performance of european cross-country oil pipelines

statistical summary of reported spillages – 2001

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

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ABSTRACT

The performance in 2001 of 35,545 km of on-shore oil pipelines in Europe is reported with regards to hydrocarbon spillage. Incidents are analysed by cause and the effectiveness of the clean up is recorded. The inventory of European oil pipelines covered by this annual report has been increased by 4800 km with the inclusion of data for Czech Republic, Hungary and Slovakia. Direct repair and clean-up costs are reported. Performance in 2001 was again better than the long-term average. Third party activities remain the main cause of spillage incidents. The report also gives the annual intelligence pig inspection statistics.

KEYWORDS

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

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SUMMARY

Seventy-two companies and other bodies operating oil pipelines in Europe, now including Czech Republic, Hungary and Slovenia, are requested to provide statistics for the CONCAWE annual report on the performance of cross-country oil pipelines.

These organisations operate some 290 different service pipelines, which at the end of 2001 had a combined length of 35,575 km, 4800 km more than in 2000 mainly due to the additional countries reported on. Volume transported in 2001 was 708 Mm^3 of crude oil and refined products, which is 27 Mm^3 more than in 2000. Total traffic volume in 2001 amounted to 131 x 10^9 m^3 x km, 8% up on 2000.

There were 15 reported oil spillages from pipelines during 2001 (12.7 per year on average since 1971). There were no associated fires or injuries. The net oil loss into the environment amounted to 180 m^3, equivalent to 0.25 parts per million (ppm) of the total volume transported. The gross spillage was 1150 m^3, which is 1.7 ppm. A total of 970 m^3, i.e. 84% of the spillage was recovered.

The causes of the oil spillages are attributed to:

- Mechanical failure — 5 incidents
- Operational — 0 incidents
- Corrosion — 3 incidents
- Natural hazard — 0 incidents
- Third party activity — 7 incidents

This report also provides comparative data for the five-year period 1997 to 2001 and a comparison of the 2001 performance versus the annual average of all reported incidents since 1971. The 2001 performance was good, although the number of spillages was above the long-term average (15 versus 12.7) with the increased pipeline inventory reported. The gross and net spillage volumes per 1000 km of pipeline were only 35% and 12%, respectively, of the long-term averages. Three of the spillages required extensive clean-up campaigns that exceeded six months duration or were particularly costly. The overall costs for repairs and clean-up of all incidents amounted to 6.8 MEUR.

Also included is the record of intelligence pig inspection activity in 2001 and the historical record since the technique was first used in 1970. In 2001, 50 inspections were completed using metal loss and/or crack detection pigs, 16 times in conjunction with geometry pigs, covering 3334 km of pipeline. In addition 4 inspections (398 km) were made using geometry pigs only.

To date, 75% 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 2001 with comments and comparisons for the five-year period 1997 to 2001 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 [4]. Prior to 1994, the reports covered only the oil industry owned oil pipelines. Since 1994, however, the non-commercially owned pipelines have been incorporated into the reports, and the spillages from these pipelines have been retrospectively added to the CONCAWE database since 1988. This year, three additional countries are covered: Czech Republic, Hungary and Slovakia.

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 2001 by CONCAWE with the active cooperation of pipeline operating companies throughout Europe. ***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 1.0 m^3 are taken into consideration only when their impact on the environment is noteworthy.

The costs comprise direct costs of the spillage incidents for pipeline repair and site clean-up/restoration, and exclude any consequential costs such as loss of income or legal costs.

The inspection activity using intelligence pigs is reported for 2001 versus 2000, for the 5-year period 1997 to 2001 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. For the first time, crack detection intelligence pig inspections are separated out from those using metal loss pigs.

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

2. WESTERN 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 2001 was 35,575 km, calculated from data provided by 72 operating companies. The pipeline network consists of about 290 separate lines. The reported length is 4800 km greater than that reported in 2000. The three newly added countries contribute 4795 km, there is one entirely new pipeline and 5 new pipeline sections (230 km), while 4 pipeline sections (45 km) have been removed from the operational pipelines inventory. Revisions to the lengths of existing pipelines make up the balance (e.g. elimination of unused loops). The additional countries and the continuing process of breaking down the records on pipelines into their piggable sections have increased the number of sections from 557 to 643.

In total, 708 Mm^3 of crude oil and refined products was transported through the pipeline system. This resulted in a total traffic volume of 131 x 10^9 m^3 x km, of which products amounted to 37.4 x 10^9 m^3 x km.

2.2. DETAILS OF 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.

2.3. CAUSES

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

2.3.1. 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.

2.3.2. Operational

There were no spillages in the operational category during 2001.

2.3.3. 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.

2.3.4. Natural hazard

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

2.3.5. 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.

3. COMPARISON WITH PREVIOUS YEARS

The comparative numbers of spillages and spillage volumes for the period 1997 - 2001, and the long-term overall percentages for the numbers and volumes of spillages since 1971, are given in **Tables 3** and **4**. The latter data are presented graphically in **Figures 1** and **2**.

In 2001, the occurrence of 15 spillages, 0.42 spills per year per 1000 km, represents a somewhat better than average result and for the sixth year running tends to reinforce the long-term trend of performance improvement. The 2001 total gross spillage volume at 1150 m^3 (32 m^3 per 1000 km of pipeline) and the net spillage volume, at 180 m^3 (5 m^3 per 1000 km of pipeline), are significantly better than the long-term annual averages, (93 m^3 and 42 m^3 per 1000 km, respectively).

- There were five spillages in the "mechanical failure" category in 2001 leading to spillage of 23 m^3 net. The data recorded since 1971 show that 3.1 spillages per year, contributing 28% of the total net 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 net volume spilled is 4%.
- There were three "corrosion" spills in 2001, two external and one internal corrosion, and 55 m^3 net was spilled. Long-term, corrosion has accounted for 3.7 incidents per year, which contributes 16% of the total net spillage.
- For the eight year in succession, no spillages resulted from a "natural hazard", which has a long-term average incidence of only 0.5 spillages per year that contributes 3% of the net spillage volume.
- There were 7 spillages in 2001 amounting to 102 m^3 net due to "third party activity". Three spills were due to direct accidental damage caused by third parties. One spill resulted from an illegal connection used for theft from the pipeline. Long-term, the third party category is the largest single cause of spillages causing 4.4 incidents per year and at 48% is also the largest contributor to the net volume spilled.
- A total of 47 spillage incidents were recorded over the five-year period 1997 to 2001. All but two caused some temporary environmental pollution. Slight pollution of soil and water resulted from 36 and 1 cases, respectively. Significant soil and contamination arose from 4 incidents, which required more extensive oil containment and clean-up efforts to restore the environment. There was one incident affecting potable water resources.

