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European downstream oil industry safety performance

Statistical summary of reported incidents – 2012

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ABSTRACT

In this nineteenth annual report on European downstream oil industry safety performance, 2012 statistics are presented on work-related personal injuries for the industry's own employees and contractors. Data were received from 38 CONCAWE Member Companies representing approximately 98% of the European refining capacity. Trends over the last nineteen years are also highlighted and the data are compared to similar statistics from related industries. This report also presents the fourth year of results for Process Safety Performance Indicators from CONCAWE members.

KEYWORDS

Accidents, AIF, CONCAWE, FAR, fatality, incidents, injury, LWI, LWIF, marketing, oil industry, refining, RAR, RWI, safety statistics, Process Safety Performance Indicators, Process Safety Events.

INTERNET

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SUMMARY

The collection and analysis of accident data are widely recognised by the oil industry as an essential element of an effective safety management system.

CONCAWE started compiling statistical data for the European downstream oil industry twenty years ago and this is the nineteenth report on this topic. This report covers data collected for 2012 and includes a full historical perspective from 1993. It also includes comparative figures from other related industry sectors. Data for 2012 were submitted by 38 CONCAWE Member Companies, together accounting for approximately 98% of the refining capacity of EU-28 plus Norway and Switzerland.

The results are reported mainly in the form of key performance indicators that have been adopted by the majority of oil companies operating in Europe as well as by other industry sectors.

Accident frequencies in the European downstream oil industry are generally at low levels and the 2012 performance continue this trend. Standing at 1.3, the Lost Work Incident Frequency (LWIF) indicator for 2012 demonstrates a reduction versus that recorded in 2011 (1.5) and maintains the positive trend of being less than 2.0 as has been the case since 2007. The responsible management of safety in the oil industry has resulted in a low level of accidents despite the intrinsic hazards of the materials handled and the operations carried out.

The fatal accident rate (1.87 per hundred million hours worked) and the total number of fatalities (10) in 2012 were marginally lower than in 2011 (11), consistent with the levels experienced over recent years. Eight of the 10 fatalities were associated with Contractors (4 Manufacturing and 4 Marketing): 3 (30%) were caused by road accidents, 2 (20%) resulted from an explosion during catalyst loading, 2 (20%) were caused by being struck by equipment, 1 (10%) resulted from a fall from height, 1 (10%) resulted from a lack of electrical isolation and 1 (10%) occurred during an armed robbery. Clearly risks associated with driving and maintenance activities continue to be a recurring theme.

For the fourth consecutive year, CONCAWE Member Companies were asked to provide Process Safety Performance Indicator (PSPI) data which describe the number of Process Safety Events (PSE) expressed as unintended Loss of Primary Containment (LOPC). Thirty-three Companies provided data in 2012 which represented a continued increase from the 28 Companies that responded in 2011, 24 in 2010 and 18 in 2009 and represents 87% of the respondents. From these responses, a Process Safety Event Rate (PSER) indicator of 1.7 for all PSEs was recorded. This continues the trend of reduction from 4.1 in 2009, to 2.3 in 2010, 2.0 in 2011 and now 1.7 in 2012.

1. INTRODUCTION

The collection and analysis of accident data are widely recognised by the oil industry as an essential element of an effective safety management system.

CONCAWE started compiling statistical data for the European downstream oil industry twenty years ago and this is the nineteenth report on this topic (see references of past reports in the reference list [1-18]. This report covers data collected for 2012 and includes a full historical perspective from 1993. It also includes comparative figures from other industry sectors where available.

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 but all those who do, collect data separately for “Manufacturing” (i.e. refining) and “Marketing” (i.e. distribution and retail, also including “head office” staff) and this split has also been applied in the CONCAWE data. Additionally, the data are split between own personnel and contractors, the latter being fully integrated in all of the companies’ safety monitoring systems.

The purpose of collecting this information is twofold:

- To provide member companies with a benchmark to compare their performance against, so that they can determine the efficacy of their 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.

From the outset, a majority of CONCAWE member companies have participated so that the sample has always represented a large portion of the industry. By 1995 virtually all CONCAWE members participated, representing about 93% of the European refining capacity (somewhat less for distribution and retail). Over the years this level of participation has peaked to >97%, although the actual number of participating companies fluctuated in line with the structural changes and mergers occurring in the industry as did the percentage of the refining capacity represented. For 2012, 38 Member Companies responded, totalling 97.6% of the refining capacity, although not all companies could supply all the requested data.

The geographical area of coverage is primarily the EU-28 together with Norway and Switzerland.

A number of key performance indicators have been adopted by the majority of oil companies operating in Europe as well as by other industries. Although there are differences in the way different companies collect basic data, these fairly straightforward parameters allow an objective comparison. There are differences noted between companies in their precise definitions or interpretation of metrics, meaning direct comparison of data from different companies could lead to erroneous conclusions. For this reason, CONCAWE does not report individual company data but rather aggregates, averages and ranges of variation.

It is noteworthy that the majority of participating companies are willing to share their data openly with other companies. This reflects the industry approach that safety is a non-competitive issue where all can learn from the experience of others and help each other to improve.

2. PERFORMANCE INDICATORS

A number of safety performance indicators have become “standard” in the oil industry and in many other industry sectors. They are mostly expressed in terms of event frequency - the number of hours worked being the common denominator representing the level of activity. Such parameters have the advantage of relying on a small number of straightforward inputs, which allows meaningful statistical analysis even when the data sets are incomplete. The performance indicators considered in this report are:

- The number of work-related fatalities and the associated Fatal Accident Rate (FAR) is expressed as the number of fatalities per 100 million hours worked.
- The All Injury Frequency (AIF) includes all recordable injuries and is expressed as the number of injuries per million hours worked.[1]
- The Lost Workday Injury Frequency (LWIF) is calculated from the number of LWIs divided by the number of hours worked expressed in millions.
- Related to LWIF is the Lost Workday Injury Severity (LWIS) expressing the average number of lost workdays per LWI.
- The Road Accident Rate (RAR) expressed in number of road accidents per million kilometres travelled.
- The Process Safety Performance Indicators (PSPI) [Appendix 2, 17, 18] measure the number of Process Safety Events (PSEs) expressed as the number of unplanned or uncontrolled releases of any material, including non-toxic and non-flammable materials from a process with the severity defined by the consequences experienced or released amount thresholds.

A more complete set of definitions is given in **Appendix 1** and the PSE criteria are further explained in **Appendix 2**.

There are, however, subtle differences in the way these parameters are used by different companies and how the data is collected and reported. The features, relevance and reliability of each indicator are further discussed below.

Fatalities and FAR

Because of their very low numbers, fatalities and, therefore, FAR are not 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. Indeed the well-known safety triangle suggests that for every fatality there have been many incidents with similar causes but less serious injury outcomes. These less severe incidents provide the opportunities to address equipment, standards, training, attitudes and practices that may prevent the near-misses, relatively minor incidents and, ultimately, the more serious accidents.

LWIF and 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

[1] AIF is often referred to as TRCF – Total Recordable Case Frequency. Refer **Appendix 1**.

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 representative and reliable indicator of all.

Not all companies keep track of the number of lost days, therefore, the overall LWIS has to be calculated taking account only of those companies that report such data.

AIF

As LWIF figures become progressively lower, these appear to reach a plateau and are prone to wider variations in relative terms. Companies that have achieved very low LWIF levels therefore need a more meaningful indicator to monitor trends and detect improvements or deterioration of performance. AIF provides such an indicator, since it records fatalities, Restricted Work Injuries (RWI) and Medical Treatment Cases (MTC) in addition to LWIs. Although it is still less widely used than LWIF, reporting improves year by year with more companies including this indicator into their performance reporting. It should also be noted that not all companies operate a restricted work system and also restricted working is not allowed in some countries, which is a potential cause of some distortion in the AIF data.

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.

RAR

It is no surprise that, since road accidents remain a cause of both fatalities and lost time injuries in the oil industry, a number of companies have chosen to segregate and monitor these separately. The data is still incomplete and there are also issues as to the precise definition of a road accident. 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.

3. 2012 RESULTS

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

Table 1 Submission of results for 2012

No of companies	Manufacturing			Marketing		
	Own staff	Contractors	All workers	Own staff	Contractors	All workers
Submission	38	36		23	19	
Including						
Road accidents[a]	8	5		9	10	
Distance travelled	12	7		15	12	
Process Safety			33			12

a) Several Companies do not report their Road accidents separately and these incidents are included in their overall statistics.

Most companies submitted data for their own Manufacturing and Marketing staff (several companies have no retail activity). Total own staff injuries are recorded by all companies, in the Manufacturing and/or Marketing categories, but this is not the case for lost days. A number of companies do not record road accidents separately and even fewer log the distance travelled. Contractor data are generally less complete.

The PSE data were requested for the fourth time in 2012 for all workers in both Manufacturing and Marketing sectors. A positive outcome of 33 companies submitting PSE data for the Manufacturing operations and 12 of those also included Marketing PSE data. This represents a progressive increase in companies reporting these data from prior years, and demonstrates a greater awareness of the issue. The results are presented in Section 4.

The aggregated 2012 results per sector and for the whole of the European downstream oil industry are shown in **Table 2**. **Figure 1a** shows the average performance indicators and their range of variability amongst reporting companies. **Figures 1b** and **1c** show the results for all injuries and AIF and lost time injuries and LWIF on a cumulative frequency basis which allows individual companies to benchmark their own results against the group. For AIF and LWIF, which are the most universally used indicators, the distribution per quartile and average for each quartile are shown for the different sectors (**Figure 2a/b**).

Table 2 Aggregated 2012 results for all reporting companies

Sector		Manufacturing			Marketing			Both Sectors		
Work Force		OS	CT	AW	OS	CT	AW	OS	CT	AW
Hours worked	Mh	111	134	245	169	120	289	280	254	534
Fatalities		0	4	4	2	4	6	2	8	10
Fatal Accident Rate	F/100 Mh	0.0	3.0	1.6	1.2	3.3	2.1	0.7	3.1	1.9
Lost work incidents	LWI	157	187	344	236	114	350	393	301	694
Lost time through LWI	days	4,528	4,282	8,810	5,772	2,279	8,051	10,300	6,561	16,861
LWI frequency	LWI/Mh	1.4	1.4	1.4	1.4	0.9	1.2	1.4	1.2	1.3
LWI severity*	lost days/LWI	32.3	27.8	30.0	28.2	29.2	28.4	29.9	28.3	29.2
All recordable incidents	AI	510	589	1,099	334	148	482	844	737	1,581
All incidents frequency	AI/Mh	4.6	4.4	4.5	2.0	1.2	1.7	3.0	2.9	3.0
Distance travelled	million km							388	773	1161
Road Accidents	RA							234	224	458
Road Accident Rate+	RA/million km							0.6	0.3	0.4

*) LWIS is calculated for those LWI where lost days are reported
+) RAR is calculated for those RA where distance is reported

