

Gatineau, Quebec  
K1A 0H3

October 31, 2002

To: Distribution

### **The 2001 Report on Benzene in Gasoline**

Please find enclosed Environment Canada's annual report on benzene in gasoline for the year 2001. Under the *Benzene in Gasoline Regulations of the Canadian Environmental Protection Act, 1999*, refiners and importers of gasoline are required to submit quarterly reports on gasoline composition to Environment Canada and, for those electing to meet yearly pool average requirements, an annual report on compliance by an auditor. This report summarizes the information provided by refiners and importers for the year 2001. The report provides information on gasoline composition, both regionally and by company, as well as reviewing refiners' and importers' compliance with the regulations.

The regulations have been successful in effecting the reduction in benzene levels in gasoline that was recommended by the Task Force on Cleaner Vehicles and Fuels and endorsed by the Canadian Council of Ministers of the Environment. The report shows that benzene levels have been significantly reduced from a pre-regulation average of 1.6% by volume to a current average of 0.7% by volume – over 50% reduction. Over the same time period, ambient benzene levels fell by 45%.

If you have questions on the report, please contact Jeffrey Guthrie at 819-956-9279.

Yours truly,

Bruce McEwen  
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Oil, Gas & Energy Branch

enclosed



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# **Benzene in Canadian Gasoline: Report on the Effect of the Benzene in Gasoline Regulations 2001** Environment Canada

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October 2002



**Environment Canada**

**Benzene in Canadian Gasoline**

**2001**

**Notice**

The information contained in this report is compiled from data submitted by the producers and importers of gasoline in Canada pursuant to the requirements of the *Benzene in Gasoline Regulations* under the *Canadian Environmental Protection Act, 1999*. Submissions have been verified for reasonableness but are subject to potential errors made at the source.



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## 1.0 Summary

This report reviews how primary suppliers have responded to the *Benzene in Gasoline Regulations*<sup>1</sup> of the *Canadian Environmental Protection Act* and summarizes the effects the regulations have had on the composition of gasoline in 2001. All of the information summarized in this report was provided to Environment Canada by the primary suppliers, pursuant to the requirements of the regulations.

The *Benzene in Gasoline Regulations* came into effect on July 1, 1999, fulfilling a recommendation of the federal-provincial Task Force on Cleaner Vehicles and Fuels. In 1995, the Task Force recommended to the Canadian Council of Ministers of the Environment (CCME) that benzene in gasoline be reduced through a federal regulation to 1% by volume and that aromatics (or equivalent benzene tailpipe emissions) be frozen at 1994 levels. The CCME endorsed this recommendation. Consequently, the federal government passed the federal *Benzene in Gasoline Regulations* on November 26, 1997.

The *Benzene in Gasoline Regulations* introduced a new approach to controlling fuel composition by allowing regulatees the option to elect to use a yearly pool average as the basis for compliance. This option provides regulatees considerable flexibility in meeting the requirements of the regulations. The regulations are primarily focused on primary suppliers (refiners, blenders and importers) who can affect the composition of gasoline. There is also a per-litre limit for benzene at the point of sale. In addition to setting a limit for gasoline benzene content, the regulations also set a limit for the benzene emission number (BEN) of gasoline, a number that relates gasoline composition to estimated emissions of benzene from vehicles.

The regulations have been very successful in achieving both of the recommendations of the Task Force: reported benzene levels have been significantly reduced and reported aromatic levels are about the same as they were in 1994. Figures 1.1 and 1.2 show how benzene and aromatics levels have changed since the coming into force of the regulations. Figure 1.3 shows that average ambient benzene concentrations, measured at Environment Canada monitoring stations across Canada, have fallen by almost 70% since 1992 and 45% since 1998, the year prior to the regulation.

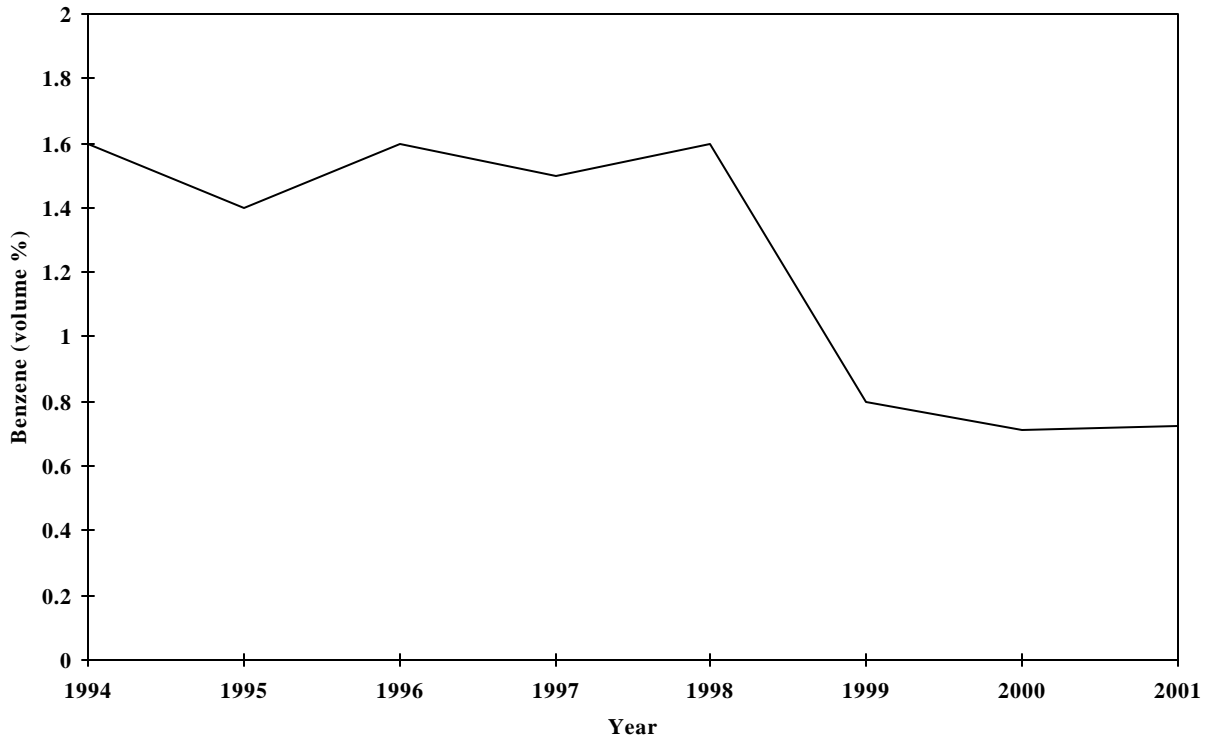
Primary suppliers reported that, with the exception of three reported maximum values, gasoline supplied in Canada in 2001 met the regulated requirements with respect to benzene concentration and BEN. Independent audits (required for those electing to be on a yearly pool average) found several instances of non-compliance with the administrative requirements of the regulations. Most primary suppliers outlined corrective action to address these issues. Environment Canada views the audits as a crucial component of the enforcement provisions of the regulations.<sup>1</sup>

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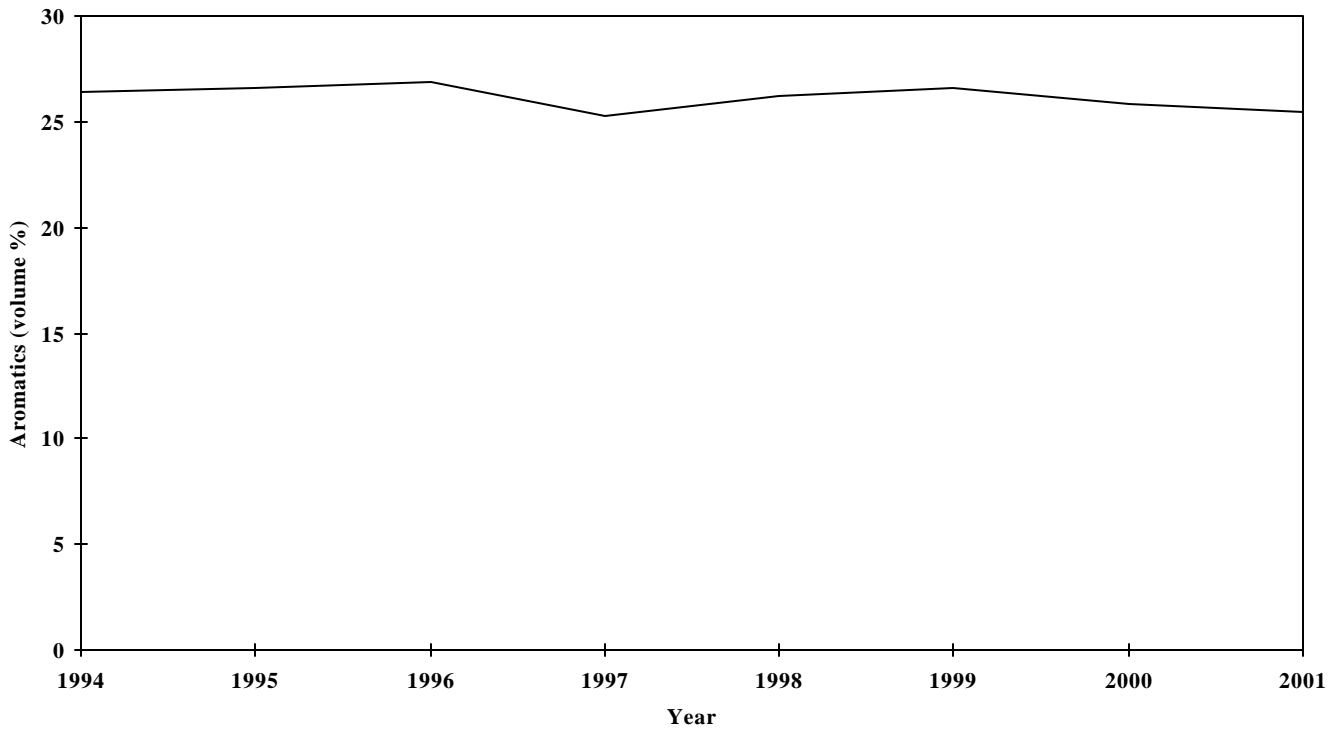
<sup>1</sup> SOR/97-493, as amended by SOR/99-204.



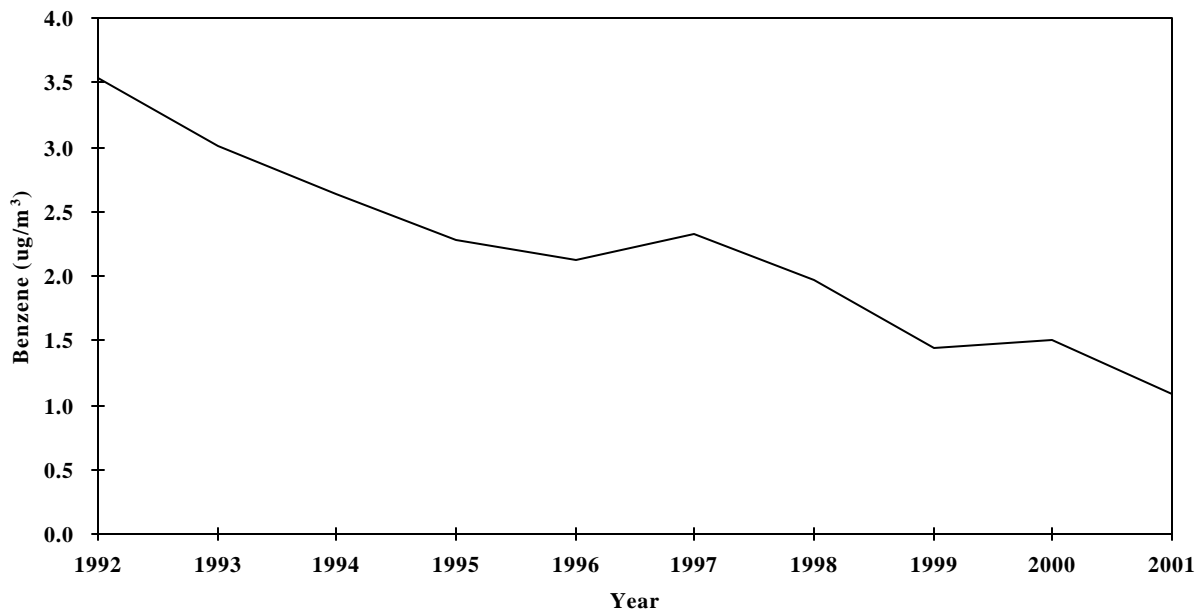
**Figure 1.1 : Average Benzene Content of Canadian Gasoline 1994-2001**



**Figure 1.2 : Average Aromatics Content of Canadian Gasoline 1994-2001**



**Figure 1.3 : Average Ambient Benzene Concentration in Canada  
1992-2001**



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Source: Tom Dann (Environment Canada), personal communication, 2002.

## 2.0 Introduction

### *2.1 Benzene in Gasoline Regulations*

This report reviews the compliance of primary suppliers' (refiners, importers and blenders) gasoline with the *Benzene in Gasoline Regulations*<sup>2</sup> of the *Canadian Environmental Protection Act, 1999*, and summarizes levels of various parameters in Canadian gasoline for 2001. The information used for this report was provided by primary suppliers, as required under the regulations.

