performance of european cross-country oil pipelines

statistical summary of reported spillages – 2003

Prepared by the CONCAWE Oil Pipelines Management Group's Special Task Force on oil pipeline spillages (OP/STF-1)

P.M. Davis
J. Dubois
A. Olcese
F. Uhlig

J-F. Larivé (Technical Coordinator)

D.E. Martin (Consultant)

ABSTRACT

This annual report covers the performance with regards to hydrocarbon spillage of 36,422 km of on-shore oil pipelines in Europe in 2003. Incidents are analysed by cause and the effectiveness of the clean up is recorded. Direct repair and clean-up costs are reported. The inventory of European oil pipelines covered by this annual report is similar to that for the 2002 exercise with the addition of product pipelines in Slovakia. Performance in 2003 was better than the long-term average. Third party activities remain one of the main causes of spillage incidents, with all but one of the spillages this year resulting from this cause. The report also gives the annual intelligence pig inspection statistics.

KEYWORDS

Clean-up, CONCAWE, intelligence pig, oil spill, pipeline, soil pollution, spillage, statistics, water pollution

INTERNET

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SUMMARY

Approximately sixty-five companies and other bodies operating oil pipelines in Europe currently provide statistics for the CONCAWE annual report on the performance of cross-country oil pipelines.

These organisations operate some 250 different service pipelines, which, at the end of 2003, had a combined length of 36,422 km, slightly longer than that for 2002. The volume transported in 2003 was 817 Mm^3 of crude oil and refined products, which is 11% higher than in 2002. Total traffic volume in 2003 amounted to 143×10^9 $m^3 \times km$, also 11% up on 2002.

There were 10 reported oil spillages from pipelines during 2003 (12.7 per year on average since 1971). There were no associated fires or injuries. The gross spillage was 2830 m^3, equivalent to 3.5 parts per million (ppm) of the total volume transported, of which nearly 90% was from a single event. A total of 1210 m^3, i.e. 43% of the spillage was recovered or safely disposed of. The net oil loss into the environment amounted therefore to 1620 m^3, or 2.0 ppm.

With the exception of one event due to mechanical failure, all other nine events, including the larger one, were the result of third party activities. This emphasises the established trend for third party actions to be the largest single cause of spillages as well as the cause of the largest spillages.

This report provides comparative data for the five-year period between 1999 and 2003 and a comparison of the 2003 performance versus the annual average of all reported incidents since 1971. In terms of numbers of spillages, the 2003 performance was better than average with less than the long-term average number of spillages (10 versus 12.7). Moreover, the system length is now much longer than in earlier years. This means that the spillage frequency of 0.27 spillages per 1000 km per year was only about half of the long term frequency of 0.53. The performance was not as good in terms of volume spilled due to one very large spill. The gross spillage volume per 1000 km of pipeline was about 86% of the long-term average (net 110%). Three of the spillages required extensive clean-up campaigns that exceeded six months duration or were particularly costly. The overall reported costs for repairs and clean-up of all incidents amounted to 2.1 M€. However, the actual costs were probably much greater as in several cases, the clean-up was still ongoing at the time of reporting.

Also included is the record of intelligence pig inspection activity in 2003 and the historical record since the technique was first used in 1970. In 2003, 144 inspections were completed using metal loss and/or crack detection pigs, 37 times in conjunction with geometry pigs, covering over 8000 km of pipeline.

To date, 80% of the current pipeline inventory has been inspected at least once using intelligence pig techniques.

1. INTRODUCTION

This report presents statistical data relating to spillages from cross-country oil pipelines reported for calendar year 2003 with comments and comparisons for the five-year period 1999 to 2003 and an overall comparison since 1971. Similar studies for preceding years are available as a series of CONCAWE reports [1,2,3] and the 30-year (1971 to 2000) performance statistics have been analysed and reported separately [4]. Prior to 1994, the reports covered only the pipelines owned by the oil industry. Since 1994, however, the non-commercially owned pipelines have been incorporated into the reports, and the spillages from these pipelines have been retroactively added to the CONCAWE database from 1988. From 2001, three additional countries were covered: the Czech Republic, Hungary and Slovakia (crude oil lines only); the product pipelines in Slovakia have been added this year.

Every endeavour is made to ensure that the content of this document is as complete as possible. In this connection, a comprehensive inventory of cross-country pipelines has been compiled and has been updated in the course of 2003 by CONCAWE with the active cooperation of pipeline operating companies throughout Europe. A general map of European land-based oil pipelines is attached to this report. ***Link to map of Refineries and Oil Pipelines in Western Europe***.

Offshore pipelines (as distinct from estuary crossings by onshore lines) are excluded.

The reported spillage volumes are approximate. Gross spillages of less than 1 m^3 are taken into consideration only when their impact on the environment was noteworthy.

The costs comprise direct costs of the spillage incidents for pipeline repair and site clean-up/restoration but exclude any consequential costs such as loss of income or legal costs. Site restoration costs are frequently understated as clean-up can take a long time, and often major costs are incurred after the data is submitted for this report.

The inspection activity using intelligence pigs is reported for 2003 versus 2002, for the 5-year period 1999 to 2003 and the overall inspection status for the currently operational pipeline inventory since the first intelligence pig inspection was carried out in 1970. The data are reported both in terms of the length (km) inspected and the number of individual sections. A single inspection may involve one or more passes of the intelligence pig over the same section.

Caution should always be exercised if statistics recorded in this report are to be utilised for comparison or application to any specific pipeline system.

