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European downstream oil industry safety performance

Statistical summary of reported incidents - 2021

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ABSTRACT

The 2021 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 forty-three Concawe Member Companies and Joint Ventures comprised of member companies, together representing more than 98% of the European refining capacity. Total work hours reported (556 million) were around 2% higher in 2021 than in 2020. In 2021, there were six fatalities reported by the industry, three Manufacturing staff, two Manufacturing contractors and one Marketing contractor. The number of Lost Workday Injuries recorded in 2021 (513) is around 8% higher than those in 2020 (476). The combined number of Tier 1 and 2 process safety events across Manufacturing and Marketing in 2021 increased by almost 25% since 2020 (246 releases in 2021, compared with 197 in 2020). Both Tier 1 and Tier 2 Manufacturing process safety events increased by more than 20% since 2020. Marketing Tier 1 events declined but Tier 2 events increased by 45%.

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

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EXECUTIVE SUMMARY

For 2021, information was received from 43 Concawe Member Companies and Joint Ventures (comprised of member companies), together accounting for greater than 98% of the available refining capacity in the EU-27, UK, Norway and Switzerland. The purpose of collecting this data is 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. Data also serve 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 2021 results for Manufacturing, Marketing and the combined downstream oil industry are shown in the table below.

All reporting companies									
Sector	**Manufacturing**			**Marketing**			**Both Sectors**		
Workforce	**OS**	**CT**	**AW**	**OS**	**CT**	**AW**	**OS**	**CT**	**AW**
Hours worked Mh	110	141	250	145	162	306	254	302	556
Fatalities	3	2	5	0	1	1	3	3	6
FAR - FA/100Mh	2.7	1.4	2.0	0.0	0.6	0.3	1.2	1.0	1.1
LWI	158	154	312	89	112	201	247	266	513
Lost time through LWI - Days	5,828	4,668	10,496	3,475	2,200	5,675	9,303	6,868	16,171
LWIF - LWI/Mh	1.44	1.12	1.26	0.61	0.69	0.66	0.97	0.89	0.93
LWIS - Lost days/LWI	38.6	38.0	38.3	41.4	23.9	32.2	39.6	31.9	35.9
AI	304	291	595	134	143	277	438	434	872
AIF - AI/Mh	2.77	2.07	2.38	0.93	0.89	0.90	1.72	1.44	1.57
Distance travelled - million km							176	417	593
RA							89	132	221
RAR							0.5	0.3	0.3
T-1PSE			75			2			77
T-2PSE			153			16			169
T-1 PSER PSI/Mh reported			0.3			0.01			0.15
T-2 PSER PSI/Mh reported			0.61			0.06			0.33
Total PSER PSI/Mh reported			0.91			0.07			0.48

OS: Own staff; CT: Contractors; AW: All workers

* LWIS is calculated for those LWI where lost days are reported

+ RAR is calculated for those RA where distance is reported

There were six fatalities reported for 2021, three Manufacturing staff, two Manufacturing contractors and one Marketing contractor. The three Manufacturing staff fatalities were as a result of a refinery unit explosion with burning hydrocarbon, one Manufacturing contractor died as a result of a fatal injury during a manual lifting activity, one further Manufacturing contractor died ten days after receiving severe burns following renovation works inside the column of a shut-down installation using a specialized vacuum vehicle and a contractor tank truck driver died in a road accident. In comparison with 2019 and 2020 (three and two fatalities, respectively), 2021 represents an unwelcome increase in the number of recorded fatalities.

In addition to fatalities Lost Workday Injuries (LWI) are also studied to identify further opportunities for continuous safety performance improvement. A total of 513 LWI were reported in 2021 (476 in the previous year) with a 2021 LWIF of 0.93, compared with 0.88 in 2020. As in previous years, a relatively small number of categories contribute to most LWI reported. In order of frequency (highest first) Slips & trips (same height), Struck by,

Overexertion and strain and Cut, puncture and scrape together account for over 56% of all LWI reported in 2021 across Manufacturing and Marketing.

For 2021, 42 companies submitted Process Safety Event (PSE) data for the Manufacturing operations and 20 submitted Marketing PSE data. The combined number of Tier 1 and 2 process safety events across Manufacturing and Marketing in 2021 increased by almost 25% since 2020 (246 releases in 2021, compared with 197 in 2020). Both Tier 1 and Tier 2 Manufacturing process safety events increased by more than 20% since 2020. Marketing Tier 1 events declined but Tier 2 events increased by 45%. 17 out of 513 LWI (3%) in 2021 were related to Tier 1 process safety events, this is an increase from one percent in 2019 and 2020. This underlines the importance of high technical standards and strict procedures in process safety.

2021 was the second year impacted by the Coronavirus pandemic, necessitating adjustments in activities in both Manufacturing and Marketing segments. There was no significant change in personal safety performance. For process safety, there was an increase in the number and frequency of events compared to 2020 but it is too early to conclude a direct correlation with the pandemic. The development of process safety performance will continue to be monitored.

1. INTRODUCTION TO 2021 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-eighth report on this topic (see references of past reports in the reference list [1-27]). This report covers data collected for 2021 as well as a full historical perspective from 1993. It also includes comparative figures from other industry sectors where available. For 2021, information was received from all forty-one Concawe Member Companies and two Joint Ventures comprised of member companies when the data is not submitted by the Member Company partners. These forty-three submissions in 2021 represent more than 98% 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. In the last ten years, the average representation was around 97% of the European Refining capacity.

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 into 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 safety 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 2021 PSE data represents 42 out of 43 of the Manufacturing companies and 98% of European refining capacity.

In 2013, the Concawe membership agreed to adopt sixteen incident categories to describe both fatalities and Lost Workday Injury (LWI) in an attempt to learn more from the actual incidents. These 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 fatalities and LWI are further explained in **Appendix 1**.

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 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.

As from 2018, additional information was gathered regarding the causal factors of Lost Workday Injuries. This information is 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 Lost Workday Injuries from which approaches to address incident prevention can be developed.

In 2019, the possibility to link reported Tier 1 Process Safety Events with Lost Workday Injuries was provided with the intention to build an understanding of the types of Process Safety Events and their causal factors that lead to direct injury.

In 2020, the opportunity to record the number of RWIs and/or MTCs linked to each Tier 2 Event was provided.

In 2021, for the first time, it was possible to record for each LWI and fatality, the type of permit to work (PTW)issued at the time of the incident and for each LWI, the number of days absent from work. This information may help member companies build a strong management system in conjunction with their PTW procedure.

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 2021

No of Companies	Manufacturing			Marketing		
	Own Staff	Contractors	All Workers	Own Staff	Contractors	All Workers
Submission	43	43		26	23	
Including						
Lost Days	39	36		23	17	
All Injuries	35	38		13	17	
Road Accidents[a]	35	31		18	14	
Distance Travelled	24	22		14	11	
Process Safety			42			20
Retail Operations						
No Retail						12
COCO						8
CODO						9
DOCO						4
DODO						6

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.

2. 2021 PERSONAL SAFETY PERFORMANCE RESULTS

The aggregated 2021 results for Manufacturing, Marketing and the combined downstream industry are shown in **Table 2.**

Table 2 Aggregated 2021 results for all reporting companies

All reporting companies									
Sector	Manufacturing			Marketing			Both Sectors		
Workforce	OS	CT	AW	OS	CT	AW	OS	CT	AW
Hours worked Mh	110	141	250	145	162	306	254	302	556
Fatalities	3	2	5	0	1	1	3	3	6
FAR - FA/100Mh	2.7	1.4	2.0	0.0	0.6	0.3	1.2	1.0	1.1
LWI	158	154	312	89	112	201	247	266	513
Lost time through LWI - Days	5,828	4,668	10,496	3,475	2,200	5,675	9,303	6,868	16,171
LWIF - LWI/Mh	1.44	1.12	1.26	0.61	0.69	0.66	0.97	0.89	0.93
LWIS* - Lost days/LWI	38.6	38.0	38.3	41.4	23.9	32.2	39.6	31.9	35.9
AI	304	291	595	134	143	277	438	434	872
AIF - AI/Mh	2.77	2.07	2.38	0.93	0.89	0.90	1.72	1.44	1.57
Distance travelled - million km							176	417	593
RA							89	132	221
RAR⁺							0.5	0.3	0.3

OS: Own staff; CT: Contractors; AW: All workers
* LWIS is calculated for those LWI where number of lost days are reported
⁺ RAR is calculated for those RA where distance is reported

2.1. 2021 FATALITIES

There were six fatalities reported for 2021, three Manufacturing staff, two Manufacturing contractors and one Marketing contractor.

- The three Manufacturing staff fatalities were as a result of a refinery unit explosion with burning hydrocarbon. The work activity of the staff at the time of the event was not related to any permit to work
- A Manufacturing contractor was fatally injured during a manual lifting activity with improper use of equipment. The injured person was observing the lift from above and was caught between a rope and a steel structure when the overhead pulley failed. The work activity of the contractor at the time of the event was related to standard work permit (without individual risk assessment)
- A Manufacturing contractor died ten days after receiving severe burns following renovation works under work permit inside the column of a shut-down installation using a specialized vacuum vehicle
- A Marketing contractor tank truck driver under a standard work permit died in a road accident.

This represents a significant increase in the annual number of reported fatalities since 2019 and 2020, when 3 and 2 fatalities were reported respectively. The 2020 data indicate that continued efforts are essential to achieve the target of zero fatalities in our industry.

2.2. 2021 LOST WORKDAY INJURIES

In 2021, there were a total of 513 Lost Workday Injuries, with 61% of these in Manufacturing and 39% in Marketing. Manufacturing LWI were fairly evenly split between own staff and contractors (158 and 154 LWI, respectively), while contractors had 56% of all Marketing LWI.

There was an increase in Lost Workday Injury Frequency (LWIF) compared with 2020. The LWIF went from 0.88 LWI/Mh in 2020 to 0.93 LWI/Mh in 2021 across all workers. Thirty-six companies reported LWI in both 2020 and 2021. Of these, 15 companies (42%) reported a lower overall LWIF in 2021 than in 2020, 2 companies had the same LWIF in 2020 and 2021 (5%) and 19 companies (53%) had a higher LWIF in 2021.

As in 2020, Manufacturing staff in 2021 is the sector with the highest LWIF (1.44 in 2021 and 1.37 in 2020). Marketing staff have the lowest recorded LWIF of all sectors in 2021 at 0.61.

For comparison purposes, the LTIF (frequency of LWI + 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 2021

	LWIF	LTIF
All Workers	0.93	0.94
Manufacturing Staff	1.44	1.47
Manufacturing Contractors	1.12	1.13
Marketing Staff	0.61	0.61
Marketing Contractors	0.69	0.70

The small differences between the two reported measures is related to the relatively small number of fatalities (6) compared with the number of LWI (513).

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 indicates a relatively small number of categories contribute to most LWI reported. In order of frequency (highest first):

- Slips & trips (same height)
- Struck by
- Overexertion and strain
- Cut, puncture and scrape

together account for over 56% of all LWI reported in 2021 across Manufacturing and Marketing

- Other frequently reported incident categories in Manufacturing include:
  - Falls from height (10% of all Manufacturing LWI)
  - Explosion or burns (9%)
  - Exposure, noise, chemical, biological, vibration (7%)
- The Marketing sector LWI differed from Manufacturing sector in a higher incidence of reported Cut, puncture and scrape LWI (13% of Marketing LWI, compared with 7% of Manufacturing LWI) and a lower incidence of Falls from height (4% of Marketing LWI, compared with 10% of Manufacturing LWI) and Explosion or burns (2% of Marketing LWI, compared with 9% of Manufacturing LWI)
- Manufacturing own staff reported more Explosion or burn type LWI than contractors, while Struck by and Falls from height were more prevalent LWI in Manufacturing contractors.
- In Marketing, Overexertion, strain was reported more for own staff than for contractors, while Struck by LWI were reported more for Marketing contractors
- Concentrating on the most frequent categories of these incidents offers the opportunity to address prevention of Lost Workday Injury across both sectors.