The *Benzene in Gasoline Regulations* were passed in November 1997 in order to reduce emissions of benzene from gasoline-powered vehicles. The regulations limit the level of benzene and the benzene emission number (BEN)<sup>3</sup> of Canadian gasoline and require reporting on the composition of gasoline that is produced, imported or blended<sup>4</sup>. The regulations apply to all types of gasoline for sale or use in Canada, except gasoline for use in aircraft or competition vehicles or for use in scientific research.

As of July 1, 1999, primary suppliers are subject to limits on the level of benzene and the BEN in gasoline they produce, blend or import. Table 2.1 summarizes the regulated limits for benzene and the BEN.

Table 2.1 : Regulated Limits for Benzene and the BEN

	Type of Limit	Benzene % by volume	BEN (*)	
			Summer	Winter
Production, Blending and Imports	Flat Limit	1.0	71	92
	Options of Yearly Pool Average -YPA Limits	0.95	59.5 (annual average)	
	- Not-to-be-exceeded cap	1.5	102	132
Sales	Flat Limit	1.5	N/A	N/A

\* Four refineries use alternative limits for BEN (under subsection 17(2) of the regulations)

<sup>2</sup> SOR/97-493, as amended by SOR/99-204; a copy of the regulations can be found at [www.ec.gc.ca/CEPARRegistry/regulations/](http://www.ec.gc.ca/CEPARRegistry/regulations/)

<sup>3</sup> BEN - The Benzene Emission Number relates gasoline composition to the estimated emissions of benzene from vehicles. It is a number calculated using various gasoline parameters and relates gasoline composition to emissions of benzene from a "typical" 1990 vehicle. (see Schedule I of the Regulations)

<sup>4</sup> The definition of "blend" in the regulations excludes mixing of complying gasoline, or the adding of only additives, commercially-pure butane or oxygenate to complying gasoline.

The regulated limits apply to individual refineries, blending facilities, and imports into a province from outside Canada. A primary supplier can elect to use flat limits or a yearly pool average limit for each of its refineries, blending or import pools. The yearly pool average is the volume-weighted average of benzene or BEN of the gasoline supplied by the primary supplier during a year. The yearly pool average limit may be selected for either benzene, BEN, or both. A maximum benzene concentration of 1.5% applies at the point of sale of gasoline.

All primary suppliers must submit quarterly reports on the levels of various parameters of gasoline to Environment Canada. Importers must notify Environment Canada at least 12 hours in advance of their intention to import more than 100 m<sup>3</sup> of gasoline at one time or any amount of gasoline-like blendstock. Independent audits must be submitted to Environment Canada by companies electing to be on a yearly pool average for benzene, BEN or both.

## ***2.2 Alternative Limits for the BEN***

Under subsection 17(2) of the regulations, a primary supplier could elect before December 1, 1998 to use alternative (higher) limits for the BEN. These alternative limits are based on the historical composition of the primary supplier's gasoline, thereby reflecting its historical BEN number. There is no expiry date for alternative BEN limits, although a primary supplier may rescind the alternative limit at any time. A supplier rescinding its alternative limit would then be subject to the normal limits for BEN.

Petro-Canada and Shell elected to use alternative (higher) limits for the BEN at their Ontario and Quebec refineries. Their alternative limits were set out in a Notice published by the Minister of the Environment in the *Canada Gazette* on September 4, 1999 (see Appendix 2).

## ***2.3 Options for Meeting the Requirements of the Regulations***

As discussed in section 2.1, primary suppliers can select either flat or yearly pool average limits for benzene and BEN as the basis for compliance. The options are selected separately for each refining, blending facility and import pool. Table 2.2 shows the number of gasoline pools subject to each type of limit for benzene and the BEN in 2001.

Table 2.2: Number of Gasoline Pools Subject to Flat and Yearly Pool Average Limits

		Flat Limits	YPA Limits
Benzene	Refineries	2	16
	Blending Facilities	1	0
	Import Pools	11	5
BEN	Refineries	7	11
	Blending Facilities	1	0
	Import Pools	15	1

## 2.4 Reporting Refineries and Importing Companies

Primary suppliers are required to register with Environment Canada using the *Registration Form for a Manufacturer, Blender or Importer of Gasoline* (Appendix 1). Table 2.3 shows the primary suppliers who registered with Environment Canada and supplied gasoline during 2001. The table also shows the type of limit the supplier is subject to for benzene and BEN: “YPA” if the primary supplier has selected a yearly pool average as its basis for compliance, and “flat” (flat per-litre limits) if otherwise.

Table 2.3 : Primary Suppliers Reporting on Gasoline Composition

	Name	Location of Production or Province of Import Facilities	Benzene Limit	BEN Limit
<b>Refiners</b>	Chevron Canada	Burnaby, British Columbia	YPA	YPA
	Consumer's Co-op	Regina, Saskatchewan	YPA	Flat
	Husky Oil	Prince George, British Columbia	YPA	YPA
	Imperial Oil - Dartmouth	Dartmouth, Nova Scotia	YPA	Flat
	Imperial Oil - Nanticoke	Jarvis, Ontario	YPA	Flat
	Imperial Oil- Sarnia	Sarnia, Ontario	YPA	Flat
	Imperial Oil - Strathcona	Strathcona, Alberta	YPA	Flat
	Irving Oil	Saint John, New Brunswick	YPA	YPA
	North Atlantic	Come-by-Chance, Newfoundland	Flat	Flat
	Parkland - Bowden	Bowden, Alberta	Flat	Flat
	Petro-Canada - Edmonton	Edmonton, Alberta	YPA	YPA
	Petro-Canada - Montreal	Montreal, Quebec	YPA	YPA
	Petro-Canada - Oakville	Oakville, Ontario	YPA	YPA
	Shell - Montreal	Montreal, Quebec	YPA	YPA
	Shell - Sarnia	Sarnia, Ontario	YPA	YPA
	Shell - Scotford	Scotford, Alberta	YPA	YPA
	Sunoco	Sarnia, Ontario	YPA	YPA
Ultramar - St-Romuald	St-Romuald, Quebec	YPA	YPA	
<b>Blenders</b>	Robbins Feed & Fuel	Thorold, Ontario	Flat	Flat
<b>Importers</b>	BP (Arco)	British Columbia	YPA	Flat
	CAMI	Ontario	Flat	Flat
	Ford	Ontario	Flat	Flat
	GM	Ontario	Flat	Flat
	Honda	Ontario	Flat	Flat
	Imperial Oil-BC	British Columbia	Flat	Flat
	Mackenzie Petroleum	Yukon	Flat	Flat
	Neste Petroleum	Quebec	Flat	Flat
	North 60 Petro	Yukon	Flat	Flat
	Northern Transportation	Nunavut	Flat	Flat
	Olco - ON	Ontario	Flat	Flat
	Parkland - YK	Yukon	Flat	Flat
	Petro-Canada - BC	British Columbia	YPA	YPA
	Petroles Norcan	Quebec	YPA	Flat
	Ultramar - NF	Newfoundland	YPA	Flat
Ultramar - OC	Quebec	YPA	Flat	

\* Locations submitting “Nil” reports were excluded from this table.

### **3.0 Compliance with the Regulations**

This section reviews the compliance of primary suppliers with reporting requirements of the regulations and reported exceedances of the benzene and BEN limits.

#### ***3.1 Information Reported***

Under section 8 of the regulations, primary suppliers must provide the information set out on the form entitled *Report on the Composition of Gasoline* (refer to Appendix 3). The information includes the maximum, quarterly average and year-to-date average values for a number of composition parameters. Primary suppliers must also report the volume of gasoline, the number of batches sampled, and the name of any oxygenates used.

#### ***3.2 Reports on Gasoline Composition***

For the period beginning January 1, 1999 and ending December 31, 2002, every primary supplier must submit a quarterly report on gasoline composition. The report must be submitted within 45 days after the last day of each calendar quarter in which gasoline was supplied. Starting in 2003, the report must be submitted once per year before February 15 of the following year.

Table 3.1 shows the date by which reports should have been submitted in 2001, and the number of reports that were either punctual or late for each quarter. Late submissions shown here are those reports dated after the date required by the regulation.

Table 3.1 : Dates of Submission

2001 Quarter	Deadline for submissions	Total number of submissions	Number of punctual submissions	Number of late submissions
First	15-May-01	29	25	4
Second	14-Aug-01	35	26	9
Third	14-Nov-01	33	31	2
Fourth	14-Feb-02	33	27	6

#### ***3.3 Exceedances of Regulated Limits***

Table 3.2 summarizes the three exceedances<sup>5</sup> of the benzene and BEN limits as reported by primary suppliers. There were no exceedances for primary suppliers on a YPA.

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<sup>5</sup> An exceedance is a reported benzene or BEN value that is above a limit prescribed in the regulations.

Table 3.2 : Reported Exceedances for those on the Flat Option

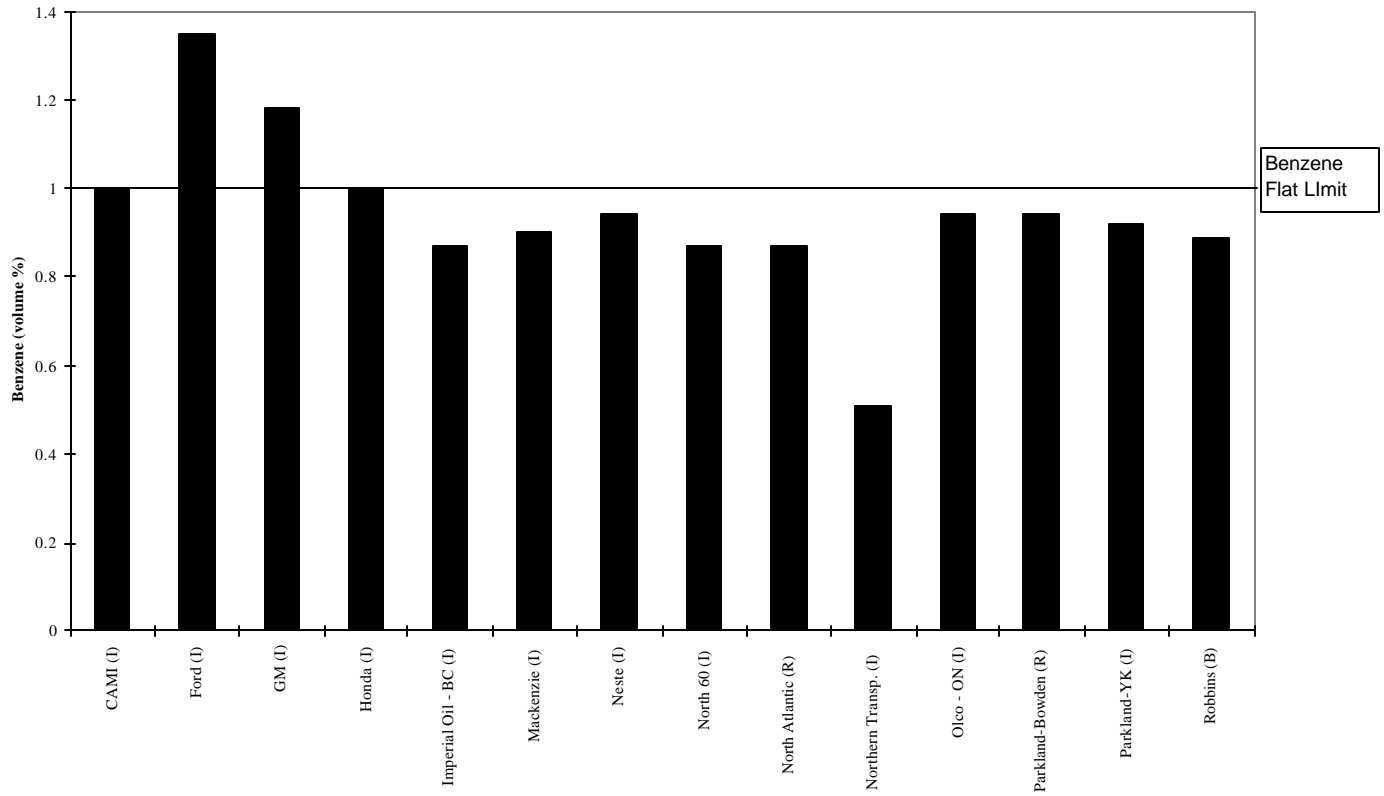
Parameter	Quarter	# of Reported Exceedances	Reported Exceedances*	Limit
Benzene	1st	2	1.18	1.0%
			1.35	1.0%
	2nd	0	-	1.0%
	3rd	0	-	1.0%
BEN	4th	0	-	1.0%
	1st	0	-	92
			*	71
	2nd	0	*	71
3rd	1	92.4	92	

\* It is important to note that for Q2 and Q3, ten reported maximum BEN values were above the summer BEN limit of 71. Three of these maximum BEN values were supplied under the winter BEN limit and seven were unknown if they were supplied under the winter or summer BEN limits. Therefore, Q2 and Q3 values above the summer BEN limit do not necessarily imply exceedance of the regulated limit. All maximum BEN values for Q2 and Q3 were below the winter BEN limit of 92.

Figures 3.1 and 3.2 show the maximum benzene level and BEN reported by primary suppliers using flat limits, as a percentage of the regulated limit.

