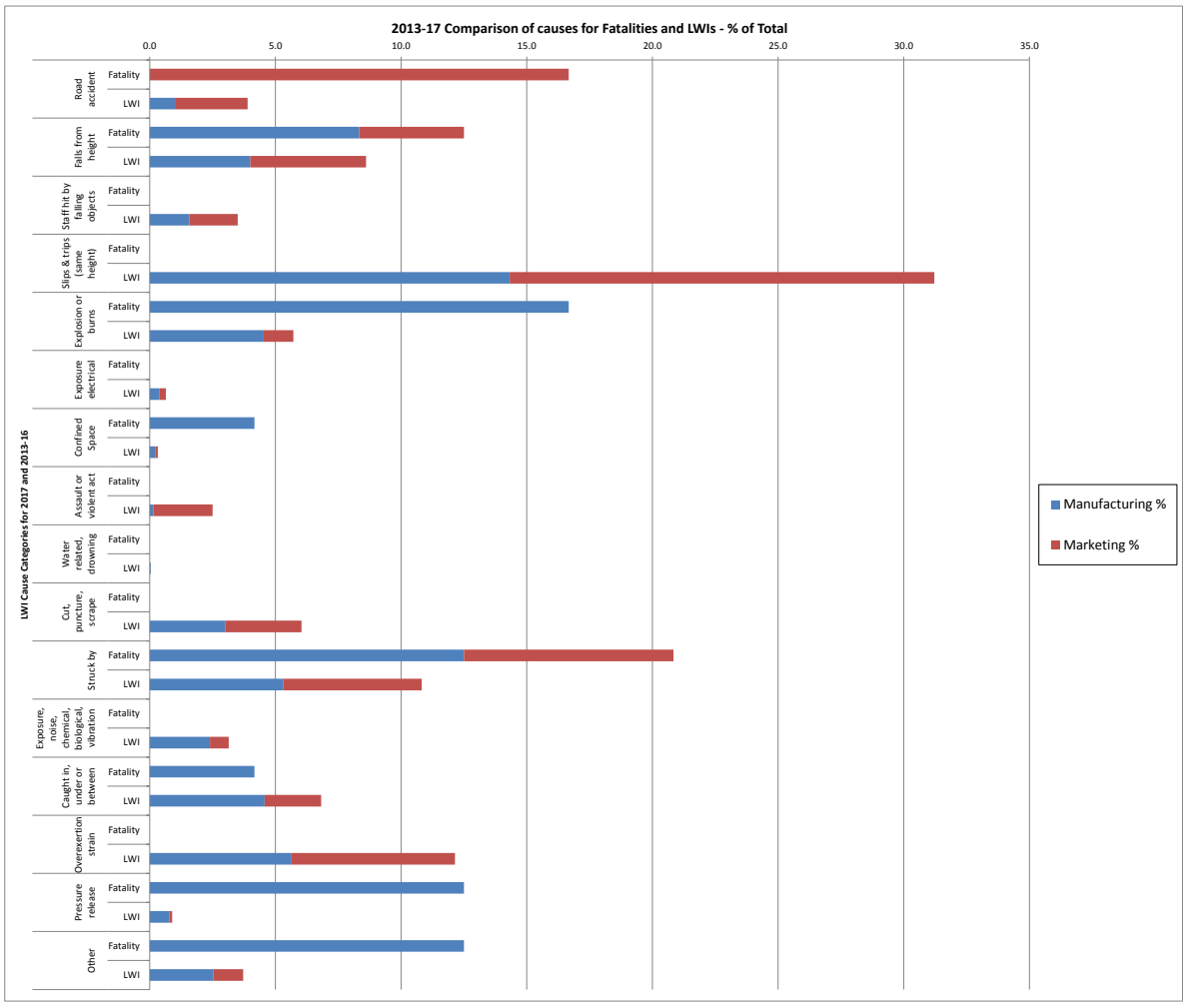
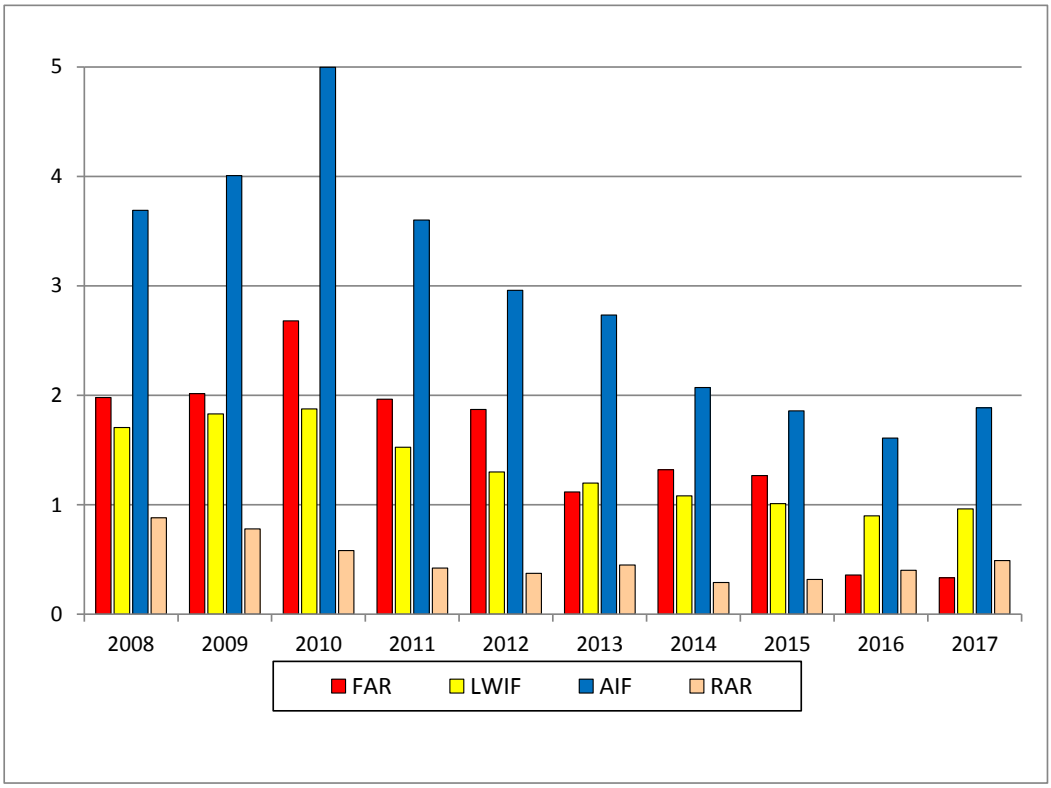


Figure 4 shows the historical evolution of the main performance indicators over the past 10 years. Fatal accident rate FAR is at its lowest at 0.33 in 2017. The Lost Workday Injury Frequency LWIF of 0.96 has plateaued over the last three years, as has the All Incident Frequency AIF. The Road Accident Rate has increased over the last four years despite a drop in kilometres driven by around 27% in the same period (see Table A2-1). It is not clear to what extent this observation is impacted by changes in reporting activities.

Figure 4 Performance indicators 2008-2017 European downstream oil industry



Figures 5a and **5b** show the Fatal Accident Rate FAR for company versus contract staff split for Manufacturing **5a** and Marketing **5b**. While FAR are in general higher in Manufacturing than in the Marketing, both sectors display a high degree of variability over the last 10 years. Own staff have in general a lower FAR than contractors and no recorded fatalities in the last two years in either sector. Further effort is required to sustain this performance level in own staff and to reduce contractor fatalities.

