The oil companies' European association for Environment, Health and Safety in refining and distribution

concawe

Performance of European cross-country oil pipelines

Detailed description of reported spillages 1994 - 2004

Performance of European cross-country oil pipelines

Narrative descriptions of spillage incidents between 1994 and 2004

This report has been published yearly by CONCAWE since 1971. Until 2004, the yearly report only dealt with detailed information on the spillages having occurred during the year. Every so often an overview report was published analysing the whole database from 1971. From the 2005 reporting year, the format and content of the report was changed to include not only the yearly performance, but also a full historical analysis since 1971, effectively creating an evergreen document updated every year. All previous reports are now obsolete.

In the single annual integrated report, it was, however, not considered practical to include the full narrative description of the circumstances and consequences of each past spillage.

Up till 1993 reports were only published on paper and are mostly out of print. Reported details of the spillage incidents have been compiled in two separate appendices.

This appendix provides this information from the 1994 reporting year, when electronic archiving first started, through to 2004.

Post 2005 the format was modified and information for that year onwards is available in a fourth appendix.

1994 SPILLAGE INCIDENTS

In 1994, 11 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorized as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 1997 m^3. The volume recovered amounted to 437 m^3, equivalent to 18% of the gross volume spilled (2434 m^3). The combined cost of pipeline repair and clean-up reported amounts to 7.5 million ECUs.

Of the 11 incidents in 1994, two have required extensive and costly clean-up programmes to be instituted. In both of these cases, clean-up was still underway at the time of this report. One of the spillages affected potable water supplies temporarily. One resulted in a fire and halted traffic on a motorway but none of the incidents involved injuries to people.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	1
76 - 99	1
51 - 75	0
26 - 50	2
1 - 25	3
0	4

Clean-up time

Time taken	No. of incidents
One day or less	2
Two days up to one week	3
Over one week up to one month	2
Longer than one month	4
Not reported	0

CAUSES

The 11 spillages of 1 m^3 gross or more reported in 1994 are categorized as follows.

Mechanical failure

Five of the 1994 incidents are categorized as mechanical failure.

A 1350 m^3 gross spillage of crude oil occurred due to the failure of the pipewall because of a metallurgical anomaly which had been in existence since the pipe was manufactured. The failure occurred while inert gas was being displaced from the pipeline during start-up after maintenance. These circumstances seriously delayed detection of the leak and contributed to the size of the spillage. During the early stage of the response to the spillage, the spilled oil ignited and burned for a few hours. The fire consumed some 1000 m^3 of the spilled oil which greatly reduced the amount remaining available for recovery. A motorway had to be closed temporarily and some electrical power lines were brought down. The spillage affected a large area of ground and a stream and resulted in pollution of a wide area. A long-term oil recovery programme has been instituted which has removed about 55 m^3 of the oil. The clean-up was still in progress more than a year after the event.

A 200 m^3 gross spillage of crude oil occurred after a pipeline ruptured in a similar fashion to the one described above at the point of a metallurgical anomaly in the pipe material. The leak was quickly detected and pinpointed. The hole was situated at the top of the pipe and sprayed a cultivated field widely, ultimately leading to the formation of a large pool of oil in the field. Oil recovery and removal of the top layer of soil have been completed, removing 40 m^3 of oil. Soil venting and bioremediation were still in progress more than 6 months after the spill.

A gasket failure in a pipeline flanged joint located in a pumpstation caused a 250 m^3 spillage of oil products. No details of the repair and clean-up were reported but the response appears to have been straightforward and the bulk (236 m^3) of the spilled oil was recovered.

A 5 m^3 spillage of light product occurred from a pipeline electrical isolation joint due to the failure of the gasket material. A general programme of replacement of gaskets of the type concerned had already been commenced by the pipeline operator due to previous failure experience. No clean-up was deemed appropriate.

A very small leak of product estimated at about 1 m^3 occurred from a micro-fissure in a defective piece of pipe where the pipe material was found to be laminated. The leak was discovered at an early stage during a route inspection by the pipeline operator. Just two days were needed to clean-up the spillage site.

Operational

There was one spillage in the operational category in 1994.

Due to a fire detection instrument anomaly which occurred on a particularly warm day, the procedure for extinguishing a fire in a pumpstation was activated. The water used filled up the slop tank which overflowed resulting in the spillage of the contents, 2 m^3 of crude oil. Difficulties were experienced in over-riding the anti-fire system and the continuing flow of fire water caused an area outside the pumpstation to be polluted including a small amount of oil in an adjacent canal. Clean-up took 3 days.

Corrosion

There were two spillages due to corrosion; one from internal and the other from external corrosion.

A gross spillage of about 10 m^3 occurred due to internal corrosion in a dead-ended branch of a pipeline inside a tank farm. The pollution reached ground lying outside of the terminal which was cleaned up within a month, recovering some 5 m^3 of oil.

External corrosion under the insulated covering of a heavy oil pipeline caused a 90 m^3 spill of fuel oil. The corrosion occurred along a bend and close to a minor dent. The intelligence pig inspection, last done 3 years previously, was able to detect the metal loss, but an incorrect evaluation resulted due to the effects of the corrosion site factors. The pollution was limited by the high viscosity of the oil and the cold weather conditions. About 30 m^3 of product was recovered in a 3 day clean-up operation.

Natural hazard

There were no spillages in 1994 due to the effects of a natural hazard event.

Third party activity

There were three incidents caused by third parties, all as a result of direct accidental damage.

A 285 m^3 gross spillage of gasoline occurred after a pipeline was punctured at a river crossing when hit by an excavating machine digging along the side of the river. Clean up was completed within a month but no product was recovered as such due to the lightness of the product and evaporation.

Agricultural ploughing punctured a pipeline and caused the spillage of 195 m^3 of products. A temporary effect on potable water supplies occurred as a result of oil percolating into a watercourse. Absorbent booms, pumps and a skimmer were used during the clean-up. The clean-up operation has lasted several months and still continues and some 25 m^3 of oil has been recovered.

A 46 m^3 spillage occurred when an excavator digging a ditch system, dug into a pipe and caused a rupture across the top half of the pipe. The spilled oil was entirely recovered in a thorough clean-up response taking almost two months to complete.

1995 SPILLAGE INCIDENTS

In 1995, 10 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorized as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 654 m^3. The volume recovered amounted to 1175 m^3, equivalent to 64% of the gross volume spilled (1829 m^3). The combined cost of pipeline repair and clean-up reported amounts to 8.8 million ECUs.

Of the 10 incidents in 1995, one required an extensive and costly clean-up programme to be instituted. Clean-up was still underway at the time of this report. One of the spillages affected a river temporarily. None resulted in fires, and none caused any injuries to people.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	2
76 - 99	0
51 - 75	3
26 - 50	1
1 - 25	2
0	2

Clean-up time

Time taken	No. of incidents
One day or less	2
Two days up to one week	0
Over one week up to one month	3
Longer than one month	4
Not reported	1

CAUSES

The 10 spillages of 1 m^3 gross or more reported in 1995 are categorized as follows.

Mechanical failure

Four of the 1995 incidents are categorized as mechanical failure.

A 280 m^3 gross spillage of naphtha occurred as a result of a construction fault, namely the failure of an incorrectly manufactured modification to a pig trap. The manufactured piece did not conform with the specification ordered. The spillage would have been avoided if proper design change procedures had been effectively carried out. The spillage affected a large area of ground as a consequence of the presence of old land drainage pipes. A rapid naphtha recovery phase was followed up with extensive removal of soil which was sent to a biological treatment unit, and replacement at the spill site with fresh soil. About 200 m^3 of the oil was recovered or safely disposed of during the soil clean-up. The costs of dealing with this spillage, at 1.2 million ECU, were appreciable.

A 53 m^3 gross spillage of gas oil resulted after a density meter‘s small bore connection pipe leaked after a material failure occurred. Oil recovery activities collected 12 m^3 of oil. Clean-up details were not reported: the site required little in the way of restoration.

A 6" pipeline leaked 115 m^3 of product due to a rupture caused by faulty pipe material: a material production fault was found to be the cause of a longitudinal crack. The failure was in a part of a river crossing and the river was temporarily affected by the spilled oil. A large part of the spill was recovered by skimming and all of the rest was successfully safely disposed of by removal of the contaminated soil. Soil and water analyses have confirmed the cleanliness of the site.

A small spot failure of a circumferential field weld due to a construction fault resulted in 30 m^3 spillage of kerosine from an 8" pipeline. Vibration from traffic on a road crossing at the site could have contributed to the failure of the faulty weld and a protective sheath has been installed. Ground water clean-up and soil removal were the main elements in the 600 thousand ECU costs incurred.

Operational

There was one spillage in the operational category in 1995.