Figures 3.3 and 3.4 show benzene and BEN levels reported by primary suppliers using YPA limits, as a percentage of the regulated limits for 2001. The yearly pool average data from Figures 3.3 and 3.4 represent the volume weighted average for all gasoline from a given primary supplier during the year. For figure 3.4, the y-axis is in units of percent of the regulated limit, as some primary suppliers were on alternative limits.

Figure 3.1 : Reported Maximum Benzene Levels for Suppliers on a Flat Limit, 2001

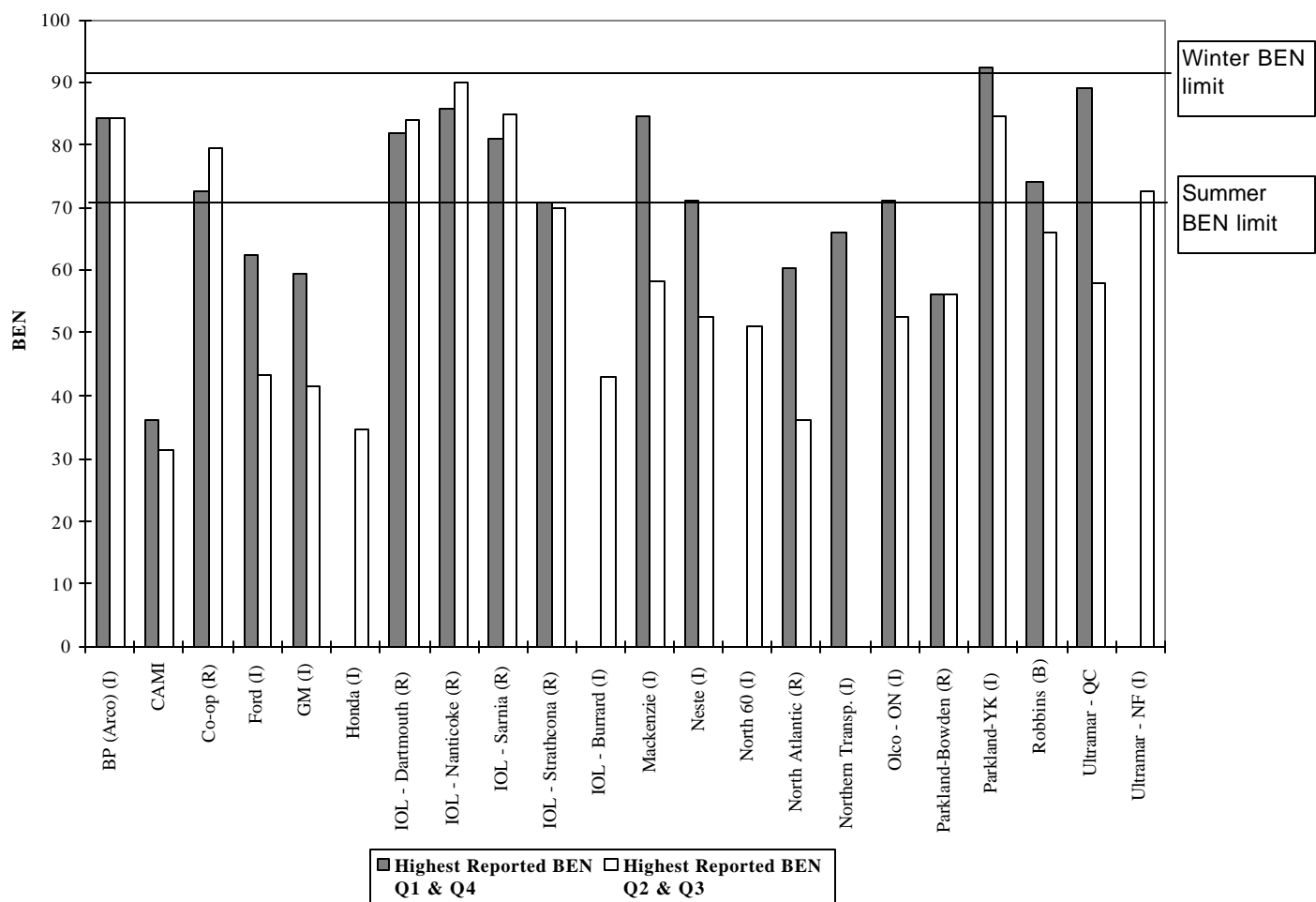


Notes:

- 1.0% vol.= Benzene Flat Limit.
- R = Refiner, B = Blender and I = Importer



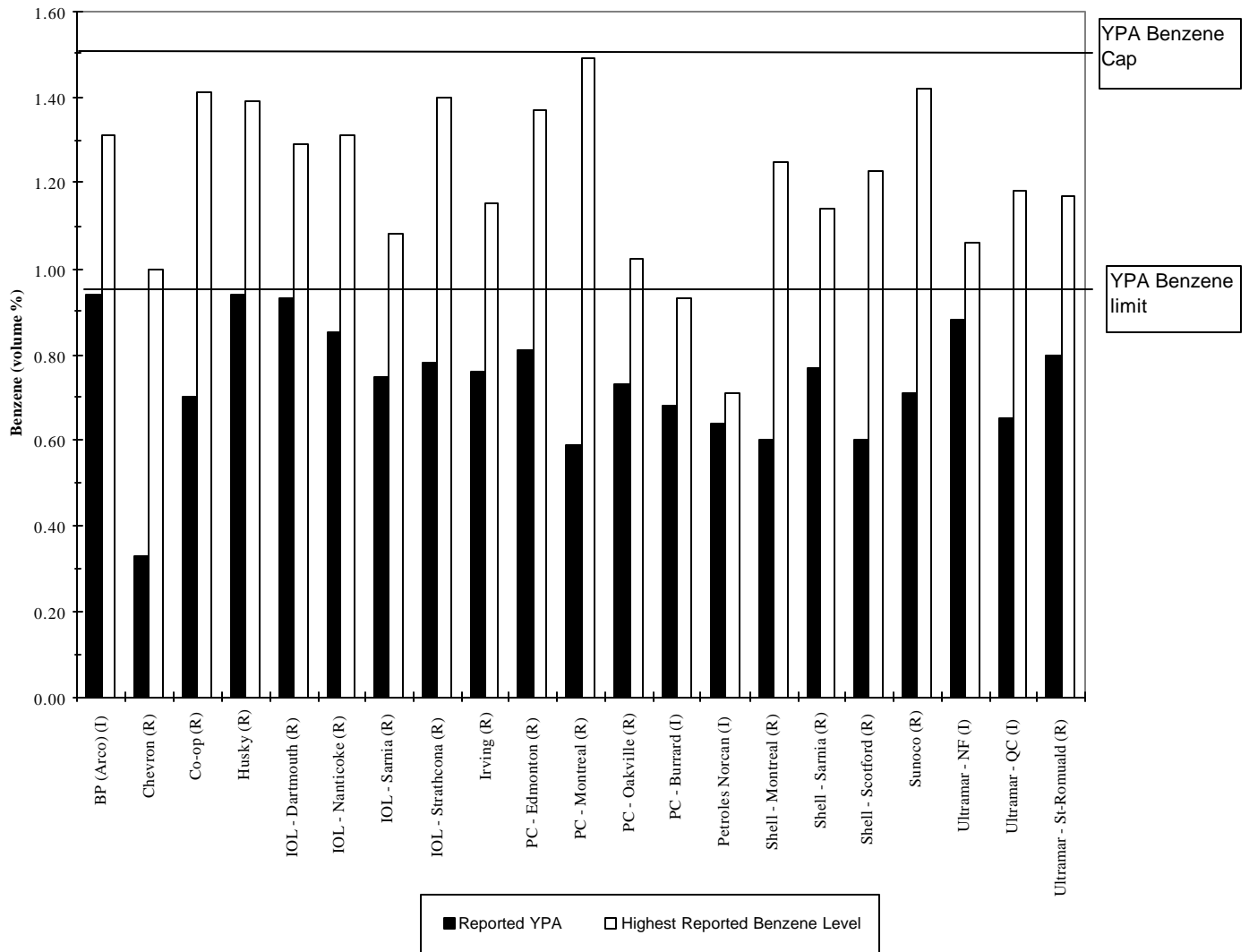
**Figure 3.2 : Reported Maximum BEN for Suppliers on a Flat Limit**



Notes:

- 92 = Flat BEN Winter Limit
- 71 = Flat BEN Summer Limit
- R = Refiner, B = Blender and I = Importer
- It is important to note that Q2 and Q3 reported BEN values include some batches supplied under the winter BEN limits. Therefore, Q2 and Q3 values above the summer BEN limit do not necessarily imply any exceedance of the regulated limit.

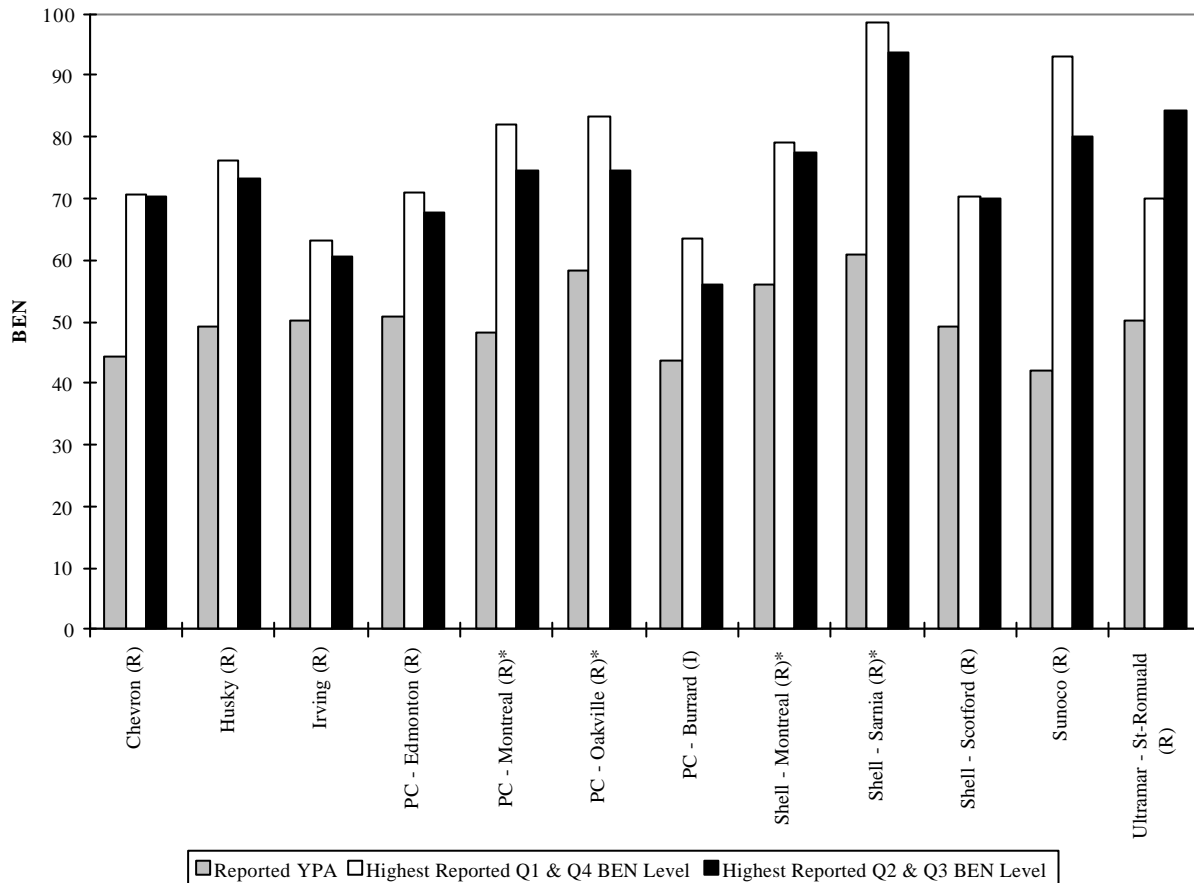
**Figure 3.3 : Reported Benzene Levels (Average and Maximum) for Suppliers on a Yearly Pool Average Limit, 2001**



**Notes:**

- 0.95% vol. = YPA.Benzene Limit
- 1.5% vol. = YPA Benzene Cap.
- R = Refiner, B = Blender and I = Importer

**Figure 3.4 : Reported BEN (Average and Maximum) Levels for Suppliers on a Yearly Pool Average Limit, 2001 - Amended**



**Notes:**

- 59.5 = YPA limit, unless a supplier used alternative limits (marked with an \*).
- 132 = YPA winter cap, unless a supplier used alternative limits (marked with an \*).
- 102 = YPA summer cap, unless a supplier used alternative limits (marked with an \*).
- R = Refiner, B = Blender and I = Importer
- It is important to note that Q2 and Q3 reported BEN values include some batches supplied under the winter BEN limits. Therefore, Q2 and Q3 values above the summer BEN limit do not necessarily imply any exceedance of the regulated limit.

### 3.4 Results of Independent Audits

Under section 22 of the regulations a primary supplier that has elected to use a yearly pool average as its basis for compliance must have an independent auditor perform an audit of the primary supplier's systems, practices and procedures and its compliance with the regulations. The auditor's report must be submitted to Environment Canada by May 31 of the year following the reporting period.