Figure 5a Fatal Accident Rate – Manufacturing 2008-2017

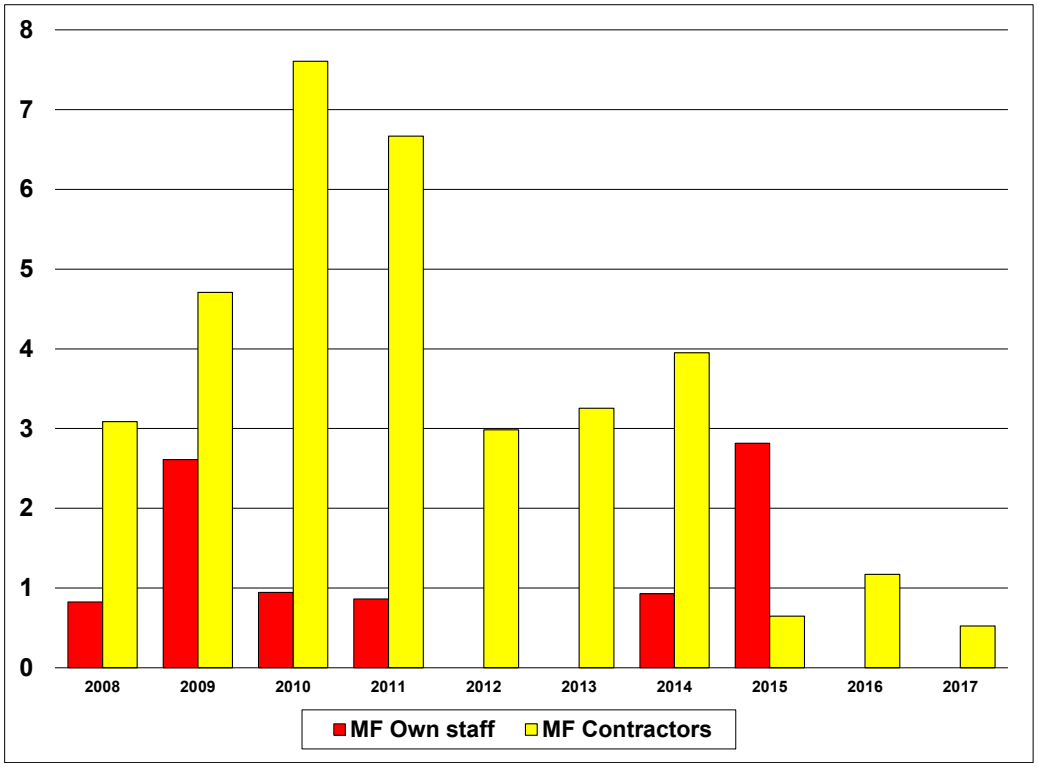


Figure 5b Fatal Accident Rate – Marketing 2008-2017

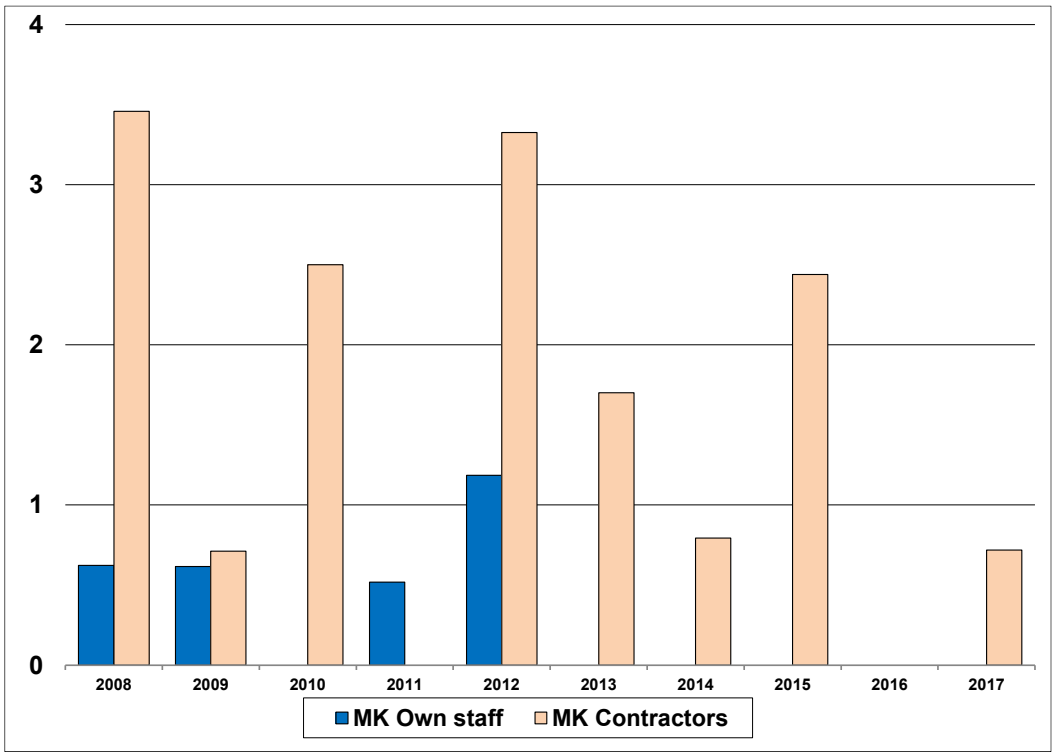
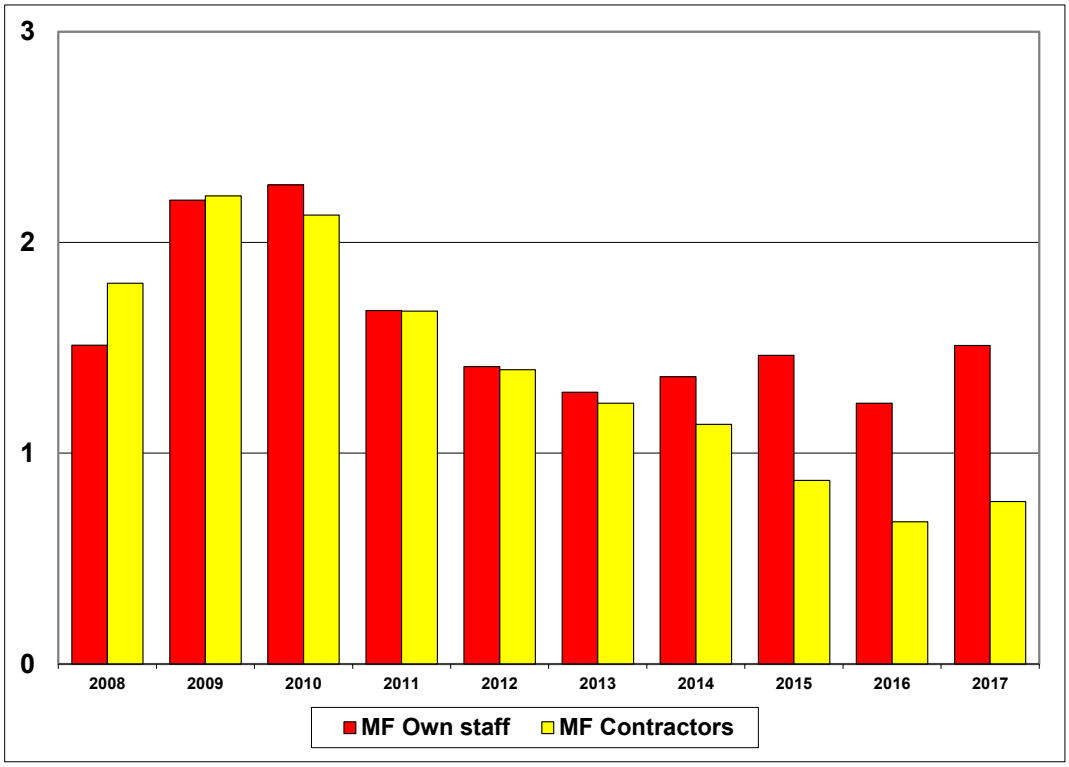


Figure 6a Lost Workday Injury Frequency – Manufacturing 2008-2017

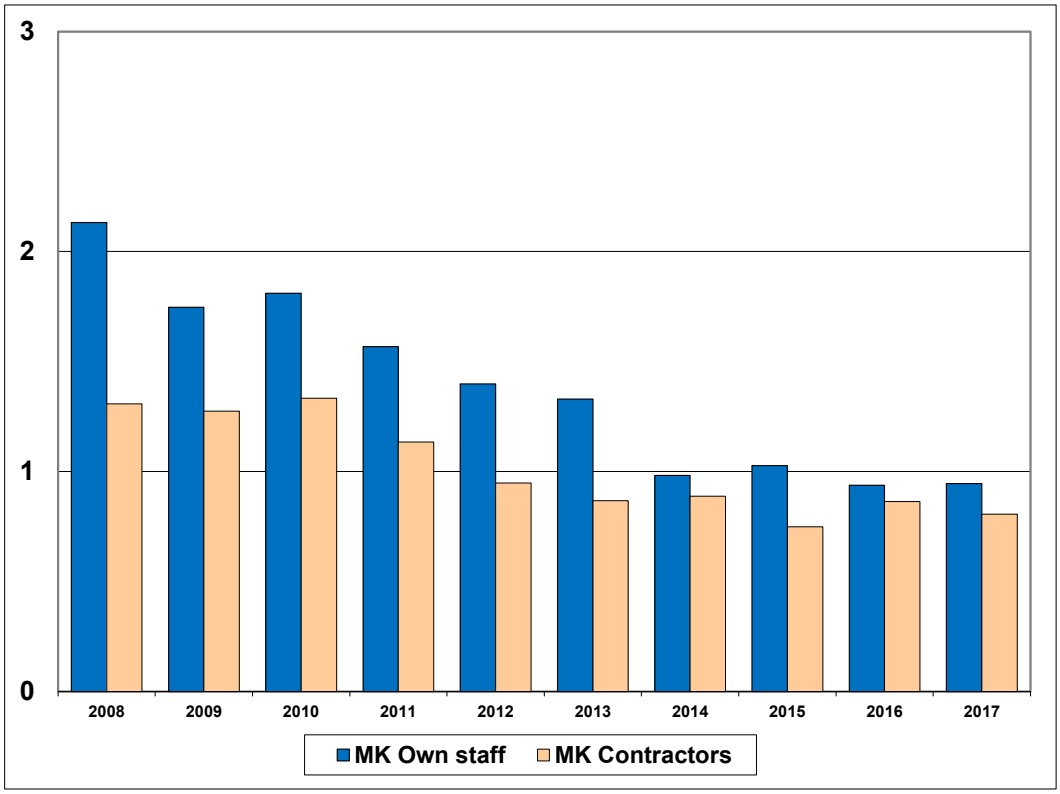


The LWIF of 0.96 LTI/Mh (Manufacturing and Marketing combined) recorded for 2017 is higher than the previous year. This is associated with an increase in LWIF for both own staff and contractors in the Manufacturing sector. Interestingly no improvement is recorded in Manufacturing own staff safety performance based on LWIF in the last six years while improvements have been seen for contractors in the same sector. 2017 however saw a slight increase in LWIF for Manufacturing contractors, the first since 2009.

In Marketing the own staff LWIF were essentially the same as in 2016 while Marketing contractors showed some improvement. The general improvement in safety performance in the Marketing sector based on LWIF over the last ten years has now plateaued.

Refer to Appendix 2 for the details.

Figure 6b Lost Workday Injury Frequency – Marketing 2008-2017



Historical figures (see **Appendix 2**) suggest that AIF peaked around 1996-97 but this was considered at the time likely the result of improved reporting standards. Since then the trend has been slowly downward for both Manufacturing and Marketing. Again, contractor performance is now better than company staff. See **Figures 6a** and **6b**.

