



United Nations
Environment
Programme



UNEP/WG.160/7
27 February 1987

Original:ENGLISH

MEDITERRANEAN ACTION PLAN

Fifth Meeting of the Working Group
for Scientific and Technical Co-operation
for MED POL

Athens, 6-10 April 1987

ASSESSMENT OF USED LUBRICATING OILS IN THE MEDITERRANEAN
SEA AND PROPOSED MEASURES FOR THEIR ELIMINATION

In collaboration with



UNIDO

UNEP

Athens, 1987

TABLE OF CONTENTS

	<u>Page No.</u>
1. INTRODUCTION	1
2. DEFINING USED LUBRICATING OILS	2 - 3
3. ASSESSMENT OF POLLUTION BY USED LUBRICATING OILS IN THE MEDITERRANEAN	4
3.1 Inputs of oil pollution in the Mediterranean	4 - 7
3.2 Sources and types of used lubricating oils reaching the Mediterranean Sea	7 - 8
3.3 Coastal, municipal and industrial wastes and runoff	8
3.3.1 Municipal wastewaters	9 - 10
3.3.2 Non-refinery industrial wastes	10 - 14
3.3.3 Urban runoff	14 - 15
3.3.4 Vehicle crankcase oils	15 - 19
3.3.5 River discharges	20
3.4. Levels of used lubricating oils in the marine environment	20
3.5 Fates of used lubricating oils in the marine environment	20 - 21
3.5.1 Physical and chemical fates	21
3.5.2 Biological fates	21 - 22
3.6 Effects of used lubricating oils on the marine environment	22 - 23
4. MEASURES TO PREVENT AND CONTROL POLLUTION BY USED LUBRICATION OILS IN THE MEDITERRANEAN	24
4.1 Alternative ways to use or dispose of used lubricating oils	24
4.2 Cost benefit analysis of used lubricating oils collection and re-utilization	24 - 26
4.3 Collection systems	26 - 27
4.4 Present National legal, administrative and technical measures relevant to the Mediterranean	27
4.4.A Algeria	27 - 28
4.4.B Cyprus	28 - 29
4.4.C Egypt	29 - 30
4.4.D France	30 - 32
4.4.E Greece	32 - 33
4.4.F Israel	33 - 34
4.4.G Italy	34 - 35
4.4.H Lebanon	36
4.4.I Libya	36
4.4.J Malta	36
4.4.K Monaco	36 - 37
4.4.L Morocco	37
4.4.M Spain	37 - 38
4.4.N Syria	38
4.4.O Tunisia	39
4.4.P Turkey	39 - 40
4.4.Q Yugoslavia	40

TABLE OF CONTENTS (Continued)

	<u>Page No.</u>
4.5 Standardization and marketing	40 - 41
4.6 Public awareness	41 - 42
5. SUGGESTED OUTLINE OF PROGRESSIVE NATIONAL MEASURES	43
5.1 Definition of used lubricating oils	43 - 44
5.2 Assessment of sources and levels of used lubricating oils	44
5.3 Controlling sources of used lubricating oils causing significant pollution	44 - 45
5.4 Industrial used oil policies	45 - 48
5.5 Controlling re-use and disposal of used lubricating oils	48
6. MEASURES PROPOSED FOR ADOPTION BY THE CONTRACTING PARTIES	49
7. REFERENCES	50 - 58

1. INTRODUCTION

Article 5 of the Protocol for the protection of the Mediterranean Sea against pollution from land-based sources (1) binds the Contracting Parties to eliminate pollution of the protocol area by substances listed in Annex I to the protocol, to elaborate and implement, jointly or individually as appropriate, the necessary programmes and measures to this end, such programmes and measures to include, in particular, common emission standards and standards for use.

Item 6 in Annex I to the protocol consists of "used lubricating oils". In conformity with the decision of the Contracting Parties at their fourth ordinary meeting in Genoa in September 1985 (2) that substances in this annex should be accorded priority over Annex II Substances in the development of the necessary programmes and measures, preparations were commenced by the Secretariat for an assessment of the state of pollution of the Mediterranean Sea by used lubricating oils to be produced. This activity was agreed to by the meeting of experts on the technical implementation of the protocol in Athens from 9 to 13 December 1985 (3), and time-tabled for implementation during the 1986-1987 biennium. A questionnaire for the acquisition of relevant country information was discussed by the Working Group for scientific and technical cooperation for MED POL at their fourth meeting in Athens from 16 to 20 June 1986 (4), and circulated.

The present report, which is based on existing material, including the response of individual countries to the questionnaire, constitutes an assessment of used lubricating oils, describing their nature, their origin, their fate after use and their effects on the Mediterranean Sea. It also contains information on legal provisions presently existing in Mediterranean countries that apply or could be applied to prevent and/or control pollution by used lubricating oils, and what measures could be appropriately taken in terms of the Protocol for the Protection of the Mediterranean Sea against pollution from land-based sources, including recommendations to the Contracting Parties thereto.

2. DEFINING USED LUBRICATING OILS

Lubricating oils are essential for many industrial and transportation purposes, as well as for many other uses:

1. Examples of industrial uses of lubricants are for hydraulic pumps, compressors, turbines and metalworking (e.g. cutting, grinding, drilling or machining of metal).
2. Transportation uses include oils for automobile engines (both gasoline and diesel), transmissions and gears; railroad and marine diesel engines; and airplane engines.
3. Other uses for oils are in electrical transformers, in rubber manufacturing processes, and in spinning and natural gas transmission equipment.

Lubricating oils are usually of lubricant base stocks, a fraction of crude petroleum that must be separated by vacuum distillation, and synthetic chemical additives. Some base stocks are entirely synthetic, e.g. liquid polyoxyalkanes and polyesters, which also are combined with additives. Additives are combined with base stocks for several purposes, depending on the use to which the lubricants will be put, e.g. to clean surfaces to be lubricated, to prevent corrosion and rust, to maintain constant viscosity, to inhibit oxidation of the oil during use and to improve lubricating properties.

Since there are literally hundreds of uses for lubricating oils, defining used lubricating oils for purposes of a regulatory or incentive-based programme depends on an assessment of the principal sources of used lubricants and their particular characteristics, and the objectives of the programme, e.g. elimination of environmental contamination, promotion of re-refining used oils into lubricants in order to conserve scarce lubricant base stocks, or encouragement of controlled burning to recover energy as fuels. Defining "wastes" or "hazardous wastes" is a related problem which should be coordinated with defining used lubricating oils, since often used oils and wastes are mixed, thus complicating the re-use or disposal of the oils. Even if other wastes have not been added to them, used lubricating oils contain chemically changed additives and contaminants that result from the uses to which they are put, e.g. dirt, metal fines, water, gasoline, lead and other trace metals.

The following are some definitions of used lubricating oils that have been adopted for various purposes:

1. "used mineral oils and used liquid mineral oil products as well as mineral oil-containing wastes from storage, business, and transportation receptacles" (5);
2. "used engine, machine, cooling and similar waste oil" (6);
3. "any oil which has been refined from crude oil, used, and as a result of such use, contaminated by physical or chemical impurities" (7);
4. "any semi-liquid or liquid used product totally or partially consisting of mineral or synthetic oil, including the oily residues from tanks, oil-water mixtures and emulsions" (8); and

5. "a petroleum-based oil which through use, storage or handling has become unsuitable for its original purpose due to the presence of impurities or loss of original properties" (9);

Several choices are apparent in these definitions. Definition No.4 includes synthetic oils. These include aircraft engine, hydraulic and automotive engine oils. If re-refining is a goal of the programme, then the refining process employed will have to be able to reclaim synthetic base stocks along with hydrocarbon base stocks or else the synthetics will be rejected as sludges. That definition also includes "emulsions". As a result, a high proportion of water will accompany these used oils (oils may constitute only 5-40% of the volume), with comparatively high costs for separating and recovering the oil. Definition No.2 refers to "cooling" oils. If electrical transformer oils, used to control temperatures, fall within this functional definition, care must be taken to specify whether synthetic transformer oils are included (as opposed to straight mineral oils), since these have until recently contained high percentages of PCBs. Definitions Nos.1 and 4 specify "liquid" or "semi-liquid" products. This excludes heavy greases and asphalt that require different treatment. Specifically excluding other substances, e.g. solvents (e.g. paint thinners and naphthas) from the definition of used lubricating oils may aid in distinguishing wastes from used oils that may be either re-refined or burned as fuels. This distinction is important since many solvents are extremely flammable and, even though they can be burned, unless that is done at very high temperatures, toxic emissions result. Also, some solvents can interfere with used oil re-refining processes and produce greater re-refining wastes. Definitions Nos.1 and 5 refer to "storage" and definition No.4 to "oily residues from tanks", thus including oil storage tanks as sources of used oil, even though the oil has not actually been "used". Definition No.4 includes "oil-water mixtures", presumably including bilge oils from ships and perhaps oil tanker residues. None of the definitions includes oil drilling or refinery wastes, however, because these are usually regarded as production or industrial process wastes. Nor are animal or vegetable oils included. They do not pose the risks that petroleum-based lubricants do.

3. ASSESSMENT OF POLLUTION BY USED LUBRICATING OILS IN THE MEDITERRANEAN

Information about used lubricating oils, specifically, in the Mediterranean Sea is quite limited. However, estimates about the sources, kinds, levels, fates and effects of such oils can be derived from general information about marine oil pollution and about the uses of lubricating oils in the nations surrounding the Mediterranean. Answers to the questionnaire sent in connection with this assessment should provide further information useful in defining the scope of pollution caused by used lubricating oils and the policy measures appropriate to eliminating it. A copy of the questionnaire sent to countries surrounding the Mediterranean is attached as Appendix A.

3.1 Inputs of oil pollution in the Mediterranean

There are, of course, several sources of petroleum pollution in the Mediterranean. Which of them are counted as sources of used lubricating oils depends on the definition adopted for these oils. A list of all major sources of petroleum pollution would include:

1. natural seeps and erosion of sedimentary rocks;
2. spills and operational (produced water) discharges from offshore petroleum production facilities;
3. refinery and oil storage wastes;
4. marine transportation, including:
 - (a) operational discharges from tankers (ballast, slop tanks and tank washing water);
 - (b) terminal and bunkering operations (e.g. spillages, pipeline or storage tank ruptures);
 - (c) dry-docking;
 - (d) bilges and fuel oil from ships (machine space bilges, fuel oil sludges, oily ballast from fuel tanks); and
 - (e) accidental spills from tankers and ships.
5. pleasure watercraft;
6. ocean dumping;
7. precipitation from the atmosphere;
8. municipal wastewaters;
9. industrial wastewaters (non-refinery);
10. urban runoff; and
11. river-borne pollution (10).

In order to reduce the chance of overlapping with the parallel assessment of petroleum hydrocarbons being prepared by the IOC (11), and because used lubricating oils are normally defined to exclude categories 1-7, this assessment will attempt to estimate, or suggest ways of estimating, used lubricating oil inputs from categories 8-11 only.

An inventory of land-based sources of pollution prepared as part of the Mediterranean Action Plan from 1977-79 (12) serves as a point of departure for estimating used oil pollution of the Mediterranean. It indicates industrial wastewaters are the principal source of pollution loads of "mineral oil" (a broader term than used lubricating oils) to the Mediterranean Sea (13). Industrial sectors contributing mineral oil that were included in that assessment were, iron and steel basic industries, motor vehicle production, petroleum refineries and crude oil terminals (14). Iron and steel basic industries were described as being chiefly in the Marseilles, Genoa and Athens areas. The "oil industry, petroleum refineries as well as oil terminals", was described as in several centres along the southern and eastern shorelines, with "additional refineries" in the North-Western basin and the Upper Adriatic (15). The assessment summarized that mineral oil discharges "are largely due to industrial activities with contributions from coastal refineries and oil terminals predominating" (16). Estimated loads of mineral oils from industrial sources for each of the ten regional Mediterranean Sea areas (17) were (18):

I.	Alboran	1,700 tons/yr	(bordered by Spain, Morocco, Algeria)
II.	North-Western	10,000 tons/yr	(bordered by Spain, France, Monaco, Italy)
III.	South-Western	600 tons/yr	(bordered by Spain, Italy, Algeria, Tunisia)
IV.	Tyrrhenian	3,000 tons/yr	(bordered by Italy, France, Tunisia)
V.	Adriatic	3,900 tons/yr	(bordered by Italy, Albania, Yugoslavia)
VI.	Ionian	10,000 tons/yr	(bordered by Italy, Albania, Greece)
VII.	Central	41,000 tons/yr	(bordered by Italy, Tunisia, Libya, Malta)
VIII.	Aegean	4,100 tons/yr	(bordered by Greece, Turkey)
IX.	North-Levantin	27,000 tons/yr	(bordered by Turkey, Cyprus, Syria, Lebanon)
X.	South-Levantin	13,000 tons/yr	(bordered by Lebanon, Israel, Egypt, Libya)

Significantly, this assessment indicated insufficient data bases for estimating mineral oil pollution loads attributable to municipal sources or rivers (19). It is of course important to avoid double-counting of pollution loads contributed by these sources, as well as urban runoff. If a load is attributed to an industrial discharge, it should not be counted in municipal sewage as well. If the industrial plant discharges oil into the municipal

sewage system, the load should be attributed to municipal sources, after reducing it by the level of sewage treatment provided. Similarly, oil counted as coming from municipal sewage treatment plants should not be counted again as river-borne, even if the sewage treatment plants discharge into rivers. Untreated urban runoff (e.g. storm water) containing oil should be counted separately from river-borne pollution from other sources, e.g. rural runoff.

The MED POL X assessment addressed this issue in a different manner, which explains why mineral oil pollution loads apparently stem entirely from industrial sources. All industrial sources of pollution located in a 20-kilometre coastal strip were counted as contributing industrial waste loads, even if they discharged into municipal sewers, as many did (20). "Other pollution sources within the Mediterranean drainage basin were covered through the inclusion of major rivers discharging into the sea" (21).

The methodology of the MED POL X assessment of industrial pollution loads included an inventory of the location, kind and size of industrial activities in coastal areas, a questionnaire to industrial waste sources, plant visits in some instances and reference to other published and unpublished sources of information. In summary:

The assessment study required a rather flexible approach ranging from direct analytical results to pure desk studies. Largely, an indirect method was applied which made use of the best information available from each country even though the basic data varied from country to country. Subsequently, these data were subjected to a computation process which made use of specific waste coefficients obtained from experience. As basic data, the following variations were considered: (i) wastewater flow data and accompanying analytical results; (ii) daily or yearly production figures; (iii) water consumption figures; and (iv) number of employees working within a given plant or an industrial sector. Wherever an indirect estimation of industrial waste loads was necessary, production figures or numbers of employees were mainly used. For this purpose, an elaborate scheme of specific coefficients of industrial waste generation was developed which provided the necessary basis for computation (22).

The assessment concluded that "The quality of estimates calculated may be considered accurate within an error range of about one order of magnitude" (23).

However, since industrial discharges into municipal sewers were counted separately, it is not clear what reductions of oil pollution loads, if any, were made to account for sewage treatment. General sanitary engineering experience indicates that primary treatment on the average removes one-third of petroleum hydrocarbons (oil and grease) in municipal wastewater and secondary treatment 40% (24). Nor were any reductions indicated for pollution abatement by industrial plants that discharge directly into the sea or rivers flowing into it. Refineries in Europe with their own wastewater treatment facilities were estimated in 1977 to discharge .04 kilograms of petroleum hydrocarbons per 10,000 kilograms/year production capacity (25). Non-refinery industrial discharges of oil, other than into municipal sewers, would depend on the limits imposed in individual plant discharge permits.

Nor could the MED POL X assessment provide any estimate of mineral oil pollution of rivers, i.e. amount of oil carried into the sea by rivers, due to lack of reliable data (26). It is likely, however, that an effort to estimate

urban runoff of oil would be a more useful approach to learning this contribution to Mediterranean Sea pollution and would largely obviate the need to estimate river-borne pollution separately (except for rural runoff), since river-borne pollution would already have been counted as municipal or industrial discharges or as urban runoff.