Incorrect operation during a pigging procedure overpressurised a pipeline causing a split which resulted in the spillage of 132 m^3 of crude oil. The splitting was promoted by a point of weakness in the vicinity of a seam weld. Clean up and remediation was carried out intensively over a 19 day period during which some 50 m^3 of the oil was recovered. A change in the operating procedures for pig receipt has been instituted to prevent recurrence.

Corrosion

There was one spillage due to corrosion, in this case it was external corrosion.

The spillage of about 1000 m^3 gross of gas oil occurred due to the external corrosion of a pipeline at the location of a cement anchorage block on a stretch of pipe in between two isolating joints. An extensive volume of subsoil down to the water table was contaminated with oil. Fortunately however, the boundaries of the pollution were naturally well-delineated all the way around the site. An extended clean-up programme was instituted which is still in progress more than a year after the spill. Oil has been recovered by taking suction on 10 wells drilled into the groundwater table and some 730 m^3 of oil has been collected. The recovery phase is being followed by bio

remediation techniques to clean the subsoil. This has been a costly exercise, amounting to over 6 million ECU.

Natural hazard

In 1995, there were no spillages due to the effects of a natural hazard event.

Third party activity

There were four incidents caused by third parties, all as a result of direct accidental damage.

A 48 m^3 gross spillage of naphtha occurred after a pipeline was punctured by a company digging drainage ditches. The location of the work was different from the site for which permission for ground working had been obtained. A thorough clean up operation over almost three months recovered some 30 m^3 of oil, leaving the soil at the site essentially free of oil.

A ditch digger operator was also responsible for puncturing a pipeline and the resulting spillage amounted to 20 m^3 of unleaded gasoline. The digger operator was aware of the presence of the pipeline. The spillage occurred in an arid area and no clean-up was necessary.

A similar occurrence caused a 139 m^3 spillage of gasoline. In this case the pipeline operator had advised restrictions on digging in the vicinity of the pipeline and permanent pipeline markers were in place. Some 26 m^3 of the oil was recovered straight away and no further clean-up was found to be necessary.

A bulldozer working unannounced within a pipeline right of way punctured the pipeline causing a 12 m^3 kerosine spillage. A thorough clean-up of the area including soil removal and disposal in accordance with agreements reached with the appropriate authorities has left the site essentially free of oil.

1996 SPILLAGE INCIDENTS

In 1996, 6 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorised as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 732 m^3. The volume recovered amounted to 682 m^3, equivalent to 48% of the gross volume spilled (1414 m^3). The combined cost of pipeline repair and clean-up reported amounts to nearly 2.2 million ECUs.

Of the 6 incidents in 1996, two required extended oil recovery and clean-up action. None of the spillages affected water quality in any respect. One of the spillages was ignited by the construction activities implicated in causing the spillage and a truck driver caught in the fire suffered fatal injuries.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	1
76 - 99	1
51 - 75	0
26 - 50	2
1 - 25	1
0	1

Clean-up time

Time taken	No. of incidents
One day or less	1
Two days up to one week	2
Over one week up to one month	1
Longer than one month	2
Not reported	0

CAUSES

The 6 spillages of 1 m^3 gross or more reported in 1996 are categorised as follows.

Mechanical failure

One of the 1996 incidents is categorised as mechanical failure.

A 165 m^3 gross spillage of product occurred as a result of a gasket failure in a pipeline flange located in a pump station. Clean-up was localised and straightforward, taking 8 days.

Operational

There was one spillage in the operational category in 1996.

Incorrect operation caused a length of pipeline not fitted with thermal relief facilities to be blocked in during a shutdown. Over pressure due to thermal expansion of the liquid contents of the pipeline caused the pipe to split spilling 292 m^3 gross of product. The operating procedure has now been modified. Clean-up and remediation took several months and the total cost of repair and clean-up amounted to 1 million ECU.

Corrosion

There was one spillage due to external corrosion.

A spillage of 1 m^3 gross of fuel oil occurred through local external corrosion which had clearly started a long time before at a point where the pipeline coating had deteriorated. The pipeline was installed over 30 years ago to carry hot fuel oils and was coated with a field applied asphalt based mixture. The spillage was small and not very fluid and thus could be cleaned up effectively in 4 days.

Natural hazard

In 1996, there were no spillages due to the effects of a natural hazard event.

Third party activity

There were three incidents caused by third parties, two as a result of direct accidental damage and one from incidental damage of unknown provenance which occurred long ago.

A 437 m^3 gross spillage of gasoline occurred and became ignited when a pipeline was punctured by the blade of a bulldozer doing construction work. A truck driver also engaged in connection with the work was caught up in the fire and suffered fatal injuries. The pipeline company and the bulldozer driver were aware that the work was taking place in the vicinity of the pipeline and considered that the physical situation and depth (1.3 metres) of the pipeline would provide sufficient cover.

Some 94 m^3 of oil remaining after the fire was collected up quickly to safeguard local aquifers.

Another bulldozer incident resulted in a 19 m^3 gross spill of product after the bulldozer hit a pipeline when back filling excavations during adjacent building works. Neither the pipeline company nor the constructors were aware of each other's existence. The spillage occurred in an arid area and no clean-up was necessary.

The incidental damage done to a pipeline many years ago resulted ultimately in the spillage of about 500 m^3 gross of product. The damage had been caused by a blow torch or gas welding equipment and a 3.5 mm diameter hole had been blocked with a wooden wedge. The origins are historic (pipeline age is 64 years) and the circumstances of the damage are unknown. Finding exactly what was leaking took several days after the discovery of leaking oil due to the complications of 10 other pipelines in the vicinity and the pipeline cover which included a block of concrete. Hence the rather large size of the leak. An extended (>6 months and still in progress at the time of the report) clean-up operation has recovered some 438 m^3 of the spilled oil. The overall costs have exceeded 1.1 million ECU.

1997 SPILLAGE INCIDENTS

In 1997, 6 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorised as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 614 m^3. The volume recovered amounted to 317 m^3, equivalent to 34% of the gross volume spilled (931 m^3). The combined cost of pipeline repair and clean-up reported amounts to nearly 8.3 million ECU.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	0
76 – 99	4
51 – 75	0
26 – 50	1
1 – 25	1
0	0

Clean-up time

Time taken	No. of incidents
One day or less	0
Two days up to one week	1
Over one week up to one month	1
Longer than one month	3
Not reported	1

Of the 6 incidents in 1997, three required extended oil recovery and clean-up action. One of these spillages affected a river and prevented abstraction of potable water for a limited period.

CAUSES

The 6 spillages of 1 m^3 gross or more reported in 1997 are categorised as follows.

Mechanical failure

None of the 1997 incidents is categorised as mechanical failure.

Operational

There were no spillages in the operational category in 1997.

Corrosion

There were three spillages due to external corrosion, two of which were occurrences of stress corrosion cracking, which is a very rare cause of spillages. One spillage was caused by internal corrosion.

The two instances of stress corrosion cracking occurred in the same pipeline within a week of each other. Pipewall ruptures occurred causing quite large spillages of products that were similar in size, 422 m^3 and 435 m^3 gross, respectively. Both spillages caused widespread underground pollution and in one case a river was polluted and abstraction of potable water was affected for a time. Both incidents received extensive clean-up attention. This included the setting up of hydraulic barriers in the subsoil to contain the spread of the oil, systems of vertical wells and horizontal drains to collect and allow

pumping off of oil/water mixture, skimming of the oil and filtration and return of the water to the hydraulic barrier. A system of antipollution barriers was installed on the river so that the oil reaching the surface was prevented from spreading. The clean-ups were still underway six months after the spillages and together involved costs of about 7 million ECU.

A spillage of 19 m^3 gross of product occurred through local external corrosion at a point where the pipeline coating had deteriorated. Although quite a large area of soil was affected (2800 m^2) the coverage was light and could be cleaned up effectively in 4 days.

Internal corrosion caused by CO_2 attack of a girth weld in a pipeline carrying unstabilised crude oil resulted in a 2 m^3 spillage. Effective clean up of this very small spillage was quickly completed.

Natural hazard

In 1997, there were no spillages due to the effects of a natural hazard event.

Third party activity

There were two incidents caused by third parties, one as a result of direct accidental damage and the other following incidental damage.

An excavation of a pipeline on behalf of the operating company resulted in a 13 m^3 gross spillage when the mechanical digger encountered an unrecorded air vent valve situated on the top of the pipe. Pipeline staff were present which helped ensure that the spillage was quickly controlled and effective clean up was accomplished in 11 days.

A 40 m^3 gross spillage of product was discovered by a third party a short period after a pipeline had re-started operations. The line, which connects refineries, storage tanks, etc to the main pipeline, was previously closed down with product under static conditions. The cause of the spillage was pre-existing damage by the teeth of a digger bucket, which had severely scratched the pipeline. A crack was found in this scratch, which opened under pressure. The time of occurrence and the identity of the digger has not been identified. Clean up required the removal of large amounts of topsoil and extensive rehabilitation of the site, costing 1 million ECU.