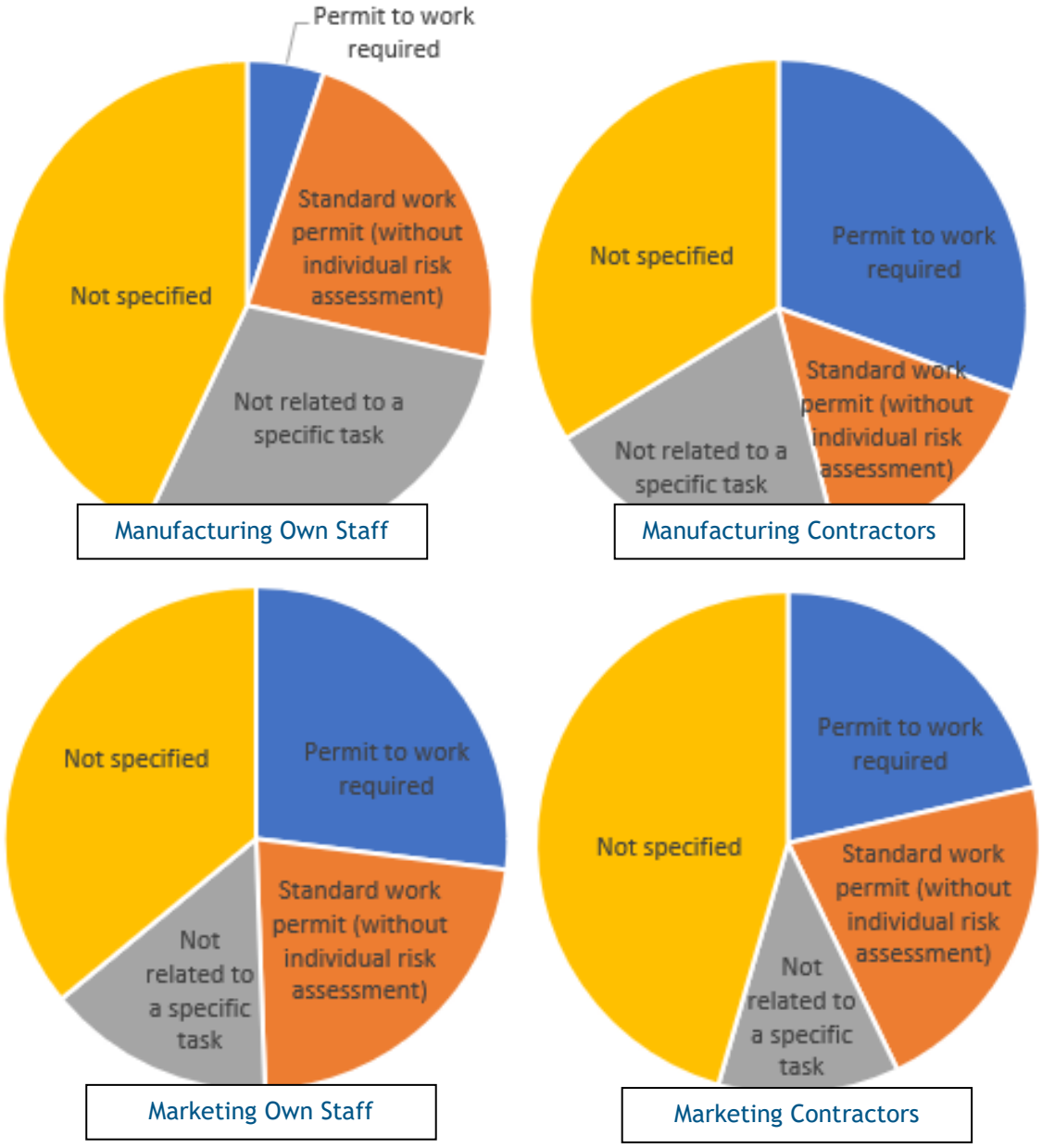
Table 4 Categories of LWI in 2021

Previous Category	Category	MF & MK Combined		Manufacturing (MF)						Marketing (MK)					
		ALL	%	OS	%	CT	%	ALL	%	OS	%	CT	%	ALL	%
Road Accident	Road accident	16	3.1	1	0.6	3	1.9	4	1.3	2	2.2	10	8.9	12	6.0
Heights/Falls	Falls from height	40	7.8	13	8.2	19	12.3	32	10.3	1	1.1	7	6.3	8	4.0
	Staff hit by falling objects	11	2.1	3	1.9	3	1.9	6	1.9	4	4.5	1	0.9	5	2.5
	Slips & trips (same height)	138	26.9	49	31.0	30	19.5	79	25.3	33	37.1	26	23.2	59	29.4
Burn/Electrical	Explosion or burns	31	6.0	18	11.4	9	5.8	27	8.7	2	2.2	2	1.8	4	2.0
	Exposure electrical	5	1.0	2	1.3	0	0.0	2	0.6	1	1.1	2	1.8	3	1.5
Confined space	Confined space	4	0.8	1	0.6	2	1.3	3	1.0	0	0.0	1	0.9	1	0.5
Other causes	Assault or violent act	8	1.6	0	0.0	0	0.0	0	0.0	4	4.5	4	3.6	8	4.0
	Water related, drowning	1	0.2	1	0.6	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0
	Cut, puncture, scrape	48	9.4	9	5.7	13	8.4	22	7.1	9	10.1	17	15.2	26	12.9
	Struck by	54	10.5	11	7.0	22	14.3	33	10.6	7	7.9	14	12.5	21	10.4
	Exposure, noise, chemical, biological, vibration	25	4.9	7	4.4	14	9.1	21	6.7	1	1.1	3	2.7	4	2.0
	Caught in, under or between	40	7.8	8	5.1	14	9.1	22	7.1	6	6.7	12	10.7	18	9.0
	Overexertion, strain	49	9.6	16	10.1	18	11.7	34	10.9	10	11.2	5	4.5	15	7.5
	Pressure release	6	1.2	4	2.5	1	0.6	5	1.6	0	0.0	1	0.9	1	0.5
	Other	37	7.2	15	9.5	6	3.9	21	6.7	9	10.1	7	6.3	16	8.0
	Total	**513**	**100**	**158**	**100**	**154**	**100**	**312**	**100**	**89**	**100**	**112**	**100**	**201**	**100**

OS Own staff; CT Contractors

For the first time in 2021, Concawe collected information about the type of permit to work in place at the time of the event leading to fatality or LWI. The assignment of type of permit to work (Permit to work required, e.g. for confined space or hot work; Standard work permit (without individual risk assessment), e.g. for sampling and driving; work not related to a specific task, e.g. cycling or walking) for each of the sectors is set out in **Figure 1A**, below.

Figure 1A *Type of Permit to work for LWI recorded by sector*

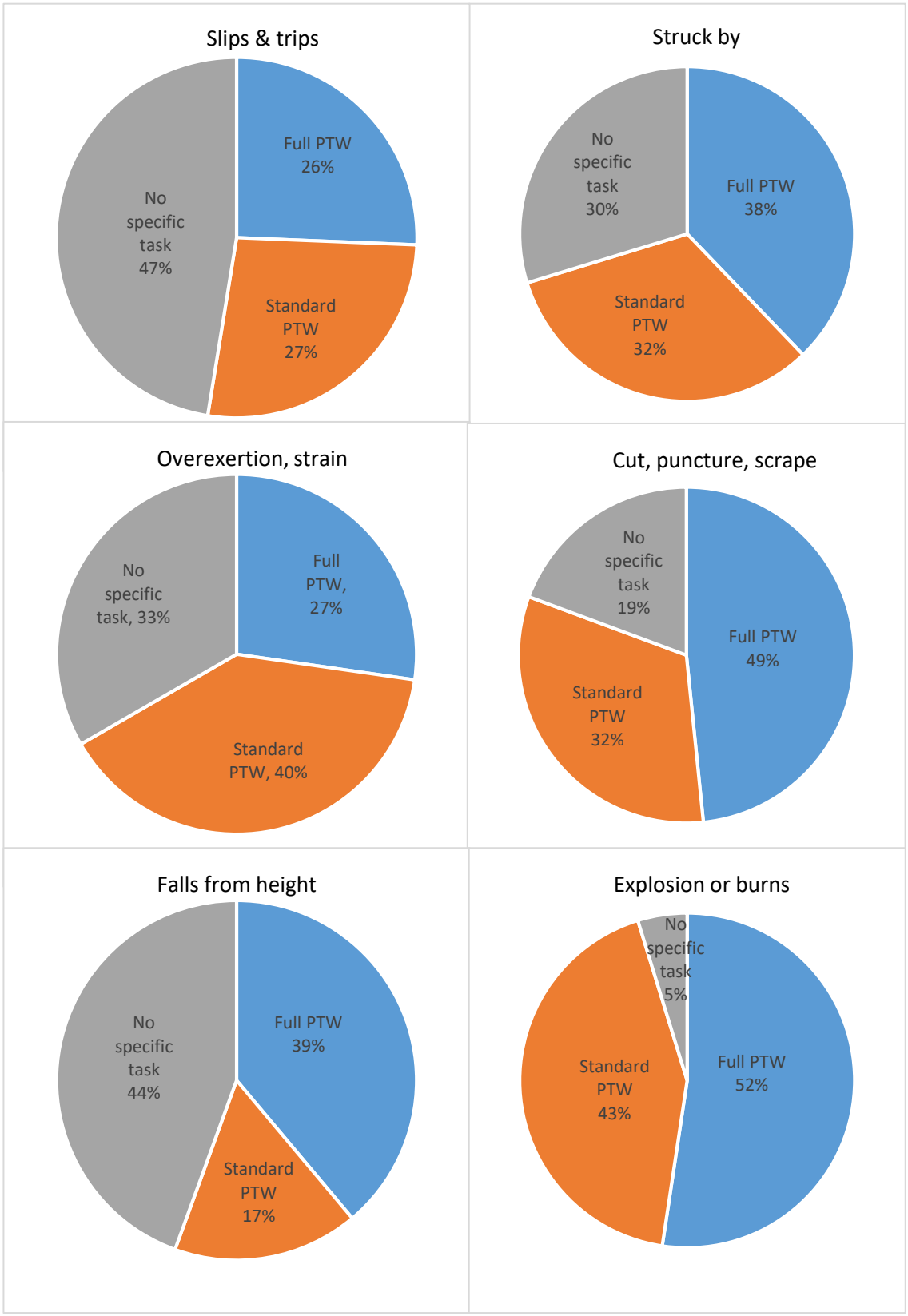


The type of permit to work (PTW) was specified in 50% of reported LWI. The highest assignment of PTW type was recorded for Manufacturing Contractors (66%) and the lowest was for Marketing Contractors (54%). Clear differences were noted between Manufacturing Own Staff and Contractors in the number of LWI related to full PTW required activities (31% of Manufacturing Contractor LWI, compared with 5% of Manufacturing Own Staff LWI).

In Marketing the type of PTW did not differ greatly between Own Staff and Contractors LWI.

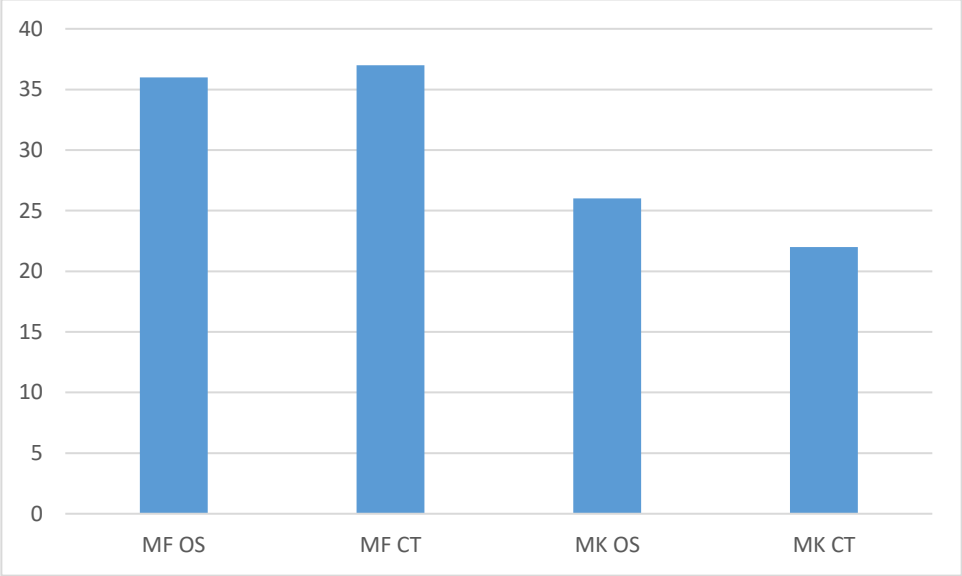
For the most frequently reported LWI, the type of PTW in place at the time of the event is presented in **Figure 1B**. The proportion of the types of PTW specified does not vary greatly between the types of LWI. A full PTW was more likely to be in place for activities related to Cut, puncture, scrape and Explosion or burns LWI. As could be expected Slips & trips reported the largest proportion of no permit to work (activity not related to a specific task) and Explosion or burns the smallest proportion.

Figure 1B Type of Permit to Work for most frequently reported LWI



The number of days absent from work for each LWI was also possible to report for the first time in 2021. 66% of LWI (337) specified the number of days absence with a total of 10526 days absence and a mean of 31 days absence per LWI. Manufacturing Own Staff and Contractors were above this mean at 36 and 37 days lost per LWI, respectively and Marketing Own Staff and Contractors at a mean of 26 and 22 days per LWI, respectively, see **Figure 1C**.

Figure 1C Mean number of days absent from work per LWI by sector (MF = Manufacturing; MK = Marketing; OS = Own Staff: CT = Contractors)



The mean number of days absent from work per LWI by Incident Category is given in **Figure 1D**. Incidents in the categories of Falls from height, Pressure release, Explosion or burns and Overexertion, strain have reported longer mean absences from the workplace than LWI related to Road accident, Slips & trips, Struck by and all other Incident Categories. However, Slips & trips type LWI incidents account for the largest total number of days absence (2972 days), largely related to the high number of incidents with 50 or less days absence, see **Figure 1E**. LWI resulting from Falls from height are fewer than Slips & trips but as a result of the highest number of incidents resulting in more than 100 days absence, this type of LWI accounts for the second highest total number of days absence (1431 days).

