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European downstream oil industry safety performance

Statistical summary of reported incidents - 2022

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ABSTRACT

The 2022 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 Concawe member companies and joint ventures comprised of member companies, together representing 96% of the European refining capacity. Total work hours reported (545 million) were around 2% lower in 2022 than in 2021. In 2022, there were eleven fatalities reported by the industry, two Manufacturing staff, four Manufacturing contractors and five Marketing contractors. The number of Lost Workday Injuries (LWI) recorded in 2022 (568) is almost 11% higher than those in 2021 (513). The combined number of Tier 1 and 2 process safety events across Manufacturing and Marketing in 2022 decreased by around 8% since 2021 (226 releases in 2022, compared with 246 in 2021). This decrease is associated with Manufacturing process safety events as Marketing Tier 1 and Tier 2 events remained constant in 2022.

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

CONTENTS

EXECUTIVE SUMMARY

For 2022, information was received from 40 Concawe Member Companies and Joint Ventures (comprised of member companies), together accounting for more than 96% 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. This data demonstrates 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 2022 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*	109	143	252	131	162	293	240	305	545
Fatalities	2	4	6	0	5	5	2	9	11
FAR - FA/100Mh	1.8	2.8	2.4	0.0	3.1	1.7	0.8	3.0	2.0
LWI	153	192	345	137	86	223	290	278	568
Lost time through LWI - Days	5,375	4,676	10,051	3,011	2,458	5,469	8,386	7,134	15,520
LWIF - LWI/Mh	1.41	1.37	1.38	1.04	0.53	0.76	1.21	0.92	1.05
LWIS** - Lost days/LWI	35.6	29.2	32.3	26.2	33.2	28.9	31.5	30.5	31.0
AI	339	351	690	176	128	304	515	479	994
AIF - AI/Mh	3.1	2.5	2.7	1.3	0.8	1.0	2.1	1.6	1.8
Distance travelled - million km							344	820	1164
Road Accidents							104	101	205
RAR***							0.28	0.12	0.17
T-1PSE			61			5			66
T-2PSE			147			13			160
T-1 PSER PSI/Mh reported			0.24			0.02			0.13
T-2 PSER PSI/Mh reported			0.58			0.05			0.31
Total PSER PSI/Mh reported			0.82			0.07			0.44

OS: Own staff; CT: Contractors; AW: All workers
*Total hours recorded in millions, rounded to whole number (rates below use data before rounding for hours associated with those companies/sectors reporting incidents)
** LWIS is calculated for those LWI where number of lost days are reported
*** RAR is calculated only when both Road accidents and Distance travelled are reported

There were eleven fatalities reported for 2022, two Manufacturing staff, four Manufacturing contractors and five Marketing contractors. The two Manufacturing staff fatalities were a result of a single explosion and fire, four Manufacturing contractors died in separate incidents (one categorised as exposure noise, chemicals, biological, vibration, one struck by, one confined space and one fall from height), five further Marketing contractors died (three in separate Road accidents and two as a result of separate explosion and burns type incidents not related to the incident above with two Manufacturing staff fatalities). In comparison with 2020 and 2021 (two and six fatalities, respectively), 2022 again represents a large and 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 568 LWI were reported in 2022 (513 in the previous year) with a 2022 LWIF of 1.05, compared with 0.93 in 2021. As in previous years, a relatively small number of categories contribute to most

LWI reported. In order of frequency (highest first) the following incident categories together account for over 57% of all LWI reported in 2022 across Manufacturing and Marketing:

slips & trips (same height)

cut, puncture and scrape

caught in under or between

struck by

For 2022, 39 companies submitted Process Safety Event (PSE) data for the Manufacturing operations and 22 submitted Marketing PSE data. The combined number of Tier 1 and 2 process safety events across Manufacturing and Marketing in 2022 decreased by around 8% since 2021 (226 releases in 2022, compared with 246 in 2021). Tier 1 Manufacturing process safety events (61 in 2022, compared with 75 in 2021) decreased by 12% and Tier 2 Manufacturing process safety events (147 in 2022, compared with 153 in 2021) decreased around 4%. Marketing Tier 1 events increased from 2 in 2021 to 5 in 2022 and Tier 2 events decreased slightly from 16 to 13 events in 2022. Two of eleven fatalities and twelve out of 568 LWI (2%) in 2022 were related to Tier 1 process safety events, this is a decrease from three percent in 2021. This underlines the importance of high technical standards and strict process safety management systems.

1. INTRODUCTION TO 2022 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-ninth report on this topic (see references of past reports in the reference list [1-28]). This report covers data collected for 2022 as well as a full historical perspective from 1993. It also includes comparative ts from other industry sectors where available. For 2022, information was received from all forty Concawe Member Companies and Joint Ventures comprised of member companies when the data is not submitted by the Member Company partners. These submissions in 2022 represent 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. 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 2022 Manufacturing PSE data represents 39 out of 40 of the Manufacturing companies and 95% of European refining capacity.

In 2013, the Concawe membership agreed to adopt sixteen incident categories to describe both fatalities and 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 LWI. The current data in **Appendix 3** (the columns from change management to the right) are aligned with the API 754 10.4.4 h descriptions [36]. Over time this will allow assessment of the main factors contributing to LWI from which approaches to address incident prevention can be developed.

In 2019, the possibility to link reported Tier 1 Process Safety Events with LWI 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 Restricted Workday Injuries (RWI) and/or Medical Treatment Cases (MTC) linked to each Tier 2 Event was provided.

In 2021, 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.

In 2022, Concawe introduced mandatory reporting of more detailed Tier 1 process safety event information to enable focus on Tier 1 events in 5 categories: Fire with damage greater than or equal to $100,000 of direct cost; Explosion with damage greater than or equal to $100,000 of direct cost; An officially declared community evacuation or community shelter-in-place, (including precautionary); Engineered pressure relief that results in one or more of four consequences (rainout, discharge to a potentially unsafe location, on on-site shelter-in-place or on-site non- precautionary evacuation and/or public measures (including precautionary)) and upset emission from a permitted or regulated source that results in one or more of the same four consequences.

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 2022

No of Companies	Manufacturing			Marketing		
	Own Staff	Contractors	All Workers	Own Staff	Contractors	All Workers
Submission	40	40		27	24	
Including						
Lost Days	37	35		24	19	
All Injuries	34	33		13	14	
Road Accidents	35	34		17	15	
Distance Travelled	26	24		15	13	
Process Safety			39			22
Retail Operations						
No Retail						12
COCO						11
CODO						8
DOCO						3
DODO						3

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. 2022 PERSONAL SAFETY PERFORMANCE RESULTS

The aggregated 2022 results for Manufacturing, Marketing and the combined downstream industry are shown in **Table 2.**

Table 2 Aggregated 2022 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*	109	143	252	131	162	293	240	305	545
Fatalities	2	4	6	0	5	5	2	9	11
FAR - FA/100Mh	1.8	2.8	2.4	0.0	3.1	1.7	0.8	3.0	2.0
LWI	153	192	345	137	86	223	290	278	568
Lost time through LWI - Days	5,375	4,676	10,051	3,011	2,458	5,469	8,386	7,134	15,520
LWIF - LWI/Mh	1.41	1.37	1.38	1.04	0.53	0.76	1.21	0.92	1.05
LWIS** - Lost days/LWI	35.6	29.2	32.3	26.2	33.2	28.9	31.5	30.5	31.0
All Injuries	339	351	690	176	128	304	515	479	994
All Injury Frequency - AI/Mh	3.1	2.5	2.7	1.3	0.8	1.0	2.1	1.6	1.8
Distance travelled - million km							344	820	1164
Road Accidents							104	101	205
RAR – RA/Million km***							0.28	0.12	0.17

OS: Own staff; CT: Contractors; AW: All workers
*Total hours recorded in millions, rounded to whole number (rates below use data before rounding for hours associated with those companies/sectors reporting incidents)
** LWIS is calculated for those LWI where number of lost days are reported
*** RAR is calculated only when both Road accidents and Distance travelled are reported

2.1. 2022 FATALITIES

There were eleven fatalities reported for 2022, two Manufacturing staff, four Manufacturing contractors and five Marketing contractors.

- Two Manufacturing staff were killed in a single explosion and fire when filling furnace supply lines with fuel gas in preparation for start-up. This was reported as a Tier 1 process safety event
- A manufacturing contractor died following inhalation of gas when opening a lid under an elevated pipeline when working in the open air. This was not reported as a process safety event
- A manufacturing contractor sustained fatal injuries when hit in the head by a concrete lance while injecting concrete into micropiles
- A manufacturing contractor died after entering a reactor to clean with pressurised water. A confined space incident category was reported
- A manufacturing contractor fell from height into the sea and drowned
- Three marketing contractors died as the result of separate road accidents. In two cases these were drivers of tank trucks that rolled over.
- Two marketing contractors died as a result of separate explosion or burns type incidents. The first was performing hot work on top of an underground tank when an explosion occurred. The second was dismantling a dome shaft at a fuel station when a spark from an electric tool is thought to have caused an explosion

This represents an 83% increase in the annual number of reported fatalities since 2021, when six fatalities were reported. The 2022 data indicate that continued efforts are essential to achieve the target of zero fatalities in our industry.

2.2. 2022 LWI

In 2022, there were a total of 568 LWI, with 61% of these in Manufacturing and 39% in Marketing. The number of Manufacturing LWI were lower amongst own staff than contractors (153 and 192 LWI, respectively), while own staff had 61% of all Marketing LWI.

There was an increase in LWI Frequency (LWIF) compared with 2021. The LWIF went from 0.93 LWI/Mh in 2021 to 1.05 LWI/Mh in 2022 to across all workers. Thirty-nine companies reported LWI in 2021 and in 2022. Of these, 18 companies (46%) reported a lower overall LWIF in 2022 than in 2021, 4 companies had the same LWIF in 2021 and 2022 (10%) and 17 companies (44%) had a higher LWIF in 2022.

As in 2021, Manufacturing staff in 2022 is the sector with the highest LWIF (1.41 in 2022 and 1.44 in 2021). Marketing contractors have the lowest recorded LWIF of all sectors in 2022 at 0.531.

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 2022

	LWIF	LTIF
All Workers	1.05	1.07
All Workers Manufacturing	1.38	1.41
Manufacturing Staff	1.41	1.43
Manufacturing Contractors	1.37	1.39
All Workers Marketing	0.76	0.78
Marketing Staff	1.04	1.04
Marketing Contractors	0.53	0.56

The small differences between the two reported measures is related to the relatively small number of fatalities (11) compared with the number of LWI (568).

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 overall frequency (highest first):

- slips & trips (same height) – 27.1%
- cut, puncture and scrape – 10.4%
- caught in under or between - 10.2%
- struck by – 9.7%

Together they account for over 57% of all LWI reported in 2022 across Manufacturing and Marketing.

- Other frequently reported incident categories in Manufacturing include:
  - overexertion, strain (8% of all Manufacturing LWI)
  - fall from height (7%)
  - exposure, noise, chemical, biological, vibration (7%)
- The Marketing sector LWI differed from Manufacturing sector in a higher incidence of slips and trips LWI (33% of Marketing LWI, compared with 23% of Manufacturing LWI) and a lower incidence of exposure, noise, chemical, biological, vibration (0.4% of Marketing LWI, compared with 7% of Manufacturing LWI).
- Manufacturing contractors reported more caught in under or between type LWI than own staff (16% of all Manufacturing contractor LWI compared with 3% of LWI for Manufacturing own staff), while explosion and burns were more prevalent LWI in Manufacturing staff (9% of all Manufacturing own staff LWI compared with 3% of all Manufacturing contractor LWI).
- In Manufacturing, overexertion, strain was reported more for own staff than for contractors (overexertion, strain reported for 9% of own staff LWI compared with 7% of contractor LWI). Both falls from height and cut, puncture and scrape incidents were less frequently reported for own staff than contractors (falls from height reported for 5% of own staff LWI compared with 9% of contractor LWI; cut, puncture and scrape reported for 8% of own staff LWI compared with 11% of contractor LWI).
- Overexertion, strain and falls from height were reported in Marketing more for own staff than for contractors (overexertion, strain reported for 10% of Marketing own staff LWI compared with 7% of Marketing contractor LWI; falls from height for 9% of Marketing own staff LWI compared with 6% of Marketing contractor LWI), while cut, puncture and scrape type LWI were reported more for contractors (19% of Marketing contractor LWI compared with 7% of Marketing own staff LWI)

Concentrating on the most frequent categories of these incidents offers the opportunity to address prevention of LWI across both sectors.