1998 SPILLAGE INCIDENTS

In 1998, 9 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorised as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 667.3 m^3. The volume recovered amounted to 660.2 m^3, equivalent to 50% of the gross volume spilled (1327.5 m^3). The combined cost of pipeline repair and clean-up reported amounted to nearly 3.2 million euro.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	1
76 – 99	3
51 – 75	1
26 – 50	1
1 – 25	2
0	1

Clean-up time

Time taken	No. of incidents
One day or less	0
Two days up to one week	0
Over one week up to one month	3
Over one month up to 6 months	1
Longer than 6 months	5
Not reported	0

There is a trend of a longer time being taken for clean-up as a result of more nearly complete removal of pollution and the use of less invasive but more time consuming methods such as bioremediation. Thus the longer than 6 months category has been added to the above table. Of the 9 incidents in 1998, five required extended oil recovery and clean-up action in this longer than six months category.

One spillage affected a watercourse temporarily but did not affect potable water supplies.

CAUSES

Seven spillages of 1 m^3 gross or more and two smaller spillages deemed reportable due to their pollution extent/costs were reported in 1998 and are categorised below.

Mechanical failure

There was one spillage in a pump station that is categorised as mechanical failure. Spillage of 30 m^3 gross occurred when a threaded joint failed on 1" auxiliary piping providing pump seal cooling. As a follow up action all such threaded joints were replaced with welded ones. Effective clean up was achieved quickly and was not costly.

Operational

There were two spillages in the operational category both resulting from overpressure caused by errors carrying out manual valve operations.

A pressure surge occurred due to accidental closure of the wrong line valve. The line pipe ruptured causing a spillage of 486 m^3 gross. The over-pressure protection system has been modified so that it will prevent reoccurrence. Clean-up has required extensive

soil removal and oil removal from a water course and site restitution has taken more than 6 months and cost 750 000 euro.

A valve operation error allowed a pump to run against a blocked-in line. Overpressure split the pipeline at a point somewhat weakened by corrosion under the pipeline's polyurethane insulation. No overpressure protection was installed. Although the spillage was only 0.3 m^3 gross, it is reported here because it sprayed fuel oil over 200 m^2 of land and has taken more than 6 months to clean up.

Corrosion

There was one spillage due to external corrosion resulting in a spillage of 250 m^3 gross. The pipeline's bituminous coating was decomposed at a point in an industrial area where a natural basin had focused contaminants. This formed an aggressive corrosive environment for the pipe leading to metal loss from the pipe exterior that resulted in a fissure. The leakage rate was quite slow at 1-2 m^3/hr and it took several days to ascertain that there was a leak and to pinpoint the location. Due to much of the pollution staying below ground and the fissured rocky nature of the surrounding ground, cleanup of the site has been very time consuming. It is still in progress a year after the incident and the costs have reached 390 000 euro.

Natural hazard

In 1998, there were no spillages due to the effects of a natural hazard event.

Third party activity

There were five incidents caused by third parties, all as a result of direct accidental damage.

A farm owner carried out an unauthorised dig to delineate a ground work area and struck a pipeline that he was aware existed. A spill of gas oil amounting to 340 m^3 gross resulted, which caused surface pollution over 500 m^2 of ground. A lengthy and expensive clean-up response has ensued that has taken more than a year at a cost of 620 000 euro.

A 15 m^3 gross spillage of product occurred during an excavation made on behalf of a pipeline company when a digging machine operator made an error and hit a pipeline. The works had involved digging a trench alongside the existing pipeline, and was being carried out under the supervision of a pipeline company representative. Effective clean up of 600 m^2 of ground affected by oil spray took 45 days and cost 30 000 euro.

During maintenance work on a pipeline, a contractor's excavator hit a 50 mm fitting on the pipeline causing a spillage of 30 m^3 gross. The pipeline had been pegged/exposed in advance and all parties were aware of its presence. The occupants of two houses were evacuated while the clean-up operation was carried out. An extremely thorough clean up has been required, taking over a year and costing in excess of 1 million euro.

A water company operative drilled a 5 mm hole into a pipeline believing it to be one of the water company's water mains. This was in spite of the pipelines being different diameters (8" vs. 6") and material (steel vs. cast iron). Although the spillage was only 0.2 m^3 gross, it is reported here due to the significant cost of 300 000 euro that was incurred during the 30 day clean up operation to restore the site.

While breaking-up farmland a tractor driver hit a pipeline with the agricultural plough he was operating. He was aware of the pipeline's presence but had not contacted the pipeline operator. A spillage of 176 m^3 gross resulted which was cleaned up in a 17 day activity at a cost of 30 000 euro.

1999 SPILLAGE INCIDENTS

In 1999, 11 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorised as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 171 m^3. The volume recovered amounted to 345 m^3, equivalent to 67% of the gross volume spilled (516 m^3). The combined cost of pipeline repair and clean-up reported amounts to 1.45 million Euro.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	3
76 – 99	1
51 – 75	4
26 – 50	0
1– 25	1
0	2

Clean-up time

Time taken	No. of incidents
One day or less	2
Two days up to one week	1
Over one week up to one month	3
Longer than one and less than 6 months	2
Longer than 6 months	2
Not reported	1

Nine of the incidents in 1999 were either relatively small or otherwise straightforward to clean up. Two spillages required extensive clean-up programmes. One of these is categorised as severe soil pollution (i.e. > 1000 m^2 of ground affected). None of the spillages affected watercourses or potable water supplies. The repair and clean-up costs at 1.45 million Euro were the lowest experienced in the past 5 years.

CAUSES

The ten spillages of 1 m^3 gross or more and one smaller spillage deemed reportable due to uncertainty about the spillage amount that were reported in 1999 are categorised below.

Mechanical failure

There were no spillages categorised as mechanical failure.

Operational

There was one spillage in the operational category resulting from an error carrying out a manual valve operation.

A pump station sump tank overflow of crude oil occurred after the accidental opening of a drain valve on a pig trap. The uncontained overflow amounted to 7 m^3 gross. Complete clean-up was achieved within one day and cost 20 000 Euro.

Corrosion

There were four spillages due to external corrosion, one of which was from a hot fuel oil pipeline, resulting in a total spillage of 199 m^3 gross, 66 m^3 net.

External corrosion caused a 1 m^3 gross spillage at a pump station. Damaged taped coating on the 4" piping of a pump manifold provided the corrosion site. The reported repair costs and clean-up days included digging out and re-protecting all the buried manifold pipework. Hence the high cost at 180 000 Euro and the extended period of 130 days taken to finish the job.

A pipeline coating fault at a cable connection allowed localised pitting by external corrosion that resulted in a 1 m^3 gross spillage. This pipeline has not been inspected by intelligence pig. Repair and clean-up cost was 7000 Euro and clean-up took 15 days.

A pipeline coming into contact with its protective casing damaged the asphalt coating of the pipeline. Localised external corrosion caused a 167 m^3 gross spillage, 64 m^3 net spillage after clean-up oil recovery. The pipeline had been inspected by intelligence pig some 3 years beforehand. Costs amounted to 28 000 Euro and clean-up took 25 days.

An application defect in the asphalt/cork heat insulation of a hot fuel oil pipeline allowed water penetration, leading to localised external corrosion underneath the covering. There was a spillage of 30 m^3 gross that was completely recovered by the clean-up. The pipeline had been inspected by intelligence pig some 5 years previously and was re-inspected to check integrity prior to re-starting operation. The costs were 156 000 Euro and clean-up took 20 days.

Natural hazard

In 1999, there were no spillages due to the effects of a natural hazard event.

Third party activity

There were six incidents caused by third parties; comprising three accidental direct damages, two malicious acts and one occurrence of incidental damage. These third party spillages totalled 310 m^3 gross, 107 m^3 net. One in the malicious category led to a fatality.

A farm worker carrying out agricultural ploughing accidentally pierced a pipeline resulting in a 29 m^3 gross spillage of which 15 m^3 was recovered along with 230 tonnes of contaminated soil. It was found that land erosion had reduced the depth of ground cover to 0.4 metres. Repair cost 4 000 Euro in a one day operation, clean-up cost is not yet established.

An attempted theft of product from a pressure sensor fitting associated with a pipeline section valve resulted in a spillage of 36 m^3 gross. Repair and clean-up cost 24 000 Euro and took 35 days.

A pipeline was hit by a bulldozer doing some works in an industrial area. At that moment the pipeline was not operating and the leak was immediately detected by a leak detection system. The spillage was 84 m^3 gross, 71 m^3 of which was subsequently recovered. As the spillage was close to a storage terminal it was relatively easy to empty the pipeline and control the spilled product. The repair and clean-up costs amounted to 75 000 Euro.