Eighteen audit reports were submitted by eleven companies in regard to sixteen refineries, eight import pools and two blenders. The audits were conducted by six audit companies.

Paragraph 22(3)(e) of the Regulations requires that the audit contain: "*an assessment by the auditor of the extent to which the primary supplier has complied with these Regulations throughout the year of the audit.*" It appears that all primary suppliers who had to submit audit reports met the regulated limits for benzene concentration and BEN.

Eight audit reports identified one or more instance of non-compliance with the administrative requirements of the regulations. Many of these involved sampling, testing, compliance plans and particularly reporting, and include:

- with respect to testing, testing equipment was not calibrated, quality control samples were not run regularly, and missed testing of batches;
- with respect to reports required by the regulations, instances of non-compliance included:
  - batches missing from volume calculations, or inconsistencies between reported volumes and stock accounting volumes,
  - late submission of reports,
  - inadequate retention of records; and
  - improper use of model parameters for BEN calculation and volume weighted averages.

Many of the recommendations of the auditors related to improving quality control procedures. Eight audits reports were accompanied by a list of corrective actions which had been taken by the primary supplier.

Environment Canada views the audits as a crucial component of the enforcement provisions of the regulations and, to be effective, the auditing process must be independent and thorough. The concept of a yearly pool average relies on the maintenance of complete records and reports. The audits are intended to provide Environment Canada assurance that the yearly pool averages are being correctly reported.

## **4.0 Canadian Gasoline Composition**

This section reviews the composition of gasoline in Canada during 2001, based on data reported by primary suppliers pursuant to the regulations. The regulations require that the following parameters are reported:

- the concentration of benzene,
- the value of BEN,
- the concentration of aromatics,
- the concentration of olefins,
- the concentration of sulphur,
- the concentration of oxygen,
- the vapour pressure,
- the evaporation fraction at 93.3 °C (200 °F - E200),
- the evaporation fraction at 148.9 °C (300 °F - E300).

Appendix 4 shows the regional and national concentrations for all parameters. Appendix 5 shows the maximum, minimum and volume-weighted average of both the reported maximum and quarterly average concentrations of all parameters. Appendix 6 shows the parameters reported by individual companies.

### ***4.1 Volume of Gasoline***

The number of batches and volume of gasoline (excluding exports) reported are summarized in Table 4.1.

Table 4.1 : Regional Volumetric Data for 2001

Region	Total Volume (m3)	Number of Batches
Atlantic	2,905,498	398
Quebec	10,166,369	1,380
Ontario	12,865,129	1,516
West*	13,281,519	2,407
National	39,218,515	5,701

\* Includes all western provinces and northern territories.

## 4.2 Regulated Parameters: Benzene and BEN

Data reported on benzene and BEN levels for 2001 are summarized in Table 4.2. The trends for benzene and BEN levels are shown graphically in Figures 4.1 and 4.2.

Table 4.2 : Benzene Concentration and BEN for 2001

Quarter	Reported Values*					
	Benzene (% Volume)			BEN		
	Minimum	Maximum	Volume Weighted Average	Minimum	Maximum	Volume Weighted Average
First	0.35	1.41	0.68	27.25	88.20	58.33
Second	0.34	1.49	0.73	27.25	90.00	46.33
Third	0.08	1.49	0.77	27.60	93.70	47.18
Fourth	0.30	1.42	0.71	34.86	98.60	59.38

\* Includes primary suppliers on alternative limits

Table 4.3 shows the trend in benzene levels between 1995 and 2001<sup>6</sup>. Nationally, benzene levels in 2001 were half of those between 1995 and 1998. These trends are shown graphically for each region and for Canada in Figures 4.1 to 4.5.

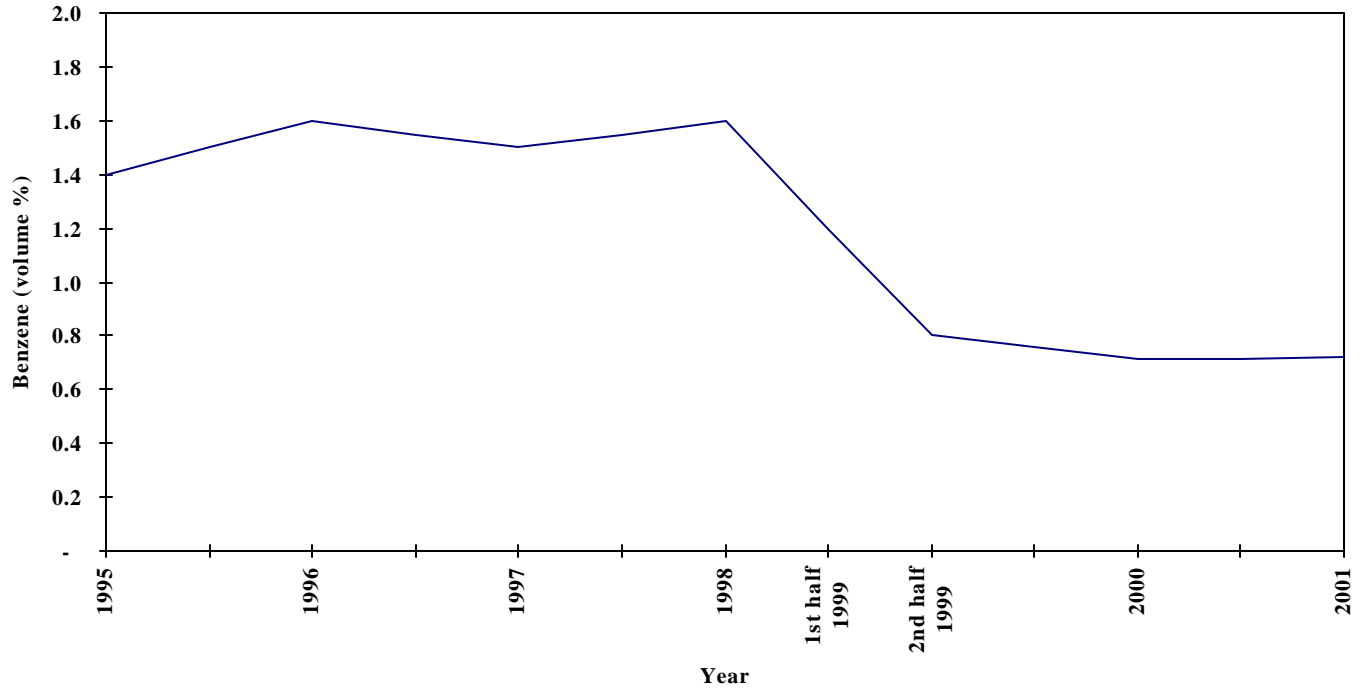
Table 4.3 : Average Benzene Content of Canadian Gasoline 1995-2001

Region	Average Benzene (volume %)							
	1995	1996	1997	1998	1999		2000	2001
					1st half	2nd half		
Atlantic	2.6	2.5	2.6	2.2	2.1	0.7	0.8	0.9
Quebec	1.6	1.9	1.7	1.7	1.4	1.0	0.6	0.7
Ontario	1.2	1.4	1.3	1.7	1.3	0.8	0.8	0.8
West	1.2	1.3	1.3	1.2	0.7	0.6	0.7	0.7
Canada	1.4	1.6	1.5	1.6	1.2	0.8	0.7	0.7

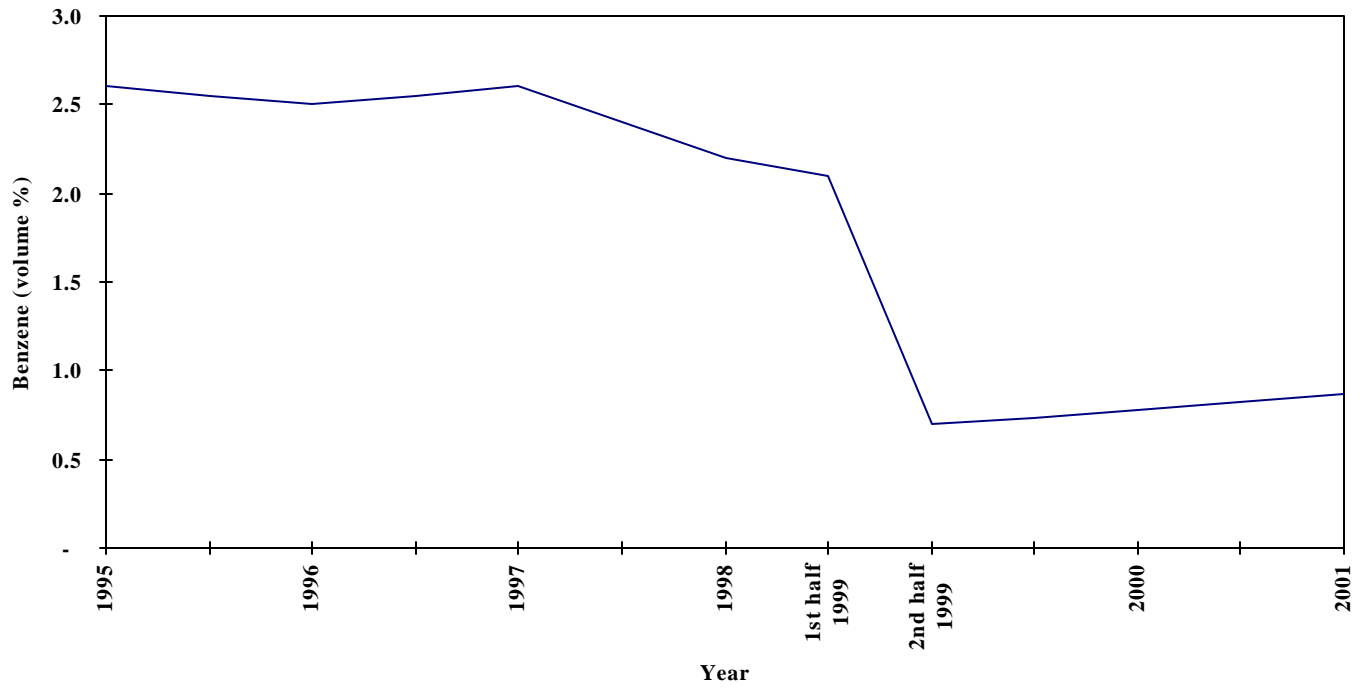
Figures 4.6 and 4.7 show the regional and national average values for benzene and BEN on a quarterly basis. As the Regulations took effect mid-1999, the data for that year is presented separately for the first and second half of the year.

<sup>6</sup> The data for 1995 to 1998 was collected from primary suppliers under a voluntary survey of benzene, aromatics and olefins in gasoline. All refiners and a number of importers participated in the survey. Annual reports on the survey were published by Environment Canada.

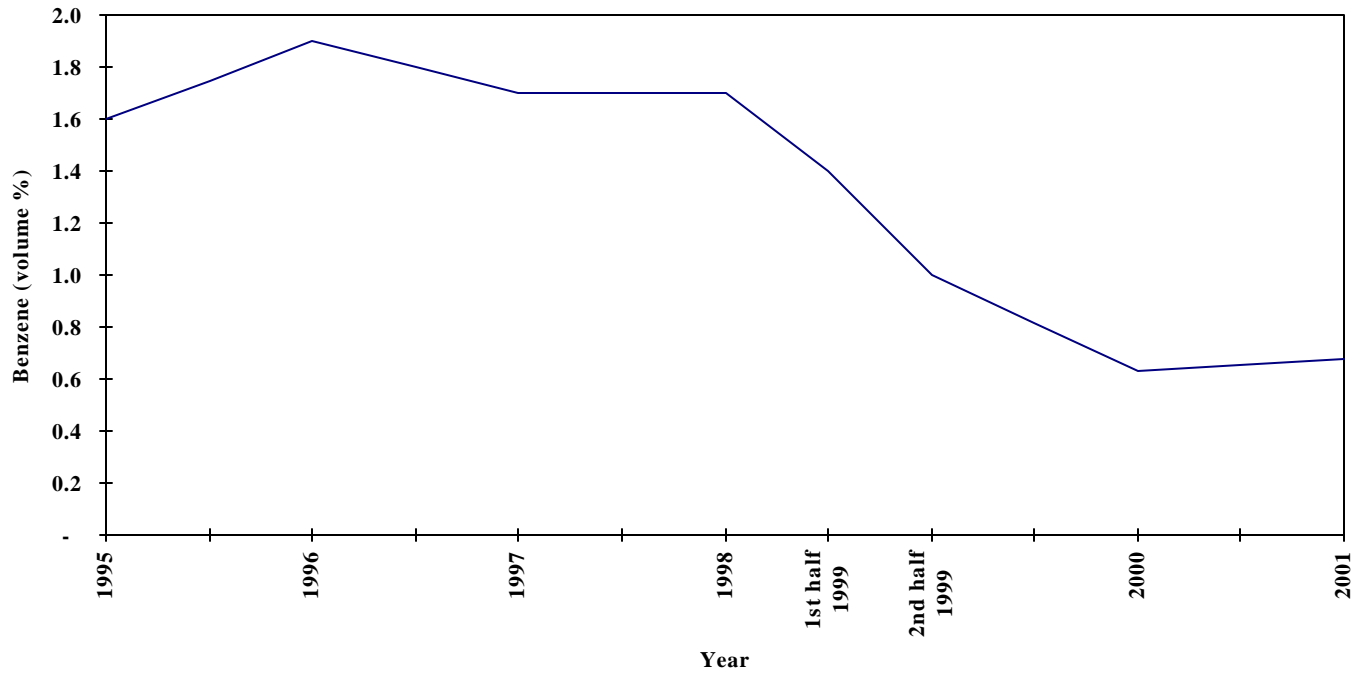
**Figure 4.1 : Average Benzene Content of Gasoline - Canada 1995-2001**