3.2 Sources and types of used lubricating oils reaching the Mediterranean Sea

Even with the questions just discussed, the kind of inventory undertaken by the MED POL X assessment is what would be needed for an accurate estimate of the amounts of used lubricating oils entering the Mediterranean. As indicated above in the section defining used lubricating oils, there are many industrial, transportation and other applications for lubricants. Thus, a starting point for this assessment is a list of the principal sources of used lubricants. This list does not include sources in categories 1-7 set forth in the preceding section, unlike the MED POL X assessment.

The industries that generate the most used oil are the primary metals, fabricated metal products, machinery, electrical equipment, transportation equipment, chemical products and rubber and plastics products industries. The types of used oils vary widely according to the specifications for particular applications. Metalworking oils, for example, range from 100% oil (so-called neat oil) to oil-water emulsions (called soluble oils) with a low percentage of oil. Both formulations require as many as half a dozen additives, e.g. to reduce wear on cutting and grinding tools. Quenching oils, used to cool hot metals, contain oxidation inhibiting additives (e.g. barium sulfonate, zinc compounds, sodium nitrate). Steel rolling and stamping oils vary but are often combinations of naphthenic mineral oils and tallow oils, with sulphur and phosphorous additives to reduce wear on the rollers. Hydraulic oils, used for example in die-casting, steel foundry operations and automobile production, usually consist of paraffinnic base stocks with only rust and oxidation inhibiting additives (e.g. a hindered phenol) and sometimes an antiwear additive (e.g. zinc dithiophosphate). Transformer oils are straight mineral oils with no additives. Turbines, either steam powered or gas-fired, generate electricity or run compressors in chemical plants or refineries, for example. Their lubricating oils are similar to hydraulic oils, although high temperature oxidation inhibiting additives are also needed.

Automobiles, trucks, buses and heavy machine equipment all use oil in their engines, gears, transmissions and hydraulic systems. Therefore, dealerships, service stations and garages all generate used oils. Amounts and types vary with the kind, age and size of the vehicles. New passenger cars produce a few gallons of drained motor oil (crankcase oil) every six months. Older cars must be serviced more frequently. Long distance trucks require up to eight gallons of gear oil in their axles. Some earthmovers need 35 gallons. Dump trucks, garbage trucks and loading vehicles generate transmission fluids from their hydraulic systems, in addition to transmission fluids from the transmissions of all vehicles. Diesel engine oils for large and small trucks (and automobiles) are another category of automotive lubricants. Several additives are contained in these lubricants, often making up more than 15% by volume. In used lubricating oils these additives are chemically changed, and the oil itself is contaminated with rust, soot, dirt, dust, lead (from gasoline), engine wear metal particles and water (condensed from vapour).

Both railroads and airplanes also use lubricants. Typically they are almost all collected at terminals and airports and recycled, and are thus unlikely components of pollution.

Other sources of used lubricating oils are refrigeration units and shock absorbers. These oils are usually made from naphthenic base stocks. Naphthenic base stocks are also used to make process oils used in rubber manufacturing. Air compressor oils are similar to turbine oils. They are made from paraffinic base stocks and have low levels of additives. Rock drill oils, used for jack hammers, air hammers and underground drills are similar to industrial gear oils. They contain additives to modify friction as well as antiwear and extreme pressure additives. Way oils are formulated to lubricate slides of machine tools, e.g. lathes, and are similar to hydraulic oils, with a friction modifier additive. Spindle oils lubricate spinning equipment in the textile industry. They are similar to hydraulic oils with rust and oxidation inhibiting additives.

Estimates of how many of the used lubricating oils reach the sea would have to be based on more detailed knowledge of the size, location and disposal practices of the sources, the number of motor vehicles registered in coastal areas, and the appropriate per capita urban runoff amount in different regions. Additional discussion regarding sources and quantities appears in the next section.

3.3 Coastal, Municipal and Industrial wastes and runoff

The estimated range of the input of petroleum hydrocarbons (PHC) into the world marine environment from municipal and industrial wastewaters, urban runoff and river discharges, and ocean dumping is from 0.6 to 3.1 million tons per annum (mta), with a best estimates of 1.2 mta (Table 3.1). Municipal wastewater appears as the largest contributor, followed by industrial discharges and urban runoff (27).

Table 3.1

Estimates of Hydrocarbons to World Oceans from Municipal and Industrial wastes and runoff (mta)

Source	1981 NRC Workshop		
	NCR (1975)	Most probable	Likely range
Municipal wastewater	0.3	0.75	0.4 - 1.5
Industrial:			
Non-refinery	0.3	0.2	0.1 - 0.3
Refinery	0.2	0.1	0.06 - 0.6
Urban runoff	0.3	0.12	0.1 - 0.2
River discharges	1.6	0.04	0.01 - 0.45
Ocean dumping	(a)	0.014	0.005 - 0.02
TOTAL	2.7	1.2	0.06 - 3.1

(a) Not estimated

NRC: National Research Council
Source: Oil in the Sea, Reference 10

3.3.1 Municipal wastewaters

In 1979, Eganhouse and Kaplan analysed 38 samples of treated municipal wastewater from five major wastewater pollution control plants in Southern California as reported in 1980 by the Southern California Coastal Water

Research Project (SCCWRP). Four of these discharges were used in making estimates for facilities serving approximately 9.8 million people in 1979 (28) (29).

The wastewater samples were analysed for total extractable organics and for total hydrocarbons (THC). The results of these analyses were compared with reported concentrations of oil and grease from the routine monitoring done by the wastewater management agencies as reported by SCCWRP. Regression analysis indicates that THC accounts for approximately 38% of the oil and grease discharged from these treatment plants.

The total mass emission from the four discharges is estimated to be approximately 43 mta in 1979, resulting in an overall contribution of oil and grease of about 12 grams per capita per day (g/cap/d). These results can be used to calculate the total per capita contribution of THC from the Southern California outfalls in 1979. This figure comes to 38% of 12 g/d or 4.5 g/d.

This figure can be used to estimate the municipal wastewater contribution of oil and grease from the Mediterranean coastal area. MED POL X has estimated the Mediterranean coastal population at 44 million residents (30). If this 44 million figure is multiplied by the 4.5 grams per capita per day, then assuming all their wastewaters were discharged into municipal waste treatment facilities, the municipal wastewater contribution to the Mediterranean Sea would be:

$$(4.5 \text{ g/cap/d}) (44 \times 10^6 \text{ residents}) (365 \text{ days/annum}) / 1 \times 10^6 \text{ grams/metric ton} = 72,270 \text{ ta, or } 0.072 \text{ mta}$$

In order to put this information into context, Table 3.2 presents estimates of the global discharge of hydrocarbons into municipal sewers.

Table 3.2(a)

Global discharge of hydrocarbons into Municipal wastewaters

Area	1980			
	Petroleum consumption (b) (millions of bbl/d)	Estimated untreated THC load (c) (mta)	Percent THC removed by treatment	Residual THC (-PHC) discharged (mta)
North America:				
United States	18.3	0.30	38(d)	0.19
Canada	1.8	0.03	38(d)	0.02
Latin America	4.2	0.07	0	0.07
Asia and Pacific	9.1	0.15	0	0.15
China	1.7	0.03	0	0.03
Middle East	2.0	0.03	0	0.03
USSR and Eastern Europe	10.5	0.17	30(e)	0.12
Western Europe	10.5	0.17	30(e)	0.12
Africa	1.2	0.02	0	0.02
TOTAL	63.1	0.97		0.75

- (a) Source: Oil in the Sea, Reference 10
 (b) Source: International Petroleum Encyclopaedia (1980)
 (c) Assuming 16.1 ta of THC per 1,000 bbl/d consumed
 (d) 1 - 185,000/298,000 = 0.38
 (e) Assumed

3.3.2 Non-refinery industrial wastes

A sizeable fraction of non-refinery industrial waste discharges into municipal wastewater systems and its PHC content have been accounted for in the previous section. However, there is a quantity of PHC that goes more or less directly into the marine environment through coastal non-refinery effluent discharges. Extremely limited quantification of this source has been made, and even less information is published for reasons of confidentiality. Previous world estimates have been made by the NRC (1981) of 0.2 mta, and the Royal Commission of Environmental Pollution (1981) of 0.150 mta.

Table 3.3 presents quantities of lubricant imports for many countries bordering the Mediterranean. If data for all the countries were available, perhaps the total lubricant imported would be about 500,000 metric tons per annum. These data do not include lubricants refined within the countries themselves. Using the 500,000 metric ton figure, an estimate of the used oil generated would be about 250,000 metric tons per annum (0.25 mta), based upon experience, approximately 50% of purchased oils end up as a collectible used oil.

Table 3.3

Imports of lubricants from OECD countries

	<u>1000 Metric Tons</u>
Morocco	N.A.
Algeria	15
Tunisia	N.A.
Libya	41
Egypt	28
Israel	N.A.
Lebanon	N.A.
Syria	N.A.
Cyprus	N.A.
Turkey	5
Greece	44**
Italy	78**
Malta (including Yugoslavia and Gibraltar)	17
Monaco	N.A.
France	133
Spain	41
	<hr/> 402

N.A. : Not available

* From O.E.C.D. (Organization for Economic Co-operation and Development) countries: Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, Japan, Finland, Australia, New Zealand and selectively Yugoslavia. 1982 data.

** Data also includes imports from other (non-O.E.C.D.) countries.

Source: Annual oil and gas statistics, 1981 and 1982. International Energy Agency, O.E.C.D., Paris, 1984 (Tables 125, 155 and 170).

Another method of estimating industrial used oils is presented below. Table 3.4 shows an estimate of used oil generated per employee per ISIC. Table 3.5 lists the employment per ISIC for countries bordering the Mediterranean. These ISIC's comprise those categories using the majority of lubricating oils in industry.

Table 3.4

Used oil generated per employee per ISIC (litres)

Description	ISIC Code	Litres per annum per employee standard
Chemical and allied products	351, 352	327
Rubber and plastic products	355	234
Primary metals	371	161
Fabricated metals	381	328
Machines, except electrical	382	80
Electrical equipment	383	167
Transportation equipment	384	338

Sources: Derived from Yates, et al., Used oil recycling in Illinois: Data book 1978 and Reference (46), Maltezou, 1976.

The Table presents average figures developed from data obtained in the New York Metropolitan Area and the State of Illinois, USA.

When the used oils per employee figures are multiplied by the total employment in the selected ISIC's, a used oil generated value of 1.76 billion litres is obtained (see Table 3.6). Assuming an average specific gravity of 0.925, this figure becomes 1.63 mta.

The 1.63 mta figure developed above is substantially higher than the used oil generated figure, 0.25 mta, obtained from Table 3.3. The primary reason for this is that Table 3.3 does not account for all shipments of lubricants from all sources, principally those lubricants produced from refineries within the countries themselves.

Other estimates of amounts of used lubricating oils generated in nations bordering the Mediterranean are limited. In Greece in 1980 consumption of lubricants according to one report, was 1000,000 tons, with 45,000-55,000 tons of used oils generated. In Italy 378,000 tons of motor oils and 252,000 tons of industrial lubricants are consumed annually, and 300,000 tons of used oils result. In France approximately 460,000 tons of motor lubricants are consumed annually and 440,000 tons of industrial lubricants. An estimated 450,000-540,000 tons of used lubricants result (31).

Table 3.5

Employment by ISIC

DESCRIPTION	ISIC CODE	ALGERIA		CYPRUS		EGYPT		FRANCE		GREECE		ISRAEL		ITALY		LEBANON		ARAB JEM-		MALTA		MOROCCO		SPAIN		ARAB REPUBLIC		INDONESIA		TURKEY		YUGOSLAVIA		TOTAL		
		1984	1984	1984	1982	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984	1984				
Chemical and allied products	351,352	7,985	1,600	72,840	317,000	25,608	13,929	237,000	***	1,054	490	***	14,846	135,000	14,600	13,608	47,340	103,000	1,005,900																	
Rubber and plastic products	355	1,138	256	6,608	92,000	3,679	4,099	59,000	***	0	1,031	***	3,280	41,000	2,400	869	10,905	36,000	262,265																	
Primary metals	371	50,944	0	46,248	214,000	8,912	4,086	222,000	***	0	0	***	867	129,000	0	5,210	58,430	125,000	864,697																	
Fabricated metals	381	37,898	2,461	33,916	234,000	40,098	41,202	189,000	***	681	1,657	***	16,687	218,000	11,700	13,938	42,760	249,000	1,132,998																	
Machines, except electrical	382	17,098	1,284	23,626	553,000	15,529	9,523	278,000	***	0	810	***	4,679	139,000	3,200	461	54,036	214,000	1,314,246																	
Electrical equipment	383	17,098	535	21,034	481,000	23,787	32,740	301,000	***	0	2,107	***	7,703	160,000	2,600	6,163	35,332	182,000	1,273,099																	
Transportation equipment	384	29,252	455	38,464	602,000	36,421	21,078	383,000	***	0	922	***	8,371	241,000	1,100	5,867	53,437	181,000	1,602,367																	
TOTAL		161,413	6,591	242,736	2,493,000	154,034	126,657	1,669,000	***	1,735	7,017	***	56,433	1,063,000	35,600	46,116	302,240	1,090,000	7,455,572																	

*** Data unavailable

Note: ISIC's listed are those producing most of the used oils generated by the manufacturing industry.

Source: Figures in the table above were obtained by multiplying the used oil per employee per ISIC in Table 3.4 times the total employment per ISIC in Table 3.5.

Table 3.6
Estimated used oil generated by ISIC per
country (Million litres)

DESCRIPTION	ISIC CODE	LIBYAN										SYRIAN							
		ALGERIA 1984	CYPRUS 1984	EGYPT 1982	FRANCE 1984	GREECE 1984	ISRAEL 1984	ITALY 1984	LEBANON ***	AHRIYA 1984	MAJMA 1984	MOROCCO ***	SPAIN 1984	REPUBLIC 1982	TUNISIA 1984	TURKEY 1984	YUGOSLAVIA 1984	TOTAL	
Chemical and allied products	351,352	2.61	.523	23.8	104	8.37	4.55	77.5	***	.345	.160	***	4.85	44.1	4.77	4.45	15.5	33.7	329
Rubber and plastic products	355	.266	.0599	1.55	21.5	.861	.959	13.8	***	0.00	.241	***	.768	9.59	.562	.203	2.55	8.42	61
Primary metals	371	8.20	0.00	7.45	34.5	1.43	.658	35.7	***	0.00	0.00	***	.139	20.8	0.00	.839	9.41	20.1	139
Fabricated metals	381	12.4	.807	11.1	76.7	13.1	13.5	62.0	***	.223	.543	***	5.47	71.5	3.84	4.57	14.0	81.7	371
Machines, except electrical	382	1.37	.103	1.89	44.2	1.24	.762	22.2	***	0.00	.0648	***	.374	11.1	.256	.0369	4.32	17.1	105
Electrical equipment	383	2.86	.0893	3.51	80.3	3.97	5.47	50.3	***	0.00	.352	***	1.29	26.7	.434	1.03	5.90	30.4	213
Transportation equipment	384	9.89	.154	13.0	203	12.3	7.12	129	***	0.00	.312	***	2.83	81.5	.372	1.98	18.1	61.2	542
TOTAL		37.6	1.74	62.3	564	41.2	33.0	391	***	.568	1.67	***	15.7	265	10.2	13.1	69.7	253	1760

*** Data unavailable

Note: ISIC's listed are those producing most of the used oils generated by the manufacturing industry.

Source: Figures in the Table above were obtained by multiplying the used oil per employee per ISIC in Table 3.4 times the total employment per ISIC in Table 3.5.