A fatigue fissure that occurred in an old pipeline dent of unknown origin resulted in a spillage that is reported to be less than 1 m^3. The presence of the leak was discovered when traces of product were noticed on the surface of the soil. Due to the difficulty of accurately assessing the amounts of slow subsurface leakages of unknown duration, this spillage has been classified as reportable. The pipeline was repaired and the spillage cleaned up satisfactorily by removing 5 m^3 of lightly contaminated soil at a cost of 54 000 Euro.

An attempted theft of product from a pipeline in a national park went fatally wrong when thieves attempted to steal product by digging a steep-sided pit to get to a pipeline with 1.5 metres of ground cover. A hole was drilled into the pipeline and the release filled the pit. A spillage of 80 m^3 gross ensued which was reported by a third party. When recovering product from the pit, the emergency response squad found a dead body. The clean-up operation recovered 60 m^3 of product in an extensive programme of rehabilitation lasting more than a year and costing 550 000 Euro.

A spillage of 80 m^3 gross occurred when a mechanical digger that was tidying up after a mountain landslide, dug into a pipeline. The pipeline had only 0.3 m of ground cover. The clean-up operation recovered 60 m^3 of product in an extensive operation lasting more than a year and costing 350 000 Euro.

2000 SPILLAGE INCIDENTS

In 2000, 6 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorised as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 84 m^3. The volume recovered amounted to 276 m^3, equivalent to 77% of the gross volume spilled (360 m^3). The combined cost of pipeline repair and clean-up reported amounts to 1.02 MEUR.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	0
76 – 99	2
51 – 75	1
26 – 50	1
1– 25	0
0	2

Clean-up time

Time taken	No. of incidents
One day or less	1
Two days up to one week	0
Over one week up to one month	1
Longer than one and less than 6 months	2
Longer than 6 months	1
Not reported	1

Four of the incidents in 2000 were relatively small and straightforward to clean up. Two spillages required more extensive clean-up programmes. Neither of these is categorised as severe soil pollution (i.e. > 1000 m^2 of ground affected). None of the spillages affected watercourses or potable water supplies. The repair and clean-up costs at 1.02 MEUR, for the second year running were the lowest experienced in the past 5 years.

CAUSES

The six spillages of 1 m^3 gross or more that were reported in 2000 are categorised below.

Mechanical failure

There was one spillage categorised as mechanical failure resulting from materials failure in the small bore pipework connection for a pressure-sensing element.

The failed pipework leaked at a sufficiently low rate that it was not picked up by the leak detection system. The spillage was eventually noticed by a passer by but mainly because of the delay but also because of the lack of a section valve near the site, what should have been a minor incident became a sizeable spillage of 175 m^3 gross. Clean-up of the spilled gasoline was very effectively achieved in a 70 day clean-up operation. The

total cost of the incident was 425,000 EUR which includes the cost of installing a new section valve in the vicinity of the pressure tapping.

Operational

There were no spillages in the operational category during 2000.

Corrosion

There was one spillage due to internal corrosion of a 12" pipeline within a crude oil receipt station, following an isolated occurrence of pitting corrosion. The spillage was discovered by a third party and shortly afterwards was detected by the infrared gas detector monitoring the area. The spillage amounted to 10 m^3 of which 3 m^3 was recovered by the removal and safe disposal of contaminated soil during an 11 day clean-up operation. The cost of the incident was 158,000 EUR. Thorough inspection of the pipework in the receipt station has confirmed that the corrosion was an isolated occurrence.

Natural hazard

Nor were there any spillages due to the effects of a natural hazard event.

Third party activity

There were four incidents caused by third parties, comprising three due to accidental direct damage, and one occurrence of incidental damage. These third party spillages totalled 175 m^3 gross, 74 m^3 net.

A contractor carrying out groundwork at a pipeline road crossing punctured the pipeline with the pneumatic drill he was using resulting in a 7 m^3 gross spillage of which 6 m^3 was recovered. The pipeline had been marked out in advance by paint sprayed on the road and the contractor was aware of the pipeline but the pipeline operator was unaware that there was further work to be carried out in the area at the time of the incident. The repair and clean-up cost was 25,000 EUR required to reinstate the pipeline and complete a clean-up operation that took month or so.

A contractor was carrying out groundwork at a site where a permit to work had been issued and working conditions set. The pipeline had been marked and exposed in advance by the pipeline company. Nevertheless, a mechanical digger hit the pipeline spilling 8 m^3 of product, none of which was recovered. Repairs cost 80,000 EUR.

A bulldozer was being used by a farmer to carry out groundworks. The farmer knew of the pipeline right of way across his land and of the need to apply for permission before carrying out such work. Nevertheless he went ahead unauthorised and hit the pipeline. The pipeline was badly holed and product spillage was 159 m^3 gross, 95 m^3 of which was subsequently recovered. An extensive and time consuming repair and clean up operation was instituted costing 160,000 EUR.

Some 33 years previously, a new pipeline was being constructed in the right of way of an existing 24" pipeline. When digging the new pipe trench, because of poor soil conditions, the 24" pipeline moved out of position. Work was then carried out to force the pipeline back into position. During this activity the pipe wall material was probably damaged which ultimately led to a leaking crack resulting in a spillage of 1 m^3 or possibly less but 150 m^2 of ground was contaminated. The presence of the leak was discovered when traces of product were noticed on the surface of the soil. Due to the difficulty of accurately assessing the amounts of slow subsurface leakages of unknown duration, this spillage has been classified as reportable. The pipeline was repaired and the site rehabilitated at a cost of 170,000 EUR.

2001 SPILLAGE INCIDENTS

In 2001, 15 incidents were recorded in which reportable oil spillages occurred. Consistent with the approach used for the previous reports, causes have been categorised as shown in the footnote to **Table 1** and further tabulated by category and volume in **Table 2**. Total net loss to the environment was 180 m^3. The volume recovered amounted to 970 m^3, equivalent to 84% of the gross volume spilled (1150 m^3). The combined cost of pipeline repair and clean-up reported was 6.8 MEUR.

Effectiveness of clean-up efforts %

Spillage recovery (%)	No. of incidents
100	0
76 – 99	6
51 – 75	1
26 – 50	2
1– 25	1
0	5

Clean-up time

Time taken	No. of incidents
One day or less	1
Two days up to one week	0
Over one week up to one month	4
Longer than one and less than 6 months	5
Longer than 6 months	4
Not reported	1

Two of the 15 spillage incidents in 2001 were relatively small and straightforward to clean up. Eleven others required more extensive clean-up programmes. The largest spillage of all and one of the smallest are both categorised as causing severe soil pollution (i.e. >1000 m^2 of ground affected). None of the spillages affected watercourses but one did affect underground potable water sources. The total repair and clean-up costs at some 6.8 MEUR includes some 1.5 MEUR to upgrade a pipeline to allow intelligence pig inspections.

CAUSES

The 15 spillages of 1 m^3 gross or more that were reported in 2001 are categorised below.

Mechanical failure

There were five spillages categorised as mechanical failure that caused spillage of 853 m^3 gross and 23 m^3 net.

Leakage from a cracked circumferential weld occurred at a 10” pipeline/rail crossing location. The leaked product was reported on the surface of the ground by a third party. The amount of the spillage was small, recorded nominally at 1 m^3 as no site estimate has been advised and no recovery was reported. Some 10 m^2 of ground was affected temporarily and the pipeline was repaired and returned to service within 4 days.

A 20” crude oil pipeline had been exposed and prepared to install a diversion of its route. To allow the installation to be completed within the available outage time, frozen water plugs were chosen as the method to seal the pipeline for cutting, and a temporary water

connection point had been installed for the water filling. Some problems were experienced with the frozen plugs delaying the construction schedule and it was decided to re-supply the refinery with crude oil before commencing with the cutting of the pipeline. As the new water connection was not designed for the pipeline working pressure, a strengthening dome was welded over the connection. When the re-supply pumping was in progress, there was a major failure of the new welds and an 800 m^3 spillage occurred. The national authorities are conducting an inquiry to decide on follow-up proceedings. The spillage temporarily affected an area of 10,000 m^2. A major clean-up effort has removed all but some 8 m^3 of oil at a total repair and clean-up cost of 2.2 MEUR.

A hairline crack developed in a 38 year old 10" pipeline resulting in gross spillage of 5 m^3 of product. The pipeline had been inspected by metal loss intelligence pig a year earlier but no warning of the problem was detected. The cracking is attributed provisionally to a manufacturing fault in the steel used in the manufacture of the pipe. Completion of a thorough metallurgical investigation is pending. The spillage site has taken over six months to clean up and the total repair and clean-up cost was 550 kEUR.

A manufactured bend on a 12" diameter product pipeline failed at a point where a pipeline changes depth. Metallurgical analysis found that the material from which the bend was manufactured was over-quenched. The failure was accelerated by pipe stresses as a consequence of incorrectly packed-in pipe trench fill material put in during construction. The spillage was 10 m^3 gross, 2 m^3 net and the repair and clean up of 120 m^2 of ground cost 140 kEUR in a 100-day operation.