Figure 7a All Injury Frequency – Manufacturing 2008-2017

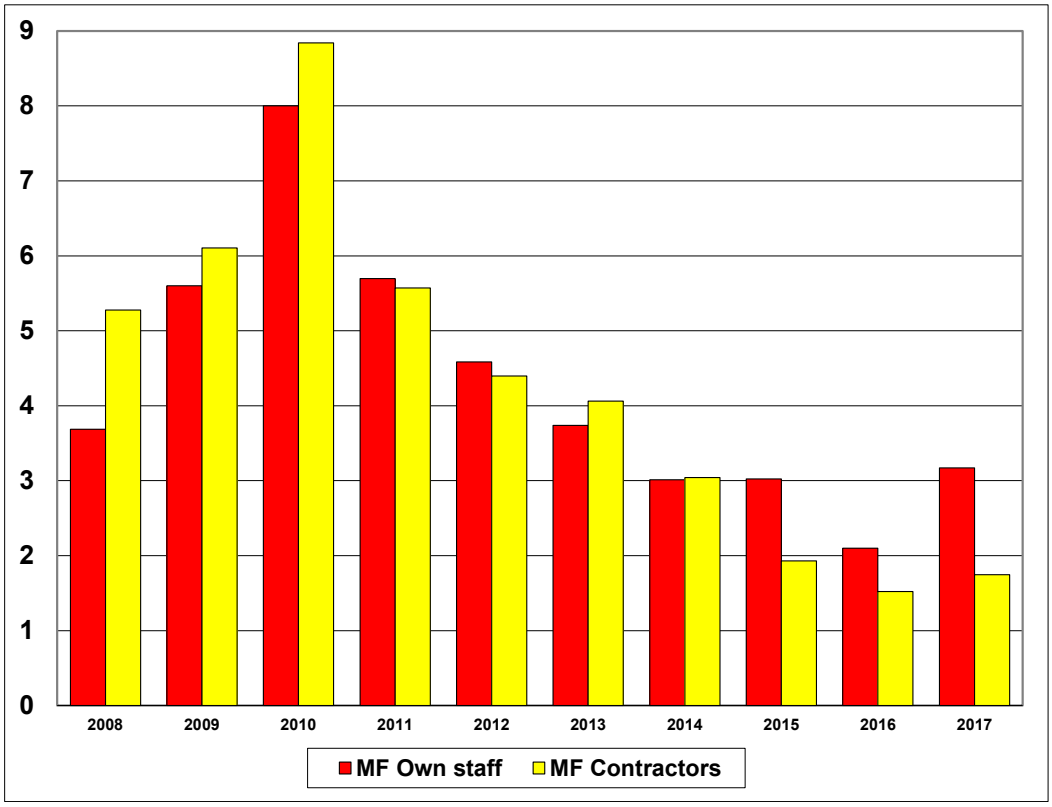
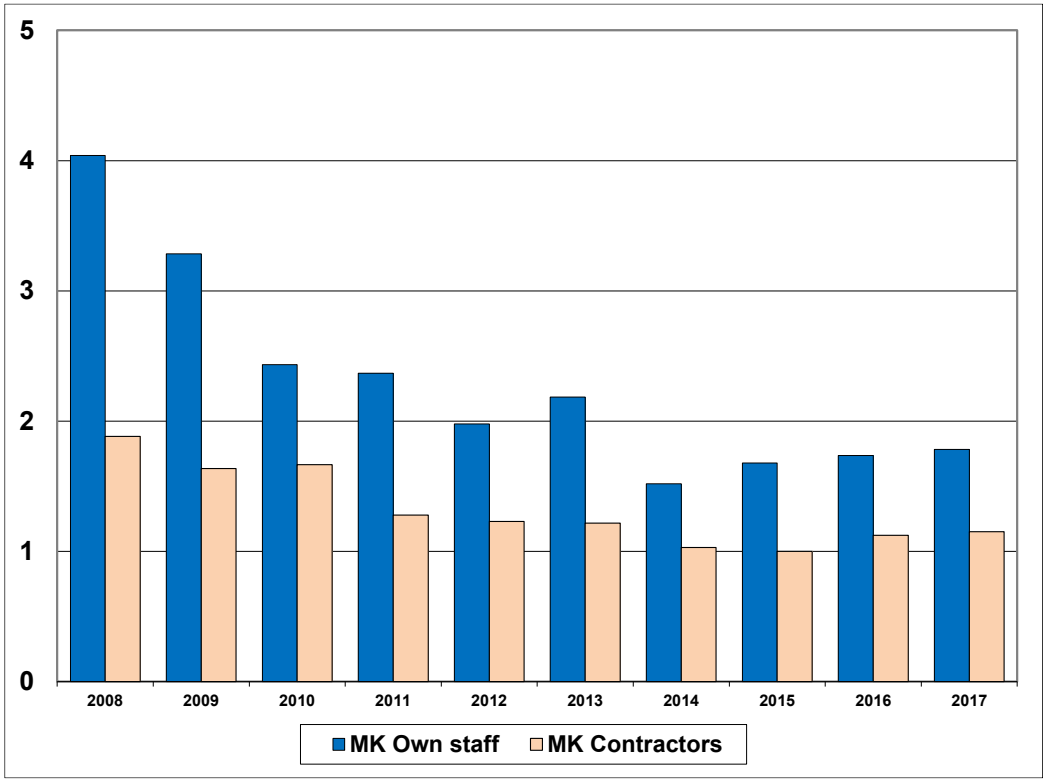
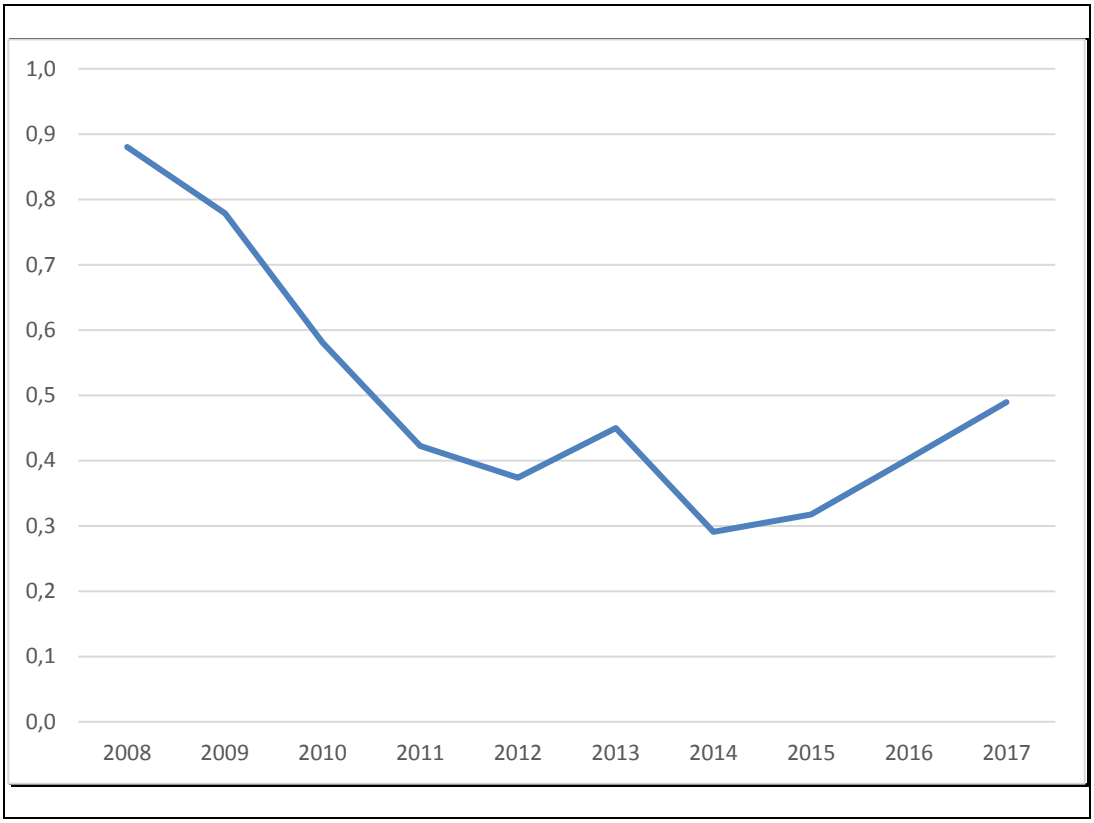


Figure 7b All Injury Frequency – Marketing 2008-2017



While there have been no fatal road accidents recorded in 2016 and 2017, the Road Accident Rate increased from 0.4 in 2016 to 0.5 in 2017. RAR has continued to rise since the lowest recorded rate in 2014 of 0.3. Road safety has been a major focus for the industry and a sustained effort is required in order to improve performance. These accidents mainly occur in the Marketing activity where the bulk of the driving takes place. See **Figure 8**.

Figure 8 Road Accident Rate 2008-2017 - European downstream oil industry



Analysis of the relative performance between the frequency datasets over the past ten years shows a consistent relationship between all reported incidents and both fatalities and Lost Workday Injury. This would suggest action to improve the performance in one or more of the Fatality and Lost Workday Injury areas will have a beneficial impact on the overall safety performance indicators of the European downstream oil industry.

3. PROCESS SAFETY

The American Petroleum Institute (API) has recommended the adoption of Process Safety Performance Indicators (PSPI) in addition to personal safety performance indicators such as those contained in this report. This is intended to better address the potential causes of major process safety incidents, which can have catastrophic effects in the petroleum industry. As from the 2009 Concawe report, the Safety Management Group of Concawe expanded the scope of industry wide safety performance indicators to address process safety, following the reporting guidelines that were developed by the API [24, 25]. The expectation is that expanding the focus to include process safety in conjunction with the personal safety will contribute to a further reduction in serious injury rates in the industry.

The Concawe Membership was requested to report their PSPI as defined by the API in 2008 [23] and as further refined in the ANSI/API recommended practice that was published in 2010 [24]. The PSPI-data that were requested are the number of Tier 1 and 2 Process Safety Events (PSE). The Concawe definitions slightly differ from those in the 2010 ANSI/API guideline to allow for the use of SI-metric units (kg/m/sec) and for the inclusion of the European Classification and Labelling definitions [26] as an alternative for classifying the PSE. In 2017, Concawe moved to reporting against the revised definitions in the 2nd edition of the API Recommended practice 754. [30]

In 2017, 38 companies submitted PSE data for the Manufacturing operations and 18 submitted Marketing PSE data. The method for validating the number of contributing Marketing companies has been upgraded in 2017 resulting in an improvement in the reported number of contributions with an increase of four versus the number in 2016 (see footnote to Table 1).

The aggregated 2017 results per sector and for the whole of the European downstream oil industry are shown in **Table 9**. **Tables 10**, **11** and **12** show the quartile ranges for PSE and PSER. **Figure 15** shows counts of the total PSE for the period 2009 to 2017 for which Concawe has data. **Figure 16** shows the same data expressed as rates for the period 2009 to 2017. The data given are for Manufacturing only, as only that data is sufficiently robust to allow the analysis provided in these presentations.