In Table 3.7 below, the results of the three different data sources are compared for the three countries identified above.

Table 3.7

Industrial used oil generated in Greece, Italy and France (mta)

	<u>Method 1*</u>	<u>Method 2**</u>	<u>Method 3***</u>
Greece	0.0220	0.0383	0.0250
Italy	0.0390	0.362	0.126
France	0.0665	0.522	0.220

* Based on imports in Table 3.3. Fifty percent of those figures are listed.

** Taken from Table 3.6.

*** Listed as identified in Reference (31). In Greece, one half of the used oil generated is assumed to come from industrial lubricants. One half of the industrial lubricants used in Italy and France are assumed to have become collectible used oils.

3.3.3 Urban runoff

The global input of petroleum hydrocarbons (PHC) to coastal waters from urban runoff was estimated by NRC (1975) to be 0.3 mta. The value was based in part on the assumption that urban runoff contributed about half the amount of PHC contributed by municipal and non-refinery wastewaters. The crudeness of this estimate was unavoidable because of the lack of measurements of PHC in urban runoff. The situation ten years later is only slightly better because most of the studies undertaken in the intervening years have focused on analytical methods of characterizing the PHC fractions rather than on mass contributions of PHC. Part of this dilemma may be due to the difficulty of representative sampling of the runoff. Other problems are the determination of mean PHC concentrations and the volume of runoff, which permit accurate estimation of mass PHC contributions. Estimates of PHC in runoff should be based on factors such as runoff area, watershed characteristics, PHC usage and population density. Recognizing the difficulties in quantifying the mass of PHC contributed and considering hydrological, physical and land use variations in urban areas (as well as the definition of urban), the authors of Oil in the Sea concluded that the best estimate of urban PHC runoff must be based on estimates of per capita contributions. Population is one of the principal generating factors of urban PHC runoff for a given petroleum consumption level. Table 3.8 shows data for per capita estimates of PHC contributions from several locations.

Despite the gross variation in per capita PHC contribution, it is believed to be the most accurate basis for current estimation of urban PHC runoff. A per capita PHC contribution of 1.0 g/cap/d is probably the most reliable estimate that can be made from present information.

Employing the unit per capita contribution of 1.0 g/cap/d per day and a coastal population of about 44 million, one can estimate the urban runoff contribution of the Mediterranean Coastal Area to be about 0.061 mta.

Table 3.8

Per capita estimates of PHC contributions in urban runoff

Location	Unit PHC contribution (g/cap/d)	Reference
Philadelphia and Trenton	0.03	Whipple and Hunter (1979)
Narragansett Bay	2.7	Hoffman <u>et al.</u> , (1982)
Los Angeles (a)	1.9	Eganhouse and Kaplan (1981)
Seattle	0.3	Wakeham (1977)
Sweden (b)	0.3	NRC (1975)

(a) Single storm extrapolated to annual runoff by author.

(b) Typical urban area (0.2 parking, 0.3 multi-family and 0.6 single family).

Source: Oil in the Sea, Reference 10

3.3.4 Vehicle crankcase oil

A major contributor to urban runoff and river contamination with oils is oils released to the environment from crankcase. This oil comes from oils on roads, oils dumped by persons changing their own oils (50% in many areas), and centralized depositories improperly disposing of oils. An attempt is made below to quantify the used oils generated from vehicles.

Since no figures on the sales or usage of crankcase oils are available at this time, the quantities of these oils must be estimated using methods that derive these data from known sources of information. Table 3.9 presents the consumption of gasoline per capita for countries bordering the Mediterranean, coastal populations and estimated gasoline used. The total gasoline used is estimated to be 6.79×10^9 kgms or 1.99×10^9 gallons. This consumption of gasoline is estimated to result from usage in about 5 million vehicles.

If it is estimated that there is an oil change of 5 litres per year, then the used oil produced would be 25×10^6 litres, or 0.0225 mta.

Another method of estimating used vehicle crankcase oils is by looking at the total vehicle registrations in each country. These figures were obtained for each country. However, figures for coastal areas were not available. Table 3.10 presents vehicle registrations per country and Table 3.11 shows the average kilometres travelled per type of vehicle per annum. Table 3.12 shows a calculation of estimated used crankcase oils for all countries surrounding the Mediterranean. A figure of 1.12×10^9 litres was developed. This value translates into about 1.01 mta of used crankcase oils produced in the Mediterranean region.

Table 3.9

Consumption of motor gasoline per capita (1981), coastal populations and quantities of gasoline consumed

	(1) Kgs per capita*	(2) Coastal population (10 ³)**	(3) Gasoline used (10 ⁶ kgs)***
Cyprus	155	185	29
Israel	198	1332	264
Lebanon	179	1159	208
Syria	65	318	21
Turkey	42	1583	67
Algeria	56	4121	231
Libya	275	1721	473
Morocco	22	1032	23
Tunisia	25	1609	40
France	323	2686	858
Greece	149	3890	580
Italy	245	11844	2902
Spain	141	5569	785
Yugoslavia	92	516	47
Egypt	(83 assumed)	2947	<u>244</u>
TOTAL:-			6789
The World		143	
OPEC Members		64	
Africa		30	
Middle East		83	
Western Europe		273	
Other Europe		133	
USA		1244	

* Source: The World Petroleum Industry, Stuart Sinclair, Facts on File Publications, New York, New York; Bicester, England, 1984.

** Source: MED POL X, Reference 12, Annex I

*** These figures were calculated by multiplying column (1) by column (2)

Table 3.10

Car and truck and bus vehicle registrations by country

Country	Total registrations		1982
	Cars	Trucks and buses	Total vehicles
Algeria	580,000	300,000	880,000
Cyprus	97,958	29,195	127,153
Egypt	461,277	221,018	682,295
France	20,420,000	2,689,500	23,109,500
Greece	999,315	526,593	1,525,908
Israel	518,858	115,299	634,157
Italy	19,616,106	1,641,706	21,257,812
Lebanon	***	***	***
Libyan Arab Jamahiriya	415,509	334,405	749,914
Malta	74,773	17,871	92,644
Monaco	123,897	3,109	17,006
Morocco	460,515	190,180	650,695
Spain	8,353,944	1,505,542	9,859,486
Syrian Arab Republic	26,000	10,961	36,961
Tunisia	141,185	147,571	288,756
Turkey	826,756	233,377	1,060,133
Yugoslavia	2,698,605	454,850	3,153,455
TOTAL:-	55,704,698	8,421,177	64,125,875

*** Data unavailable

* Source: World Motor Vehicle Data 1984-85 Edition.
Pages 40-42.

Table 3.11

Average annual distance travelled

Country	Year used	Average annual distance in kilometres per vehicle			Average annual distance in miles per vehicle		
		Cars	Buses	Goods vehicles	Cars	Buses	Goods vehicles
Algeria	-	***	***	***	***	***	***
Cyprus	-	***	***	***	***	***	***
Egypt	1982	***	63,000	44,000	***	39,060	27,280
France	1983	12,400	48,000	20,000	7,688	29,760	12,400
Greece	1979	11,900	***	22,800	7,378	***	14,136
Israel	1981	16,471	64,000	32,000	10,212	39,680	19,840
Italy	1982	11,200	512,400	22,119	6,944	317,688	13,714
Lebanon	-	***	***	***	***	***	***
Libyan Arab Jamahiriya	-	***	***	***	***	***	***
Malta	-	***	***	***	***	***	***
Monaco	-	***	***	***	***	***	***
Morocco	-	***	***	***	***	***	***
Spain	1983	9,500	23,250	41,000	5,890	14,415	25,420
Syrian Arab Republic	-	***	***	***	***	***	***
Tunisia	-	***	***	***	***	***	***
Turkey	-	***	***	***	***	***	***
Yugoslavia	1982	12,500	58,000	40,000	7,750	35,960	24,800

*** Data unavailable

Source: International Road Federation: World Road Statistics, 1979-1983. 1984 edition, pages 80-98.

Table 3.12

Estimated used crankcase oils in the Mediterranean Region

CARS

Assumptions:	1 Oil change per year	
	5 litres of oil per change	
	55,704,698 Estimated total number of cars registered	
	$5 \times 1 \times 55,704,698 =$ litres lube oil per per year	
Therefore:	278,523,490 litres of used lube oil produced per year	278,523,490 litres

Total number of "Trucks and Buses" registered = 8,421,177

TRUCKS/PICK-UPS : 5,116,707 (60.76% of total)

Assumptions:	every 3 months 1st oil change 7 litres
	every 6 months 2nd oil change 11 litres
	1st oil change $7 \times 4 \times 5,116,707 =$ litres lube oil per year
	2nd oil change $11 \times 2 \times 5,116,707 =$ litres lube oil per year

Therefore:	1st oil change = 143,267,800 litres	
	2nd oil change = <u>112,567,557</u> litres	
	255,835,357 litres	255,835,357 litres

TRUCKS/BUSES : 1,567,181 (18.61% of total)

Assumptions:	every 2 months 1st oil change 15 litres
	every 3 months 2nd oil change 26 litres
	1st oil change $15 \times 6 \times 1,567,181 =$ litres lube oil per year
	2nd oil change $26 \times 4 \times 1,567,181 =$ litres lube oil per year

Therefore:	1st oil change = 141,046,294 litres	
	2nd oil change = <u>162,986,828</u> litres	
	304,033,122 litres	304,033,122 litres

TRUCKS/TRUCKS : 1,737,289 (20.63% of total)

Assumptions:	every 4 months 1st oil change 11 litres
	every 6 months 2nd oil change 64 litres
	1st oil change $11 \times 3 \times 1,737,289 =$ litres lube oil per year
	2nd oil change $64 \times 2 \times 1,737,289 =$ litres lube oil per year

Therefore:	1st oil change = 57,330,531 litres	
	2nd oil change = <u>222,372,968</u> litres	
	279,703,499 litres	<u>279,703,499</u> litres
		1,118,095,468 litres

NOTE: The Registration figures are broken down into only two categories, "Cars" and "Trucks and Buses". The latter category has been broken down into assumed percentages.

3.3.5 River discharges

Examination of the input of hydrocarbons to the Mediterranean indicated that river discharges may be an important hydrocarbon input. The major sources of hydrocarbons in rivers are the untreated and treated wastewater discharges, runoff (both urban and rural) and spills. Insufficient data exist to quantify river discharge quantities of oil into the Mediterranean.

3.4 Levels of used lubricating oils in the marine environment

There is some reported data about levels of petroleum hydrocarbons in the Mediterranean Sea in general, but little about what proportion might be attributed to used lubricating oils, as distinct from other possible sources. High molecular weight hydrocarbons averaged 6.9-25.8 micrograms/litre (ug/l) in the Mediterranean in 1974-75, with highest concentrations in the Alboran Sea and the area off Libya (32). Other studies indicate a range of 1-195 ug/l (33). The mean density of floating tar in the Mediterranean was 10 mg/square metre and the total was 25,000 tons according to several studies during the 1970's (34). Concentrations apparently declined in the Ionian Sea but increased in the Alboran and Tyrrhenian Seas (35). Most pelagic tars that have been analysed appear to have come from tanker sludge residues, weathered crude oil, fuel oil residues and other residues of indeterminate origin (36). Tar substances contained in industrial effluents in Villefranche Bay in the 1960's resulted in bottom sediments containing 500 ug/100 g of benzopyrenes at a depth of 8-13 centimetres and 1.6 ug/100 g at a depth of 200 centimetres (37). These last mentioned levels are presumably the result of used lubricating oils.

Surface samples in the Adriatic showed 4,000 ug/l, Liguro-Provencale samples averaged 560 ug/l and in the Aegean Sea surface samples contained 1,700 ug/l (38). "In effect, the Mediterranean is considered to be the most oil-polluted sea in the world for which data are available. The largest source of this pollution is land-based discharges, which contribute 45% of the total input. Marine transportation accounts for an additional 35%, atmospheric rainout adds 10% and natural seepage is thought to contribute another 10%....An estimated 115,000 tonnes per year are reported to be entering the Mediterranean from industrial discharges in the coastal zone....Regional effects of oil pollution may be particularly important in terms of oxygen supply to the Mediterranean. The northern Adriatic, the Aegean and the Liguro-Provencale basin are the "lungs of the Mediterranean". These areas are currently being subjected to high levels of oil pollution, due to heavy industrialization, which may affect the ecology of the whole Mediterranean Sea" (39).

Information about levels along the coasts are much more important than general levels of petroleum hydrocarbons at sea because that is where human and biotic exposure is highest and impacts on sensitive areas such as estuaries are greatest. The effects of such exposure and impacts are summarised in section 3.6.

3.5 Fates of used lubricating oils in the marine environment (40)

What happens to oil when it is introduced into the marine environment, that is, what physical, chemical and biological transformations occur? Chronic discharges of oil are a much greater source than oil spills (41), but the oil from these sources is more dispersed and less concentrated than from spills. Therefore, the fates of oil from spills have more often been studied

and reported, although they do not differ essentially from the fates of chronically discharged oils, including used lubricating oils. Specific fates of course depend on the specific properties of the oils discharged, that is, on their density, viscosity, solubility, etc., and these properties change over time as the physical, chemical and biological processes have their effects.

3.5.1 Physical and chemical fates

Oil on the surface of the ocean is transported as a result of the winds over the water or the currents in it, or both. These physical processes are called advection. It is also transported by spreading processes that depend on the interaction of gravity, inertia, surface tension, friction, etc. The effects of these processes vary with the thickness of the oil on the water surface.

Evaporation changes both the physical and chemical properties of oil. Rates of evaporation depend on the area involved, i.e. how much the oil has spread, wind speed, the composition and temperature of the oil and the relative activity of the water. Evaporated oil is oxidised photochemically.

Dissolution of oil depends on the water solubility of its components, and low molecular weight aromatic hydrocarbons (e.g. benzene, toluene, xylenes) are the most soluble. They are also the most volatile, so the more they evaporate the less they dissolve, and many evaporate even after they have dissolved or are subject to photochemical oxidation in the water. Because the most soluble compounds, the simple aromatics, are also the most toxic their effects on the biological systems of the marine environment are disproportionately higher than their amounts.

Oil on the surface is also subject to vertical dispersion, i.e. transport downward into the water in small droplets or emulsions. This exposes subsurface organisms to dissolved oil. Some of this oil may be deposited as sediment in faecal pellets. Formation of emulsions, in particular, depends on the chemical composition of the oil involved. High viscosities and the presence of asphaltenes and higher molecular weight waxes correlate with greater emulsion stability. Light distillates (e.g. gasoline) and light lube oils generally do not form stable emulsions.

Undissolved oil may also be photo-oxidized. The products and effects of this process depend on the condition of the oil and the nature of the light it is exposed to.

In addition to sedimentation in faecal matter, oil may be adsorbed onto mineral particles in sea water and settle as sediments. Oil may also be mixed directly with sediments by water action.

3.5.2 Biological fates

Oil compounds, especially alkanes and simple monoaromatics, are biodegraded by micro-organisms (bacteria, yeasts and fungi). One-celled algae are also able to metabolize some hydrocarbons. Invertebrate and vertebrate animals do not utilize hydrocarbons as a source of carbon, as micro-organisms do, but they do take them up from water or via their food, especially if they are dissolved or adsorbed onto sediments. Bivalves (e.g. mussels, oysters, clams) accumulate hydrocarbons in their tissues and eliminate them only incompletely. Crabs and lobsters take them up too, but metabolize them

differently. Fish take in oil compounds via their gills and concentrate them principally in their liver and nerve tissues. It is possible that young fish are more susceptible to toxic effects from oil than adults. Birds take in volatile compounds via their lungs and other compounds via absorption through the gut, e.g. after preening. Mammals, e.g. seals, also absorb hydrocarbons via skin or lungs and via their diets.

