

CONSUMED IN USE STUDY:

DRAFT REPORT

August, 2005

Rob Spence - Consultant

Prepared by

Rob Spence

EXECUTIVE SUMMARY

The purpose of this consumed in use study was to develop a lubricating oil consumption standard with the following deliverables:

1. Consumption rates by product type and class of trade expressed as a percentage of virgin oil sales.
 - *The percentage of consumed in use for B.C. is **30.1%***
2. Expected future trends in consumption rates by product type and class of trade
 - *Future trends for lubricant use within classes of trade are the result of conversations with end users and industry experts. The consultant has summarized these comments and added some personal opinion to the mix. Overall, the consumed in use factors for lubricants have been steadily improving, (i.e. reduced consumption), for years, and the combination of technological improvements, fleet turnovers, and environmental awareness should ensure that the trend continues for the foreseeable future.*
3. Used oil lost through oil filter collection and processing operations
4. Virgin oil lost through oil container collection and processing operations.
 - *The scope of this project was changed part way through the study to limit the development of the consumption standard to, “consumed in use” as opposed to a more encompassing, “available, (or not available), for collection”. Components such as oil in filter and container losses, plus other losses are discussed in the conclusion section of this report, but they do not form part of the consumed in use calculations.*
5. Recommendation as to how this standard could be peer reviewed.
 - *Aside from individual OEM’s, the two organizations that have knowledge of lubricant use in equipment and which industries use them heavily, are oil company and oil sellers, and collector/processors. Representatives of these organizations are on the BCUOMA board and could delegate appropriate personnel in their organizations to review this report.*

TABLE OF CONTENTS

1	Introduction.....	1
2	Method of Approach.....	2
2.1	Factors considered in CIU Volume Calculations.....	2
2.1.1	Virgin Oil Sales.....	2
2.1.2	Market Share by Class of Trade.....	3
2.1.3	Consumed in Use Factors	3
2.2	Overall CIU Volume Calculation	4
3	Results & Analyses.....	6
4	Future Trends and Conclusions	7
4.1	Future Work.....	7
5	Tables.....	9

TABLE OF TABLES

Table 1	2004 sales from 2005 Lubricants Profile Report Data - (thousands of liters)	9
Table 2	Market Share % by Industry Class of Trade	10
Table 3	Consumed in Use factors	11
Table 4	Consumed in Use volumes.....	12
Table 4a	Class of Trade CIU as a percentage of the total CIU.....	13
Table 4b	CIU as a percent of product virgin oil sales.....	13

1 INTRODUCTION

This study was undertaken to calculate consumed in use rates for EHC applicable lubricants within lubricant using industries, and apply the rates against sales numbers that are representative for those industries. The result is consumed in use volumes and percentages for lubricants within industry classes of trade.

The work was approved to proceed in 3 phases as follows:

1. Road mapping – determination of a data gathering methodology
2. Data gathering – using phase 1 methodology.
3. Data compilation, analysis and report writing.

It was agreed early on that the data gathering methodology would be a combination of end user interviews, OEM information, and industry expert opinions, including the consultant's experience with lubricants and their application. Heavy weighting was given to the end user data, as users are often the only ones that know how much oil is added between drain intervals.

It was also agreed early on that hard data would not be available for all products and industries regardless of how much time was devoted to the study. Extrapolating data with opinions and best estimates would be used whenever the hard data was not available.

The consumed in use (**CIU**) numbers are calculated by multiplying the consumed in use factors by lubricant/industry market shares, against lubricant sales.

- **Lubricant sales volumes** were taken directly from the 2005 Lubricants Profile Report.. A chart showing the sales and the percentage they represent of total EHC applicable sales is in the table section.
- **Market share** was arrived at by a combination of Statistics Canada GDP analysis, and industry expert opinion. The market share chart is in the table section.
- **Consumed in use factors** are the result of all the end user and industry expert interviews, weighed against the consultant's experience. Included in a separate section under section 2 "method of approach" is an example for heavy duty engine oil and passenger car motor oil calculations, as collectively they represent ~50% of EHC sales. In addition to high volume, heavy duty engine oil is used in all industry classes of trade and a separate consumed in use calculation was made for each industry.