A similar failure also occurred on a 6" diameter product pipeline. There too over-quenched material was found in a failed manufactured bend and permanent stresses existed due to incorrect technology used during construction. The spillage was 37 m^3 gross, 7 m^3 net and repair and clean up of 900 m^2 of ground cost 240 kEUR, taking 260 days.

Operational

There were no spillages in the operational category during 2001.

Corrosion

There were three corrosion occurrences, two external and one internal. The total gross spillage was 113 m^3 and net 55 m^3.

Localised external corrosion pitting affected a 34" pipeline laid within a duct in a port area. The taped pipe coating had become de-laminated allowing the ambient marine air to promote corrosion. The crude oil spillage was detected by an automatic detection system fitted within the duct. The pipeline was not pumping at the time. Gross spillage was 6 m^3 of which 5 m^3 was recovered from the duct, which entirely contained the extent of the affected area. The corrosion had progressed so far because the pipeline design precluded inspection by intelligence pig. The cost of repairing the corrosion and to modify the pipeline for pigging was 1.5 MEUR, and the clean up of the site cost a further 0.4 MEUR.

At a pump station of a $12^3/_4$" product pipeline, a pump was changed over to pump into a little-used discharge manifold, which ruptured due to severe internal corrosion. A spillage of 103 m^3 of product occurred of which some 53 m^3 has been recovered. The manifold pipework was replaced at a cost of 40 kEUR and the clean up of 225 m^2 of ground inside and around the pump station took several months.

A 12" product pipeline developed a pinhole leak due to localised external corrosion at a point where the pipe coating had decomposed. The leakage rate was tiny and probably had been leaking for quite some time. Whilst the gross spillage was estimated to be only around 4 m^3, the area of ground affected was 1000 m^2. Consequently the costs, mainly for clean up, amounted to 265 kEUR.

Natural hazard

There were no spillages due to the effects of a natural hazard event.

Third party activity

There were 7 incidents caused by third parties, comprising three due to accidental direct damage, and four occurrences of malicious damage. These third party spillages totalled 184 m^3 gross, 102 m^3 net.

Agricultural ploughing in ground adjacent to an earth bank forming the right of way of a 6" pipeline had been permitted after notification to the groundwork reporting system and the pipeline assessed as outside the area of working. The plough hit the pipeline within the boundary of the field causing 4 small holes in the pipeline. Investigation showed that earlier agricultural works had extended the borders of the farmer's plot thus confiscating land in the pipeline right of way and leaving only 48 cm of cover for the pipeline. The pipeline was not pumping at the time. The product spillage has been recorded nominally at 5 m^3 and nominal cost and clean up time data have been entered as no site estimates or recovery details have been reported. The spillage temporarily affected some 400 m^2 of ground.

A 10" product pipeline was hit and punctured by a mechanical digger carrying out ditch digging work for construction of a third party pipeline. The groundwork contractor had correctly advised the pipeline operating company about the work beforehand and had been told the procedures that must be followed. These procedures were not correctly followed. The pipeline was static at the time and the spillage amount was limited at 10 m^3 and clean up removed all but 1 m^3 was recovered.

A bulldozer carrying out route clearance for a new road struck a $10^3/_4$" pipeline causing a 55 m^3 spillage of product. It was fortunate that the pipeline was not pumping at the time, as the hole made in the pipeline was very large (40 cm^2). The pipeline company had discovered road construction taking place some distance from the pipeline 7 days earlier during a routine aerial right of way patrol. The road-building contractor was advised about the existence of a pipeline and notified of the exact location of the right of way. The contractor encroached the right of way without taking any precautions to safeguard the pipeline. The spillage took 125 days to clean up and the total cost was 20 kEUR.

Thieves made a well-executed illicit hot tap connection with manual valve on a 16" product pipeline and successfully stole product from it. Spillages evidently occurred during container filling, which eventually led to discovery when a third party reported a smell of diesel. The amount of product stolen is unknown but believed to be modest as it was undetectable by the pipeline's leak detection system. Some 2 m^3 of spillage has remained lost in the ground around the connection. Repair and clean-up costs were 360 kEUR.

Three further spillages were caused by theft attempts involving holes between 5 mm and 8 mm in diameter drilled in the pipelines. These spillages totalled 112 m^3 gross, and the net spillage was 43 m^3 (average 14 m^3 net). Two of these spillages followed attacks on the same pipeline that carries crude oil. One of the incidents resulted in the temporary pollution of potable water resources. In other respects from the pollution viewpoint these incidents were relatively minor with areas of ground between 250 and 400 m^2 affected. Repairs and clean up cost a total of 845 kEUR.

2002 SPILLAGE INCIDENTS

In 2002, 14 incidents were recorded in which reportable oil spillages occurred. A summarised analysis of causes and spilt 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.

Table 1 Summary of causes and spilt volumes for 2002 incidents

Category (by cause)	Number of Incidents		Spilt volume (m^3)			Average volume per incident (m^3)	
	Pipeline	Pump/ Receipt Station	Gross	Recovered	Net	Gross	Net
A. Mechanical failure	1	-	10	0	10	10	10
B. Operational	-	-	0	0	0	-	-
C. Corrosion	5	1	493	415	78	82	13
D. Natural hazard	1	-	250	230	20	250	20
E. Third party activity	6	-	1432	1222	210	239	53
Total	**13**	**1**	**2185**	**1867**	**318**	**156**	**23**

Figure 1 Effectiveness of clean-up efforts

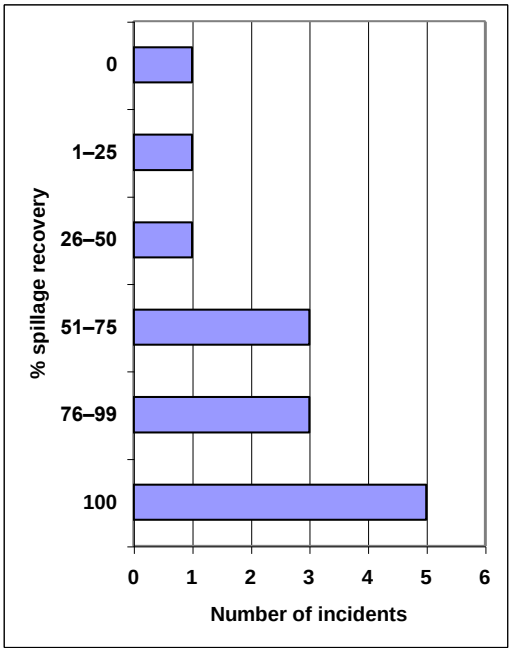
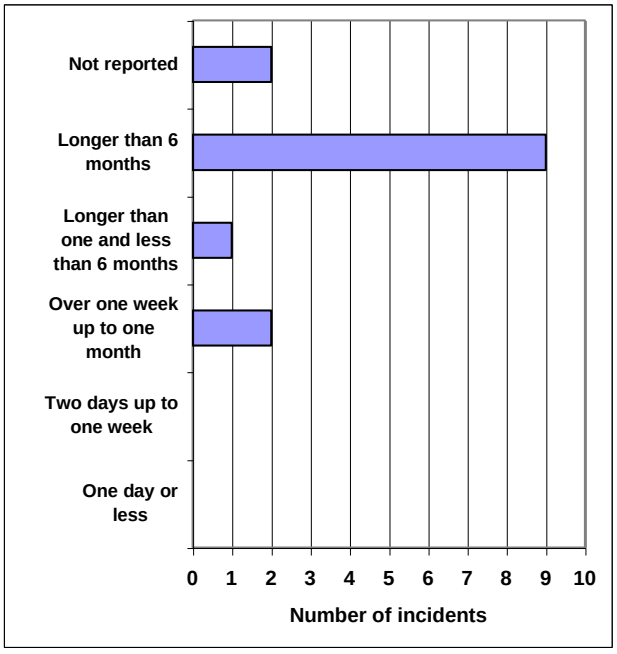
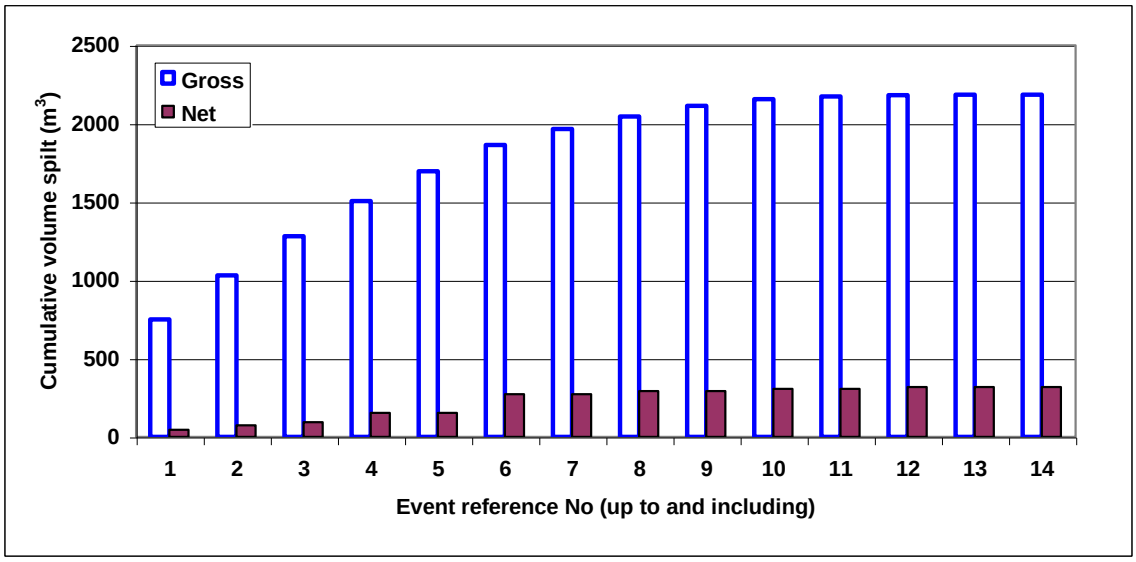