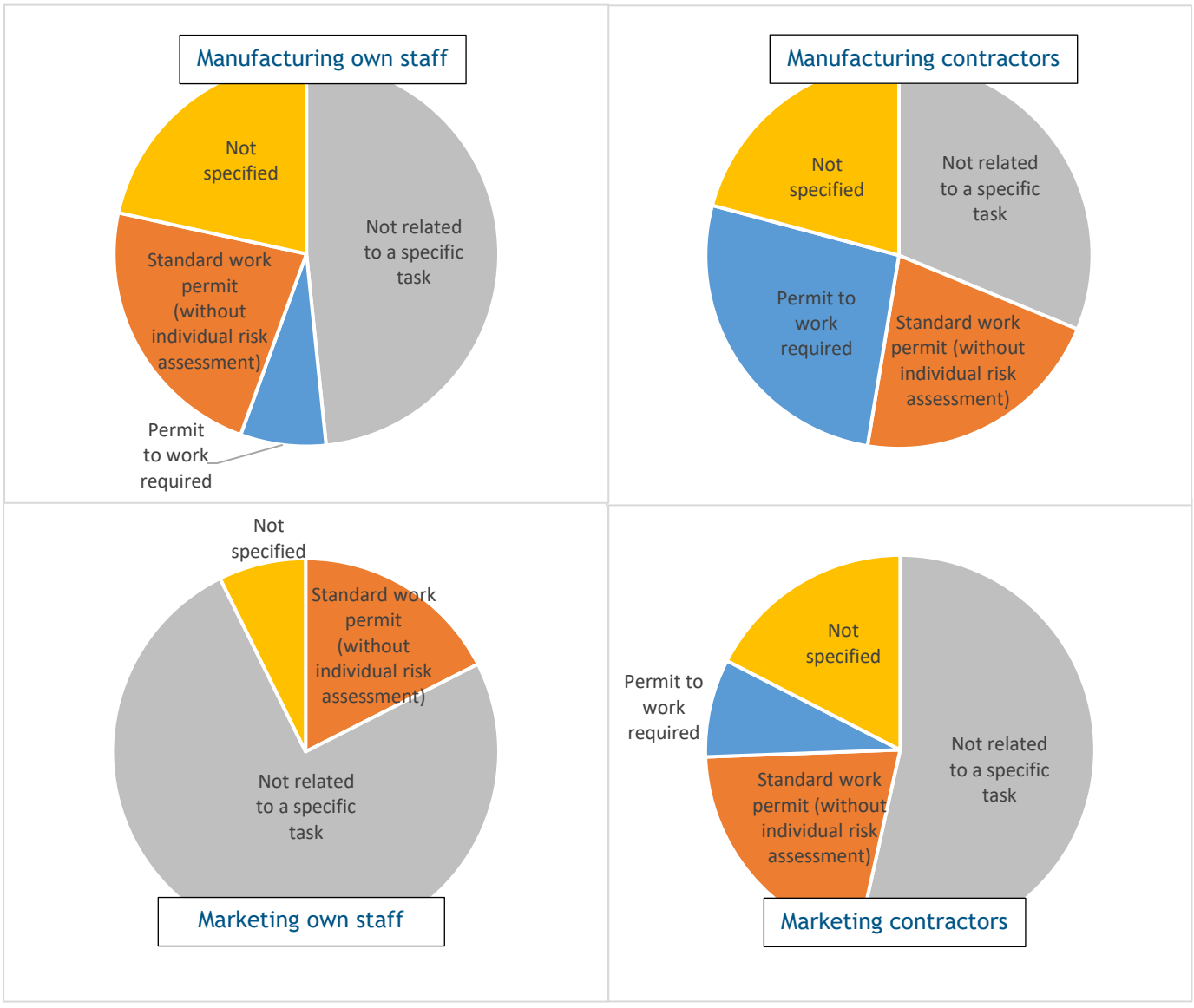
Table 4 LWI by Incident Category in 2022

Previous Category	Category	MF & MK Combined		Manufacturing (MF)						Marketing (MK)					
		All	%	OS	%	CT	%	AL	%	OS	%	CT	%	AL	%
Road Accident	Road accident	15	2.6	4	2.6	3	1.6	7	2.0	6	4.4	2	2.3	8	3.6
Height/Falls	Falls from height	42	7.4	8	5.2	17	8.9	25	7.2	12	8.8	5	5.8	17	7.6
	Staff hit by falling objects	13	2.3	1	0.7	5	2.6	6	1.7	5	3.6	2	2.3	7	3.1
	Slips & trips (same height)	154	27.1	37	24.2	43	22.4	80	23.2	46	33.6	28	32.6	74	33.2
Burn/ Electrical	Explosion or burns	29	5.1	14	9.2	6	3.1	20	5.8	3	2.2	6	7.0	9	4.0
	Exposure electrical	3	0.5	1	0.7	2	1.0	3	0.9	0	0.0	0	0.0	0	0.0
Confined Space	Confined space	1	0.2	1	0.7	0	0.0	1	0.3	0	0.0	0	0.0	0	0.0
Other Causes	Assault or violent act	5	0.9	0	0.0	0	0.0	0	0.0	3	2.2	2	2.3	5	2.2
	Water related, drowning	1	0.2	0	0.0	1	0.5	1	0.3	0	0.0	0	0.0	0	0.0
	Cut, puncture, scrape	59	10.4	12	7.8	21	10.9	33	9.6	10	7.3	16	18.6	26	11.7
	Struck by	55	9.7	15	9.8	19	9.9	34	9.9	13	9.5	8	9.3	21	9.4
	Exposure, noise, chemical, biological, vibration	25	4.4	12	7.8	12	6.3	24	7.0	0	0.0	1	1.2	1	0.4
	Caught in, under or between	58	10.2	5	3.3	31	16.1	36	10.4	14	10.2	8	9.3	22	9.9
	Overexertion, strain	48	8.5	14	9.2	14	7.3	28	8.1	14	10.2	6	7.0	20	9.0
	Pressure release	7	1.2	5	3.3	2	1.0	7	2.0	0	0.0	0	0.0	0	0.0
	Other	53	9.3	24	15.7	16	8.3	40	11.6	11	8.0	2	2.3	13	5.8
	Total	568	100.0	153	100.0	192	100.0	345	100.0	137	100.0	86	100.0	223	100.0

OS: Own staff; CT: Contractors; AW: All workers MF: Manufacturing; MK: Marketing

For the second year in 2022, Concawe collected information to link the event leading to the LWI to the type of Permit to Work (PTW) required to execute the task, if any. The assignment of type of PTW (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 without PTW not related to a specific task, e.g., cycling or walking) for each of the sectors is set out in **Figure 1A**, below.

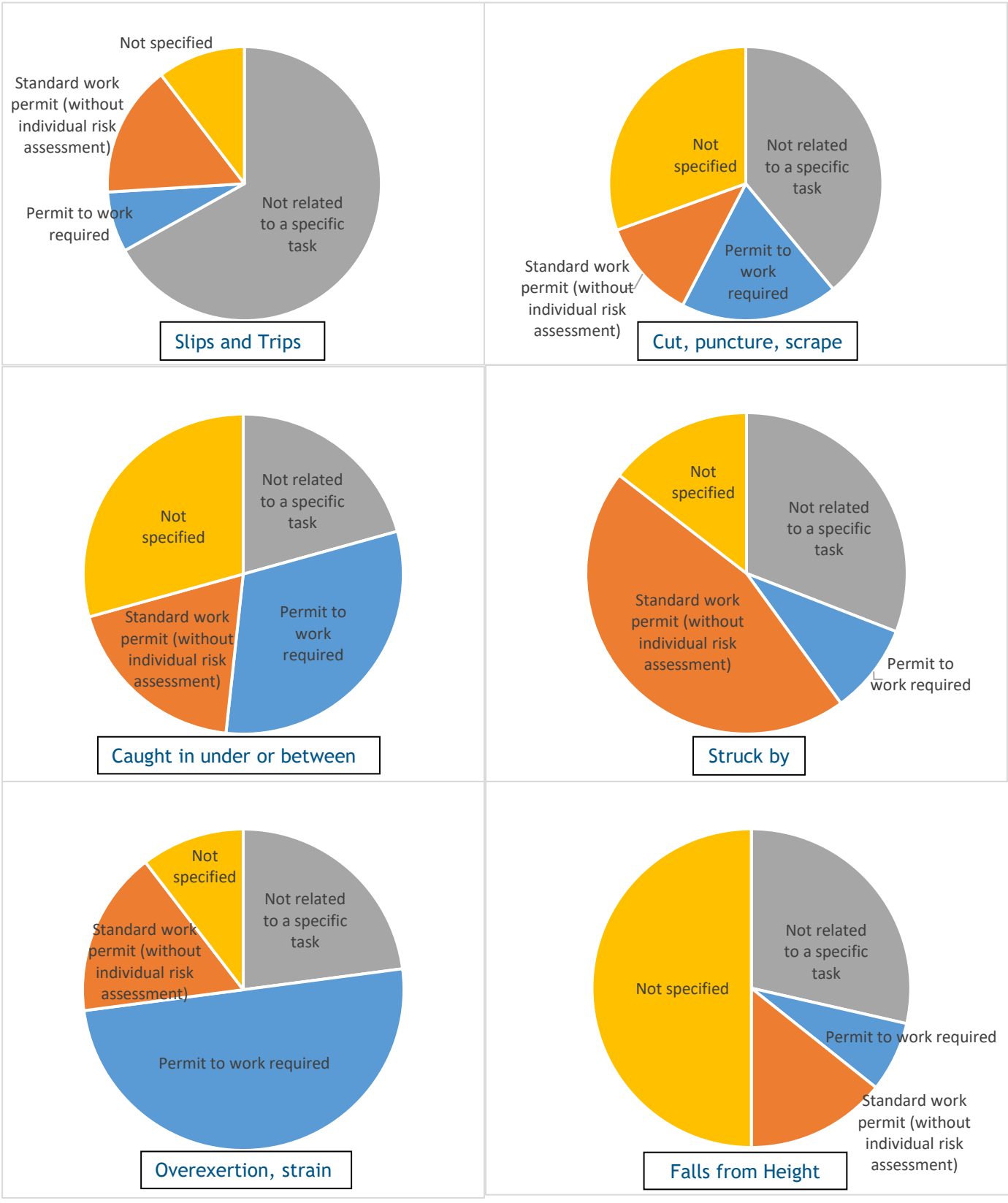
Figure 1A Type of Permit to work for LWI recorded by sector



Most LWI occur in each sector during work that is not related to a specific task. For own staff in general there is a much larger proportion of LWI during work that is not related to a specific task than for contractors. For Manufacturing own staff almost half of reported LWI were related to tasks not requiring a permit and for Marketing own staff this proportion was around three quarters of LWI. The sector that reported the most LWI during work subject to a specific permit is Manufacturing contractors. No LWI for Marketing own staff were recorded during work subject to a specific permit. Unlike other sectors, the proportion of specification and type of PTW associated with marketing own staff incidents in 2022 is quite different to that reported in 2021 when only 15% of LWI were not related to a specific task and 22% of LWI were related to work requiring a permit.

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 varies between the LWI categories. A full PTW was more likely to be in place at the time of events leading to LWI associated with overexertion, strain and caught in under or between categorised incidents than for LWI associated with slips and trips or falls from height. The proportion of all falls from height in 2022 while working under a full PTW was less than half that in 2021 (7% of falls from height in 2022 versus 18% in 2021). As in 2021, slips & trips reported the largest proportion of no PTW (activity not related to a specific task) and caught in under or between the smallest proportion.

Figure 1B Type of PTW at LWI event for most frequently reported Incident Categories



The number of days absent from work per LWI was reported in 2022 for 74 % of LWI (420 LWI) compared with 66% of LWI in 2021. The total number of days absence recorded for individual LWI in 2022 was 12,638 (the total number of days absence for all LWI reported, 15,520). The mean absence per LWI is 30 days with Manufacturing Own Staff and Marketing Contractors above this mean at 37 and 34 days lost per LWI, respectively and Manufacturing Contractors and Marketing Own Staff below the mean at 25 and 26 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)

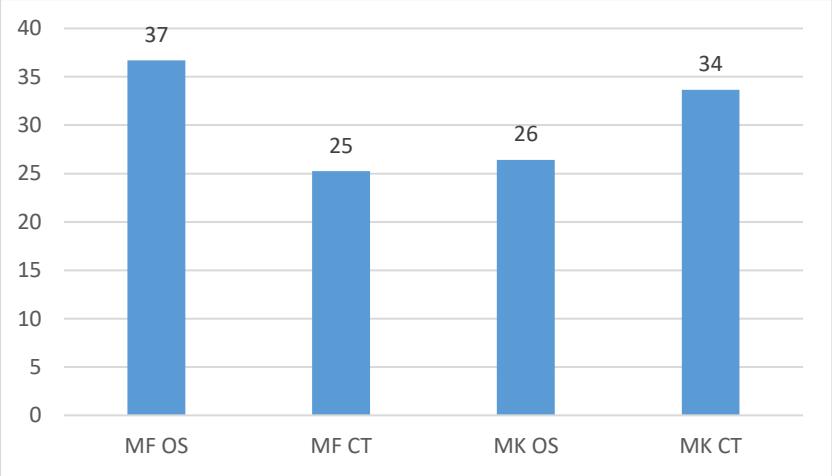
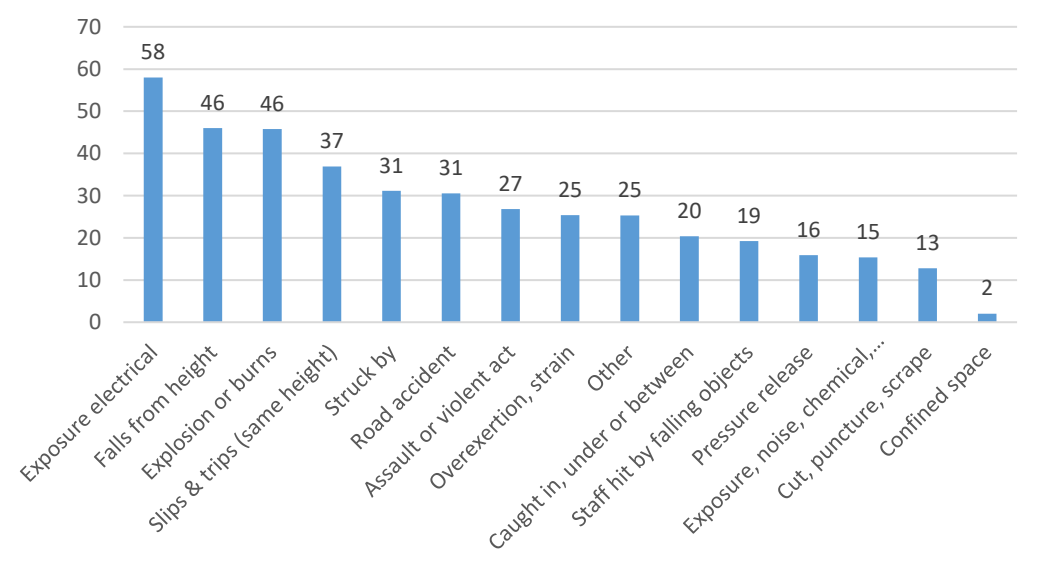