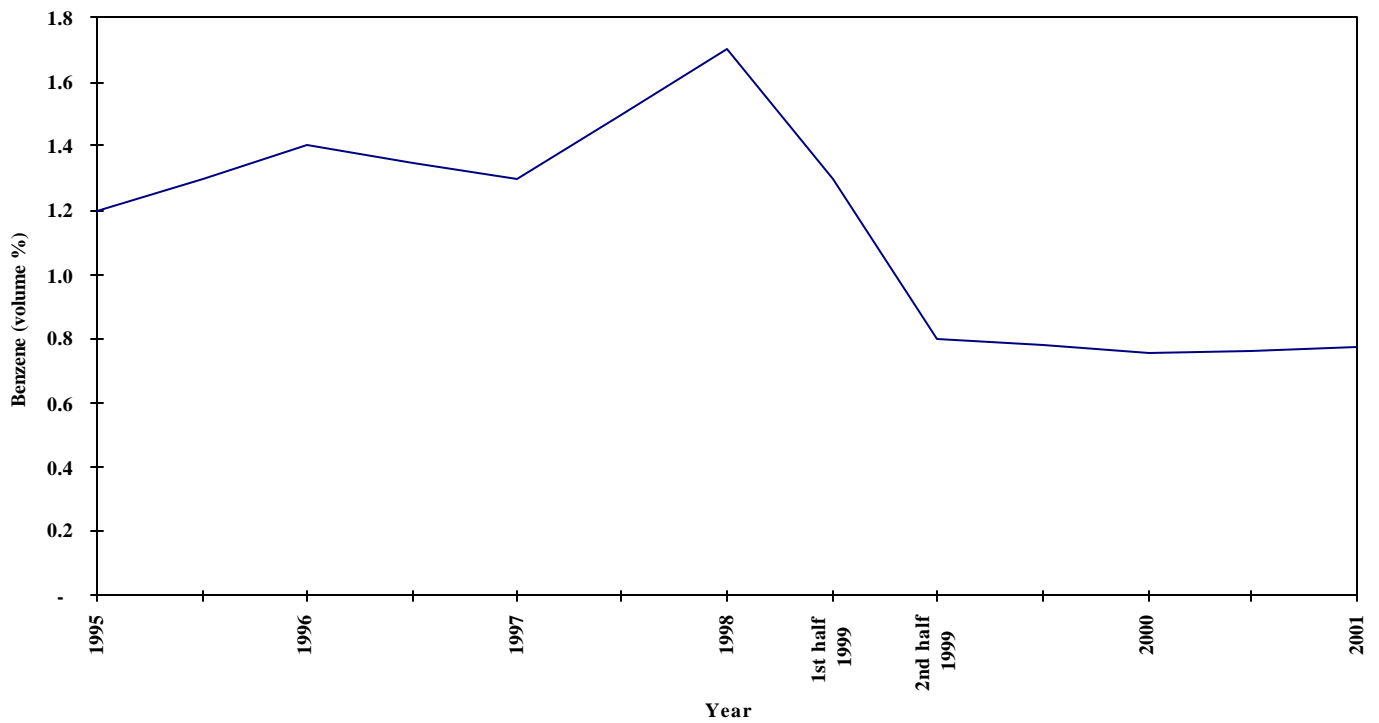
**Figure 4.2 : Average Benzene Content of Gasoline - Atlantic 1995-2001**



**Figure 4.3 : Average Benzene Content of Gasoline - Quebec 1995-2001**

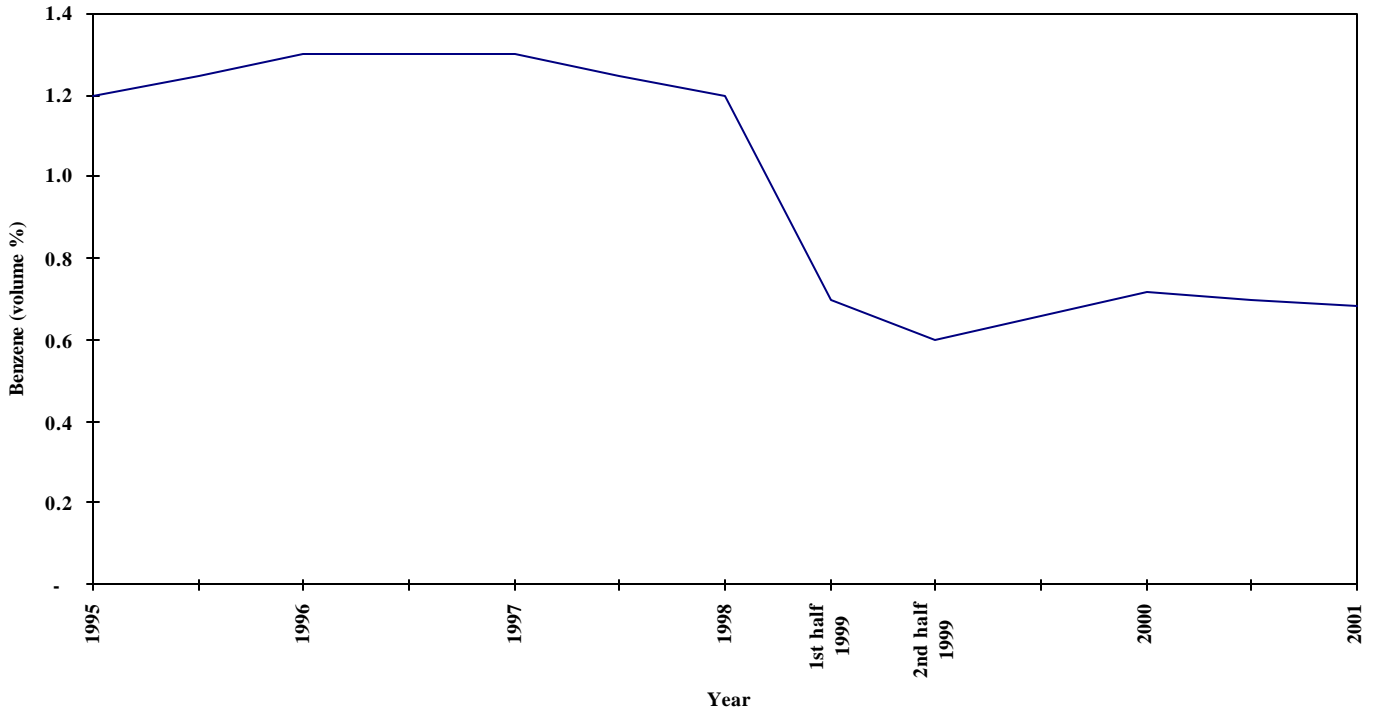


**Figure 4.4 : Average Benzene Content of Gasoline - Ontario 1995-2001**

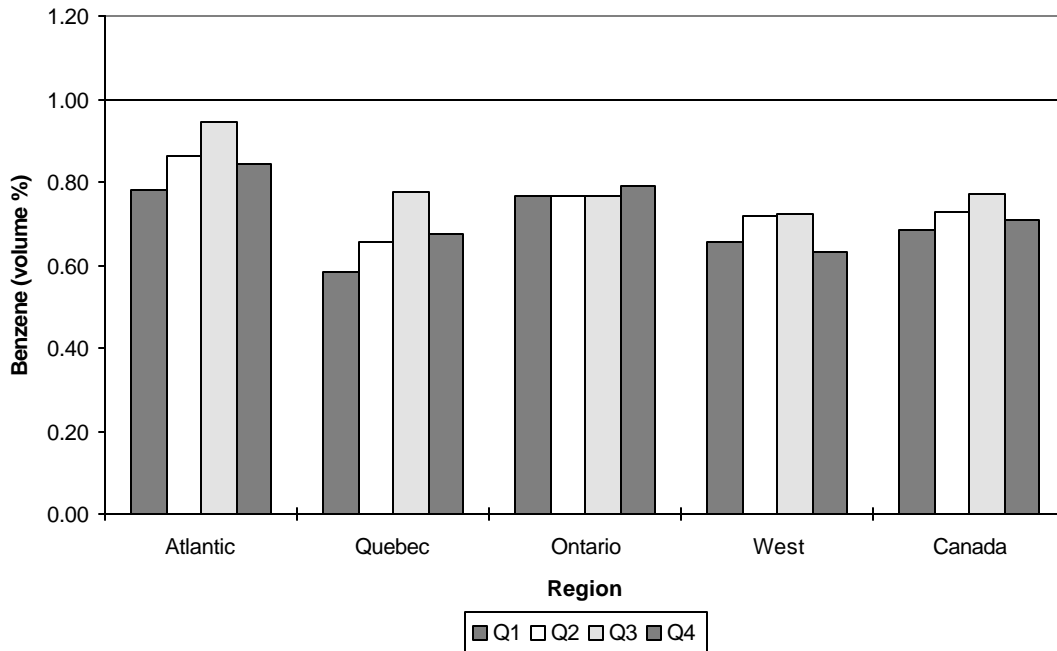




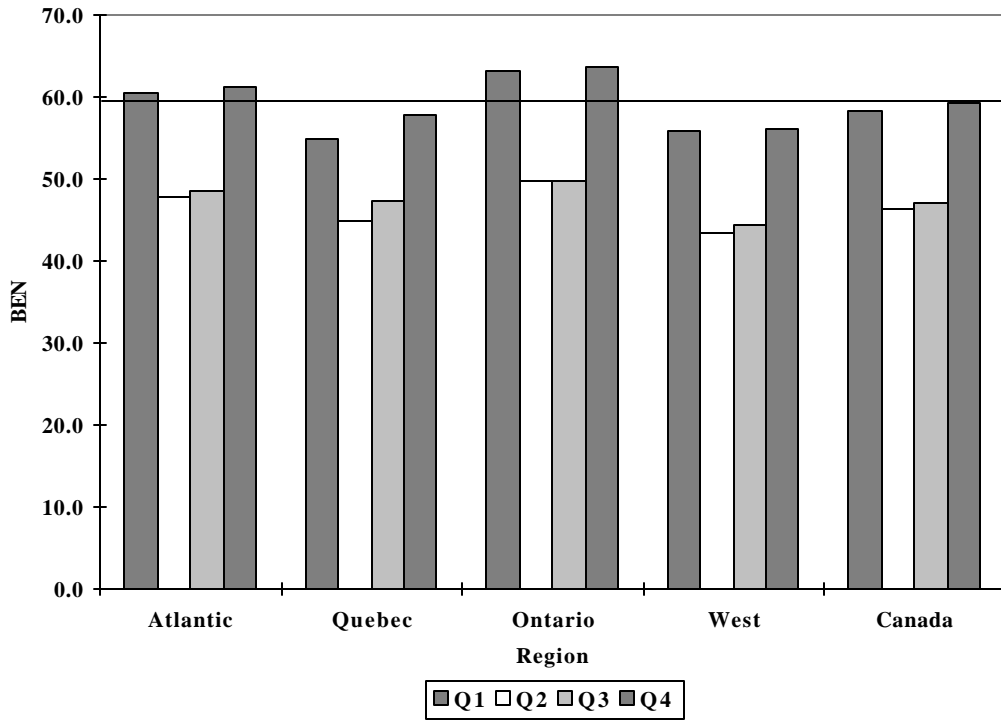
**Figure 4.5 : Average Benzene Content of Gasoline - West 1995-2001**



**Figure 4.6 : Average Benzene Concentration of Canadian Gasoline 2001**



**Figure 4.7 : Average BEN of Canadian Gasoline 2001**



Notes:

- The annual average BEN limit for primary suppliers on a YPA is 59.5.

### 4.3 Reported Oxygen Concentration

Primary suppliers are required to report the type of oxygenate that they use and the oxygen concentration of the gasoline produced or imported. Tables 4.4 and 4.5 summarize the concentration of oxygen resulting from the addition of MTBE and ethanol, respectively.

Table 4.4: Average Concentration of MTBE Reported (% by volume)

Region	Average Concentration of MTBE based on all Volumes of Gasoline Reported (% by volume)		Maximum Concentration of MTBE based on all Volumes of Gasoline containing MTBE (% by volume)	
	2000	2001	2000	2001
Atlantic	0.85	1.13	14.89	15.39
Quebec	0.02	0.08	3.00	7.11
Ontario	0.00	0.00	11.44	12.22
West	0.21	0.01	15.56	10.78
Canada	0.14	0.11	15.56	15.39

Notes:

1. The regulations do not require reporting of oxygenate blended downstream of the refinery (except for a few special incidences described in the regulations). These values are therefore likely to be underestimates of oxygenate usage.
2. 15 % MTBE by volume = approximately 2.7 wt % oxygen.