The rate of biodegradation of oils depends on the components and their toxicity, the temperature of the water and the availability of oxygen and mineral nutrients. Previous exposure of the environment to hydrocarbons enhances the rate of biological degradation. Metabolism of some aromatic hydrocarbons converts them into toxic, mutagenic and carcinogenic derivatives.

Used lubricating oils disposed of on land or in surface waters are also subject to evaporation, dissolution, adsorption and biodegradation. Some also leach or flow into groundwaters.

3.6 Effects of used lubricating oils on the marine environment

Like crude oil, refined oil contains paraffin hydrocarbons (alkanes), naphthene hydrocarbons (cycloalkanes), and aromatic hydrocarbons (42). Refined lubricating oils generally are composed of 20-40% paraffins, 30-55% naphthenes and 15-45% aromatics (43). Effects on the marine environment of used lubricating oils are attributable both to the hydrocarbon compounds in the oil and to the additives and contaminants the oil contains. There is by now a vast body of research on the effects of differing petroleum hydrocarbons under various circumstances (44). Literature concerning the effects of additives and contaminants in oils on the marine environment is more limited. In order not to trespass on the IOC assessment of petroleum hydrocarbons, this section only summarizes the effects of petroleum on the marine environment briefly, to give an indication of the similar effects caused by the oil components of used lubricating oils. Typical contaminants contained in used oils are listed and their effects are indicated briefly.

Oil has effects on biological processes. Chromosome mutations sometimes occur, at least in fish. Development and reproduction are interfered with, e.g. egg hatches are reduced and larval fish backs become crooked. Pathological effects also occur, e.g. lesions on eyes. Physiology and metabolism of both plants and animals are affected, e.g. photosynthesis is inhibited in phytoplankton and animal feeding, and respiration and growth are disturbed. The behaviour of micro-organisms and higher organisms alike is influenced, e.g. by avoiding petroleum contamination or as a result of interference with chemoreception.

Petroleum also affects the marine food web. The effects vary with the type and amount of oil, the nature of the impacted area (e.g. open sea vs. estuarine marsh), the nutritional status of the organisms, oxygen concentration and the previous history of exposure of the area to hydrocarbons. All levels of the food chain are affected: micro-organisms, plankton, intertidal and subtidal plants, intertidal invertebrates, some of which are of economic significance as human foods (e.g. bivalves and crustacea), fish (especially during larval stage), including tainting that reduces their marketability. This also applies to invertebrates such as oysters, lobsters, clams and mussels, mammals (seals, whales and polar bear, for example), and birds (increased mortality due to loss of insulation and waterproofing from feathers).

Oil pollution affects ecosystems, chiefly by altering food web relationships (e.g. by depletion of certain species) or competition for space. Wetlands, marshes and estuaries are especially vulnerable. Many plants and animals are subjected to toxic effects or smothered, with resulting reductions in population and growth rate. Species diversity declines, opportunistic species burgeon and then crash from overproduction, gradually stability returns. Bays and estuaries are particularly subject to damage from chronic pollution by low concentrations of hydrocarbons (45). Coastal and offshore areas are not as severely impacted, but shifts towards predominance of nanoplankton and a food web based on detritus have been observed.

There are some concerns that long-term exposure to oils containing carcinogens, e.g. by eating seafoods contaminated with polyaromatic hydrocarbons (PAH's), e.g. benzo(a)pyrene, may enhance the risk of human cancer. "PAH's enter into the marine environment from a wide range of sources, including surface runoff from land, atmospheric fallout and rainout, as well as from the more traditional sources of spills and discharges of petroleum. A major contributor of PAH's is the direct combustion of fossil fuels, i.e. gasoline and diesel-powered vehicles, electrical and heat-generation operations, catalytic cracking of crude oils in refining and related industrial processes, and refuse burning. Most significant in the formation of PAH's are those processes that utilize high temperature pyrolysis of organic material" (46). In addition, used motor oils have been found to be mutagenic in aquatic environments (47).

There is also concern that synergisms between oil and other contaminants may enhance the toxicity of each. The contaminants most frequently found in used lubricating oils are polynuclear aromatic hydrocarbons, chlorinated hydrocarbons, PCB's, nitrosamines, lead, barium, chromium and cadmium. Each of these contaminants has been determined to pose sufficiently serious risks to warrant water quality criteria for marine aquatic environments and human health in the United States (48).

4. MEASURES TO PREVENT AND CONTROL POLLUTION BY USED LUBRICATING OILS IN THE MEDITERRANEAN

4.1 Alternative ways to use or dispose of used lubricating oils

Used lubricating oils may be either re-used or disposed of. They may be re-used as lubricants and as fuels or fuel supplements and for miscellaneous other purposes. Disposal possibilities range from indiscriminate dumping to hazardous waste treatment.

Re-use as a lubricant may involve re-refining the oil to remove impurities and adding new additives to make the re-refined oils suitable for specified purposes, or it may simply involve a less demanding application of the used oil to consume the remaining lubricant properties. Re-use as a fuel may occur in public solid waste or sewage treatment plant sludge incinerators. Used lubricating oils may be blended with fuel oils as a fuel supplement, after they have been treated to remove water, volatile components and suspended solids (usually called "reprocessing"), and then burned in electric power plant steam boilers or cement kilns or other industrial process or used to heat greenhouses, warehouses, etc. Used lubricating oils may also be used as a component in making asphalt, spread to keep down dust on parking lots or roads, or painted on concrete forms or timbers.

Disposal may be into the garbage or a landfill, onto an unused lot of land, into a sewer, by open burning, or in accordance with hazardous waste treatment requirements, e.g. high temperature incineration or special landfilling. Land treatment is also possible, i.e. spreading the used oil over the ground in controlled quantities and cultivating the ground so that the oil may be biodegraded.

4.2 Cost-benefit analysis of used lubricating oils collection and re-utilization

Whether and how used lubricating oils are re-used or disposed of is, absent any government regulation or incentives or public services, entirely a matter of the costs of collecting and preparing the oils for re-use and the prices paid for the alternative uses. Although the specific costs and prices are determined by supply and demand in relatively localized markets, they ultimately depend on the world oil economy. Generally, when the price of crude petroleum is high, there is more demand for used oil and better prices can be obtained for products made from it. When the price of crude petroleum is low, however, products made from virgin oil are less expensive and there is correspondingly less demand for products from used oil and, hence, less used oil collected for re-use.

Uncounted in the costs and prices upon which decisions about whether and how to collect, re-use and dispose of used oils by private firms and persons are based, are the costs to the public, i.e. to society, of environmental damage resulting from these decisions. Environmental damages also have costs, although they are often not quantified. If used lubricating oils are disposed of by dumping them on land, for example, the costs may be loss of arable soil, contamination of ground water that serves as a source of drinking water and pollution of surface fresh and marine waters and harm to the living organisms in them. Similarly, used oil burned as a fuel or fuel supplement with little or no effort to remove contaminants either before or after burning causes pollution of the air from emissions of these contaminants or their by-products, e.g. lead, with consequences to public health. How high the

costs of environmental damage are depends on how much oil is involved, what contaminants it contains, how it is re-used or disposed of, and where it happens. These costs too, will vary with local circumstances. To prevent or limit them, as well as to conserve the oil resource itself, are the principal purposes of government intervention by imposing regulations or by providing public services or incentives in order to influence private decisions about used oil collection, re-use and disposal.

The costs of collecting used lubricating oils depend on how much oil is generated in an area and of what quality, how many collection points exist, how big the truck (or other means of transportation) is that is used to collect the oil, what the costs of operating the truck and the company that owns it are and how often it is collected. If the demand for used lubricating oils is high the collector might be willing to go further to collect them or incur the additional cost of paying the generator for the used oil on the grounds that the prices that can be obtained from selling it exceed the total costs, leaving it profitable to collect the oil even with those payments. If the demand for used oils is low, however, a collector may charge for his services. This may encourage the generator to dispose of (or use) the oil in ways that cost less than these charges. Low demand (or highly contaminated oil) may also make it difficult for the collector to sell the used oils and give him an incentive to dispose of inexpensively what he has collected. In part to avoid environmentally damaging disposal, many governments regulate collectors, thus adding the costs of compliance with the regulations to the costs of collection.

Assuming the collector is independent, i.e. not owned by a business that prepared used oils for re-use, where he sells his oil depends on what prices he is offered for it by those competing to obtain it for alternative re-uses. If virgin fuel oil in a locale is expensive, a person who inexpensively reprocesses used oils to sell them in turn as fuel supplements may be able to bid higher for the used oils than a person whose higher costs to re-refine the oils into new lubricants prevent him from paying as much as the reprocessor for the feedstocks because he would not be able to sell his re-refined product at a profit.

Unlike used automotive lubricating oils, used industrial lubricants tend to vary in composition, with the result that collectors are less willing to collect them and the industries are more inclined to segregate and collect their own oils for one kind or another of re-use or disposal.

Whether used oil is reprocessed for burning or re-refined for lubricants or disposed of again, absent any government intervention, depends on whether it is profitable to prepare the oil for re-use. Re-refining, for example, incurs costs for labour, chemicals, energy, plant maintenance, waste disposal, taxes, insurance, and for the used lubricating oils as feedstocks. These costs vary with the re-refining process employed. Although filtering and heating used oils to prepare them for sale as a fuel supplement is less expensive than re-refining, whether a firm purchases them depends in turn on calculations by the firm of whether the increased costs of maintenance of burning equipment and of pretreatment or air pollution control exceed the savings of not buying the relatively small percentage of virgin fuel oil for which the reprocessed used oils would substitute. In some circumstances a collector may find he is offered the highest price for used oils by those who want to re-use them, without incurring any preparation costs, to suppress road dust or stabilize sandy soils.

To go beyond this general discussion of the trade-offs involved in used lubricating oil collection, re-use and disposal requires detailed data about environmental damages (and their costs), the costs of collection and preparation and the prices offered for various products made from used oil or charged for different ways of disposal in particular regions and at specific times (49).

4.3 Collection systems

In the circumstances just described, i.e. where collection of used lubricating oils is not provided as a public service or encouraged by fiscal incentives (e.g. subsidies or tax measures) or required by regulation, small independent oil collectors will flourish where and when demand for used oils is high and decline under contrary conditions. These opportunistic entrepreneurs compete with longer-established collection businesses, also often small, that respond to service calls, or enter into contracts to provide regular pick-up or delivery services, or visit generators who usually have considerable quantities of used oils.

As a means of stabilizing their supplies of feedstocks, some re-refining and re-processing enterprises have established their own collection services.

Unlike used automotive lubricants, which by the nature of their sources are both dispersed and mixed with one another (although not with other wastes), used lubricants from industrial sources are more concentrated and more susceptible to segregation. Collection of different industrial lubricants and ease of recycling them are both promoted by establishing in-plant collection areas for each kind as well as separate sewers for process wastes, sanitary wastes and storm runoff wastes. In existing plants where separate sewers may not be practical, traps can be established to catch most of the used lubricants before they mix with other wastes.

Various special arrangements may be made by sources that regularly generate large quantities. Industrial firms often segregate, collect and ship their used oil in a closed loop arrangement with a particular re-refiner who returns a product that meets agreed-upon specifications. Collection services may be provided by the re-refiner or the firm may transport the used oil itself. Transport is usually least expensive by truck, but sometimes it occurs by rail or barge. Occasionally the oil is carried by pipeline, e.g. where land treatment is the disposal method.

A special problem is presented by individuals who prefer to change the oil in their cars themselves. It is usually inconvenient for the person to take the crankcase drainings to a service station or garage and often people who do make that effort are not welcome. Both voluntary and government-sponsored programmes to enlist the cooperation of such places in serving as collection centres and to publicize their locations have been undertaken as one response to the phenomenon of self-changers, which is an increasing phenomenon in some areas.

Because the adequacy of collection is both vulnerable to changing economic conditions and essential to preventing environmental damage and waste of resources caused by improper disposal, many governments have decided to provide or support collection systems. Regular household pick-up, similar to newspaper or garbage collection, is one form of such public service, and establishment and maintenance of central collection points is another. Some governments enter into contracts obligating the contractors to pick up all or

minimum quantities of used oils within specified districts so long as they do not contain specified kinds or levels of contaminants (sometimes these contracts specify where the contractor must take what he collects). Waste exchanges are operated by some governments as a means of promoting the sale of materials, often from industrial production processes, from firms that regard them as wastes to those that view them as resources, thus preventing entry of the materials into the waste stream. A few governments arrange for special boats that can pump out oil bilges at harbours and ports.

4.4 Present national legal, administrative and technical measures relevant to the Mediterranean

Several surveys have been published of legislation in nations bordering the Mediterranean that is relevant to land-based sources of pollution in general (50). The questionnaire prepared in connection with this assessment has requested copies of laws, regulations and directives that apply, or could be applied, to define used lubricating oils and to control their generation, collection, storage, transport, disposal or re-use in order to have complete and up-to-date information specific to the subject. Such laws could relate to air and water pollution control, waste management, regulation of industrial plants or transportation service facilities, soil or ground water protection, coastal zone or marine environment protection, fire prevention or general public health, in addition to used lubricating oils themselves. The following summaries of the legal authorities or administrative measures of each nation are based on the existing surveys cited, except where other noted, e.g. where copies of existing legislation or information about experience under it are available.

4.4.A Algeria

Law No. 83-03 of 5 February 1983 on environmental protection requires that "establishments used for industrial, commercial ...purposes ...be ...operated...to comply with provisions made... to avoid atmospheric pollution" in a decree (51).

It also authorizes decrees determining "the conditions for regulation or prohibition... of direct or indirect discharges, runoff, disposal or dumping of water or of materials and... any act liable to adversely affect the quality of surface waters, any groundwater or coastal waters". It authorizes decrees determining "the conditions for the regulation of the placing on sale and distribution of certain products liable to give rise to discharges... prohibited or regulated" in accordance with the decrees described in the preceding sentence or "liable to increase the harmfulness... caused by such discharges".

The law states that it is prohibited to "discharge, dump, or incinerate at sea materials... that are liable to be prejudiced to public health and to biological resources, to hinder maritime activities, including... fishing, to adversely affect the quality of seawater, from the standpoint of its use, or to harm the amenity value of the sea". A list of such materials shall, if necessary, be laid down by regulatory texts. The Minister for Environmental Protection may, after public inquiry, authorize such discharges, dumping, or incineration "under conditions... guaranteed to be harmless and entail no nuisances, and shall determine the time limit within which the prohibition... shall apply" to existing intentional discharges or dumping operations.

Factories, workshops or other installations that "may cause hazards to or adverse effects on... the amenity value of the neighbourhood, health, safety or public hygiene, agriculture, the protection of nature and the environment, or the conservation of sites and monuments" shall be defined in a List of Classified Installations which shall be laid down by decree. The decree shall subject the installations to "licensure or notification depending on the seriousness of the hazards or adverse effects entailed by their operation". The decree applies automatically to new installations and shall specify "the time limits within which it shall apply to existing installations and the conditions governing such application". Licenses may be granted, after public inquiry, only if hazards or adverse effects "are eliminated or prevented by measures specified in the order" made by the Minister for Environmental Protection. The Minister may inspect all classified installations except those under the jurisdiction of the Minister of National Defense.

Any person who produces or possesses wastes, defined as "all residues from a process of production, conversion, or use of any substance, material, or product," under conditions that "produce harmful effects on the soil, flora and fauna, cause deterioration of sites or the countryside, pollute air or water, cause noise or odours and, in general, adversely affect human health and the environment, shall be required to dispose of or arrange for the disposal of the wastes "in a way that avoids these effects". "Disposal of wastes" includes "the collection, transport, storage, sorting and treatment necessary for the recovery of energy or of reusable elements and materials, and the dumping in or discharge into the natural environment of all other products under conditions suitable for preventing the nuisances mentioned. Producers or importers must establish that wastes derived at any stage from the products they produce or import may be disposed of under the conditions specified in the law, and the Ministers for Environmental Protection is authorized to obtain information on procedures for disposal and the consequences of utilization of products. Manufacture, possession for sale, placing on sale, sale, and supply to the consumer of products that generate wastes may be regulated to facilitate the disposal of the wastes, or prohibited. Producers, importers and distributors of such products, or of materials used in their production, shall be required to provide for or contribute to the disposal of wastes produced. Persons possessing wastes from such products shall be required to convey them to establishments or services specified by the Minister for Environmental Protection. Waste disposal installations are subject to the provisions applicable to classified installations summarized above. Waste disposal practices, in the stages set forth in section 90, must be carried out under conditions that facilitate the recovery of materials or of reusable forms of energy.