Figure 2 Clean-up time



Total net loss to the environment was 318 m^3. The volume recovered amounted to 1867 m^3, equivalent to 85% of the gross volume spilled (2185 m^3). The cumulative spill sizes are shown in **Figure 3**.

Figure 3 Cumulative spilt volumes



Most of the 14 spillage incidents in 2002 required extensive clean-up programmes. Seven spillages are categorised as causing significant soil pollution (i.e. >1000 m^2 of ground affected) and the largest spill affected no less than 20,000 m^2. Three of the spillages affected water courses but none affected underground potable water sources. The repair and clean-up costs were some 4.4 million € although no costs were recorded for three of the spills.

CAUSES

The 14 spillages of 1 m^3 gross or more that were reported in 2002 are categorised below.

Mechanical failure

There was one spillage categorised as mechanical failure that caused a spillage of 10 m^3 gross, none of which was recovered. The leak was from a defective pipeline insulation joint and the presence of oil on the ground was reported by a third party. Some 325 m^2 of ground was affected and subsequently cleaned up which took 20 days. A small amount of oil entered a water course.

OPERATIONAL

There were no spillages in the operational category during 2002.

Corrosion

There were six spillages caused by corrosion, five external and one stress corrosion cracking. The total gross and net spillage was 492 m^3 and 78 m^3 respectively.

An area of external corrosion approximately 100 mm by 8 m affected a 20” pipeline laid within a port area where the soil was saturated with sea water. The crude oil spillage was detected by routine monitoring by the pipeline operator. Gross spillage was 100 m^3, all of which was recovered. The cost of repairing the corrosion was 150,000 €, and the clean up of the site cost a further 2 million € and took over one month. Since the spillage, the pipeline has been inspected by a geometry pig and an ultrasonic metal loss pig.

Water entered under the thermal insulation of a pipeline used to transport hot fuel oil. Reaction between a flame retardant in the foam and water generated hydrochloric acid causing a spot of corrosion (pin-hole). The leak was spotted by a third party and the

pipeline shut down for corrective action. It was repaired by sleeving the line and an intelligence pig run was carried out afterwards. The line was then left full of gas oil. Whilst the pipeline was shut down, another small leak was observed some 200 m away from the first. Both leaks were small and assessed by an independent consultant to be only about 0.5 m^3 which is below the normal threshold for reporting. However, taken together, the total volume was approximately 1 m^3. Also, extensive soil contamination occurred, partly because oil entered water drain systems and spread out further around other neighbouring pipelines. In fact, the contamination from the second leak looked worse, despite the line being shut in at the time. Clean-up took 6 months and cost 1 million €. Both this and a similar line are now out of service whilst renovation is planned for 2004.

External corrosion of piping within a tank farm / pump station but downstream of the high pressure pump, caused a weak area approximately 6 mm in diameter in a 6" pipeline. A hole, about 1 mm in diameter formed in this area and about 400 m^2 of ground was contaminated with oil. The leak was reported by staff. Repairs to the pipeline cost about 20,000 €. Clean-up was continuing 6 months after the incident.

An area of generalised corrosion with localised pitting in a 10" pipeline caused a spillage of 80 m^3 of product. The leak was first observed by a mechanical contractor for the pipeline company who happened to be on site. Almost simultaneously, a drop in pressure and increase in flow rate was observed by the control room staff. Although recovery operations collected 60 m^3 of free product, 3000 m^2 of soil was contaminated. Clean-up was still ongoing after 6 months.

Corrosion caused a pinhole leak in the welded end of an 8" pipeline carrying jet fuel. A programme of replacing all these joints was in progress, and the leak was discovered during this programme. Approximately 70 m^3 was spilt in an industrial area and virtually all the oil was recovered. The pipeline had last been inspected by a metal loss intelligence pig in 1998.

Stress Corrosion Cracking

Unintentional closure of a pressure control valve caused a pressure surge in a 12¾" pipeline. The maximum allowable operating pressure of the pipeline was not exceeded but the pipeline broke at a weak point where there was an area of stress corrosion cracking. Gross spillage was 225 m^3 of gasoil of which 167 m^3 was recovered. The area of ground affected was 400 m^2 with the cost for clean up (which took over 6 months) of 375,000 €.

Natural hazard

A slow movement of earth caused a 1" drain line to be pushed away from the body of an isolating valve causing the joint to rupture. 230 m^3 of free product was recovered but an area of 5000 m^2 was contaminated in an industrial area. Clean up is expected to take over one year.

Third party activity

There were six incidents caused by third parties, comprising four due to accidental direct damage, one caused by malicious damage (theft) and one due to incidental damage where failure resulted from damage to the pipeline in the past. These third party spillages totalled 1156 m^3 gross, 842 m^3 net.

A contractor working for the pipeline company damaged a 16" line carrying crude oil. 750 m^3 of crude oil escaped of which 705 m^3 was recovered. Some 20,000 m^2 of ground was contaminated and the clean-up cost 360,000 € and took over 6 months.

An operator working for the pipeline company damaged a 30" crude oil pipeline. The pipeline was shut in at the time so only 1 to 2 m^3 of oil escaped. Virtually all of this was

recovered although 0.3 m^3 entered a water course. Repairs to the pipeline cost 7000 €, clean-up cost 60,000 € and disposal of contaminated soil cost 5000 €.

Despite being aware of the presence of the pipeline which was shown by permanent markers, a ditching contractor struck an 8" pipeline and damaged it with machine claw marks and associated cracks. During pressure testing, a pin hole developed allowing approximately 170 m^3 of jet fuel to escape. 50 m^3 of this was spilt on the ground and was recovered but 120 m^3 entered a water course. Damage to the environment was assessed as medium and lasted for less than 6 months.

A third party digging a ditch punctured a 20" crude oil pipeline. The line is surveyed weekly and had last been inspected three days before the incident. Some 280 m^3 of oil was spilt of which 70 m^3 was recovered and a further 180 m^3 was removed and safely disposed of together with soil. Approximately 12,000 m^2 of soil was contaminated. Repairs to the pipeline cost 22,000 €, the clean up took over 6 months and cost 138,000 € while the cost of disposing of contaminated soil cost 131,000 €.

An attempt was made to steal oil from a 12" crude oil pipeline. A "hot tap" was attempted using a drill and a manual valve. This resulted in the spillage of 40 m^3 of oil of which 25 m^3 was recovered. 6000 m^2 of ground was contaminated. The clean-up took less than 6 months and cost 100,000 €.

There was one failure caused by incidental damage. That is, where the pipeline had been damaged at some point in the past which eventually led to a failure. An 8" pipeline transporting gasoline suffered a pinhole leak which was detected by the automatic detection system. Approximately 190 m^3 was spilt in an industrial area, all of which was recovered and there was no long term effect on the environment. The pipeline, which had last had a metal loss pig run in 1992, had been damaged by some unknown machinery, despite being buried by 4 m of cover. Machine claw marks were found on the pipe which had removed the coating and caused corrosion. In this area, there are a number of pipes, many of which are well below the surface. It is believed that work on a water pipeline directly above this line caused the damage.