Table 4.5: Average Concentration of Ethanol Reported (% by volume)

Region	Average Concentration of Ethanol based on all volumes of Gasoline reported (% by volume)		Maximum Concentration of Ethanol based on all volumes of Gasoline containing ethanol (% by volume)	
	2000	2001	2000	2001
Atlantic	0.00	0.00	0.00	0.00
Quebec	0.04	0.00	10.00	10.00
Ontario	1.43	1.69	10.00	10.00
West	0.00	0.00	0.57	0.00
Canada	0.46	0.60	10.00	10.00

Notes:

1. The regulations do not require reporting of oxygenate blended downstream of the refinery (except for a few special incidences described in the regulations). These values are therefore likely to be underestimates of oxygenate usage.
2. 10 % ethanol by volume = approximately 3.7 wt % oxygen.

### 4.4 Trends of Aromatics and Olefins

During 1994 to 1998 data on the aromatic and olefin concentration in gasoline were collected by Environment Canada under a voluntary survey of benzene, aromatics and olefins content of gasoline. When gasoline is combusted in the vehicle's engine, aromatics in the gasoline can form benzene (a known human carcinogen), while olefins can form 1,3-butadiene (a probable human carcinogen).

Trends for aromatics and olefins content are shown in tables 4.6 and 4.7, respectively<sup>7</sup>. These data shows that reported levels of aromatics and olefins for 2001 are similar to those for previous years. Note a decrease in aromatics and an increase in olefins in the Atlantic region.

Table 4.6 : Average Aromatics Content of Canadian Gasoline 1995-2001

Region	Average Aromatics (volume %)							2001
	1995	1996	1997	1998	1999		2000	
					1st half	2nd half		
Atlantic	31.6	29.4	30.3	31.5	30.8	28.3	28.0	25.9
Quebec	28.5	27.3	24.8	22.0	26.1	27.4	25.4	25.4
Ontario	26.3	28.5	28.1	30.2	27.9	29.0	28.3	27.6
West	24.6	24.5	23.1	24.1	23.9	23.4	23.6	23.5
Canada	26.6	26.9	25.3	26.2	26.2	26.6	25.8	25.5

Table 4.7 : Average Olefins Content of Canadian Gasoline 1997-2001

Region	Average Olefins (volume %)							2001
	1995	1996	1997	1998	1999		2000	
					1st half	2nd half		
Atlantic	-	-	8.7	13.6	11.7	14.1	15.1	17.4
Quebec	-	-	14.1	12.5	13.3	14.2	13.6	14.1
Ontario	-	-	10.2	9.4	10.8	9.7	10.3	10.5
West	-	-	10.9	9.8	9.4	10.2	10.1	10.9
Canada	-	-	11.2	10.6	11.0	11.4	11.4	12.1

(-) = not available, olefins were not part of the survey until 1997.

#### 4.5 Comparison of Imported vs. Domestic Gasoline

Table 4.8 compares the data provided by refiners and importers. As shown in table 2.3, flat limits were selected by the majority of importers while the YPA option was selected by the majority of refiners. As shown in table 4.8, importers reported lower maximum values for all parameters except E200 and lower average values for parameters other than E300, aromatics and olefins.

<sup>7</sup> The data for 1995 to 1998 was collected from primary suppliers under a voluntary survey of benzene, aromatics and olefins in gasoline. All refiners and a number of importers participated in the survey. Annual reports on the survey were published by Environment Canada.

Table 4.8: Comparison of All Importers and Refiners for All Parameters

	Reported Maxima		Average Reported	
	Importers	Refiners	Importers	Refiners
Oxygen (wt %)	2.20	3.70	0.09	0.23
Sulphur (wt %)	0.088	0.097	0.024	0.028
Vapour Pressure (kPa)	103.2	110.0	64.8	84.3
E200 (vol %)	87.0	84.2	46.5	50.1
E300 (vol %)	97.0	98.0	84.5	84.0
Aromatics (vol %)	51.5	52.8	28.7	25.3
Olefins (vol %)	36.9	43.3	16.5	11.9
Benzene (vol %)	1.35	1.49	0.71	0.72
BEN	92.4	98.6	48.9	52.8

#### 4.6 Toxic Emissions Number (TEN) and the Complex Model

The Complex Model is a set of equations relating gasoline composition to emissions from a “typical” 1990 vehicle. The model was developed by the EPA and used to establish the regulated requirements for reformulated gasoline in the U.S. The Complex Model addresses emissions of VOCs, NO<sub>x</sub> and five toxics - benzene, 1,3-butadiene, formaldehyde, acetaldehyde and polycyclic organic matter (POM). The first four of these, benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, have been classified as toxic under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

The Canadian *Benzene in Gasoline Regulations* include limits for the Benzene Emissions Number, which is calculated using the EPA’s complex model equations. The controls on the BEN were developed with the view that the concept could be expanded to address other toxic substances in the future. In this regard, the *Notice of Intent on Cleaner Vehicles, Engines and Fuels*<sup>8</sup> indicates that Environment Canada will study the effect on emissions of toxic substances from vehicles of setting additional limits for gasoline composition.

This section of the report analyzes the toxics emissions performance of Canadian gasoline. The analysis is based on the sum of the four substances that have been found to be “toxic” under CEPA 1999. ‘TEN’ is used to refer to this Canadian toxics emission number. (The difference between TEN and the U.S. sum of toxics is that TEN does not include POM.)

TEN values for Canadian gasoline have been estimated based on the properties reported by primary suppliers in 2001. The resulting regional and national values for TEN are presented in Table 4.9 below<sup>9</sup>. TEN values for individual refiners/importers are presented in Appendix 6. An analysis was also carried out for TEN using the same parameters as before but with a sulphur concentration of 25 ppm, expected to be representative of gasoline sulphur levels in 2005 after the final compositional requirements of the *Sulphur in Gasoline Regulations* take effect.

<sup>8</sup> Environment Minister David Anderson’s *Notice of Intent on Cleaner Vehicles, Engines and Fuels* was published in the Canada Gazette on February 17. The Notice sets out the federal agenda on vehicles and fuels in Canada for the next decade. The Notice is available at [http://www.ec.gc.ca/Ceparegistry/documents/notices/g1-13507\\_n1.pdf](http://www.ec.gc.ca/Ceparegistry/documents/notices/g1-13507_n1.pdf)

<sup>9</sup> The TEN values were computed from average concentrations of the input gasoline parameters, rather than using batch-by-batch analysis (as was reported for BEN). Such batch-by-batch TEN values are not available to Environment Canada. Due to the non-linearity of the TEN equations, there will be a small error introduced by the use of average data for the input parameters.

Table 4.9: Annual TEN for 2001 & 2005

Region	Annual TEN (based on reported parameters)		Annual TEN (estimated, assuming 25 ppm S)
	2000	2001	2005
Atlantic	89	88	83
Quebec	84	84	79
Ontario	92	90	81
West	82	82	77
Canada	86	86	79

The regulated requirements for U.S. reformulated gasoline for 2000 and beyond limit the sum of toxics to 83.2 (21.5% below a baseline of 106). Subtracting a constant value for POM - taken to be approximately 3.6 - from this value gives a TEN value of 79.6. It is estimated that the Canadian gasoline pool will have a value below this by 2005, except in Ontario and Atlantic Canada.

In 1998, the total toxics performance averaged across the U.S. reformulated gasoline pool was 11.6% lower than the required level. This is roughly equivalent to a toxics performance of 76.2 (using the Complex Model equations for the year 2000 and beyond). Subtracting POM gives a TEN equivalent of 72.6. Therefore, it is expected that the average TEN levels for gasoline in all regions of Canada will be above the average TEN level for US gasoline in 2005.

# Appendix 1

Sample of "*Registration Form for a  
Manufacturer, Blender or Importer of Gasoline*"





Environment Canada  
Benzene in Gasoline Regulations (SOR/97-493)

**Schedule 2**

**Registration Form for a Manufacturer, Blender, or Importer of Gasoline**

1. Company Name \_\_\_\_\_

Company address \_\_\_\_\_

Type of primary supplier (*check on or more*):

Manufacturer

Blender

Importer

2. Name and location of each refinery and typical annual volume, in m<sup>3</sup>, of each type of gasoline manufactured at each refinery:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. Name and location of each blending facility, typical blending material(s) and typical annual volume, in m<sup>3</sup>, of each type of gasoline blended at each facility:

*(For cargo tankers, railway cars, boats, marine vessels or other mobile blending facilities, indicate only the type and number of mobile facilities and the province of operation.)*

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

4. Each usual point and mode of importation and typical annual volume, in m<sup>3</sup>, of each type of gasoline imported:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

5. Authorized official \_\_\_\_\_ Telephone no. (\_\_\_\_) \_\_\_\_ - \_\_\_\_\_

Title \_\_\_\_\_ Fax no. (\_\_\_\_) \_\_\_\_ - \_\_\_\_\_

Signature \_\_\_\_\_ Date \_\_\_\_\_



# **Appendix 2**

## *Alternative Limits under the Benzene in Gasoline Regulations*













# **Appendix 3**

Sample of Form, "Report on  
Composition of Gasoline"



Schedule 3

**Report on Composition of Gasoline**

Note: This Form is provided for your convenience in reporting. For reporting details, refer to the Regulations.

This report, in respect of section 8 and schedule 3 of the federal *Benzene in Gasoline Regulations*, should be submitted:

- a) by every primary supplier as defined in the Regulations
- b) within 45 days after the last day of each calendar quarter during which gasoline is supplied for the years 1999 to 2002 (quarterly reporting)
- c) after 2003, on or before February 15 of each year (annual reporting)
- d) to the appropriate regional office of Environment Canada

Registration Number	Year	Quarter (if before 2003)
Company Name		
Company Address		

Type of primary supplier (*check on or more*):  Manufacturer  Blender  Importer

Has a yearly pool average been elected for this year?  Yes  No  
 If yes, for which parameters?  Benzene  Benzene Emissions Number (BEN)  
 If yes, has your compliance plan been updated during the reporting period?  Yes  No

Note: Updated compliance plans must be submitted to the Minister pursuant to subsection 21(3) of the Benzene in Gasoline Regulations.

Name and location of the refinery, blending facility or points of importation in the province, covered by this report: (Refer to Notes A and B)

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Composition of gasoline supplied during this reporting period:

Volume of Gasoline supplied in m <sup>3</sup>	Number of batches supplied	Name of any oxygenates added

Item	Column 1 Parameter	Column 2 Maximum Value	Column 3 Quarterly volume-weighted average value (not to be completed after 2002)	Column 4 Year-to-date volume-weighted average values
1.	Oxygen Concentration (% by weight)			
2.	Sulphur Concentration (% by weight)			
3.	Vapor pressure at 37.8°C (100°F)(kPa)			
4.	Evaporative fraction at 93.3°C (200°F) (% by volume)			
5.	Evaporative fraction at 148.9°C (300°F) (% by volume)			
6.	Aromatics Concentration (% by volume)			
7.	Olefins Concentration (% by volume)			
8.	Benzene Concentration (% by volume)			
9.	Benzene Emissions Number (Refer to note C)			

Authorized Official	Telephone No.
Title	Fax No.

Signature	Date
-----------	------

(\* Refer to note F

Notes for Schedule 3

- A. This *Report on Composition of Gasoline* must be submitted separately for each refinery, blending facility and province of importation, or any combination of them described under section 18 of the *Benzene in Gasoline Regulations*.
- B. For Note A, the name and location for cargo tankers, railway cars, boats, marine vessels or other mobile blending facilities are replaced by the type of mobile facilities, their number and the province of operation, or the name and location of the non-mobile facility with which they are grouped.
- C. The average benzene emissions number is the volume-weighted average of the benzene emissions numbers for each batch; it is not calculated from the average model parameters.
- D. Under subsection 13(2) of the *Benzene in Gasoline Regulations*, for each batch of gasoline-like blendstock dispatched or imported by the primary supplier during the period covered by this Report, the primary supplier must report to the Minister, in an annex to this Report, the name and address of the purchaser or receiver, the date of dispatch or importation and the volume.
- E. Under subsection 2(2) of Schedule 1 to the *Benzene in Gasoline Regulations*, the primary supplier must report to the Minister, in an annex to this Report, each occurrence of a model parameter that is outside the acceptable range, the reason for each occurrence and the volume of gasoline affected.
- F. Authorized official is a defined term (refer to subsection 1(1) of the *Benzene in Gasoline Regulations*.)