4. INTELLIGENCE PIG INSPECTIONS 2001 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 action. 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. This is the first year that crack detection inspections have been specifically identified. Previously such data were combined with the metal loss type, and a start has been made to split these data retrospectively.

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
2001	2453	946	1341	35,573
2000	3631	523	2292	30,756
5-year Average	3666	415	2404	31,415

In 2001, metal loss and crack detection intelligence pig inspection activity measured in kilometres fell just short of the average over the last 5 years. Geometry pig inspections fell 45% short of the average. Also, the 2000 records have been revised to include previously missing data and are now shown to be in line with the 5-year average. Some 9% of the inventory was inspected using metal loss or crack detection pigs and 4% 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
2001	43	11	20	643
2000	45	2	38	557
5-year Average	57	4	38	547

In 2001, 50 inspections used metal loss and/or crack detection pigs, 16 times in conjunction with geometry pigs. Of these inspections, 26 used metal loss pigs only, 8 used crack detection pigs only and 4 used geometry pigs only. The numbers of pipeline sections inspected were roughly similar to the kilometres inspected, i.e. the inspected sections were about the same length as the average section in the inventory.

Table 4.3 Coverage of intelligence pig inspections since first used (i.e. 1970-2001)

Type of Inspection	Pipeline Sections No.	Pipeline Length km
Metal loss and/or crack detection only	140	9045
Geometry only	6	732
Pipewall & geometry	276	17,005
Total inspected	422	26,782
Total Inventory (2001)	643	35,573

The data in this table are calculated for the pipelines in service at end 2001. Over the period that intelligence pigs have been in use, 5661 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. For example 3923 km of closed pipelines were never inspected during their service lives. By contrast, the never-inspected length in the operational inventory (8791 km at end 2001) will decrease in future years.

Since the first recorded intelligence pig inspection in 1970, some 75% of the current pipeline inventory length and 67% 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 50% of length and 44% of sections.

The total number of inspections on existing pipelines made to date is 1159, comprising 748 using metal loss, 21 using crack detection and 390 using geometry pigs. There are insufficient data on crack detection to provide repeat inspections

Table 4.4 Repeat metal loss pig inspections by pipe sections, 1970-2001

Inspections	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
No. of sections	227	251	90	40	16	5	8	1	1	0	2	0	1	1

Note. Covers only pipelines still active in 2001. Total number of metal loss pig inspections = 748.

Table 4.5 Repeat geometry pig inspections by pipe sections, 1970-2001

Inspections	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
No. of sections	361	205	55	16	6	0	1	0	0	0	0	0	0	0

Note. Covers only pipelines still active in 2001. Total number geometry pig inspections = 390.

The above tables show that repeat inspections (2 or more) have been carried out on only 165 and 78 pipeline sections, respectively, using metal loss and geometry pigs. No trends for repeat inspections intervals are yet apparent.

5. REFERENCES

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Table 1 Details of 2001 spillage incidents

				Spillage (m^3)				Cause					
No.	Pipeline or Pump/Receipt Station	Pipe Spec. mm (inch)	Commodity	Spilled	Recovered	Net	How Discovered	Category	Origin	Potable/ Other water Pollution	Soil Pollution Area (m^2)	Estimated Cost (EUR)	Clean -up Days
1	P/L	5L 255 x 7.1 10" x 0.312"	Product	1	0	1	Third party passer-by	Mechanical failure A (a)	Cracked circumferential weld	No/None	Yes 10	N/A	-
2	P/L	5LB 150 x 6.00 6" x 0.30	Product	5	0	5	Third party worker	Third party accidental E (a)	Plough punctures	No/None	Yes 400	50,000	100
3	P/L	5LX-42 855 x 12.7 34" x 0.55	Crude oil	6	5	1	Automatic detection system	External corrosion C (a)	Localised pitting external corrosion	No/None	Yes 500	1,900,000	N/A
4	P/L	Temporary connection to 20"	Crude oil	800	792	8	Routine monitoring p/l operator	Mechanical failure A (a)	Weld failure at strengthening dome over temporary connection	No/None	Yes 10,000	2,200,000	30
5	P/S	Pump discharge manifold	Product	103	53	50	Routine monitoring p/l operator	Internal corrosion C (b)	Corrosion inside little-used manifold pipework	No/None	Yes 225	40,000	8
6	P/L	5LB 250 x 7.8 10" x 0.39"	Product	10	9	1	Third party worker	Third party accidental E (a)	Ditch digger bucket struck pipeline	No/None	Yes N/A	150,000	30
7	P/L	5LX-X52 400 x 17.09 16" x 0.75"	Product	2	0	2	Third party passer-by	Third party malicious E (b)	Illegal connection (hot tap/manual valve) - spillage during thefts	No/None	Yes 350	360,000	280
8	P/L	5LX-52 300 x 9.52 12" x 0.45"	Product	4	0	4	Third party passer-by	External corrosion C (a)	Localised pitting external corrosion	No/None	Yes 1000	265,000	25
9	P/L	5LX-52 275 x 6.6 10.75 x 0.33	Product	55	4	51	Third party worker	Third party accidental E (a)	Bulldozer involved in road construction struck pipeline	No/None	Yes N/A	20,000	125
10	P/L	5LX-X52 250 x 7.0 10" x 0.35"	Product	5	0	5	Third party passer-by	Mechanical failure A (b)	Fissure in pipe wall caused by faulty pipe material	No/None	Yes 500	550,000	>180
11	P/L	St.35.29 200 x 9.0 8" x 0.39"	Product	85	61	24	Routine monitoring P/L staff	Third party malicious E(b)	Theft attempt - hole drilled in pipeline	Yes/None	Yes 400	730,000	200
12	P/L	11353 CSN 425715 300 x 7.5 12" x 0.34"	Product	10	8	2	Third party	Materials fault A(b)	Over-quenched pipe bend material	No/None	Yes 120	140,000	100

Table 1 Details of 2001 spillage incidents (continued)

