This generic scenarios report for lube additives contains the following:

1. 4 one-page worksheets
2. A general information section
3. An assumption/calculation section
4. A reference list

AD

INITIAL REVIEW ENGINEERING REPORT CBI YES NO
PMN NO.:
ENGINEER: LUBE OIL ADDITIVE MANUFACTURE
DATE:

BASIS: Additive production volume 1,000,000 kg PMN/yr
Additive concentration in lube product 1.0% kg PMN / kg Lube

MANUFACTURE:

The PMN is the product of a specialty chemical manufacturing process. The nature of the production process varies among additives. Most of the PMN is diluted to between 90 – 50 % in mineral oil to facillitate handling.

Site/Location: Manufacturing 2 sites c3 300 days/yr r2

Process Descr.: Varies. Most are batch specialty chemical operations.

Occup. Exposure

Inhalation: Negligible r2

workers
Exposure _____ mg/day _____ days/yr
Basis: Low vapor pressure

Dermal: _____

workers 45 c4
Exposure 3,900 mg/day r3 250 days/yr
Basis: Transfer procedures may result in
Incidental contact, 2 hands, 100% PMN concentration
Assume 50% of plant workers are exposed.

Environmental Release:

Water: 58 kg/site/dy c5 350 days/yr
source: residual product
basis: equipment cleaning and spillage

Air, direct negl kg/site/dy _____ days/yr
source
basis low vapor pressure

Incineration: 0.0 kg/yr source:

Land: 7,800 kg/yr c6 source: residual product

Assumptions:

INITIAL REVIEW ENGINEERING REPORT CBI YES NO

PMN NO.:

ENGINEER: LUBE OIL ADDITIVE BLENDING

DATE:

BASIS: Additive production volume 1,000,000 kg PMN/yr

Additive concentration in lube product 1.0% kg PMN / kg Lube

PROCESSING: PMN is blended with basestock and other addtives to make lubricant product

Site/Location: 2 blending sites exposed c8 300 days/yr

Process Descr.: 10% PMN in aditive package is blended with base stock to about 1.0% concentration and then packaged in cans or drums. Blending is usually done in-line.

Occup. Exposure

Inhalation: Negligible r5

workers

Exposure mg/day days/yr

Basis: Low vapor pressure

Dermal: Yes

workers 30 c9

Exposure 390 mg/day r3 250 days/yr

Basis: Transfer procedures may result in Incidental contact, 2 hands, 10% PMN concentration Assume 50% of plant workers are exposed.

Environmental Release:

Water: 0.07 kg/site/dy c10 350 days/yr

source: Spillage

basis: Spillage during transfer and sampling.

Air, direct: negl. kg/site/dy days/yr

source

basis low vapor pressure

Incineration: 0 kg/yr source:

Land: 0 kg/yr source:

Assumptions: All spillage is recovered in process sewer.

INITIAL REVIEW ENGINEERING REPORT CBI YES NO
PMN NO.:
ENGINEER: LOA END USE – AUTOMOTIVE SERVICE
DATE: 05-Aug-92

BASIS: Additive production volume 1,000,000 kg PMN/yr
Additive concentration in lube product 1.0% kg PMN/kg lube

USE: Automotive crankcase oil in oil changing shops. Two types of shops are included: general auto and p

Site:	Pure Lube	4,000	total sites	r15	47	exposed to PMN	c13	300
	General Automotive	57,629	total sites	r14	684	exposed to PMN	c11	300
Workers:	Pure Lube	20,000	total	r15	190	exposed to PMN	c14	250
	General Automotive	222,720	total	r14	1,851	exposed to PMN	c12	250

Basis: Estimate production 29.3 (MM gal/yr) (c1) of lube with PMN, 1.2% (c2) of the lu
Assume lube product containing the PMN is used in applications in the same proportion as indu
Process Descr.: Workers drain out oil from automobiles and add fresh oil containing 1.0% PMN
Used oil is collected and recycled.