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

Figure 1a Average 2012 performance indicators with range of variability

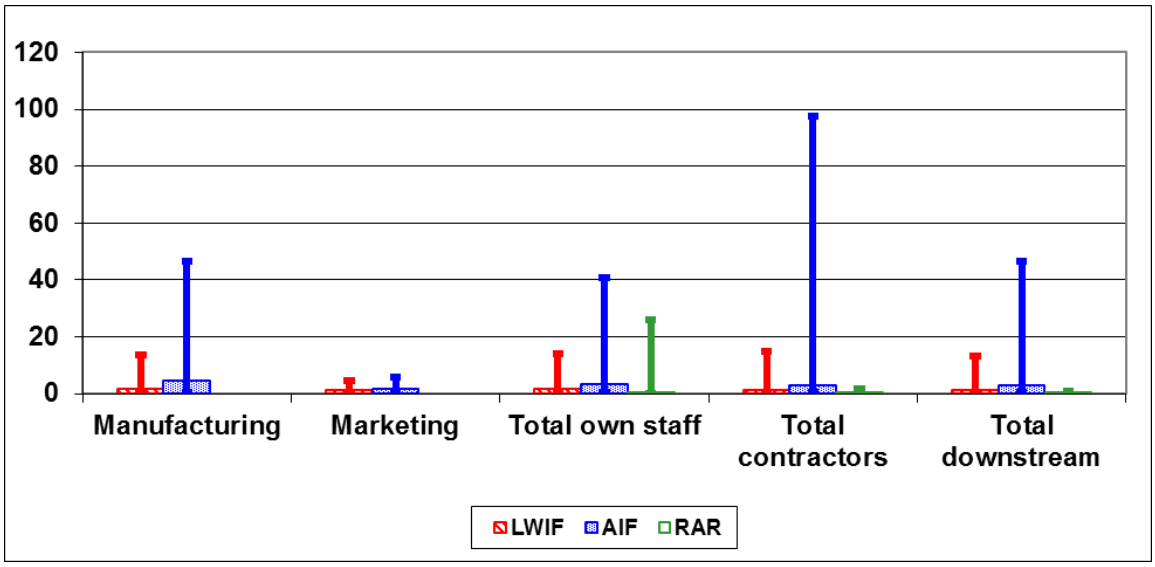


Figure 1b Cumulative Frequency Analysis All Injury Frequency

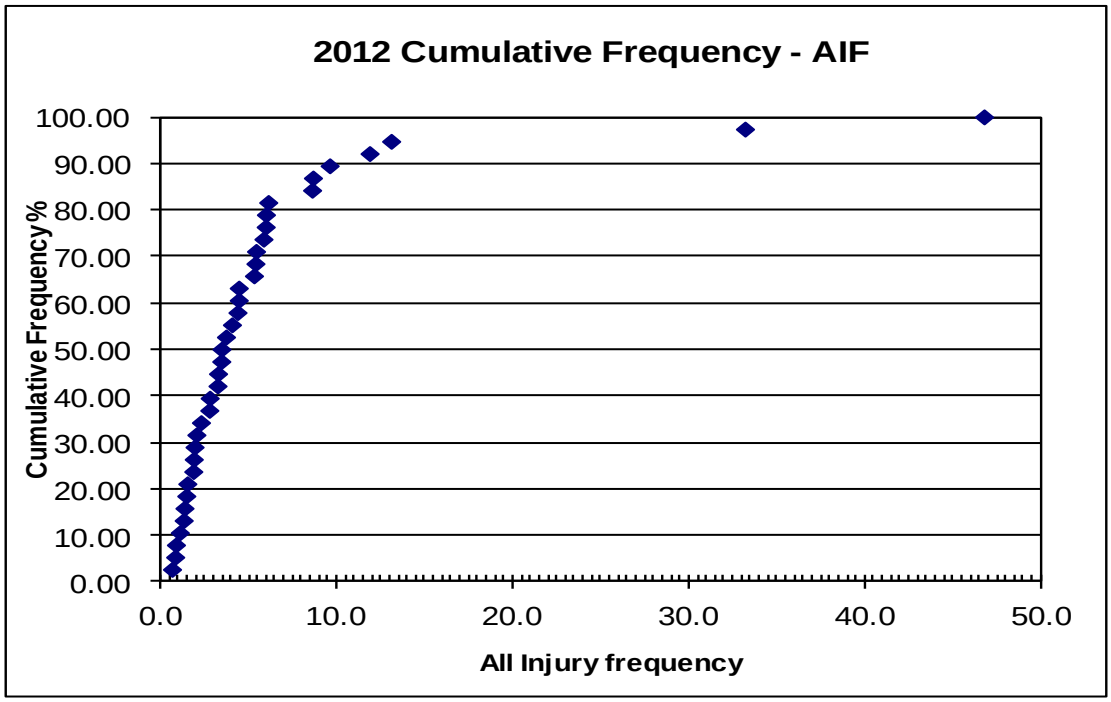


Figure 1c Cumulative Frequency Analysis Lost Work Injury Frequency

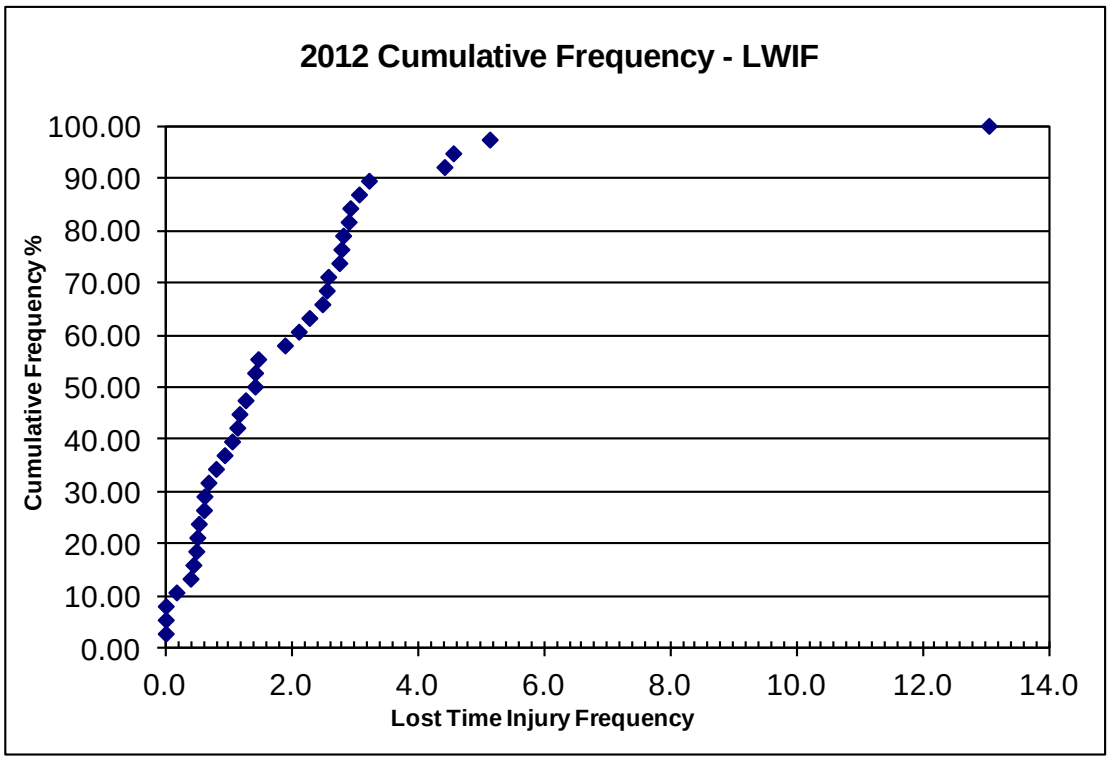


Figure 2a AIF quartile distribution ranges and average values for each quartile range

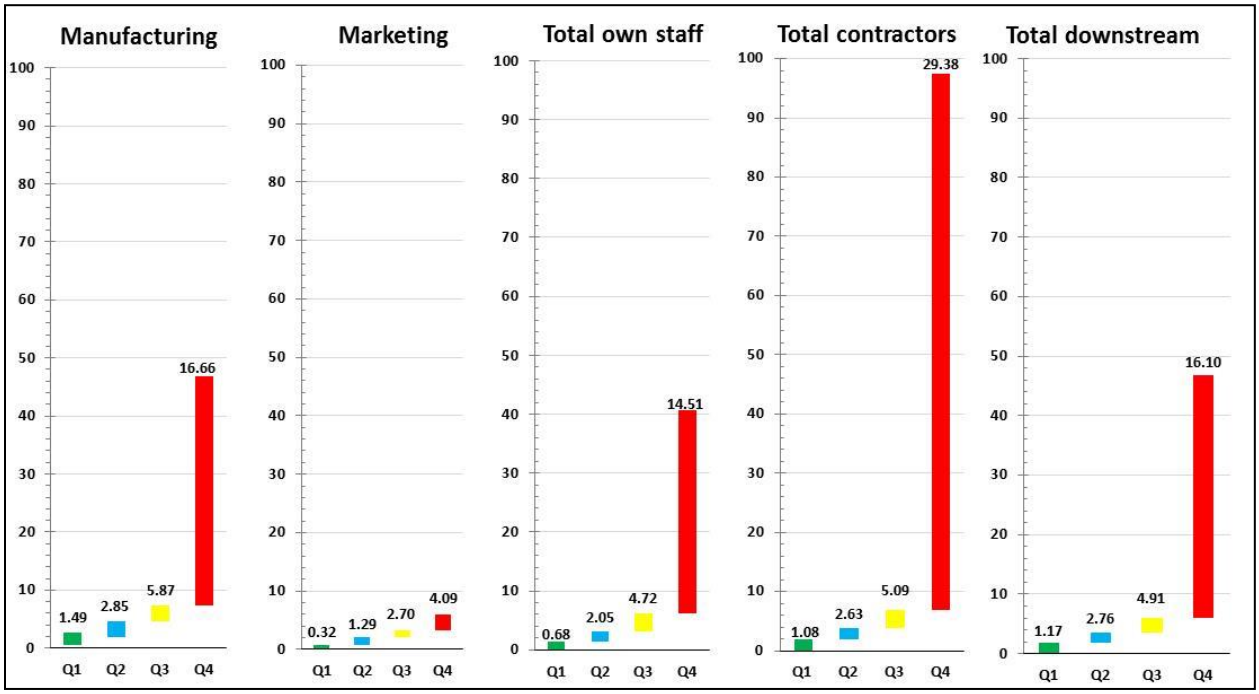
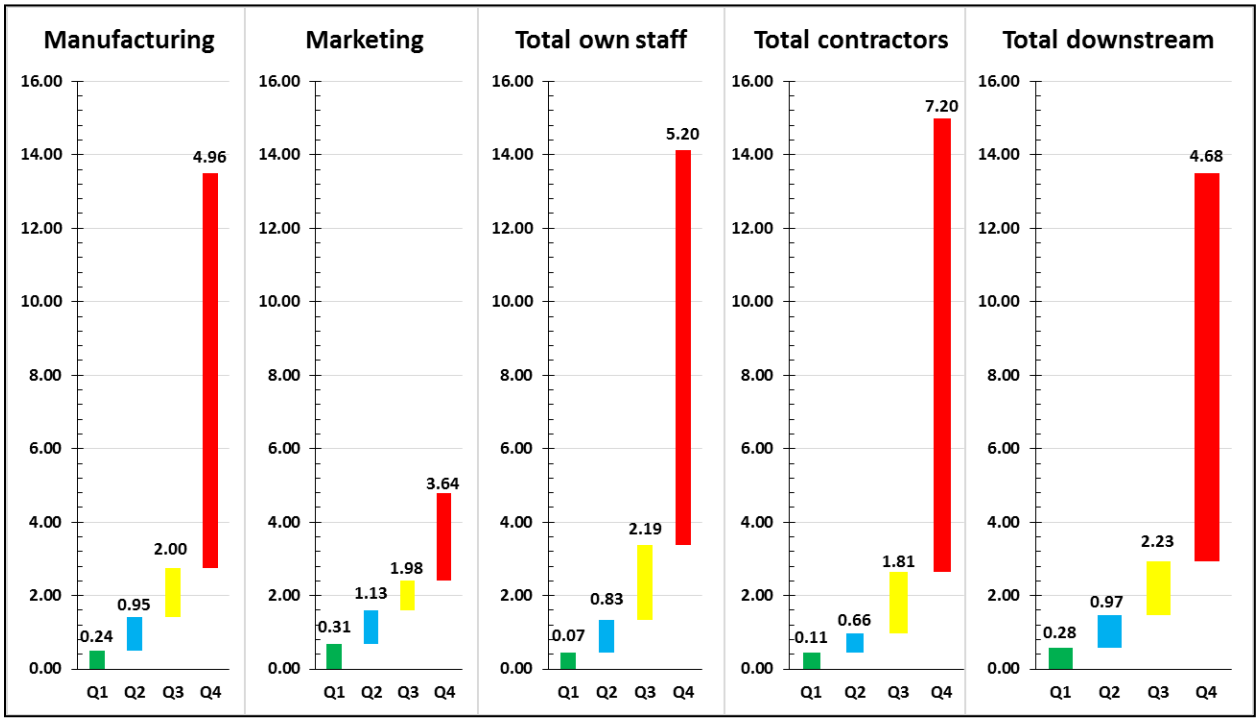
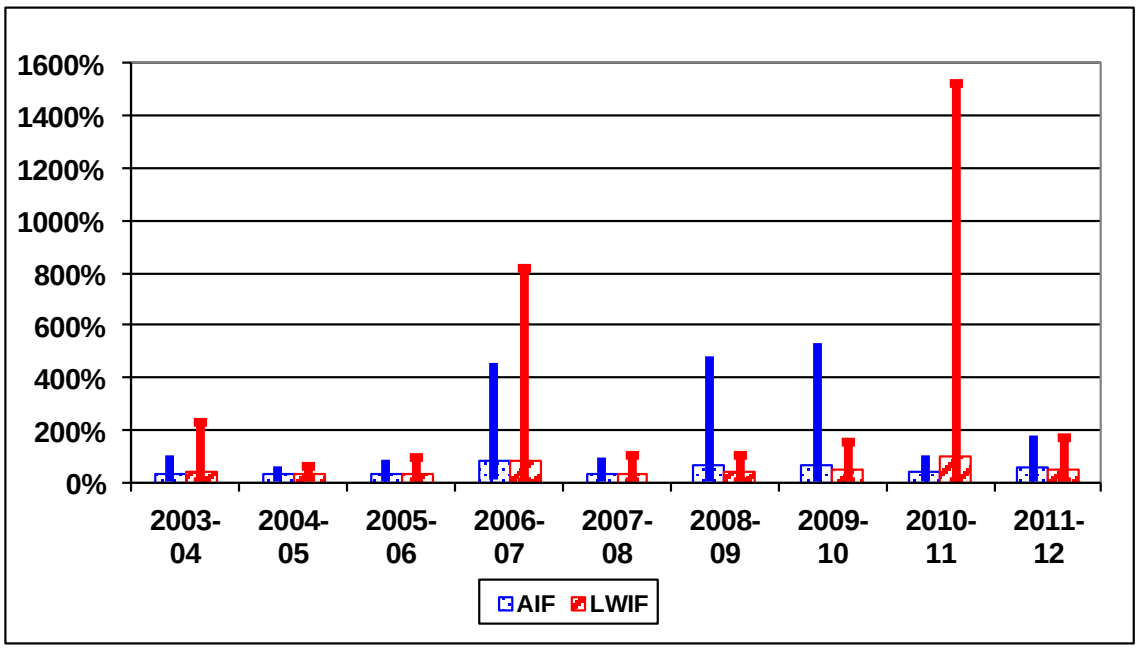


Figure 2b LWIF quartile distribution ranges and average values for each quartile range



The average performance indicator figures clearly conceal a wide range of individual values between reporting companies. **Figure 3** shows that the variability is significantly less when looking at year-on-year figures for each company individually.

Figure 3 Year-on-year performance indicator variations
Average for all reporting companies



In summary, there are large differences in reported figures between companies but, for the most part, these differences also do not change much over the years. This reflects genuine levels of performance achieved by different organisations but also differences in the way companies monitor and classify incidents and collect their data.

LWI Causes

For the 2012 reporting year it was agreed to continue the work started in 2010 to categorise the causes of reported lost work time injuries (LWI) under the 6 headings previously used for fatality reporting. A total of 694 LWI's were reported in 2012 of which 569 (82%) were allocated to the agreed categories within the company submissions.

The results are described in **Table 3** below.