				Spillage (m^3)				Cause					
No.	Pipeline or Pump/Receipt Station	Pipe Spec. mm (inch)	Commodity	Spilled	Recovered	Net	How Discovered	Category	Origin	Potable/ Other water Pollution	Soil Pollution Area (m^2)	Estimated Cost (EUR)	Clean -up Days
13	P/L	11353 CSN 425715 150 x 4.5 6" x 0.19"	Product	37	30	7	Pressure testing	Materials fault A(b)	Over-quenched pipe bend material	No/None	Yes 900	240,000	260
14	P/L	X52 300 x 6.0 12" x 0.26"	Crude	17	5	12	Routine monitoring P/L staff	Third party malicious E(b)	Theft attempt - hole drilled in pipeline	No/None	Yes 400	65,000	180
15	P/L	X52 300 x 6.0 12" x 0.26"	Crude	10	3	7	Routine monitoring P/L staff	Third party malicious E(b)	Theft attempt - hole drilled in pipeline	No/None	Yes 250	50,000	180
			TOTAL	1150	970	180						6,761,000	

Cause/Category:

A Mechanical failure
(a) Construction fault
(b) Materials fault

B Operational
(a) System malfunction
(b) Human error

C Corrosion
(a) External
(b) Internal
(c) Stress corrosion cracking

D Natural hazard
(a) Landslide/subsidence
(b) Flooding
(c) Other

E Third party activity
(a) Direct damage – accidental
(b) Direct damage – malicious
(c) Incidental damage

Notes: (i) The value of the EUR at end 2001 was 0.9 USD (ii) N/A = Not Available

Table 2 Analysis of 2001 incidents

Main category	Number of Incidents		Spillage in cubic metres (m^3)			Average volume per incident (m^3)	
	Pipeline	**Pump/ Receipt Station**	**Gross**	**Recovered**	**Net**	**Gross**	**Net**
Mechanical failure	5	-	853	830	23	171	5
Operational	-	-	0	0	0	-	-
Corrosion	3	-	113	58	55	38	18
Natural hazard	-	-	0	0	0	-	-
Third party activity	7	-	184	82	102	26	15
Total	**15**	**-**	**1150**	**970**	**180**	**77**	**12**

Table 3 Five-year comparison by cause, volume and effect: 1997 – 2001

	1997	1998	1999	2000	2001	1997-2001
COMBINED LENGTH (km x 10^3)	30.8	30.0	29.9	30.8	35.6	-
COMBINED THROUGHPUT (m^3 x 10^6)	657	680	674	672	708	-
COMBINED TRAFFIC VOLUME (m^3 x km x 10^9)	117	123	125	126	131	-
	Number of Incidents					
MECHANICAL FAILURE						
Construction	-	-	-	-	2	2
Material	1	-	1	1	3	6
OPERATIONAL						
System	-	-	-	-	-	-
Human	2	1	1	-	-	4
CORROSION						
External	1	4	1	-	2	8
Internal	-	-	-	1	1	2
NATURAL HAZARD						
Subsidence	-	-	-	-	-	-
Flooding	-	-	-	-	-	-
Other	-	-	-	-	-	-
THIRD PARTY ACTIVITY						
Accidental	5	3	2	3	3	16
Malicious	-	2	-	-	4	6
Incidental	-	1	1	1	-	3
	9	11	6	6	15	47
NET SPILLAGE INCIDENTS						
0 - 10 m^3	4	5	1	4	11	25
11 -100 m^3	3	6	3	0	4	16
101- 1000 m^3	2	0	2	2	-	6
In excess of 1000 m^3	-	-	-	-	-	-
POLLUTION RESULTING						
None	-	1	-	1	-	2
SOIL						
Slight	9	9	5	5	13	41
Significant	-	1	1	-	2	4
WATER COURSES						
Slight	1	-	-	-	-	1
Significant	-	-	-	-	-	-
POTABLE WATER	-	-	-	-	1	1

Table 4 Comparison with previous years

1. Volume spilled in cubic metres

Main category	1997	1998	1999	2000	2001	1997-2001
A. Mechanical failure	- (-)	30 (1)	- (-)	175 (1)	853 (5)	1058 (7)
B. Operational	- (-)	486 (2)	7 (1)	- (-)	- (-)	493 (3)
C. Corrosion	878 (4)	250 (1)	199 (4)	10 (1)	113 (3)	1450 (13)
D. Natural hazard	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
E. Third party activity	53 (2)	561 (5)	310 (6)	175 (4)	184 (7)	1171 (24)
Gross spillage	931 (6)	1327 (9)	516 (11)	360 (6)	1150 (15)	4284 (47)
Recovered	317	660	345	276	970	2568
Net loss	614	667	171	84	180	1717
Average net loss/incident	102	74	16	14	12	37
Average net loss/1000 km	19	22	6	3	5	11

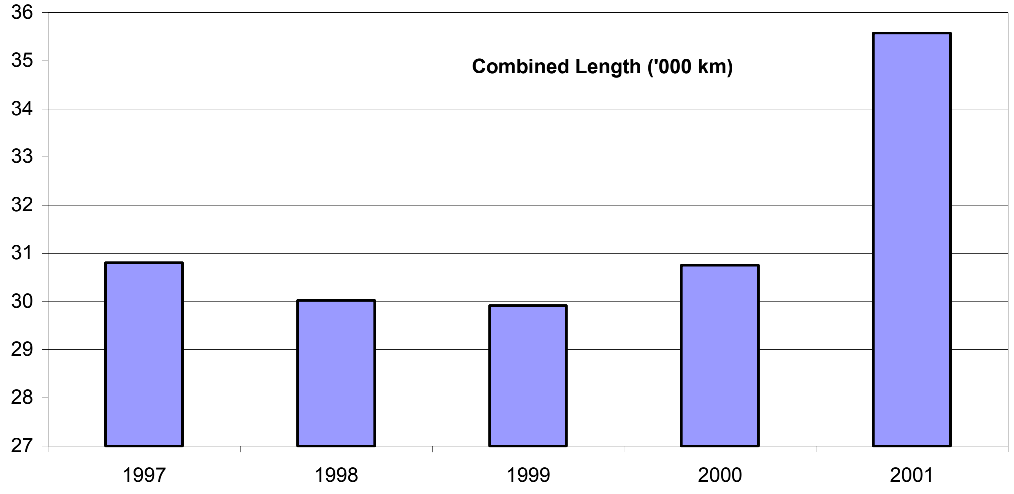
Figures in parenthesis denote number of incidents