2 METHOD OF APPROACH

BCUOMA nominated specific oil company board members as contacts for the consultant. He also used his own industry contacts developed over years as an oil company technical specialist in lubricant applications. The consultant confirmed with those contacts what the principal lubricant using industries in their respective areas were, and in most instances obtained lists of their customers to contact. The consultant spent two months traveling throughout B.C. documenting end user and industry expert interviews. Most end user data was gathered by documenting drain intervals and sump sizes for various pieces of equipment and either documented oil top ups, or estimates of oil additions between drains.

Passenger car motor oil from the outset required a different approach, and luckily one of the board members of MARRC, Joe Casciano, agreed to solicit oil change and top up data from his customers at Canadian Tire. The result of this data and a similar program with Mr. Lube totaled over 194 customer/vehicle samplings which formed the consumed in use factors for passenger cars and light trucks.

The lubricants selected for analysis are from R.W. Hodgson's Lubricants Profile Report. The top selling eight lubricants represent over 90% of EHC applicable sales, and the consultant bundled the remaining five lubricants under an "all other" category.

The industry classes of trade were selected by a combination of Statistics Canada GDP analysis, the oil company representatives' input, and the consultant's knowledge of lubricant applications. The result of this compilation of data was a lubricant within industry class of trade market share report which is included in the body of this report.

The consultant limited the categories to the broader definitions and resisted displaying sub categories. As an example, forestry is not broken down to components such as logging, sawmills, pulp & paper etc. but their varying lubricant use was factored into the consumed in use calculations. In other industries with multiple businesses, the varied lubricant use was also considered.

The final report contains the consumed in use numbers for each product, and industry class of trade and the results section contain analyses of the data presented.

2.1 Factors considered in CIU Volume Calculations

Three factors comprise the Consumed in Use (CIU) volume calculations presented later in this report: Virgin oil Sales numbers, Market Share by Class of Trade and Consumed in Use factors (%CIU).

2.1.1 *Virgin Oil Sales*

Table 1 shows the virgin oil sales taken directly from the 2005 Lubricants Profile Report. The sales are by major product and the percentage that each represents of total B.C. Sales.

2.1.2 Market Share by Class of Trade

Table 2 shows the % Market Share by Industry Class of Trade.

Assigning market share for products within industry classes of trade was an evolving process. Initially, eight of the top rated “lubricant using industries” were selected from Statistics Canada GDP Reports. These findings could not be applied directly against all product groups. Some lubricants like marine engine oil and railroad engine oil are obvious in that they represent only one industry class of trade. Products like heavy duty engine oil and hydraulic oil are used in many different industries and they were assigned different percentages for the each industry. The assignment of percentages was the result of many discussions with OEM’s, oil company and oil seller representatives, oil collector/processors, and the consultant’s own knowledge of industry lubrication application requirements.

2.1.3 Consumed in Use Factors

The consumed in use percentage factors for each product and industry class of trade were calculated by combining and massaging the data collected from the end users and industry expert interviews. By definition, consumed in use factor is calculated using the following formula:

$$\% CIU = \text{oil added to equipment between drain period} / \text{oil purchases in the same time period}$$

Tables 6 shows the calculated consumed in use factors. To illustrate the data collection and analyses, two examples of the % CIU calculation are presented here; one for heavy duty engine oil in the trucking industry, and one for passenger car motor oil.

Example 1 - Heavy Duty Engine Oil in Trucking:

Highway Trucking – numbers below represent averages for their respective fleets.
(Consumption as a % of total purchases, additions and the sump size)

- Company A = 4-6 L on 40 L sumps = $5/45 = \underline{11.1\%}$
- Company B = $6.4/49.4 = \underline{13.0\%}$
- Company C = $6/56 = \underline{10.7\%}$
- Maxim Truck Rentals = $13.5/53.5 = \underline{25.2\%}$
- SAE Paper from 1988 documented oil consumption in Cat, Cummins and Mack highway truck engines at $26/92 = \underline{28.3\%}$ These vintage engines would not feature large in any current operation’s fleet, but any fleet with significantly older equipment will have definitely have higher average oil consumption.