2. EUROPEAN PIPELINE PERFORMANCE

2.1. GENERAL DATA

The total length of crude oil and petroleum products cross-country pipelines in operation in the monitored European countries at the end of 2003 was 36,422 km, calculated from data provided by approximately 65 operating companies. The pipeline network consists of about 250 separate lines. The reported length is 830 km longer than that reported for 2002. There is one new pipeline of 5 km length included for the first time and 31 km of another pipeline brought back into service. The Slovak product system totalling some 460 km and a number of additional Czech crude pipelines (298 km) have been added to the database. Two pipeline sections (10 km) have been removed from the operational pipelines inventory. Revisions to the lengths of existing pipelines make up the balance. The continuing process of breaking down the records on pipelines into their piggable sections has slightly increased the number of sections this year.

In total, 817 Mm^3 of crude oil and refined products was transported through the pipeline system in 2002. This resulted in a total traffic volume of 143 x 10^9 m^3 x km. Both of these figures are approximately 11% higher than in 2002. The throughput of products alone was 253 Mm^3 giving a traffic volume of 38.4 x 10^9 m^3 x km.

2.2. DETAILS OF SPILLAGE INCIDENTS

In 2003, 10 incidents were recorded in which reportable oil spillages occurred. This was four less than in 2002. However, the total volume of oil spilled was higher than for 2002 due to the occurrence of a very large spill, estimated at 2500 m^3. This is equal to the fifth largest spill on record. A summarised analysis of causes and spilled volumes is shown in **Table 1; Figures 1 and 2** illustrate the effectiveness of the clean-up operations and the time required. Details of each incident are given in **Appendix 1** which also includes a list of the categories of causes for spillage, consistent with the approach used for the previous reports.

In the past, there has been some lack of clarity with regard to the precise meaning of the terms ‘oil recovered’ and ‘net volume of spill’. Oil recovered could refer either to oil recovered as liquid oil alone, or could include oil removed from the environment mixed with soil and subsequently destroyed. This year, the questions asked of those reporting a spill have been changed so that these two categories of oil ‘recovered’ are reported separately. As this is the first year that this has been done, comparisons with previous years will be made using reported total “removed oil”.

Table 1 Summary of causes and spilled volumes for 2003 incidents

Category (by cause)	Number of incidents		Spilled volume (m^3)				Average volume per incident (m^3)	
	Pipeline	Pump Station	Gross	Recovered as oil	Removed	Net Loss	Gross	Net
A. Mechanical failure	1	0	30	30	30	0	30	0
B. Operational	0	0	0	0	0	0	0	0
C. Corrosion	0	0	0	0	0	0	0	0
D. Natural hazard	0	0	0	0	0	0	0	0
E. Third party activity	9	0	2800	1154	1180	1623	311	180
Total	**10**	**0**	**2830**	**1184**	**1210**	**1620**	**283**	**162**

Figure 1 Effectiveness of clean-up efforts

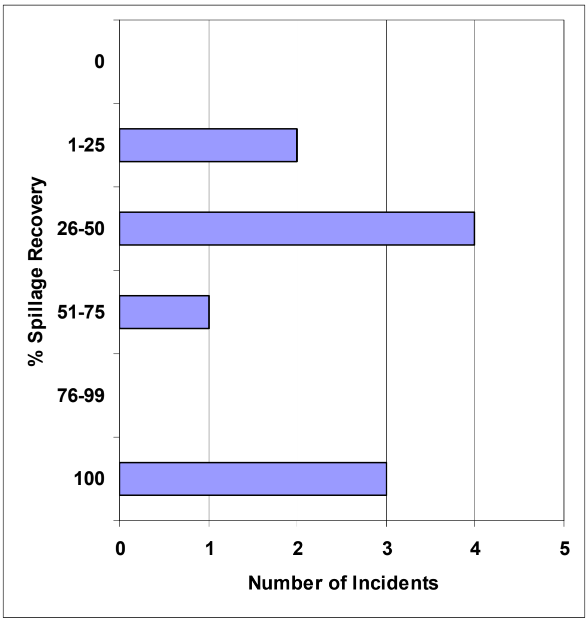
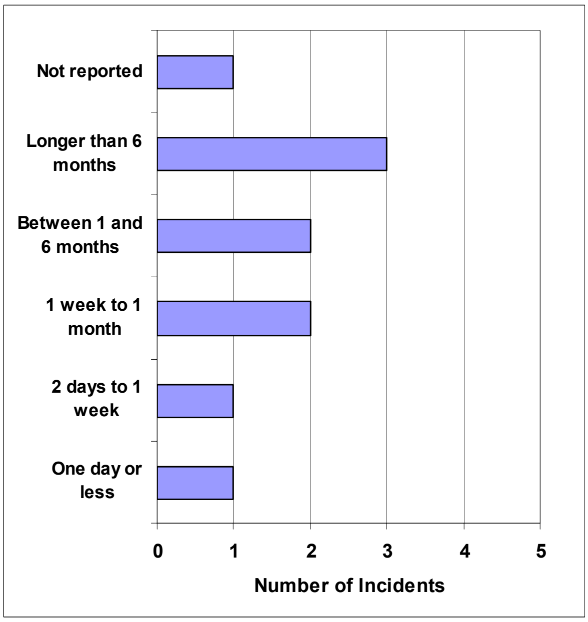
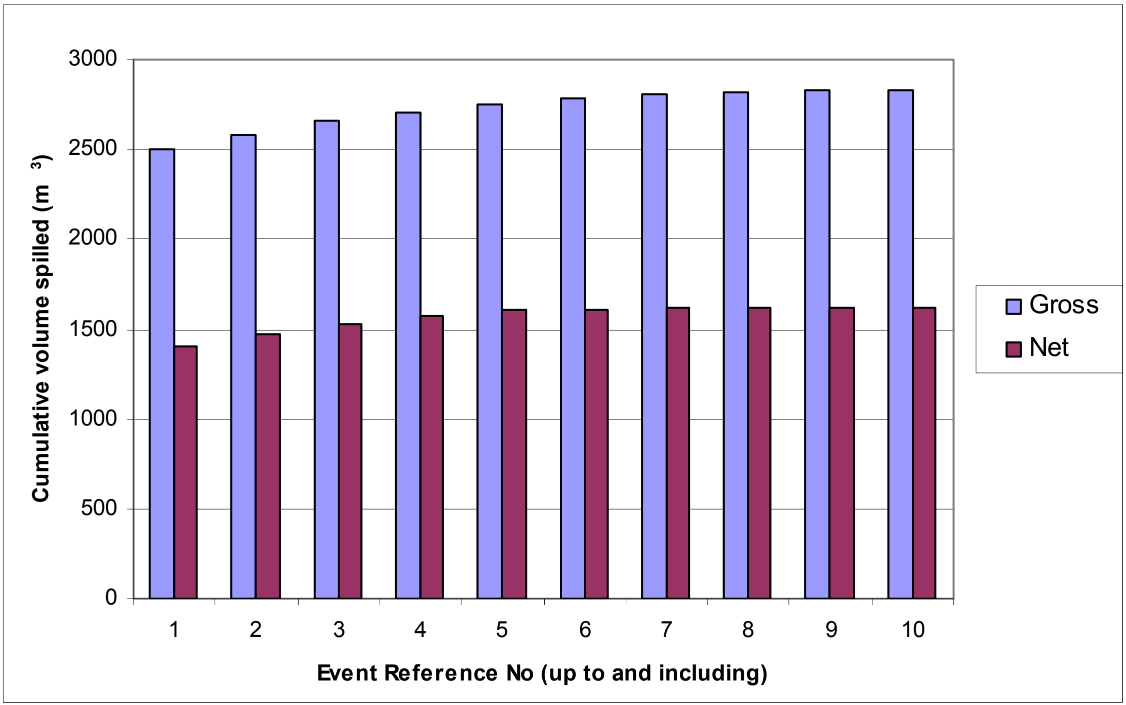