Occup.
Exposure Inhalation: Negligible

workers
Exposure mg/day days/yr
Basis: Low vapor pressure

Dermal: Yes
Pure Quick Lube:
workers 190 c14
Exposure 91 mg/day r3 250 days/yr
Basis: Routine emmersion, 2 hands, 1% PMN concentration
7 mg/cm^2 typically remaining on skin.

General Auto.:
workers 1,851 c12
Exposure 65 mg/day r3 250 days/yr
Basis: Routine emmersion, 2 hands, 1% PMN concentration
5 mg/cm^2 typically remaining on skin, as per OTS guidelines

Environmental
Release:

Water: negl. kg/site/day days/yr
source:
basis: responsible handling of spent oil

Air, direct negl. kg/site/day days/yr
source
basis low vapor pressure

Incineration: 99,516 kg/yr c15 source: used oil

Land: 9,257 kg/yr c16 source: used oil
Basis: Incineration release from burning of used oil.
Land release results from dumping, landfilling, and road oiling

INITIAL REVIEW ENGINEERING REPORT CBI YES NO
'MN NO.:
NGINEER: LOA END USE – DO–IT–YOURSELF
DATE:

BASIS: Additive production 1,000,000 kg PMN/yr
Additive concentration in lube product 1.0% kg PMN / kg Lube

USE: Automotive crankcase oil in the Do–It–Yourself oil change market

Site/Location: 360,814 MM home c17 8 days/yr r17

Process Descr.: Persons drain oil from automobiles and add fresh oil containing 1.0% PMN to crankcase. Used oil is disposed of as noted in Exhibit 2.

Occup. Exposure Inhalation: Negligible

workers
Exposure mg/day days/yr
Basis: Low vapor pressure

Dermal: Yes

persons 360,814 MM c18
Exposure 39 mg/day r3 8 days/yr r17
Basis: Incidental contact, 2 hands, 1% PMN concentration
8.4 oil changes per year average for DYI (r17).

Environmental Release:

Water: negl. kg/site/day days/yr
source:
basis: responsible handling of spent oil

Air, direct negl. kg/site/day days/yr
source
basis low vapor pressure

Incineration: 2,982 kg/yr c19 source: used oil

Land: 65,610 kg/yr c20 source: used oil

Basis:
30.0% of virgin DYI oil is consumed during use. r17
4.1% of DYI used oil is burned. r16
60.8% of DYI used oil is dumped. r16
29.9% of DYI used oil is landfilled r16
0.0% of used oil oil is used for road oiling r16

LOA GENERAL INFORMATION SECTION

Lubricating Oil Additive is a broad term to describe numerous chemicals used to enhance the properties of base oils to meet the performance needs of automotive and industrial equipment.

Lubricating oils, especially automotive oils, are called on to perform not only their basic functions of reducing friction, heat, and wear, but many others as well. They must minimize sludge and varnish deposits, inhibit rust and corrosion, prevent wear and scuffing under extreme pressure conditions, and neutralize and disperse harmful contaminants in the oil. These functions must be performed under a wide range of operating conditions. Because straight mineral oils are incapable of meeting such requirement for any significant period of time, oil additives have been developed to improve their performance(7). The concentration of an LOA in a lubricating oil can range from less than one percent to over 20%. This report focuses on the manufacture, blending and end use (gasoline & diesel engine oils) of the LOAs.

The two major lubricant use categories are automotive (passenger car, aviation oils, transmission fluids, diesel engine oils) and industrial (railroad, marine and natural gas engine oils, tractor oils, gear oils, etc.). In 1988, gasoline engine oils and diesel engine oils accounted for 65% of the LOA demand in the U.S.(8). Today more than 30 companies produce LOAs or "packages" of LOAs and sell them to lube oil blending facilities. A few large companies both manufacture LOAs and then blend LOAs into lube oils. The production volume of an LOA is classified as "nonreported" or "confidential" by most of the major LOA manufacturers(2).

Exhibit 1 presents types of LOA and their functions.