Table 3 Causes of LWI in 2012

Causes of LWI in 2012	Manufacturing	Marketing	Combined	% 2012	% 2011	% 2010
Falls	107	109	216	38%	33%	39%
Construction/Maintenance	51	19	70	12%	20%	17%
Burn/Electrical	28	6	34	6%	7%	6%
Road Accident	8	21	29	5%	3%	4%
Confined Space	1	0	1	0%	0%	1%
Other	74	145	219	39%	37%	33%
Total	269	300	569	100%	100%	100%

After only 3 years of collecting this data it is possible to draw some limited conclusions about the causes of LWI which could suggest areas of focus. Falls and Construction and Maintenance appear to be two areas of concern for all operations while Road Accidents is still an area of concern especially for the Marketing and Distribution activities. The high number of incidents categorised as having the cause "Other" suggests that there might be benefit reviewing and possibly modify the categories to ensure the collection of the most useful data in the future.

4. 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. In 2010 the Safety Management Group of CONCAWE decided to expand the scope of industry wide safety performance indicators to address process safety, following the reporting guidelines that were developed by the API [17,18]. Combining a focus on process safety in conjunction with the personal safety factors collected thus far could contribute to a further reduction in serious injury rates in the industry.

The CONCAWE Membership was requested to report their PSPI indicators as defined by the API in 2008 [18] and as further refined in the ANSI/API recommended practise that was published in 2010 [19]. The PSPI-data that were requested are the number of Tier 1 and 2 Process Safety Events (PSE's), as further defined in **Appendix 2** of this report. The definitions of these slightly differ from those that are described in the ANSI/API guideline to align the quantities to SI-metric units (kg/m/sec) and the inclusion of the European Classification and Labelling definitions that are in force in the EU [20] that can be used as an alternative for classifying the PSE. However, for the time being most CONCAWE members have expressed a preference for reporting their PSE's according to the ANSI/API definitions.

The aggregated 2012 results per sector and for the whole of the European downstream oil industry are shown in **Table 4**. **Figure 4a** shows the total Process Safety Event Rate (PSER) on a cumulative frequency basis which allows individual companies to benchmark their own results against the group. The PSER is the number of PSE per million total work hours reported. The distribution per quartile and average values for each quartile range are shown for Total PSE and Total PSER in **Figures 4b/c**.

In **Figures 5a/b/c** the cumulative frequencies for the PSER are given for Manufacturing only, as the data are sufficiently robust to allow the analysis provided in these presentations. These allow individual companies to benchmark their results for the Manufacturing sector against the group.

Table 4 Aggregated 2012 Process Safety results for all reporting companies

Sector		Manufacturing	Marketing	Both Sectors
Companies	Total	38	23	23
	PS reporting	33	12	12
	%	87%	52%	52%
Hours worked Mh	Total	245.2	289.0	534.3
	PS reporting	236.5 (220.3)[a]	180.8	417.3
	%	96% (90%)[a]	63%	78%
T-1 PSI	PSI	139	14	153
T-2 PSI	PSI	484	52	536
T-1 PSIR	$PSI/Mh_{reported}$	0.59	0.08	0.37
T-2 PSIR	$PSI/Mh_{reported}$	2.20	0.29	1.34
Total PSIR	$PSI/Mh_{reported}$	2.63	0.37	1.65

a) Between brackets the amount of hours reported by the Companies that provided T-2 PSEs is given. This amount is applied when calculating the T2-PSER

Figure 4a Cumulative Frequency Analysis Total PSER

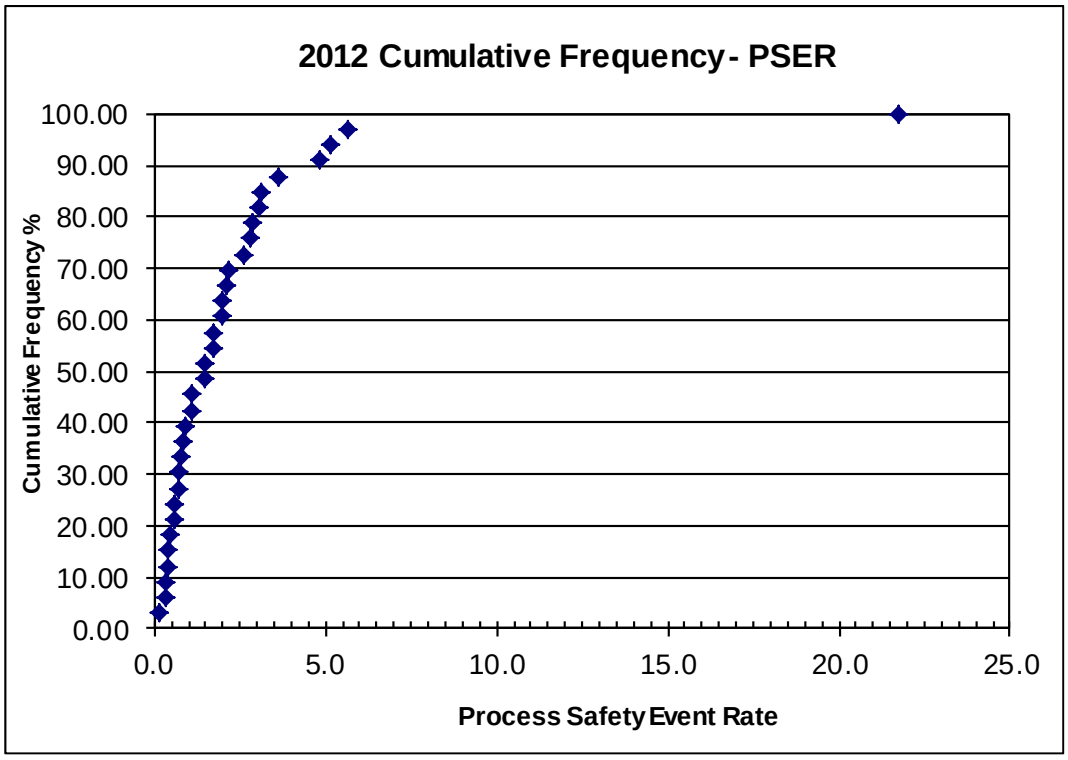


Figure 4b Total PSE quartile distribution ranges and average values for each quartile range

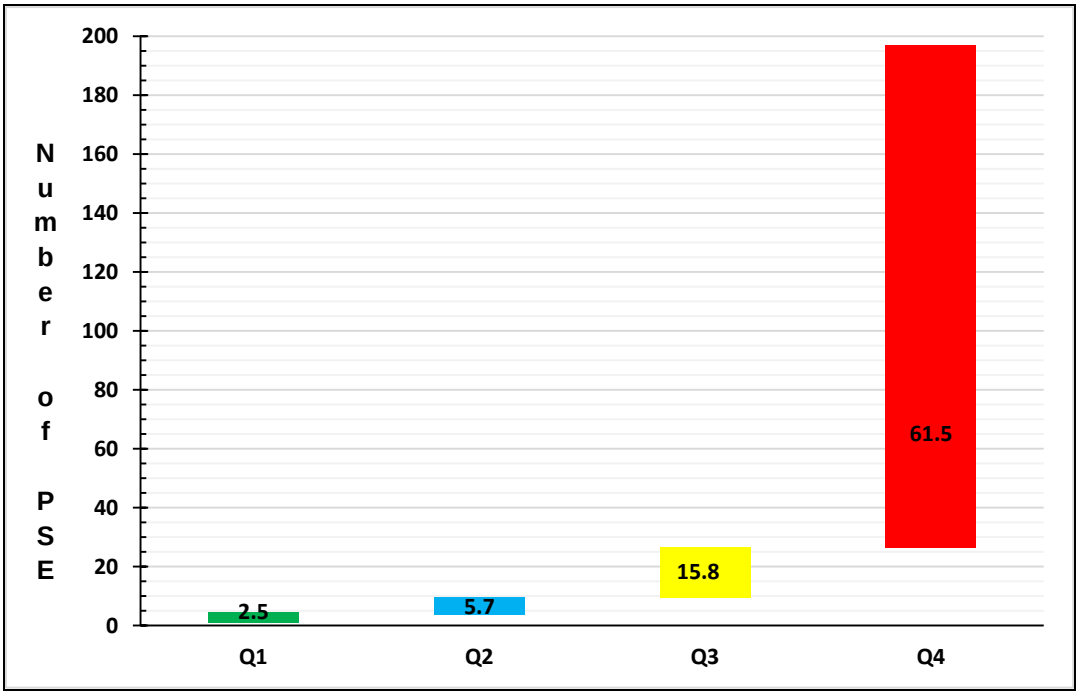


Figure 4c Total PSER quartile distribution ranges and average values for each quartile range