Figure 2 Clean-up time



Total loss to the environment was 2830 m^3 of which 1210 m^3 was removed from the environment (43%). Of this 1184 m^3 was recovered as oil. The cumulative spill sizes are shown in **Figure 3**.

Figure 3 Cumulative spilled volumes



Several of the 10 spillage incidents in 2003 required extensive clean-up programmes. Two spillages are categorised as causing significant soil pollution (i.e. >1000 m^2 of ground affected) and the largest spill affected no less than 80,000 m^2, the second largest area of ground affected on record. This resulted not only from the size of the spill but also from its location and the time before detection. Two of the spillages affected surface water courses and one of these also affected ground waters. The reported repair and clean-up costs were some 2.1 million € although no costs were reported for three of the spills. Of this total, no less than 2 million € was for the clean up of the largest spill.

2.3. CAUSES

The 10 spillages of 1 m^3 gross or more that were reported in 2003 are categorised below. There were also two minor spills (a few litres each) which were below the 1 m^3 threshold for reporting and caused negligible environmental impact.

2.3.1. Mechanical failure

Event No 6:
A spillage from a 14” pipeline was caused by a defective weld. 30 m^3 of aviation kerosene was lost before the leak was detected by the leak detection system. All of the oil was recovered. There was no pollution of water resources and the clean up was completed in 2 days. Also, one of the minor spills mentioned was caused by pipe lamination. Further investigations on this pipeline are now being conducted.

2.3.2. Operational

There were no spillages in the operational category during 2003.

2.3.3. Corrosion

There were no spillages caused by corrosion in 2003 apart from one of the minor spills mentioned above. This was caused by external microbiological corrosion in an area of wet ground.

2.3.4. Natural hazard

There were no spills caused by natural hazards during 2003.

2.3.5. Third party activity

There were nine incidents caused by third parties, of which three were due to accidental direct damage, four were caused by malicious damage (theft) and two resulted from hitherto undetected damage to the pipeline caused by a third party in the past. These third party spillages totalled 2800 m^3 gross, 1620 m^3 net.

Event No 1:
A third party reported oil appearing on the surface of a canal. At first this was thought to be from a disused pipeline between two tank farms, but when the oil continued appearing, it was decided to pressure test an operational 20-inch line in the area. This revealed a leak, and the pipeline was immediately flushed with water. The leak was located and excavation revealed that a length of the pipe was badly damaged with dents, gouges and a crack. This damage was immediately under a sewer which had been laid in 2000 but which was not supposed to have crossed the pipeline at this point. Further excavations revealed that the sewer had been installed directly over the pipe for a distance of 30 m with a vertical separation of only 10 cm instead of the 40 cm required by law. It is estimated that 2500 m^3 of oil was spilled. The point where the oil appeared on the canal was a long distance from the site of the leak, as the oil had travelled through the disturbed ground around the numerous pipes in the area. This explains the large volume of oil spilled before the leak was noticed. Altogether 80,000 m^2 of ground were contaminated and both surface and groundwater were impacted. Repairs and clean-up cost 2 million € and the pipeline has now been taken out of service. Although the clean-up by three-phase extraction was completed within two months, it is estimated that the effects on the environment will continue for over 6 months.

Event No 2:
A bulldozer carrying out ground works for a farmer hit a 10-inch pipeline and tore a hole 200 mm x 150 mm in it. There are two parallel pipelines in this area which are both clearly marked by permanent markers. The driver was aware of the pipelines. Approximately 85 m^3 of gas oil was spilled, of which 9 m^3 was recovered. 1800 m^2 of ground was contaminated. Extensive works were carried out to control the spillage as it was close to a protected environmental area. As a result, there was no pollution of water resources. Repairs to the pipeline cost 20,000 € with the clean-up costing a further 11,300 €.