Figure 1D Mean number of days absent from work per LWI by Incident Category

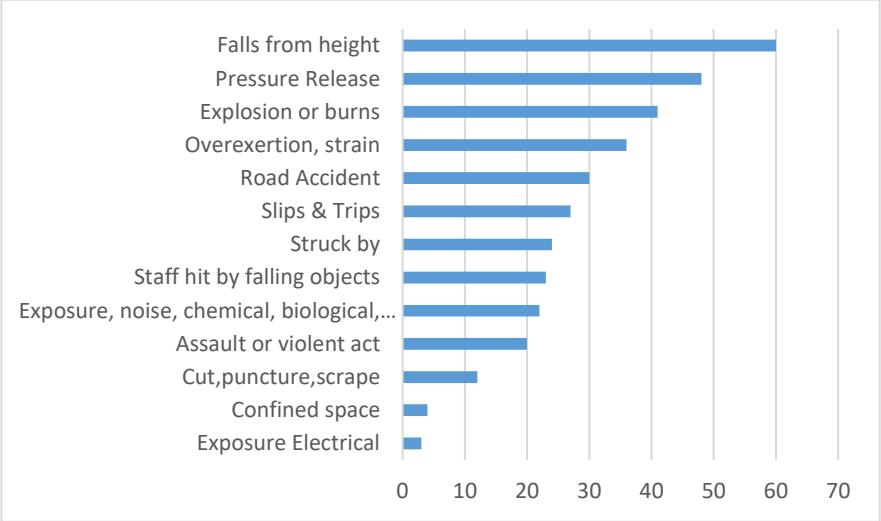
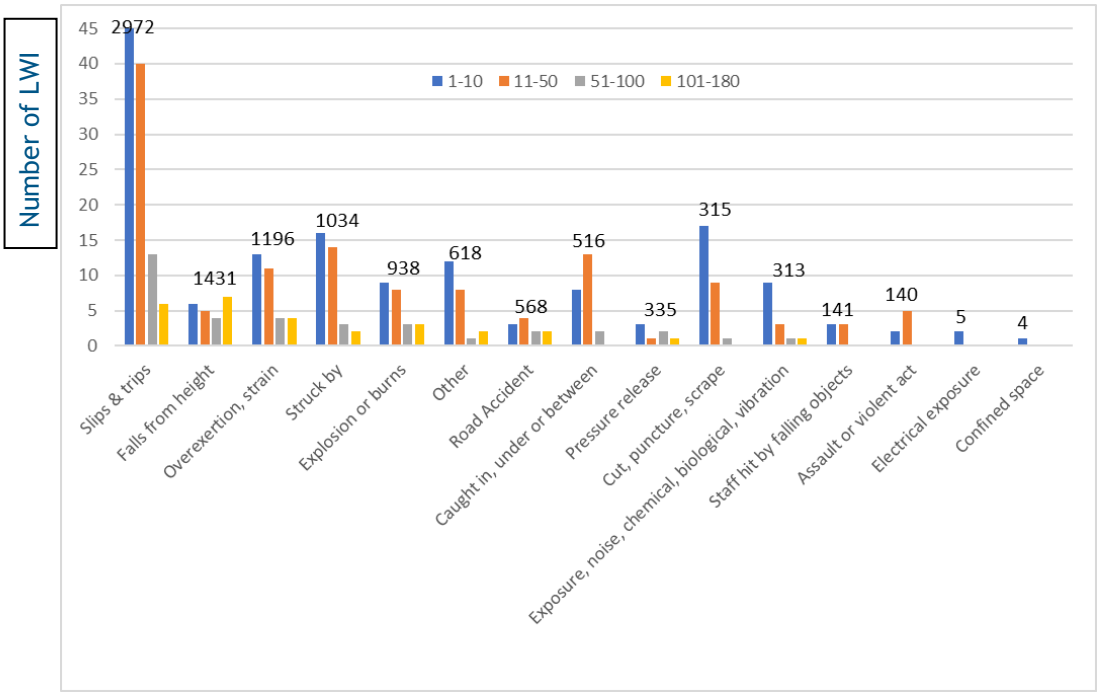


Figure 1E Distribution of number of days absent from work per LWI by Incident Category (days absence grouped 1-10 days, 11-50 day, 51-100 days and 101-180 days per LWI). Values above bars indicate total number of days absence reported for all incidents in each category type



As in 2020, Concawe collected causal factors where available for each LWI, see **Figure 1F** and **Appendix 3**. Causal factors are described in alignment with API RP754 (2021) and multiple factors may be recorded per LWI. Causal factors were not available for 16% of LWI (84 LWI incidents) in 2021 (similar to 2020 when 17% of incidents had no causal factor available. In many cases, the absence of causal factors reflects ongoing investigations.

The most commonly reported causal factors across all LWI are Human Factors (31% of causal factors reported), Safe Work Practices & Procedures (13%), Risk Assessment (12%), Knowledge and Skills (8%), Procedures (7%), Design (6%) and 10% of LWI causal factors were reported as Other (used to specify where an incident cannot be logically classed under any other category).

Human Factors was the causal factor most frequently assigned to LWI in both Manufacturing and Marketing incidents. Safe Work Practices & Procedures and Risk Assessment were the second most frequently assigned causal factors in Manufacturing and Marketing, respectively. Manufacturing incidents reported Risk Assessment and Knowledge and skills as third and fourth most frequent causal factors. Safe Work Practices & Procedures and Knowledge and skills were the third and fourth most frequently reported causal factors in Marketing incidents.

There was little difference between the most frequently reported causal factors in some of the most commonly occurring incident categories. Human factors was the most commonly assigned causal factor in Slips & trips and Struck by LWI incidents across Manufacturing and Marketing. Risk Assessment and Design were also commonly reported causal factors in Slips & trips and after Human Factors, Struck by LWI were most frequently reported with Risk Assessment and Safe Work Practices & Procedures as causal factors. Causal factors reported for Manufacturing Explosion or burns LWI were equally split between Human factors, Procedures, Risk Assessment and Safe Work Practices and Procedures.

Figure 1F Causal factors recorded for all Lost Workday Injuries in 2021

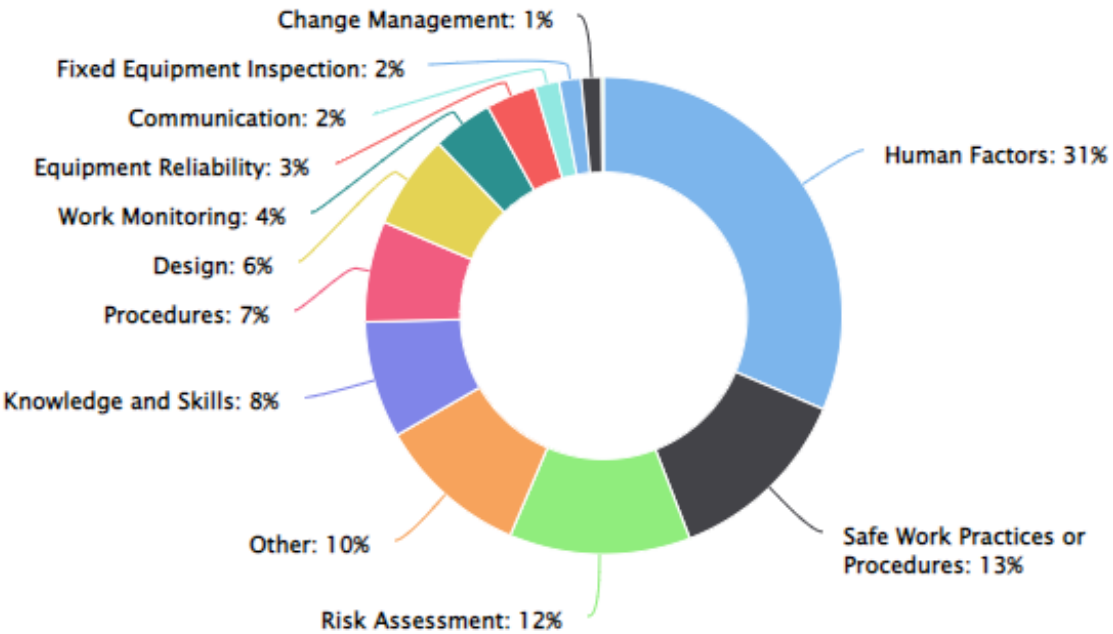


Table 5a and 5b show the Lost Workday Injury frequency statistics broken down in to quartiles. This demonstrates a wide range of variability in performance between the top performing members (Quartile 1 – Q1) and the bottom performing members (Quartile 4 – Q4).

Table 5a 2021 LWIF quartile distribution ranges and average values for each quartile range

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	0.55	0.28	0.00	0.21	0.03	0.00	0.25	0.05	0.00	0.34	0.12	0.00	0.56	0.28
Q2	0.56	1.40	0.99	0.25	0.60	0.41	0.35	1.19	0.63	0.36	0.96	0.74	0.71	1.09	0.88
Q3	1.41	3.40	2.02	0.70	0.80	0.77	1.21	3.37	2.17	1.04	2.17	1.55	1.15	2.96	1.90
Q4	4.40	16.06	7.45	0.99	30.77	8.99	3.56	17.56	6.64	2.96	23.82	10.57	4.40	16.06	7.60

Table 5b 2021 LWIF quartile distribution by staff type: ranges and average values for each quartile range

LWIF	Manufacturing Staff			Manufacturing Contractors			Marketing Staff			Marketing Contractors		
	low	high	average	low	high	average	low	high	average	low	high	average
Q1	0.00	0.32	0.03	0.00	0.35	0.09	0.00	0.00	0.00	0.00	0.34	0.11
Q2	0.35	1.30	0.77	0.36	1.01	0.74	0.00	0.06	0.01	0.40	0.73	0.62
Q3	1.34	3.72	2.42	1.13	2.51	1.61	0.23	0.72	0.47	1.06	2.56	1.48
Q4	3.81	17.56	7.03	3.42	23.82	9.98	0.78	14.23	3.94	3.43	80.00	37.44

The quartile distribution ranges and average values for each quartile for the 2021 All Injury Frequency (AIF) are shown in **Table 6**. The average performance indicator figures for the industry conceal a wide range of individual values between reporting companies.

Table 6a 2021 AIF quartile distribution by sector: ranges and average values for each quartile range

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	0.45	1.15	0.84	0.00	0.34	0.11	0.00	0.59	0.19	0.00	0.81	0.32	0.41	1.01	0.77
Q2	1.20	2.84	1.84	0.42	0.68	0.57	0.67	1.52	1.04	0.83	1.55	1.34	1.03	2.40	1.41
Q3	3.01	5.95	4.11	0.70	1.00	0.85	1.67	4.93	3.23	1.63	8.57	3.70	2.60	5.40	3.69
Q4	6.38	20.65	11.10	1.02	30.77	9.31	4.94	23.41	10.31	8.76	23.82	15.28	6.38	20.65	11.14

Table 6b 2021 AIF quartile distribution by staff type: ranges and average values for each quartile range

AIF	Manufacturing Staff			Manufacturing Contractors			Marketing Staff			Marketing Contractors		
	low	high	average	low	high	average	low	high	average	low	high	average
Q1	0.00	0.68	0.17	0.00	1.00	0.32	0.00	0.00	0.00	0.00	0.67	0.32
Q2	0.85	2.18	1.29	1.06	1.76	1.44	0.00	0.12	0.02	0.67	1.06	0.83
Q3	2.43	5.03	3.91	2.02	8.76	4.15	0.48	0.76	0.65	1.07	3.42	1.87
Q4	5.42	23.41	10.90	9.91	23.82	15.20	0.78	14.23	4.66	3.81	80.00	37.53

2.3. PERFORMANCE TRENDS IN THE LAST TEN YEARS 2012 TO 2021

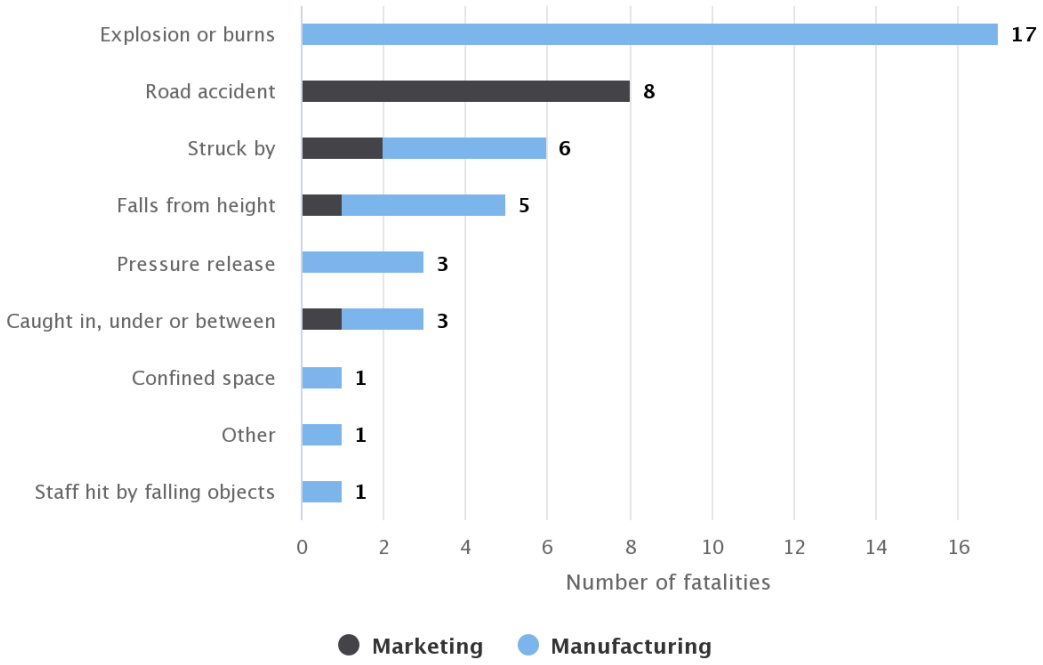
Performance indicators are particularly useful for identifying trends and patterns when considered over time. The historical trends for the European downstream oil industry over the past ten years are summarised in this section. Ten years has been chosen as a period reasonably representative of actual 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 7 Fatalities by sector 2012-2021

Fatalities over ten years by sector			
Year	**Manufacturing**	**Marketing**	**Total**
2012	7	6	13
2013	4	2	6
2014	6	1	7
2015	5	3	8
2016	2	0	2
2017	1	1	2
2018	7	3	10
2019	3	0	3
2020	1	1	2
2021	5	1	6
Total	41	18	59

The total number of fatalities in 2021 (six) is the highest number of annual fatalities recorded in the sector since 2018 and is just above the ten-year average. Continuous focus on understanding causal factors and putting in place clearly defined preventative actions are required to achieve and sustain our objective of zero fatalities in both Manufacturing and Marketing.

Figure 2 Number of fatalities by incident category 2013-2021



Since Concawe moved to reporting fatalities against the same 16 categories as Lost Workday Injury in 2013, 'Explosions or Burns' (17 fatalities), 'Road Accident' (eight fatalities) and 'Struck by' (six fatalities) have been the largest contributors to fatalities in the industry. Together, the three categories account for approximately 69% of the fatalities experienced in the industry since 2013.

Until 2013, Concawe compiled fatality data against broad 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.