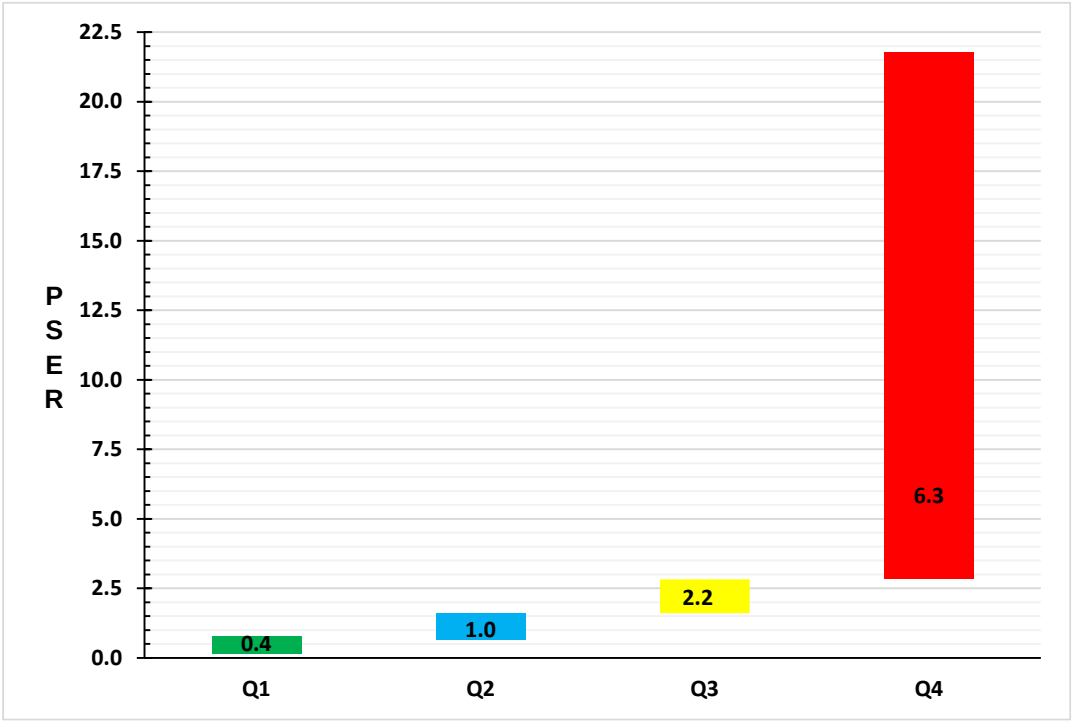


Figure 5a Cumulative frequency chart for all Manufacturing PSER

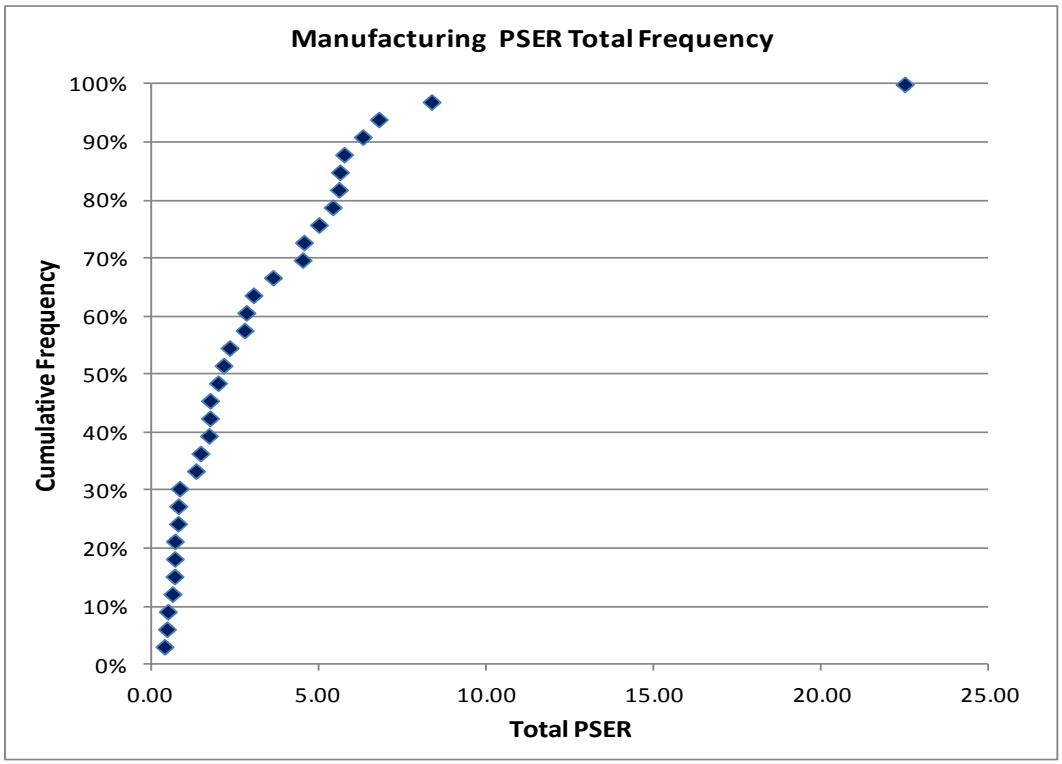


Figure 5b Cumulative frequency chart for Tier 1 Manufacturing PSER

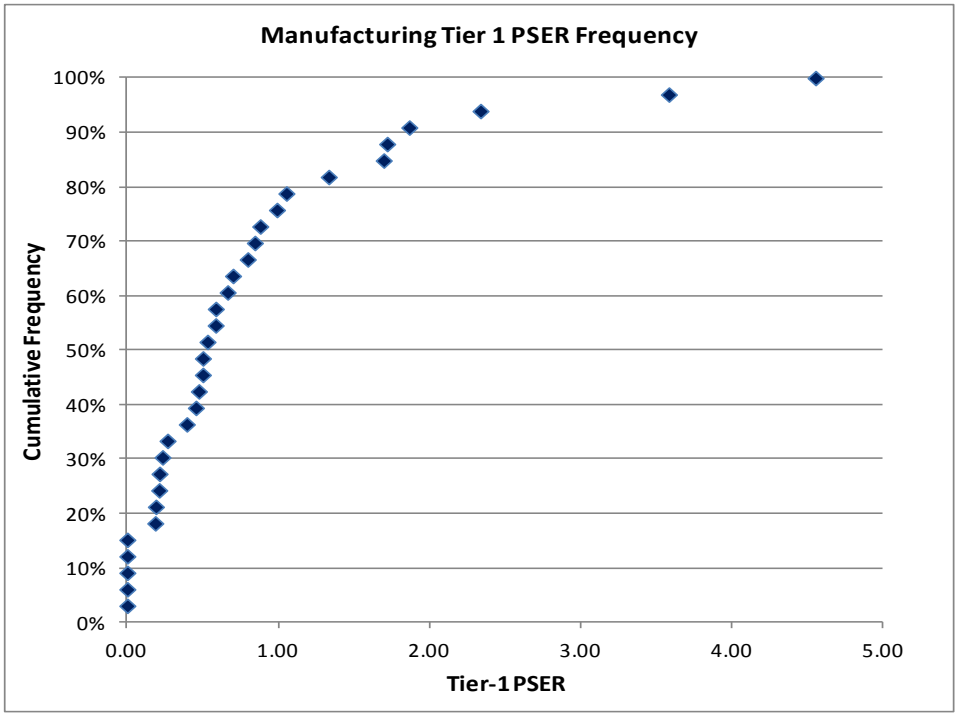
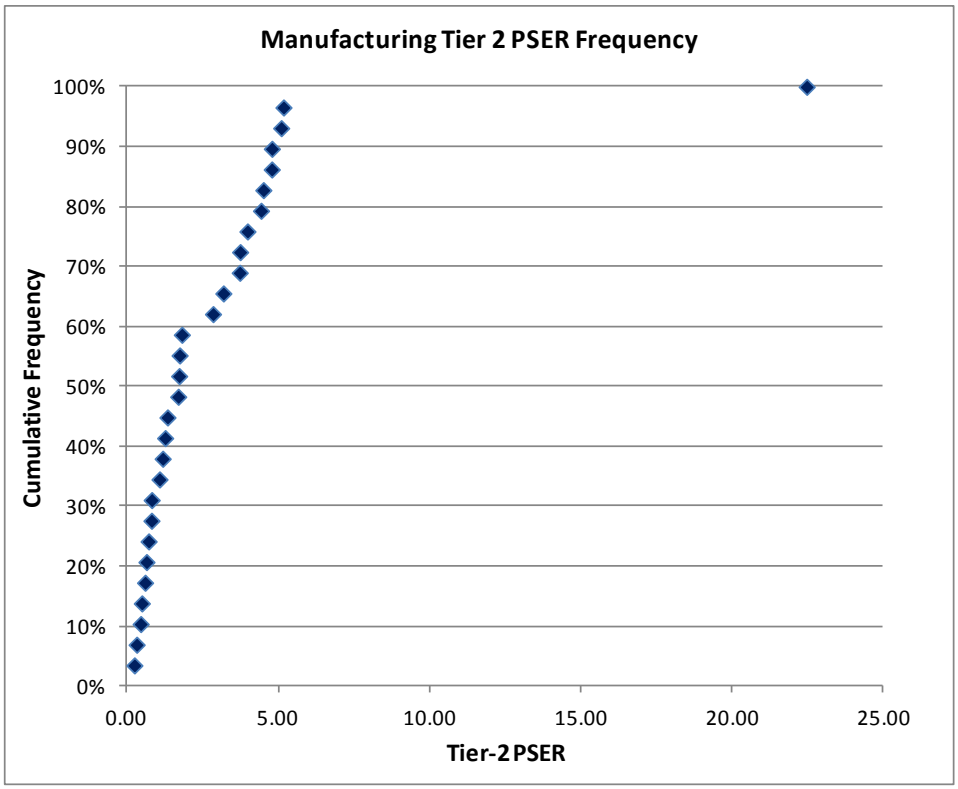


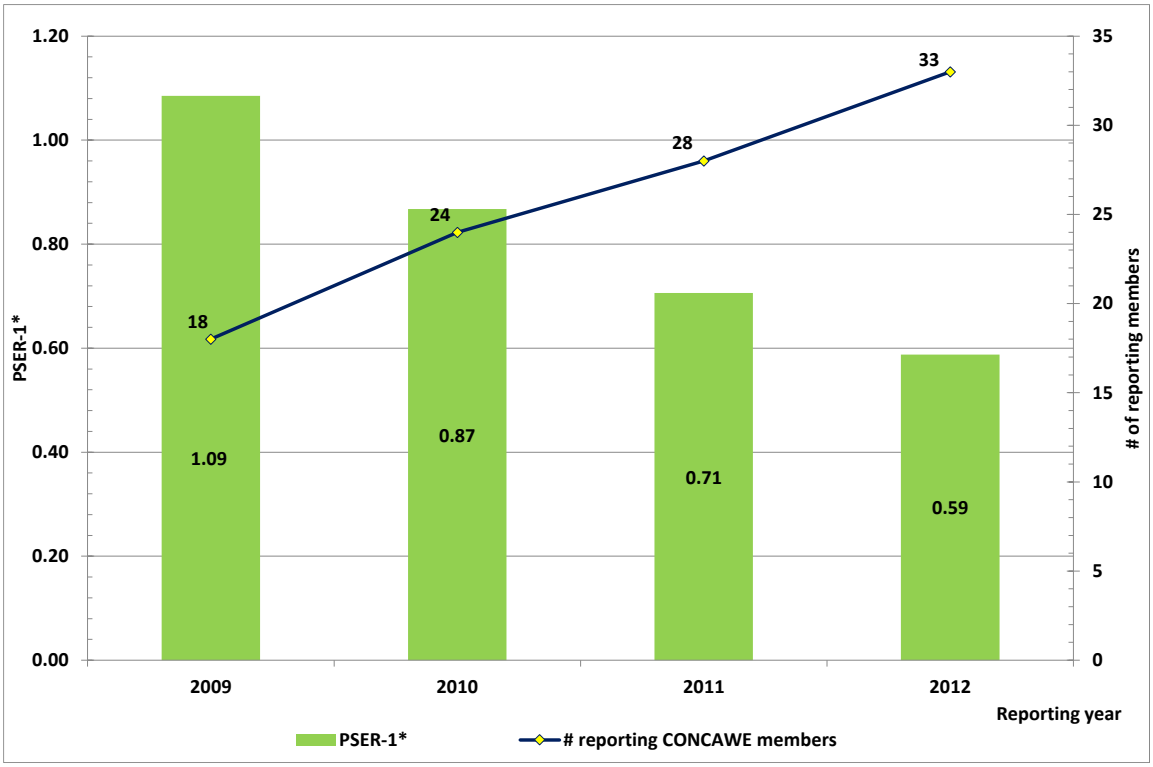
Figure 5c Cumulative frequency chart for Tier 2 Manufacturing PSER



The data provided indicated that none of the PSEs from Tier 1 Manufacturing Companies resulted in a fatality. The number of LWIs resulting from the PSEs is not established, as this information is not available.

The extent of reporting of Process Safety data was again very positive. In this fourth year of data collection a total of 87% of the Manufacturing operations and 52% of the Marketing operations provided the requested information. However, although this learning process continues and leads to an improved reporting discipline in the Companies, the quality of data remains somewhat scattered. The results are included in this report and show that the CONCAWE membership takes process safety very seriously. The results do not yet allow firm conclusions on the current PS-performance. However, it is possible to speculate that since data gathering started the awareness of the issue has grown and, possibly, even that this awareness has initiated improvement in control measures leading to the observed reduction in Process Safety events. This is demonstrated in the range of graphs for Manufacturing and Total PSPI responses presented in **Figures 6a-e** which show the results recorded by this survey over the 4 years of CONCAWE reporting and the associated trends.

Figure 6a Manufacturing PSER-1 2009-2012



* PSER-1 the number of releases of hazardous substances per 1 million hours worked causing a fatality, injury, fire or explosion leading to damages valued over € 25,000 or above set threshold values indicative to have the potential to cause these (see appendix 2).