Table 9 Aggregated 2017 Process Safety results for all reporting companies

Sector	Manufacturing	Marketing	Both Sectors
Companies - Total	39	27	26
- PS reporting	38	18	17
- %	97%	67%	65%
Hours worked - Total Mh	303.2	295.5	598.7
- PS reporting	293.5(278.4)a	217.7(172.1)a	475.6
- %	97%	74%	85%
T-1 PSE	62	8	70
T-2 PSE	187	30	217
T-1 PSER PSI/Mh reported	0.21	0.04	0.14
T-2 PSER PSI/Mh reported	0.67	0.17	0.48
Total PSER PSI/Mh reported	0.85	0.17	0.56

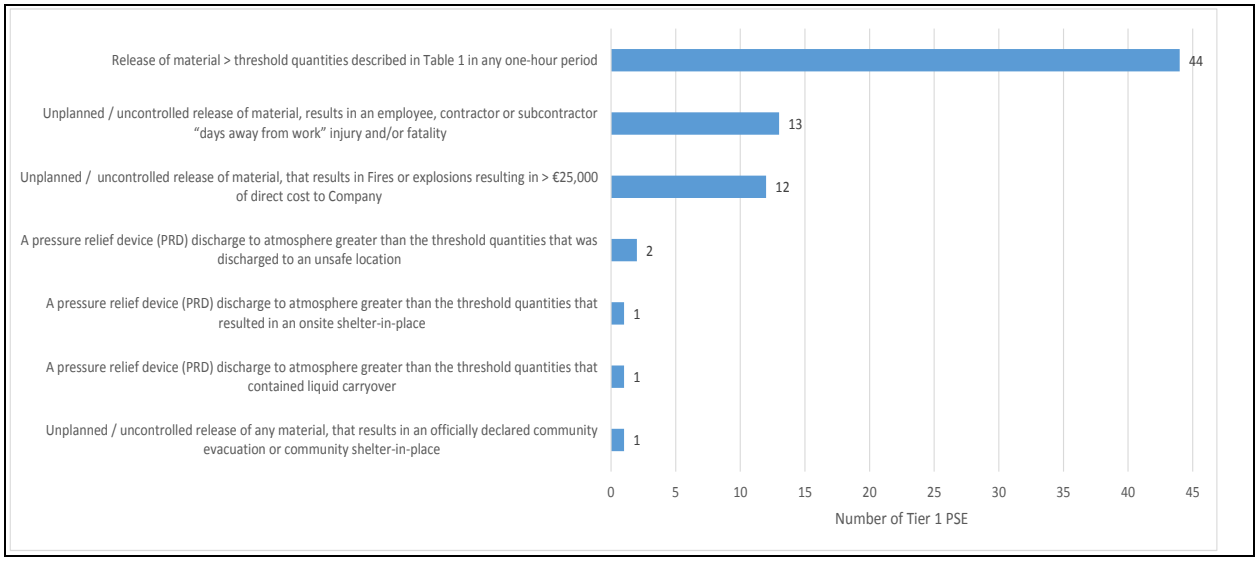
(a) Between brackets the number of hours reported by companies that provided T-2 PSEs is given. This number is applied when calculating the T-2 PSER.

The total number of Tier 1 and Tier 2 process safety events reported at Manufacturing sites where the higher process safety risks currently exist declined from 282 in 2016 to 249 in 2017. The number of companies reporting process safety data increased from 33 in 2016 to 38 in 2017 which suggests a greater focus in this area across the industry.

For the first time in the 2017 data collection process additional information has been gathered regarding the circumstances of Tier 1 Process Safety Events. There were 70 PSE-1 events recorded in 2017 across Manufacturing and Marketing, and the additional information gathered is provided in table form in Appendix 3. The following comments relate to the notable responses within each category:

Type of Tier 1 PSE: The majority of events (60%) relate to the release of material greater than threshold in any 1 hour period while a release of material resulting in LTI or Fatality or damage greater than €25,000 accounts for a further 34% of cases. See Figure 9 below for details.

Figure 9



Type of Process: The most significant process for Process Safety Events in both Refining and Petrochemical areas was tank farm operations (30% in Refining, 36% Petrochemical). See Figure 10a and b below for details.

Figure 10a

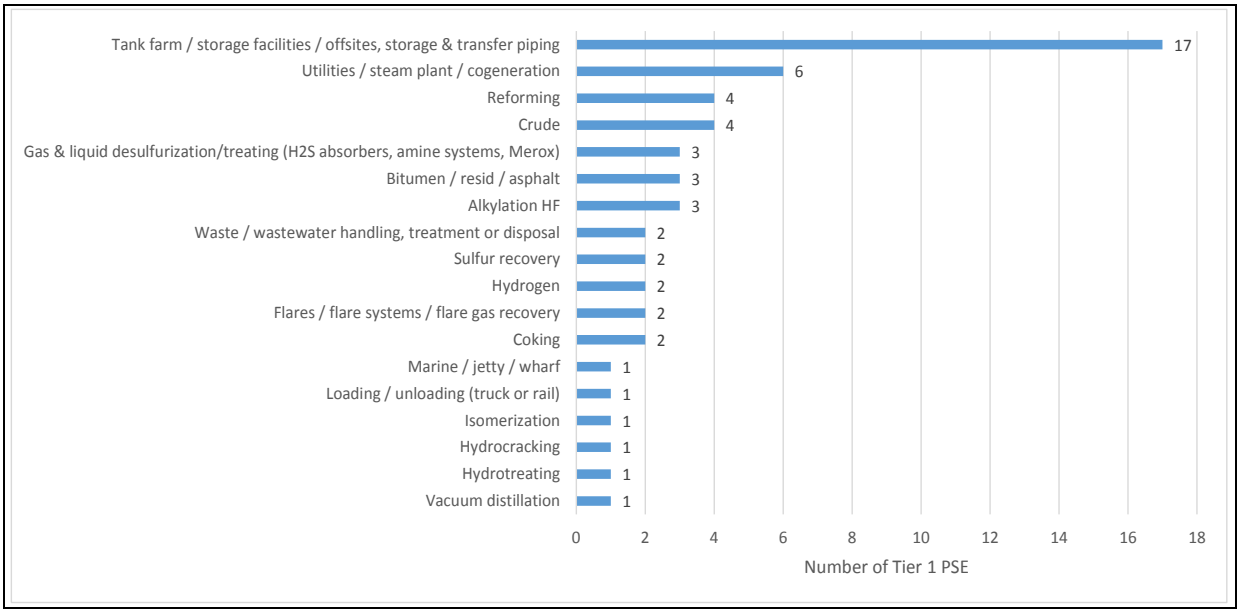
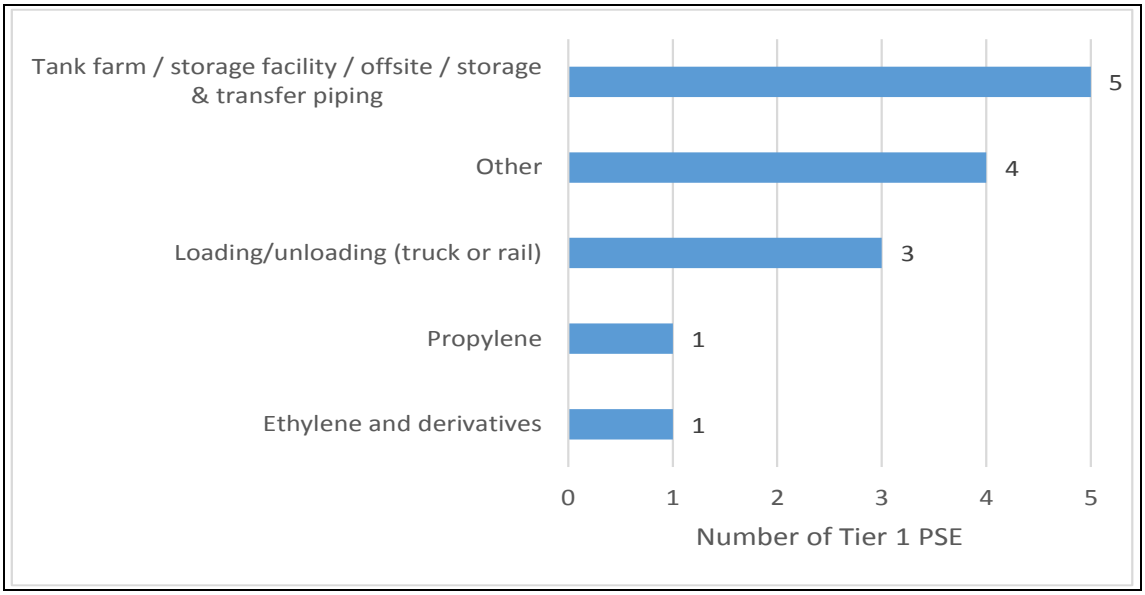
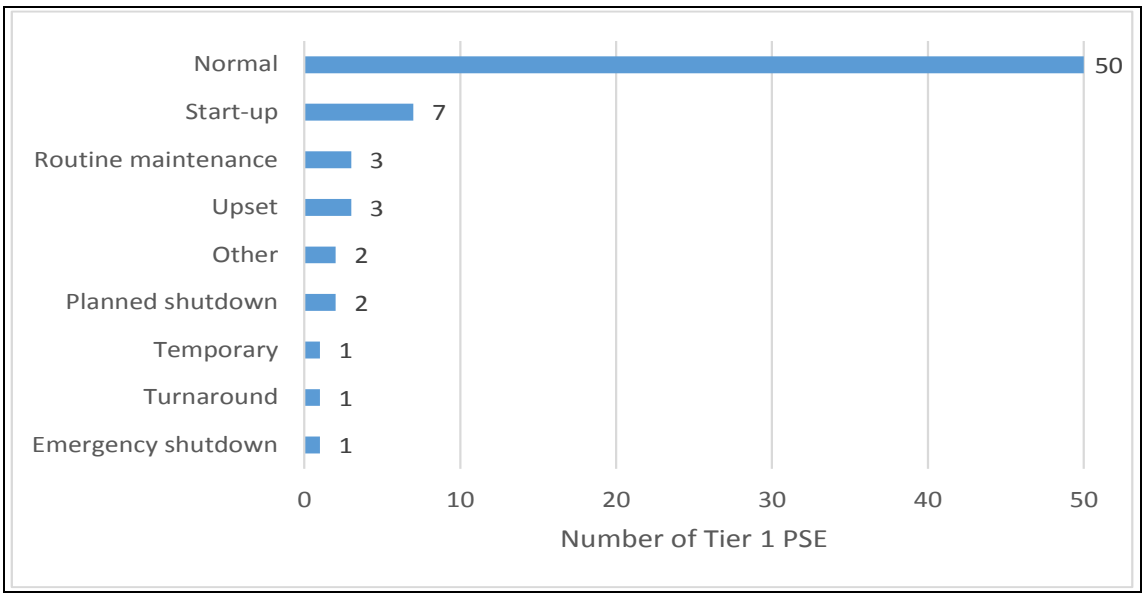