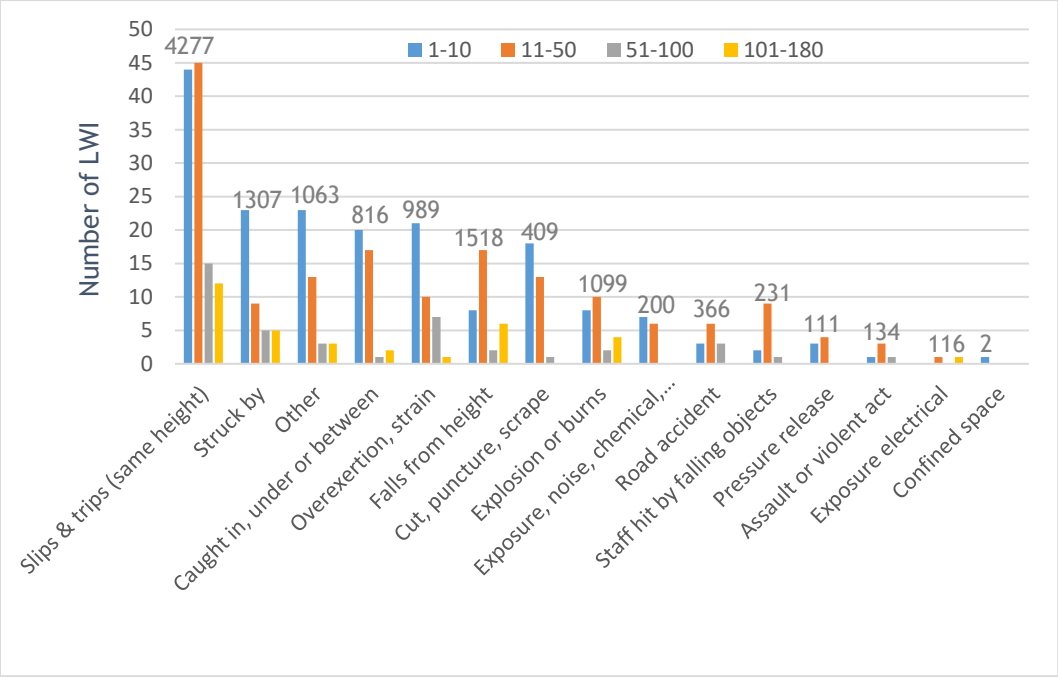
Figure 1D Mean number of days absent from work per LWI by incident category



The mean number of days absent from work per LWI by incident category is given in **Figure 1D**. Incidents in the categories of exposure electrical, falls from height, explosion or burns and slips & trips, struck by and road accident reported longer mean absences from the workplace (mean ≥30 days) than LWI related to assault or violent act, overexertion, strain and all other incident categories.

Slips & trips type LWI account for the largest total number of days absence (4277 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 high number of incidents resulting in more than 100 days absence, this type of LWI accounts for the second highest total number of days absence (1518 days).

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 incident category



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 8% of LWI (47 LWI) in 2022 (lower than in 2021 when 16% 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 (29% of causal factors reported), safe work practices & procedures (14%), risk assessment (13%), design (7%), procedures (7%) and knowledge and skills (6%). 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 design as third and fourth most frequent causal factors. Safe work practices & procedures and procedures 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; cut, puncture, scrape and caught in, under or between LWI across Manufacturing and Marketing. Risk Assessment safe work practices or procedures and design were also commonly reported causal factors in slips & trips and after human factors, cut, puncture, scrape LWI were most frequently reported with risk assessment and safe work practices & procedures as causal factors. Causal factors reported for caught in under or between LWI were human factors, safe work practices and procedures, risk assessment and procedures.

Figure 1F Causal factors recorded for all LWI in 2022

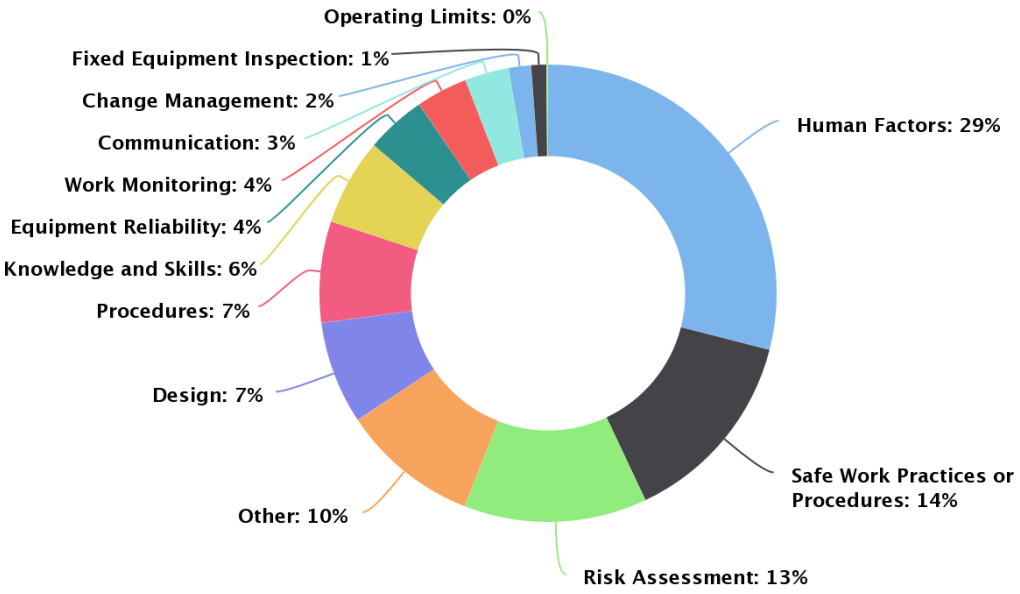


Table 5 shows the LWI frequency statistics broken down into quartiles. This demonstrates a wide range of variability in performance between the top performing members (Quartile 1 – Q1) and the bottom performing members (Quartile 4 – Q4).

Table 5A 2022 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	0.47	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.10
Q2	0.51	1.51	0.91	0.00	0.40	0.16	0.46	1.07	0.73	0.00	0.71	0.40	0.47	1.09	0.78
Q3	1.71	2.91	2.30	0.40	0.79	0.59	1.16	2.49	1.86	0.74	2.64	1.60	1.23	2.56	1.95
Q4	3.20	16.34	6.79	0.85	13.15	3.10	3.35	15.63	7.21	2.94	18.17	7.20	2.60	14.74	6.88

Table 5B 2022 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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q2	0.00	1.38	0.84	0.00	0.94	0.45	0.00	0.00	0.00	0.00	0.40	0.25
Q3	1.40	2.58	2.10	0.98	3.22	1.95	0.00	0.51	0.35	0.56	1.08	0.70
Q4	2.85	15.63	6.78	3.55	18.17	7.60	0.71	13.38	3.84	1.13	3.20	1.96

The quartile distribution ranges and average values for each quartile for the 2022 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 2022 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	0.00	1.01	0.67	0.00	0.00	0.00	0.00	0.68	0.29	0.00	0.62	0.14	0.00	1.03	0.66
Q2	1.28	2.62	2.03	0.00	0.52	0.24	0.80	1.95	1.19	0.70	1.77	1.16	1.12	2.36	1.53
Q3	2.68	5.78	4.35	0.60	0.91	0.74	2.00	6.69	3.49	2.01	5.38	3.28	2.73	5.83	4.09
Q4	6.15	33.50	12.04	0.98	13.15	3.56	6.85	43.49	14.10	5.53	23.63	10.34	6.03	33.50	11.36

Table 6B 2022 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	0.58	0.21	0.00	0.65	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Q2	0.65	2.17	1.57	0.70	2.25	1.40	0.00	0.32	0.05	0.00	0.56	0.34
Q3	2.42	6.33	3.37	2.48	5.64	3.66	0.41	0.78	0.52	0.74	1.62	1.28
Q4	6.69	43.49	14.92	6.18	23.63	11.44	0.87	13.38	4.58	1.64	3.20	2.22

2.3. PERFORMANCE TRENDS IN THE LAST 10 YEARS - 2013 TO 2022

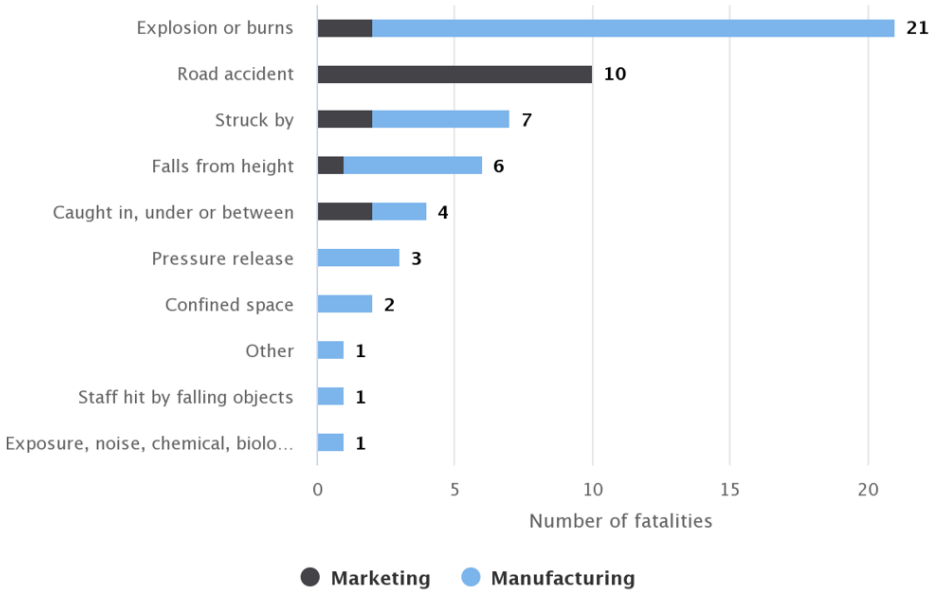
Performance indicators are particularly useful for identifying trends and patterns when considered over time. The historical trends for the European downstream oil industry over the past ten years are summarised in this section. Ten years has been chosen as a period reasonably representative of actual 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 2013-2022

Year	Manufacturing	Marketing	Total
2013	4	2	6
2014	6	1	7
2015	4	3	7
2016	2	0	2
2017	1	1	2
2018	7	3	10
2019	3	0	3
2020	1	1	2
2021	5	1	6
2022	6	5	11
Total	**39**	**17**	**56**

The total number of fatalities in 2022 (eleven) is the highest number of annual fatalities recorded in the last 10 years. Continuous focus on understanding causal factors and putting in place clearly defined preventative actions and mitigative are required to achieve and sustain our objective of zero fatalities in both Manufacturing and Marketing.

Figure 2 Number of fatalities by category 2013-2022



Since Concawe moved to reporting fatalities against the same 16 categories as LWI in 2013, 'explosions or burns' (21 fatalities), 'road accident' (10 fatalities) and 'struck by'

(7 fatalities) have been the largest contributors to fatalities in the industry. Together, these three categories account for 67% 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.

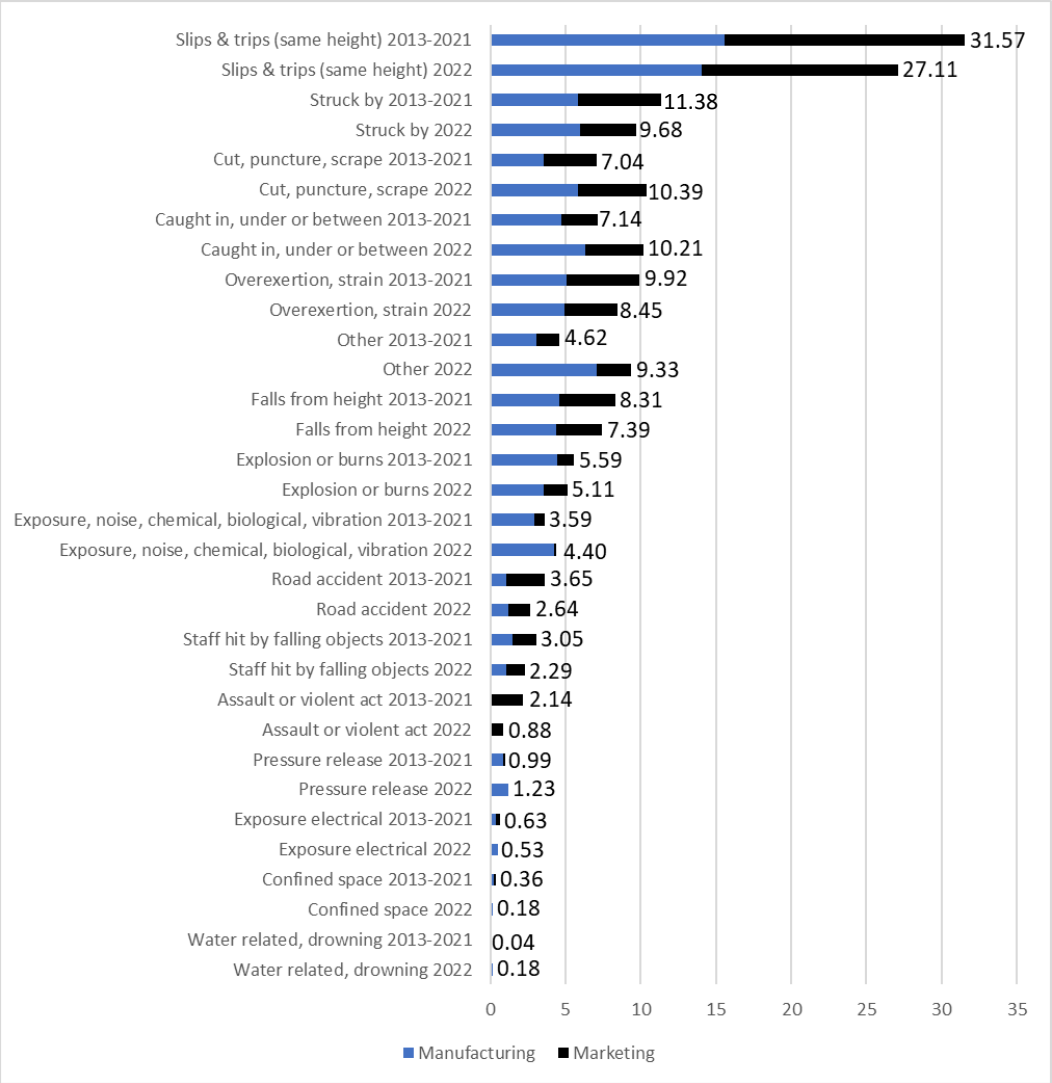
Explosion or burns and road accidents are the most prevalent fatal incident categories recorded in the period 2009-2018. Road accidents have declined as an overall percentage of all fatalities compared to 1998-2008 when they represented almost half of all fatalities. This could be because of an increase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

Struck by, falls from height, caught in, under or between and pressure release categorised incidents are the next most prevalent, accounting for more than almost a quarter of fatalities since 2013.