Under Title II of Decree No. 81-267 of 1 October 1981 the chairman of the communal people's assembly is responsible for arranging for wastewater treatment and eliminating pollution.

4.4.B Cyprus

The Foreshore Protection Law of 7 December 1934, as amended in 1961 and 1964, authorizes the District Officer to prohibit or limit dumping of engine oils or any other fluid lubricating oil (as well as liquid ballast) on any specified part of the foreshore, into the sea within a specified distance from the low water mark, or from any pier, wharf, quay, etc.

Section 5 of the Public Rivers Protection Law of 19 May 1930, Ch.82 of the Laws of Cyprus, authorizes the District Officer to prohibit or impose conditions on the dumping of any refuse in the bed or on the banks of any river.

Section 8B of regulations dated 22 July 1971 under the Fisheries Law of 15 May 1931, Ch.135 of the Laws of Cyprus, prohibit the contamination of maritime or surface waters by substances that may have a direct or indirect adverse effect on the development or survival of fish.

Under the Municipal Corporations Law of 10 June 1930, Ch.240 of the Laws of Cyprus, municipalities may take legal proceedings against a person who pollutes so as to create a health hazard.

4.4.C Egypt

Section 1 of Law No.13 of 28 August 1904 on troublesome, unhealthy and dangerous establishments provides that activities considered unhealthy require a licence from the Ministry of Public Health.

The order of the Cairo Governorate of 13 October 1924 restricts dumping of wastewater and garbage into the zones of the Nile or on its banks.

Section 2 of Law No.196 of 30 April 1953, as amended by Law No.33 of 1954, requires a license for the discharge of industrial and certain categories of domestic wastes into the Nile, other water courses, canals, drains, ponds or marshes.

The Oil Pollution Regulations impose obligations on port refineries, including a requirement that they report any accident that has caused serious pollution in harbours and territorial waters.

Order No.56 of 11 January 1962 provides for protection of harbour and territorial waters from oil pollution, though perhaps only from ships.

Law No.35 of 1946, as amended by Law No.645 of 1954, applies to discharges of industrial wastewaters into public sewers.

Chapter I of Law No.93 of 1962 on the discharge of liquid wastes, as implemented by regulations contained in Decree No.649 of 1967, requires a license for the discharge into public sewers from public places and from industrial or other establishments specified by the Minister of Housing and Utilities upon his determination that the establishment observes applicable health regulations. The license specifies wastewater characteristics in accordance with standards of the Ministers of Housing and Utilities and of Health. The sewage authority may require elimination of the cause of the discharge that causes a public health or similar hazard.

Chapter II of Law No.93 governs discharges into watercourses of public sewage and from private buildings and industrial establishments. Local authorities representing the Ministries of Health, Public Works and Industry must approve the discharges, after consulting the sewage authority. The sewage authority may issue a license if the wastewaters can be assimilated by the watercourse. Wastewater characteristics are specified for discharges into watercourses as they are for those into public sewers.

The regulations in Decree No.649, mentioned above, require the construction of traps in industrial establishments and garages for oil. They also authorize the sewage authority to require pretreatment of wastes that would be harmful to the sewage system. The decree also specifies standards for wastewaters discharged into different classifications of watercourses and into public sewers: industrial wastewaters discharged into the Nile (Class A) or drainage canals (Class B) may not contain more than 10 mg/l of oil and grease. For Class A waters, the discharges may not contain any materials that may adversely affect fish or other aquatic organisms or which may adversely affect the quality of water for drinking or other domestic purposes. For Class B waters, discharges must not exceed standards for several metals, including lead. Seas and lakes are Class C waters. Discharges into Class C waters may not contain matter that may adversely affect beaches, marine installations, shellfish breeding areas, fish or other aquatic organisms. Wastewaters discharged into public sewers may not contain more than 100 mg/l of oil and grease, or any substances liable to be harmful to fish, or any materials with a flash point lower than 85 °C.

Section 9 of Law No.74 of 1971 on irrigation and drainage prohibits dumping of any substances harmful to health into any watercourse used for irrigation and drainage.

4.4.D France

France is a nation with a long history of preferring the re-refining of used lubricating oils (53). Most recently, as a member of the European Economic Community, France has complied with the requirements of the Council Directive of 16 June 1975 on the disposal of waste oils (54). Briefly, this directive requires member states to ensure the safe collection and disposal of waste oils, as defined in the directive (55). Disposal is to be carried out by either regeneration (i.e. re-refining) or combustion (i.e. burning) other than for destruction or both. Discharges into internal surface waters, ground water, coastal waters and drainage systems are prohibited, as are deposits or discharges harmful to soil, uncontrolled discharges of waste oil processing residues, and waste oil processing that violates existing air pollution standards. Member states must ensure that one or more enterprises collect and/or dispose of waste oils offered by holders, "where appropriate in the zone assigned to them by the competent authorities". Disposal enterprises must obtain a permit, with conditions required by "the state of technical development", and both collection and disposal enterprises must carry out their operations without "avoidable risk of water, air or soil pollution". Persons holding waste oils who cannot comply with the prohibitions mentioned above must offer them to a collector or disposer and holders of waste oils with more than fixed quantities or percentages of impurities must handle them separately. Establishments that produce, collect and/or dispose of more than a minimum amount of waste oils per year (fixed by each member nation and limited by the directive to not more than 500 litres) must "keep a record of the quantity, quality, origin and location of such oils and of their dispatch and receipt, including the dates of the latter and/or convey such information to the competent authorities on request" (55). Disposal enterprises are to be inspected periodically. Where a nation assigns enterprise zones of collection or disposal it may grant them "indemnities" for their services not to exceed "annual uncovered costs actually recorded by the undertaking, taking into account a reasonable profit". The indemnities may be financed by charges imposed on products that become waste oils after use.

France has implemented the EEC Directive by Decree No.79-981 of 21 November 1979, although the definition of used oils excludes oil-water emulsions and tank residues, which are regulated under other waste management laws (56). Used oil generators are required to collect used oils, store them so as to avoid their contamination, and give them to approved collectors or, with prior authorization, to approved disposal facilities. Approvals, in the form of agreements, are issued by the Ministry of the Environment that include requirements for environmental protection and for what must be done with the used oils collected. Also with prior authorization, a generator may dispose of used oils on its own. France requires that used oils be re-refined into a lubricant where economically feasible. Special permission is required for burning used oils that are unsuitable for re-refining as a fuel, although unauthorized burning as a fuel is reported to be substantial (57). France has assigned one licenced collector exclusively to each department. The collector assigned may subcontract collection of up to 30% of the volume in his department. Some large collection companies have franchises for collection in several departments (in industrial areas there are some unauthorized collectors (58)). All amounts over 200 litres must be collected within 15 days of notice and they must be given as directed by ANRED (59), the national agency for recovery and disposal of wastes, almost always to one of the nearly forty re-refiners.

Until March 1985, prices for motor oils, compressor oils and gearbox oils were fixed by decree on a sliding scale, depending on amounts to be collected, and the market set prices for transformer, turbine and transmission oils. This system was abandoned when the European Court of Justice held the French prohibition on export of used oils inconsistent with the Treaty of Rome establishing the Common Market (quite a bit of used oil generated in France had been exported to places where its use as a fuel was not so restricted and it brought higher prices than had been established. The only imports were from enterprises in Luxembourg under contract (60)). Now it is only required that prices for collection transactions be published.

Collectors must report monthly to the Ministry on volumes collected, supplies, costs and amounts delivered to disposal facilities and must give receipts to generators from whom they collect. Disposal facilities must keep records on dates of receipt, amounts, origins and characteristics of used oils received, and dates, amounts and characteristics of re-refined oils produced, and their destinations. From July 1, 1979 to December 31, 1981, France levied a tax on new and re-refined oils placed on the market that financed grants to used oil generators, collectors and disposal facilities for investment in storage, collection and treatment facilities (61). This decree also abolished tax preferences for re-refined products. Re-refiners also received a subsidy for each ton re-refined during this period. A subsidy to re-refiners was restored on a temporary basis in 1985 in order that they could compete for used oils that were being purchased for use as fuels. Increased efforts to enforce the prohibition on burning were also announced. France also spent 2.2 million francs for public education in 1980.

France also has legislation specifically prohibiting discharges of used (and new) oils into waters (62) and limiting emissions of air pollutants from used oil burning (63). Disposal of process wastes, sludges and emulsions must be in accordance with Law No.75-633 of 15 July 1975 on waste disposal and with the Law of 19 July 1976 on classified installations. The former law defines wastes in Article 1 as "all residues of an operation involving manufacturing, processing or use of any substance, material, product, or... all abandoned goods or goods that their holder intends to abandon". Article 2 imposes an

obligation that "everyone who produces or holds waste... is required to ensure that it is disposed of under proper conditions and to avoid (harmful) effects". Certain industrial wastes, including those constituted principally of hydrocarbons, those arising from petroleum refining, and polychlorinated biphenyls, must be disposed of by approved treatment installations (64). Industries that generate such wastes may be required to keep records and file reports on them and to complete a declaration when they are transported on how they will be disposed of.

Industrial discharges into public sewers must be authorized by the community and may be subject to pretreatment requirements (65). Discharges to watercourses require a permit under the Law No.64-1245 of 16 December 1964: "All direct or indirect discharges, flows or deposits of water or matter generally liable to alter the quality of surface waters, groundwaters, or the water of the seas within territorial limits" are subject to authorization (66). Article 2 of this law prohibits "discharges or deposits into the waters of the sea or any kind, particularly industrial and atomic wastes liable to result in damage to public health, as well as the underwater flora and fauna, and to endanger the economic and tourist development of the coastal regions". Authorizations to discharge are granted where the substances involved can be guaranteed to be harmless, under conditions concerning amount of waste, flow, receiving water characteristics, etc. Again, the Decree of 8 March 1977 prohibits the discharge of used oils and lubricants into watercourses and sea waters.

4.4.E Greece

Law No.743 of 13 October 1977 (67) applies to pollution of ports, coasts and territorial waters of Greece by installations, vessels or tankers. Installations are defined to include oil refineries, oil installations, shipyards, ship repairing units, industries and plants of any kind, situated near the coast or using the coast for their functional needs or having an important and direct effect on the marine environment. Discharge of any waste or sewage that may cause pollution is prohibited in ports, and coastal and territorial waters. "Pollution" is defined as presence in the sea of any substance which alters the natural condition of sea water or renders it harmful to human health or fauna and flora of the sea or, in general, is inconsistent with its intended uses. "Discharge" is defined as runoff or release, "waste" as solid or semi-liquid wastes of any nature discharged from ships, tankers and land-based installations, and "sewage" as liquid wastes of installations or industries whether or not they contain residues of substances used or produced by them. Discharges into the sea require a permit, which is granted "if there is no danger of pollution" (68). Installations where oil is transferred or ships are repaired must have reception facilities adequate to receive oils, oil mixtures and other pollutants without delay and must take all necessary measures to avoid pollution. Terms and conditions for the approval of shore reception facilities, i.e. installations to receive and dispose of residues, oil mixtures, toxic substances and sewage from vessels and tankers, are fixed by joint decision of the Ministers of Industry and Power and of Merchant Marine (with the cooperation of Public Works and Social Services if land-generated liquid or solid waste and sewage are involved). Reception facilities must have the same permit as is required for industrial plants (69).

Sanitary Regulations Elb/221/1965 of 22 January 1965 establish water quality standards in Section 4 based on the intended uses of classes of surface waters and sea waters. A standard common to surface and sea water

classes 1-4 is "no toxic or otherwise harmful wastes or oily... wastes which either alone or in combination could render the waters... unsuitable for their intended uses". Class 5 surface waters may not contain oils in quantities that cause nuisance, contamination or other damage. Another common standard is that "there must be no... oils... from sewage or industrial wastes". Section 5 of the Regulations provides that discharges of sewage or industrial wastes must have a permit, and be treated so that receiving waters are not made unsuitable for their intended uses. Section 2 requires that all necessary steps have been taken to prevent hazards to public health, interference with natural self-purification, and economic losses in general. The prefects decide whether applications for permits are granted, upon the recommendation of a committee of affected communities and responsible authorities. Sections 7 and 8 require licenses for disposal of sewage and industrial wastes onto or into the ground. They prohibit such discharges into wells or onto ground with fissures or holes, and authorize them if the ground is porous at a specified distance from the disposal point to any waters. Private waste disposal systems are governed by Section 9, which includes provisions for grease interceptors.

Sanitary regulations Gl/18464/1969 of 4/29 September 1969 (70) elaborates on the 1965 regulations summarized above with respect to protection of the Athens water supply. Direct or indirect discharges of oil upstream of water supply treatment plants are prohibited by Section 2, and discharges of sewage or industrial wastes are prohibited by Section 3 into two artificial lakes, Marathon and Iliki, or streams that flow into them. Drinking water quality in general is governed by Sanitary Regulations G3a/761/1968 of 6 March/10 April 1968 (71). Article 5 of these regulations specifies limits on levels of substances and compounds in drinking water.

The sanitary Regulation Elb/301 of 10 February 1964 concerning collection, transportation and disposal of refuse, i.e. solid waste, semi-solid materials, liquid wastes of dwellings, institutions, factories and other installations that are disposed of on land, provides that it must be collected by means that avoid unhealthy situations or nuisance (an obligation of the municipalities) and stored in special containers until carried away (72). No controls specific to waste oils exist.

4.4.F Israel

The Oil in Navigable Waters Ordinance of 1936, as amended in 1977, proscribes discharges of oil from installations on land, and establishes a Sea Pollution Prevention Fund.

The Ports (Prevention of Pollution) Rules of 1935, in Section 2, prohibit depositing of polluting substances into ports other than Haifa and Ashod. These two ports are covered by the Ports Authority Law of 1961. That law invokes the authority of the Minister of Transport to issue regulations under the Ports Ordinance to prohibit pollution of port waters or any place on land from which pollution may spread to a port, waterway or navigable river. Section 172 of the Port Regulations of 1971, as amended, prohibits the flow of drainage water into a port or place from which it may reach the port. Any other substance that might pollute sea water may only be allowed by the harbour master under conditions he sets.

Sewage outfall pipes into the Mediterranean are regulated by the Territorial Waters Committee under the Building and Planning Law of 1965. Other provisions concerning sewage are contained in the Local Authorities (Sewage) Law of 1962, as amended.

Industrial discharges are controlled via the Water (Use of Water in Industry). Regulations of 1964 that require all industries that use more than 5,000 cubic metres/year and all whose effluents are polluting a water source to submit a plan for effluent discharge control for approval by the Water Commissioner. The Licensing of Businesses Law of 1968, as amended, requires businesses designated by order to have a license in order to ensure environmental quality. An approved plan for waste removal and treatment is a condition of obtaining a license.

Water pollution is controlled under the Water Law of 1959, as amended. It covers discharges that may cause pollution (i.e. change in water properties) from industrial establishments, buildings, sewage treatment plants, machines or means of transportation. It authorizes regulations concerning the location and establishment of specific sources of pollution, the use of certain substances or methods in production processes and the manufacture, import, distribution and marketing of certain substances and products. The Water Commissioner may require submissions of and approve a binding plan for disposal of wastes by sources of pollution.