ADDRESSES OF ENVIRONMENT CANADA'S REGIONAL OFFICES

Newfoundland, Nova Scotia, New Brunswick and Prince Edward Island

Director  
Environmental Protection - Atlantic Region  
Environment Canada  
45 Alderney Drive  
16<sup>th</sup> floor, Queen Square  
Dartmouth, Nova Scotia B2Y 2N6

Quebec

Director  
Environmental Protection - Quebec Region  
Environment Canada  
105 rue McGill, 4<sup>th</sup> floor  
Montreal, Quebec H2Y 2E7

Ontario

Director  
Environmental Protection - Ontario Region  
Environment Canada  
4905 Dufferin Street  
Downsview, Ontario M3H 5T4

Manitoba, Saskatchewan, Alberta, Nunavut, and Northwest Territories

Director  
Environmental Protection - Prairies and Northern Region  
Environment Canada  
Twin Atria #2, 2<sup>nd</sup> floor  
4999 - 98<sup>th</sup> Avenue  
Edmonton, Alberta

British Columbia and Yukon

Director  
Environmental Protection - Pacific and Yukon Region  
Environment Canada

224 West Esplanade  
North Vancouver, British Columbia V7M 3H7

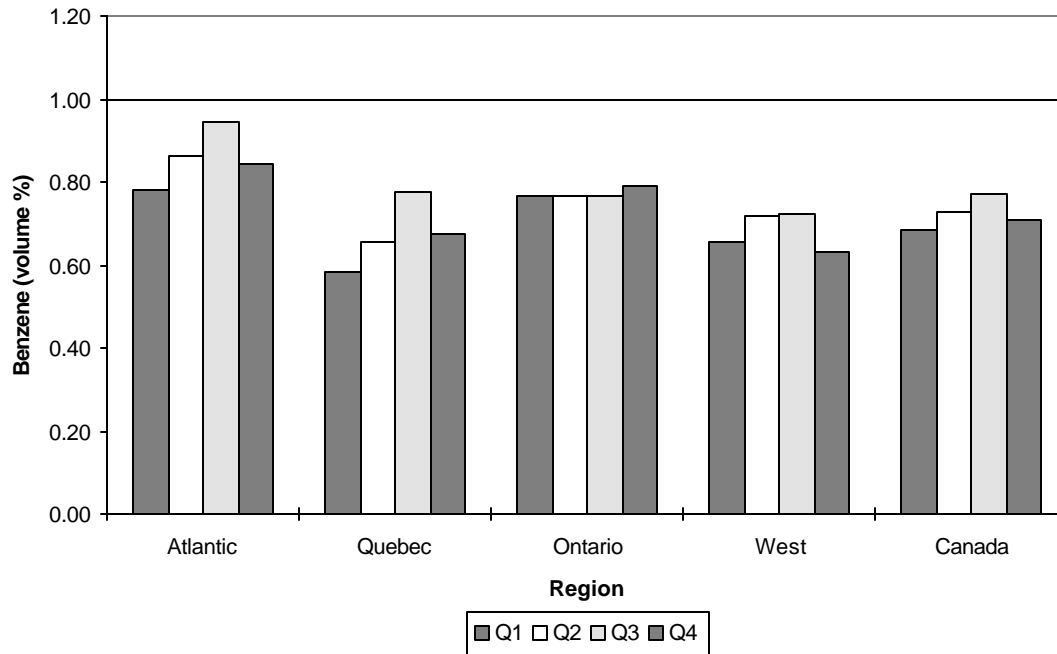
# **Appendix 4**

Regional and National Quarterly Data for all  
Parameters





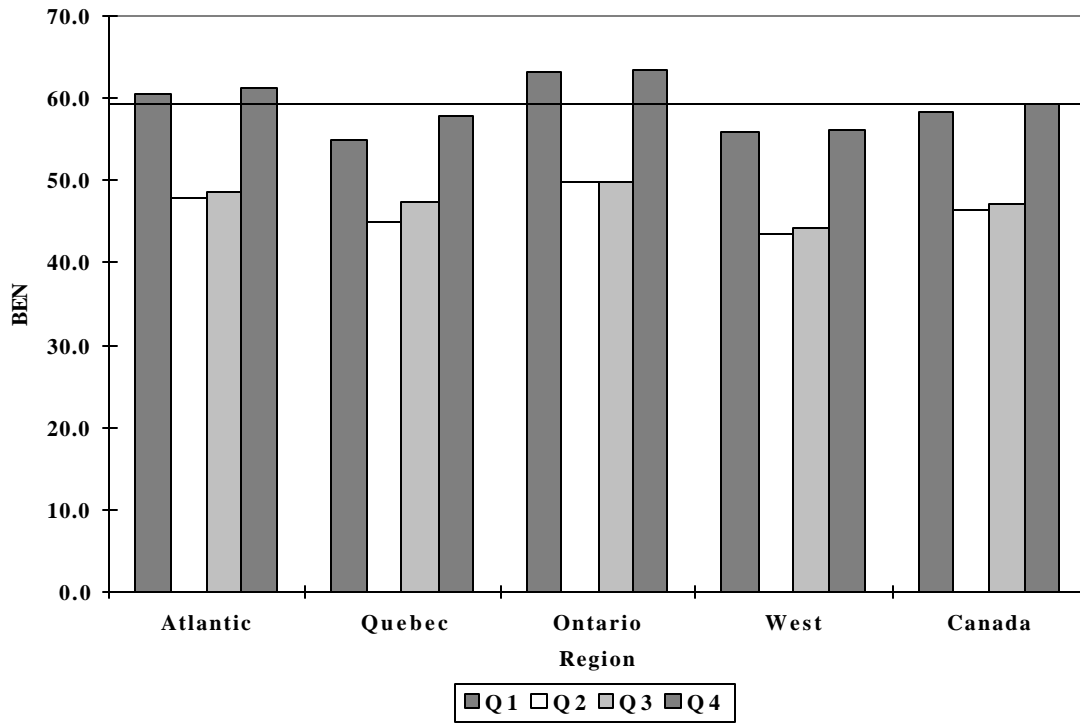
**Figure A4.1 : Average Benzene Concentration of Canadian Gasoline  
2001**



**Table A4.1 : Average Benzene Concentration (% by volume)**

	Q1	Q2	Q3	Q4
Atlantic	0.78	0.86	0.94	0.84
Quebec	0.59	0.65	0.78	0.67
Ontario	0.77	0.77	0.77	0.79
West	0.66	0.72	0.73	0.63
Canada	0.68	0.73	0.77	0.71

**Figure A4.2 : Average BEN of Canadian Gasoline 2001**

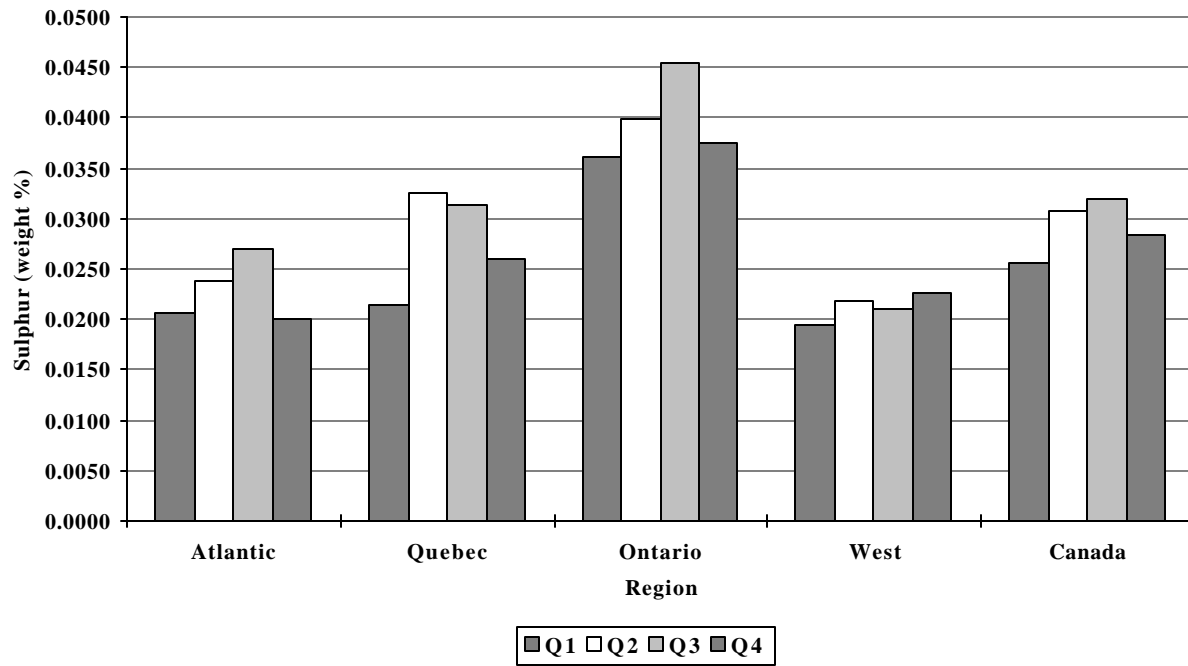


- The annual average BEN limit is 59.5.

**Table A4.2 : Average BEN**

	Q1	Q2	Q3	Q4
Atlantic	60.5	47.9	48.6	61.2
Quebec	54.9	44.9	47.4	57.8
Ontario	63.1	49.8	49.7	63.5
West	55.8	43.5	44.3	56.1
Canada	58.3	46.3	47.2	59.4

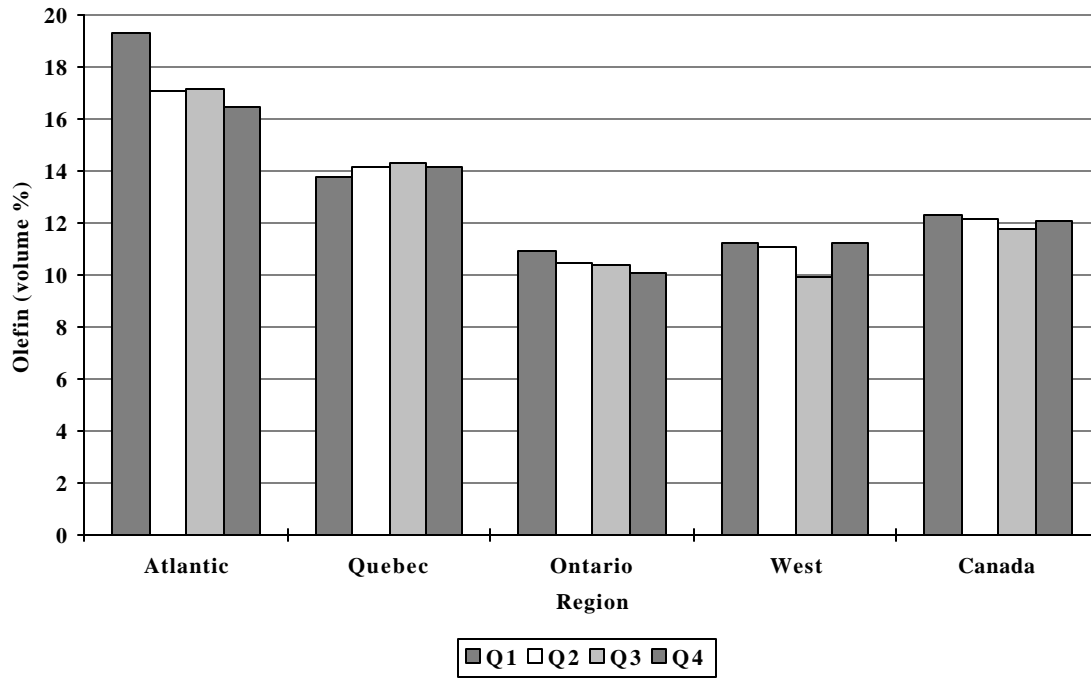
**Figure A4.3 : Average Sulphur Concentration of Canadian Gasoline 2001**



**Table A4.3 : Average Sulphur Concentration (% by weight)**

	Q1	Q2	Q3	Q4
Atlantic	0.0206	0.0239	0.0270	0.0200
Quebec	0.0215	0.0325	0.0313	0.0261
Ontario	0.0362	0.0400	0.0455	0.0376
West	0.0195	0.0217	0.0211	0.0226
Canada	0.0256	0.0307	0.0319	0.0283

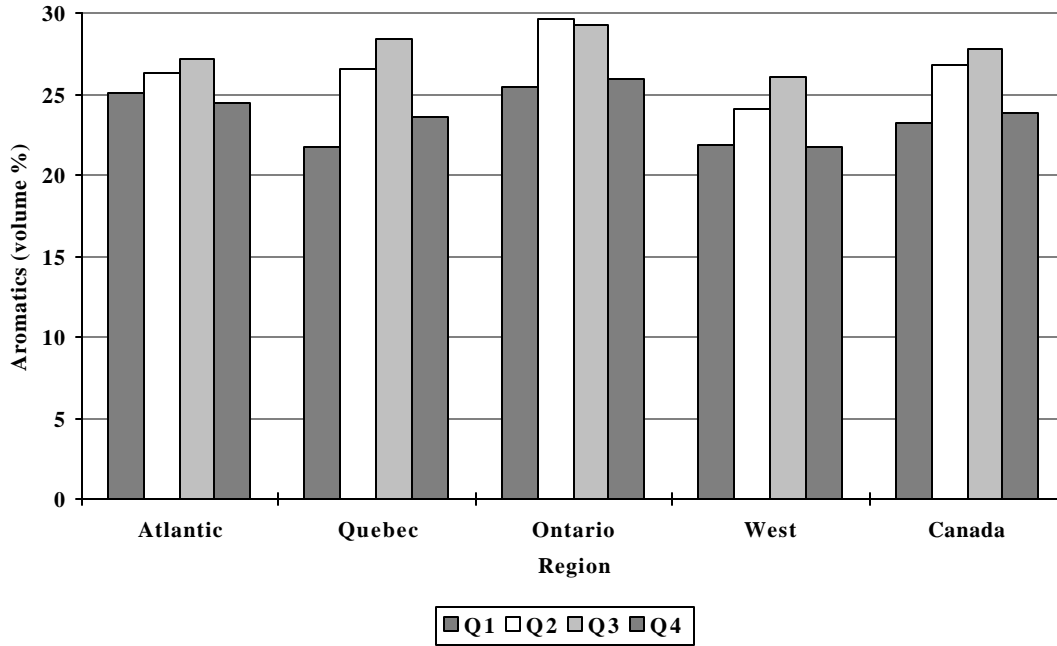
**Figure A4.4 : Average Olefin Concentration of Canadian Gasoline  
2001**