Event No 3:
An attempt was made to steal product from a 10-inch pipeline. A three-quarter inch pipe was inserted into the pipeline but protruded inside the pipe. It is not known how much product was stolen, but the next time that a cleaning pig was run, it hit the connecting pipe and knocked it off. The spillage was detected at the pipeline control centre and the pipeline shut down within 5 minutes. However, nearly 75 m^3 of gas oil was spilled on agricultural land, contaminating 500 m^2 of soil. Nearly 25 m^3 of oil was recovered leaving approximately 50 m^3 in the ground. The clay soil and the local conditions allowed the product to be isolated easily. Repairs to the pipeline cost 21,630 € with the clean-up costing a further 32,550 €.

Event No 4:
Thieves made 5 small hot tap connections (5 mm each) on a 16-inch products pipeline with an iron pipe and a manual valve and successfully stole product. When the pipeline pressure rose to 44 bar, a spillage occurred due to the inadequate pressure rating of the equipment used by the thieves. The spillage was detected by the automatic pressure sensing equipment, the section of pipeline was shut-in and the site located by operators on foot. 52 m^3 of gas oil was lost which affected 400 m^2 of soil but there was no pollution of water resources. Repairs to the pipeline cost 50,000 €. So far, some contaminated soil has been removed but a monitoring programme has been established and plans made for a full clean-up involving soil vapour extraction and bio-venting. These plans have to be approved by the local authorities.

Event No 5:
A bulldozer carrying out groundwork for road construction in a commercial area punctured a 10-inch pipeline. This was despite the fact that the driver was aware of the presence of the pipeline and knew that there were restrictions on excavations in the area. 45 m^3 of gas oil was spilled, of which 14 m^3 was recovered as oil. 600 m^2 of ground was contaminated. As the leak was comparatively small, the clean-up only took 25 days at a cost of 8140 € with a further 3650 € to repair the pipe. There was no contamination of water resources.

Event No 7:
Thieves drilled a small hole (4 mm diameter) into a 16-inch pipeline in an agricultural area, then tried to close the hole and re-covered the pipeline with earth. The closure failed under pipeline pressure and 28 m^3 of gas oil was spilled and was reported by a third party. The spill contaminated some 200 m^3 of soil. Approximately 18 m^3 of oil was removed with soil in the initial clean-up and there was no pollution of water resources. Repairs to the pipe cost 40,000 € and the initial clean-up cost 26,000 €. Similar plans to those for the previous spill are being prepared.

Event No 8:
A minor leak in a 12-inch product pipeline was detected during a routine (10-yearly) pressure test to 110% of the maximum allowable service pressure. The location of the leak was detected by using a scraper pig equipped with a transmitter. Investigation showed that the pipeline had been scraped by some sort of machinery at some point in the past. In total, 11 m^3 of oil was spilled of which 1 m^3 was recovered as oil. There was some pollution of surface water. Clean-up was carried out by excavation of the polluted soil which covered some 800 m^2. Another 3 m^3 was recovered with oily soil. The line had last been inspected by a metal loss pig in 2003.

Event No 9:
An illegal connection was made by drilling a hole in a 16-inch crude oil pipeline through a manual valve and a fixed collar with a high pressure hydraulic hose for connection. A rubber gasket in the collar was not oil-resistant and failed. Fortunately, the pumps were shut down at this time so that the volume spilled was only 5 m^3. The leak was detected by a routine low level aerial survey of the line, in fact the crew smelt the oil. The leak was near a forest and there was no pollution of water resources. 3 m^3 of oil was recovered as oil and the rest removed with soil for safe disposal. Repairs to the pipeline cost 8000 € with clean-up costing a further 12,000 € making 20,000 € in total.

Event No 10:
A digger carrying out excavations punctured a 6" pipeline carrying aviation kerosene. The spillage was quickly detected by the leak detection system so that spillage was restricted to 2 m^3, all of which was recovered. There was no pollution of water resources and clean up was completed within 1 day.

3. COMPARISON WITH PREVIOUS YEARS

The comparative numbers of spillages and spillage volumes for the period 1999 - 2003, and the long-term overall percentages for the numbers and volumes of spillages since 1971, are given in **Tables 2** and **3**. The latter data are also presented graphically in **Figures 4** and **5**.

In 2003, the occurrence of 10 spillages represents a better performance than that achieved in 2002, and slightly better than the long-term average of 12.7 spills per year. Taking into consideration the fact that the length of pipelines included in the survey has increased over the years, it is much better than the average result as measured by the frequency (0.27 per 1000 km/year in 2003 versus a long-term average of 0.53 spills per 1000 km/year).

In terms of spillage volumes, 2003 was worse than the previous four years although nearly 90% of the gross spillage (86% net) resulted from one incident (see **Figure 3**). The 2003 total gross spillage volume of 2830 m^3 is also greater than the long term average (2175 m^3) and the net spillage volume (1620 m^3) is much higher than the long term average (970 m^3). Relative to the total length of pipeline under survey however, the performance was of the same order of magnitude than the long-term annual average (78 litres per km gross and 44 litres per km net in 2003 compared to long-term averages of 90 and 40 litres per km per year).