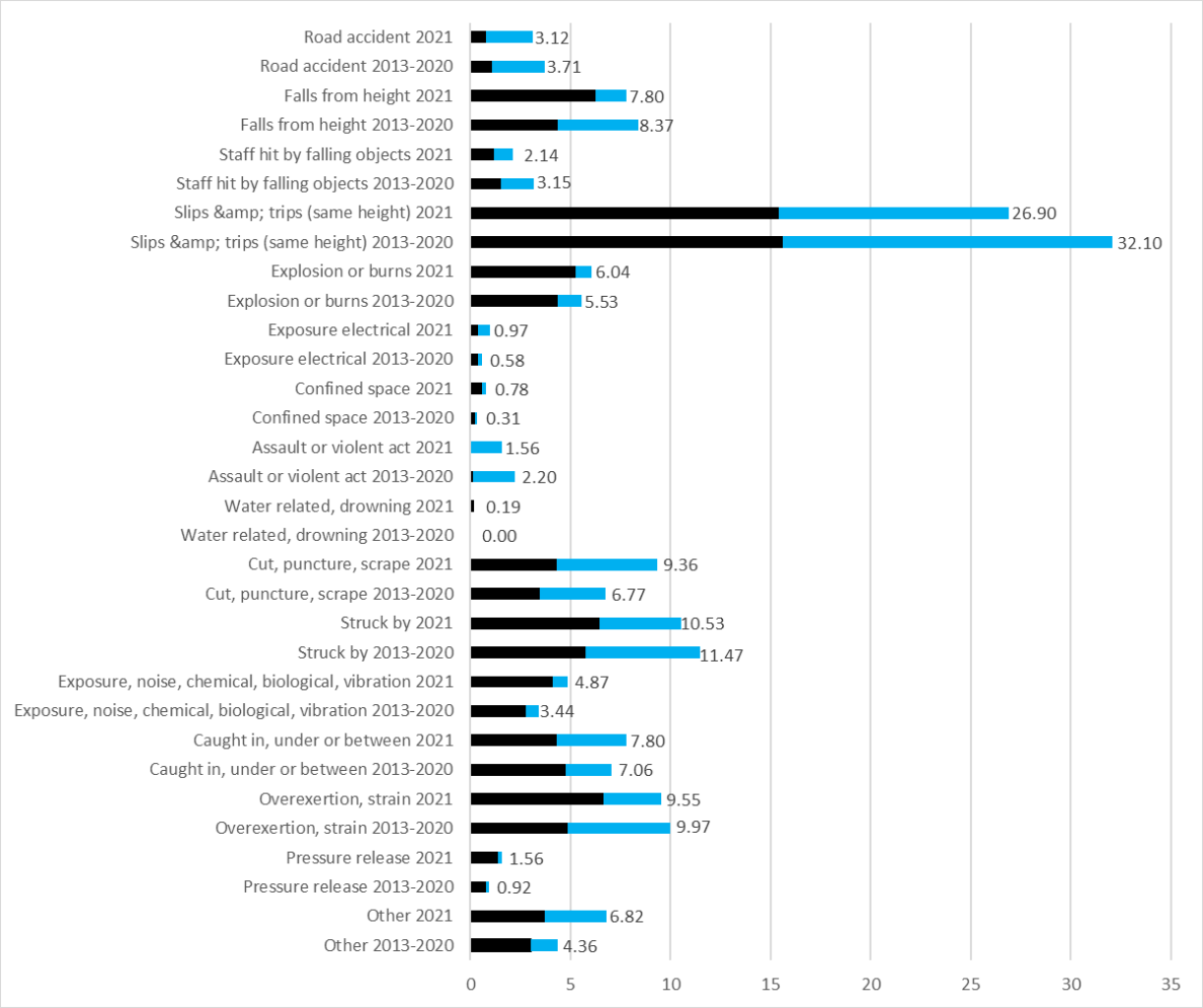
Explosion or burns and Road Accidents are the most prevalent fatal incident categories recorded in the period 2009-2018. Road Accidents have declined as an overall percentage of all fatalities compared to 1998-2008 when they represented almost half of all fatalities. This could be because of an increase in focus on Road Safety and the introduction of in-vehicle technology to help drivers. A fatal vehicle accident occurred in 2021 and four fatalities related to Explosion or burns were recorded in 2021.

Falls from Height, Pressure Release and Caught in, under or between categorised incidents are the next most prevalent, accounting for more than almost a quarter of fatalities since 2013.

The 2013-2021 reported fatalities is each of the sectors (**Appendix Tables A2-2 to A2-5**), indicate the higher prevalence of Contractor fatalities (26 fatalities in Manufacturing and ten in Marketing) than own Staff (eight fatalities in Manufacturing and one in Marketing).

LWI category data has been available since 2013; a summary is shown in **Table A2-6 (Appendix 2)** and in **Figure 3**.

Figure 3 Percentage LWI in Manufacturing and Marketing by Incident category in 2021 compared with period 2013-2020



Since Concawe began collecting LWI data against the 16 categories in 2013 a pattern has been emerging. As in fatalities, a limited number of categories contribute to most LWI.

In 2021, almost 72% of LWI were as a result of the following:

- Slips & Trips (same height) 26.9% (32.1% in 2013-2020)
- Struck by 10.5% (11.5% in 2013-2020)
- Overexertion, strain 9.6% (10.0% in 2013-2020)
- Cut, Puncture, Scrape 9.4% (6.8% in 2013-2020)
- Caught in, under or between 7.8% (7.1% in 2013-2020)
- Falls from Height 7.8% (8.4% in 2013-2020)

2021 saw the largest increases in LWI for the categories of Cut, puncture, scrape (increase of 2.6% compared with 2013-2020 average reported annual figures) and Exposure noise, chemical, biological and vibration (1.4% increase) see **Figure 3**. The proportion of recorded LWI is generally similar for Manufacturing and Marketing sectors. The largest change in the

proportion of LWI attribution is a 5.0% decrease in the proportion of Marketing sector Slips & trips in 2021 compared with 2013-2020.

Concawe started collecting information about LWI incident categories split between staff and contractors for the first time in 2018.

- For the most frequent LWI incident category, Slips & trips, the staff / contractor split in 2021 is 59 / 41 %, more evenly distributed than in 2020 (64 / 36%).
- The main causal factor attributed to 691 Slips & trips incidents in 2018 (192 incidents), 2019 (222 incidents), 2020 (139 incidents) and 2021 (138 incidents) was Human Factors (54%), followed by Safe working practices or Procedures, Design and Risk Assessment (each at 9%)
- The next most frequent LWI incident category is Struck by with a staff / contractor split of 32/68 % in 2021 (56 / 44% in 2020) and Cut, puncture, scrape split of 38 / 62% (43 / 57% in 2020)
- The LWI incident category with the greatest difference between staff and contractors in 2021 is Water related, drowning, (100 / 0%).
- There were more reported Contractors LWI than Own Staff LWI in 2021 for the following Incident Categories: Struck by; Cut, puncture, scrape; Road Accident; Falls from height; Confined space; Exposure, noise, chemical, biological, vibration and Caught in, under, between.

No direct correlation is observed between categories of LWI and fatalities in the period 2013 – 2021 (**Figure 4**). However, a focus on reducing LWI in the following areas may have the potential to address the causes of 31 fatalities recorded since 2013. These areas are:

- ▫ Process Safety to address Explosion or Burns related incidents
- ▫ Operational safety focused on Working at Height
- ▫ Road Accidents

Figure 4 LWI and Fatalities incident categories for 2013-2021

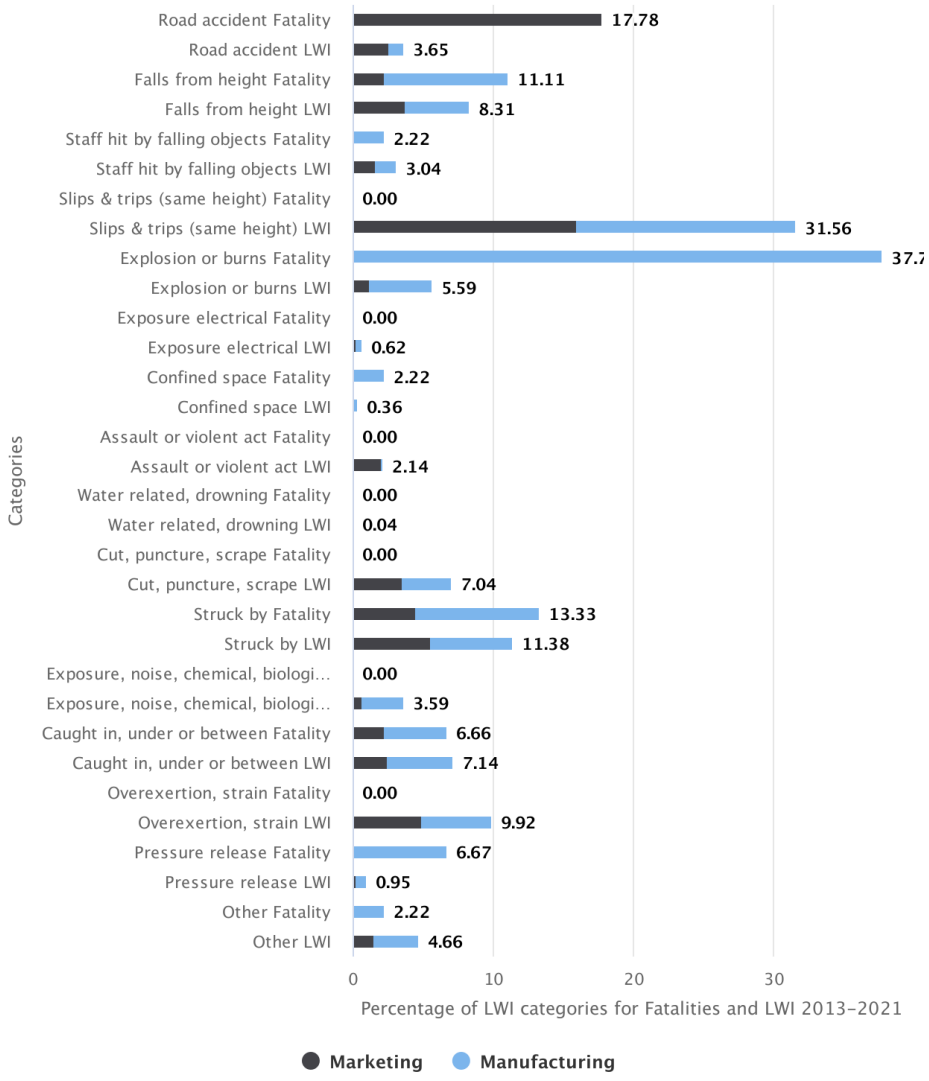
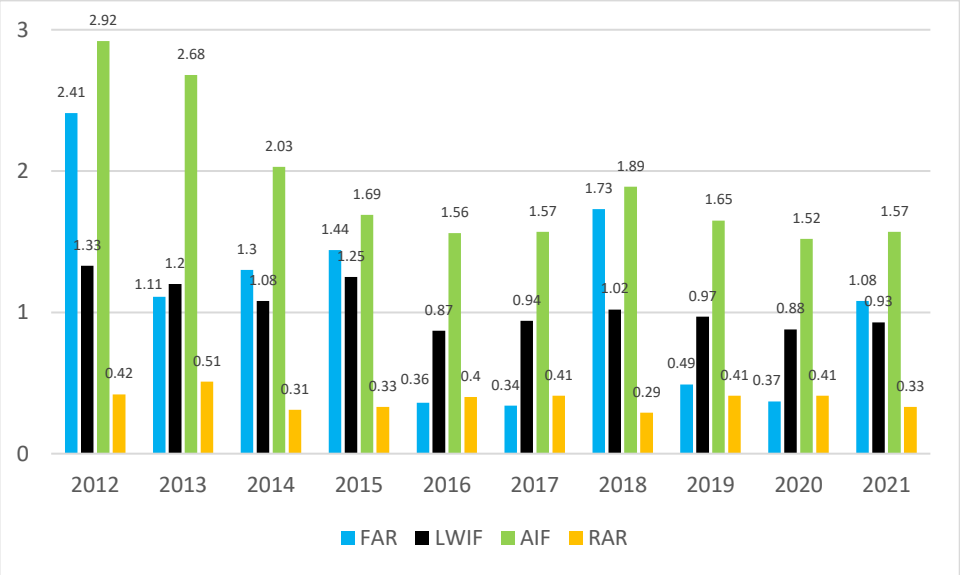


Figure 5 shows the historical evolution of the main personal safety performance indicators over the past ten years across all workers. With six fatal incidents in 2021, the Fatal Accident Rate (FAR) across all sectors is 1.08 in 2021, the highest rate recorded since 2018 when it was 1.73. The Lost Workday Injury Frequency LWIF of 0.93 in 2021 is similar to the previous five years, when it has been in the range of 0.87 to 1.02. Similarly, the All Incident Frequency AIF of 2021 at 1.57 is in the range of the last seven years (1.52-1.89). The Road Accident Rate RAR in 2021 is 0.33, the lowest since 2018 (0.29) and the total recorded distance driven in 2021 (593 million km) is 3% higher than in 2020 (see **Table A2-1**).

Figure 5 Performance indicators over the last ten years 2012-2021 European downstream oil industry



2021 was the second year impacted by the Coronavirus pandemic, necessitating adjustments in activities in both Manufacturing and Marketing segments. There was no significant change in personal safety performance and no direct correlation or clear pandemic effect can be read from the data collected.

Figures 6a and 6b show the Fatal Accident Rate FAR for own staff versus contractors for Manufacturing (**6a**) and Marketing (**6b**). 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. Further effort is required to reduce contractor and maintain staff fatalities at zero.