Figure 10b



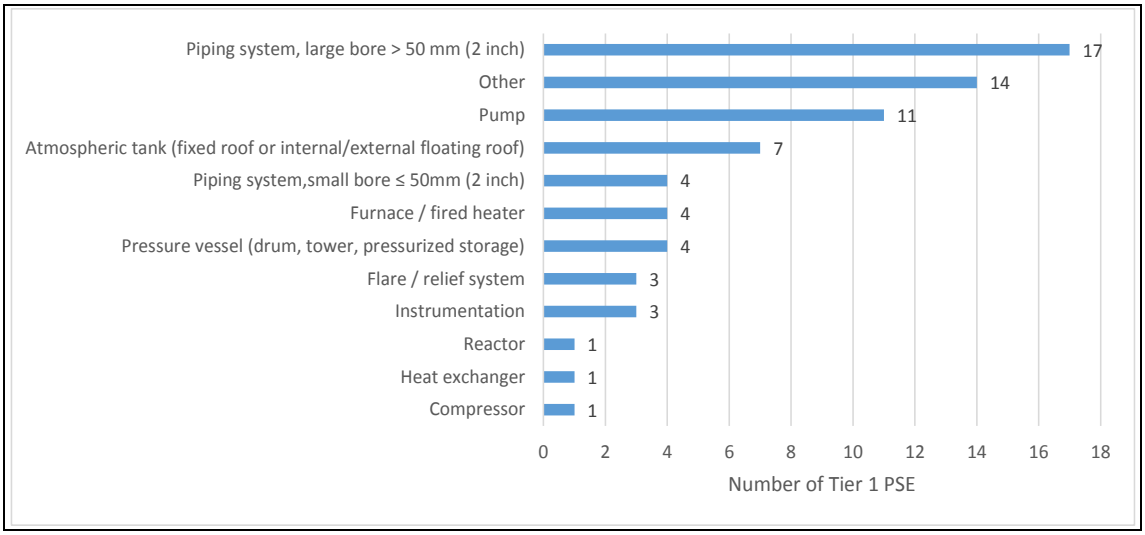
Mode of Operation: The most common response for Process Safety Events was during normal operation (71%). See Figure 11 below for details.

Figure 11



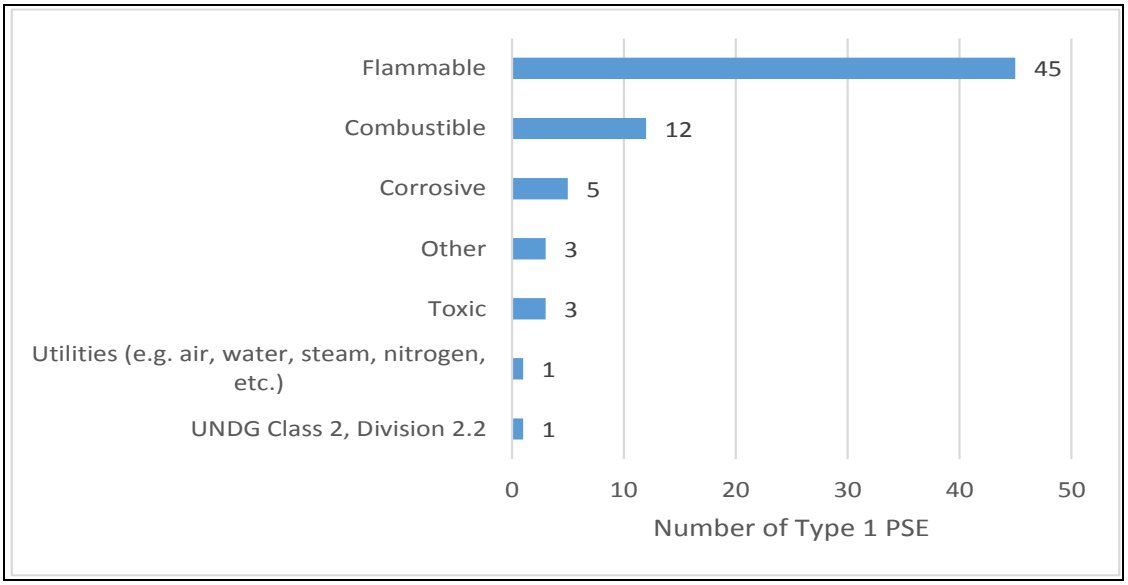
Point of Release: Piping systems (large bore) (24%) and pumps (16%) were the notable points of release for Process Safety Events. See Figure 12 below for details.

Figure 12



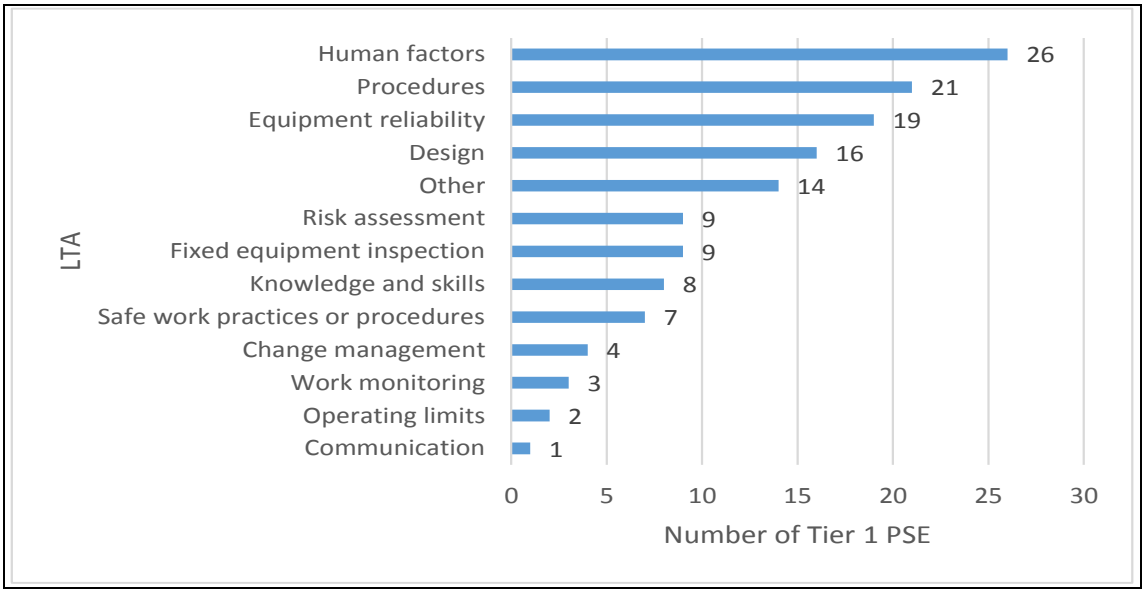
Type of material: The most common material type in Process Safety Events was flammable (64%). See Figure 13 below for details.

Figure 13



Causal Factors: Human Factors (19%), Procedures (15%) and Equipment Reliability (14%) make up 47% of the causal factors for all Tier 1 events. See Figure 14 below for details.

Figure 14



Over time the collection of this information across the industry is expected to result in an evaluation of the main factors contributing to process safety incidents which will facilitate the development of approaches to address incident prevention.

Tier 1 and 2 process safety incidents are investigated in detail within member companies and considerable effort is expended in identifying root causes and responding accordingly. As with Fatalities and Lost Workday Injury cases in personal safety, such events are now relatively infrequent occurrences at each site so establishing trends on a site by site basis and across the industry is a challenge. To overcome this, many members now look to Tier 3 process safety events for their site based improvement activity. The definition of a Tier 3 incident is often asset specific and therefore trending such events across the Industry is not practicable at this time.

Table 10 Total PSE quartile distribution ranges and average values for each quartile range

PSE	Low	High	Average
Q1	0	2	0.8
Q2	2	4	2.8
Q3	4	8	6.2
Q4	11	41	19.2

Table 11 Manufacturing PSE quartile distribution ranges and average values for each quartile range

Manufacturing PSE			
PSE	Low	High	Average
Q1	0	1	0.6
Q2	1	4	2.4
Q3	4	8	5.9
Q4	10	34	17.9

Table 12 Total PSER quartile distribution ranges and average values for each quartile range

Total PSER			
PSER	Low	High	Average
Q1	0.00	0.24	0.11
Q2	0.25	0.70	0.50
Q3	0.70	1.45	0.94
Q4	1.68	11.64	5.68

The 2017 ratio of Tier 1 to Tier 2 process safety events for Concawe was 0.33, down from 0.39 in 2016. The Concawe T1 PSER was 0.21 in 2017, down from 0.30 in 2016. The Concawe T2 PSER was 0.67 in 2017, down from 0.85 in 2016.)

The number of LWIs resulting from the PSEs is not established, as this information is not currently available.