- There was one spillage in the "mechanical failure" category in 2003 leading to a spillage of 30 m^3, all of which was recovered. The data recorded since 1971 show that 3.0 spillages per year, contributing 31% of the total spillage volume, result from this category of incident.
- There were no spillages in the "operational" category. The long-term average performance is 0.9 incidents per year, and the contribution to gross volume spilled is 3.6%.
- Unusually, there were no "corrosion" spills in 2003. Long-term, corrosion has accounted for 3.7 incidents per year, which contributes 19% of the total spillage.
- There were no spillages resulting from a "natural hazard". This category has a long-term average incidence of only 0.45 spillages per year and contributes 4% of the gross spillage volume.
- Nine out the ten spillages recorded in 2003 accounting for 99% of the gross spilled volume (2830 m^3) were related to "third party activity". This emphasises the established trend for third party actions to be the largest single cause of spillages as well as the cause of the largest spillages. The long-term average figures for this category are 4.7 incidents per year and 42% of the total volume spilled.
- A total of 51 spillage incidents were recorded over the five-year period 1999 to 2003. All but four caused some temporary environmental pollution. Slight pollution of soil and water resulted from 40 and 4 cases respectively. Significant soil contamination arose from 12 incidents which required more extensive oil containment and clean-up efforts to restore the environment. There was one incident affecting potable water resources.

Table 2 Five-year comparison by cause, volume and effect: 1999 – 2003

	1999	2000	2001	2002	2003	1999-2003
COMBINED LENGTH (km x 10^3)	30.7	30.8	35.6	35.6	36.4	-
COMBINED THROUGHPUT (m^3 x 10^6)	674	672	708	724	817	-
COMBINED TRAFFIC VOLUME (m^3 x km x 10^9)	125	126	131	125	143	-
Number of Incidents						
MECHANICAL FAILURE						
Construction	-	-	2	-	1	3
Material	1	1	3	1	-	6
OPERATIONAL						
System	-	-	-	-	-	-
Human	1	-	-	-	-	1
CORROSION						
External	1	-	2	5	-	8
Internal	-	1	1	-	-	2
Stress corrosion cracking	-	-	-	1	-	1
NATURAL HAZARD						
Subsidence	-	-	-	-	-	-
Flooding	-	-	-	-	-	-
Other	-	-	-	1	-	1
THIRD PARTY ACTIVITY						
Accidental	2	3	3	4	3	15
Malicious	-	-	4	1	4	9
Incidental	1	1	-	1	2	5
	6	6	15	14	10	51
NET SPILLAGE INCIDENTS						
0 - 10 m^3	1	4	11	7	2	25
11 -100 m^3	3	-	4	6	7	20
101- 1000 m^3	2	2	-	1	-	5
In excess of 1000 m^3	-	-	-	-	1	1
POLLUTION RESULTING						
None		1	-	2	-	3
SOIL						
Slight	5	5	13	5	8	36
Significant	1	-	2	7	2	12
WATER COURSES						
Slight	-	-	-	3	1	4
Significant	-	-	-	-	1	1
POTABLE WATER	-	-	1	-	-	1

Table 3 Comparison with previous years

1. Volume spilled per cause (m^3)

Main category	**1999**	**2000**	**2001**	**2002**	**2003**	**1999-2003**
A. Mechanical failure	- (-)	175 (1)	853 (5)	10 (1)	30 (1)	1068 (8)
B. Operational	7 (1)	- (-)	- (-)	- (-)	- (-)	7 (1)
C. Corrosion	199 (4)	10 (1)	113 (3)	493 (6)	- (-)	815 (14)
D. Natural hazard	- (-)	- (-)	- (-)	250 (1)	- (-)	250 (1)
E. Third party activity	310 (6)	175 (4)	184 (7)	1432 (6)	2800 (9)	4901 (32)
Gross spillage	516 (11)	360 (6)	1150 (15)	2185 (14)	2830 (10)	7041 (56)
Recovered	345	276	970	1867	1210	4668
Net loss	171	84	180	318	1620	2373
Average gross loss / incident	47	60	77	156	283	126
Average net loss / incident	16	14	12	23	162	42
Average gross loss/1000 km	17	12	32	61	78	42
Average net loss/1000 km	6	3	5	9	45	14

Figures in parentheses denote number of incidents

2. Comparisons since 1971

	Number of Incidents			**Percentage Gross Volume Spilled (m^3/yr)**	
	2003	**Average / yr 1971-2003**	**Percentage 1971-2003**	**2003**	**1971-2003**
A. Mechanical failure	1	3.0	23.4%	1.1	31.4%
B. Operational	-	0.9	6.9%	0	3.6%
C. Corrosion	-	3.7	3.7%	0	18.9%
D. Natural hazard	-	0.5	3.6%	0	4.1%
E. Third party activity	9	4.7	36.8%	98.9	42.1%

Note: The non-commercially owned pipelines data are in the database from 1988 onwards. Pipelines in Hungary, the Czech Republic and Slovak (crude lines) were added in 2001 and the Slovak product lines in 2003.