The 2013-2022 reported fatalities in each of the sectors (**Appendix Tables A2-2 to A2-5**), indicate the higher prevalence of Contractor fatalities (29 fatalities in Manufacturing and 16 in Marketing) than own Staff (10 fatalities in Manufacturing and 1 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 of LWI by incident category in Manufacturing and Marketing in 2022 compared with period 2013-2021



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

In 2022, 73% of LWI were as a result of the following:

- slips & trips (same height) 27.1% (31.6% in 2013-2021)
- cut, puncture, scrape 10.4% (7.0% in 2013-2021)
- caught in, under or between 10.2% (7.1% in 2013-2021)
- struck by 9.7% (11.4% in 2013-2021)
- overexertion, strain 8.5% (9.9% in 2013-2021)
- falls from height 7.4% (8.3% in 2013-2021)

2022 saw the largest increases in LWI for the categories of cut, puncture, scrape (increase of 3.4% compared with 2013-2021 average reported annual figures) and caught in, under or between (3.1% increase) see **Figure 3**. The proportion of recorded LWI is generally similar in 2022 and 2013-2021 for Manufacturing and Marketing sectors. The largest change in the proportion of LWI attribution in Manufacturing is a 2.3% increase in the proportion of cut, puncture or scrape category incidents in 2022 compared with 2013-2021. In Marketing the largest shift in LWI attribution is a 2.9% decrease in the proportion of slips and trips incidents.

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

- For the most frequent LWI category, slips & trips, the staff / contractor split in 2022 is 54 / 46 %, more evenly distributed than in 2021 (59 / 41%)
- The main causal factor attributed to 154 slips & trips incidents in 2022 was Human factors (63%). For own staff slips and trips, Human factors was associated with 67% of incidents and for contractors this figure is 44%.
- The next most frequent LWI category is cut, puncture, scrape with a staff / contractor split of 37 / 63% (38 / 62% in 2021) and caught in, under or between with a staff / contractor split of 33 / 67% in 2022 (32 / 68% in 2021)
- The LWI categories with the greatest difference between staff and contractors in 2022 are confined space (100 / 0%) and water related, drowning (0 / 100%).
- There were more reported contractors LWI than own Staff LWI in 2022 for the following incident categories: caught in, under, between, cut, puncture, scrape; exposure electrical, falls from height, staff hit by falling object and exposure, noise, chemical, biological, vibration

No direct correlation is observed between categories of LWI and fatalities in the period 2013 – 2022 (**Figure 4**). However, a focus on reducing LWI in the following areas may have the potential to address the causes of 57 fatalities recorded since 2013. These areas are:

- Process Safety to address explosion or burns related incidents
- Operational safety focused on working at height and on actions to prevent incidents in the category struck by
- Road accidents

Figure 4 LWI and Fatalities 2013-2022 by Incident Category

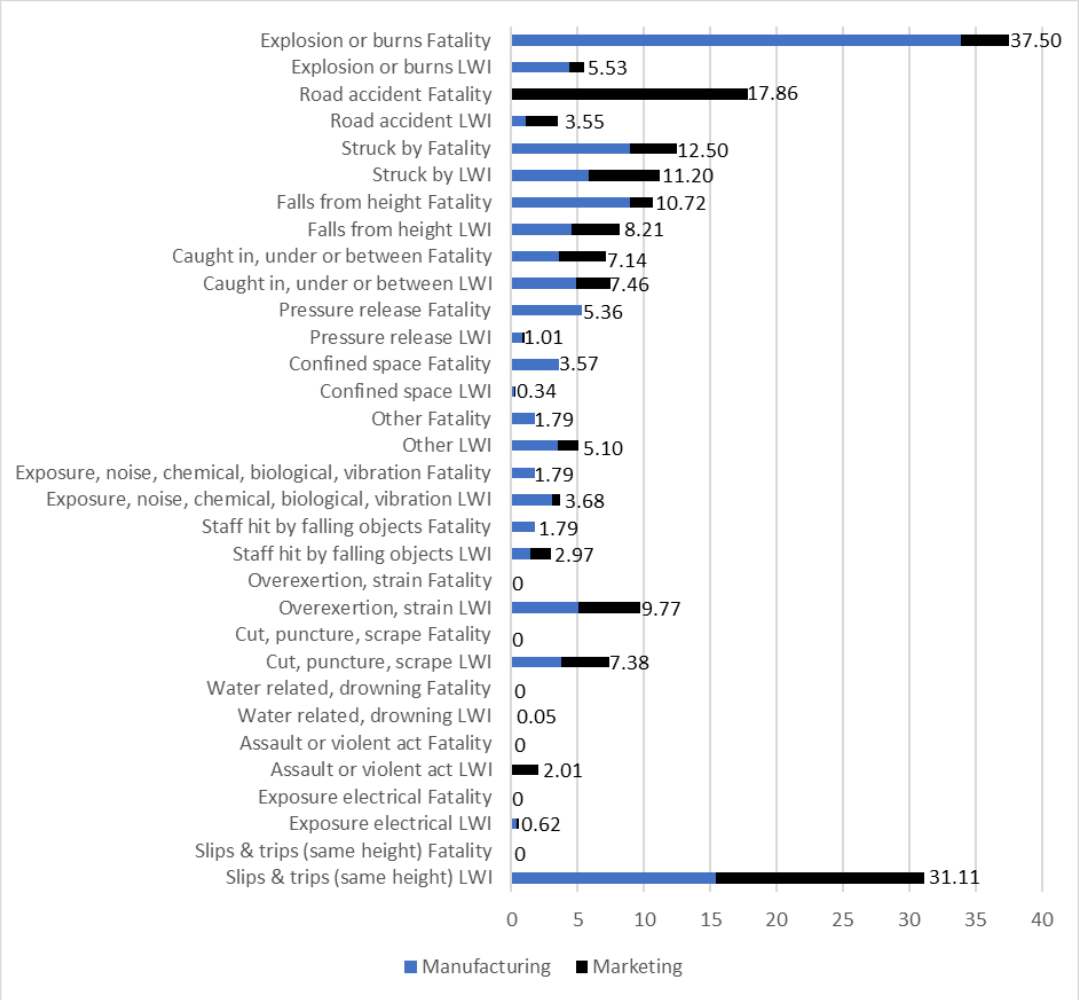


Figure 5A shows the historical evolution of the main personal safety performance indicators over the past ten years across all workers. With ten fatal incidents (with 11 casualties) in 2022, the Fatal Accident Rate (FAR) across all sectors is 2.02 in 2022, the highest rate recorded. The LWIF of 1.05 in 2022 is the highest since 2015 (when it was 1.25). Similarly, the All Injury Frequency AIF of 2022 at 1.82 is the highest since 2018 (when it was 1.89). The Road Accident Rate RAR in 2022 is 0.17, the lowest recorded in the last ten years. The total recorded distance driven in 2022 (1164 million km) is 96% higher than in 2021 (see **Table A2-1**). **Figures 5B and 5C** show the same data split for Manufacturing and Marketing, respectively.

Figure 5A Performance indicators over the last ten years for the European downstream oil industry