2003 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

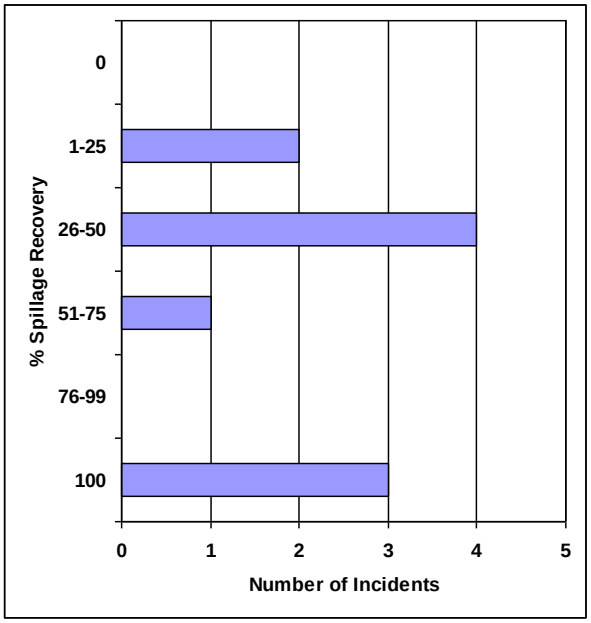
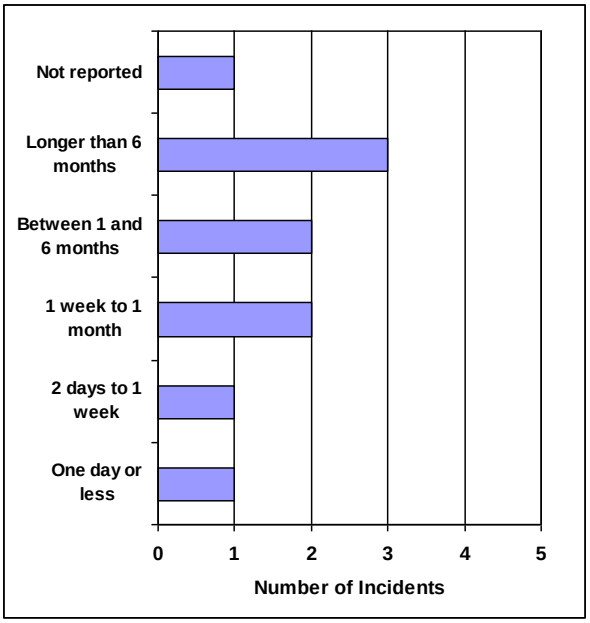
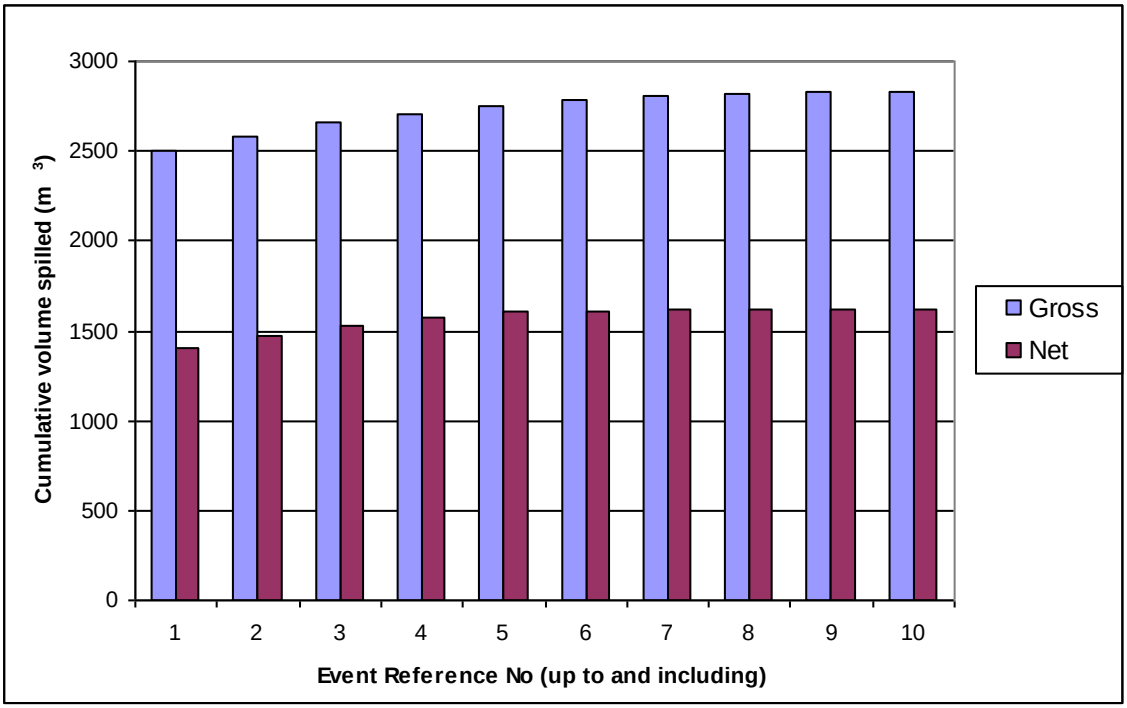


Figure 2 Clean-up time



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.

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.

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.

Operational

There were no spillages in the operational category during 2003.

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.

Natural hazard

There were no spills caused by natural hazards during 2003.

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.

2004 SPILLAGE INCIDENTS

In 2004, only five incidents were recorded in which reportable oil spillages occurred. This was half the number reported in the 2003 report and the lowest annual number of reported spillages since CONCAWE has been collecting such data. However, two further spillages that occurred in 2003 were reported late bringing the total number for that year to twelve. The total volume of oil spilled in 2004 was very low at 138 m^3 although the volume spilled in one incident could not be reported for legal reasons. A summarised analysis of causes and spilled volumes is shown in **Table 1.** The effectiveness of the clean-up operations and the time required are illustrated in **Figures 1 & 2**. The revised causes and volumes for 2003 are presented in **Tables 2 & 3**. 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. As last 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 only the second 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 2004 incidents***

Category (by cause)	Number of incidents		Spilled volume (m^3)				Average volume per incident (m^3)	
	Pipeline	Pump Station	Gross	Recovered as oil	Total Removed	Net Loss	Gross	Net
A. Mechanical failure	2	1	47.5	2.3	33	14.2	15.8	4.7
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	2	0	90*	40*	40*	50*	90*	50*
Total	**4**	**1**	**137.5***	**42.3***	**73***	**64.2***	**26.5***	**13.7***

* Excludes volumes from Event 5 which also is not counted for averages

Figure 1 Effectiveness of clean-up efforts

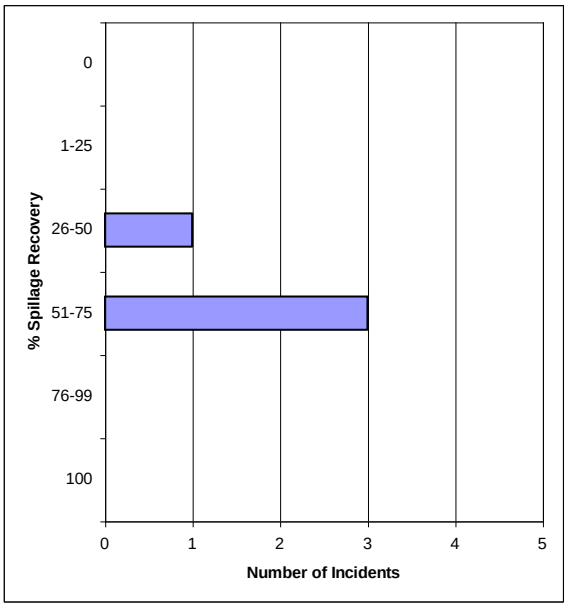
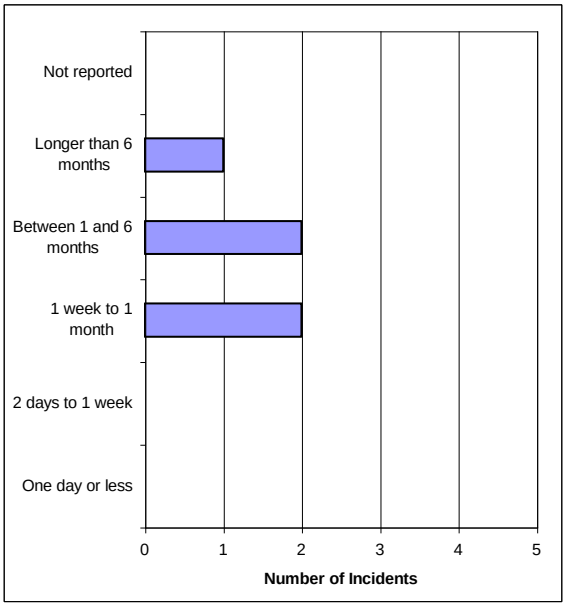