Figure 4 Five-year comparison: length, throughput and relative spillage

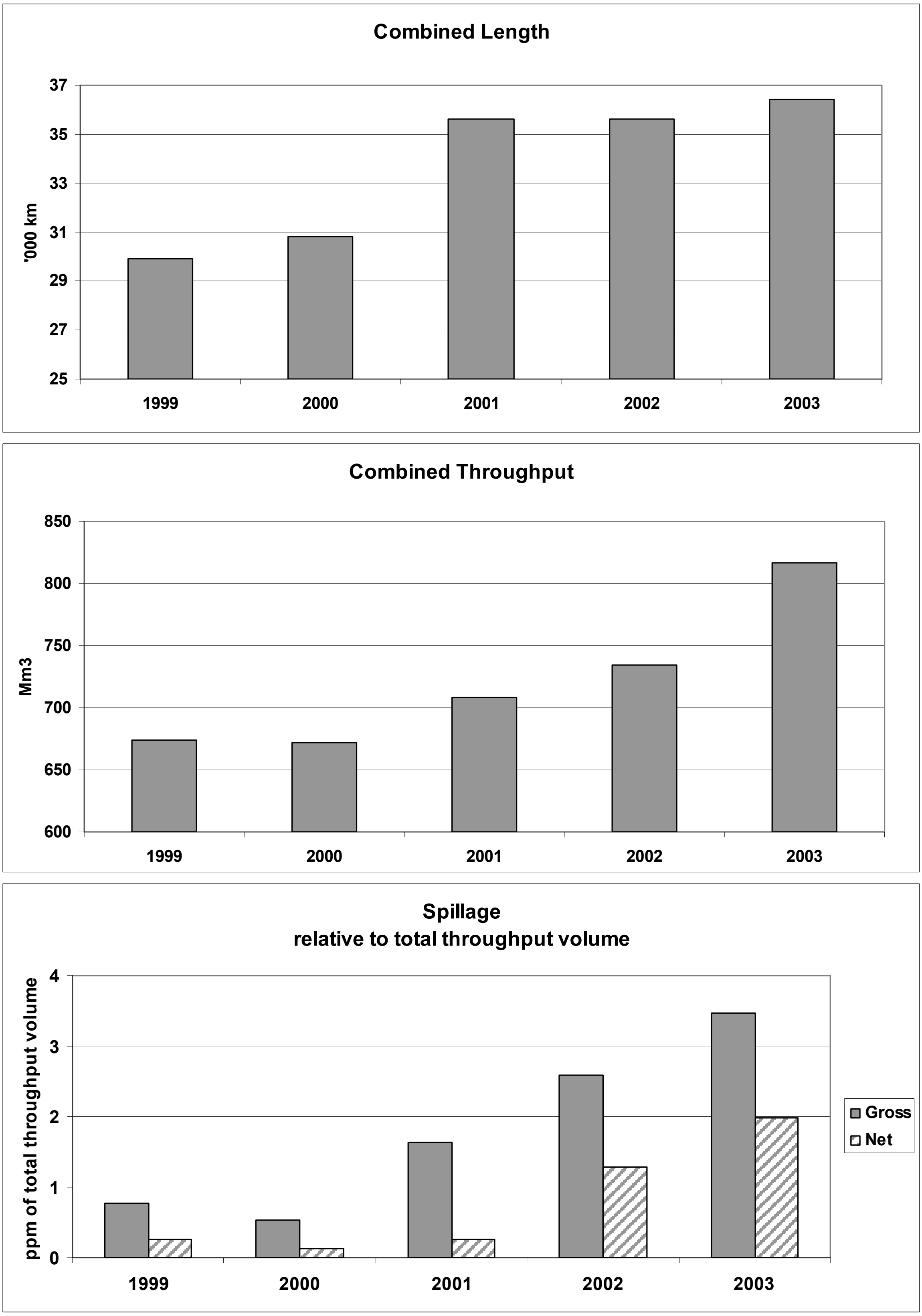
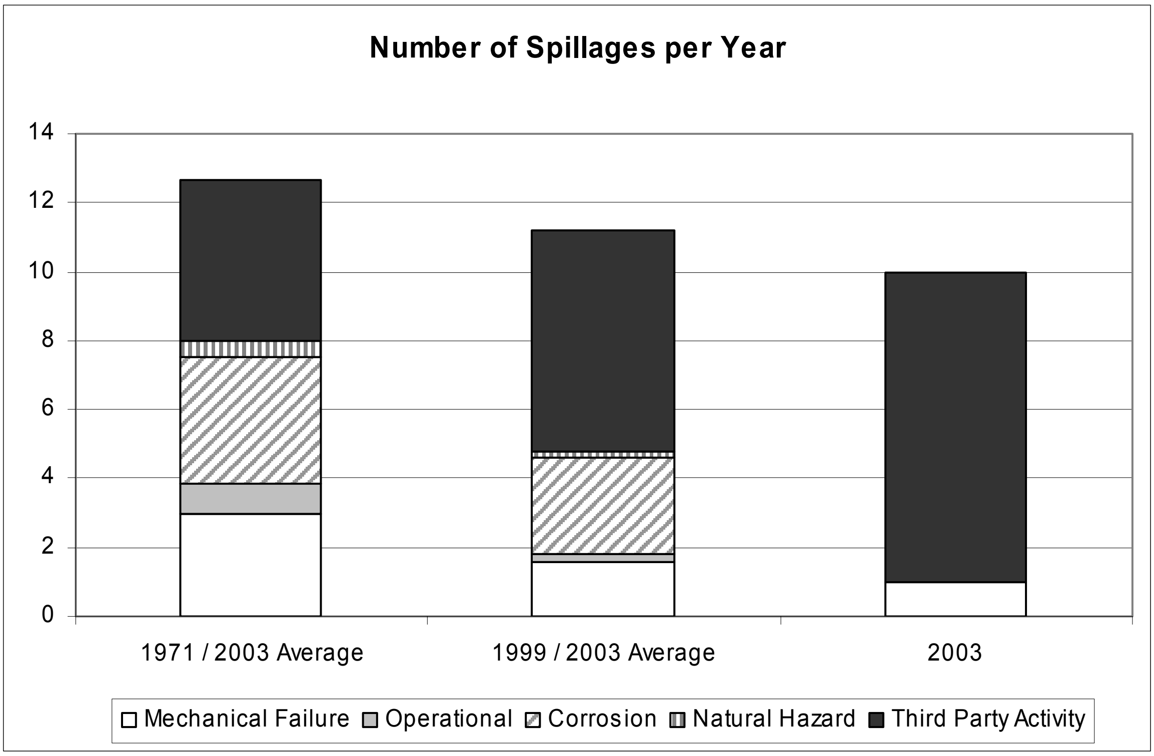
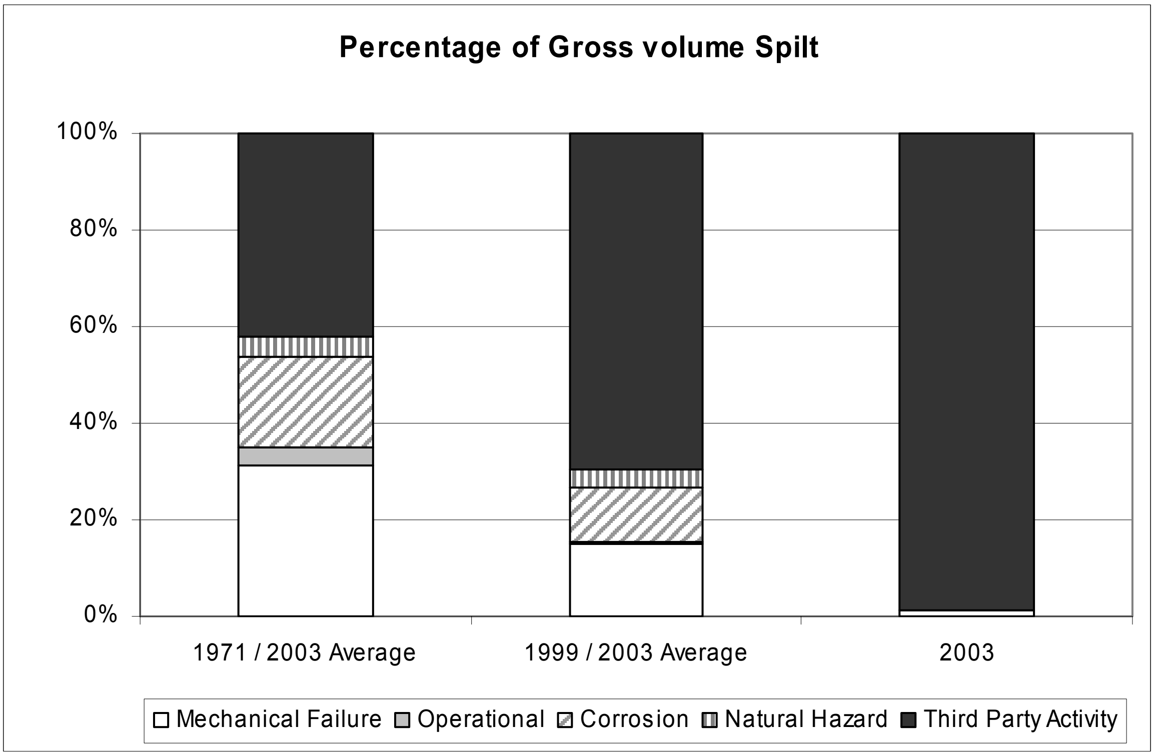