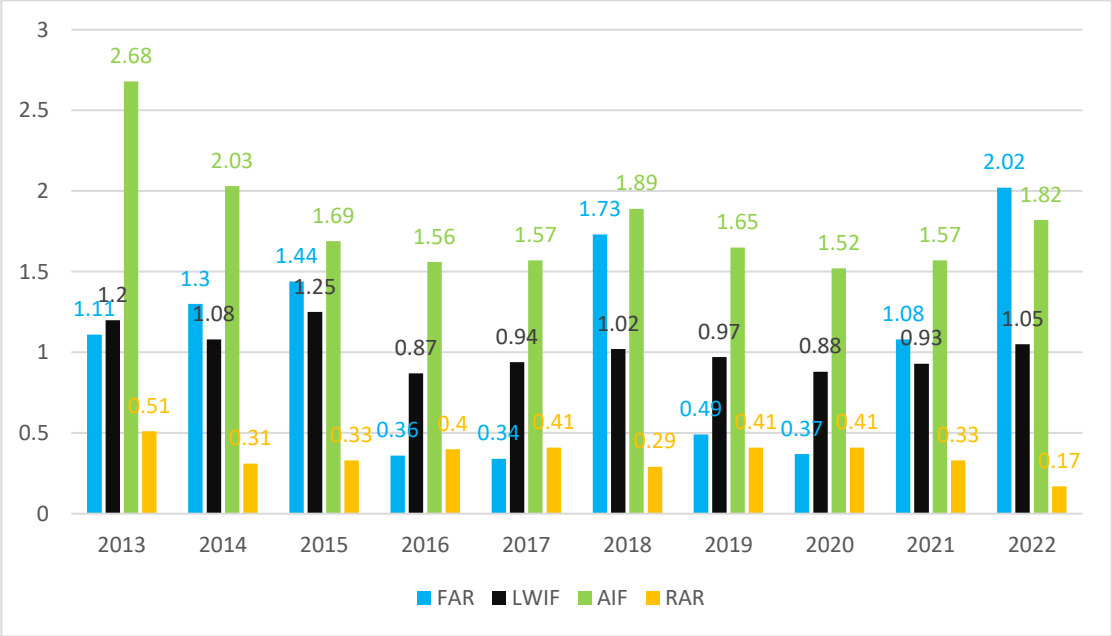


Figure 5B Performance indicators over the last ten years for Manufacturing

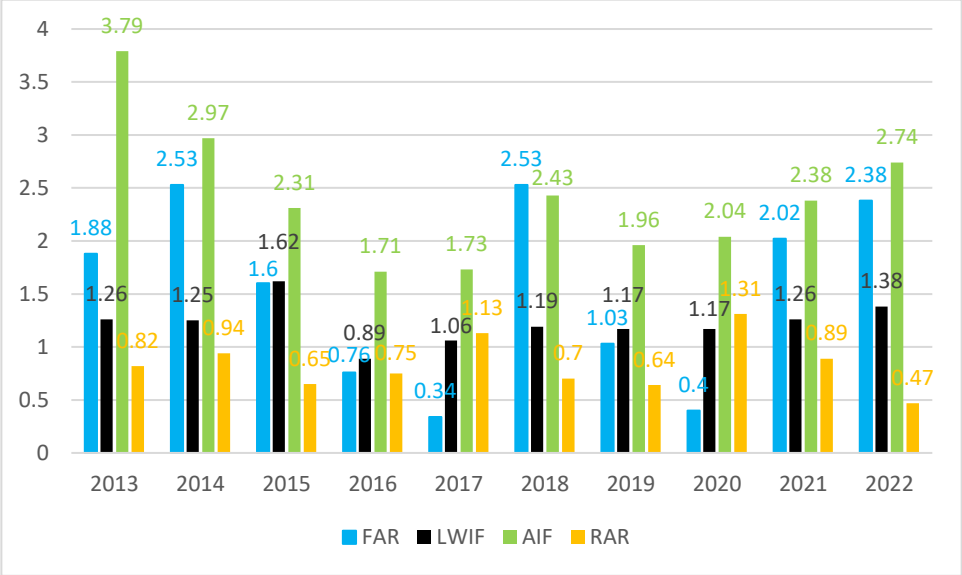
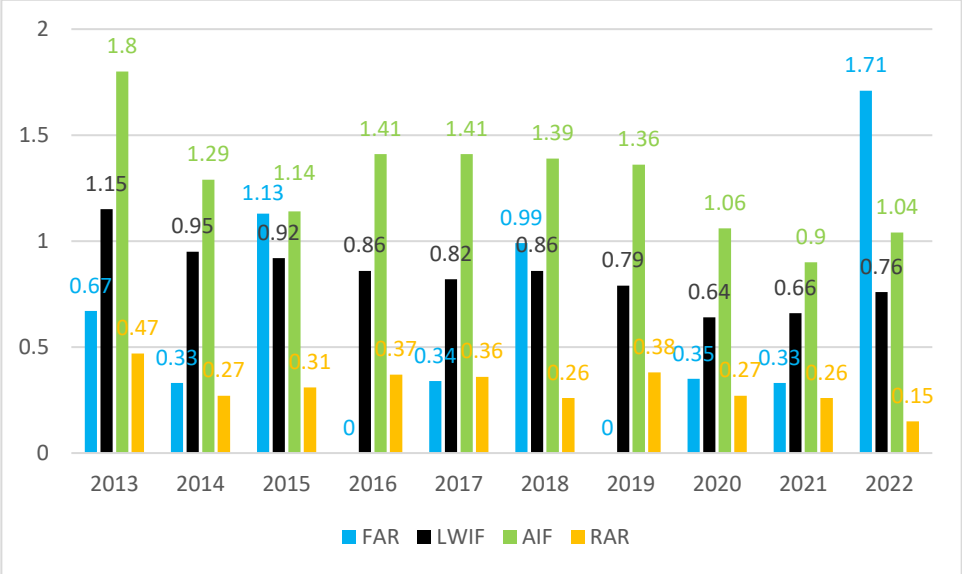
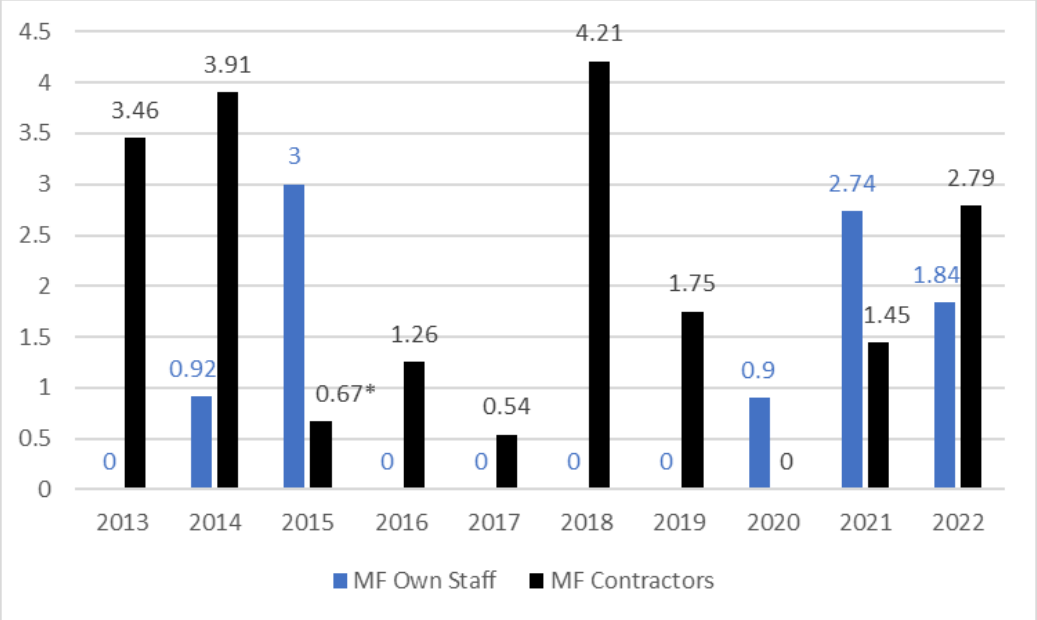


Figure 5C Performance indicators over the last ten years for Marketing



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 ten years. Further effort is required to reduce staff and contractor fatalities to zero.

Figure 6A Manufacturing Fatal Accident Rate (number of fatalities per 100 million hours worked) in the last ten years



****Previously reported as 1.34. The current value of 0.67 is based on new information reported in 2023 that the number of manufacturing contractor fatalities in 2015 is 1 instead of 2.***

Figure 6B Marketing Fatal Accident Rate (number of fatalities per 100 million hours worked) in the last 10 years

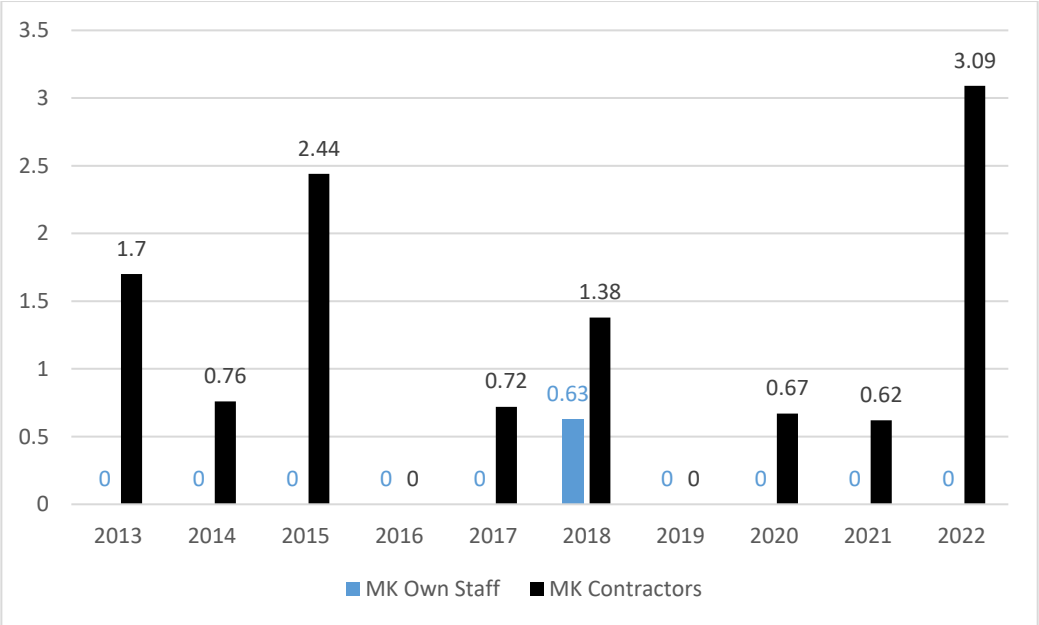
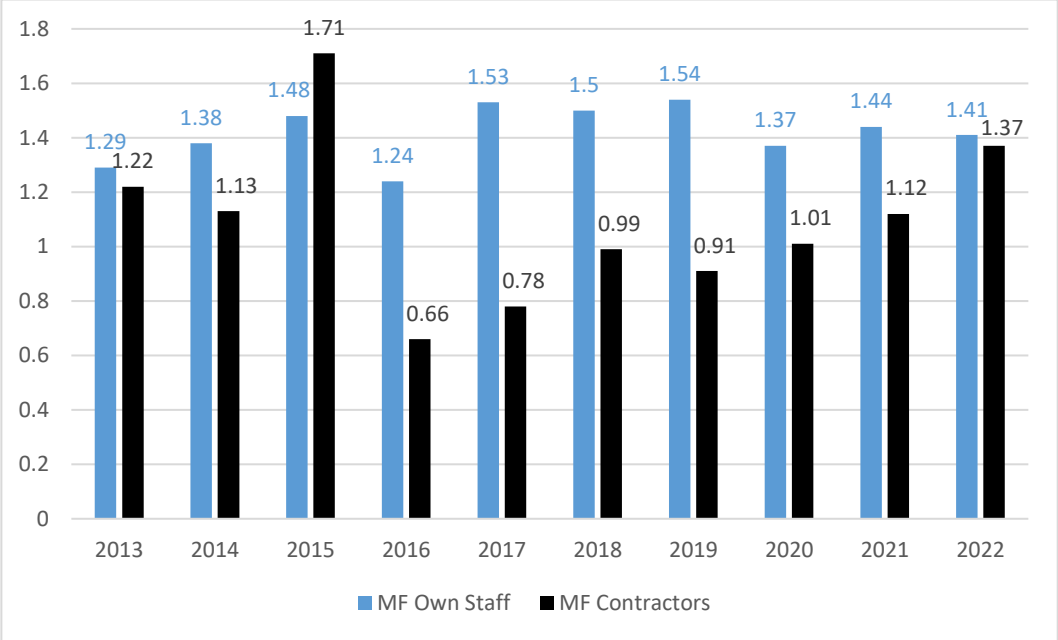


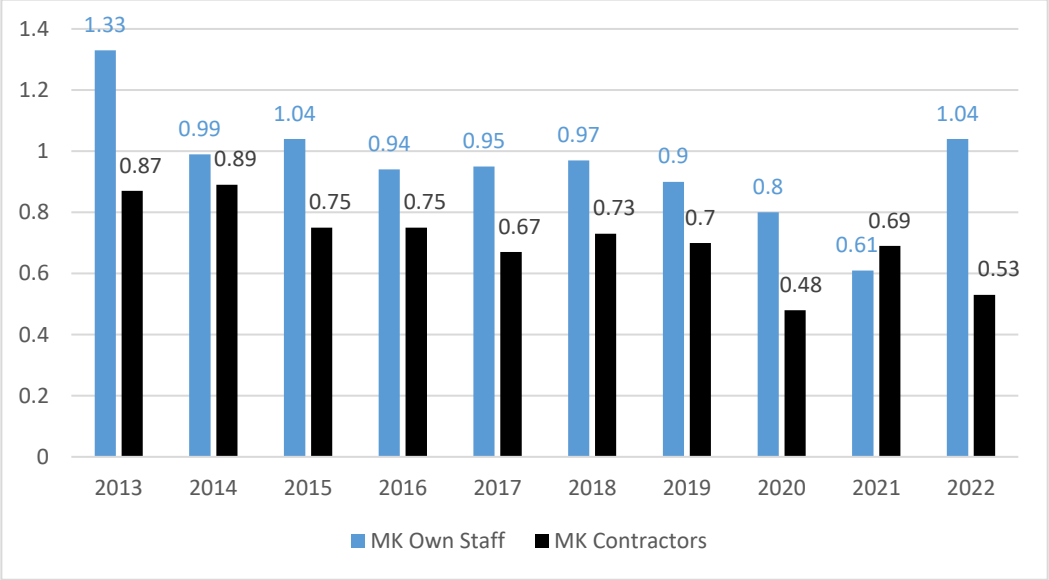
Figure 7A shows Manufacturing own staff LWIF in 2022 at 1.41, within the range of LWIF recorded in the last ten years (1.24 – 1.54). Manufacturing contractor LWIF is consistently lower than Manufacturing own staff over the last six years, however it is of concern that the 2022 value at 1.37 is more than double that in 2016 since which time it has been steadily increasing.

Figure 7A Manufacturing LWIF in the last ten years



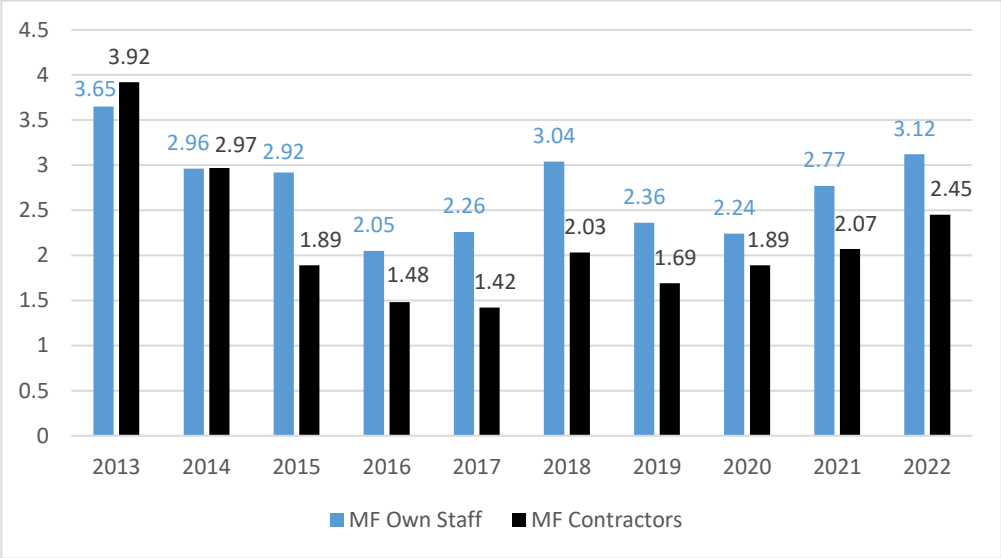
In 2022, Marketing own staff had the highest LWIF recorded (1.04) since 2013. Marketing contractors LWIF reduced in 2022 to 0.53 from 0.69 in 2021 and is currently lower than in most of the last 10 years (see **Figure 7B and Appendix 2 Table A2-4**).

Figure 7B Marketing LWIF in the last ten years



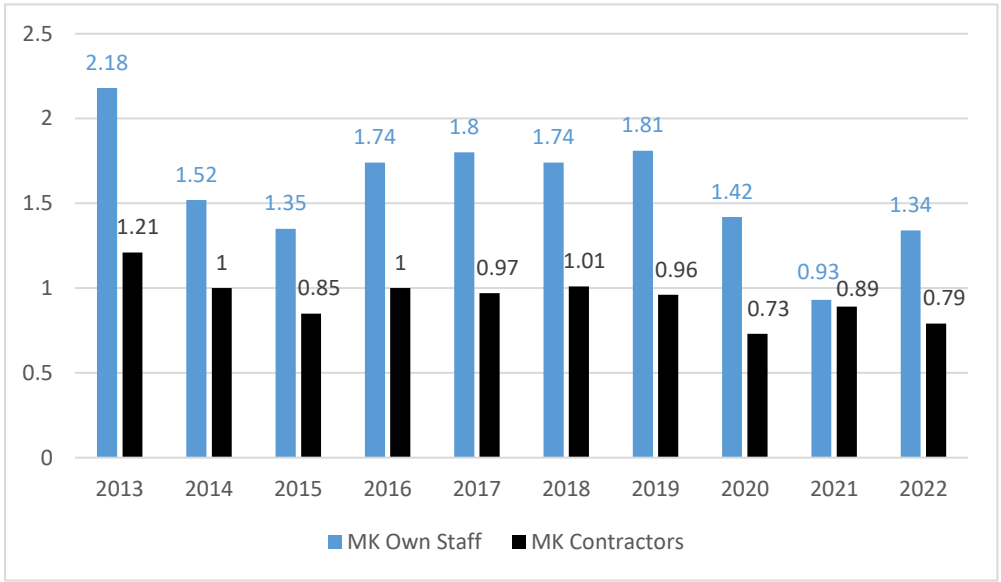
Historical figures (see **Appendix 2**) suggest that AIF peaked around 1996-97 but this was considered at the time likely the result of improved reporting standards. The downward trend in recorded Manufacturing AIF since 2010 ended in 2016 for staff and in 2017 for contractors. Since then, own staff and contractor AIF in Manufacturing have increased to 3.12 and 2.45, respectively in 2022 (**Figure 8A**).