EXHIBIT 1 SUMMARY OF MAJOR LUBE OIL ADDITIVES AND THEIR FUNCTIONS,

Type	Typical Compounds	Functions	Percent of Additive found in Lube Oil[a]
Viscosity index (VI) improvers	Ethylene-propylene copolymers, polymethacrylates, block stryene-isoprene or butadiene copolymers.	Reduce rate of viscosity change with temperature, reduce cold starting effort and oil and fuel consumption. Some products combine VI improvement with dispersant function.	2-5%
Detergents	Neutral or basic metallic sulfonates and phenates, phosphonates, salicylates. Usually based on Ca, Mg, or Ba.	Suspend carbon, sludge, water, and other contaminants in oil. Basic or overbased detergents neutralize acids, inhibit corrosion.	2-20%
Dispersants	Polybutenyl succinimides, succinic esters, modified Mannich bases.	Suspend sludge formed at low engine temperatures.	2-20%

EXHIBIT 1 SUMMARY OF MAJOR LUBE OIL ADDITIVES AND THEIR FUNCTIONS (Continued)

Type	Typical Compounds	Functions	Percent of Additive found in Lube Oil[a]
Antioxidants	Zinc dialkyldithiophosphates, hindered phenols, amines, various organic compounds containing N, S, or P.	Inhibit oxidation of oil, prevent formation of sludge, varnish and corrosive substances.	0.5-1.0%
Corrosion and rust inhibitors	Zinc dialkyldithiophosphates, dithiocarbamates, various organic acids, amines, and esters containing one or more of N, S, and P.	Form protective film on metal to prevent rust or corrosion. Some compounds deactivate metal surfaces which can catalyze oil oxidation.	Not available
Extreme pressure (EP) antiwear, antifriction additives	Zinc dialkyldithiophosphates, organic phosphates, sulfurized olefins, fatty acids, esters, organic chlorine, and lead compounds.	Form protective surface film on metal parts to prevent seizing and galling, reduce friction and wear.	~1.0%
Pour Point depressants	Polymethacrylates, alkylated naphthalene or phenols.	Reduce oil viscosity at low temperatures.	1% or less
Antifoamants	Silicone polymers.	Reduce foaming during processing and in service.	Not available

Other LOAs include: Antiodorants, Antiwear Agents, Biocides, Color Stabilizers, Emulsifiers, Friction Modifiers, Metal Deactivators, and Tackiness Agents.

Since numerous chemicals make up each functional class and the chemicals can vary widely (from a simple inorganic salt to a moderately complex organic specialty), little can be said about the manufacture of these chemicals that would be common to all or even most of them. The following is generalized process description information.

General Manufacturing Process Information:

Most additive components are manufactured in batch processes, but a few are produced by continuous chemical processes (or a portion of the total process is continuous). The size of the batch can vary from 5 metric tons to over 100 metric tons. Most additive plant capacities are in the range of 10-25 thousand metric tons per year. The individual unit size depends on the additive being made, the kind of chemistry involved, and the market needs of the producer. In general, most additive manufacture is in batch equipment, which in many cases is used for multiproduct additive manufacture(10).

The additive is piped to tanks or trucks for storage or transport until blended with other additives

to create an "additive package" or with the lube oil itself.

General Blending (Formulation) Information(6):

1. Batch Blending

In batch blending, the chemical additives and the fuel or lubricant are combined in a tank and mixed thoroughly. After laboratory analysis, the blended product is pumped to storage or shipping tanks. Batch blending is most adaptable to small refineries or blending plants in which varieties of liquid blends are produced.

2. Partial In-Line Blending

To achieve partial in-line blending, components are simultaneously introduced into a pipeline (blending header) in proportions approximately the product specification, are mixed by the turbulence in the line and are allowed to flow into product storage tanks. Small amounts of additives or blend stock are added to the storage tanks and mechanically mixed during the final adjustment.

For both batch and partial in-line systems, the quantity of additives to be blended is determined by gauging a small tank, by weighing, or by metering. Liquids are pumped from drums or weigh tanks into the mixing tank by small proportioning pumps and dry, solid additives are usually added by vacuum education out of a drum.

3. Continuous In-Line Blending

In continuous blending, all components of a product and all additives are blended in a pipeline with such accuracy that at any given moment, finished product may be obtained from the line. Because of the efficiency of this system, no provisions for reblending are necessary. The pumping rates of liquid additives are metered and controlled to assure product quality.