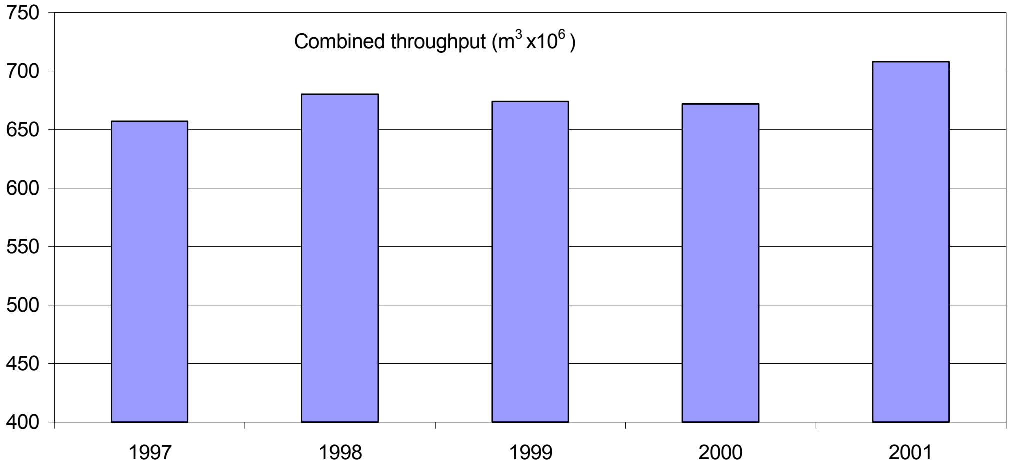
2. Comparisons since 1971

Main category	Number of incidents		Net volume spilled %	
	2001	Average per year 1971-2001	2001	1971-2001
A. Mechanical failure	5	3.1	13	28
B. Operational	-	0.9	-	4
C. Corrosion	3	3.7	31	16
D Natural hazard	-	0.5	-	3
E. Third party activity	7	4.5	57	48

Note: The non-commercially owned pipelines data are in the database from 1988 onwards and 3 eastern European countries are added in 2001.

Figure 1 Five-year comparison: length, throughput and relative spillage





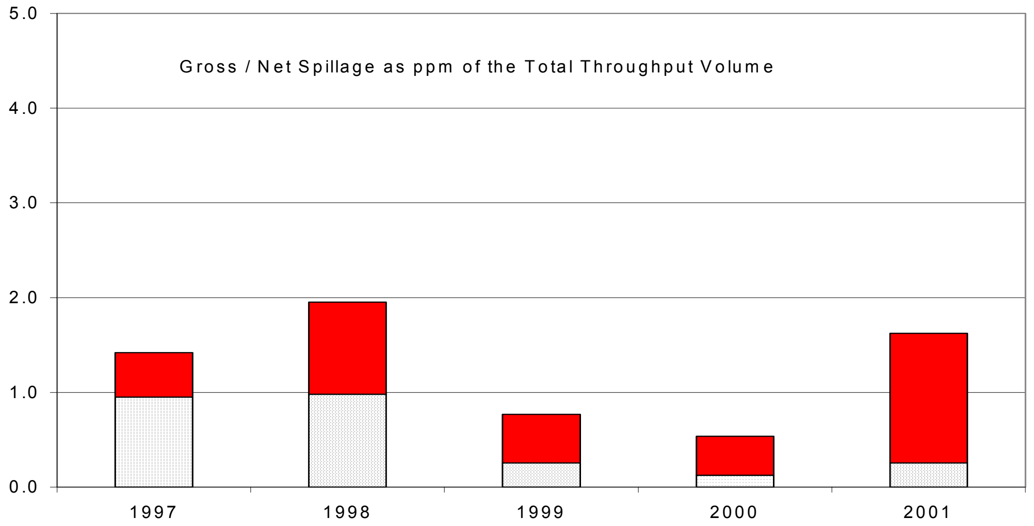
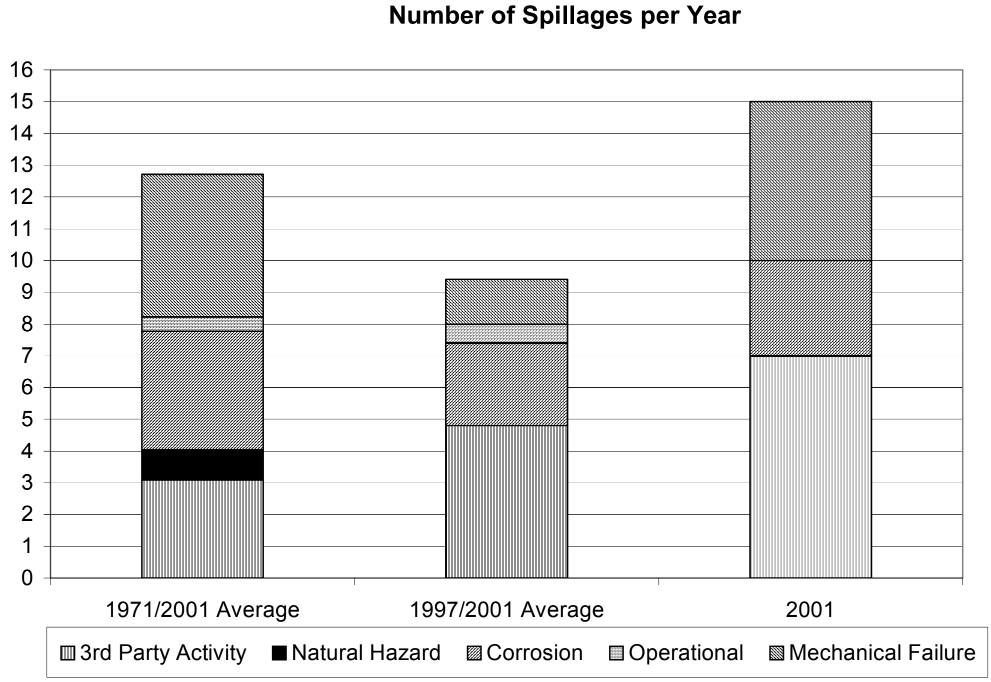