Figure 15 Process Safety Events 2009-2017 - Manufacturing Staff and Contractors

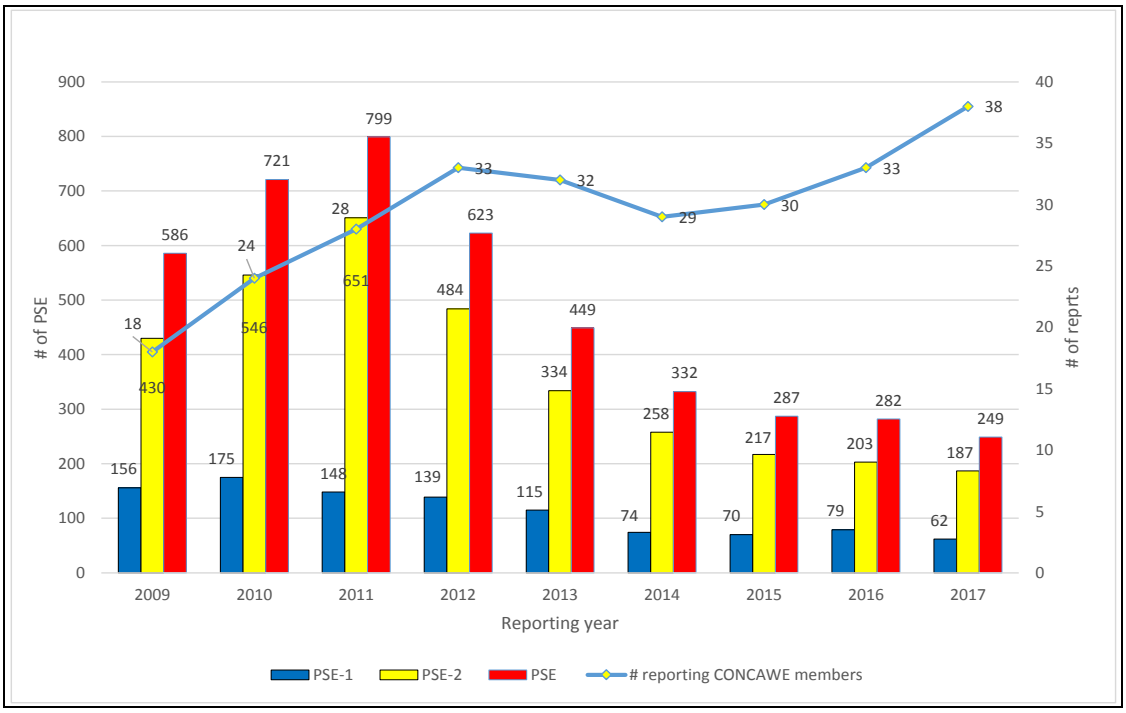
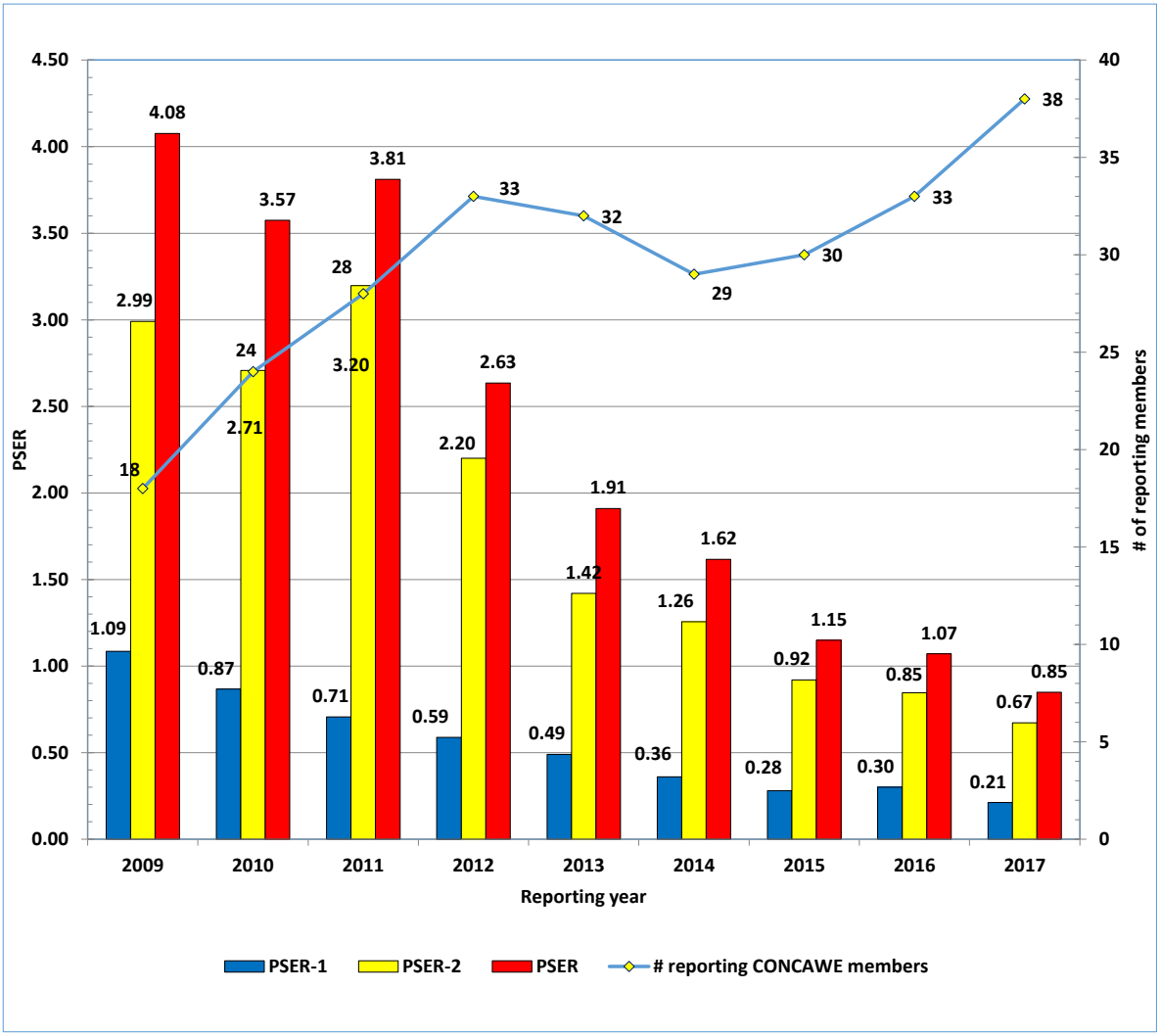


Figure 16 Process Safety Event Rate 2009-2017 - Manufacturing Staff and Contractors



4. COMPARISON WITH OTHER SECTORS

Most of the safety performance indicators used in the oil industry, and particularly LWIF, have also been adopted in many other sectors so that meaningful comparisons are possible, see Table 13. The IOGP statistics concern the upstream oil industry covering oil and gas exploration and production activities [27]. In comparison with IOGP statistics for European onshore, Concawe recorded higher fatalities, LWIF and AIF.

Table 13 Comparison of oil industry safety performance (own staff and contractors)

	Concawe 2017	International Association of Oil & Gas Producers - IOGP 2017			
		Onshore		Onshore and Offshore	
		Europe	World	Europe	World
FAR	0.3	0.0	1.1	0.0	1.1
LWIF	1.0	0.5	0.2	0.8	0.3
AIF	1.9	1.1	0.8	2.1	1.0

The American Petroleum Institute API reports that the US Petroleum Refining sector has experienced the same injury and illness rate from 2016 to 2017, 0.6 incidents (job-related nonfatal injuries and illnesses) per 100 workers [28]. Note that this figure does not refer to lost workdays.

A Lost Time Injury Rate for employees of 6.8 was recorded by the European Chemical Industry Association - Cefic in 2015 [29]. As a measure of number of lost time incidents per million working hours, this value is comparable with the Concawe LWIF, which in 2015 was 1.01.

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APPENDIX 1 EUROPEAN OIL INDUSTRY STATISTICS DEFINITIONS AND GUIDING NOTES

Several safety performance indicators have become "standard" in the oil industry and in many other industry sectors. They are mostly expressed in terms of frequency of the incident with the number of hours worked being the common denominator. This taken to be representative of the overall level of activity. Such parameters have the advantage of relying on a small number of straightforward inputs allowing meaningful statistical analysis even when the data sets are incomplete. The "standard" performance indicators considered in this report are FAR, LWIF, LWIS, RAR, AIF, and PSE(R) [23, 24]. There are subtle differences in the way these parameters are used, collected, and reported by different companies. The features, relevance and reliability of each indicator are therefore discussed below in the guidance section.

Abbreviations and Definitions

1.	AIF (TRCF)	All Injury Frequency (Total Recordable Case Frequency) which is calculated from the sum of fatalities, LWIs, RWIs and MTCs divided by number of hours worked expressed in millions of hours.
2.	COCO	Company owned and operated sites.
3.	CODO	Company owned, Dealer operated sites.
4.	Contractor	A company or an individual engaged to carry out specified work under a contract on company premises (incl. retail stations and office buildings). Off-site contractor activities are considered only for transportation and loading/unloading of hydrocarbons and other products performed on behalf of the company.
5.	Distance travelled	This is the distance, expressed in millions of kilometres, covered by company owned delivery vehicles, contractor delivery vehicles and company cars whether leased or owned. It should also include kilometres travelled in employee's cars when on company business.
6.	DOCO	Dealer owned, Company operated sites.
7.	DODO	Dealer owned and operated sites.
8.	FAR	Fatal Accident rate is calculated from the number of fatalities divided by the number of hours worked expressed in hundred million.
9.	Fatality	This is a death resulting from a work-related injury where the injured person dies within twelve months of the injury.
10.	Hours worked	Hours worked by employees and contractors. Estimates should be used where contractor data is not available.
11.	LOPC	Loss of Primary Containment (LOPC) is an unplanned or uncontrolled release of any material from primary containment, including non-toxic and non-flammable materials (e.g., steam, hot condensate, nitrogen, compressed CO_2, or compressed air).
12.	LWI	Lost Workday Injury is a work-related injury that causes the injured person to be away from work for at least one normal shift because he is unfit to perform any duties.

13. LWIF	Lost Workday Injury Frequency is calculated from the number of LWIs divided by the number of hours worked expressed in millions.
14. LWIS	Lost Workday Injury Severity is the total number of days lost as a result of LWIs divided by the number of LWIs.
15. Marketing	Marketing includes all non-Manufacturing activities including Retail Operation which comprises the selling of products to the public at Company owned and operated sites (COCO), Company owned, Dealer operated sites (CODO), Dealer owned, Company operated sites (DOCO) and Dealer owned and operated sites (DODO) as well as "Head Office" personnel and other Marketing activities. COCO and DOCO retail operations are likely to be operated by staff and/or contractors while CODO are likely to be operated by contractors. DODO retail operations are not usually operated by Company staff or contractors and hence their hours are not usually included.
16. MTC	Medical Treatment Case is a work-related personal injury which requires treatment by a medical professional and does not result in time away from work or restriction in duties. It excludes all cases involving first aid treatments as specified in OSHA 1904.7(b) (5) even if these treatments are performed by a medical professional.
17. RAR	Road Accident Rate is calculated from the number of accidents divided by the kilometres travelled expressed in millions.
18. PSE	A Process Safety Event is an unplanned or uncontrolled LOPC. The severity of the PSE is defined by the consequences of the LOPC.
19. PSER	Process Safety Event Rate (PSER) is calculated as the number of PSE (Tier 1, Tier 2 or Total) divided by the total number of hours worked (including contractor hours) expressed in millions.
20. Road Accidents	Any incident involving any of the vehicles described above that occurs on or off-road resulting in a recordable injury (fatality, LTI, MTI, RWI), asset damage greater than EUR 2.500 or loss of containment greater than a Tier 2 Process Safety incident. It excludes all accidents where the vehicle was legally parked, the journey to or from the driver's home and normal place of work, minor wear and tear, vandalism, or theft. On-site incidents involving cars or trucks should be covered in the site statistics.
21. RWI	Restricted Workday Injury is a work-related injury which causes the injured person to be assigned to other work on a temporary basis or to work his normal job less than full time or to work at his normal job without undertaking all the normal duties.
22. Tier 1 PSE	A Tier 1 Process Safety Event (T-1 PSE) is a loss of primary containment (LOPC) with the greatest consequence. Refer to the definitions in API (2010) ANSI/API Recommended practice 754 for further details. Note Concawe has modified the unit and costs in API RP754 to reflect SI units and € costs. See previous Concawe safety reports [18-22] for further details

23. Tier 2 PSE	A Tier 2 Process Safety Event (T-2 PSE) is a LOPC with lesser consequence. Refer to the definitions in API (2010) ANSI/API Recommended practice 754 for further details. Note Concawe has modified the unit and costs in API RP754 to reflect SI units and € costs. See previous Concawe safety reports [18-22] for further details
24. Total days lost	The number of calendar days lost through LWIs counting from the day after the injury occurred.