Continuous in-line blending is best for use in larger refineries or blending plants making several grades of products. When products must be transferred directly to pipelines or bulk transport facilities without the use of final-product storage, continuous in-line blending is the only satisfactory system.

To provide examples of the wide-ranging manufacturing process descriptions, five commonly used additives were selected. Information on the following additives is provided(7):

Name	Primary Functions
Polyalkenyl succinimide	Dispersant
Zinc dialkldithiophosphate	Oxidation, corrosion, and wear inhibitor
Overbased magnesium sulfonate	Detergent
Modified ethylene-propylene copolymer	VI improver-dispersant
Overbased calcium phenate	Detergent

Process for Polyisobutenyl Succinimide

The major reactions for this process are the formation of polyisobutenyl succinic anhydride by the reaction of polyisobutene with maleic anhydride followed by the acylation of an amine by the polyisobutenyl succinic anhydride.

Chlorine is used to promote the reaction between polyisobutene and maleic anhydride. A mixture of the reactants is chlorinated at 180°C (356°F) for 5 hours and then, after excess maleic anhydride is stripped out under vacuum, the batch is dehydrochlorinated by heating it to 210°C (410°F). The reaction product is mixed with tetraethylene pentamine and held at 160°C (320°F) for 4 hours to complete the formation of the product, polyisobutenyl succinimide. The batch is filtered and diluted to 50% concentration with mineral oil.

Process for Zinc Dialkyldithiophosphates

Zinc dialkldithiophosphates are prepared by the reaction between P_2S_5 and one or more alcohols to form a dialkyldithiophosphoric acid, followed by neutralization of the acid with zinc oxide.

Solid P_2S_5 is added to a mixture of isobutyl and amyl alcohols at 70° to 80°C (160° to 180°F), with the evolution of H_2S. The acid reaction product is stripped of residual H_2S by blowing with nitrogen, and is neutralized with solid Zn0 at 80° to 85°C (175° to 185°F). The batch may be diluted with 10-20% mineral oil, and filtered.

Process for Overbased Magnesium Sulfonates

Sulfonates for oil additives are prepared by neutralizing an oil-soluble sulfonic acid with a metal base, usually a hydroxide or oxide of Ca, Mg, or Ba. If a highly alkaline "overbased" product is desired, a large excess of metal based is used, and CO_2 is injected into the mixture, to form a stable colloidal dispersion of metal salt which does not separate from the sulfonate.

In the process for making an overbased Mg sulfonate, alkylbenzenes (by-product from detergent manufacture) are sulfonated with a mixture of SO_3 and air. The sulfonic acid is diluted with heptane and neutralized with a stoichiometric amount of MgO. The additional MgO required for overbasing is then dispersed into the solution and carbonated at about 52°C (125°F) by injecting gaseous CO_2 into the mixture. A small amount of activator solution containing methanol, ammonia, and water is added to promote the formulation of a stable colloidal dispersion of basic Mg compounds. The product is diluted with oil to a concentration of about 40% and purified by filtration and distillation.

Process for Ethylene-Propylene Copolymer

Copolymers of ethylene and propylene or terpolymers of ethylene, propylene and a diene (EPDM polymers) are rubbery substances that can be used along as VI improvers or polymerized with various nitrogen-containing compounds to form multifunctional VI improver-dispersants. Our process is for an EPDM VI improver-dispersant.

An EPDM polymer (made from ethylene, propylene, and 1,4-hexadiene) is dissolved in hot oil at about 140°C (284°F). It is then polymerized with dimethylaminoethyl methacrylate at 140°C (284°F). Dicumyl peroxide is used as a free-radical initiator. The product is diluted with oil and purified by vacuum distillation and filtration. The product contains about 12% polymer.

Process for Overbased Calcium Phenate

Phenates used for oil additives are typically made by reacting alkylphenols or alkylphenol sulfides within alkaline earth metal base such as an oxide of Ca, Mg, or Ba. Overbasing is accomplished by carbonating with gaseous CO_2.