Figure 2 Comparative spillage data



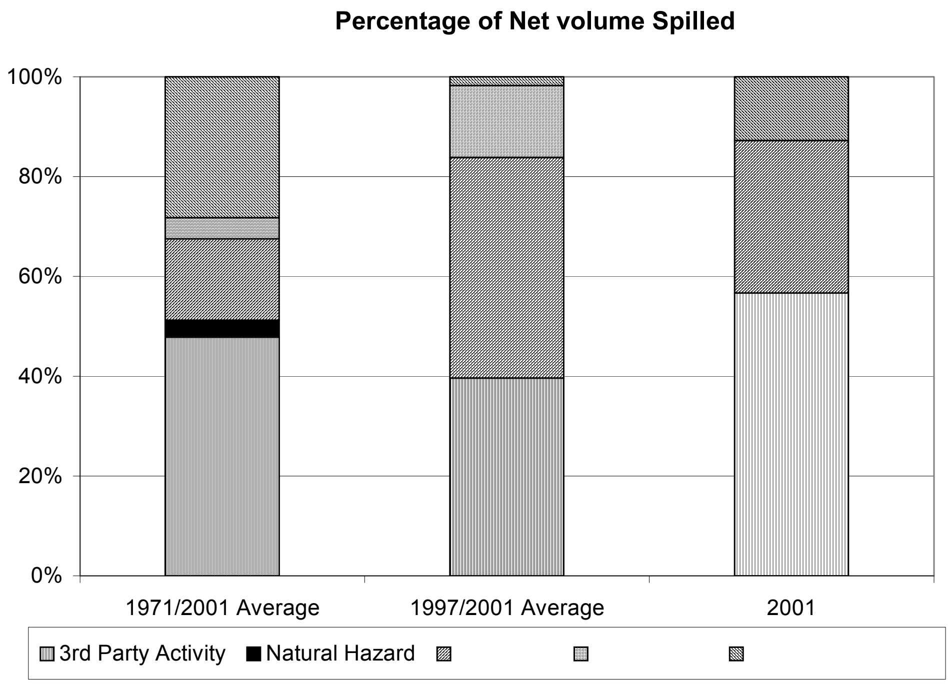


Figure 3 Crude oil lines: Le Havre area detail

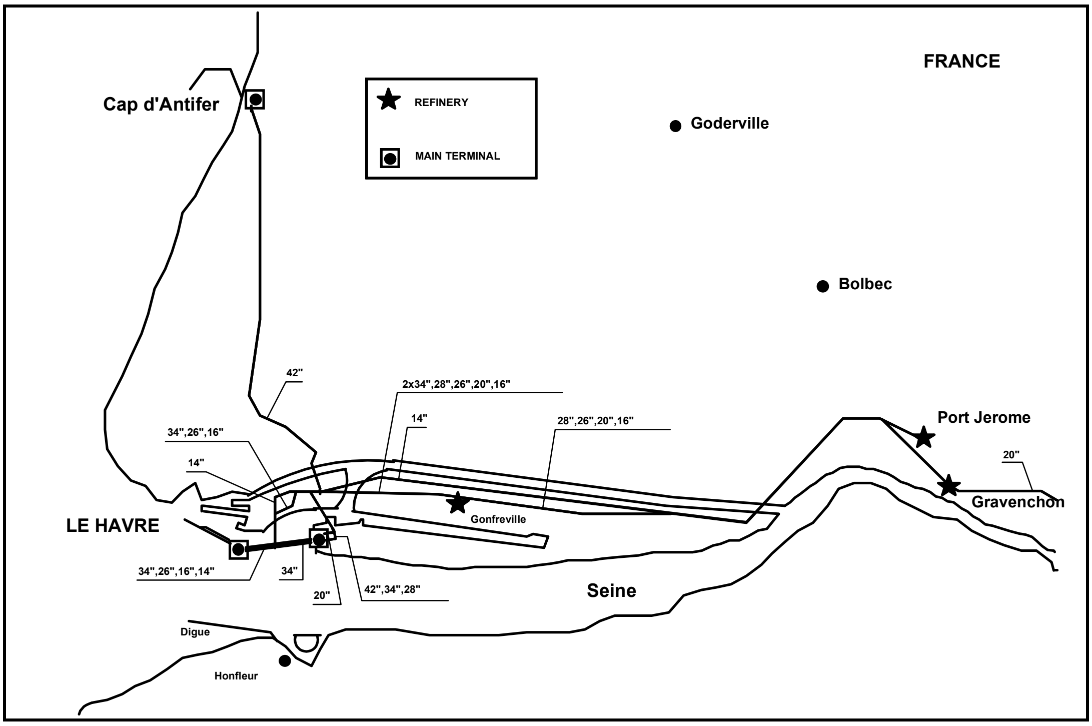


Figure 4 Product lines: Le Havre – Paris