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



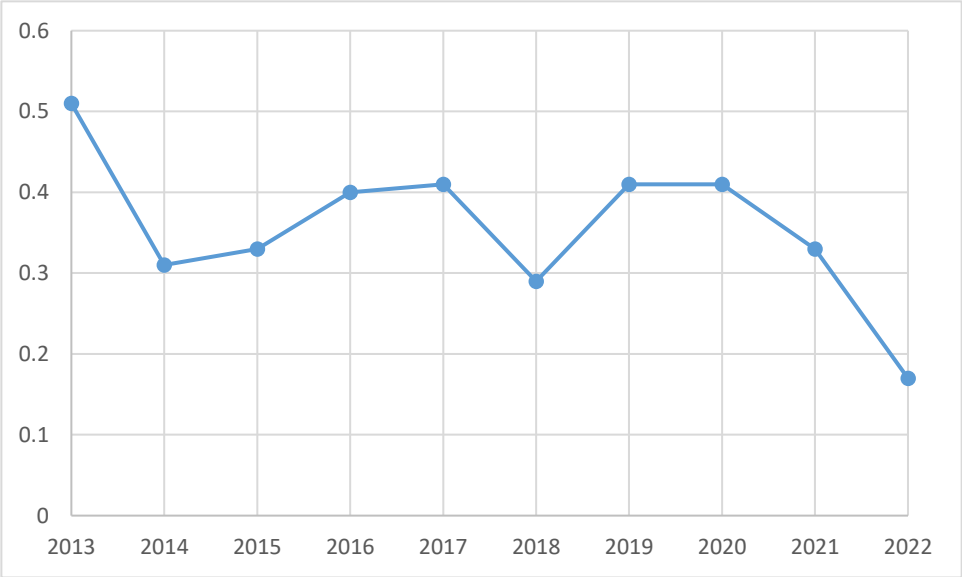
Marketing own staff AIF in 2022 at 1.34 is an increase since 2021 but still lower than those recorded in other years. For Marketing contractors with an AIF at 0.79, this is also at the lower end of the range recorded in the last ten years (0.73-1.21), see **Figure 8B** and **Appendix 2 Tables A2-4** and **A2-5**.

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



With a slight decrease in number of road accidents (205 in 2022 compared with 221 in 2021) and a 96% increase in kilometres driven in 2022 (1164 million km in 2022 compared with 593 million km in 2021), the Road Accident Rate in 2022 dropped from 0.33 in 2021 to 0.17, the lowest rate recorded by Concawe. The large increase in recorded distance driven is associated mainly with member companies reporting this data for the first time. Road safety has been a major focus for the industry and a sustained effort is required in order to improve performance. Road accidents mainly occur in the Marketing activity where the bulk of the driving takes place (Manufacturing 6% and Marketing 94% of total driving distance reported in 2022).

Figure 9 Road Accident Rate in the last ten years - 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 [29, 30]. 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 754 in 2008 [29] and as further refined in the ANSI/API recommended practice that was published in 2010 [30] and the third edition released in 2021 [36]. The PSPI-data that were requested are the number of Tier 1 and 2 Process Safety Events (PSE). Concawe does not explicitly instruct member companies as to which material hazard classification option should be used when determining PSE Tier 1/2. 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 [31] as an alternative for classifying the PSE. In 2017, Concawe moved to reporting in line with the revised definitions of the second edition of the API Recommended Practice 754 (2016) [34] that was followed by the third edition in 2021 [36]. More detailed consequence related Tier 1 data was collected for the first time in 2022 based on the API 754 consequence classifications.

In 2022, 39 companies and joint ventures submitted PSE data for the Manufacturing operations, three less than in 2021 and 22 companies submitted Marketing PSE data, two more than last year.

The aggregated 2022 results per sector and for the whole of the European downstream oil industry are shown in **Table 8**.

Table 8 Aggregated 2022 Process Safety (PS) results for all reporting companies

Sector	Manufacturing	Marketing	Both Sectors
Companies - Total	40	27	27
- PS Reporting	**39**	**22**	**22**
- %	98	81	81
Hours worked - Total Mh	251.7	293.2	544.9
- PS Reporting	251.0	257.2	508.3
- %	98	81	81
T-1 PSE	61	5	66
T-2 PSE	147	13	160
T-1 PSER PSI/Mh reported	0.24	0.02	0.13
T-2 PSER PSI/Mh reported	0.58	0.05	0.31
Total PSER PSI/Mh reported	0.82	0.07	0.44

Of the 22 companies that reported Process Safety Events across both Manufacturing and Marketing, six companies reported zero Tier 1 events, 3 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 decreased by 9 % in 2022 from 228 in 2021 to 208 in 2022, see **Figure 15**.

The ratio of Tier 1 to Tier 2 Manufacturing process safety events in 2022 is 0.42 (61 Tier 1 and 147 Tier 2). This is lower than both the 2021 ratio of 0.49 (75 Tier 1 and 153 Tier 2) and the 2020 ratio of 0.52, but remains in the range of ratios recorded since 2017 (0.32-0.64).

The Manufacturing Tier 1 PSE rate (PSER – number of Tier 1 process safety events per million hours reported) in 2022 was lower at 0.24 compared with 0.30 in 2021 and 0.25 in 2020. However, lower Manufacturing Tier 1 PSER have been recorded in previous years (0.19 in 2019, 0.16 in 2018 and 0.14 in 2017). The Manufacturing Tier 2 PSER was also lower in 2022 at 0.58, compared with 0.61 in 2021. Lower Manufacturing Tier 2 PSER have been recorded (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 2022, twelve Manufacturing Tier 1 events (and zero Marketing Tier 1 events) equal to almost 20% of Tier 1 events, were associated with two Manufacturing staff fatalities as a result of a single explosion and fire and 12 LWI. This is a slight decrease in number of Tier 1 PSE related-injuries compared with 2021 when 17 Tier 1 events (22% of all Tier 1 events) were associated with 17 LWI and three fatalities. In 2020 five Tier 1 PSE (7.6% of Tier 1 PSE in 2020) resulted in 5 LWI.

The Tier 1 incident leading to the double fatality (manufacturing staff) was reported as an explosion and burn categorized incident with causal factors assigned as human factors and procedures.

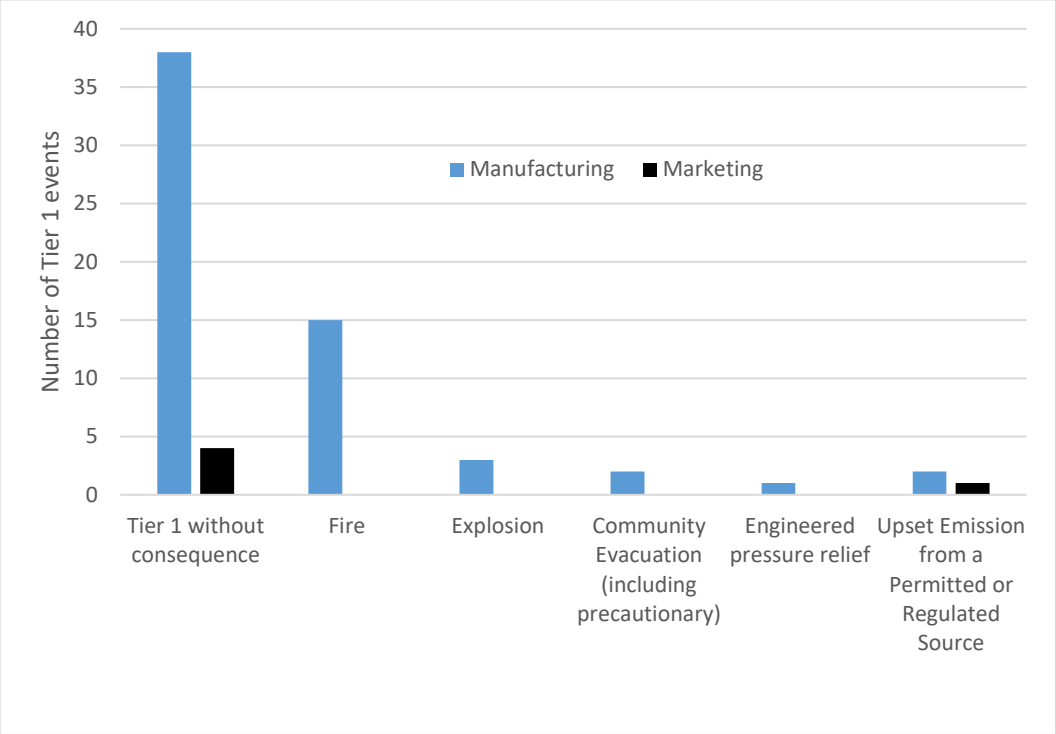
Of the 12 LWI associated with Manufacturing Tier 1 events, four LWI were categorized as “exposure, noise, chemical, biological, vibration” three LWI were categorized as “explosion or burns”, three LWI were categorized “pressure release”, one as struck by and one as “other”.

“Change management” was the most commonly assigned causal factor (five assignments) for these Tier 1 events leading to LWI. “equipment reliability”, “design” and “safe working practices or procedures” were the next most frequently assigned causal factors (three assignments each).

As in 2021 and 2020, no Tier 2 PSE were reported to be associated with RWI or MTC in 2022.

For the first time in 2022, Concawe collected information about the consequences of the 61 Manufacturing and 5 Marketing Tier 1 process safety events. No consequence was recorded for 38 Manufacturing and 4 Marketing Tier 1 PSE. The most commonly recorded consequence of Manufacturing Tier 1 was Fire (15 Tier 1 PSE), see **Figure 10**.

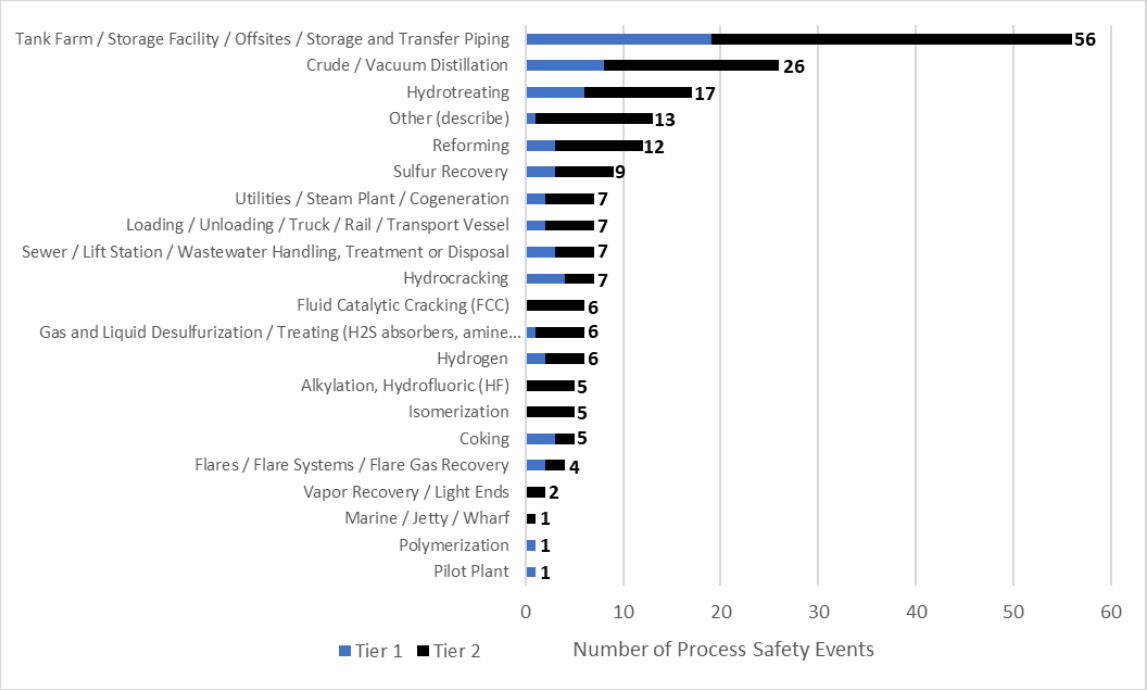
Figure 10 Consequences of Tier 1 process safety events



Information for the combined 226 Tier 1 and Tier 2 PSE across Manufacturing and Marketing in 2022 are provided in table form in **Appendix 4**. The following comments relate to the notable responses within each category.