In the process for an overbased sulfurized Ca alkylphenate, a mixture of dodecylphenol, elemental sulfer, and CaO are reacted at 135°C (275°F) in the presence of ethylene glycol, which acts as a mutual solvent and promoter for the reaction. Hydrogen sulfide is formed as a by-product and is removed by blowing nitrogen through the batch. The reaction product is carbonated with CO_2 at 150°C (302°F) under a pressure of 85 psig. It is then diluted with oil to a concentration of 42% and is purified by filtration and vacuum distillation.

End Use General Information

The most significant dermal contact and environmental releases associated with lubricant oil additives occurs during the end use of the product. The dermal contact occurs while removing spent oil and adding new oil to automobiles or machinery. The environmental releases result from the disposition of used oil.

Exhibit 2 presents the volumes of oil consumed in various end use applications. In estimating dermal exposure and environmental releases, we have focused on the Automotive uses. The reasoning is that persons handling oil in industrial settings will be more likely to wear personal protective equipment and so the dermal exposure will not be as high. Also, industrial users will employ proper used oil handling procedures, therefore the environmental releases may be lower than those in the automotive service. Note that a significant amount of incineration release from oil used in industrial applications is not considered in our analysis.

A basic assumption we have made is that oil produced that contains the PMN will be allotted among the automotive and industrial applications in the same proportions as are presented in exhibit 2. If one knows that the end uses for lube oils containing the PMN will be significantly different than those presented in exhibit 2 than he/she may want to adjust the exposure/release estimates accordingly.

When estimating dermal exposure in the automotive industry, we considered three scenarios. The first is a general automotive shop. Frequently, employees in these shops will change oil in automotive crankcases. We also considered pure lube oil change shops. These are service centers that specialize in oil changing and employees in these shops may receive a higher exposure to lubricant oil additives than employees in general automotive shops. There are about 4,000 such pure lube shops in operation (15), and each shop has, on average, 4 employees that work with the oil. Note, there are employees in the general automotive category that have jobs similar to employees in the pure lube shops, but those persons are not included in the pure lube category. Finally, we considered the do-it-yourself market. Approximately 3.4 million persons change their own oil each year (17). The exposure for these individuals is not great because of the relative infrequency with which they change oil. However, the environmental releases associated with this group are significant.

Exhibit 3 presents the disposition of used oil from automotive crankcases in 1988 (16). Note that 83.2 % of the used oil handled by automotive and pure lube shops is burned, and that 90.7 % of the used oil handled by the do-it-yourself persons is either dumped or landfilled. We have assumed that the oil handled by these two groups will be disposed of in the same fashion.

Exhibit # 2
Inital Review Engineering Report
Lubricant Oil Additives
Automotive and Industrial Oil Sales
by Distribution Channel

			MM gal per yr	% of total
Automotive:	Retail			
	Quick lube *	130		
	General automotive *	389		
	Retail sales (DIY) *	255		
	Total Retail		774	31.3%
	Commercial accounts		467	18.9%
	Factory (initial lubricant fill)		54	2.2%
	Undistributed (not classified)		135	5.5%
	Total automotive		1,430	57.8%
Industrial:				
	General industrial oils		394	15.9%
	Metalworking fluids		113	4.6%
	Process oils		391	15.8%
	Industrial engine oils		145	5.8%
	Total industrial		1,042	42.2%
	Total overal		2,472	

* Subcategories for the automotive retail sales are based on estimates that 33% of the retail market is DYI and 25% of the non-DYI market is quick lube.

Source: National Petroleum Refiners Association
1990 Report on U.S. Lubricating Oil Sales

Exhibit # 3
·itial Review Engineering Report
.ubricant Oil Additives
Automotive Crankcase Oil Disposition

	Auto Service Stations		Do-It-Yourself	
	MM gal per yr	% of Total	MM gal per yr	% of Total
Disposition				
burned	258	83.2%	8	4.1%
Lube oil and non-fuel	28	9.0%	10	5.2%
dumped	15	4.8%	118	60.8%
landfilled	5	1.6%	58	29.9%
road oiling	4	1.3%	0	0.0%
Total Used Oil Handled	310		194	

Source:

Clayton Environmental / TBS
RIA, Used Oil
Revised 1988 Gasoline Crankcase Used Oil Flows in the U.S.
February 1992

Assumptions and Sample Calculations

This section contains sample calculations pertaining to the one-page worksheets. The sources for the data and assumptions are represented by a number in parenthesis which refers to the numbers on the reference page.