Maxim’s info is somewhat questionable and is higher than the average of the other data.
Weighing the corroborating data 2:1 to Maxim, the mean average = 13.5%

In addition to this data which is primarily highway trucking and does represent the majority of HDEO, there are several other trucking categories without specific data. City buses, garbage

trucks, & dump trucks comprise the majority of this remaining sector and collectively they are all much higher consumed in use services – best estimate 30%, and contribution to overall trucking market share - 20%.

Mean average consumed in use for all trucking is adjusted to **16.8%**

Example 2 – Passenger Car Motor Oil:

PCMO Usage from 194 vehicles (pickups and wide variety of passenger car types) monitored by Canadian Tire & Mr. Lube

1. 2000 and newer vehicles:
 - 105 vehicles out of 194
 - 67 vehicles had no oil added between drains
 - 38 vehicles had oil added
 - average oil consumption = 29.5 L / 105 = 0.28 L
 - average sump size = 5.0 L
 - consumed in use $-.28/5.28 = 5.3\%$

2. 1999 and older vehicles:
 - 89 out of 194 vehicles
 - 37 vehicles had no oil added between drains
 - 52 vehicles had oil added
 - average oil consumption = 48.0 L / 89 = 0.54 L
 - average sump size = 5.0 L
 - consumed in use $-.54/5.54 = 9.7\%$

Average consumed in use for all vehicles = $105/194 \times 5.3\%$ plus $89/194 \times 9.7\% = 7.3\%$

The nature of this data gathering effort would likely always err on the forgetful side for oil additions. It also does not account in anyway for the DIY market which arguably may have a higher oil consumption factor. For these the average is rounded up to **8.0%**.

NOTE - In the early stages of the study, a wealth of fleet data was gathered for the western provinces, breaking down vehicle type and age. Because this consumed in use calculation was based on a large number of vehicles, (194), the idea of tailoring the consumption to a provincial fleet was deemed overkill. An extreme adjustment to account for provincial fleet variation would probably be 1.0 % down or up in consumption and this only amounts to only ~200,000L of consumed in use oil for B.C.

2.2 Overall CIU Volume Calculation

Summarizing, the calculation for total CIU volume of a given product type for a given class of trade can be summarized as follows:

CIU Volume (liters) = Virgin Oils x Market Share x CIU factor

To further illustrate the calculation, the CIU volume for passenger car motor oil (Product Type) in the automotive industry (Class of Trade) for British Columbia is as follows:

$$\text{CIU Volume (liters)} = 22,810,000 \text{ liters} \times 85\% \times 8\% = 1,551,080 \text{ liters}$$

The CIU Volume results are summarized in a table in Section 5 :

- **Table 4** – CIU Volumes by Product Type and Class of Trade
 - Table 4a - Class of Trade CIU as a percentage of the total CIU
 - Table 4b - CIU for each Product Type as a percentage of the product's virgin oil sales.

3 RESULTS & ANALYSES

The results provide an interesting comparison of overall consumed in use volumes and percentage of virgin oil sales with the number that the BCUOMA has used in the past. BCUOMA has used 35.5 % and this report estimates the number at **30.1%**.

Some interesting analyses highlights are:

- Passenger car motor oil and ATF which are predominantly used in the automotive class of trade, represents 28.5% of all EHC applicable sales, but the consumed in use factors are very low at 8.0% and 4.0% respectively. The impact of these lubricants and class of trade on overall consumed in use is much lower than anticipated.
- Trucking averages 30% of the heavy duty engine oil market share by sales, but contributes only 4.3% of the total consumed in use volume of virgin EHC total oil sales. This again is due to the relatively low overall consumed in use factor, (17%), applied to this category. Trucking's contribution to consumed in use is lower than expected.

There is a gap between consumed in use and what is available for collection. Although this study did not attempt to quantify available for collection volumes, the consultant did encounter some creative handling methods for used oil and they are listed below:

- By far the biggest removal of used oil from the collection pool was oil used in space heaters.
- Many industries; forestry, logging, sawmills, etc. that have chain drives, utilize used oil for chain and other lubrication uses.
- Some engine manufactures; Caterpillar and Cummins for example, manufacture metering devices to allow used engine oil to be mixed with diesel and burned in the engine, although this could be considered consumed in use
- Although it was not verified, the oil and gas industry has in the past routinely disposed of used oils by pouring them back down drill holes.
- From time to time end users will return stale dated product to a supplier. The sale still stands and the final resting place for the product is varied.
- Although its disposal is likely proper, there are retains of oil in every oil container from 1 L to 200 + L drums that does not necessarily get accounted for, i.e. it is not consumed in use, and not always available for collection.