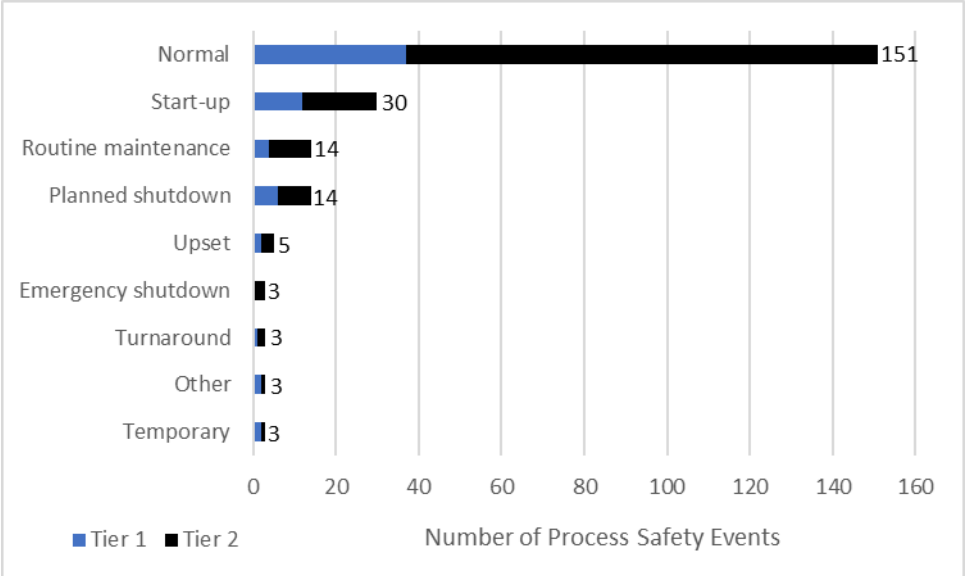
Type of Process: Process Safety Events in 2022 most frequently occurred in storage facilities or transfer piping (25% of all Process Safety Events, 29% of Tier 1 PSE and 23% of Tier 2 PSE), see **Figure 11** and **Table A4-1**. This finding is in alignment with recorded PSE since 2017. Note that five PSE Tier 1 and 18 Tier 2 PSE attributed to petrochemical processes are not included in **Figure 11** as this refers to refining processes only.

Figure 11 Number of Tier 1 and 2 Process Safety Events (Manufacturing and Marketing) reported in 2022 by Refining Process



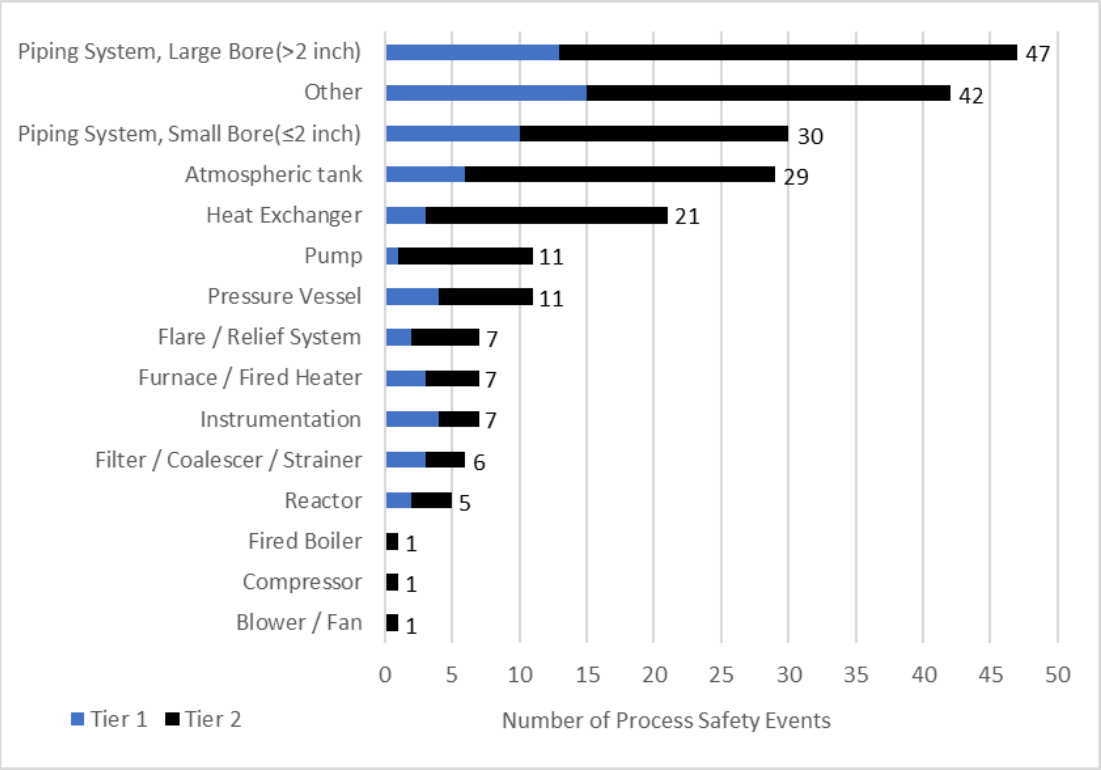
Mode of Operation: Sixty-six percent of Process Safety Events occurred during normal operation, see **Figure 12** and **Table A4-3**. For Tier 1 events, 56% occurred during normal operation and 70% of Tier 2 events occurred during normal operation. The overall percentage is in line with data since 2017.

Figure 12 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2022 by mode of operation



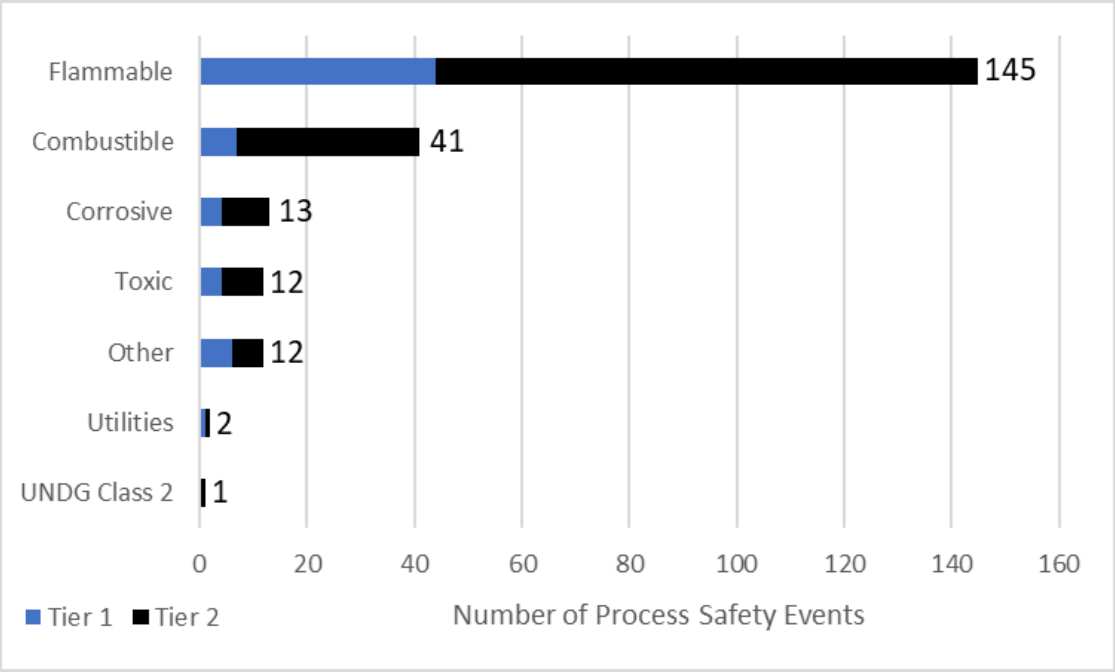
Point of Release: As in previous years, large bore piping remained the main point of release for Process Safety Events (21% of all PSE in 2022, 20% of Tier 1 and 21% of Tier 2 events), see **Figure 13** and **Table A4-4.**

Figure 13 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2022 by point of release



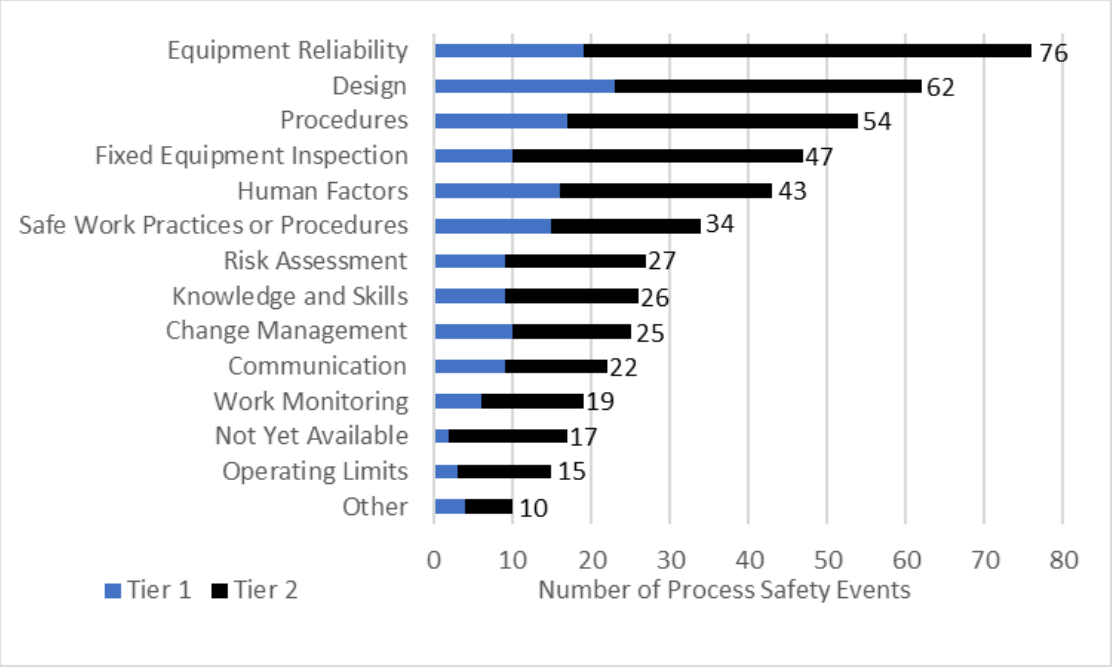
Type of material: Figure 14 and **Table A4-5** indicate that flammable material was most frequently released in Process Safety Events in 2022 (63% of all PSE, 78% of Tier 1 and 62% of Tier 2 events). Again, this aligns with data from the previous three years.

Figure 14 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2022 by type of material released



Causal Factors: Equipment Reliability (allocated to 30% of events), Design (24%), Fixed Equipment Inspection (19%) and Procedures (17%) are the most frequently cited causal factors across all Process Safety Events in 2022, see **Figure 15** and **Table A4-6**. For Tier 1 PSE the most frequently cited causal factors are Design (27%), Change Management (18%), Equipment Reliability (18%) and Human Factors (16%). Equipment Reliability was cited most frequently as a causal factor of Tier 2 PSE (allocated to 36% of Tier 2 PSE), Design (24%), Fixed Equipment Inspection (23%) and Procedures (22%) were also cited.

Figure 15 Number of Tier 1 and Tier 2 Process Safety Events (Manufacturing and Marketing) reported in 2022 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 events are investigated in detail within member companies and considerable effort is expended in identifying root causes and responding accordingly. As with fatalities and LWI 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 event 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	0.5
Q2	1	3	2.6
Q3	4	8	6.0
Q4	8	20	14.9

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

Manufacturing PSE			
PSE	Low	High	Average
Q1	0	1	0.4
Q2	1	3	2.6
Q3	3	7	5.3
Q4	8	18	13.8

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	0.25	0.08
Q2	0.26	0.51	0.39
Q3	0.63	1.61	1.06
Q4	1.75	7.89	3.71

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

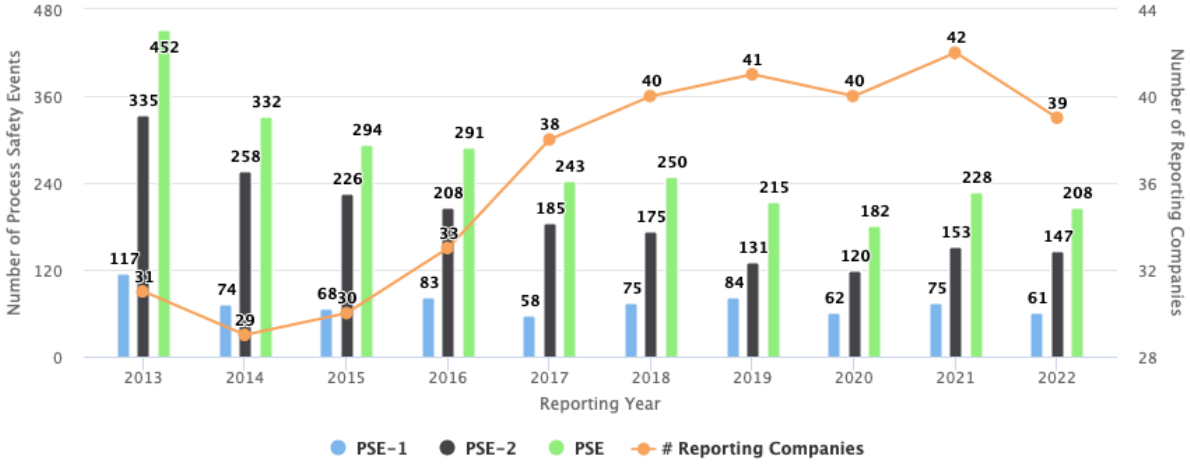
Manufacturing PSER			
PSER	Low	High	Average
Q1	0.00	0.34	0.11
Q2	0.44	0.76	0.60
Q3	0.76	2.10	1.36
Q4	2.17	7.89	3.85

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	0.03	0.15	0.09
Q4	0.16	0.40	0.29

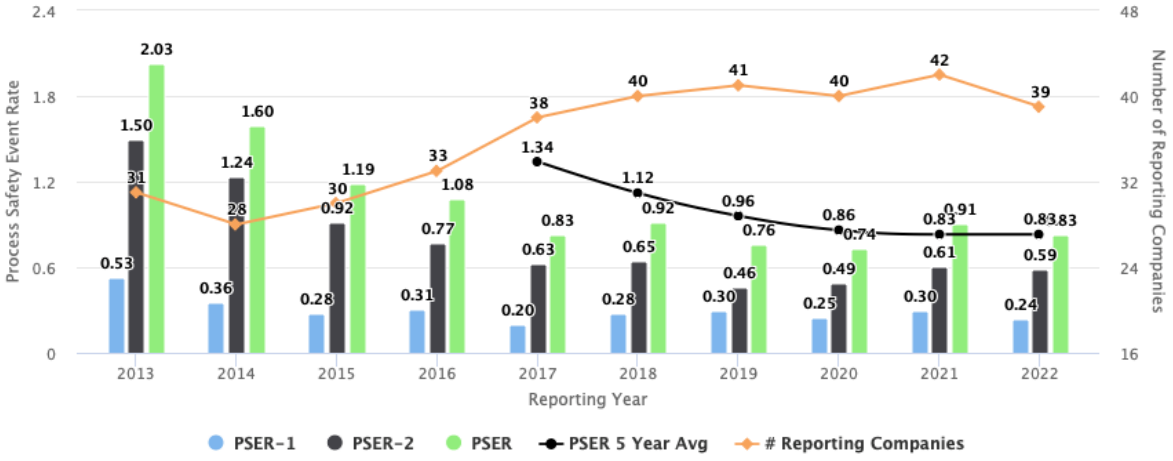
Figure 16 shows counts of the total reported Manufacturing PSE for the period 2013 to 2022. **Figure 17** shows the same data expressed as rates. The data given are for Manufacturing, as only that data is sufficiently robust to allow the analysis provided in these presentations.