4.4.G Italy (73)

Under the authority of Law 42 of 9 February 1982 delegating implementation of EEC directives to the government, Italy has implemented EEC Directive 75/439/EEC somewhat differently than France, although it too prefers that lubricating oils be re-refined. Presidential Decree No.691 of 23 August 1982 requires generators either to have a permit to use used oils as a fuel or to provide them to a disposal consortium. Generators must store oils so as to avoid contamination. Authority exists to establish levels of contamination by water and other substances above which the generator would have to treat the oils or pay for their treatment. The consortium must give priority to re-refining to produce base lubricants unless that is not technically possible or economically reasonable. Second priority is disposal methods allowing greatest recovery of energy. The consortium consists of all enterprises involved in producing re-refined or new lubricating oils and is responsible for organizing collection and disposal of used oils throughout the country. Article 2 of DPR No.691 requires disposal to conform to requirements of other legislation concerning protection of surface and ground waters, coastal waters, drainage systems, soils and air (74). All re-refiners must be licensed under the Petroleum Law. Chronological records must be kept on the volume, origin and location of oils by those who generate, collect or dispose of more than 500 litres a year. Uncovered costs of collection and disposal of used oils are to be financed by charges levied by the consortium on its members in proportion to the volumes of new and used lubricating oils imported or marketed. The tax advantage for products made from used oil was abolished in 1982 (75).

Discharges of any kind, public or private, direct and indirect, into surface waters (inland and marine) and groundwaters, into sewers, onto land and into subsoils, are controlled under Law 319 of 1976 and Law 650 of 24 December 1979. Manufacturing establishments, narrowly defined, and civil installations (including agricultural enterprises) must meet different limitations on discharges, and discharges (and enlargements of sources) must be authorized. Discharges into public sewers by manufacturing and civil installations must conform to limits established in regulations issued by the communities of consortia that operate sewage treatment facilities. Discharges of mineral oils into surface waters from new manufacturing installations may not exceed 5 mg/l. Existing manufacturing installations were to have met this

limit by 1985. From 1979 until then a limit of 20 mg/l applied. The limit of 10 mg/l also applies to discharges into public sewers by manufacturing installations during the period before sewage treatment plants are constructed. No similar limit applies to civil installation discharges during this period. Article 9 of Law 319 of 1976 provides that these limits may not be met by diluting the effluent with water extracted for that purpose. These and other limits do not apply to the contents of solid matters in sludge from treatment plants, but discharges of such sludge into coastal or territorial waters must conform to requirements set by the head of the Maritime Department and may not alter the marine environment so as to change its ecological structure or biological productivity, or endanger fishing, cause the spread of pathogens, damage aesthetics or possibilities for tourism, or inconvenience marine traffic.

The location of disposal of effluents on land or into subsoils is controlled by communities or consortia for industrial waste disposal. The limit of 5 mg/l set forth above for discharges containing oil into surface waters applies to discharges onto land, until local rules are promulgated, and in addition the discharges may not contain substances which alter the structure of the soil or its permeability, aeration or capacity for biodegradation. Discharges of sludges from manufacturing or treatment processes onto land may likewise not alter the chemical and physical structure of the soil, and must be treated to make them suitable for being deposited. Technical provisions of 4 February 1977 set forth parameters for assessing the amounts of oils and hydrocarbons in the sludge in relation to the characteristics of the land. Subsoil disposal is not permitted if it may damage groundwater.

Law No.366 of 20 March 1941 governs disposal of solid wastes generated in public areas and in homes and offices and includes provisions for recycling of usable industrial wastes. Rules for community collection in the law are supplemented by instructions from the Ministry of Health.

Article 71 of the Navigational Code prohibits discharges of any kind into port waters, while Article 76 requires managers of industrial installations or storage facilities located in wharves, quays or navigable canals to avoid fouling waters in accordance with orders of the head of the Maritime Department. Article 82 of the implementing regulations, DPR 328 of 15 February 1952, incorporates these provisions and extends them to waters beyond quaysides for cleaning operations that are to be conducted by whoever loads or unloads in port.

Article 15(e) of Law 963 of 1965 concerning fishing in marine waters, a criminal provision, prohibits discharges of substances which injure aquatic organisms or cause alteration of the environment in a way harmful to them. It has been applied to discharges of industrial process wastes, e.g. in Scarlino.

Italy and Yugoslavia have a 1977 agreement that provides for a joint commission to protect the Adriatic Sea and its coastal areas by studying problems of pollution and making recommendations for research and other provisions. Law 405 of 29 July 1981 provided financing for studies under this agreement. Italy, France and Monaco also have an agreement for the protection of Mediterranean waters in the Tyrrhenian Sea which came into force on March 1, 1981.

4.4.H Lebanon

Decree Law 2775 of 28 September 1928 concerning marine fisheries prohibits discharges of pollutants into public waters and seas and regulations under this law govern construction of factories along the coast whose discharges might affect fisheries.

Decree No.2761 of 19 December 1933 contains provisions governing industrial wastewater and sewage disposal. Section 12 requires authorization of public health and agriculture authorities for treated sewage to be discharged into surface waters or used for agricultural purposes.

4.4.I Libya

The Water Law of 28 September 1965 contains a general prohibition on pollution.

Section 3 of Petroleum Regulation No.8 of 1968 requires holders of concessions to drill for petroleum to take all reasonable precautions to avoid hazard or damage to natural resources.

Section 18 of Law No.130 of 26 September 1972 invests municipalities with the responsibility for sewage disposal.

Section 21 of the Health Law of 13 December 1973 prohibits any action that may lead to environmental pollution and requires all necessary steps to ensure purity of water. Regulations governing wastewater and refuse disposal are also authorized.

4.4.J Malta

The Marine Pollution (Prevention and Control) Act of 1977 has as its objective "to give effect to the provisions of international and regional conventions and protocols relating to the protection of the marine environment". It contains provisions for controlling land-based pollution.

Section 210 of Chapter 13 of the Code of Police Laws, as amended in 1972, imposes penalties on any person who allows petroleum or other oil or mixture of them to run into internal or territorial waters or harbours from any land-based installation. Section 209 proscribes leaving anything that may cause injury to public health or nuisance in any harbour or on any wharf. Section 104 requires the owner of a building to take necessary measures to prevent flow from drains or pipes. Section 138 imposes a duty on all persons to avoid negligent pollution of public water supplies.

Section 31 of the Port Regulations of 1966 contains a prohibition on discharges of oil that may apply to land-based sources.

The Sewage Matter Removal Regulations of 1911 apply to that subject.

4.4.K Monaco

Section 1 of Law No.954 of 19 April 1974 prohibits dumping, spilling, depositing, or direct or indirect discharge of materials or substances into inland maritime waters, territorial seas, surface waters or groundwater that may cause deterioration of water quality, jeopardize natural functions of marine flora or fauna, harm public health or jeopardize economic development

or tourism. Section 3 authorizes ordinances controlling or prohibiting the import, manufacture, distribution, sale or use of products liable to cause pollution and governing the operation of establishments which may be sources of pollution.

Similar authority is contained in Sovereign Ordinance No.4884 of 7 March 1972. Section 1 prohibits direct or indirect dumping or discharge of materials or objects into inland waters or territorial seas or any other activity that may cause or increase deterioration in water quality. Section 3 requires new installations intending to withdraw sea water or discharge into it to submit treatment plans for approval and obtain authorization to operate.

An agreement signed on May 10, 1976 by Monaco, France and Italy establishes a commission to bring about collaboration to control water pollution along the coast between St. Raphael, France and Genoa, Italy.

4.4.L Morocco

The Vizierial Order of 26 May 1916 on the protection of municipal water supplies prohibits garbage disposal, construction and other activities in or near waters contained in aquaducts, reservoirs, wells and other sources or conveyances of water supplies.

The Dahir of 1 August 1925 contains provisions prohibiting dumping into watercourses of any substances harmful to public health or animals.

4.4.M Spain

The Order of 27 May 1967 prohibits discharge into the sea of all petroleum products or residues containing such products by industries. Permits for discharges including such products in amounts that will not cause water pollution are authorized under section 10(4) of Act No.28/69 on Coasts of 26 April 1969. Rules on the design and construction of installations for wastewater treatment and discharge into the sea are contained in a Resolution of 23 April 1969. Direct untreated discharges are prohibited. Criteria in rules 13-15 specify varying minimum dilutions of wastewaters depending on kind of treatment and location of discharge. Section 24 of the rules requires a license for industrial discharges. These discharges must be treated to remove substances harmful to marine fauna or flora or to public health in beach areas. These rules have been updated by the Order of 29 April 1977 approving instructions for discharges from land-based sources into the sea via outfalls. Receiving water quality standards based on categories of use and effluent characteristics, treatment requirements and outfall design standards are set forth. The Order of 27 May 1971 on measures to control pollution of the sea requires refineries, petrochemical plants and fuel supply establishments that load or unload oil to have a vessel that can discharge substances into surface waters.

The Water Act of 13 June 1879 prohibits discharges of harmful substances into waters. The royal decree of 16 November 1900 prohibits discharges of polluted waters from factories into rivers, streams, estuaries or bays. The Decree of 9 February 1925 prohibits discharges of untreated sewage into rivers unless the assimilative capacity is adequate and authorize municipalites to prescribe treatment methods for industrial effluents or to prohibit them. The Regulations on the Administration of Watercourses of 14 November 1958, in Chapter 2, Section 11, requires licenses for discharges of wastewaters from industrial establishments, etc., that may contaminate public waters. Licenses

are granted only after approval of a suitable treatment plant. The 1958 regulations were amended by the Order of 14 September 1959, authorizing the imposition of maximum amounts of pollutants in effluents, establishing classifications of receiving waters and discharges, and coordinating licenses to use public waters with discharge permits. The Order of 23 March 1960, amended by Decree No.2414/61 of 30 November 1961, added requirements for information to be provided in applications for licenses to discharge, required that each license must set limits for several characteristics, including amount of fats and oils, and added authority for water commissioners to monitor compliance and enforce the requirements. The Order of 14 April 1980 prescribes detailed measures for water pollution abatement, including authority for water commissioners to require joint abatement action by dischargers.

The Decree of 30 November 1961 (No.2414, referred to above) also defines "unhealthy or harmful activities" as those that discharge products that may be directly or indirectly harmful to human health and prohibits new activities of this kind unless they comply with the Regulations of 14 November 1958. Industrial discharges must conform to specified effluent characteristics.

The Law on River Fisheries of 20 February 1942, implemented by the Decrees of 6 April 1943 and 13 August 1966, discharges of any substance liable to harm fish directly or indirectly or interfere with their physiological or ecological requirements.

Law No.42 of 19 November 1975 prescribes how solid wastes and residues from industrial, domestic and agricultural activities are to be collected and treated, having regard for protection of the environment and subsoil and recovery of resources from waste materials.

4.4.N Syria

Article 32 of Legislative Decree No.30 of 25 August 1964 on the protection of aquatic organisms strictly prohibits allowing wastes from factories and laboratories that are harmful to fish and other aquatic life to flow into public waters (defined in Article 1 as inland waters, sea waters and estuaries). Chemical and petroleum substances may likewise not be discharged from sewers. Owners of factories and laboratories and petroleum or chemical pipelines must take necessary measures to avoid harm to these waters and the construction of any of these establishments after the effective date of the decree requires the authorization of the Minister of Agriculture, which will specify measures to prevent harm.

Law No.10 of 26 March 1972 concerning pollution of water by oil assigns responsibility for land-based sources of pollution to the owner or operator of the installation or factory concerned. The owner, operator or person possessing equipment for the storage, transport or pumping of petroleum is responsible for pollution from these sources. Petroleum pumping stations and storage depots are responsible for constructing facilities for storing petroleum wastes from ships. Instructions concerning pollution control measures in ports were issued on 19 April 1973 based on Law No.10.

4.4.0 Tunisia

Law No.75-16 of 31 March 1975 enacted a comprehensive water code. Article 108 prohibits the discharge or dumping into marine waters of any matter, especially domestic or industrial wastes that may injure public health or fauna or flora or the economic development of coastal regions or their tourist potential. Article 109 prohibits discharge into public waters of wastewaters, wastes or other substances that may harm public health or eventual uses of the waters. Depositing on land of anything that may cause ground or surface water pollution is prohibited by Article 110. Article 116 authorizes the discharge of treated wastewaters, provided they contain no suspended, floating or dissolved matter capable of forming deposits on the banks or bed of the watercourse involved or interfering with downstream uses. Article 124 authorizes government decrees regulating discharges and other acts liable to cause deterioration, specifying water quality criteria and monitoring receiving water and effluent characteristics. Article 134 provides that the Minister of Agriculture must approve non-domestic discharges into public sewers. Pretreatment may be required (Decree No.79-768 of 8 September 1979 governs connections with and discharges into public sewers in further detail). Article 136 provides for a decree concerning dangerous, unhealthy and troublesome establishments, including a requirement that new establishments must file an application specifying treatment of the effluents.

Section 12 of the Decree of 26 July 1951 concerning sea fisheries prohibits discharges of effluents or wastes into the sea, tidal reaches of rivers, streams or canals without authorization.

4.4.P Turkey

The Water Resources Act of 1971 prohibits, in Section 20, dumping into inland waters or marine waters where the sea is being used, substances harmful to water-derived resources or the health of those consuming them or to pipelines, tools, materials or equipment. The Water Resources Ordinance of 1973 based on the 1971 law requires, in Part VIII, Article 1, that industries must take all possible precautions to prevent pollution by products prohibited by the ordinance within two years. Article 2 of Part VIII requires municipalities to prevent pollution by sewers within five years. Annex 5 of the ordinance specifies substances whose physical properties or chemical concentrations indicate they may not be discharged. The Ministerial Ordinances of 4 September 1959 and 29 March 1960 require permits for the discharge of wastewater into watercourses and discharges are classified and wastewater characteristics are prescribed.

Regulations on Groundwater dated 20 July 1961, based on the Ground Water Act of 16 December 1960, require that proper measures be taken to prevent pollution of surface or ground waters on their being made unfit for use. Licenses are required under the act for projects that entail utilization of groundwater.

Under Section 4 of the Ports Law of 1925, as amended in 1965, permission is required to build jetties, quays, docks, factories, warehouses, etc. along the coastline or in coastal areas. Dumping of refuse or ballast into the water may be prohibited at specified points.

Section 242 of the Public Health Law of 6 May 1930 prohibits the construction of establishments that may contaminate rivers, streams or springs and the dumping of industrial wastewater into rivers and streams unless it has first been rendered harmless. Section 244 prohibits discharges of sewage or contaminated domestic wastewater for sewers or municipal drains into rivers and streams unless it is verified that the discharges will not endanger health.

4.4.Q Yugoslavia

The Decree of 28 December 1973 on inter-republic and international waters applies to surface and groundwaters of importance to two or more republics and to maritime coastal waters. The waters are classified according to their intended uses and requisite quality, i.e. physical, biological, chemical and bacteriological properties. Substances liable to endanger life and health of persons, fish and animals (dangerous substances) may not be introduced into these waters if they are liable to adversely affect the characteristics of the receiving waters. Discharges of effluents that would cause water quality deterioration are deemed "harmful". They may be prohibited or subject to treatment requirements. Products that contain persistent polluting substances may be prohibited from sale.

The Basic Law on Waters was promulgated by the Decree of 15 March 1965. Wastes dangerous to human life or health, fish or livestock may not be discharged. These include those that produce a film of fatty substances, petroleum or petroleum derivatives on the surface of the water. Wastewater treatment plants are prerequisites to the licenses required for construction of any plant, facility or building that may discharge harmful wastes, i.e. those liable to cause changes in physical, chemical or biological properties of waters to an extent that may prevent or restrict their use.

Section 14 of the Basic Law concerning Sanitary Inspection of 1 March 1965 requires approval of the location and plans for facilities for the disposal of effluents and other wastes from built-up areas and industrial installations.