Concawe Categorization of causes for Fatalities and LWIs

Previous Category	Current Concawe Incident Category	Description
Road accident	Road accident	Incidents involving motorised vehicles designed for transporting people and goods over land e.g. cars, buses, and trucks. Pedestrians struck by a vehicle are classes as road accidents. Fatal incidents from a mobile crane would only be road accidents if the crane were being moved between locations.
Height/Falls	Falls from height	A person falls from one level to another.
	Staff hit by falling objects	Incidents where injury results from being hit by flying or falling objects.
	Slips & trips (same height)	Slips, trips, and falls caused by falling over or onto something at the same height.
Burn/electrical	Explosion or burns	Burns or other effects of fires, explosions, and extremes of temperature. "Explosion" means a rapid combustion not an overpressure.
	Exposure electrical	Exposure to electrical shock or electrical burns etc.
Confined space entry	Confined Space	Incidents which occur within a confined space. Spaces are considered "confined" because their configurations hinder the activities of employees who must enter, work in, and exit them. Confined spaces include, but are not limited to underground vaults, tanks, storage bins, manholes, pits, silos, process vessels and pipelines.
Construction / Maintenance & Other	Assault or violent act	Intentional attempt, threat, or act of bodily injury by a person or persons or by violent harmful actions of unknown intent, includes intentional acts of damage to property.
	Water related, drowning	Incidents/events in which water played a significant role including drowning.
	Cut, puncture, scrape	Abrasions, scratches, and wounds that penetrate the skin.
	Struck by	Incidents/events where injury results from being hit by moving equipment or machinery, or by moving objects. Also includes vehicle incidents where the vehicle is struck by or struck against another object.
	Exposure, noise, chemical, biological, vibration	Exposure to noise, chemical substances (including asphyxiation due to lack of oxygen not associated with a confined space), hazardous biological material, vibration, or radiation.
	Caught in, under or between	Injury where injured person is crushed or similarly injured between machinery moving parts or other objects, caught between rolling tubulars or objects being moved, crushed between a ship and a dock, or similar incidents. Also includes vehicle incidents involving a rollover.
	Overexertion, strain	Physical overexertion, e.g. muscle strain.

Previous Category	Current Concawe Incident Category	Description
	Pressure release	Failure of or release of gas, liquid or object from a pressurised system.
	Other	Used to specify where an incident cannot be logically classed under any other category.

Guidance

Fatalities and Fatal Accident Rate (FAR)	Because of their very low numbers, fatalities and, therefore, FAR are not necessarily reliable indicators of the safety performance of a Company or Industry. A single accident can produce several fatalities and cause an abnormally high result in the indicator for a certain year. Conversely, the lack of fatalities is certainly no guarantee of a safe operation. The safety pyramid of H.W. Heinrich[2] implies that for every fatality there have been many other incidents with less serious injury outcomes. These less severe incidents provide the opportunities to address equipment, standards, training, attitudes, and practices that may prevent both the less, and the more serious incidents.
Lost Workday Injury Frequency (LWIF) and Lost Workday Injury Severity (LWIS)	The LWIF is the most common indicator in the oil and other industries and has been in use for many years. It is now common practice to include not only a company's own staff but also contractors in the statistics and this is done almost universally in the oil industry. All companies without exception collect employee LWIF data for at least their own staff and this is, therefore, the most frequently used and reliable indicator. Not all companies keep track of the number of lost days and, in some cases, the numbers are skewed by local interpretation. The overall LWIS reported is calculated taking account only of those companies that report the data. It should also be noted that the difference in interpretation of days lost results in a wide variation in the results and hence trends are difficult to identify.
All Injury Frequency (AIF)	As LWIF figures become progressively lower they appear to reach a plateau. Companies that have achieved very low LWIF levels may need a more meaningful indicator to monitor trends and detect improvements or deterioration of performance. AIF would provide such an indicator, since it records fatalities, Restricted Work Injuries (RWI) and Medical Treatment Cases (MTC) in addition to LWIs. Although it is still less widely used than LWIF, reporting improves year by year with more companies including this indicator into their performance reporting. It should also be noted that not all companies operate a restricted work system and also restricted working is not allowed in some countries. As the total number of injuries is not reported by all companies, only the worked hours for which this number is available are taken into account in the calculation of the overall AIF figure.

[2] Industrial Accident Prevention. H.W. Heinrich, 1931.

Road Accident Rate (RAR)

It is no surprise that, since road accidents remain a cause of both fatalities and Lost Workday Injury in the oil industry, a number of companies have chosen to calculate and monitor these separately outside of their impact on the overall statistics. This allows some extra focus on this key area of concern. The separate road accident data is still incomplete and the overall figures should therefore be considered as indicative only. For this reason, Concawe only reports RAR data for the whole downstream industry and all personnel involved (own staff and contractors), since the level of reporting is insufficient for the segmented data to be analysed. It must be noted, however, that the vast majority of road accidents occur in distribution and retail activities where both sales employees and truck drivers travel longer distances.

APPENDIX 2 HISTORICAL DATA 1993 TO 2017

Table A2-1 Performance indicators - All sectors

Year	Fatalities	FAR	AIF	LWIF	LWIS	RAR	Million Hours Reported	Distance Travelled Million km
1993	18	5.04	7.88	4.66	27	3.8	357.0	252
1994	19	5.36	7.42	3.96	25	3.1	354.8	227
1995	13	3.55	11.15	4.64	24	2.6	366.4	627
1996	14	3.33	10.72	4.71	19	2.0	420.6	705
1997	15	3.39	11.40	4.57	23	1.9	442.0	720
1998	12	2.55	9.91	4.48	22	1.5	469.7	369
1999	8	1.78	9.45	4.27	21	0.9	448.5	474
2000	13	2.74	8.78	4.25	25	0.9	475.1	1084
2001	14	2.83	9.53	4.28	24	0.8	495.5	1112
2002	16	3.33	6.92	3.91	23	1.1	480.0	1123
2003	22	4.14	6.34	3.22	30	1.0	531.6	1459
2004	12	2.34	6.28	3.17	33	1.0	513.3	1016
2005	11	1.89	4.47	2.57	35	0.9	581.7	1364
2006	7	1.47	4.62	2.48	30	1.6	477.5	557
2007	15	2.79	4.00	1.88	35	0.9	538.2	1069
2008	11	1.98	3.69	1.71	28	0.9	555.5	1004
2009	11	2.02	4.01	1.83	29	0.8	545.5	1036
2010	14	2.68	5.00	1.87	30	0.6	522.2	1011
2011	11	1.97	3.60	1.53	41	0.4	559.8	1085
2012	10	1.87	2.96	1.30	29	0.4	534.3	1161
2013	6	1.12	2.73	1.20	34	0.5	536.5	1175
2014	7	1.32	2.07	1.08	43	0.3	529.7	1269
2015	7	1.27	1.86	1.01	37	0.3	553.0	1109
2016	2	0.36	1.61	0.90	34	0.4	558.4	831
2017	**2**	**0.33**	**1.89**	**0.96**	**34**	**0.5**	**598.7**	**925**

Table A2-2 Performance indicators – Manufacturing Staff

Year	Fatalities	FAR	AIF	LWIF	LWIS
1993	2	2.67	12.71	3.84	50
1994	3	3.98	10.24	2.93	29
1995	1	1.08	12.23	3.58	29
1996	0	0.00	14.83	3.94	28
1997	2	1.76	15.09	4.78	24
1998	1	0.92	10.76	4.70	20
1999	0	0.00	12.46	4.45	16
2000	0	0.00	13.89	3.14	30
2001	5	5.56	9.91	3.35	27
2002	4	5.44	9.67	2.95	28
2003	2	2.50	8.38	2.90	38
2004	3	3.30	6.63	1.87	51
2005	0	0.00	5.11	1.83	44
2006	0	0.00	5.06	1.98	28
2007	0	0.00	3.93	1.78	33
2008	1	0.83	3.69	1.51	32
2009	3	2.61	5.60	2.20	34
2010	1	0.95	8.00	2.27	28
2011	1	0.86	5.70	1.68	77
2012	0	0.00	4.58	1.41	32
2013	0	0.00	3.74	1.29	33
2014	1	0.93	3.01	1.36	44
2015	3	2.82	3.02	1.46	41
2016	0	0.00	2.10	1.24	34
2017	**0**	**0.00**	**3.17**	**1.51**	**35**

Table A2-3 Performance indicators – Manufacturing Contractors

Year	Fatalities	FAR	AIF	LWIF	LWIS
1993	8	20.68	13.11	5.35	20
1994	1	2.63	12.73	4.57	36
1995	0	0.00	12.57	7.39	24
1996	3	5.03	18.66	8.26	19
1997	1	1.78	28.45	8.84	23
1998	0	0.00	25.08	9.32	24
1999	2	3.53	24.47	8.14	19
2000	2	3.07	20.96	8.00	23
2001	3	4.09	18.13	6.89	24
2002	6	9.89	14.34	6.31	23
2003	6	8.41	12.78	4.55	42
2004	5	6.16	10.23	3.54	30
2005	3	3.36	8.02	3.07	33
2006	2	2.07	6.82	2.88	31
2007	8	7.01	6.20	2.30	25
2008	4	3.09	5.28	1.81	26
2009	6	4.71	6.10	2.22	32
2010	10	7.61	8.84	2.13	32
2011	9	6.67	5.57	1.67	31
2012	4	2.99	4.40	1.40	28
2013	4	3.26	4.06	1.24	34
2014	5	3.95	3.04	1.14	46
2015	1	0.65	1.93	0.87	36
2016	2	1.17	1.52	0.67	42
2017	1	0.52	1.75	0.77	36