General

SAMPLE CALCULATIONS

1 Total lube oil prdn containing additive(MMgal/yr) =
{ Additive Prdn Vol (kg PMN/yr)/(.01 kg PMN /kg lube oil) } * gal oil /lb oil * lb/kg /1,000,000
Note: this procedure taken from reference (17).

Assume, additive production (kg/yr)	1,000,000	
Assume additive concentration in lube product (wt/wt)	0.01	(6)
Data, Lube Oil Specific Gravity	0.9	(11)
Conv. factor, 0.133 gal/lb oil * 2.2 lb/kg/1,000,000	2.935E-07	
Lube prdn w/ additive(MM gal oil/yr) = (1,000,000/0.01)* 2.935 E-7	29.3	

2 Percent of total lube market = Production of lube containing additive / Total lube production

Calculation above (1), Production of lube containing additive (MM ga	29.3	
Data, Total lube production (MM gal/yr)	2,472	(12)
Percent = 29.3 / 2472	1.2%	

Manufacturing

3 # manufacture sites using PMN

Assume # of sites equals	2	(1)

Because of economic competition, manufacture of a new PMN will limited to a small # of sites.

4 # Manf. workers exposed = # of manf. sites * # workers per site * % of workers exposed

Assume # of sites equals	2	(1)
Data, plant employees per site	45	(2)
Assume, % of plant employees exposed	50%	(1)
# manufacturing employees exposed = 2 * 45 * 0.50	45	

5 Manf. water release(kg PMN/site/day) = Release per batch * # batches per site per yr / days operation per yr

Release per batch (kg PMN/batch)	1,013	(4)
Assume, releases for the LOA cited in the Federal Register are applicable to the releases associated with this PMN.		(1)
Assume, batches per year	20	(1)
Assume, days of operation per year	350	(1)
Water release (kg PMN/site/day) = 1,013 * 300 / 350	58	

6 Manf. land release(kg PMN/site/yr) = Release per batch * # batches per site per year

Release per batch(kg PMN/batch)	390	(4)
Assume, releases for the LOA cited in the Federal Register are applicable to the releases associated with this PMN.		(1)
Assume, batches per year	20	(1)
Land release(kg PMN/site/yr) = 390 * 300	7,800	

SAMPLE CALCULATIONS

7 Lube production per blend site (MM gal/yr/site) =
Typical refinery crude capacity (bpd) * lube yield on crude * gal/bbl * days/yr / 1,000,000

Assume, typical refinery crude capacity (bbls/day)	100,000	(##)
A .me lube yield on crude (vol/vol)	0.01	(##)
Conversion factor, 42 gal/bbl * 350 days/yr / 1,000,000	0.0147	
Lube production per site (MM gal/yr/site) = 100,000 * 0.01 * 0.0147	14.7	

8 # of blend sites exposed = Total Lube prdn containing additive (MM gal/yr) / Lube production per site (MM gal/yr/site)

Calc from above (1), Lube prdn w/ additive(MM gal oil/yr)	29.3	
Calc from above (7), Lube production per blend site (MM gal/yr/site)	14.7	
# blend sites = 29.3 / 14.7	2	

9 # Blend Employees exposed = # Blend sites * Employees per blend site * percent of employees exposed

calc from above (9), # blend sites	2	
Data, employees per blend site	30	(6)
Assume, percent of plant employees exposed	50%	(1)
# blend employees exposed = 2 * 30 * 0.5	30	

10 Blend Water Release(kg PMN/site/day) = refinery lube oil discharge limit * PMN concentration in lube oil

lube oil discharge limit (kg lube oil/1,000 cu. meter crude day)	4.39	(##)
Assume, typical refinery 100,000 bpd crude oil	100,000	(##)
Assume, concentration of PMN in lube oil (wt/wt)	0.01	(6)
Calc, 4.39 kg lube oil/1,000 cu. meter crude day * 1 cu. meter/254.2 gal * 42gal/bbl * 100,000 bbls/day * 0.01 kg PMN/kg lube oil	0.07	

Note: assume all spills are realized as water releases.