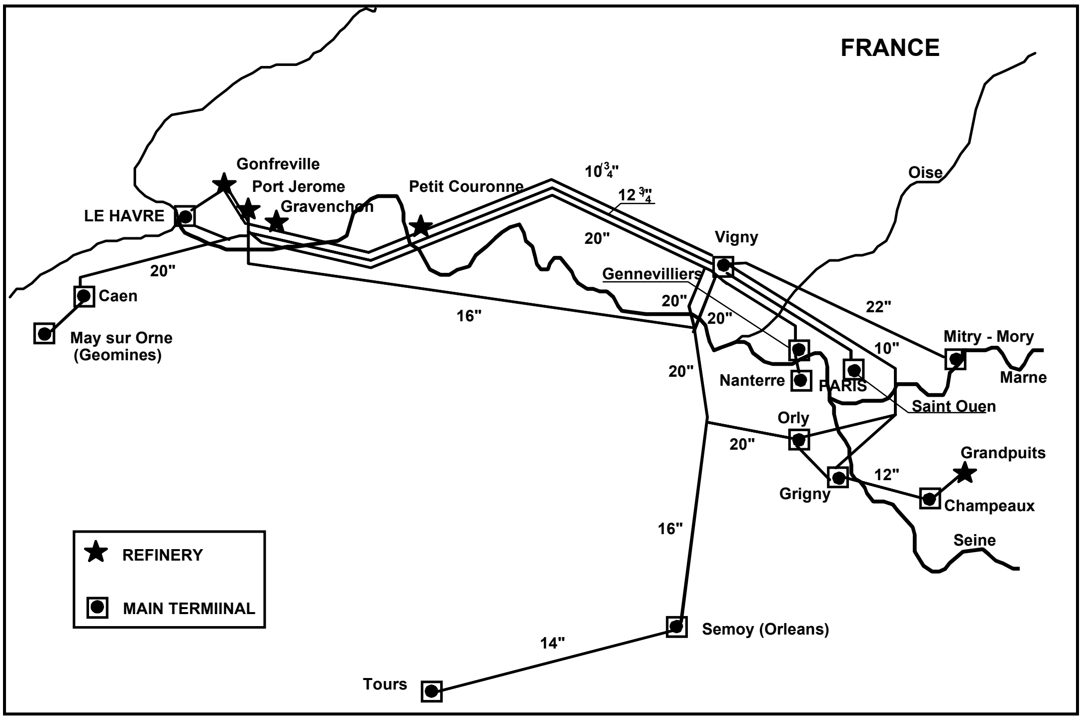


Figure 5 Product lines: Le Havre area detail

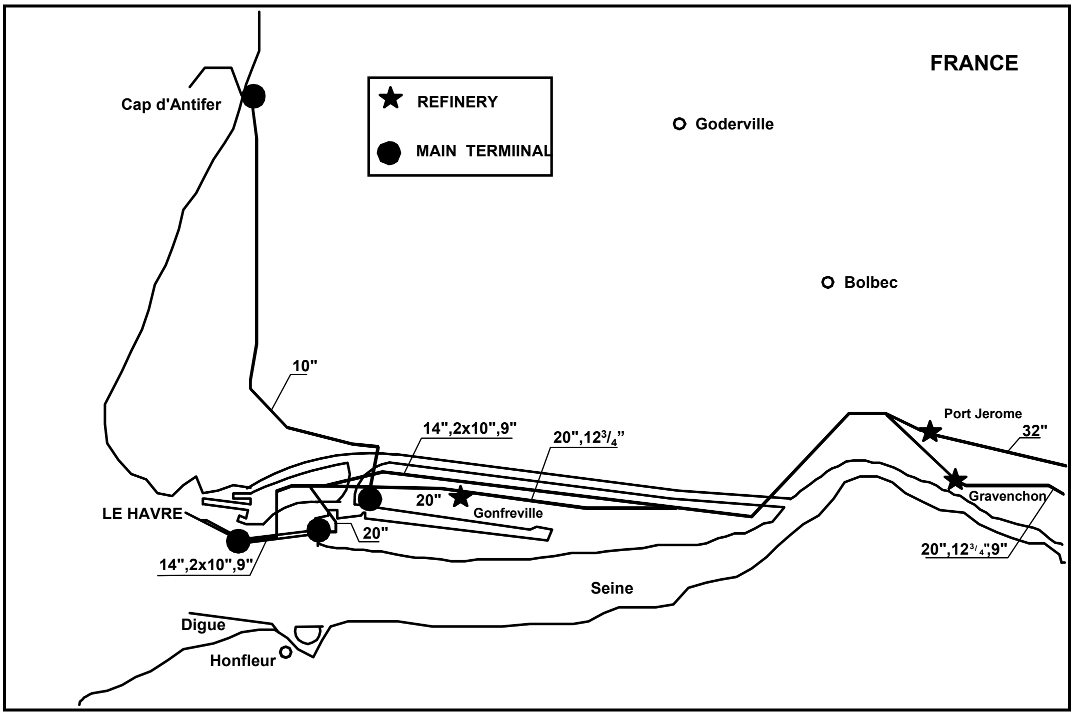


Figure 6 Crude oil lines: Marseille area

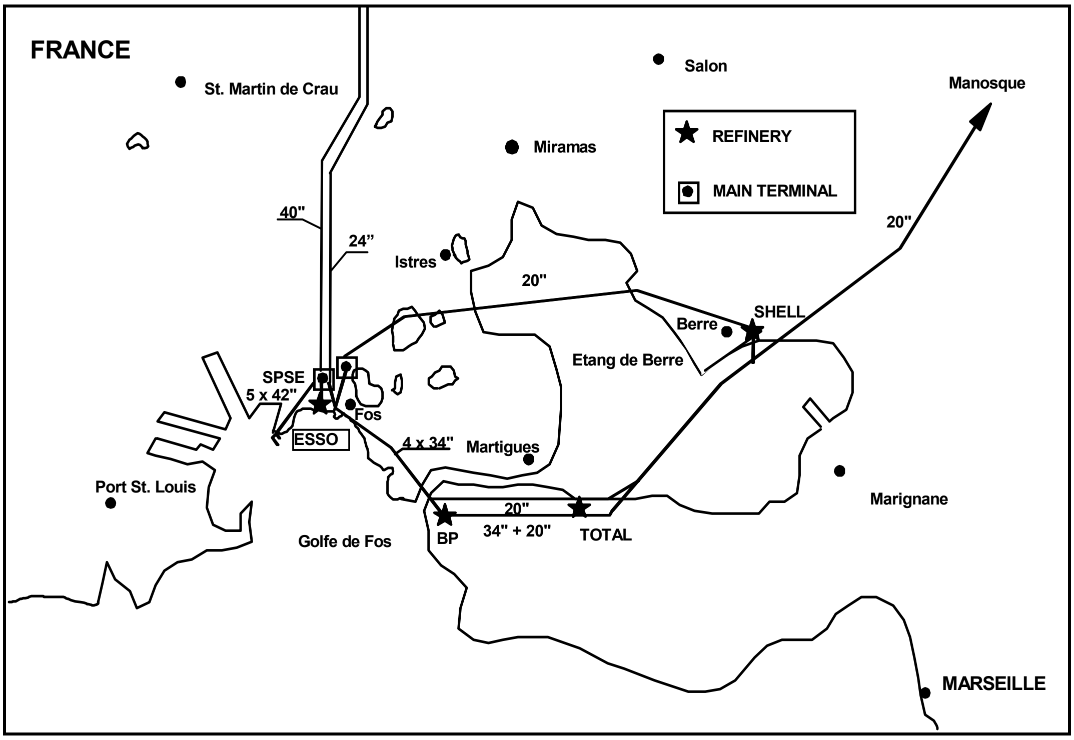


Figure 7 Product lines: Marseille area