Figure 5 Long-term comparative spillage data per category





4. INTELLIGENCE PIG INSPECTIONS STATISTICS

An assessment of the condition of a pipeline can be obtained by sending intelligence gathering pigs through a section of pipeline and analysing the recorded data to define a programme to validate the location and establish the nature and severity of indicated defects. This is followed up with suitably prioritised defect monitoring or repair actions. The intelligence pigs used to prevent leaks have one of three basic functions. There are metal loss measurement and crack detection pigs that record imperfections within the pipe material and on the internal or external walls. These use ultrasonic or magnetic techniques. The third type is the geometry pig that measures the internal pipe diameter and takes roundness measurements.

Each inspection of a pipe section can involve one or more passes of either one or more types of pig. Annual records are kept of completed inspections for the three types of pig and the length (km) and number of sections inspected.

Table 4.1 Length (km) of pipeline inspected using intelligence pigs

Inspection year	Metal Loss Pig	Crack Detection Pig	Geometry Pig	Total Pipeline Inventory
2003	4817	710	2461	35,575
2002	2925	902	2824	35,509
5-year Average	3597	710	2327	32,398

In 2003, metal loss intelligence pig inspection activity measured in kilometres was much greater than in 2002 and was also well above the average over the last 5 years which had itself been on the increase. This year however, crack detection pig activity was slightly down on 2002 but equal to the average for the last 5 years. Geometry pig inspections were about average. Some 13.6% of the inventory was inspected using metal loss pigs, 2.0% using crack detection pigs and 6.9% using geometry pigs.

Table 4.2 Number of pipeline sections inspected using intelligence pigs

Inspection year	Metal Loss Pig	Crack Detection Pig	Geometry Pig	Total Inventory of Sections
2003	72	6	39	672
2002	52	11	36	643
5-year Average	54	6	36	611

In 2003, 144 inspections used metal loss and/or crack detection pigs, 37 times in conjunction with geometry pigs. In addition, 8 inspections used geometry pigs only but there were no inspections using crack detection pigs only.

Table 4.3 Coverage of intelligence pig inspections since first used (i.e. 1970-2002)

Type of Inspection	Pipeline Sections No.	Pipeline Length km
Metal loss and/or crack detection only	144	8562
Geometry only	8	481
Pipe wall & geometry	309	19,018
Total inspected (at least once)	461	28,061
Total Inventory (2003)	672	35,509

The data in this table are calculated for the pipelines in service at end 2003, ignoring the pipelines which have been shut down, many of which were never inspected in their lifetime. Over the period that intelligence pigs have been in use, 6108 km of pipelines have been shut down. If these had been retained in the data set analysed, they would have distorted the interpretation of the results. The never-inspected length in the operational inventory (7448 km at end 2003) should continue to decrease in future years.

Since the first recorded intelligence pig inspection in 1970, some 79% of the current pipeline inventory length and 69% of the inventory pipeline sections have been inspected at least once using any one of the pig types. Most of these have included the use of metal loss and/or crack detection pigs with only 1% inspected by geometry pig only. The use of geometry pigs has been included at least once in 55% of length and 47% of sections.