Figure 6b Manufacturing PSEs 2009-2012

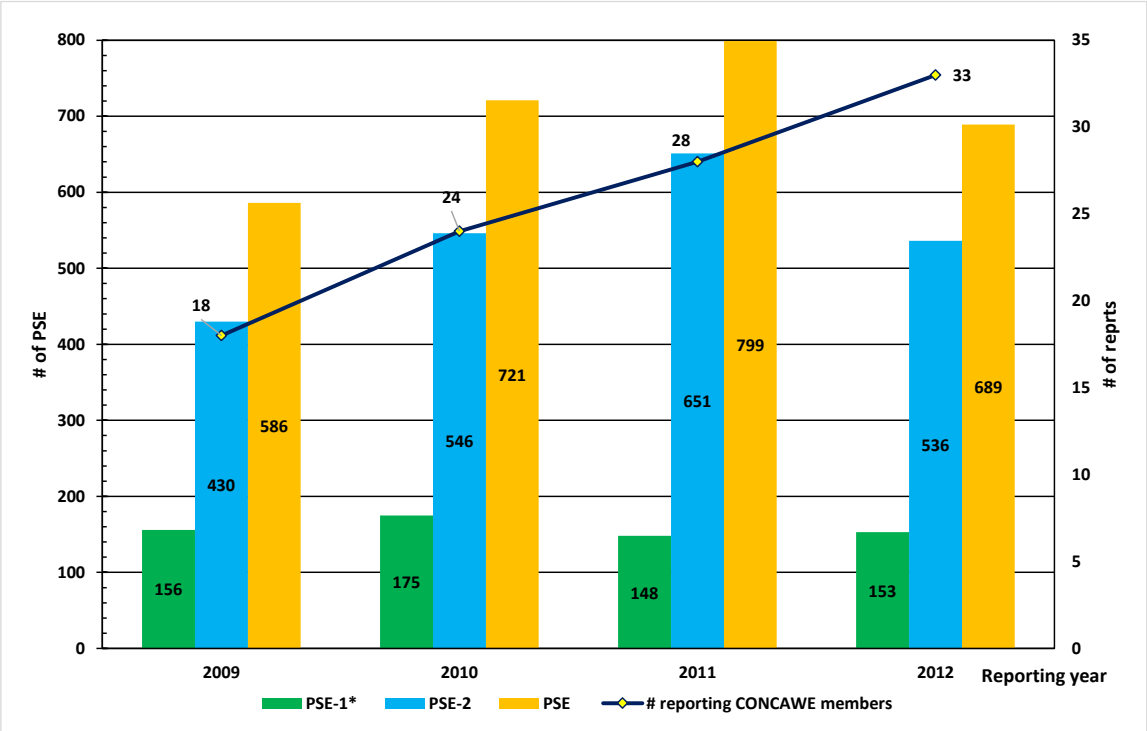


Figure 6c Average Manufacturing PSEs 2009-2012

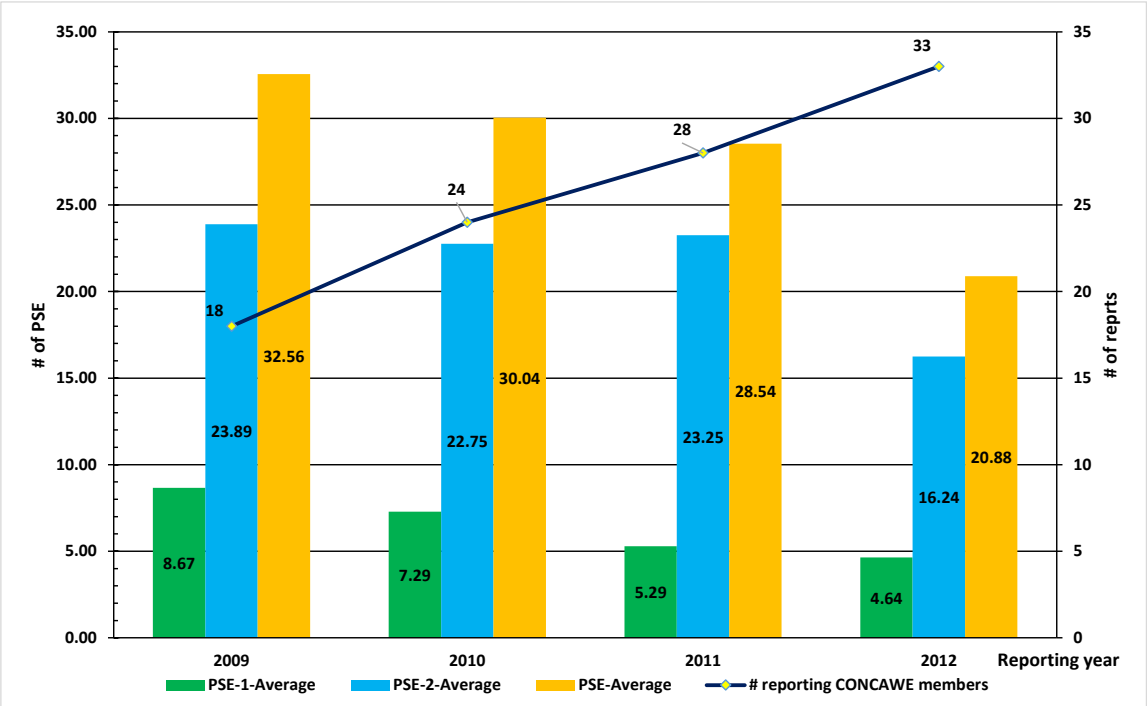


Figure 6d Manufacturing PSERs 2009-2012

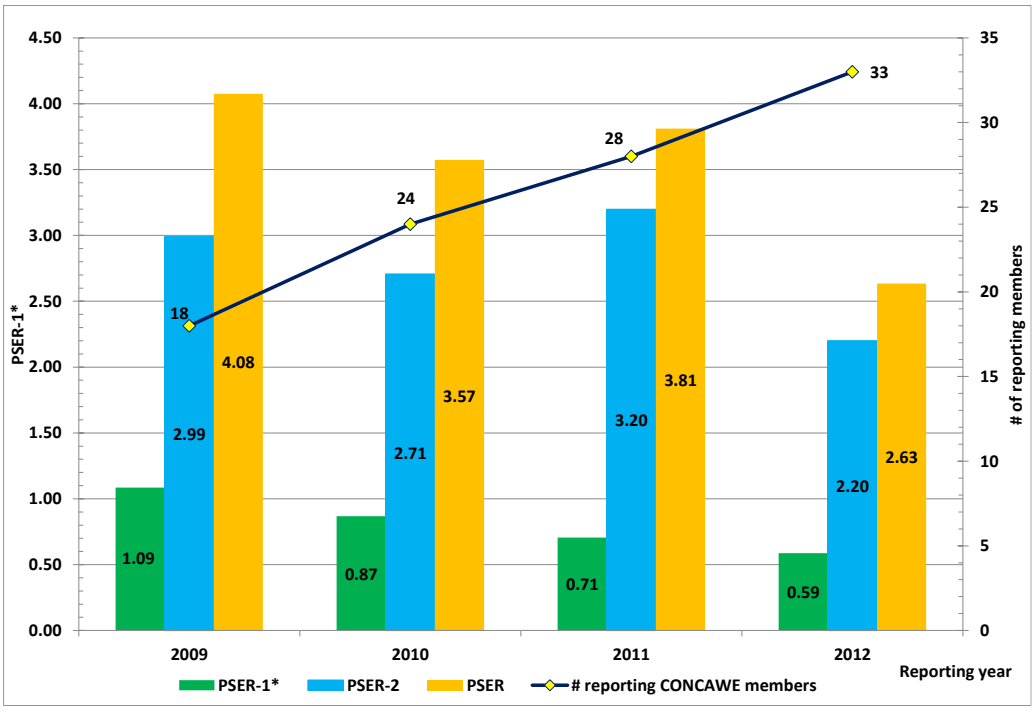
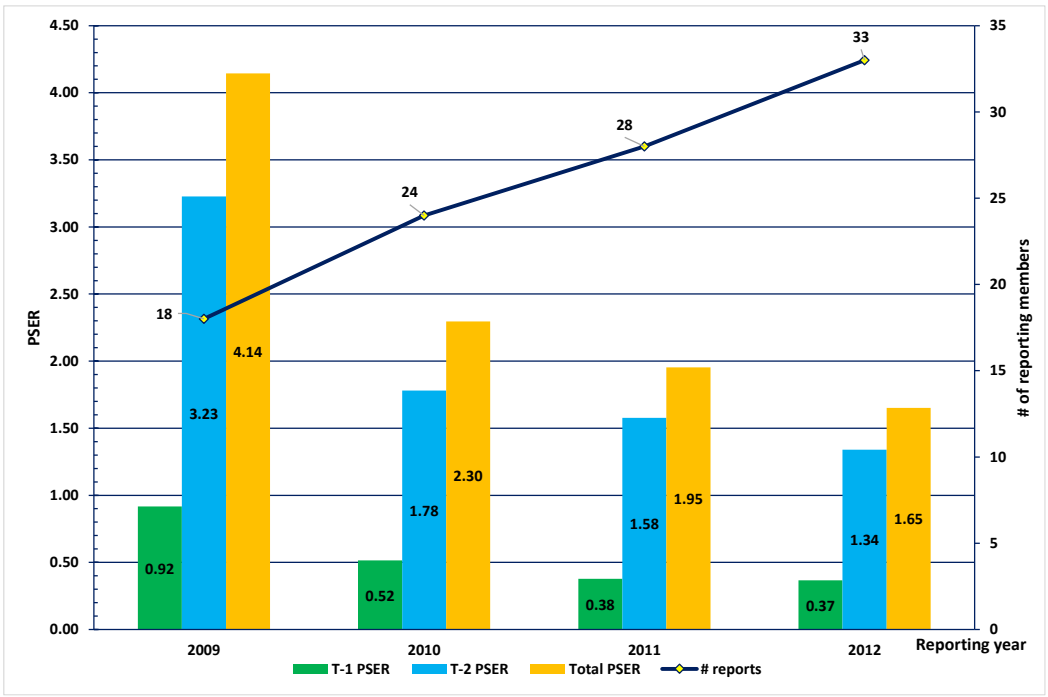


Figure 6e Total PSERs 2009-2012



5. HISTORICAL TRENDS

The performance indicators are of particular interest when considering their evolution over the years. The historical trends for the European downstream oil industry as a whole are shown in **Figures 7a/b** and **Table 5**.

Figure 7a Historical evolution of main performance indicators
Yearly data for the whole European downstream industry

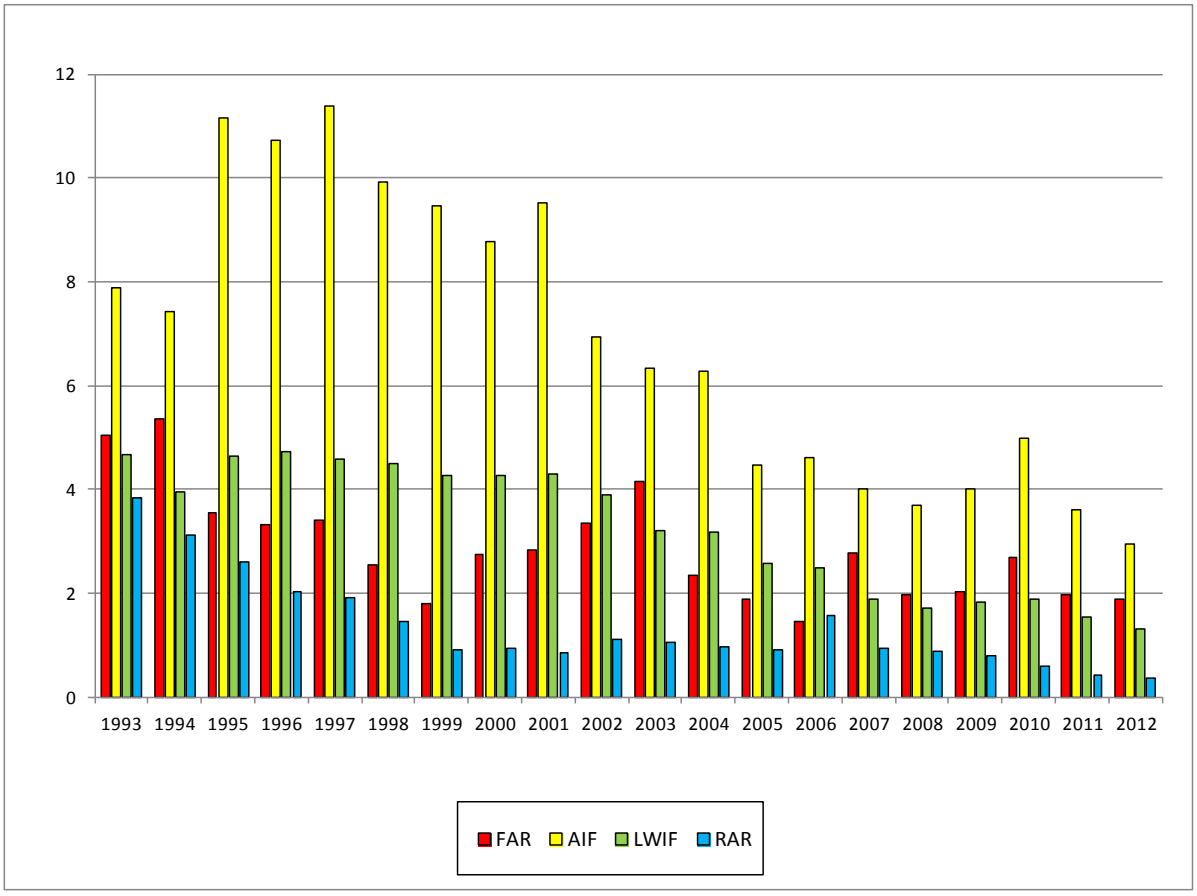


Figure 7b Historical evolution of main performance indicators
3-year rolling average for the whole European downstream industry

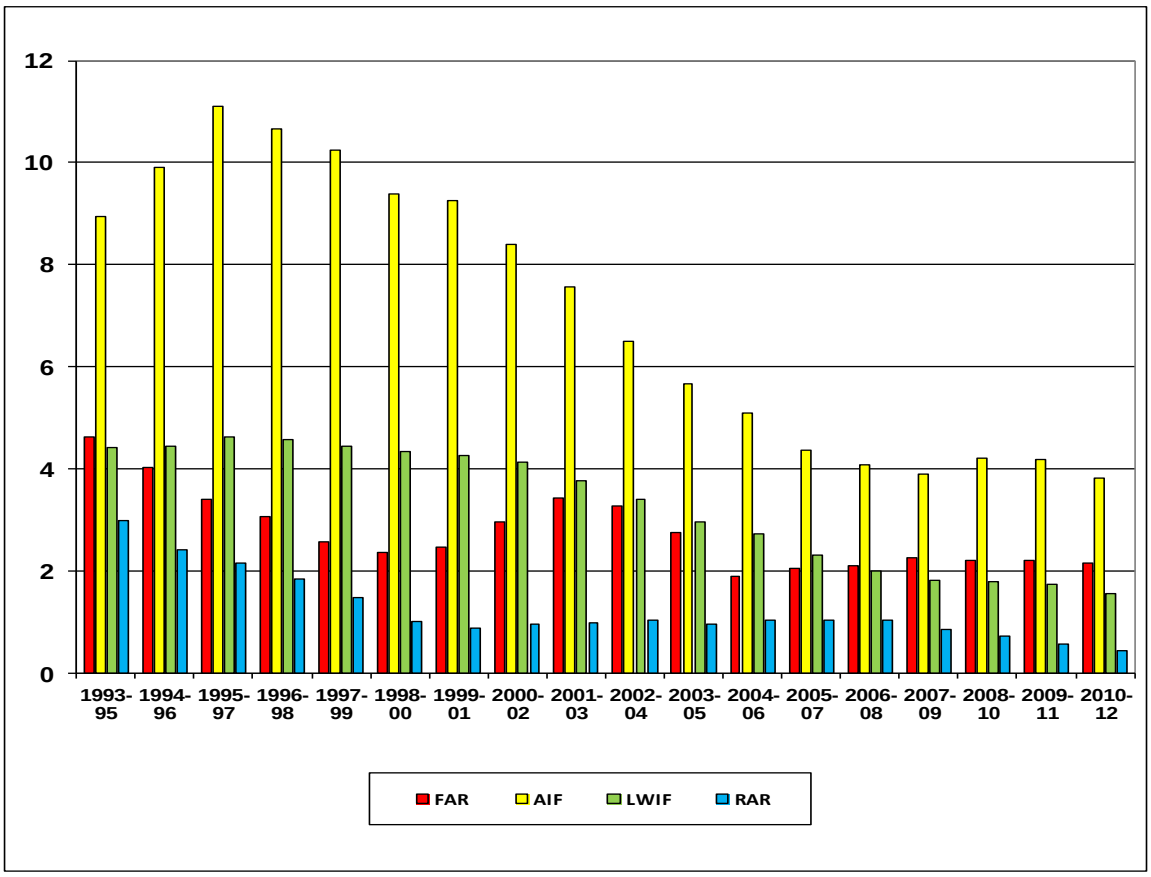


Table 5 Historical evolution of performance indicators

Year	Fatalities	FAR	AIF	LWIF	LWIS	RAR	Million Hours Reported[2]
1993	18	5.0	7.9	4.7	27	3.8	357.0
1994	19	5.4	7.4	4.0	25	3.1	354.8
1995	13	3.5	11.2	4.6	24	2.6	366.4
1996	14	3.3	10.7	4.7	19	2.0	420.6
1997	15	3.4	11.4	4.6	23	1.9	442.0
1998	12	2.6	9.9	4.5	22	1.5	469.7
1999	8	1.8	9.4	4.3	21	0.9	448.5
2000	13	2.7	8.8	4.3	25	0.9	475.1
2001	14	2.8	9.5	4.3	24	0.8	495.5
2002	16	3.3	6.9	3.9	23	1.1	480.0
2003	22	4.1	6.3	3.2	30	1.0	531.6
2004	12	2.3	6.3	3.2	33	1.0	513.3
2005	11	1.9	4.5	2.6	35	0.9	581.7
2006	7	1.5	4.6	2.5	30	1.6	477.5
2007	15	2.8	4.0	1.9	35	0.9	538.2
2008	11	2.0	3.7	1.7	28	0.9	555.5
2009	11	2.0	4.0	1.8	29	0.8	545.5
2010	14	2.7	5.0	1.9	30	0.6	522.2
2011	11	2.0	3.6	1.5	41	0.4	559.8
2012	10	1.9	3.0	1.3	29	0.4	534.3
Averages							
1993-2012	13	2.8	6.5	3.1	26	1.1	483.5
3-year rolling average							
Year	Fatalities	FAR	AIF	LWIF	LWIS	RAR	Million Hours Reported[2]
1993-95	17	4.6	8.9	4.4	25	3.0	359.4
1994-96	15	4.0	9.9	4.5	22	2.4	380.6
1995-97	14	3.4	11.1	4.6	22	2.2	409.7
1996-98	14	3.1	10.7	4.6	21	1.9	444.1
1997-99	12	2.6	10.3	4.4	22	1.5	453.4
1998-00	11	2.4	9.4	4.3	23	1.0	464.4
1999-01	12	2.5	9.3	4.3	23	0.9	473.0
2000-02	14	3.0	8.4	4.1	24	1.0	483.5
2001-03	17	3.5	7.6	3.8	25	1.0	502.3
2002-04	17	3.3	6.5	3.4	28	1.0	508.3
2003-05	15	2.8	5.7	3.0	32	1.0	542.2
2004-06	10	1.9	5.1	2.7	33	1.1	524.2
2005-07	11	2.1	4.4	2.3	33	1.0	532.5
2006-08	11	2.1	4.1	2.0	31	1.1	523.7
2007-09	12	2.3	3.9	1.8	31	0.9	546.4
2008-10	12	2.2	4.2	1.8	29	0.7	541.1
2009-11	12	2.2	4.2	1.7	33	0.6	542.5
2010-12	12	2.2	3.8	1.6	34	0.5	538.7

Figures 8a-c show the 3-year rolling average for FAR, AIF and LWIF segmented into the Manufacturing and Marketing activities, each split between own staff and contractors.