Figure 6a Fatal Accident Rate (number of fatalities per 100 million hours worked) – Manufacturing in the last ten years 2012-2021

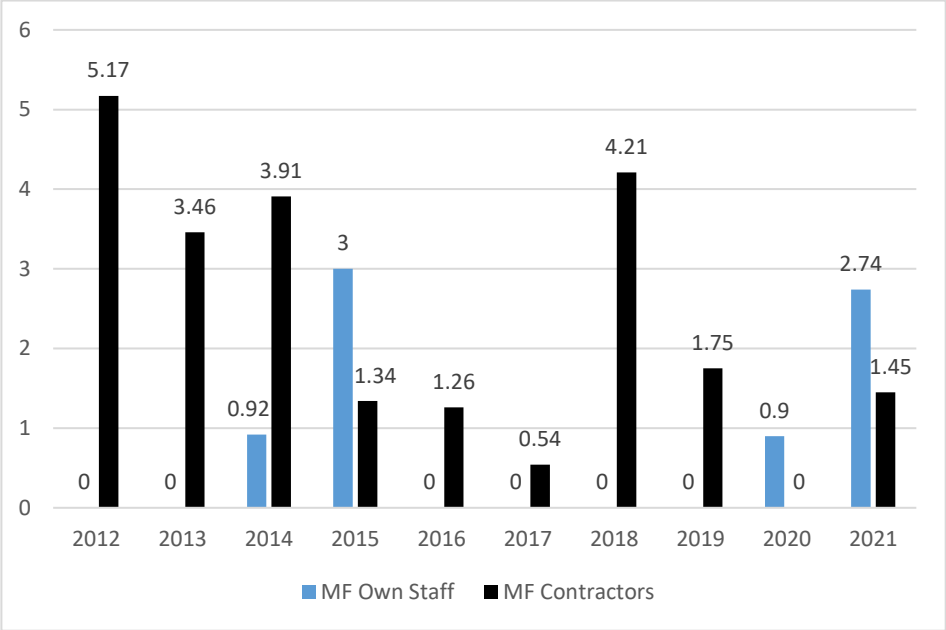


Figure 6b Fatal Accident Rate (number of fatalities per 100 million hours worked) – Marketing in the last ten years 2012-2021

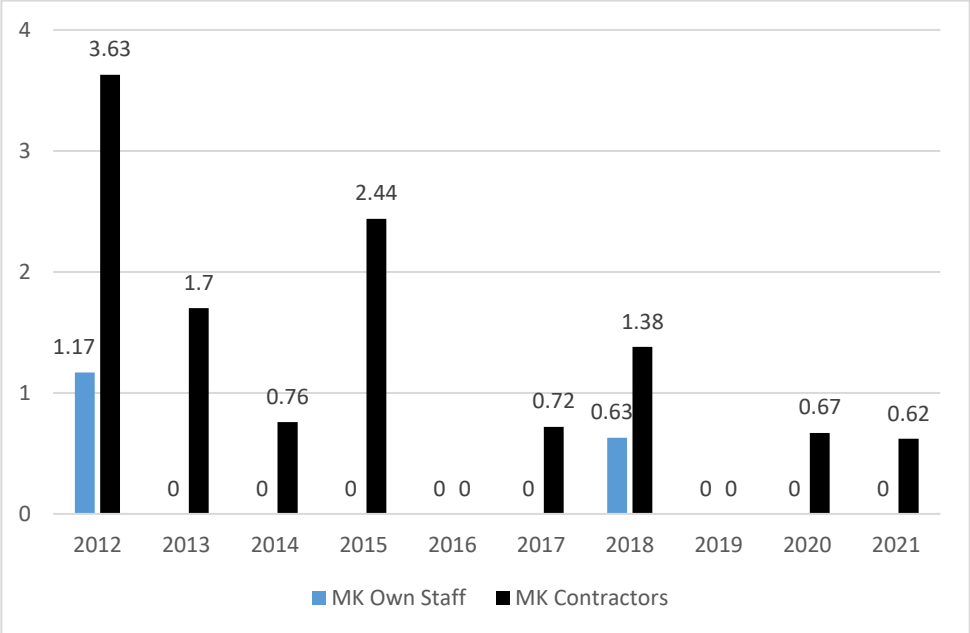
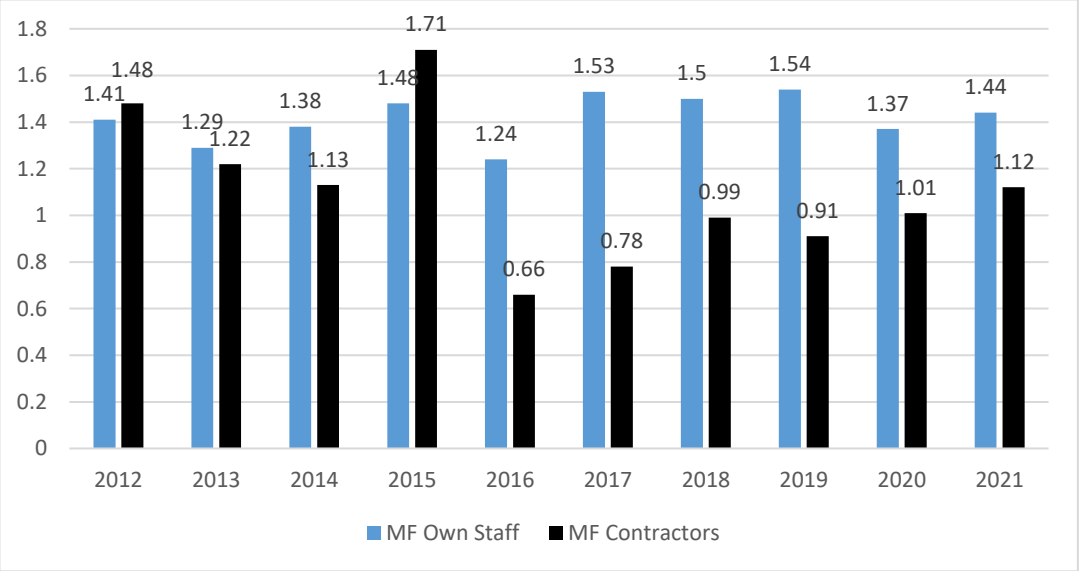


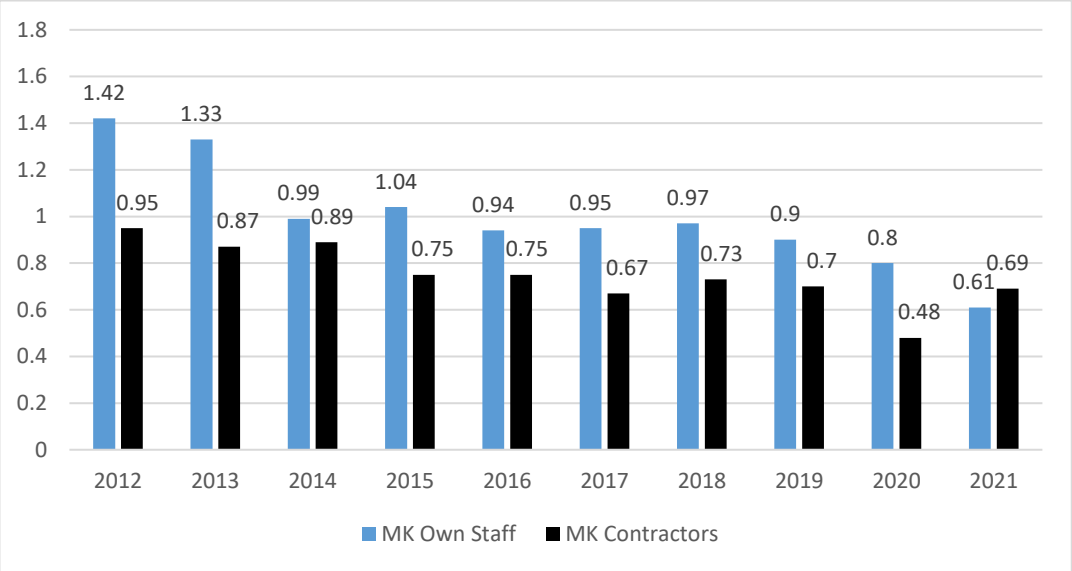
Figure 7a shows Manufacturing own staff LWIF in 2021 at 1.44, within the range of LWIF recorded in the last ten years (1.24 – 1.54). Manufacturing contractor LWIF is consistently lower than Manufacturing own staff over the last six years, however it is of concern that the 2021 value at 1.12 is almost double that in 2016 since which time it has been steadily increasing.

Figure 7a Lost Workday Injury Frequency – Manufacturing in the last ten years 2012-2021



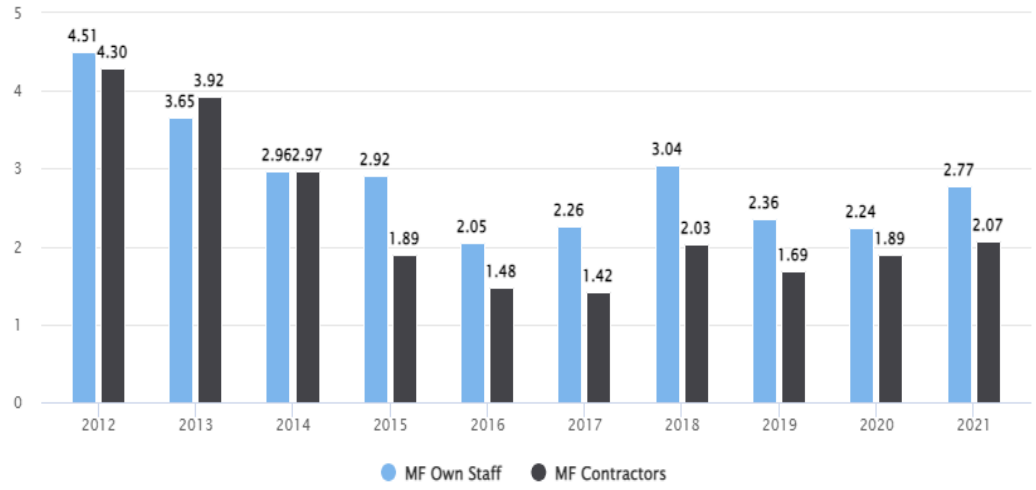
Marketing own staff had the lowest LWIF ever recorded in 2021 at 0.61, whereas the LWIF of Marketing contractors is back at the same level as in 2019 (see **Figure 7b and Appendix 2 Table A2-4**).

Figure 7b Lost Workday Injury Frequency – Marketing in the last ten years 2012-2021



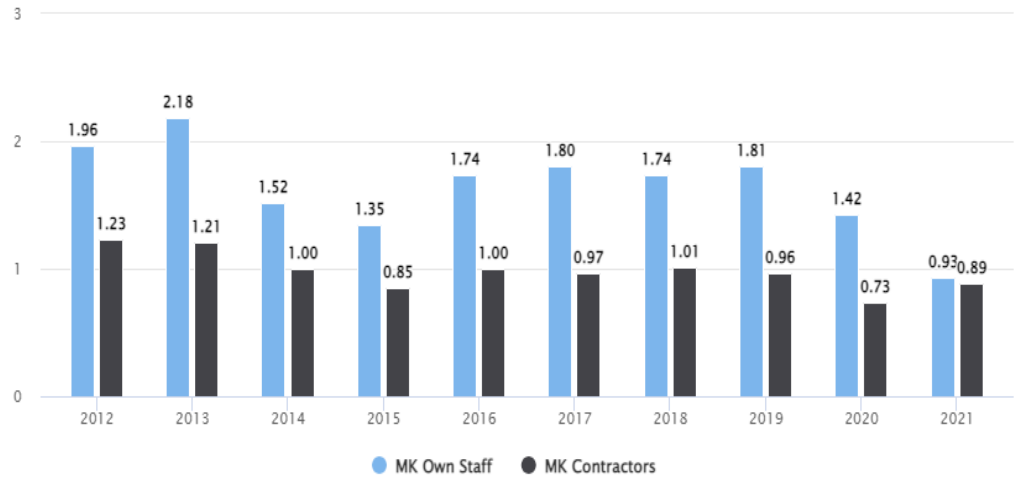
Historical figures (see **Appendix 2**) suggest that AIF peaked around 1996-97 but this was considered at the time likely the result of improved reporting standards. The downward trend in recorded Manufacturing AIF since 2010 ended in 2016. Since then own staff and contractor AIF in Manufacturing have increased to 2.77 and 2.07, respectively in 2021 (**Figure 8a**).

Figure 8a All Injury Frequency (sum of fatalities, LWI, RWI, MTC per million hours worked) – Manufacturing in the last ten years 2012-2021



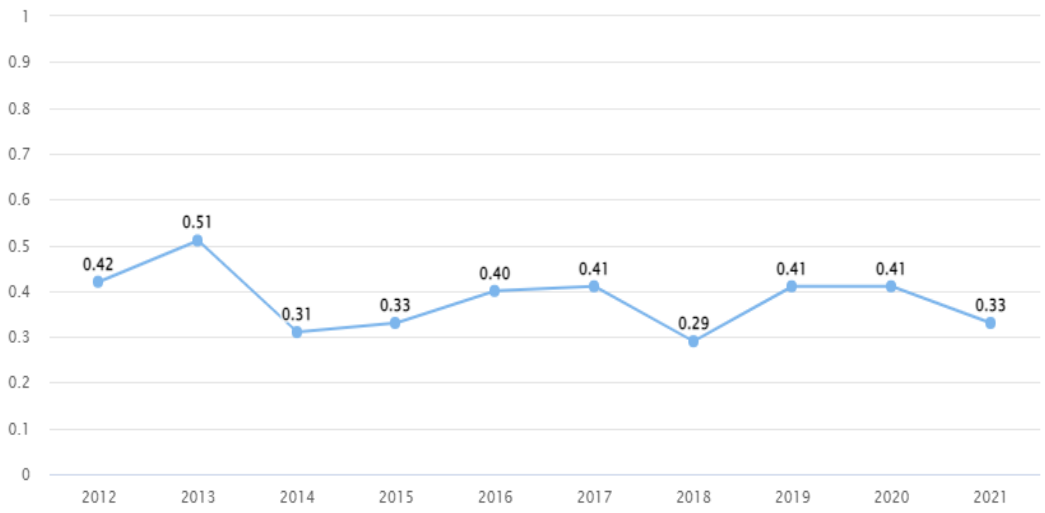
Marketing AIF in 2021 at 0.93 for own staff is the lowest ever recorded and a Marketing contractor AIF in 2021 of 0.89 is within the range recorded since 2014 (0.73 - 1.01), see **Figure 8b** and **Appendix 2 Tables A2-4** and **A2-5.**

Figure 8b All Injury Frequency (sum of fatalities, LWI, RWI, MTC per million hours worked) – Marketing in the last ten years 2012-2021



With a slight increase in kilometres driven in 2021 (593 million km in 2021 compared with 576 million km in 2020), the Road Accident Rate in 2021 dropped from 0.41 in 2020 to 0.33 in 2021, the lowest rate in three years. Road safety has been a major focus for the industry and a sustained effort is required in order to improve performance to below the lowest rates recorded in 2018 (0.29), see **Figure 9**. These accidents mainly occur in the Marketing activity where the bulk of the driving takes place.