The total number of inspections on existing pipelines made to date is 1344, comprising 847 using metal loss, 44 using crack detection and 453 using geometry pigs. Many pipeline sections have been inspected a number of times as shown in **Tables 4.4, 4.5 & 4.6.** This mainly applies to metal loss pig inspections with no fewer than 188 pipe sections having been inspected more than once and 92 twice or more. Two pipeline sections have been inspected no fewer than 14 times.

Table 4.4 Repeat metal loss pig inspections by pipe sections, 1970-2003

Inspections	0	1	2	3	4	5	6	7	8	9	10	11	12 13	14
No. of sections	224	262	98	45	23	13	3	3	0	1	1	1	0	2

Note. Covers only pipelines still active in 2003. Total number of metal loss pig inspections = 847.

The number of crack pig inspections is far fewer, with only 44 in total. However, three pipe sections have been inspected twice and one section 5 times.

Table 4.5 Repeat crack pig inspections by pipe sections, 1970-2003

Inspections	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7 and more**
No. of sections	639	33	3	0	0	1	0	0

Note. Covers only pipelines still active in 2003. Total number of crack pig inspections = 44.

There have been more repeat inspections using geometry pigs although not as many as using metal loss pigs. 98 pipe sections have been inspected more than once with one pipeline having been inspected 6 times.

Table 4.6 Repeat geometry pig inspections by pipe sections, 1970-2003

Inspections	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7 and more**
No. of sections	359	219	69	22	6	0	1	0

Note. Covers only pipelines still active in 2003. Total number geometry pig inspections = 453.

The above tables show that repeat inspections (2 or more) have been carried out on 292 pipeline sections using metal loss, crack or geometry pigs.

5. REFERENCES

1. CONCAWE (1969) Oil spillages from pipelines - Western Europe - statistical summary of reported incidents 1966 - 1968 inclusive. Document 3874. Brussels: CONCAWE

2. CONCAWE (1972) Spillages from oil industry cross-country pipelines in Western Europe. Statistical summary of reported incidents 1966 - 1970. Report No. 2/72. Brussels: CONCAWE

3. CONCAWE Performance of oil industry cross-country pipelines in Western Europe. Statistical summary of reported spillages. Reports No. 2/73, 1/74, 5/74, 7/75, 7/76, 9/77, 3/78, 6/79, 10/80, 2/82, 11/82, 9/83, 12/84, 9/85, 7/86, 8/87, 8/88, 9/89, 6/90, 4/91, 4/92, 2/93, 5/94, 4/95, 4/96, 7/97, 6/98, 3/99, 3/00, 4/01, 1/03, 7/04. Brussels: CONCAWE

4. CONCAWE (2002) Western European cross-country oil pipelines 30-year performance statistics. Report No. 1/02. Brussels: CONCAWE

APPENDIX 1

DETAILS OF 2003 SPILLAGE INCIDENTS

(Table: See next page)

	Pipeline data				Spillage (m^3)				Cause		Consequences			
Ref No	Location (1)	Pipe Spec.	Dia x thickness mm (inch)	Commodity transported	Spilled	Recov'd (2)	Net loss to environment (3)	How Discovered	Category (4)	Origin	Water pollution	Soil pollution area (m^2)	Estimated Cost (k€)	Clean-up (days)
1	P/L	API5L	508 x 6.35 (20" x 0.25")	Product	2500	1100	1400	Third Party Pressure testing	E(c)	Pipeline damaged by laying of sewer	Significant pollution of surface and underground water	80,000	2,000	Over 6 months
2	P/L	API 5L X-42	305 x 6.35 (10.75" x 0.25")	Product	83	9	74	Automatic detection system	E(a)	Pipeline holed by bulldozer despite adequate markings	None	1,800	31	Less than 6 months
3	P/L	API 5L X-42	305 x 6.35 (10.75" x 0.25")	Product	74	24	49	Automatic detection system	E(b)	An illegal connection had been made to the pipe. This was damaged by a pig.	None	500	54	Less than 6 months
4	P/L	5LX X52	405 x 7.09 (16" x 0.28")	Product	52	3 (0)	49 (52)	Pressure testing	E(b)	Illegal connection - spillage due to use of inadequate equipment	None	400	>56	Over 6 months
5	P/L	API 5L X-42	305 x 6.35 (10.75" x 0.25")	Product	45	14	31	Third Party	E(a)	Pipeline holed by bulldozer despite adequate markings	None	600	12	25
6	P/L			Product	30	30	0	Automatic detection system	A(a)	Defective Weld	None		Unknown	2
7	P/L	5LX X52	405 x 7.09 (16" x 0.28")	Product	28	18 (0)	10 (28)	Third Party	E(b)	Illegal connection attempt	None	200	> 66	Over 6 months
8	P/L	X52	275 x 8 (10.75" x 0.32")	Product	11	4 (1)	7 (10)	Pressure testing	E(c)	Damage to pipeline by machinery	Pollution of surface water	800	Unknown	Unknown
9	P/L	X 52	405 x 5.5 (16" x 0.22")	Crude oil	5	5 (3)	0 (2)	Aerial Surveillance (odour)	E(b)	Illegal connection - spillage due to use of non oil resistant collar	None	120	20	Less than 1 month
10	P/L			Product	2	2	0	Automatic detection system	E(a)	Pipeline damaged by digger	None		Unknown	1

(1) Pipeline (P/L) or Pump/Receipt Station (P/S)
(2) In bracket, volume recovered as oil where different
(3) In bracket, net oil loss to the environment where different

(4) Categories of spillage causes

		Secondary		
Main		(a)	(b)	(c)
A	Mechanical failure	Construction fault	Material fault	
B	Operational	System malfunction	Human error	
C	Corrosion	External	Internal	Stress corrosion
D	Natural hazard	Landslide/ subsidence	Flooding	Other
E	Third party actiivity	Direct damage -accidental	Direct damage -malicious	Incidental damage

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