Regulations of 30 June 1950 on the maintenance of order in harbours authorize a harbour master to require treatment of discharges from factories and workshops. Section 10 of the regulations prohibit throwing garbage or other polluting substances into harbour waters.

Section 35 of the Basic Law on Fisheries of 27 February 1965 prohibits discharges into marine waters or rivers or lakes connected with them of industrial wastes or any other materials capable of killing fish or other marine animals, adversely affecting biological conditions governing their growth and development, or reducing their economic value.

4.5 Standardization and marketing

Because lubricating oils become contaminated with water, sludge, metal particles, etc. during use, it is important to determine how much of the contaminants must be removed for the used oil to be suitable for a particular re-use and to have available relatively inexpensive tests to make sure they are suitable. There are, of course, specifications that oils must meet for their initial uses, whether they are used as lubricants or for fuel. Some of these specifications, as well as test procedures to determine if they are met, are established as standards by testing societies, industrial or professional associations, or public agencies (both military and non-military), some by the

purchaser who has a particular application in mind. Automotive engineers, for example, specify the quality standards motor oils must meet for different engines. Similarly, there are several grades of fuel oils. These standards may be enforced by agencies that test the quality of selected products. For motor oils these tests range from relatively simple laboratory bench tests to expensive engine sequence tests that involve using the oil in an engine for many hours and then dismantling and examining the engine.

Re-refining removes more or less all of the contaminants, depending on the process used, leaving base stock oils comparable to those distilled from crude petroleum that can be made usable for a variety of purposes by the addition of selected additives. When available test procedures establish that products made from used oils are substantially equivalent to those made from "virgin" oil (76), the fuel and lubricant products made from used oils can be placed on the open market as well as purchased by government procurement programmes, and there is a considerable incentive to collect and re-use used oils.

In order to inform consumers, some laws require that oil products made in part from used oils be so labelled. Other laws achieve the same effect by prohibiting the sale of any fuel or lubricating oil in any manner that may deceive the purchaser about its nature or quality. Such requirements tend to impair the marketability of products made from used oils (77). It is preferable to label such products on the basis of performance characteristics or suitability for specified uses.

Marketing of products made from used oils can also be promoted by exempting them from taxes placed on products made from virgin oils.

Marketability is not an issue in situations where the generator of used lubricating oils segregates them from other wastes and provides them to a re-refiner to be specially treated and returned for re-use. Acceptability of products made from used lubricating oils is often more easily established with government procurement agencies and large commercial or industrial purchasers than with individual consumers (78).

4.6 Public awareness

Education of the public about the harm and waste that can be caused by improper disposal or re-use of used lubricating oils and the benefits that can accrue from collecting them and conserving their resource values is an effective means to establishing a foundation of awareness upon which a variety of policies and programmes can be built. Important elements in the information to be conveyed are that oil is both scarce and valuable, that significant damage to environmental and human health can be caused by dumping oils or burning them without precautions to prevent air pollution, and that it can be relatively easy to conserve the resource and avoid the damage by keeping used oils separate from other wastes, collecting them and either storing them until they are picked up or taking them where they will be properly re-used or disposed of.

There are of course many ways to convey this message and many audiences who should hear it. For industries, it can be useful to prepare and distribute a manual that explains how to handle lubricants in a plant so as to reduce the amount of used oils generated (by selecting the most appropriate lubricants, extending their useful lives, performing preventive maintenance and using automatic lubricating systems and filters where possible, for

example), to segregate used oils from other plant wastes by establishing in-plant collection systems and separate sewers or traps to keep them from mixing with wastewaters and to reclaim as much as possible (e.g. by settling, centrifuging or filtering) in the plant.

Because the use of automotive lubricants is more dispersed they are more difficult to collect. Public awareness about these used oils is accordingly more important. It can be promoted through discussion in driver education and auto mechanic courses and by providing information in vehicle operator manuals and in connection with vehicle registration and driver licensing. It can also be publicized by signs, brochures or bumper stickers at sales outlets, by labels on oil containers, by media or information campaigns conducted or sponsored by public agencies (e.g. as an insert in tax or utility bill mailings), conservation or civic organizations, oil industry associations, or all three. Case histories of successful public education efforts can be distributed at the local and regional level as a means of creating further interest and giving examples of how to act.

Some programmes have distributed containers for collecting oil free of charge. Some donate the proceeds of the oil collected to charity.

Public education efforts may be effectively coordinated with other components of public policy concerning collection, re-use and disposal of used lubricating oils. If legal requirements, prohibitions or limitations apply, they should be publicized. If local collection facilities (e.g. recycling centres) have been established, privately (e.g. gas stations) or publicly, their locations and hours should be announced. If pick-up services are provided, on call or on a regular basis, this should be advertised.

5. SUGGESTED OUTLINE OF PROGRESSIVE NATIONAL MEASURES

Article 5 of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources provides that the Parties "undertake to eliminate pollution... from land-based sources by substances listed in Annex I", including used lubricating oils. The parties "shall elaborate and implement, jointly or individually, as appropriate, the necessary programmes and measures", including "common emission standards and standards for use" (79). Article 7 provides that the parties "shall progressively formulate and adopt... common guidelines and, as appropriate, standards or criteria (80) dealing in particular with... the control and progressive replacement of products, installations and industrial and other processes causing significant pollution of the marine environment" (81) and "specific requirements concerning the quantities of the substances listed in Annexes I and II discharged, their concentration in effluents and methods of discharging them" (82).

The common guidelines, standards and criteria referred to in Article 7 "shall take into account local ecological, geographical and physical characteristics, the economic capacity of the Parties and their need for development, the level of existing pollution and the real absorptive capacity of the marine environment" (83). The programmes and measures referred to in Article 5 "shall be adopted by taking into account, for their progressive implementation, the capacity to adapt and reconvert existing installations, the economic capacity of the Parties and their need for development" (84).

In December 1985, the Meeting of Experts of the Technical Implementation of the Protocol agreed on a workplan and time-table for activities towards the development of programmes and measures for the implementation of the Protocol, which reflect the provisions of Articles 5 and 7 of the Protocol set forth above. Insofar as substances were concerned, priority was given to those in Annex I (85).

In light of the provisions of Articles 5 and 7 of the Protocol, and of the December 1985 workplan for the implementation of the Protocol, the following outline of progressive national measures concerning used lubricating oils is suggested:

5.1 Definition of used lubricating oils

1. Discharges of oil from oil production, refining and storage installations should not be included within the scope of the definition of used lubricating oils, even though they constitute significant sources of pollution of the Mediterranean Sea, because they are not "used" and, in addition, are often not "lubricating" oils.
2. It should also be recognized that "used lubricating oils" are those made at least in part from petroleum (including chemical additives) but do not include lubricants that are wholly synthetic or chlorinated lubricating or insulating oils, e.g. those containing PCB's or PCT's. Experience under the European Economic Community directive definition that includes synthetic oils has led the Commission to propose amending the definition to exclude them on the grounds that they "give rise to rather different management problems" (86). Used motor vehicle lubricants consisting of mixtures of mineral oils and synthetic oils would still be

included, since "such oils do not differ greatly from the other lubricants in question" (87). Contamination of used lubricating oils with PCB's has been a severe and continuing problem in several countries, e.g. in the Federal Republic of Germany, which has had a comprehensive used oil collection and recycling law since 1968 (88).

3. In addition, the term "used lubricating oils" should not include other substances such as pesticide residues, gasoline, solvents, PCB's or hazardous wastes, or include oils with more than specified proportions of other substances.

5.2 Assessment of sources and levels of used lubricating oils

1. A special effort should be made within the survey intended to update the 1977 MED POL X pilot project to provide data that will facilitate the determination of levels of oil pollution in the Mediterranean that are attributable to sources of used lubricating oils as distinct from other sources of petroleum pollution. Article 7 of the Protocol calls for such information to be taken into account in formulating common guidelines, standards or criteria for controlling significant causes of pollution (89).
2. Each country should conduct its own assessment of the sources of used lubricating oils, kinds and amounts generated and current collection, re-use and disposal practices within its borders as a means of determining not only its pollution load, but also other environmental and public health effects of those practices. Such assessments constitute a basis for deciding how to implement measures agreed upon by the Parties under the Protocol to eliminate pollution of the Mediterranean, as well as any additional measures taken as a matter of national policies (90).

5.3 Controlling sources of used lubricating oils causing significant pollution

1. Once the "installations and industrial and other processes causing significant pollution of the marine environment" have been identified by these regional and national assessments, they should be regulated by a system of authorization that would control used lubricating oil generation. Authorizations issued and periodically reviewed for renewal under this system should require each source:
 - (a) to collect used lubricating oils and keep them separate from other substances and wastes;
 - (b) to limit or prohibit amounts of used lubricating oils discharged into water or onto land or burned as a supplemental fuel and specify the pretreatment and emission or effluent applicable controls when they are discharged or burned (cf. Article 7(1)(e) of the Protocol), (there can be serious health and equipment operational effects from burning untreated used oil (92); and
 - (c) to transfer used lubricating oils that are collected but not re-used or burned as a supplemental fuel on the premises to an authorized collector.

2. Concurrently, a public education programme should be undertaken, including:
 - (a) the preparation and distribution of a manual on how to separate and collect used crankcase lubricating oils; and
 - (b) public information on the environmental and resource conservation benefits from collecting used lubricating oils.

5.4 Industrial used oil policies (93)

Surveys of industrial used oils volumes, and their physical and chemical properties indicate that there is a potential for much greater re-use and recovery of oil than is presently practiced. Policies aimed at promoting recovery could be designed in a number of different ways to encourage the generators of used oil, and consumers of recycled oil, toward more conservation oriented actions. Among the desired actions that regulatory and educational policies might seek to promote are:

- (1) a re-examination of the relative economics of disposal, versus recovery by industries (particularly those impacted by wastewater treatment and solid waste regulations);
- (2) the segregation of used oil streams within manufacturing plants so that the value of such oil is greater to the plant itself and to firms specializing in oil recycling and re-refining;
- (3) the improvement of the market for recycled or re-refined oil, by seeking to change consumer attitudes towards its use.

Two specific policy initiatives are outlined below that would provide incentives in one or more of these areas. These policies include:

- (1) an industrial environmental education programme aimed at aiding industry in assessing the benefits and costs of oil recovery programmes;
- (2) the designation of used oil recovery equipment such that there are tax advantages for this equipment such as faster tax write-offs and property tax exemptions.

These two policies are examined below in terms of the required action and the mechanism by which a policy would foster industrial used oil recovery.

In order to aid in assessing these policy impacts, an example of an economic analysis of one type of in-plant oil recycling system has been chosen as a benchmark against which to analyze how a firm may react to the implementation of policies presented above. This example is not presented to characterize used oil recycling economics in general, but only to illustrate the relative impact of potential policies.

Figure 5.1 shows the number of years that industrial used oil generators would have to operate an oil filtering recycling system for a "typical oil" in order to pay for the initial purchase price of the system. The payback period varies significantly with the volume of oil involved and the type of use of the recycled product. In general, the most favourable economic conditions for recycling are for the large volume users who recycle oil as fuel. This

applies only if the oil does not contain high levels of contaminants which may be harmful if emitted to the air and which are difficult to remove, e.g. trace metals. The payback periods for small volume users are not conducive to in-plant recycling with high capital cost equipment. However, this oil might be sent to a re-refiner.

The sensitivity of recycling economics to oil volume suggests that, for maximum efficiency, policies be aimed at the education of middle volume users. Partial subsidization of demonstrations of recovery systems should also be directed toward middle volume users, in order to promote an awareness of the benefits of oil conservation practices by the categories of firms most likely to respond to such demonstrations.

1. Industrial education programme

(a) Policy action: The policy action would consist of disseminating information to industries that would aim them in assessing the feasibility and economics of increased industrial oil recovery. A used oil audit manual might be prepared describing the procedure to inventory oils used in manufacturing processes and the equipment presently available for recovery operations. Distribution of the manual would constitute implementation of one phase of an industrial education programme.

(b) Mechanism by which recovery is encouraged: The manual would seek to draw attention to the potential of industrial oil recovery. Those industries presently facing wastewater and other oily waste problems should be targeted for attention. Significant savings can often be realized in wastewater treatment, investment in other pollution control equipment and recycling of oils and minimizing oily waste production. The large fraction of unaccounted oil indicated by some industrial surveys suggests that the dissemination of procedural techniques to aid such industries to evaluate investments in recovery equipment would be beneficial.

A major thrust of such a manual would be to encourage in-plant oil segregation, filtering, centrifuging and use of settling equipment. Such equipment can be employed to lengthen the life of the oil in the plant or to lower the water and contamination levels of used oil, allowing more economical recovery by professional recycling firms.

2. Tax advantage for oil recovery equipment

(a) Policy action: A declaration that oil recovery equipment be granted some tax advantages would be helpful. In some countries, there are a number of tax advantages afforded to pollution control equipment. These include:

- (1) a real property tax exemption;
- (2) a sales-use tax exemption;
- (3) accelerated depreciation of pollution control equipment;
- (4) financial programmes for the purchase of pollution control facilities.

Figure 5-1 Equipment Costs and Payback Period vs. Drums of Oils

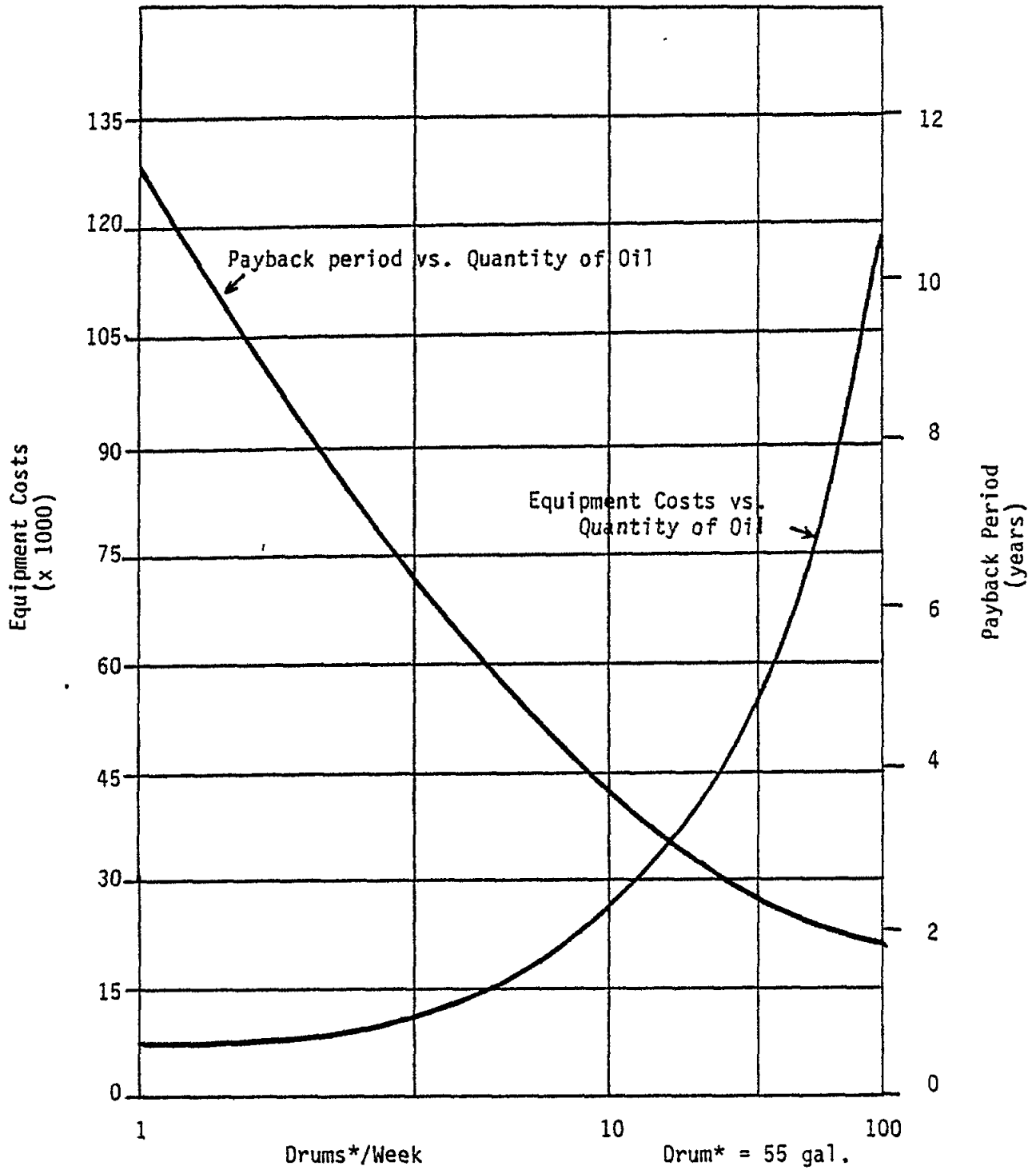


Figure 5.1 Equipment costs and payback period vs. drums of oils

- (b) Mechanism to foster industrial oil recovery: It is difficult to assess the impact of these tax benefits without reference to a specific firm's financial situation. One major benefit to firms could be derived from the accelerated depreciation benefits. A significant tax benefit could accrue to those specializing in used oil recovery. It would raise their after-tax profit margin, and thereby provide incentives to recover presently marginal oil. This, in turn, would raise the price which they would be willing to pay to used oil generators for the oil.