Figure 16 Manufacturing Process Safety Events in the last ten years



The number of companies reporting Manufacturing PSE (39) is the lowest recorded since 2018. The total number of Manufacturing Tier 1 and Tier 2 events has decreased in 2022 and is within the range recorded in the last 4 years.

Figure 17 Manufacturing Process Safety Event Rate in the last ten years



2022 saw a plateau in the 5-year rolling average of Manufacturing PSER despite slight reductions since last year in both Tier 1 PSER and Tier 2 PSER.

4. COMPARISON WITH OTHER SECTORS

Most of the safety performance indicators used in the oil industry 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 [32]. In comparison with IOGP statistics for European onshore, Concawe recorded a 2.02 fatality rate, a 1.05 LWIF and 1.82 AIF. These Concawe rates include marketing activities, which are typically not represented in the IOGP data.

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

	Concawe 2022	International Association of Oil & Gas Producers IOGP 2022	
		Europe Onshore	Europe Onshore & Offshore
FAR	2.02	0	0
LTIF	1.07	0.57	0.77
AIF*	1.82	1.03	1.82

FAR is per 100 million work hours
LTIF and AIF per million work hours
*AIF reported as Total Recordable Injury Rate (TRIR) by IOGP (number of recordable injuries (fatalities + LWI + RWI + MTC) per million 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 1.6 per 100 full-time workers in 2021 [33]. 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 2021 LTIF expressed per 200,000 work hours is 0.19.

The US Refining Tier 1 and 2 PSE rates recorded by API for 2022 are 0.0682 and 0.1728, respectively [35]. The Concawe rates are 0.026 and 0.062 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) [29, 30]. 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. 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	LWI Frequency is calculated from the number of LWIs divided by the number of hours worked expressed in millions.
15. LWIS	LWI Severity is the total number of days lost as a result of LWIs divided by the number of LWIs.
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 (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 [18-28] 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 (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 [18-28] for further details
25. 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.
	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.
LWI Frequency (LWIF) and LWI 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, RWI and 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 LWI 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 2022

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	7	1.26	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
2022	11	2.02	1.82	1.05	31	0.2	544.9	1,164

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
2022	2	1.84	3.12	1.41	36

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	1*	0.67*	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
2022	4	2.79	2.45	1.37	29

**Previously reported as 2 fatalities and FAR of 1.34.*
The current values are consistent with new information reported in 2023

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
2022	0	0.00	1.34	1.04	26

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	0.69	24
2022	5	3.09	0.79	0.53	33

Table A2-6 LWI causes 2018-2022 – Staff and Contractors in both Manufacturing and Marketing

		LWI 2022				2021	2020	2019	2018
Causes		**Manufacturing**	**Marketing**	**Combined**	**%**	**%**	**%**	**%**	**%**
Road Accident	Road Accident	7	8	15	2.6	3.1	3.4	3.4	3.4
Heights/Falls	Falls from height	25	17	42	7.4	7.8	5.5	8.3	9.6
	Staff hit by falling objects	6	7	13	2.3	2.1	1.9	3.1	2.6
	Slips & trips (same height)	80	74	154	27.1	26.9	29.2	37.8	33.0
Burn/Electrical	Explosion or burns	20	9	29	5.1	6.0	6.1	3.2	6.5
	Exposure electrical	3	0	3	0.5	1.0	0.4	0.9	0.2
Confined Space	Confined Space	1	0	1	0.2	0.8	0.4	0.2	0.3
Other Causes	Assault or violent act	0	5	5	0.9	1.6	1.1	2.0	1.9
	Water related, drowning	1	0	1	0.2	0.2	0.0	0.0	0.0
	Cut, puncture, scrape	33	26	59	10.4	9.4	9.2	6.5	8.6
	Struck by	34	21	55	9.7	10.5	13.0	13.3	11.5
	Exposure, noise, chemical, biological, vibration	24	1	25	4.4	4.9	4.8	4.1	3.1
	Caught in, under or between	36	22	58	10.2	7.8	7.1	8.0	7.2
	Overexertion, strain	28	20	48	8.5	9.6	8.2	5.5	5.5
	Pressure release	7	0	7	1.2	1.6	1.7	0.7	0.7
	Other	40	13	53	9.3	6.8	8.0	3.1	5.8
	Total	345	223	568	100	100	100	100	100

APPENDIX 3 LWI 2022 - CAUSAL FACTORS

		Number of Causal Factors assigned to LWI (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	2	0	0	0	1	0	0	1	1
Manufacturing	Caught in, under or between	1	6	2	2	1	13	5	0	10	11	12	3	5	5
Marketing	Caught in, under or between	0	1	0	0	1	15	1	1	0	0	2	1	1	3
Manufacturing	Confined space	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Marketing	Confined space	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacturing	Cut, puncture, scrape	0	2	2	4	1	13	6	0	4	8	10	1	3	5
Marketing	Cut, puncture, scrape	1	0	0	2	0	14	1	0	3	6	2	0	2	2
Manufacturing	Explosion or burns	2	2	9	3	1	6	5	0	2	8	8	5	4	6
Marketing	Explosion or burns	0	0	0	2	0	2	1	0	3	1	3	0	2	0
Manufacturing	Exposure electrical	0	0	0	1	0	1	0	0	1	0	0	0	0	1
Marketing	Exposure electrical	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacturing	Exposure, noise, chemical, biological, vibration	1	1	6	3	0	4	2	0	6	4	15	1	1	1
Marketing	Exposure, noise, chemical, biological, vibration	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Manufacturing	Falls from height	0	1	4	2	0	15	4	0	5	7	11	4	2	2
Marketing	Falls from height	0	1	1	0	0	9	2	0	4	6	2	1	0	1
Manufacturing	Other	0	0	5	5	1	13	2	0	2	4	8	0	12	1
Marketing	Other	1	0	0	0	0	8	0	0	0	1	1	0	2	0
Manufacturing	Overexertion, strain	0	0	4	0	0	9	4	0	2	12	10	1	3	2
Marketing	Overexertion, strain	1	0	3	1	1	13	2	0	4	3	3	0	1	0
Manufacturing	Pressure release	3	4	1	0	0	2	2	0	1	0	5	2	1	0
Marketing	Pressure release	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacturing	Road accident	0	0	0	1	1	3	0	0	0	0	0	0	4	1
Marketing	Road accident	0	0	0	1	0	4	1	0	0	1	0	0	3	0
Manufacturing	Slips & trips (same height)	2	4	9	2	1	44	8	0	7	20	11	4	23	10
Marketing	Slips & trips (same height)	0	1	7	6	1	53	4	0	3	9	5	1	10	1
Manufacturing	Staff hit by falling objects	1	1	1	1	0	1	1	0	2	2	0	3	2	3
Marketing	Staff hit by falling objects	0	0	1	1	1	2	0	0	0	1	2	1	0	1
Manufacturing	Struck by	0	5	7	2	0	16	4	0	4	7	16	5	5	0
Marketing	Struck by	1	0	5	1	0	9	2	0	4	8	4	1	3	1
Manufacturing	Water related, drowning	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Marketing	Water related, drowning	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	15	29	68	40	10	271	57	1	67	121	131	34	91	47

APPENDIX 4 PROCESS SAFETY EVENTS 2022

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

Type of Process: Refining	Number of Tier 1	Number of Tier 2
1. Active Warehouse	0	0
2. Alkylation, Hydrofluoric (HF)	0	5
3. Alkylation, Sulfuric	0	0
4. Bitumen / Resid / Asphalt	0	0
5. Calcining	0	0
6. Coking	3	2
7. Crude / Vacuum Distillation	8	18
8. Flares / Flare Systems / Flare Gas Recovery	2	2
9. Fluid Catalytic Cracking (FCC)	0	6
10. Gas and Liquid Desulfurization / Treating (H2S absorbers, amine systems, Merox)	1	5
11. Hydrocracking	4	3
12. Hydrogen	2	4
13. Hydrotreating	6	11
14. Isomerization	0	5
15. Loading / Unloading / Truck / Rail / Transport Vessel	2	5
16. Marine / Jetty / Wharf	0	1
17. Other (describe)	1	12
18. Pilot Plant	1	0
19. Polymerization	1	0
20. Reforming	3	9
21. Sewer / Lift Station / Wastewater Handling, Treatment or Disposal	3	4
22. Sulfur Recovery	3	6
23. Tank Farm / Storage Facility / Offsites / Storage and Transfer Piping	19	37
24. Utilities / Steam Plant / Cogeneration	2	5
25. Vapor Recovery / Light Ends	0	2
Total	**61**	**142**

Table A4-2 Tier 1 and 2 Process Safety events 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	1
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	1	0
15. ethylene and derivatives	1	2
16. ethylene dichloride and derivatives	0	0
17. ethylene oxide	0	0
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)	1	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)	1	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	0
43. propylene	0	0
44. propylene oxide and derivatives	1	1
45. specialty chemicals	0	0
46. styrene-butadiene	0	4
47. synthesis gas (CO, H2),	0	0
48. tank farm/storage facility/offsite/storage & transfer piping	0	0
49. toluene	0	2
50. utilities/steam plant/cogeneration	0	0
51. waste/wastewater handling, treatment or disposal	0	0
52. xylene	0	0
Total	**5**	**18**

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

Mode of Operation	Number of Tier 1 events	Number of Tier 2 events
1. Emergency shutdown	0	3
2. Normal	37	114
3. Other (describe)	2	1
4. Planned shutdown	6	8
5. Routine maintenance	4	10
6. Start-up	12	18
7. Temporary	2	1
8. Turnaround	1	2
9. Upset	2	3
Total	**66**	**160**

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

Point of Release	Number of Tier 1 events	Number of Tier 2 events
1. Atmospheric tank	6	23
2. Blower/Fan	0	1
3. Compressor	0	1
4. Cooling Tower	0	0
5. Filter/Coalescer/Strainer	3	3
6. Fired Boiler	0	1
7. Flare/Relief System	2	5
8. Furnace/fired heater	3	4
9. Heat exchanger	3	18
10. Instrumentation	4	3
11. Other (describe)	15	27
12. Piping system, large bore (>2)	13	34
13. Piping system, small bore (<2)	10	20
14. Pressure Vessel	4	7
15. Pump	1	10
16. Reactor	2	3
Total	**66**	**160**

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

Type of Material released	Number of Tier 1 events	Number of Tier 2 events
1. Combustible	7	34
2. Corrosive	4	9
3. Flammable	44	101
4. Other	6	6
5. Toxic	4	8
6. UNDG Class 2	0	1
7. Utilities	1	1
Total	**66**	**160**

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

Causal Factor	Number times Causal Factor assigned* **Tier 1**	Number times Causal Factor assigned* **Tier 2**
1. Change Management	10	15
2. Communication	9	13
3. Design	23	39
4. Equipment Reliability	19	57
5. Fixed Equipment Inspection	10	37
6. Human Factors	16	27
7. Knowledge and Skills	9	17
8. Operating Limits	3	12
9. Procedures	17	37
10. Risk Assessment	9	18
11. Safe Work Practices or Procedures	15	19
12. Work Monitoring	6	13
13. Other	4	6
14. Not Yet Available	2	15
Total	**152**	**325**

*More than one causal factor may be assigned to a single Tier 1/2 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	Gunvor	Neste	Saras
Gruppo API	H&R	Nynas	Shell
BP	Hellenic Petroleum	OMV	St1
CEPSA	Ineos	Phillips 66	Tamoil
Crossbridge	IPLOM	PKN Orlen	TotalEnergies
ENI	Irving	Preem	Valero
Equinor	Klesch	Q8	Varo
ESSAR	LUKOIL	Repsol	Vitol
ExxonMobil	MOL Group	Rompetrol	
GALP Energia	Motor Oil (Hellas)	Sara	

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