4 FUTURE TRENDS AND CONCLUSIONS

- Internal combustion engines have seen dramatic improvement in oil consumption especially in the last decade of technological changes.
- Some “fleets” turn over faster than others, and the most significant changes are in passenger car and light truck vehicles. Other “fleets” like the fishing fleet is very slow to change and adopt new technology. Highway trucking is some where in between.
- PCMO and HDEO collectively represent ~ 50% of the EHC applicable volumes. The rate of improvement in oil consumption in internal combustion engines is slowing, but the overall reduction in oil consumption will continue for years as fleets turnover and reap the benefits of lower oil consumption engines.
- Many industries that used to tolerate leakage and spills of lubricants no longer will, or are in the process of improving maintenance practices. Pulp mills that routinely allowed chronic leaking circulating systems to flow oil to effluent ponds for handling, now practice containment and capture for recycling, which effectively removes oil from the consumed in use category to available for collection.
- Environmental awareness and fines have combined to reduce leakage and spills in industries like logging and agriculture and others. This effectively reduces the consumed in use rates for many lubricants.
- Future lubricant consumption calculations will be influenced by which industries are in decline and those that are in growth mode. The consumed in use factors assigned to those industries will determine the overall improvement in consumed in use for a region or province. An existing example is the oil & gas industry which has high consumed in use numbers and will see large increases in lubricant volumes.

Overall, the consumed in use rates for lubricants have been steadily improving for years, and the combination of technological improvements, fleet turnovers, and environmental awareness should ensure that the trend continues for the foreseeable future.

4.1 Future Work

It is the opinion of the consultant that the consumed in use factors for lubricant use in various types of equipment, and the industry market share calculations for lubricants, is open to scrutiny, but the methodology for gathering the data proved to be sound. There is no argument that the accuracy of the report could be improved by simply accumulating more data points. Regardless of adjustments, the consumed in use factors can be applied to other regions and to future volume reports.

If any further work on the consumed in use standard is undertaken, it should focus on gaining better access to those industries and products used that make a significant impact on the overall consumed in use volumes. The best way to gain access is by following the same methodology employed in this study, which is to have oil company, or oil seller representatives initiate meetings with their customers. Some end users, (customers), need long lead times.

Some potential weak data areas in this study that would benefit from additional data are:

- Marine – marine engine oil, which is primarily B.C. Ferries.
- Agriculture – ideally attend one of their association meetings, and be on their meeting agenda.
- Railroad – need data from CNR.

5 TABLES

Table 1 – 2004 sales from 2005 Lubricants Profile Report Data - (thousands of liters)

PRODUCT	B.C.	TOTAL CANADA
Paper Machine Oil	689 0.7%	4303
Compressor Oil	1325 1.4%	7338
Circulating/Turbine Oil	1110 1.2%	10064
Industrial Gear Oil	2464 2.8%	16504
Automotive Gear Oil	2368 2.5%	18813
Marine Engine Oil	4018 4.2%	16155
Railroad Engine Oil	2780 2.9%	17558
Tractor Hydraulic Fluid	4973 5.2%	38315
Automatic Transmission Fluid	4506 4.7%	246404
Natural Gas Engine Oil	8286 8.7%	48726
Hydraulic Oil	16093 16.8%	101336
Heavy Duty Engine Oil	24287 25.4%	178149
Passenger Car Motor Oil	22810 23.8%	246404
EHC APPLICABLE TOTALS	95709	950069