Figure 8a Historical evolution of Fatality Accident Rate segmented 3-year rolling average
(MF: Manufacturing; MK: Marketing)

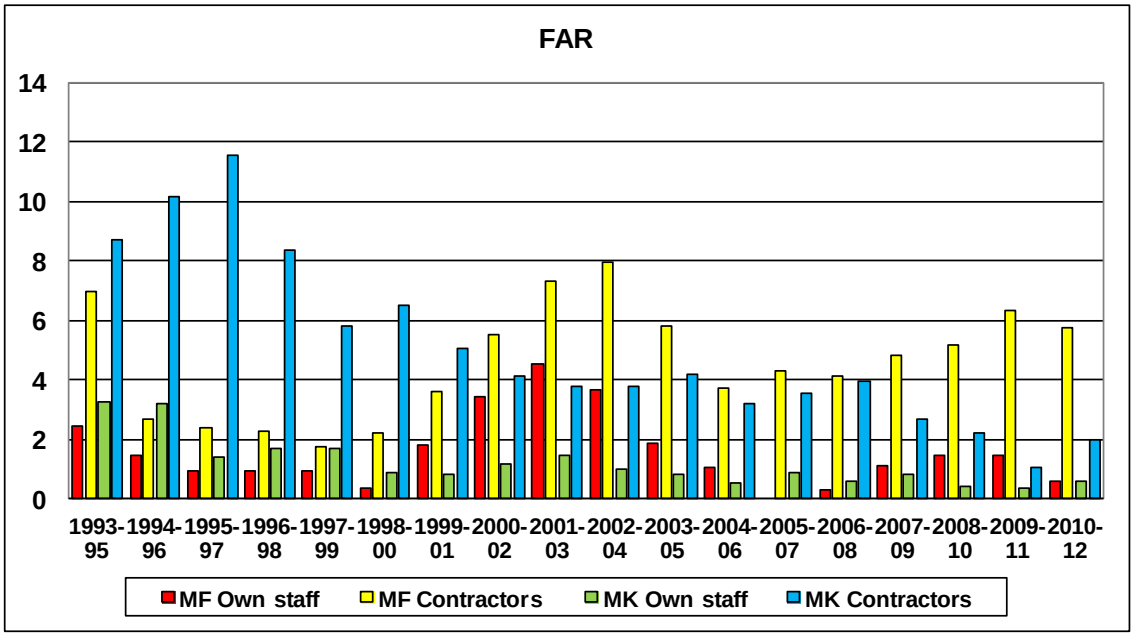


Figure 8b Historical evolution of Lost Work Injury Frequency segmented 3-year rolling average
(MF: Manufacturing; MK: Marketing)

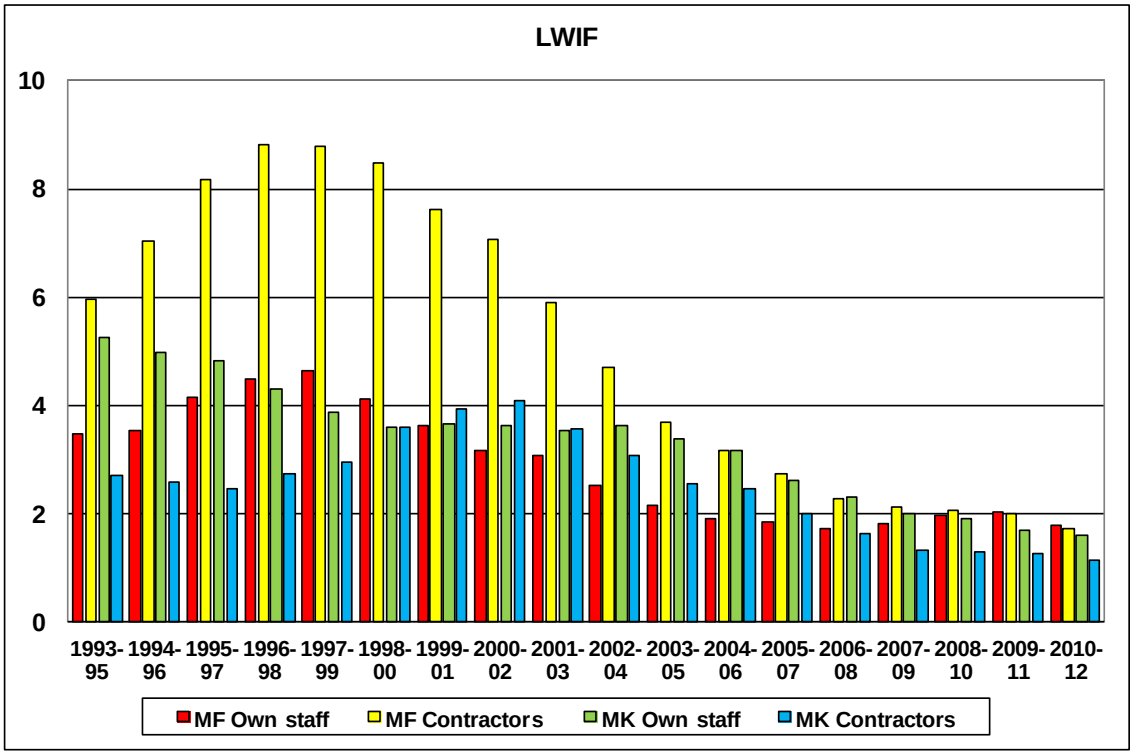
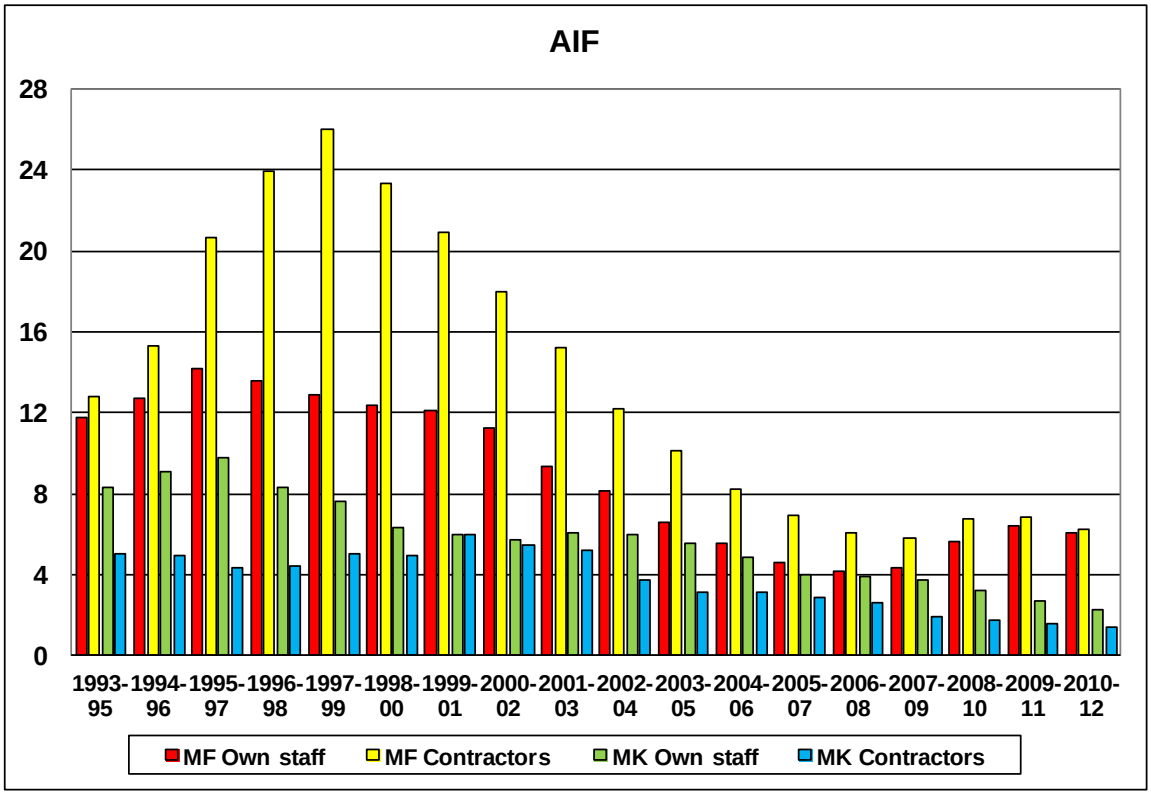


Figure 8c Historical evolution of All Injury Frequency segmented 3-year rolling average
(MF: Manufacturing; MK: Marketing)



A total of 10 fatalities were reported for 2012 with 2 fatalities resulting from an explosion during a catalyst loading and the remaining 8 being the consequence of 8 independent incidents. The absolute number of fatalities and the FAR have been at consistently low levels since 2004 and this continues in 2012. Contractors, both Manufacturing and Marketing, appeared to be the most vulnerable work group experiencing 8 fatalities. Clearly this is of concern and all companies should maintain focus on ensuring that the contractor workforce is fully integrated into the companies' safety management systems. As discussed in Section 2, it should be kept in mind that the FAR is notoriously prone to large variations.

The LWIF of 1.3 recorded for 2012 is the lowest value since the collection of this data commenced in 1993 and maintains the trend of less than 2.0 for the sixth consecutive year, the longest consistent period since CONCAWE started to collect these data. This indicator initially had greater reductions in Manufacturing than in Marketing, however, since 2006 figures for the 4 categories continue to remain very close.

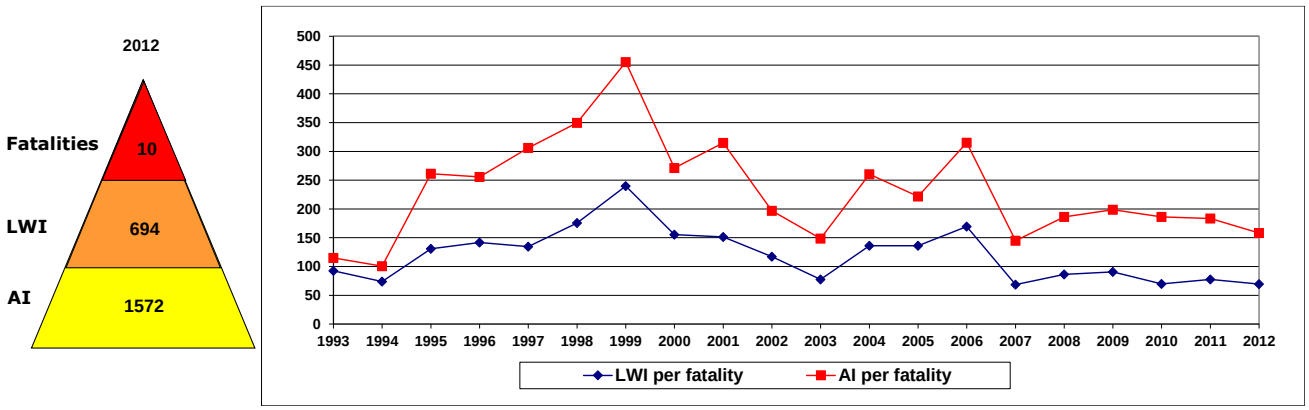
The figures suggest that AIF peaked around 1996-97 but this is likely the result of improved reporting standards. Since this time the trend has been slowly downward.

In 2012 road traffic accidents maintained the low rate of 0.4 as achieved in 2011. It has been a major focus for the industry and it is pleasing to see the reduction in the number of accidents being maintained. These accidents essentially occur in the Marketing activity where the bulk of the driving takes place. However, there were 3

fatalities as a result of road accidents in 2012 so there is clearly more work to be done in this area.

One point of particular interest is the "safety triangle" i.e. the relationship between the total number of recordable incidents, the number of LWIs and the number of fatalities. This diagram is illustrative but not to scale. This is shown in **Figure 9a**. Also shown is a graph of LWI and AI per fatality.

Figure 9a The safety triangle



The figure above illustrates the declining number of fatalities until 1999 whereas the total number of incidents remained fairly *constant*. The period from 2000 to 2003 saw a steady increase in fatalities while both AI and LWI were still on a decreasing trend, resulting in a decrease of the ratios. The lower number of fatalities from 2004 to 2009 reversed the trend resulting in relatively steady ratios with a small positive spike in 2006 when there were only 7 fatalities. Since this time both the number of fatalities and the ratio of AI and LWI to fatalities have remained relatively constant.