Figure 9 Road Accident Rate last ten years 2012-2021 - 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 [28, 29]. 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 [28] and as further refined in the ANSI/API recommended practice that was published in 2010 and third edition released in 2021 [29]. 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 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 [30] as an alternative for classifying the PSE. In 2017, Concawe moved to reporting against the revised definitions in the second edition of the API Recommended practice 754 (2016) [33].

In 2021, 42 companies and joint ventures submitted PSE data for the Manufacturing operations, two more than in 2020 and 20 companies submitted Marketing PSE data, one less than last year.

The aggregated 2021 results per sector and for the whole of the European downstream oil industry are shown in **Table 8**.

Table 8 Aggregated 2021 Process Safety (PS) results for all reporting companies

Sector	Manufacturing	Marketing	Both Sectors
Companies - Total	43	26	26
- PS Reporting	42	20	20
- %	98	77	77
Hours worked - Total Mh	250.1	306.3	556.4
- PS Reporting	249.4	262.4	511.8
- %	98	77	77
T-1 PSE	75	2	77
T-2 PSE	153	16	169
T-1 PSER PSI/Mh reported	0.30	0.01	0.15
T-2 PSER PSI/Mh reported	0.61	0.06	0.33
Total PSER PSI/Mh reported	0.91	0.07	0.48

Of the 20 companies that reported Process Safety Events across both Manufacturing and Marketing, three companies reported zero Tier 1 events, 2 different companies reported zero Tier 2 events and two companies reported zero Tier 1 and Tier 2 events.

The total number of Tier 1 and Tier 2 process safety events reported at Manufacturing sites where the higher process safety risks exist has increased by 25 % in 2021 to 228 from 182 in 2020, see **Figure 15**. This value needs careful monitoring in future reports.

The ratio of Tier 1 to Tier 2 Manufacturing process safety events in 2021 is 0.49 (75 Tier 1 and 153 Tier 2). This is lower than the 2020 ratio of 0.52, but remains in the range of ratios recorded 2017 to 2020 (0.32-0.64).

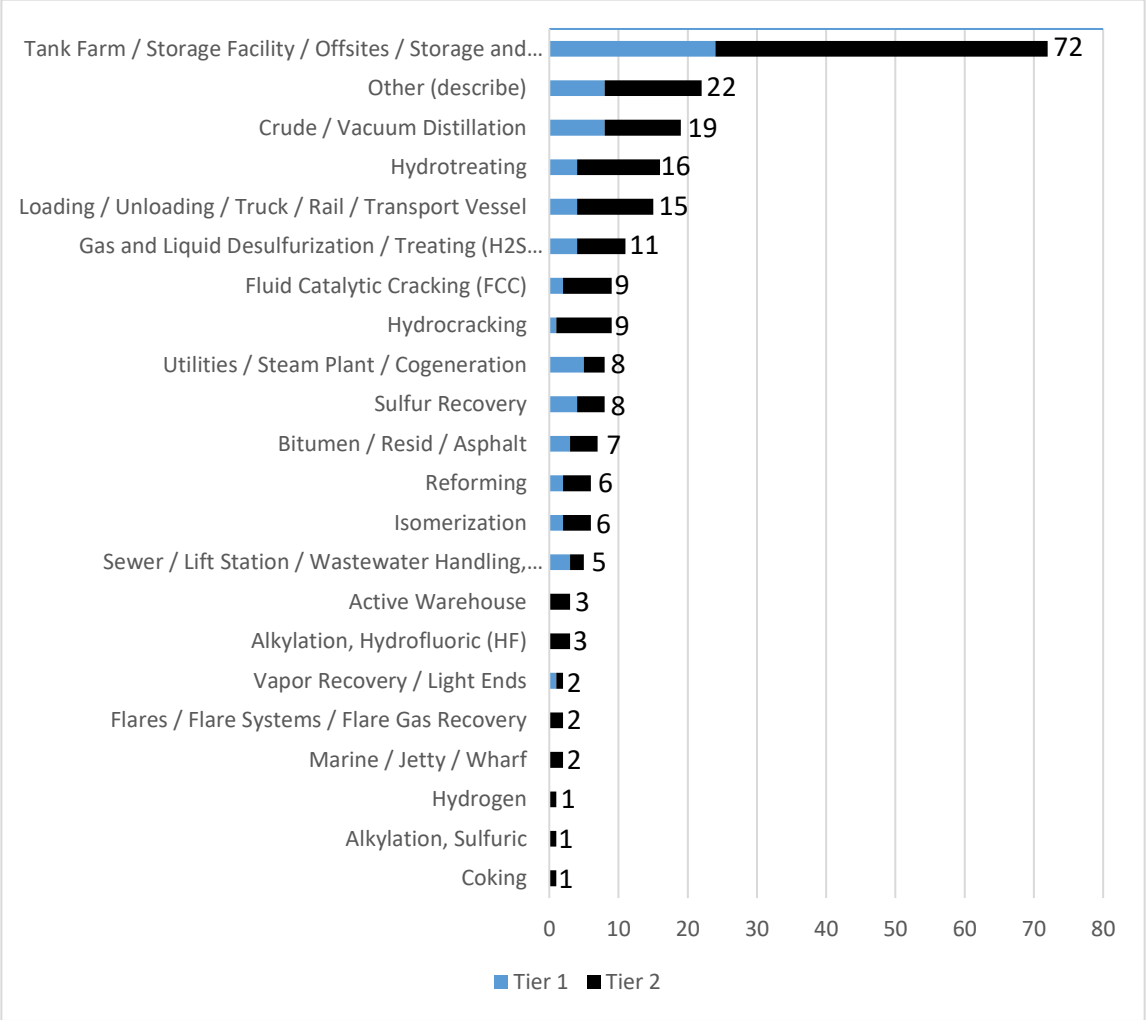
The Manufacturing Tier 1 PSER in 2021 was higher at 0.30 compared with 0.25 in 2020, 0.19 in 2019, 0.16 in 2018 and 0.14 in 2017. The Manufacturing Tier 2 PSER was also higher in 2021 at 0.61, compared with 0.49 in 2020, 0.30 in 2019, 0.40 in 2018 and 0.48 in 2017.

The number of Tier 1 PSEs resulting in LWI or fatality was reported for the first time in 2019. In 2021, 17 Tier 1 events (22% of all Tier 1 events) were associated with 17 LWI and three fatalities. This is a large increase in number of Tier 1 PSE related-injuries compared with 2020, when five Tier 1 PSE (7.6% of Tier 1 PSE in 2020) resulted in LWI. Nine LWI and three fatalities were categorized as “Explosion or burns” (direct contact with hot released material), four LWI were categorized as “Exposure, noise, chemical, biological, vibration” (direct contact with released material) and three LWI as “Pressure Release” (Failure of, or release of gas, liquid or object from a pressurised system). “Procedures” was cited the most commonly assigned causal factor (nine assignments) for these Tier 1 events leading to Explosion or Burns categories LWI and Fatalities. “Exposure, noise, chemical, biological, vibration” categorized Tier 1 with LWI were mostly associated with the causal factor “Safe working Practices or Procedures and the Tier 1 events with Pressure Release categorized LWI (three Tier 1 events) were associated with a variety of causal factors. Two of these three events were associated with the causal factor Risk Assessment.

As in 2020, no Tier 2 PSE were reported to be associated with Restricted Workday Injuries or Medical Treatment Cases in 2021. Information for the combined 246 Tier 1 and Tier 2 PSE across Manufacturing and Marketing in 2021 are provided in table form in **Appendix 4**. The following comments relate to the notable responses within each category:

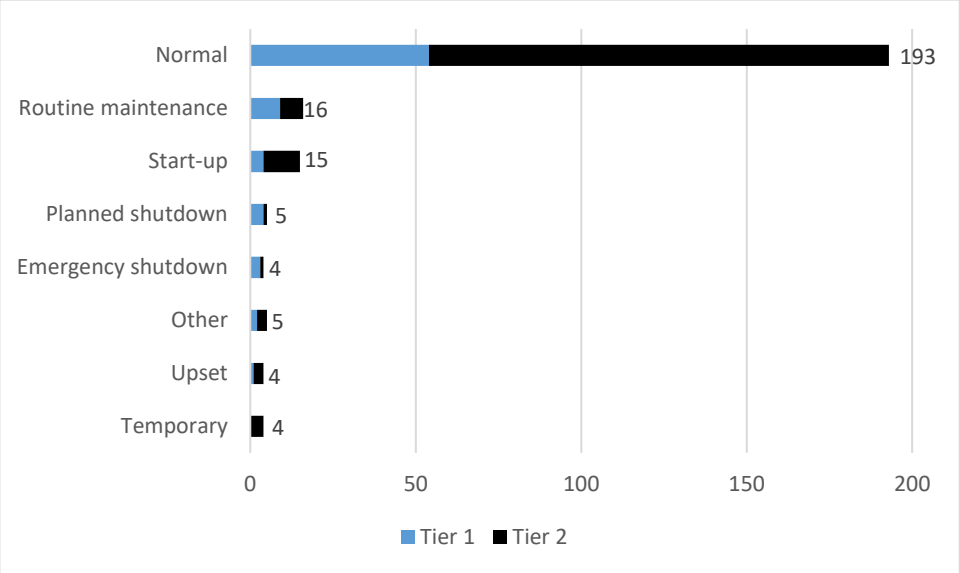
Type of Process: Process Safety Events in 2021 most frequently occurred in storage facilities or transfer piping (29% of all Process Safety Events, 31% of Tier 1 PSE and 28% of Tier 2 PSE), see **Figure 10** and **Table A4-1**. This finding is in alignment with recorded PSE since 2017. Note that two PSE Tier 1 and 16 Tier 2 PSE attributed to petrochemical processes are not included in **Figure 10**.

Figure 10 Number of Tier 1 and 2 Process Safety Events (Manufacturing and Marketing) reported in 2021 by Refining Process



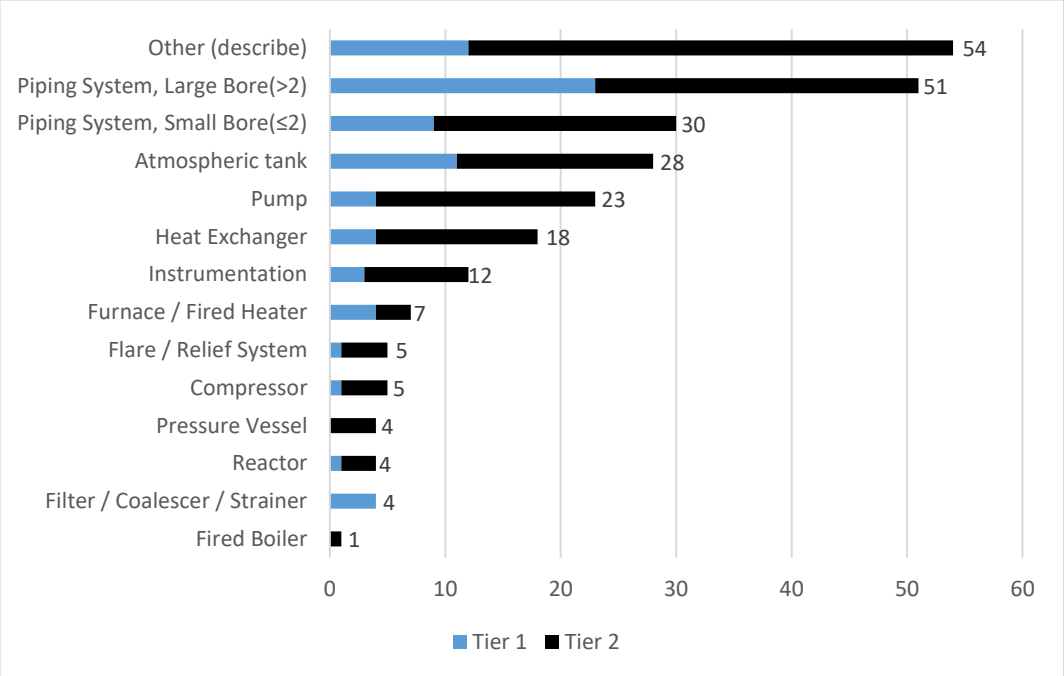
Mode of Operation: Seventy-eight percent of Process Safety Events occurred during normal operation, see **Figure 11** and **Table A4-3**. For Tier 1 events, 70% occurred during normal operation and 82% of Tier 2 events occurred during normal operation. The overall percentage is in line with data since 2017.