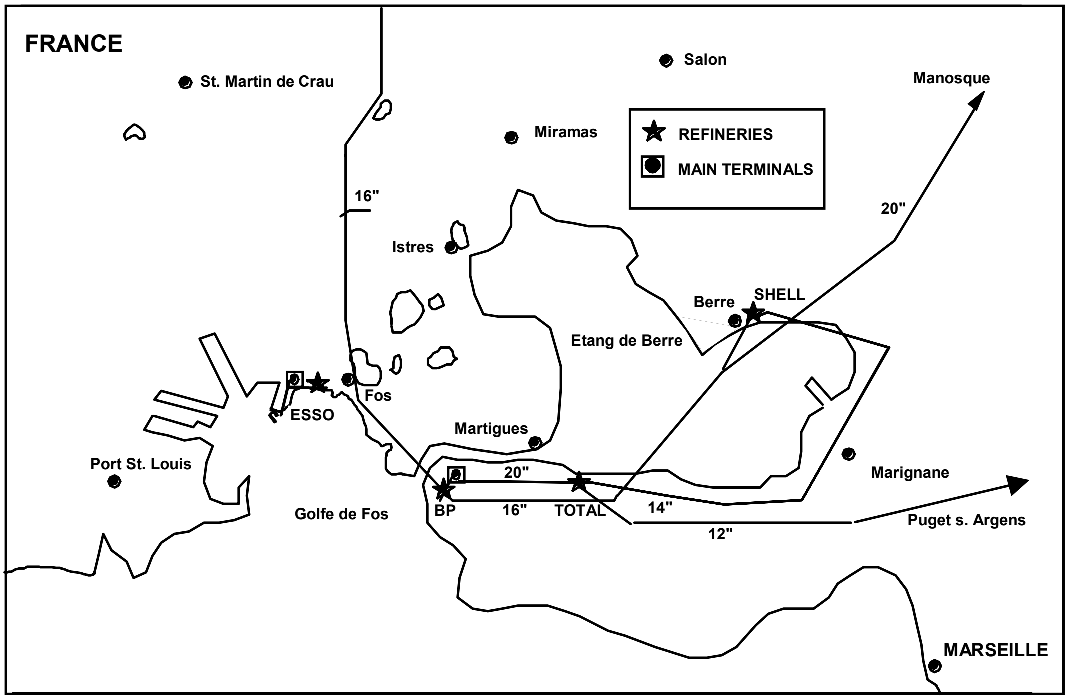


Figure 8 Crude oil lines: Rotterdam - Europoort

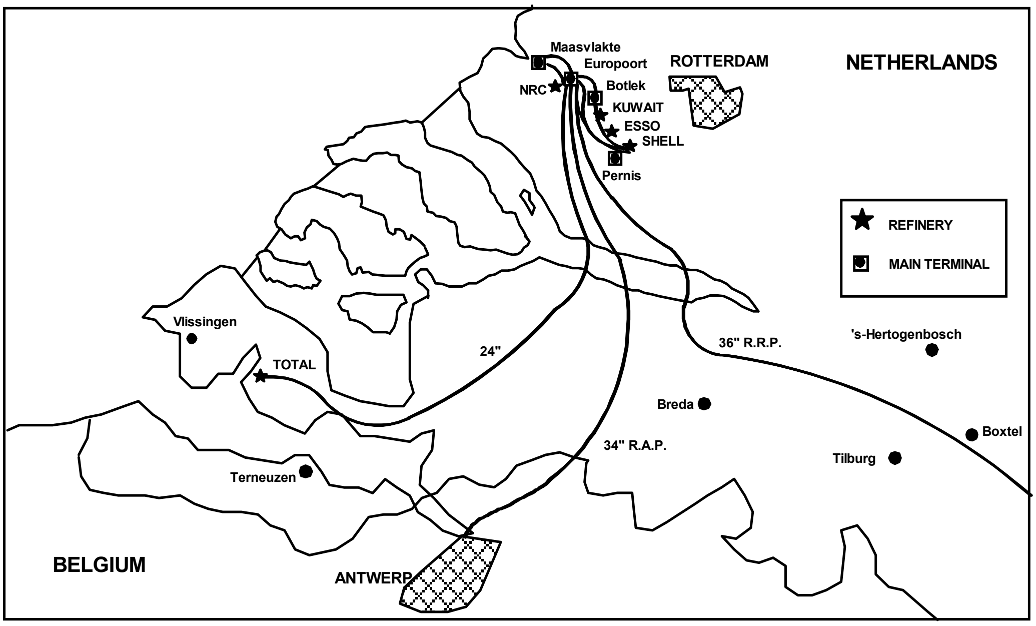


Figure 9 Product lines: Rotterdam - Europoort (excluding local interconnecting lines)