11 # Gen Auto Sites using PMN = Total # Gen Auto sites * Percent of total lube market

Assume, uses of lubes with this additive are in the same proportion as industry overal		(13)
Data, # General auto sites	57,629	(14)
Calculation above (2), Percent of total lube market	1.2%	
# Gen Auto sites exposed = 75,734 * .012	684	

12 # of Gen Auto worker exposed = Total # Gen Auto worker * % worker exposed * % of total lube market

Data, Employees in Auto Service	222,720	(14)
Assume, percent of total employees exposed	70.0%	(13)
Calculation above (2), Percent of total lube market	1.2%	
# Gen Auto employees exposed = 1,800,018 * 0.7 * .012	1,851	

13 # of Pure Lube Sites Using PMN = Total # pure lube sites * percent of total lube market

Data, Total # pure lube shop	4,000	(15)
Calculation above (2), Percent of total lube market	1.2%	
# pure lube sites exposed = 4,000 * .012	47	

14 # pure lube employees exposed = Total # pure lube shops * Employees per shop * percent of employees exposed * percent of total lube market

Data, Total # pure lube shop	4,000	(15)
Data, total employees per shop	5	(15)
Data, percent of employees exposed	0.8	(15)
Calculation above (2), Percent of total lube market	1.2%	
# pure lube employees exposed = 4,000 * 5 * 0.8 * 0.012	190	

15 General Auto and Pure Lube incineration release (kg PMN/yr) =
total lube consumed by gen auto and pure lube (MMgal/yr) * percent total lube market
* gal used oil / gal virgin fill * used oil burned/total used oil * lbs/gal * kg/lb * kg PMN/kg oil * 1,000,000

Data, virgin oil consumed gen auto & pure lube (MM gal/yr)	518	(12)
Calculation above (2), Percent of total lube market	1.2%	
Data, percent used oil burned by auto service industry,	83.2%	(16)
Data, gal used oil per gal virgin fill in auto service	57.0%	(17)
Conv. factor, 7.5 lbs/gal*0.4545 kg/lb * 1,000,000	3,409,088	
Assume, PMN concentration (wt/wt)	0.01	(6)
Incineration = 518 * 0.012*0.832*0.57*7.5*0.45*0.01/1,000,000	99,516	

16 Gen Auto & Pure Lube Land release (kg PMN/yr) = total auto w/ PMN consumed by gen auto and pure lube (MMgal/yr) * percent of total lube market * gal used oil / gal virgin fill * used oil landfilled, road oil, dumped/total used oil * lbs/gal * kg/lb * kg PMN/kg oil * 1,000,000

Data, virgin oil consumed gen auto & pure lube (MM gal/yr)	518	(12)
Calculation above (2), Percent of total lube market	1.2%	
Data, % used oil landfilled by auto service industry	1.6%	(16)
Data, % used oil used dumped by auto service industry	4.8%	(16)
Data, % used oil used for road oiling by auto service industry	1.3%	(16)
Data, gal used oil per gal virgin fill in auto service	57.0%	(17)
Conv. factor, 7.5 lbs/gal*0.4545 kg/lb*1,000,000	3,409,088	
Assume, PMN concentration (wt/wt)	0.01	(6)
Landfill = 518*0.012*0.057*(0.016+0.048+0.013)*7.5*0.45*1,000,0	9,257	

SAMPLE CALCULATIONS

17 # DIY sites using PMN = total DYI cons.(MM gal/yr) * % market share * 1,000,000/ avg cons per DIY home(gal/yr)

Data, total DYI automotive consumption (MM gal/yr)	255	(12)
Data, oil consumption per DYI household per year (gal/yr)	8.4	(17)
Calculation above (2), Percent of total lube market	1.2%	
# DIY sites using PMN = 255 * 0.012 * 1,000,000 / 8.4	360,814	