Figure 9b Relationship between the frequencies FAR, AIF and LWIF

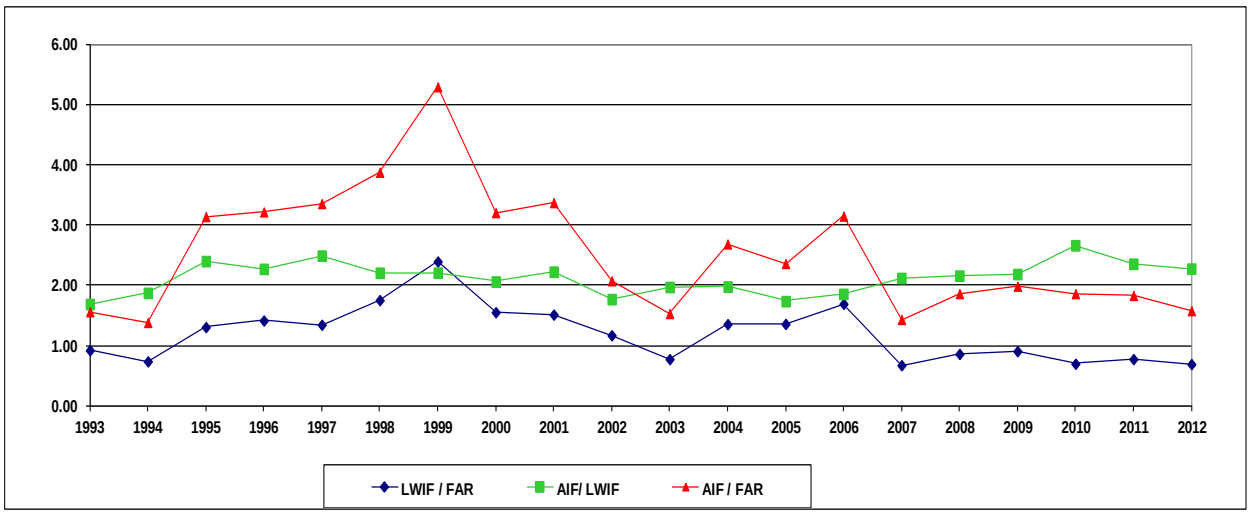


Figure 9b illustrates the relationship between the frequencies, FAR, AIF and LWIF. Since 2004 these frequencies have been relatively steady compared to each other. Fatalities remain at a disappointing level.

Figure 10 details the causes of the 10 fatalities recorded in 2012 and **Figure 11** shows the percentage of the main causes over the last 5 years and for all years since this information was first collected in 1998. In 2012, 3 fatalities were caused as a result of road accidents, 3 fatalities resulted from construction or maintenance activities, 1 fatality was the result of a fall from height, 1 fatality was due to failed electrical isolation ("Burn/Electrical"), 1 fatality was due to being struck by a pipe ("Other") and 1 fatality occurred during armed robbery ("Other").

For the last 5-year period, construction/maintenance/operations activities and road accidents remain the principal causes of fatalities.

Figure 10 Causes of fatalities in 2012

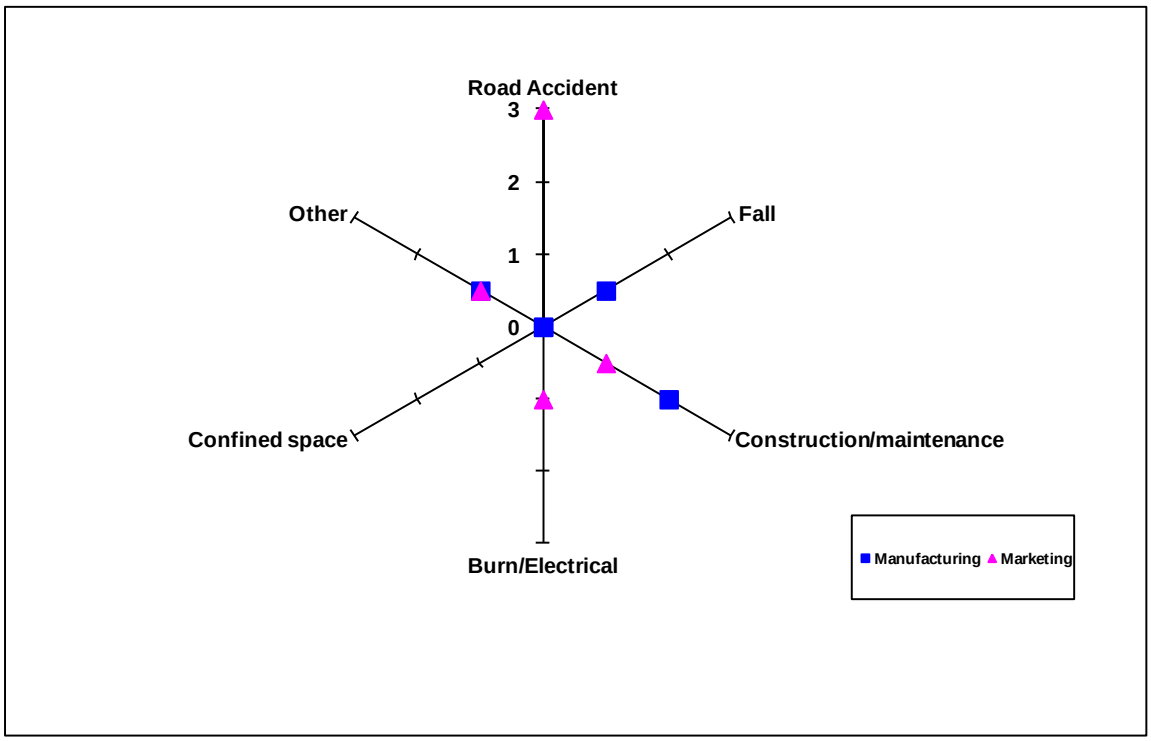
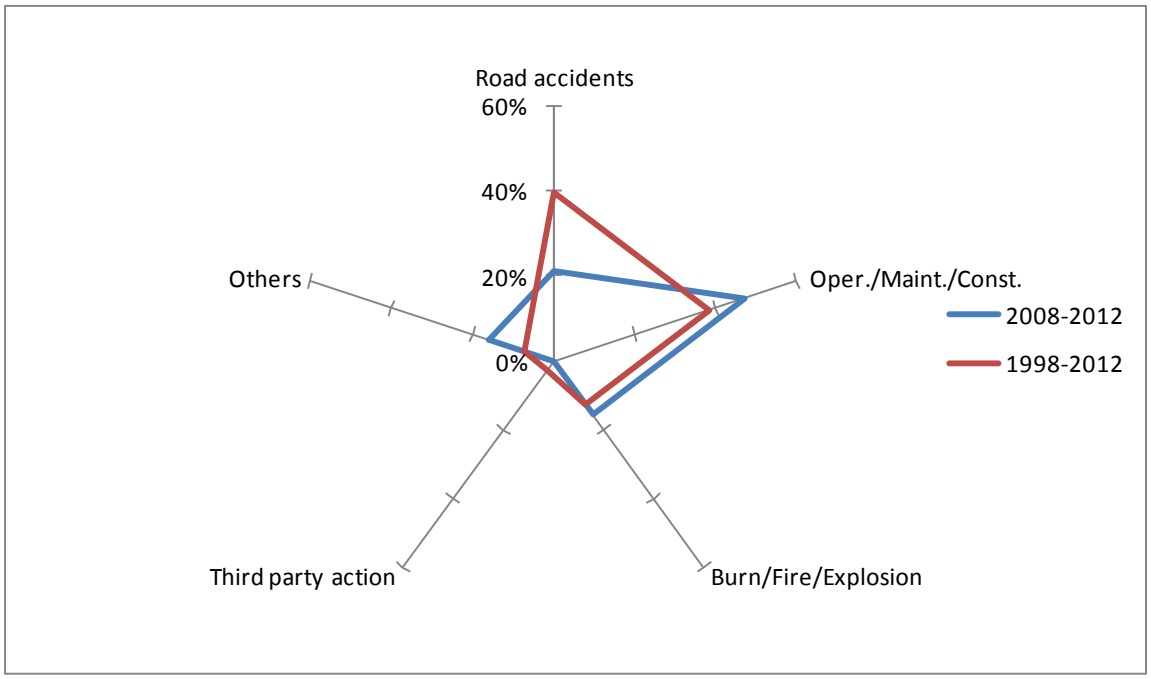


Figure 11 Causes of fatalities from 2008 to 2012 and from 1998 to 2012



6. 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.

Table 6 Comparison of the safety performance of the downstream oil industry

	CONCAWE	OGP 2012[1]		CEFIC	API 2011
	2012	Europe	World	2008	Manufacturing
FAR	1.9	0.5	2.4	0.97[2]	NA
AIF	2.9	2.6	1.7	NA	NA
LWIF	1.3	0.9	0.5	6.6	6.1[3]

OGP Oil & Gas Producers

CEFIC Conseil Européen des Fédérations de l'Industrie Chimique

(1) Own staff and contractors

(2) Estimated from the figure of 1.74 fatalities per 100,000 workers reported by CEFIC (assuming 1800 h/a worked per worker)

(3) Estimated from 1.1 injuries per 100 FT Refinery workers API WIIS-report 2003-2011

The OGP statistics concern the "upstream" oil industry covering oil and gas exploration and production activities [21]. This sector shows better FAR, AIF and LWIF performances than the downstream, on a global basis, which was also the case in previous years.

The 2008 data for the EU chemical industry (CEFIC) [23], and the 2011 data for OGP [22] and API [25] have been shown because the 2012 data from these organisations is not yet publicly available.

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APPENDIX 1 EUROPEAN OIL INDUSTRY STATISTICS DEFINITIONS AND GUIDING NOTES

1. Hours worked	Hours worked by employees and contractors. Estimates should be used where contractor data is not available.
2. Fatality	This is a death resulting from a work related injury where the injured person dies within twelve months of the injury.
3. 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.
4. Total days lost	The number of calendar days lost through LWIs counting from the day after the injury occurred.
5. 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.
6. MTC	Medical Treatment Case is a work related injury which requires the attention of a medical practitioner. It excludes first aid treatment.
7. 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.
8. LWIF	Lost Workday Injury Frequency is calculated from the number of LWIs divided by the number of hours worked expressed in millions.
9. LWIS	Lost Workday Injury Severity is the total number of days lost as a result of LWIs divided by the number of LWIs.
10. Distance travelled	This is the distance, expressed in millions of kilometres, covered by company owned delivery vehicles and company cars whether leased or owned. It should also include kilometres travelled in employee's cars when on company business.
11. Road Accidents	Any accident involving any of the vehicles described above.
12. RAR	Road Accident Rate is calculated from the number of accidents divided by the kilometres travelled expressed in millions.
13. FAR	Fatal Accident rate is calculated from the number of fatalities divided by the number of hours worked expressed in hundred millions.
14. 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).
15. PSE	A Process Safety Event is an unplanned or uncontrolled LOPC. The severity of the PSE is defined by the consequences of the LOPC.

16. Tier 1 PSE

A Tier 1 Process Safety Event (T-1 PSE) is a loss of primary containment (LOPC) with the greatest consequence. A T-1 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g., steam, hot condensate, nitrogen, compressed CO_2 or compressed air), from a process that results in one or more of the consequences listed below:

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

17. Tier 2 PSE

A Tier 2 Process Safety Event (T-2 PSE) is a LOPC with lesser consequence. A T-2 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g., steam, hot condensate, nitrogen, compressed CO_2 or compressed air), from a process that results in one or more of the consequences listed below and is not reported in Tier 1:

- An employee, contractor or subcontractor recordable injury; or·
- A fire or explosion resulting in greater than or equal to €2,500 of direct cost to the Company; or
- A pressure relief device (PRD) discharge to atmosphere or to a downstream destructive device greater than the threshold quantity in **Table 2** of **Appendix 2** that results in one or more of the following four consequences:
  - liquid carryover; or
  - discharge to a potentially unsafe location; or
  - an onsite shelter-in-place; or
  - public protective measures (e.g., road closure) and;
- A release of material greater than the threshold quantities described in **Table 2** of **Appendix 2** in any one-hour period.

18. 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.

Statistics are collected under two groupings: Manufacturing (refineries) and Marketing.

Marketing includes all non-refining activities (e.g. terminals and distribution facilities) including "Head Office" personnel.

Where data are not available directly, Members are requested to present the best estimate possible.

APPENDIX 2 CONCAWE PROCESS SAFETY PERFORMANCE INDICATORS DEFINITIONS

Within CONCAWE the decision has been taken to start gathering Process Safety Performance Indicator (PSPI) data, as of 2010.

Aligning this initiative with developments globally, the decision has been made to adopt the indicators of the forthcoming ANSI/API guideline "Process Safety Performance Indicators for the Refining and Petrochemical Industries" that was published as ANSI/API Guideline 754 in April 2010 [REF 1].

This short note provides an overview of the performance indicator that CONCAWE intends to collect from its membership for the European Refining and Distribution Industry, which are the Tier 1 and 2 PSPI of this guideline with minor alteration to allow the alternative use of the criteria that are embedded in EU-legislation and the fact that in Europe quantities are reported in the SI-metric system (kg/m/sec). However, the classification of Process Safety Events (PSE) preferentially should follow the scheme set in the aforementioned guideline.

The purpose of this Appendix is to inform the Member Companies on this with the aim to allow them to initiate the gathering of these requested PSEs as of 2010.

It is realised that this might be cumbersome for some members and, therefore, the reporting of these indicators will need to develop overtime. However, it is expected that within a few years the internal data gathering and reporting to CONCAWE will develop such that meaningful analyses can be performed for the European Refining and Distribution Industry that enables and allows comparing with other regions where this data is collected and reported.

In the forthcoming API guidance 4 Tiers of PSPIs are mentioned. However, the data collection and evaluation within CONCAWE will restrict itself to the Tier 1 & 2 PSPIs.

The criteria for the classification of Tier 1 and 2 PSEs are provided below, followed by a decision tree that assists in the classification of these.

Tier 1 Performance Indicator — Process Safety Event (T-1 PSE)

Tier 1 Indicator Purpose

The count of Tier 1 process safety events is the most lagging process safety performance indicator (PSPI) and represents incidents with greater consequence resulting from actual losses of containment.