Table A2-4 Performance indicators – Marketing Staff

Year	Fatalities	FAR	AIF	LWIF	LWIS
1993	2	1.20	6.07	5.68	23
1994	13	8.07	5.95	5.16	21
1995	1	0.62	12.00	4.93	22
1996	2	1.11	8.64	4.89	18
1997	4	2.40	8.62	4.61	23
1998	3	1.64	7.73	3.41	21
1999	2	1.12	6.50	3.67	23
2000	0	0.00	4.71	3.68	29
2001	3	1.42	6.68	3.63	27
2002	4	2.10	5.66	3.61	22
2003	2	0.98	5.73	3.33	19
2004	0	0.00	6.62	3.90	25
2005	3	1.40	4.17	2.98	36
2006	0	0.00	3.73	2.63	23
2007	2	1.18	3.98	2.12	31
2008	1	0.62	4.04	2.13	27
2009	1	0.62	3.28	1.75	22
2010	0	0.00	2.43	1.81	26
2011	1	0.52	2.37	1.57	32
2012	2	1.19	1.98	1.40	28
2013	0	0.00	2.18	1.33	33
2014	0	0.00	1.52	0.98	42
2015	0	0.00	1.68	1.03	40
2016	0	0.00	1.74	0.94	25
2017	0	0.00	1.78	0.95	36

Table A2-5 Performance indicators – Marketing Contractors

Year	Fatalities	FAR	AIF	LWIF	LWIS
1993	6	7.83	3.66	2.90	21
1994	2	2.49	4.34	2.21	25
1995	11	18.16	7.03	3.09	21
1996	9	11.85	3.54	2.57	11
1997	8	7.60	3.37	2.01	20
1998	8	6.79	5.87	3.50	19
1999	4	3.30	5.60	3.23	18
2000	11	9.66	2.86	4.06	17
2001	3	2.48	8.20	4.52	17
2002	2	1.29	4.41	3.79	20
2003	12	6.82	3.40	2.68	31
2004	4	2.77	3.33	2.79	43
2005	5	2.73	2.61	2.28	28
2006	5	4.58	3.79	2.32	19
2007	5	3.94	2.35	1.39	22
2008	5	3.46	1.88	1.31	20
2009	1	0.71	1.64	1.27	28
2010	3	2.50	1.67	1.33	36
2011	0	0.00	1.28	1.13	21
2012	4	3.33	1.23	0.95	29
2013	2	1.70	1.22	0.87	37
2014	1	0.79	1.03	0.89	38
2015	3	2.44	1.00	0.75	25
2016	0	0.00	1.12	0.86	37
2017	1	0.72	1.15	0.81	28

Table A2-6 Lost Workday Injury causes 2013-2017 – Staff and Contractors in both Manufacturing and Marketing

LWI 2017					2016	2015	2014	2013
Causes	Manufacturing	Marketing	Combined	%	%	%	%	%
Road accident	8	18	26	4.8%	4.1%	4.2%	3.9%	4.4%
Falls from height	27	17	44	8.0%	7.3%	8.6%	8.6%	10.3%
Staff hit by falling objects	7	5	12	2.2%	3.0%	3.1%	4.6%	3.6%
Slips & trips (same height)	104	85	189	34.6%	30.1%	29.5%	27.1%	32.7%
Explosion or burns	17	7	24	4.4%	7.3%	6.0%	6.2%	4.8%
Exposure electrical	1	0	1	0.2%	0.4%	0.7%	0.5%	0.6%
Confined Space	1	0	1	0.2%	0.2%	0.2%	0.2%	0.8%
Assault or violent act	2	15	17	3.1%	3.0%	3.1%	2.8%	1.7%
Water related, drowning	0	0	0	0.0%	0.0%	0.0%	0.0%	0.2%
Cut, puncture, scrape	18	14	32	5.9%	5.7%	4.6%	8.6%	5.0%
Struck by	32	24	56	10.2%	8.3%	11.9%	10.9%	9.6%
Exposure, noise, chemical, biological, vibration	18	7	25	4.6%	3.5%	2.6%	2.5%	2.6%
Caught in, under or between	14	8	22	4.0%	6.1%	9.0%	7.7%	7.3%
Overexertion, strain	32	45	77	14.1%	15.2%	13.9%	10.0%	12.4%
Pressure release	4	1	5	0.9%	1.2%	0.7%	0.9%	0.9%
Other	13	3	16	2.9%	4.5%	1.8%	5.6%	3.1%
Total	298	249	547	100.0%	100.0%	100.0%	100.0%	100.0%

APPENDIX 3 PROCESS SAFETY MEASURES 2017

Table A3-1

Type of Tier 1PSE	
Unplanned or uncontrolled release of any material, that results in an employee, contractor or subcontractor "days away from work" injury and/or fatality	13
Unplanned or uncontrolled release of any material, that results in Hospital admission and/or fatality of a third-party	0
Unplanned or uncontrolled release of any material, that results in an officially declared community evacuation or community shelter-in-place	1
Unplanned or uncontrolled release of any material, that results in Fires or explosions resulting in greater than or equal to €25,000 of direct cost to the Company	12
A pressure relief device (PRD) discharge to atmosphere greater than the threshold quantities that contained liquid carryover	1
A pressure relief device (PRD) discharge to atmosphere greater than the threshold quantities that was discharged to an unsafe location	2
A pressure relief device (PRD) discharge to atmosphere greater than the threshold quantities that resulted in an onsite shelter-in-place	1
A pressure relief device (PRD) discharge to atmosphere greater than the threshold quantities that resulted in public protective measures (e.g., road closure)	0
A release of material greater than the threshold quantities described in Table 1 in any one-hour period.	44
Total	74

Table A3-2

Type of Process	
Refining	
1. active warehouse	
2. alkylation HF	3
3. alkylation, sulfuric	
4. bitumen / resid / asphalt	3
5. calcining	
6. coking	2
7. crude	4
8. vacuum distillation	1
9. fcc	
10. flares / flare systems / flare gas recovery	2
11. gas and liquid desulfurization/treating (H2S absorbers, amine systems, Merox)	3
12. hydrogen	2
13. hydrotreating	1
14. hydrocracking	1
15. isomerization	1
16. loading / unloading (truck or rail)	1
17. marine / jetty / wharf	1
18. pilot plan	
19. reforming	4
20. sulfur recovery	2
21. tank farm / storage facilities / offsites, storage & transfer piping	17
22. utilities / steam plant / cogeneration	6
23. vapor recovery / light ends	
24. waste / wastewater handling, treatment or disposal	2
25. other (describe)	
Total	56

Table A3-3

Type of Process	
Petrochemical & Other Process	
1. active warehouse,	
2. synthesis gas (CO, H2)	
3. LNG	
4. methane	
5. methanol	
6. methyl mercaptan	
7. formaldehyde and derivatives	
8. acetic acid and derivatives	
9. dehydrogenation (propylene, butylenes)	
10. ethane	
11. ethylene and derivatives	1
12. ethanol	
13. ethylene oxide	
14. flares / flare systems / flare gas recovery	
15. glycols (ethylene, propylene)	
16. NGL fractionation	
17. polyethylene	
18. ethylene dichloride and derivatives	
19. ethyl benzene and derivatives	
20. polystyrene	
21. styrene-butadiene	
22. phenol	
23. propane	
24. propylene	1
25. polypropylene	
26. isopropanol	
27. propylene oxide and derivatives	
28. butane	
29. isobutane	
30. isobutene	
31. butadiene	
32. MTBE	
33. ETBE	
34. pentane	
35. hexane	
36. cyclohexane	
37. hexanol	
38. aromatics derivatives (cumene, dis-proportionation, aromatic isomerization, linear alkylbenzene)	
39. benzene	
40. toluene	
41. xylene	
42. paraxylene	
43. amines derivatives	
44. diisocyanates (TDA, MDA, IPDA, etc.)	
45. isocyanates	
46. specialty chemicals	
47. loading/unloading (truck or rail)	**3**
48. pilot plant	
49. tank farm / storage facility / offsite / storage & transfer piping	**5**
50. utilities / steam plant / cogeneration	
51. waste/wastewater handling, treatment or disposal	
52. other (describe)	4
Total	**14**

Table A3-4

Mode of Operation	
1. start-up	7
2. planned shutdown	2
3. emergency shutdown	1
4. normal	**50**
5. upset	3
6. turnaround	1
7. routine maintenance	3
8. temporary	1
9. other (describe)	2
Total	70

Table A3-5

Point of release	
1. pump	**11**
2. compressor	1
3. blower / fan	
4. pressure vessel (drum, tower, pressurized storage)	4
5. filter / coalescer	
6. furnace / fired heater	4
7. fired boiler	
8. heat exchanger	1
9. instrumentation	3
10. cooling tower	
11. piping system,small bore ≤50mm (2 inch)	4
12. piping system, large bore > 50 mm (2 inch)	**17**
13. reactor	1
14. atmospheric tank (fixed roof or internal/external floating roof)	7
15. flare / relief system	3
16. other (describe)	14
Total	70

Table A3-6

Type of material	
1. flammable	45
2. combustible	12
3. toxic	3
4. corrosive	5
5. UNDG Class 2, Division 2.2	1
6. utilities (e.g. air, water, steam, nitrogen, etc.)	1
7. other (describe)	3
Total	70

Table A3-7

Causal Factors	
1) change management LTA	4
2) communication LTA	1
3) design LTA	16
4) equipment reliability LTA	19
5) fixed equipment inspection LTA	9
6) human factors LTA	26
7) knowledge and skills LTA	8
8) operating limits LTA	2
9) procedures LTA	21
10) risk assessment LTA	9
11) safe work practices or procedures LTA	7
12) work monitoring LTA	3
13) other (describe)	14
Total	139

APPENDIX 4 CONCAWE MEMBER COMPANIES THAT SUBMITTED DATA

The following member companies provided the data upon which this report is based.

ALMA Petroli s.a.	Gruppo API	ATCP	BP
CEPSA	ENI	ESSAR	ExxonMobil
GALP Energia	Gunvor	H&R	Hellenic Petroleum
IPLOM	Irving	Rompetrol	Q8
Gruppa Lotos	LUKOIL	MOL Group	Motor Oil (Hellas)
Neste	Nynas	OMV	Petroineos
P66	PKN Orlen	Preem	Raffinerie Heide
Repsol	Sara	Saras	Shell
St1	Statoil	Tamoil	Total
Total ERG	Valero	VaroEnergy	VPR Energy

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ISBN 978-2-87567-091-5