Figure 11 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2021 by mode of operation



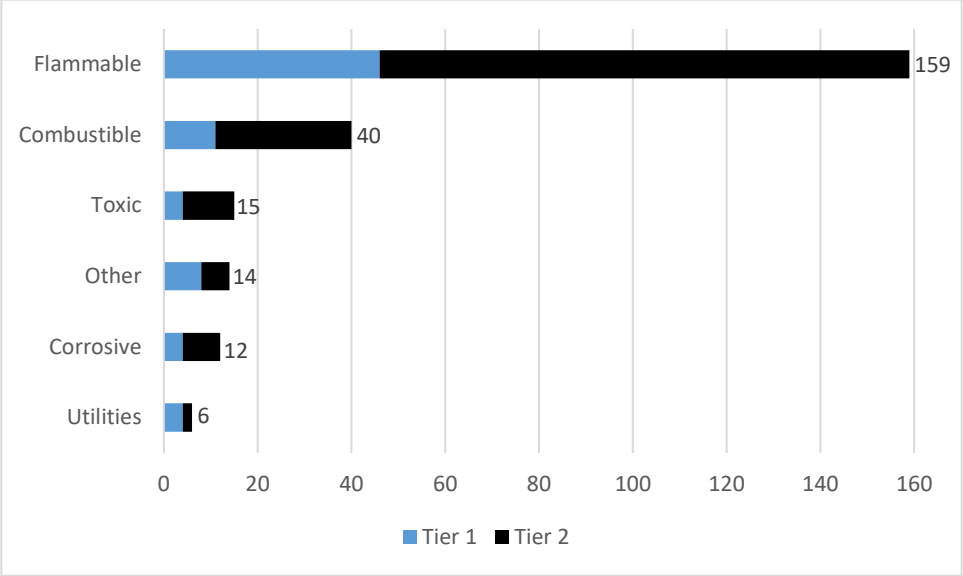
Point of Release: As in previous years, large bore piping remained the main point of release for Process Safety Events (21% of all PSE in 2021, 30% of Tier 1 and 17% of Tier 2 events), see **Figure 12** and **Table A4-4**.

Figure 12 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2021 by point of release



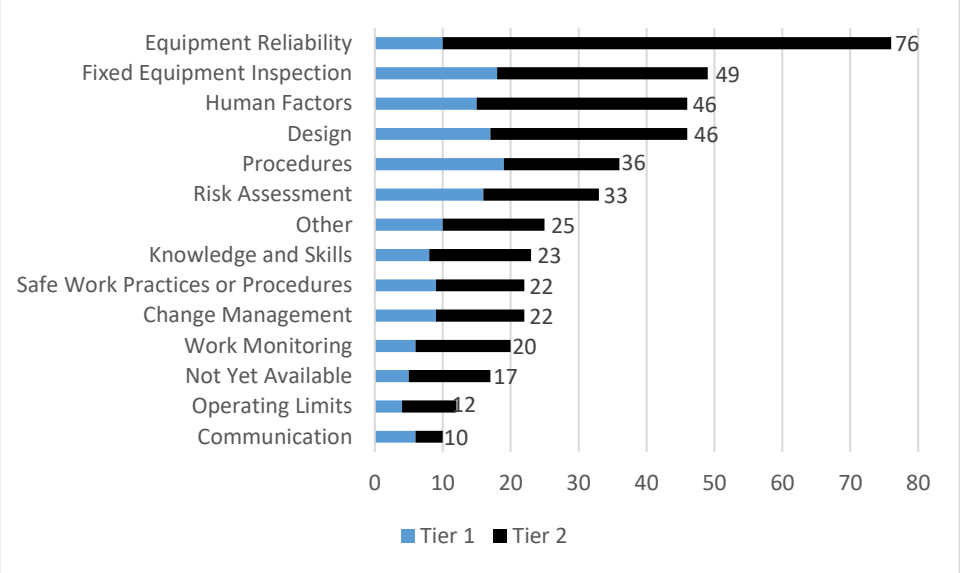
Type of material: Figure 13 and **Table A4-5** indicate that flammable material was most frequently released in Process Safety Events in 2021 (64% of all PSE, 60% of Tier 1 and 67% of Tier 2 events). Again, this aligns with data from the previous three years.

Figure 13 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2021 by type of material



Causal Factors: Equipment Reliability (allocated to 31% of events), Fixed Equipment Inspection (20%), Human Factors (19%) and Design (19%), are the most frequently cited causal factors across all Process Safety Events in 2021, see **Figure 14** and **Table A4-6**. For Tier 1 PSE the most frequently cited causal factors are Procedures (25%), Fixed Equipment Inspection (23%), Design (22%) and Risk Assessment (21%). Equipment Reliability was cited most frequently as a causal factor of Tier 2 PSE (allocated to 39% of Tier 2 PSE), Fixed Equipment Inspection (18%), Human Factors (18%) and Design (17%), were also cited. With Equipment Reliability cited most frequently as a causal factor for both Tier 1 and 2 PSE and the aforementioned 25% rise in total number of PSE since 2020, careful attention is required in this area.

Figure 14 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2021 by causal factor (note that more than one causal factor may be assigned to an event)



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.

Tables 9, 10, 11 and 12 show the quartile ranges for PSE and PSER.

Table 9 Total PSE quartile distribution ranges and average values for each quartile range

Manufacturing and Marketing PSE			
PSE	Low	High	Average
Q1	0	1	0.3
Q2	1	3	2.2
Q3	3	9	6.4
Q4	10	27	16.6

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

Manufacturing PSE			
PSE	Low	High	Average
Q1	0	1	0.3
Q2	1	3	2.2
Q3	3	9	6.0
Q4	9	23	15.0

Table 11 Total PSER quartile distribution ranges and average values for each quartile range

Manufacturing and Marketing PSER			
PSER	Low	High	Average
Q1	0.00	0.19	0.03
Q2	0.19	0.56	0.38
Q3	0.60	2.29	1.25
Q4	2.37	6.62	3.88

Table 12 A Manufacturing PSER quartile distribution ranges and average values for each quartile

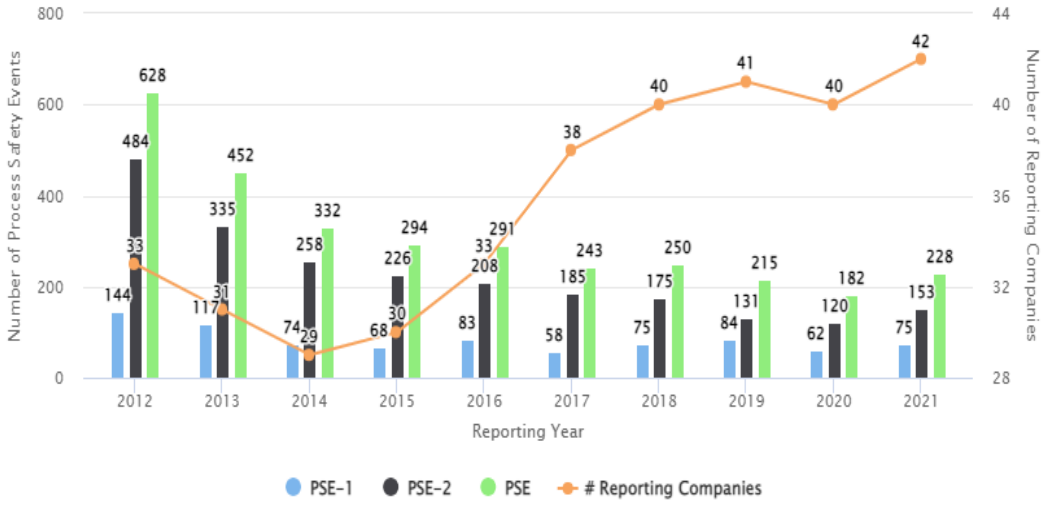
Manufacturing PSER			
PSER	Low	High	Average
Q1	0.00	0.19	0.04
Q2	0.27	0.89	0.60
Q3	0.91	2.37	1.47
Q4	2.64	7.24	4.21

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

Marketing PSER			
PSER	Low	High	Average
Q1	0.00	0.00	0.00
Q2	0.00	0.00	0.00
Q3	0.00	0.08	0.03
Q4	0.14	1.98	0.57

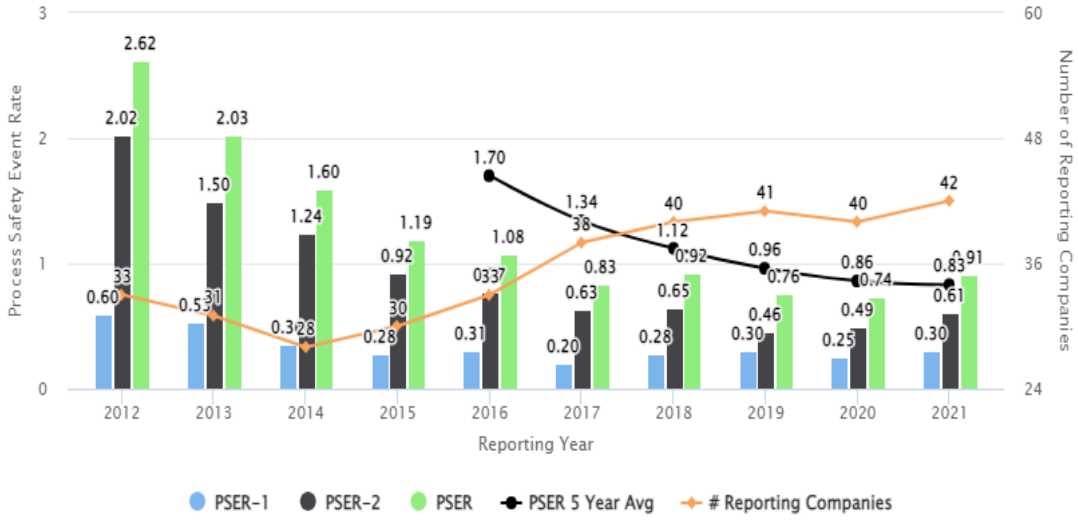
Figure 15 shows counts of the total reported Manufacturing PSE for the period 2012 to 2021. **Figure 16** shows the same data expressed as rates. The data given are for Manufacturing, as only that data is sufficiently robust to allow the analysis provided in these presentations.

Figure 15 Process Safety Events 2012-2021 - Manufacturing



The number of companies reporting Manufacturing PSE (42) is the highest recorded. The total number of Manufacturing Tier 1 and Tier 2 events in the highest in three years (228). Both Tier 1 and Tier 2 events increased since 2020, when they were the lowest recorded.

Figure 16 Process Safety Event Rate 2012-2021 - Manufacturing



The year 2021 saw a continuation of the decline in five year rolling average for Manufacturing PSER, with the lowest rate recorded at 0.83. However, the Tier 1 and Tier 2 PSER in 2021 are greater than in 2020 (Tier 1 PSER 0.30 in 2021, cf 0.25 in 2020; Tier 2 PSER 0.61 in 2021, cf 0.49 in 2020).

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 cover the oil and gas exploration and production activities of participating IOGP Member Companies [31]. In comparison with IOGP statistics for European onshore, Concawe recorded a 1.08 fatality rate, a 0.93 lost workday injury frequency and 1.57 all injury frequency.

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

	Concawe 2021	International Association of Oil & Gas Producers - IOGP 2021	
		Onshore	Onshore and Offshore
		Europe	Europe
FAR	1.08	1.48	0.87
LWIF	0.93	0.63*	0.82*
AIF	1.57	1.27	1.93

FAR is per 100 million work hours
LWIF and AIF per million work hours
*IOGP values are quoted as Lost Time Injury Rate (LTIR), the number of lost time injuries (fatalities + lost work day cases) incidents per 1,000,000 hours worked.

The American Petroleum Institute (API) reports that the rate of job-related nonfatal injuries and illnesses for the US Petroleum Refining sector was 0.5 per 100 full-time workers in 2020 [32]. Note this figure does not refer to lost workdays. Note also that this figure is based upon 200,000 work hours as a denominator compared with 1,000,000 work hours used by Concawe. The Concawe 2020 LTIF expressed per 200,000 work hours is 0.18.

The US Refining Tier 1 and 2 PSE rates recorded by API for 2020 are 0.0612 and 0.1311, respectively [34]. These rates are comparable with 0.038 and 0.058 recorded by Concawe when expressed per 200,000 work hours.

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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) [26, 27]. 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, LWI, RWI 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. LTIF	Lost Time Injury Frequency is calculated from the sum of fatalities and LWI divided by the number of hours worked expressed in millions
13. 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.
14. LWIF	Lost Workday Injury Frequency is calculated from the number of LWI divided by the number of hours worked expressed in millions.
15. LWIS	Lost Workday Injury Severity is the total number of days lost as a result of LWI divided by the number of LWI.
16. 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.
17. 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.
18. RAR	Road Accident Rate is calculated from the number of accidents divided by the kilometres travelled expressed in millions.
19. PSE	A Process Safety Event is an unplanned or uncontrolled LOPC. The severity of the PSE is defined by the consequences of the LOPC.
20. 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.
21. RA 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.

22. 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.
23. 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 (20121 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 [18-25] for further details
24. Tier 2 PSE	A Tier 2 Process Safety Event (T-2 PSE) is a LOPC with lesser consequence. Refer to the definitions in API (2021) 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 [18-25] for further details
25. Total days lost	The number of calendar days lost through LWI counting from the day after the injury occurred.

Concawe Categorization of causes for Fatalities and LWI

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.
	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 LWI. 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.
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.