5.5 Controlling re-use and disposal of used lubricating oils

Within a reasonable period of establishing the system for authorizing significant sources of used lubricating oils, two other authorization systems should be concurrently established:

1. a system of authorizing collectors, specifying minimum amounts of used lubricating oils that must be collected; and
2. a system of authorizing alternative means of re-use and disposal, specifying what authorized collectors may do with what they collect, e.g. re-refine it, burn it as a fuel supplement after prescribed pretreatment or with prescribed emission controls, or dispose of it in accordance with approved hazardous waste disposal techniques.

6. MEASURES PROPOSED FOR ADOPTION BY THE CONTRACTING PARTIES

The information provided in this document, and the replies (although few in number) received to the relevant questionnaire sent to countries, confirm the indication that used lubricating oils constitute a marine pollution problem in the Mediterranean region, and that their disposal should therefore be subject to appropriate control measures. In a number of Mediterranean countries, the discharge of used lubricating oils into the marine environment is prohibited by national legislation. In others, the stipulations, though not specific to used lubricating oils, follow the same principle. It is therefore considered that, in keeping with the trend already existing at individual national level, Mediterranean States should jointly adopt the principle that no discharges of used lubricating oils into the marine environment should be permitted, and in conformity with this principle, take appropriate progressive measures, taking into account the various measures available outlined in Chapter 5 of this document, and their own national circumstances, to ensure eventual compliance by the earliest feasible date.

On the basis of the above, the following recommendations are submitted for the consideration of the Working Group, with a view to their transmission by the Secretariat to the Contracting Parties:

- (a) Adopt the principle that wastes containing used lubricating oils should not be discharged into the marine environment.
- (b) Undertake to progressively implement, through appropriate national procedures, programmes and measures to ensure the eventual realization of this principle by the earliest feasible date dictated by national circumstances.
- (c) In the progressive formulation and implementation of national control measures, take into account, as and where appropriate, the various control measures available, including recovery and re-use of used lubricating oils.
- (d) Provide the Secretariat to the Convention with the fullest information possible on:
 - relevant national data regarding used lubricating oils, including legislative and administrative measures controlling disposal, necessary for the regular availability of an updated regional overview.
 - progressive measures taken on (b) and (c) above.

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51. Kuwabara, S., The Legal Regime of the Protection of the Mediterranean against Pollution from Land-Based Sources, Tycooly International Publishing Limited, Dublin, 1984, ch.4; "Pollutants from Land-based Sources in the Mediterranean", supra, Annex IV, pp.91-94; WHO/UNEP Secretariats, Protection of the Mediterranean Sea Against Pollution from Land-Based Sources: A Survey of National Legislation, WHO and UNEP, Geneva, 1976.
52. Sections 33 and 35, Law No.83-03 of 5 February 1983 on environmental protection, Journal officiel de la Republique algerienne democratique et populaire, 8 February 1983. No.6. pp.250-264. This summary is based on an English translation of excerpts of the law published in the International Digest of Health Legislation, 1984, 35(1), pp.176-194.
53. Id., section 78, Existing installations subject to these requirements that were, prior to their effective date, governed by Ordinance No.76-04 of 20 February 1976 and Decree No.76-34 of 20 February 1976 concerning dangerous, unhealthy, or troublesome establishments, were allowed no more than two years from the effective date of the law to report to the competent authority, "which shall subject them to measures necessary to safeguard the interests mentioned in section 74". Id., section 82.
54. See Irwin, "Used Oil: Comparative Legislative Controls of Collection, Recycling, and Disposal", 6 Ecology Law Quarterly 699, 712-13 (1978); Irwin and Liroff, Used Oil Law in the United States and Europe, EPA-600/5-74-025, July 1974, pp.130-34.
55. Directive 75/439/EEC, Official Journal of the European Communities, No. L194/23, 25 July 1975.
56. See text at note 5, supra.
57. See Commission of the European Communities, Proposal, supra, p.6. Decree 77-254 of 8 March 1977 prohibits discharges of new and used oils into surface, ground, and sea waters. Despax, Michel, and W. Coulet, The Law and Practice Relating to Pollution Control in France, 2nd Edition, Graham and Trotman Limited, London, 1984, p.40.
58. Commission of the European Communities, Proposal, supra, p.23.

59. Environmental Resources Limited, "Implementation of Directive 75/439/EEC on the Disposal of Waste Oils", Sept. 1983, p.42.
60. See Decree No.76-473 of 25 May 1976.
61. Commission of the European Communities, Proposal, supra, p.26; Environmental Resources Limited, supra, p.54.
62. Decree No.79-517 of 30 June 1979; Environmental Resources Limited, supra, pp.32, 34.
63. Despax and Coulet, supra, pp.40, 84.
64. Arrete of 21 May 1980; Environmental Resources Limited, supra, p.18.
65. Decree No.77-974 of 19 August 1977.
66. Despax and Coulet, supra, p.36.
67. Id., p.39; Article 1, Decree of 23 February 1973.
68. The summary of this law is based on a translation of excerpts and on Chapter 6.2 of Timagenis and Pavlopoulos, The Law and Practice Relating to Pollution Control in Greece, Graham and Trotman Limited, London, 1984.
69. Law No.743 of 13 October 1977, Article 3(2). Discharges of lubricating oils, hydraulic brake fluids, and their mixtures are prohibited.
70. Timagenis and Pavlopous, supra, at 62. See generally, id., Ch.4.
71. Government Gazette No.624/1969 B.
72. Government Gazette No.189/1968 B.
73. Timagenis and Pavlopous, supra, at 93, 95, 99.
74. This summary is based on Guttieres, M., and U. Ruffolo, The Law and Practice Relating to Pollution Control in Italy, 2nd Edition, Graham and Trotman Limited, London, 1984; S. Ercman, European Environmental Law: Legal and Economic Appraisal, Bubenberg Verlag AG, Bern, 1977; Italian Water Research Institute, National Research Council, "Technical and Economical Aspects of the New Italian Law for Water Pollution Control", Rome, no date; and Environmental Resources Limited, supra.
75. Air pollution is controlled under the Act on the Control of Atmospheric Pollution, No.615, of 13 July 1966; Ercman, supra, p.153.
76. Law No.1852 of 31 December 1962, Article 12. See Irwin, "Used Oil: Comparative Legislative Controls of Collection, Recycling and Disposal", supra, p.712; Irwin and Liroff, Used Oil Law in the United States and Europe, supra, pp.134-35.
77. See, e.g. Becker, D.A., and Comeford, J.J., "Recycled Oil Program: Phase I - Test Procedures for Recycled Oil used as Burner Fuel", National Bureau of Standards (NBS) (U.S.), Technical Note 1130 (1980); Becker, D.A. and Hsu, S., "NBS Provisional Tests for Re-refined Engine Oil", Measurements and Standards for Recycled Oil - IV, NBS Special Publication 674, U.S. Department of Commerce, National Bureau of Standards, July 1984, pp.309-17.

78. See Irwin and Liroff, Used Oil Law in the United States and Europe, supra, pp.39-51, 75-81. See also, section 4, Used Oil Recycling Act of 1980, 94 Stat. 2055-56, codified in 42 U.S.C. 6914a and 6363, and House Report No.96-1415, pages 5-6, reprinted in 1980 U.S. Code Cong. & Ad. News, 4355-57.
- 79 See Cukor, P., "Marketing Barriers for Recycled Oil", Measurements and Standards for Recycled Oil, NBS Special Publication 488, U.S. Department of Commerce, National Bureau of Standards, pp.115-121 (1977).
80. "Emission standards" may be understood specifically as limiting kinds and amounts of air pollutants and generally as containing similar limits for wastewater discharges, also called effluent standards. "Standards for use" may be understood as providing for different levels of ambient air or water quality, depending on location or intended uses or both.
81. "Criteria" was defined at the 1972 Stockholm Conference as "the quantitative relations between the exposure to a pollutant and the risk or magnitude of an undesirable effect under specified circumstances defined by environmental variables and target variables", Kuwabara, supra, p.60.
82. Protocol, Article 7(1)(d). The draft recommendations for formulating these common guidelines discussed at the December 1985 Meeting of Experts on the Technical Implementation of the Protocol provided:
 17. Activities under this heading should be initially devoted to the identification of problem areas and, wherever possible, their categorization from the solution viewpoint into short, medium and long term.
 18. The guidelines eventually developed should essentially deal with the following:
 - (a) control of products, installations and processes causing significant pollution;
 - (b) the progressive replacement of such products, installations and processes by other, more innocuous ones.
 19. The guidelines should cover, Inter alia, the following:
 - (a) identification of products, processes and installations in relation to the presence therein of harmful substances included in Annexes I and II to the protocol;
 - (b) regulation, by means of appropriate control measures, of the use and production of products, of the employment of processes, and of the operation of installations resulting in effluents containing harmful substances in concentrations above prescribed limits;
 - (c) selection of products, processes and installations which could be efficiently and economically replaced;
 - (d) selection of modifications in manufacturing systems and of types of treatment for waste effluents.

20. The guidelines would also have to include:
- (a) lists of harmful substances, which would have to be constantly updated;
 - (b) common criteria governing the control of products, processes and installations, and the discharge of effluents from installations involved;
 - (c) common criteria regarding the recommended replacement of products, processes and installations;
 - (d) successive limits of substitute products, processes and unit operations, taking due account of the availability of low and non-waste technology;
 - (e) reference lists of industrial and other activities requiring special surveillance.
21. In order to implement the principles presented above, a step-by-step approach is proposed and a detailed workplan and timetable is presented in the Annex to this document.

Draft Recommendations for the Formulation of Common Guidelines, Standards and Criteria in Terms of Article 7 of the Protocol, UNEP/WG.125/6, 10 October 1985.

The minutes of the meeting stated that in the discussion of the actions proposed in this document (concerning this and other paragraphs of Article 7) "a strong emphasis was placed on the importance of re-use and recycling of wastes and wastewaters, and it was urged that as much attention as possible should be given to this aspect".

Report of the Meeting of Experts of the Technical Implementation of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources, UNEP/WG.125/10, 10 December 1985, p.5, paragraph 30.

83. Protocol, Article 7(1)(e). "The above problem will be dealt with for each of the groups of substances listed in Annexes I and II to the Protocol within the preparation of respective assessments and proposed measures". Draft Recommendations for the Formulation of Common Guidelines, supra, p.6, paragraph 22.
84. Protocol, Article 7(2).
85. Id., Article 7(3).
86. Report of the Meeting of Experts of the Technical Implementation of the Protocol, supra, Annex IV (General Guidelines) and V (Annex I Substance Guidelines) state:

Annex IV:

- (a) The existing level of pollution of the Mediterranean Sea and the severity of its effects on the Mediterranean ecosystem, human health and amenities should be used as indications guiding the timetable for the formulation of measures.

- (b) The Protocol should be implemented progressively through a step-by-step process, according to a long-term workplan and timetable agreed by the Contracting Parties.
- (c) The best available information on scientific and technical matters should be used in formulating proposals for measures to be taken under the Protocol.
- (d) The ecological, geographical and physical characteristics of the Mediterranean Sea and its coastal zone, including the absorptive capacity of the marine environment, should be taken into account in formulating the measures.
- (e) The implementation of the Protocol should be linked with and reinforced by the other components of the Action Plan, MED POL in particular.
- (f) The programme and measures for the implementation of the Protocol shall include common guidelines, standards or criteria, wherever appropriate.
- (g) The measures adopted individually or jointly under the Protocol should take into account the economic capacity of the Contracting Parties.
- (h) Assistance should be made available to developing countries in the implementation of the Protocol. Such assistance should include exchange of information in the fields of service and technology, training in pollution control methodologies as well as acquisition of appropriate pollution control technologies on advantageous terms.
- (i) Annex IV of the Protocol concerning pollution from land-based sources transported by the atmosphere, should be prepared in accordance with the provisions of Article 4 of the Protocol.

Annex V: (for substances listed in Annex I)

- (a) A survey of land-based sources and amounts of pollutants reaching the Mediterranean Sea should be prepared as an updating of the MED POL X exercise.
- (b) For each of the group of substances listed in Annex I to the Protocol, an assessment of the state of pollution in the Mediterranean Sea should be prepared. Such assessments would include, inter alia:
 - Sources of pollution in the Mediterranean Sea;
 - Levels of pollution;
 - Effects of pollution;
 - Present legal, administrative and technical measures at national and international levels.
- (c) Such assessments should include all available relevant information from the Contracting Parties (Article 8 of the Protocol), from other components of MAP, in particular MED POL, as well as from other sources (e.g. Paris/Oslo Commission, Baltic Convention, etc.).

(d) Preparatory work should take already existing material fully into account. This would avoid (a) overlap and duplication of work, which would be uneconomic and time consuming, and (b) the production of sets of standards and criteria which could be at variance with already existing norms and, as a result, place a number of countries in a difficult position regarding compliance. Eventually, a certain degree of variance with already existing criteria might very well turn out to be necessary, but this would have to be fully justified. e) On the basis of such assessments, measures would be proposed which should take into account the provisions of Article 7 of the Protocol.

87. Proposal for a Council Directive, *supra*, p.38.

88. Id., p.39.

89. See Irwin and Burhenne, "A Model Waste Oil Disposal Program in the Federal Republic of Germany", 1 Ecology Law Quarterly 471 (1971); Irwin and Liroff, *supra*, note 51, pp.85-120, 188-248; Irwin, *supra*, pp.714-716, 723-726.

90. The Draft Recommendations for the Formulation of Common Guidelines, *supra*, notes that the "present incomplete state of knowledge regarding the level of existing pollution in the Mediterranean" has to be taken into account and that common guidelines therefore "have to be preceded by relevant studies on conditions prevailing in the Mediterranean region", page 3, paragraphs 5 and 6.

91. "The following general factors have to be taken into account: ...the wide degree of variation between the coastal zones of the different parts of the Mediterranean Sea, not only from the socio-economic, but also from the geographic, oceanographic and ecological viewpoints. Any common guidelines would therefore ... have to be designed in such a way as to enable each individual state to apply them according to its own specific circumstances". Id.

92. Yates, John J., et al., The Operational and Environmental Effects of Burning Unprocessed Used Oil, Association of Petroleum Re-refiners, Washington, D.C., June, 1983.

93. Yates, John J., and Harriet P. Croke, Used Oil Recycling in Illinois: A Review and Public Policy Analysis, Chicago, IL, August, 1978.