Table 2 – Market Share % by Industry Class of Trade

Industry Classes of trade	Lubricants								
	Passenger Car Motor Oil	Heavy Duty Eng. Oil	Hydraulic fluid	Tractor Hydraulic fluid	ATF	Railroad Eng. Oil	Natural Gas Eng. Oil	Marine Eng. Oil	*All other
Automotive	85	-	-	-	90	-	-	-	20
Agriculture	-	5	5	90	-	-	-	-	5
Construction	-	10	20	-	2	-	-	-	10
Forestry	5	20	50	-	2	-	-	-	25
Marine	-	10	-	-	-	-	-	100	2
Mining	-	5	5	-	-	-	-	-	5
Oil and Gas	-	10	10	-	-	-	100	-	5
Trucking	5	30	-	-	6	-	-	-	15
Railroad	-	2	-	-	-	100	-	-	3
Utilities	-	3	-	-	-	-	-	-	5
All other	5	5	10	10	-	-	-	-	5
Totals	100	100	100	100	100	100	100	100	100

***All other products:** Paper Machine Oil, Compressor Oil, Turbine Oil, Industrial Gear Oil, Automotive Gear Oil

Table 3 – Consumed in Use factors

Industry Classes of trade	Passenger Car Motor Oil	Heavy Duty Eng. Oil	Hydraulic Fluid	Tractor Hydraulic Fluid	Automatic Transmission Fluid	Railroad Eng. Oil	Natural Gas Eng. Oil	Marine Eng. Oil	**All other
Automotive	8%	-	-	-	4%	-	-	-	5%
Agriculture	-	34%	20%	20%	-	-	-	-	10%
Construction	-	41%	20%	-	4%	-	-	-	10%
Forestry	8%	57%	30%	-	4%	-	-	-	20%
Marine	-	61%	-	-	-	-	-	60%	20%
Mining	-	39%	30%	-	-	-	-	-	20%
Oil and Gas	-	37%	30%	-	-	-	80%	-	20%
Trucking	8%	17%	-	-	5%	-	-	-	20%
Railroad	-	100%	-	-	-	63%	-	-	20%
Utilities	-	45%	-	-	-	-	-	-	20%
All other	8%	20%	30%	20%	-	-	-	-	20%

**** All other products: paper machine oil, compressor oil, turbine oil, industrial oil, automotive gear oil**

Table 4 – Consumed in Use volumes

	Lubricants									
Industry Classes of trade	Passenger Car Motor Oil	Heavy Duty Eng. Oil	Hydraulic Fluid	Tractor Hydraulic Fluid	Automatic Transmission Fluid	Railroad Eng. Oil	Natural Gas Eng. Oil	Marine Eng. Oil	**All other	Total
2004 volume Thousands/L	22810	24287	16093	4973	4506	2780	8286	4018	7956	95709
Consumed in use volumes										
Automotive	1551	-	-	-	162	-	-	-	78	1791
Agriculture	-	418	161	895	-	-	-	-	40	1514
Construction	-	988	644	-	4	-	-	-	80	1716
Forestry	91	2774	2415	-	4	-	-	-	398	5682
Marine	-	1491	-	-	-	-	-	2411	32	3934
Mining	-	472	241	-	-	-	-	-	80	793
Oil and Gas	-	899	483	-	-	-	6629	-	80	8091
Trucking	91	1224	-	-	11	-	-	-	239	1565
Railroad	-	486	-	-	-	1738	-	-	48	2272
Utilities	-	328	-	-	-	-	-	-	80	408
All other	91	243	483	100	-	-	-	-	80	997
Totals	1824	9323	4427	995	181	1738	6629	2411	1235	28763

30.1% of EHC applicable sales are consumed in use

**** All other products: paper machine oil, compressor oil, turbine oil, industrial oil, automotive gear oil**

Table 4a – Class of Trade CIU as a percentage of the total CIU

Industry Classes of trade	% CIU by COT
Automotive	6.2%
Agriculture	5.3%
Construction	6.0%
Forestry	19.8%
Marine	13.7%
Mining	2.8%
Oil and Gas	28.1%
Trucking	5.4%
Railroad	7.9%
Utilities	1.4%
All other	3.5%

Table 4b – CIU as a percent of product virgin oil sales

Product Type	% CIU by Product
Passenger Car Motor Oil	8.0%
Heavy Duty Eng. Oil	38.4%
Hydraulic Fluid	27.5%
Tractor Hydraulic Fluid	20.0%
Automatic Transmission Fluid	4.0%
Railroad Eng. Oil	62.5%
Natural Gas Eng. Oil	80.0%
Marine Eng. Oil	60.0%
All other	15.5%