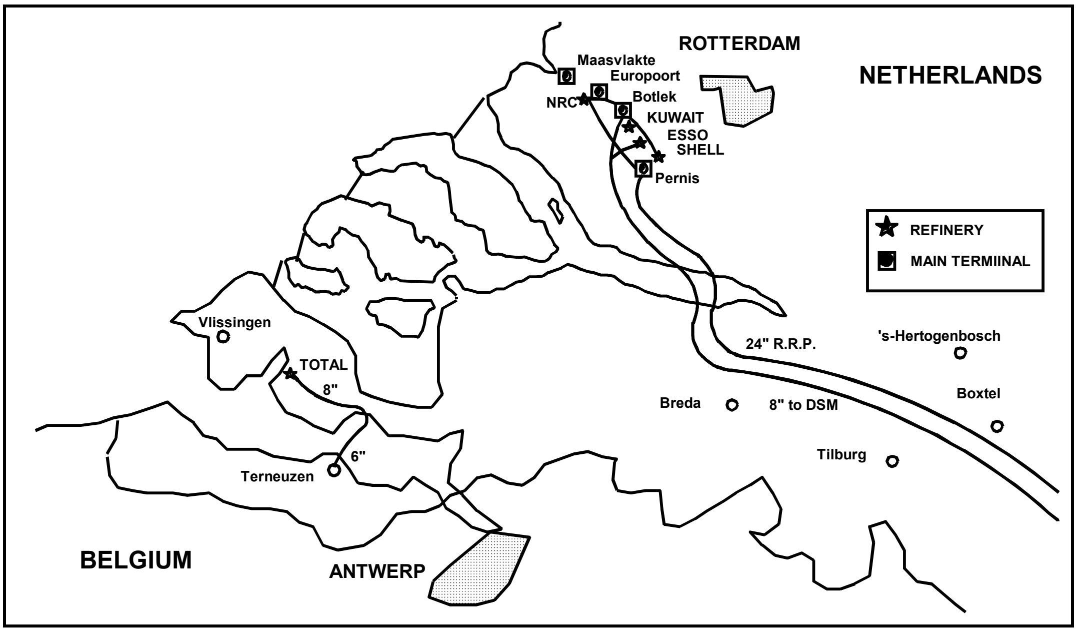


Figure 10 Crude oil lines: Northern Italy

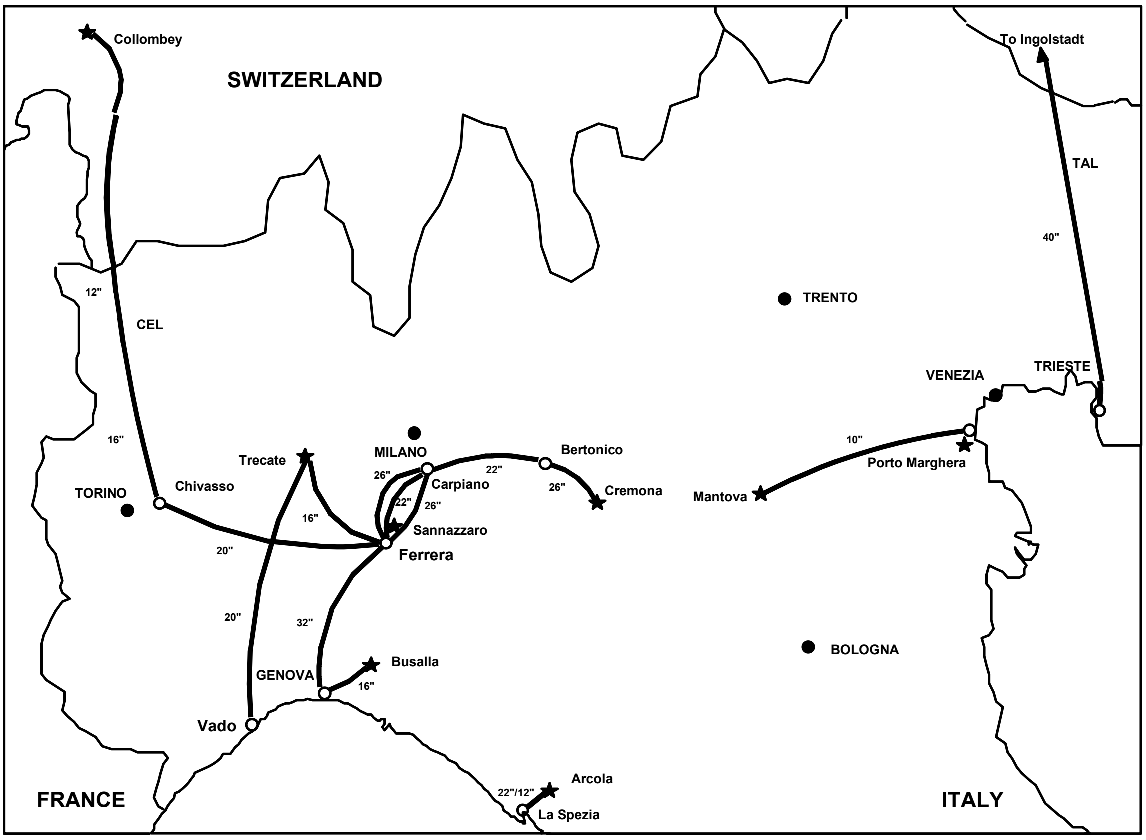
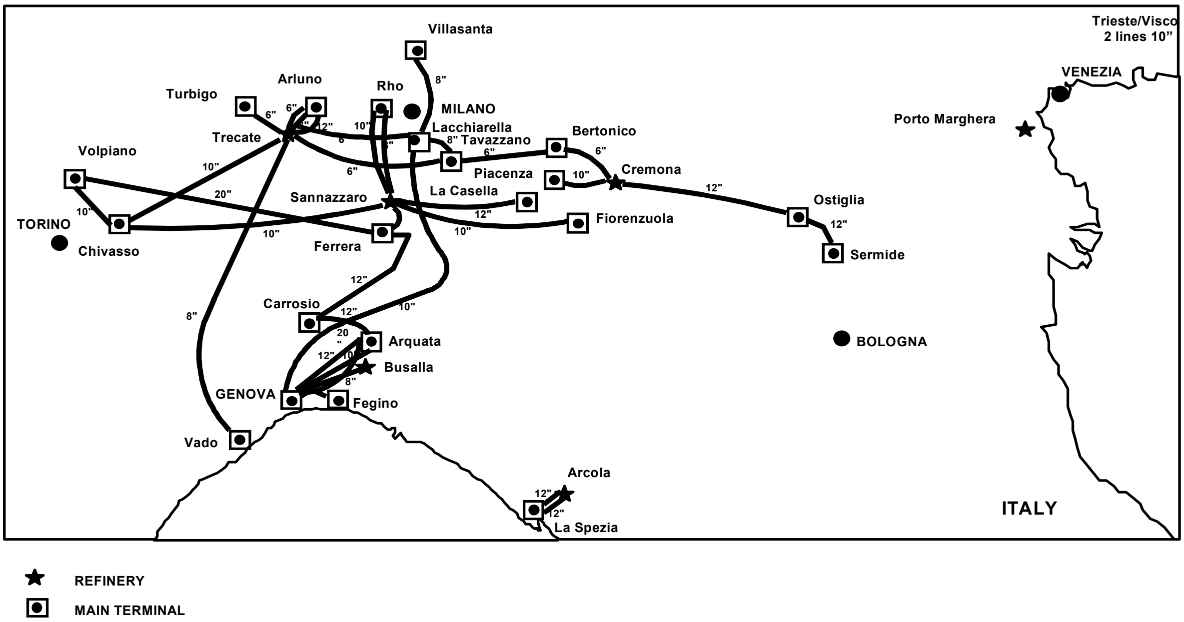


Figure 11 Product lines: Northern Italy



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