Tier 1 Indicator Definition and Consequences

A Tier 1 Process Safety Event (T-1 PSE) is a loss of primary containment (LOPC) with the greatest consequence as defined by this document. A T-1 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g., steam, hot condensate, nitrogen or other inert gases, compressed CO_2 or compressed air[2]), from a process that results in one or more of the consequences listed below:

[2] Non-toxic and non-flammable materials (e.g., steam, hot water, nitrogen, compressed CO_2 or compressed air) have no threshold quantities and are only included in this definition as a result of their potential to result in one of the other consequences. Event involving these only become reported, if these result in one of the consequences indicated.

- An employee, contractor or subcontractor “days away from work” injury and/or fatality; or
- A hospital admission and/or fatality of a third-party; or
- An officially declared community evacuation or community shelter-in-place; or
- A fire or explosion resulting in greater than or equal to €25,000 of direct cost to the Company; or
- A pressure relief device (PRD) discharge to atmosphere or to a downstream destructive device that results in one or more of the following four consequences:
    - liquid carryover; or
    - discharge to a potentially unsafe location; or
    - an on-site shelter-in-place; or
    - public protective measures (e.g., road closure);

  and a PRD discharge quantity greater than the threshold quantities in **Table 1**; or
- Any release of material greater than the threshold quantities described in **Table 1** in any one-hour period.

Calculation of Tier 1 PSE Rate

The Tier 1 PSE Rate shall be calculated as follows:

Tier 1 PSE Rate = (Total Tier 1 PSE Count / Total Work Hours) x 1,000,000[3]

[3] Total work hours include employees and contractors. The 1,000,000 hours is the CONCAWE denominator that is also applied in the operational safety statistics frequency estimations.

Table A2-1 Tier-1 Material Release Threshold Quantities

Threshold Release Category	Material Hazard Classification[1,3,4]	Threshold Quantity (outdoor release)	Threshold Quantity (indoor[2] release)
1	TIH Zone A or EU-CLP Category 1 Hazardous Materials[5]	5 kg	2.5 kg
2	TIH Zone B or EU-CLP Category 2 Hazardous Materials[5]	25 kg	12.5 kg
3	TIH Zone C or EU-CLP Category 3 Hazardous Materials[5]	100 kg	50 kg
4	TIH Zone D or EU CLP Category 4 Hazardous Materials[5]	200 kg	100 kg
5	Flammable Gases or Liquids with Boiling Point ≤ 35°C and Flash Point < 23°C or Other Packing Group I Materials	500 kg	250 kg
6	Liquids with Boiling Point > 35°C and Flash Point < 23°C or Other Packing Group II Materials	1000 kg	500 kg
7	Liquids with Flash Point ≥ 23°C and ≤ 60°C or Liquids with Flash Point > 60°C released at a temperature at or above Flash Point or strong acids/bases or Other Packing Group III Materials	2000 kg	1000 kg

1 Many materials exhibit multiple hazards. Correct placement in Hazard Zone or Packing Group shall preferentially follow the rules of the UN Recommendations on the Transportation of Dangerous Goods, Section 2 [REF 2] or the Classifications according to DOT 49 CFR 173.2a [REF 3], as explained in the ANSI/API guideline 754 Annex B. Alternatively, the classifications of EU Regulation EC-1272/2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 [REF 4] that implement the UN harmonised System can be used.

[2]A structure composed of four complete (floor to ceiling) walls, floor and roof.

[3] For solutions not listed on the UNDG, the anhydrous component shall determine the TIH hazard zone or Packing Group classification. The threshold quantity of the solution shall be back calculated based on the threshold quantity of the dry component weight.

[4] For mixtures where the UNDG classification is unknown, the fraction of threshold quantity release for each component may be calculated. If the sum of the fractions is equal to or greater than 100%, the mixture exceeds the threshold quantity. Where there are clear and independent toxic and flammable consequences associated with the mixture, the toxic and flammable hazards are calculated independently.

[5] For vapours, the hazardous classifications only apply to inhalation toxicity. Whereas for liquids, the oral and dermal toxicity should be assessed, as well as described in the ANSI/API guideline Annex B.

Tier 2 Performance Indicators – Process Safety Events (T-2-PSE)

Tier 2 Indicator Purpose

The count of Tier 2 process safety events represents LOPC events with a lesser consequence. Tier 2 PSEs, even those that have been contained by secondary systems, indicate system weaknesses that may be potential precursors of future, more significant incidents In that sense, Tier 2 PSEs can provide a company with opportunities for learning and improvement of its process safety performance.

Tier 2 Indicator Definition and Consequences

A Tier 2 Process Safety Event (T-2 PSE) is a LOPC with lesser consequence. A T-2 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g., steam, hot condensate, nitrogen, compressed CO_2 or compressed air[1]), from a process that results in one or more of the consequences listed below and is not reported in Tier 1:

An employee, contractor or subcontractor recordable injury; or

- A fire or explosion resulting in greater than or equal to €2,500 of direct cost to the Company; or
- A pressure relief device (PRD) discharge to atmosphere or to a downstream destructive device that results in one or more of the following four consequences:
    - liquid carryover; or
    - discharge to a potentially unsafe location; or
    - an onsite shelter-in-place; or
    - public protective measures (e.g., road closure);

  and a PRD discharge quantity greater than the threshold quantity in **Table 2**; or
- A release of material greater than the threshold quantities described in **Table 2** in any one-hour period.

Calculation of Tier 2 PSE Rate

The Tier 2 PSE rate shall be calculated as follows:

Tier 2 PSE Rate = (Total Tier 2 PSE Count / Total Work Hours) x 1,000,000[5]

Table A2-2 Tier-2 Material Release Threshold Quantities

Threshold Release Category	Material Hazard Classification[1,3,4]	Threshold Quantity (outdoor release)	Threshold Quantity (indoor[2] release)
1	TIH Zone A or EU-CLP Category 1 Hazardous Materials[5]	0.5 kg	0.25 kg
2	TIH Zone B or EU-CLP Category 2 Hazardous Materials[5]	2.5 kg	1.25 kg
3	TIH Zone C or EU-CLP Category 3 Hazardous Materials[5]	10 kg	5 kg
4	TIH Zone D or EU CLP Category 4 Hazardous Materials[5]	20 kg	10 kg
5	Flammable Gases or Liquids with Boiling Point ≤ 35°C and Flash Point < 23°C or Other Packing Group I Materials	50 kg	25 kg
6	Liquids with a Boiling Point > 35°C and Flash Point < 60°C or Liquids with Flash Point > 60°C released at or above Flash Point; or Other Packing Group II and III Materials or Strong acids and bases	100 kg	50 kg
7	Liquids with Flash Point > 60°C released at a temperature below Flash Point or Moderate acids/bases	1000 kg	500 kg

In order to simplify determination of reporting thresholds for Tier 2, Categories 6 and 7 in Tier 1 have been combined into one category in Tier 2 (Category 6). The simplification is intended to provide less complicated requirements for those events with lesser consequences.

[1] Many materials exhibit multiple hazards. Correct placement in Hazard Zone or Packing Group shall preferentially follow the rules of the UN Recommendations on the Transportation of Dangerous Goods, Section 2 [REF 2] or the Classifications according to DOT 49 CFR 173.2a [REF 3], as explained in the ANSI/API guideline 754 Annex B. Alternatively, the classifications of EU Regulation EC-1272/2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 [REF 4] that implement the UN harmonised System can be used.

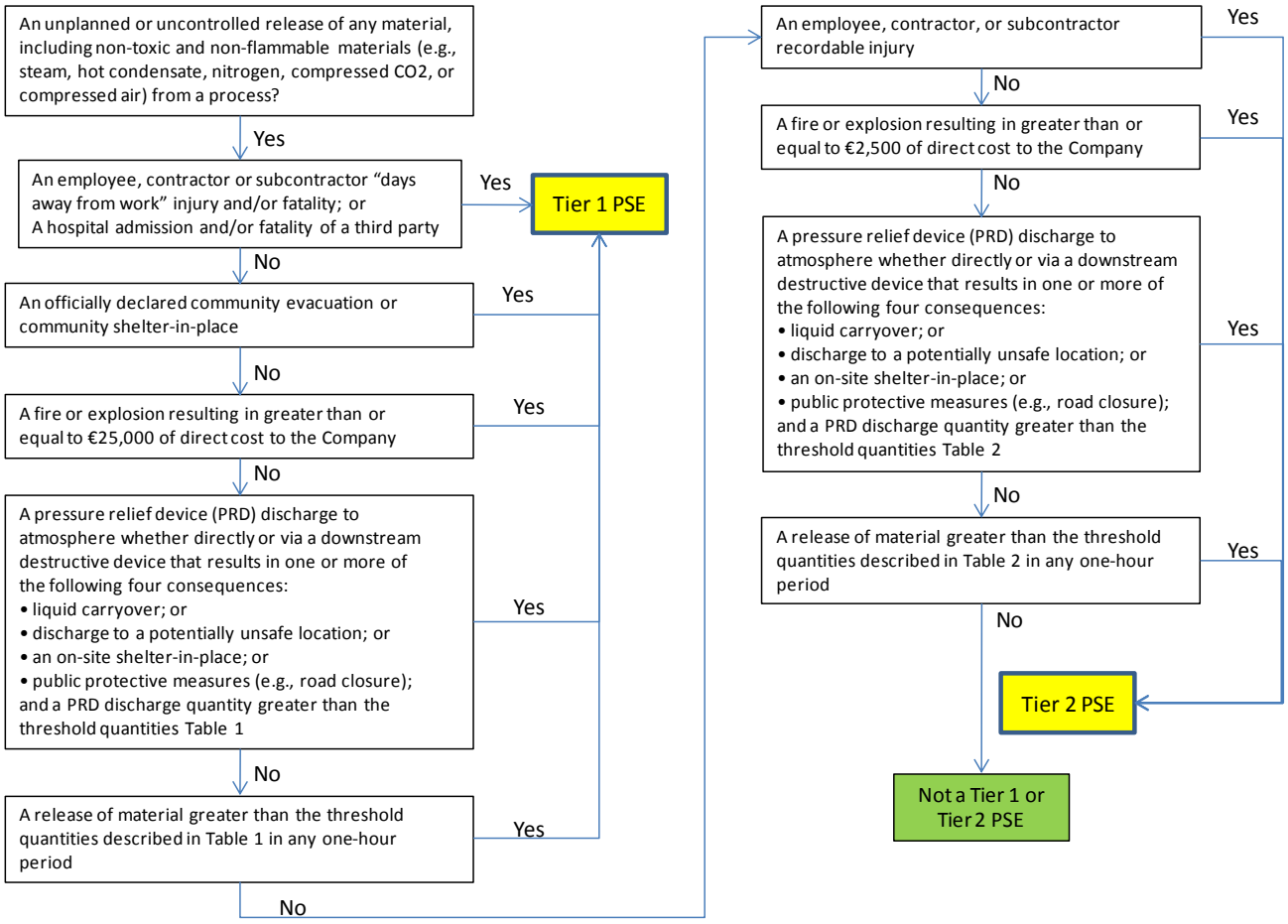
[2] A structure composed of four complete (floor to ceiling) walls, floor and roof.

[3] For solutions not listed on the UNDG, the anhydrous component shall determine the TIH hazard zone or Packing Group classification. The threshold quantity of the solution shall be back calculated based on the threshold quantity of the dry component weight.

[4] For mixtures where the UNDG classification is unknown, the fraction of threshold quantity release for each component may be calculated. If the sum of the fractions is equal to or greater than 100%, the mixture exceeds the threshold quantity. Where there are clear and independent toxic and flammable consequences associated with the mixture, the toxic and flammable hazards are calculated independently.

[5] For vapours, the hazardous classifications only apply to inhalation toxicity. Whereas for liquids, the oral and dermal toxicity should be assessed, as well as described in the ANSI/API guideline Annex B.

PSE Classification Decision Logic Tree



Bibliography of Appendix 2

The following documents are directly referenced in this recommended practice.

[1] API (2010) ANSI/API Recommended practice 754. Process safety performance indicators for the refining and petrochemical industries. Washington DC: American Petroleum Institute

[2] UNECE (2009) European agreement concerning the international carriage of dangerous goods by road (ADR 2009) ECE/TRANS/202, Vol. I and II. Geneva: United Nations Economic Commission for Europe

[3] U.S. Government (2006) 49 CFR – Chapter 1 – Part 173. Classification of a material having more than one hazard

[4] EU (2008) Regulation (EC) No. 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No. 1907/2006. Official Journal of the European Union No. L353, 31.12.2008

FURTHER READING

The following documents are not directly referenced in this note but provide a useful source of relevant information.

[A] API (2008) API guide to report process safety incidents – December 2007 (report year 2008). Washington DC: American Petroleum Institute

[B] Center for Chemical Process Safety (2009) Guidelines for process safety metrics. Hoboken, New Jersey: John Wiley& Sons, Inc.

[C] Baker, J.A. et al (2007) The report of the BP U.S. refineries independent safety review panel - January 2007

[D] Broadribb, M.P. et al (2009) Cheddar or Swiss? How Strong are your Barriers? (One company's experience with process safety metrics). Presentation at 5th Global Congress on Process Safety, April 26-30, 2009, Tampa FL

[E] Center for Chemical Process Safety (2007) Guidelines for risk based process safety. Hoboken, New Jersey: John Wiley& Sons, Inc.

[F] NEI (2007) Regulatory assessment performance indicator guideline. NEI 99-02 Revision 5. Washington DC: Nuclear Energy Institute

[G] OECD (2008) Guidance on developing safety performance indicators related to chemical accident prevention, preparedness and response. Series on Chemical Accidents No. 19. Paris: Organisation for Economic Coordination and Development

[H] U.S. Chemical Safety and Hazard Investigation Board (2007) Investigation report - Refinery explosion and fire (15 killed, 180 injured). BP, Texas City, March 23, 2005. Report No. 2005-04-I-TX

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