18 # DIY persons exposed = # DIY sites using PMN

Assume one person in each household perfoms all DIY oil changes		(17)
Calc from above (17), # DIY sites exposed	30	
Calculation above (2), Percent of total lube market	1.2%	
# DIY employees exposed = 74,548	360,814	

19 DIY Incineration release (kgPMN/yr) =
total lube consumed by DYI * % of market * vol used oil/vol virgin fill * lb/gal * kg/lb * kg PMN/kg oil

Data, virgin oil consumed DIY market (MM gal/yr)	255	(12)
Assume, concentration of PMN in lube oil (wt/wt)	0.01	(6)
Calculation above (2), Percent of total lube market	1.2%	
Data, percent DIY used oil burned	4.1%	(16)
Data, volume used oil per volume virgin fill in DIY service	70.0%	(17)
Conv. factor, 7.5 lb/gal * 0.4545 kg/lb * 1,000,000	3,408,750	(11)
Incineration release (kg PMN/yr) = 255 * 0.01 * 0.012 * 0.041 * 0.7	2,982	

DIY Land release (kgPMN/yr) =
total lube consumed by DYI * % of market * vol used oil/vol virgin fill * lb/gal * kg/lb * kg PMN/kg oil

Data, virgin oil consumed DIY market (MM gal/yr), exhibit 1	255	(12)
Assume, concentration of PMN in lube oil (wt/wt)	0.01	(6)
Calculation above (2), Percent of total lube market	1.2%	
Data, percent DYI used oil dumped	60.8%	(16)
Data, percent DYI used oil landfilled	29.9%	(16)
Data, volume used oil per volume virgin fill in DIY service	70.0%	(17)
Conv. factor, 7.5 lb/gal * 0.45 kg/lb * 1,000,000	3,408,750	(11)
Land Release(kg PMN/yr)=255*0.01*0.012*(.608+0.299)*0.70*16,	65,610	

REFERENCES

1. Professional engineering judgement of Robert Cappabianca.

2. Private communication with additive manufacturers.

3. Chemical Engineering Branch Manual for the Preparation of Engineering Assessment. Prepared for the U.S. Environmental Protection Agency (February 28, 1991).

4. Federal Registrar, Vol. 49, No. 141, page 29453, PMN-84-941, July 20, 1984.

5. Private communication with blending industry representative.

6. Walk, Haydel, and Associates, Inc., Industrial Process Profiles to Support PMN Review: Lube and Fuel Additives, OTS, USEPA, (no date).

7. SRI International, Lube Oil Additives, Report No. 157, May 1983.

8. Ozimek Data Corporation, G. Willette and R. Ozimek, Additives for Lubricants, A Time for Change, paper presented at the NPRA National Fuels and Lubricants Meeting, November 2-3, 1989.

9. Kirk-Othmer, Encyclopedia of Chemical Technology, Vol. 14, page 477-526.

10. SRI International, Specialty Chemicals, Strategy for Success, Vol. 6, November 1990.

11. Perry's Chemical Engineering Handbook, 5th Edition

12. National Petroleum Refiners Association, 1990 Report on U.S. Lubricating Oil Sales

13. Professional engineering judgement of Phil DiPietro

14. Bureau of Labor Statistics, Employment and Wages Annual Averages 1990, November 1991, General Automotive Repair Shops, SIC 7538

15. Convenient Automotive Services Institute, Letter to the EPA in response to the used oil listing effort, November 7, 1991 and follow-up conversation with personnel associated with the Institute.

16. Clayton Environmental / TBS, RIA for used oil February 2, 1992 and follow-up conversations with personnel associated with Clayton Environmental

17. Versar Inc., Exposure Assessment for Lubricant Additives, EPA contract No. 68-01-6271 Task no. 25, July 19, 1982

18. Science Applications International Corporation, Virgin Oil Characterization (Draft), EPA Contract No. 68-01-7490, January 31, 1990

19. U.S. Environmental Protection Agency, Office of Toxic Substances, Approaches for Developing Screening Quality Estimates for Occupational Exposure Used by the U.S. EPA's Office of Toxic Substances and their Applicability to the OECD SIDS Program, December 20, 1991