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

APPENDIX 2 HISTORICAL DATA 1993 TO 2021

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	4.00	1.83	30	0.8	545.3	1,036
2010	14	2.68	5.00	1.87	30	0.6	522.2	1,011
2011	11	1.91	3.48	1.48	42	0.5	577.2	1,084
2012	13	2.41	2.92	1.33	29	0.4	538.9	1,164
2013	6	1.11	2.68	1.20	34	0.5	540.5	1,178
2014	7	1.30	2.03	1.08	43	0.3	539.3	1,271
2015	8	1.44	1.69	1.25	29	0.3	554.7	1,111
2016	2	0.36	1.56	0.87	34	0.4	559.6	833
2017	2	0.34	1.57	0.94	34	0.4	594.3	953
2018	10	1.73	1.89	1.02	35	0.3	579.1	978
2019	3	0.49	1.65	0.97	35	0.4	617.6	818
2020	2	0.37	1.52	0.88	35	0.4	542.5	576
2021	6	1.08	1.57	0.93	36	0.3	556.4	593

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	2.63	5.60	2.20	34
2010	1	1.02	8.00	2.27	28
2011	1	0.86	5.70	1.69	76
2012	0	0.00	4.51	1.41	32
2013	0	0.00	3.65	1.29	33
2014	1	0.92	2.96	1.38	44
2015	3	3.00	2.92	1.48	41
2016	0	0.00	2.05	1.24	34
2017	0	0.00	2.26	1.53	35
2018	0	0.00	3.04	1.50	42
2019	0	0.00	2.36	1.54	32
2020	1	0.90	2.24	1.37	39
2021	3	2.74	2.77	1.44	39

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	4.75	6.07	2.21	33
2010	10	7.61	8.84	2.13	32
2011	9	6.59	5.51	1.70	34
2012	7	5.17	4.30	1.48	26
2013	4	3.46	3.92	1.22	32
2014	5	3.91	2.97	1.13	46
2015	2	1.34	1.89	1.71	18
2016	2	1.26	1.48	0.66	42
2017	1	0.54	1.42	0.78	36
2018	7	4.21	2.03	0.99	37
2019	3	1.75	1.69	0.91	40
2020	0	0.00	1.89	1.01	34
2021	2	1.45	2.07	1.12	38

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	0.48	2.17	1.43	32
2012	2	1.17	1.96	1.42	29
2013	0	0.00	2.18	1.33	34
2014	0	0.00	1.52	0.99	43
2015	0	0.00	1.35	1.04	40
2016	0	0.00	1.74	0.94	25
2017	0	0.00	1.80	0.95	36
2018	1	0.63	1.74	0.97	31
2019	0	0.00	1.81	0.90	42
2020	0	0.00	1.42	0.80	29
2021	0	0.00	0.93	0.61	41

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	2.53	1.67	1.33	36
2011	0	0.00	1.23	1.08	19
2012	4	3.63	1.23	0.95	29
2013	2	1.70	1.21	0.87	37
2014	1	0.76	1.00	0.89	37
2015	3	2.44	0.85	0.75	25
2016	0	0.00	1.00	0.75	37
2017	1	0.72	0.97	0.67	28
2018	2	1.38	1.01	0.73	28
2019	0	0.00	0.96	0.70	25
2020	1	0.67	0.73	0.48	35
2021	1	0.62	0.89	0.68	24

Table A2-6 Lost Workday Injury categories 2017-2021 – Staff and Contractors in both Manufacturing and Marketing

		LWI 2021				2020	2019	2018	2017
Categories		**Manufacturing**	**Marketing**	**Combined**	**%**	**%**	**%**	**%**	**%**
Road Accident	Road Accident	4	12	16	3.1	3.4	3.4	3.4	2.9
Heights/Falls	Falls from height	32	8	40	7.8	5.5	8.3	9.6	7.8
	Staff hit by falling objects	6	5	11	2.1	1.9	3.1	2.6	3.1
	Slips & trips (same height)	79	59	138	26.9	29.2	37.8	33.0	36.5
Burn/Electrical	Explosion or burns	27	4	31	6.0	6.1	3.2	6.5	4.5
	Exposure electrical	2	3	5	1.0	0.4	0.9	0.2	0.9
Confined Space	Confined Space	3	1	4	0.8	0.4	0.2	0.3	0.2
Other Causes	Assault or violent act	0	8	8	1.6	1.1	2.0	1.9	2.0
	Water related, drowning	1	0	1	0.2	0.0	0.0	0.0	0.0
	Cut, puncture, scrape	22	26	48	9.4	9.2	6.5	8.6	6.4
	Struck by	33	21	54	10.5	13.0	13.3	11.5	13.3
	Exposure, noise, chemical, biological, vibration	21	4	25	4.9	4.8	4.1	3.1	4.7
	Caught in, under or between	22	18	40	7.8	7.1	8.0	7.2	3.8
	Overexertion, strain	34	15	49	9.6	8.2	5.5	5.5	9.5
	Pressure release	5	1	6	1.2	1.7	0.7	0.7	0.7
	Other	21	16	37	7.2	8.0	3.1	5.8	3.6
	Total	312	201	513	100	100	100	100	100

APPENDIX 3 LOST WORKDAY INJURIES 2021 - CAUSAL FACTORS

		Number of Causal Factors assigned to Lost Workday Injuries (more than one causal factor can be assigned to a single LWI)													
Sector	Incident Category	Change Management	Communication	Design	Equipment Reliability	Fixed Equipment Inspection	Human Factors	Knowledge and Skills	Operating Limits	Procedures	Risk Assessment	Safe Work Practices or Procedures	Work Monitoring	Other	Not Yet Available
Manufacturing	Assault or violent act	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Marketing	Assault or violent act	0	0	0	0	0	1	0	0	0	3	0	0	4	1
Manufacturing	Caught in, under or between	0	0	3	0	1	9	5	0	3	10	10	2	0	1
Marketing	Caught in, under or between	0	0	0	2	0	9	2	0	1	3	1	1	1	2
Manufacturing	Confined space	0	2	0	0	0	3	1	0	0	0	3	1	0	0
Marketing	Confined space	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Manufacturing	Cut, puncture, scrape	0	0	2	1	2	6	3	0	1	2	8	0	5	2
Marketing	Cut, puncture, scrape	0	0	0	0	0	10	3	0	1	1	10	0	2	3
Manufacturing	Explosion or burns	1	1	4	1	0	8	5	0	7	8	8	0	2	2
Marketing	Explosion or burns	0	0	0	0	0	1	1	0	2	1	1	0	0	0
Manufacturing	Exposure electrical	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Marketing	Exposure electrical	1	0	0	0	1	0	1	0	0	0	0	2	0	1
Manufacturing	Exposure, noise, chemical, biological, vibration	1	0	4	5	2	5	2	1	2	4	8	2	1	3
Marketing	Exposure, noise, chemical, biological, vibration	0	0	0	0	0	1	1	0	1	0	0	0	0	1
Manufacturing	Falls from height	1	2	4	2	0	15	3	0	3	6	6	3	5	2
Marketing	Falls from height	0	1	0	0	0	2	2	0	1	3	2	1	0	0
Manufacturing	Other	1	1	3	1	0	11	3	0	3	4	3	1	7	0
Marketing	Other	0	0	0	1	0	7	0	0	0	0	3	0	3	4
Manufacturing	Overexertion, strain	0	1	2	2	0	12	3	0	1	6	7	2	6	4
Marketing	Overexertion, strain	0	0	0	2	0	8	0	0	2	1	0	0	1	1
Manufacturing	Pressure release	1	1	1	0	2	1	4	0	3	1	0	3	1	0
Marketing	Pressure release	0	0	0	0	0	0	1	0	1	0	0	0	0	0
Manufacturing	Road accident	0	0	1	0	0	3	1	0	1	0	0	0	1	0
Marketing	Road accident	1	0	0	0	0	4	1	0	2	4	1	2	4	1
Manufacturing	Slips & trips (same height)	2	0	12	6	1	43	2	0	4	11	5	3	12	3
Marketing	Slips & trips (same height)	0	0	1	0	0	49	1	0	2	3	2	0	11	0
Manufacturing	Staff hit by falling objects	0	1	1	0	1	2	1	0	2	3	1	2	1	0
Marketing	Staff hit by falling objects	0	0	1	1	0	2	2	0	2	0	1	0	0	0
Manufacturing	Struck by	0	1	6	1	1	15	7	0	3	8	9	5	5	0
Marketing	Struck by	1	1	1	0	0	3	3	0	2	7	4	0	3	2
Manufacturing	Water related, drowning	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Marketing	Water related, drowning	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	10	12	47	25	11	230	58	1	50	90	93	30	75	35

APPENDIX 4 PROCESS SAFETY EVENTS 2021

Table A4-1 Tier 1 and 2 Process Safety incidents by Type of Process (Refining)

Type of Process: Refining	Tier 1	Tier 2
1. Active Warehouse	0	3
2. Alkylation, Hydrofluoric (HF)	0	3
3. Alkylation, Sulfuric	0	1
4. Bitumen / Resid / Asphalt	3	4
5. Calcining	0	0
6. Coking	0	1
7. Crude / Vacuum Distillation	8	11
8. Flares / Flare Systems / Flare Gas Recovery	0	2
9. Fluid Catalytic Cracking (FCC)	2	7
10. Gas and Liquid Desulfurization / Treating (H2S absorbers, amine systems, Merox)	4	7
11. Hydrocracking	1	8
12. Hydrogen	0	1
13. Hydrotreating	4	12
14. Isomerization	2	4
15. Loading / Unloading / Truck / Rail / Transport Vessel	4	11
16. Marine / Jetty / Wharf	0	2
17. Other (describe)	8	14
18. Pilot Plant	0	0
19. Polymerization	0	0
20. Reforming	2	4
21. Sewer / Lift Station / Wastewater Handling, Treatment or Disposal	3	2
22. Sulfur Recovery	4	4
23. Tank Farm / Storage Facility / Offsites / Storage and Transfer Piping	24	48
24. Utilities / Steam Plant / Cogeneration	5	3
25. Vapor Recovery / Light Ends	1	1
Total	**75**	**153**

Table A4-2 Tier 1 and 2 Process Safety incidents by Type of Process (Petrochemical & other process)

Type of Process: Petrochemical	Number of Tier 1 events	Number of Tier 2 events
1. acetic acid and derivatives	0	0
2. active warehouse	0	0
3. amines derivatives	0	0
4. aromatics derivatives (cumene, dis-proportionation, aromatic isomerization, linear alkylbenzene)	0	0
5. benzene	0	0
6. butadiene	0	0
7. butane	0	0
8. cyclohexane	0	0
9. dehydrogenation (propylene, butylenes)	0	0
10. diisocyanates (TDA, MDA, IPDA, etc.)	0	0
11. ETBE	0	0
12. ethane	0	0
13. ethanol	0	0
14. ethyl benzene and derivatives	0	1
15. ethylene and derivatives	0	0
16. ethylene dichloride and derivatives	0	0
17. ethylene oxide	0	1
18. flares/flare systems/flare gas recovery	0	0
19. formaldehyde and derivatives	0	0
20. glycols (ethylene, propylene)	0	0
21. hexane	0	0
22. hexanol	0	0
23. isobutane	0	0
24. isobutene	0	0
25. isocyanates	0	0
26. isopropanol	0	0
27. LNG	0	0
28. loading/unloading (truck or rail)	0	5
29. methane	0	0
30. methanol	0	0
31. methyl mercaptan	0	0
32. MTBE	0	0
33. NGL fractionation	0	0
34. Other (describe)	0	3
35. paraxylene	0	0
36. pentane	0	0
37. phenol	0	0
38. pilot plant	0	0
39. polyethylene	0	0
40. polypropylene	0	0
41. polystyrene	0	0
42. propane	0	1
43. propylene	0	0
44. propylene oxide and derivatives	0	0
45. specialty chemicals	0	0
46. styrene-butadiene	1	0
47. synthesis gas (CO, H2),	0	1
48. tank farm/storage facility/offsite/storage & transfer piping	0	0
49. toluene	1	4
50. utilities/steam plant/cogeneration	0	0
51. waste/wastewater handling, treatment or disposal	0	0
52. xylene	0	0
Total	**2**	**16**

Table A4-3 Tier 1 and 2 Process Safety incidents by Mode of Operation

Mode of Operation	Number of Tier 1 events	Number of Tier 2 events
1. Emergency shutdown	3	1
2. Normal	54	139
3. Other (describe)	2	3
4. Planned shutdown	4	1
5. Routine maintenance	9	7
6. Start-up	4	11
7. Temporary	0	4
8. Turnaround	0	0
9. Upset	1	3
Total	**77**	**169**

Table A4-4 Tier 1 and 2 Process Safety incidents by Point of release

Point of Release	Number of Tier 1 events	Number of Tier 2 events
1. Atmospheric tank	11	17
2. Blower/Fan	0	0
3. Compressor	1	4
4. Cooling Tower	0	0
5. Filter/Coalescer/Strainer	4	0
6. Fired Boiler	0	1
7. Flare/Relief System	1	4
8. Furnace/fired heater	4	3
9. Heat exchanger	4	14
10. Instrumentation	3	9
11. Other (describe)	12	42
12. Piping system, large bore(>2)	23	28
13. Piping system, small bore(?2)	9	21
14. Pressure Vessel	0	4
15. Pump	4	19
16. Reactor	1	3
Total	**77**	**169**

Table A4-5 Tier 1 and 2 Process Safety incidents by Type of Material

Type of Material	Number of Tier 1 events	Number of Tier 2 events
1. Combustible	11	29
2. Corrosive	4	8
3. Flammable	46	113
4. Other	8	6
5. Toxic	4	11
6. UNDG Class 2	0	0
7. Utilities	4	2
Total	**77**	**169**

Table A4-6 Tier 1 and 2 Process Safety incidents by Causal Factor

Causal Factors	Number times Causal Factor assigned* **Tier 1**	Number times Causal Factor assigned* **Tier 2**
1. Change Management	9	13
2. Communication	6	4
3. Design	17	29
4. Equipment Reliability	10	66
5. Fixed Equipment Inspection	18	31
6. Human Factors	15	31
7. Knowledge and Skills	8	15
8. Operating Limits	4	8
9. Procedures	19	17
10. Risk Assessment	16	17
11. Safe Work Practices or Procedures	9	13
12. Work Monitoring	6	14
13. Other	10	15
14. Not Yet Available	5	12
Total	**152**	**285**

*More than one causal factor may be assigned to a single process safety event

APPENDIX 5 CONCAWE MEMBER COMPANIES THAT SUBMITTED DATA

The following member companies provided the data upon which this report is based. The report includes additional data from two member company joint ventures when these are not provided in the member company submissions.

ALMA Petroli	GALP Energia	MOL Group	Repsol
Gruppo API	Gunvor	Motor Oil (Hellas)	Sara
ATCP	H&R	Neste	Saras
BP	Hellenic Petroleum	Nynas	Shell
CEPSA	IPLOM	OMV	St1
Crossbridge	Irving	Petroineos	Tamoil
ENI	Rompetrol	Phillips 66	TotalEnergies
Equinor	Q8	PKN Orlen	Valero
ESSAR	Gruppa Lotos	Preem	VaroEnergy
ExxonMobil	LUKOIL	Raffinerie Heide	VPR Energy

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