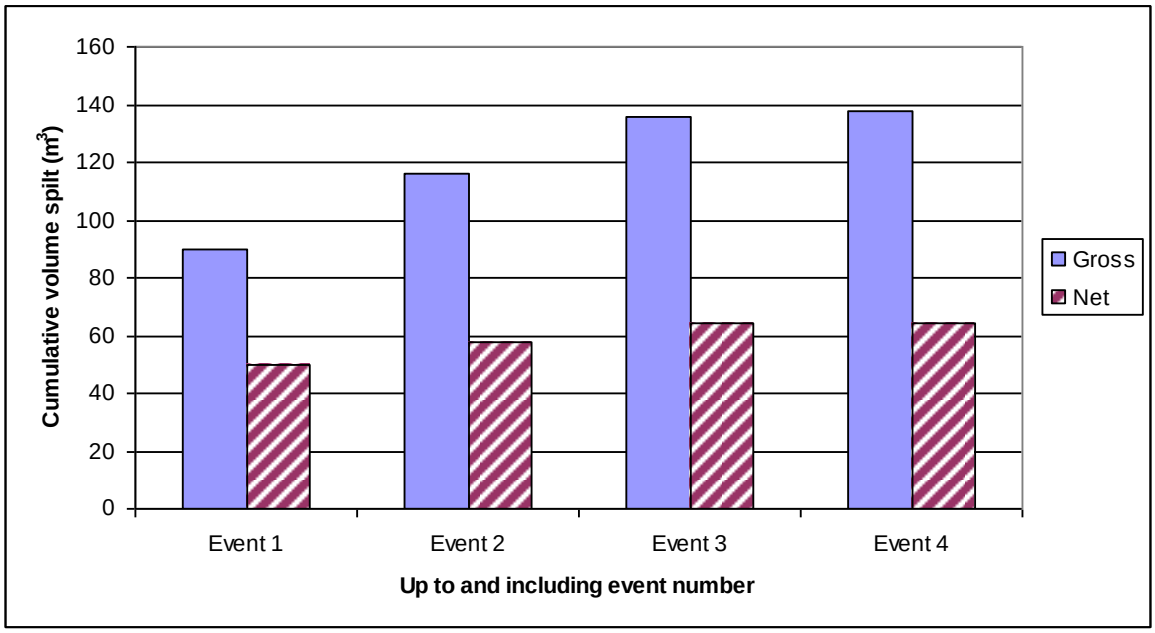
Figure 2 Clean-up time



* Excludes volumes from Event 5 which also is not counted for averages

Total spillage was 137.5 m^3 of which 73 m^3 was removed from the environment (53%). Of this 42.3 m^3 was recovered as oil. The cumulative spilled volumes are shown in **Figure 3**.

Figure 3 Cumulative spilled volumes *



* Excludes volumes from Event 5

Three of the five spillage incidents in 2004 and the two late reported spills from 2003 required extensive clean-up programmes. Despite the generally small volumes spilled, four of these spillages are categorised as causing significant soil pollution (i.e. >1000 m^2 of ground affected). One of these spillages affected groundwater and both the spills from

2003 affected marine waters. The reported repair and clean-up costs were high at some 10.4 million €.

CAUSES

The five spillages of 1 m^3 gross volume or more that were reported in 2004, and also the two spillages from 2003 which were only reported recently, are described below under the various causes of spillage.

Mechanical failure

There were three spillages in 2004 attributed to mechanical failure:

2004 Event No 2:
A sudden pressure drop in a 10" pipeline carrying gasoline was detected in the control room by a sudden pressure drop and the pipeline was immediately shut down. The failure was found to be in a very short piece of pipe between the main pipeline and a valve. In the time taken for the pipeline to be depressurised, some 26 m^3 of gasoline was lost. Of this, it is estimated that 18 m^3 was removed in contaminated soil leaving a net loss of 8 m^3 of gasoline. This resulted in some 6000 m^2 of land being contaminated. Groundwater was also contaminated. The mechanical failure is believed to be the result of inadequate support for the valve. The valve had been resting on the ground, but soil had been moved from under it during a maintenance operation and not properly replaced. The soil therefore subsided leaving the valve unsupported allowing it to vibrate as the pipeline pressure fluctuated during use. This resulted in a fatigue failure in the weakest part of the pipe. Initial clean-up work has been carried out as well as studies to identify the best clean-up solution. A final clean-up plan has now been agreed with the Authorities. This will involve land farming to clean the soil and "pump and treat" for the groundwater. Repairs to the pipeline cost 500,000 €, disposal of contaminated soil cost 150,000 € and the final clean-up will cost 3,500,000 € and continue until 2008.

2004 Event No 3:
A gasket in a flange in a pumping station failed and crude oil sprayed out. The leak was observed by the pump station operators and the pumps switched off. However, the flow through the line was 1200 m^3/h so that by the time the line had depressurised, some 20 m^3 of oil had spilled on the ground. Because of heavy rain, the oil escaped over the retaining wall around the pump and contaminated about 200 m^2 of ground. About 2 m^3 of liquid oil was recovered and a further 12 m^3 removed as oily sand and taken away for safe disposal. It is estimated that about 6 m^3 was left in the sandy sub-soil of the installation. The cost of repairs to the pump station was 340,000 €, the clean-up cost 245,000 € and the disposal of contaminated soil cost 215,000 € giving a total cost of 800,000 €. Clean up was completed within 18 days.

2004 Event No 4:
When a 16" pipeline was laid in 1973 under a road in a rural area, it appears that a dent was caused during construction. Over the period since then, cycle fatigue led to the formation of a through-wall hairline crack. A local farmer reported oil on his land leading to the discovery of the leak. It is estimated that 1.5 m^3 of oil was spilt of which 0.3 m^3 was recovered as oil. Clean-up was effected by digging up the contaminated soil which was safely disposed of at an approved waste site. Approximately 1 m^3 of oil was recovered in this way leaving about 0.2 m^3 to degrade in the soil. Clean-up was effected in less than one month with repairs to the pipeline costing 250,000 €, clean-up costing 60,000 € and soil disposal costing 500,000 € resulting in a total cost of 810,000 €. The clean-up took about three months to complete.

Operational

There were no spillages in the operational category during 2004.

Corrosion

There was one spillage caused by corrosion. This was one of the late reported spillages from 2003.

2003 Event No 11:
A leak was discovered during routine monitoring by the pipeline operator where a 12" pipeline crossed a channel in a port area. The pipeline was immediately shut down, and only 1.5 m^3 of gas oil was spilled, contaminating 5 m^2 of land and the channel. Upon investigation, a small hole (1 x 2 mm) was discovered which had been caused by external corrosion. Water jetting was used to clean the land area. Boats equipped with skimmers were used to recover oil from the water surface so that effectively all the spilled oil was recovered. Repairs to the pipeline cost 5000 €, clean-up 10,000 € and disposal of recovered oil another 10,000 € making a total cost of 25,000 €. Clean up was completed in 20 days.

Natural hazard

There were no spills caused by natural hazards during 2004.

Third party activity

There was one late reported spill from 2003 and two spills in 2004 caused by third party activity.

2003 Event No 12:
During excavation works on a wharf in a port area a digger punctured a 12" pipeline. This was reported by a third party and the pipeline shut down. It is estimated that 2 m^3 of gas oil was spilled, contaminating 5 m^2 of land while oil also entered the sea. The ground was cleaned with water jetting and oil removed from the sea by skimming boats. It is estimated that 1.6 m^3 of oil was recovered and the remainder of the oil removed with contaminated soil. The costs were 8,000 € for repairs to the pipeline, 50,000 € for clean-up and 30,000 € for disposal of soil making a total cost of 88,000 €.

2004 Event No 1:
Whilst ploughing on agricultural land on the outskirts of a small town, the plough struck an eight inch pipeline full of gasoline. A small gash 25 by 1 mm was cut in the pipe, but fortunately an automatic system stopped the plough causing more damage. At this point, the pipeline was only 0.5 m below the surface but the farmer was aware of the presence of the pipe. Although the pipeline was shut down at the time, the hilly nature of the terrain provided enough hydrostatic head to cause 90 m^3 of oil to leak out. 40 m^3 was recovered as liquid but 50 m^3 escaped into the soil. The polluted area has been delimited and a clean-up plan presented to the Authorities. The pipeline has been repaired at a cost of 10,000 € but the cost and time for clean-up is not yet known.

2004 Event No 5:
An electricity pylon close to a main railway line in an industrial area fell over and punctured a 10" pipeline even though this was 1.5 m below ground at this point. A hole, 100 mm by 50 mm was torn in the pipe. The leak was detected by the pipeline automatic detection system. The pipeline was not in operation at the time, but the residual pressure of 35 bar caused jet fuel to be spilled over an area of 2000 m^2. No estimate of the volumes spilled can be given because the case is subject to legal restraints. The pipeline was out of operation for 30 days. The contaminated soil has been removed and the hole backfilled. The contaminated soil on the railway land will be cleaned by an in-situ method. Repairs to the pipeline have cost 233,000 € but clean-up has cost 2.99 million € and taken 4 months. The total costs are estimated at 3.2 million €.