**Table A4.4 : Average Olefin Concentration (% by volume)**

	Q1	Q2	Q3	Q4
Atlantic	19.3	17.1	17.1	16.5
Quebec	13.8	14.2	14.3	14.1
Ontario	10.9	10.5	10.4	10.1
West	11.3	11.1	10.0	11.3
Canada	12.3	12.1	11.8	12.1

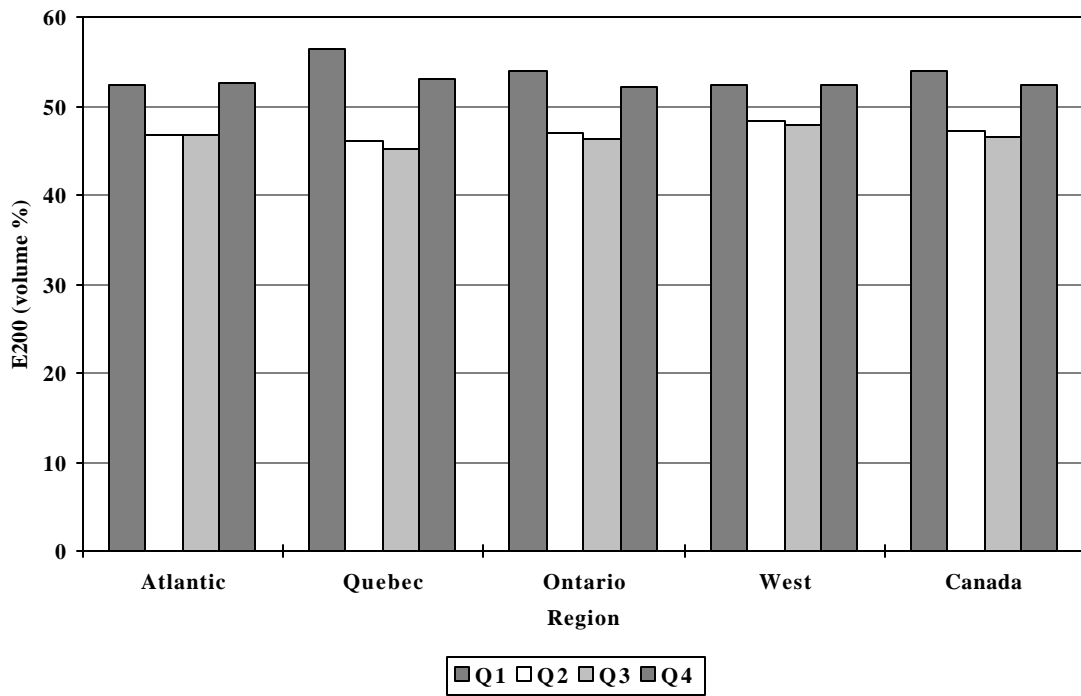
**Figure A4.5 : Average Aromatics Concentration of Canadian Gasoline 2001**



**Table A4.5: Average Aromatics Concentration (% by volume)**

	Q1	Q2	Q3	Q4
Atlantic	25.1	26.4	27.1	24.4
Quebec	21.8	26.5	28.4	23.5
Ontario	25.4	29.7	29.3	25.9
West	21.9	24.0	26.1	21.7
Canada	23.3	26.7	27.8	23.8

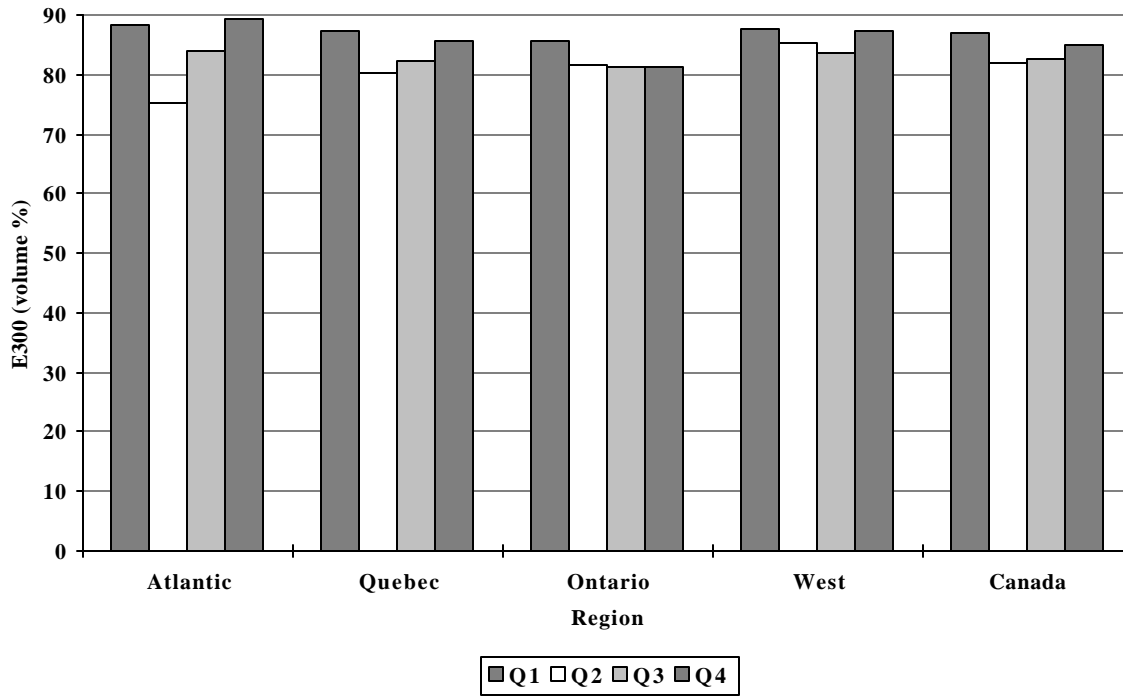
**Figure A4.6 : Average E200 of Canadian Gasoline 2001**



**Table A4.6 : Average E200 (% by volume)**

	Q1	Q2	Q3	Q4
Atlantic	52.4	46.7	46.7	52.6
Quebec	56.5	46.2	45.1	53.0
Ontario	53.9	47.0	46.3	52.2
West	52.3	48.3	47.8	52.3
Canada	53.9	47.2	46.5	52.5

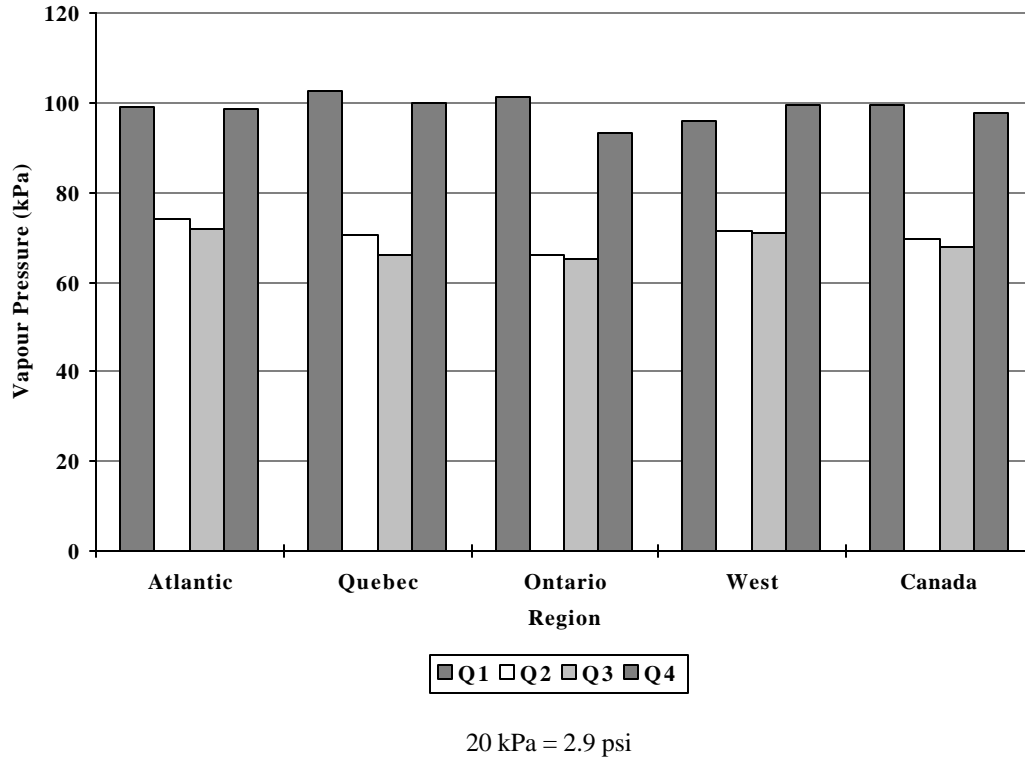
**Figure A4.7 : Average E300 of Canadian Gasoline 2001**



**Table A4.7 : Average E300 (% by volume)**

	Q1	Q2	Q3	Q4
Atlantic	88.2	75.2	84.1	89.2
Quebec	87.3	80.3	82.4	85.6
Ontario	85.5	81.5	81.3	81.2
West	87.5	85.2	83.7	87.3
Canada	86.9	81.9	82.6	84.9

**Figure A4.8 : Average Vapour Pressure of Canadian Gasoline 2001**

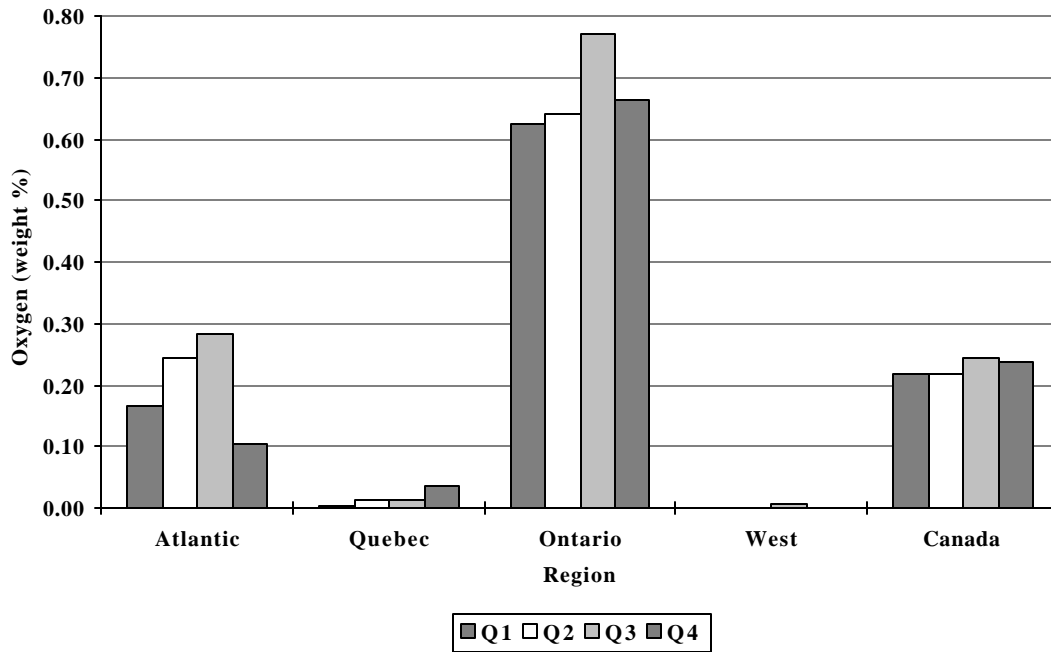


**Table A4.8 : Average Vapour Pressure (kPa)**

	Q1	Q2	Q3	Q4
Atlantic	99.1	74.3	72.0	98.7
Quebec	102.7	70.3	66.1	100.0
Ontario	101.3	66.1	65.0	93.2
West	95.9	71.5	71.1	99.5
Canada	99.6	69.6	67.9	97.5



**Figure A4.9 : Average Oxygen Concentration of Canadian Gasoline  
2001**



- Primarily ethanol in Ontario and MTBE elsewhere.

**Table A4.9 : Average Oxygen Concentration (% by weight)**

	Q1	Q2	Q3	Q4
Atlantic	0.16	0.24	0.28	0.10
Quebec	0.00	0.01	0.01	0.04
Ontario	0.62	0.64	0.77	0.66
West	0.00	0.00	0.01	0.00
Canada	0.22	0.22	0.24	0.24



# **Appendix 5**

Regional Data on the Maximum and Quarterly  
Averages for all Parameters



Table A5.1 : Reported Data for Benzene: Maximum, Minimum and Yearly Pool Averages  
(% by volume)

Region	Volume (m3)	Maximum	Minimum	Volume Weighted Average
Atlantic	2,905,498	1.29	0.60	0.86
Quebec	10,166,369	1.49	0.35	0.68
Ontario	12,865,129	1.42	0.08	0.77
West	13,281,519	1.41	0.28	0.68
Canada	39,218,515	1.49	0.08	0.72

Table A5.2 : Reported Data for BEN: Maximum, Minimum and Yearly Pool Averages

Region	Winter (1st and 4th Quarters)				Summer (2nd and 3rd Quarters)			
	Volume (m3)	Maximum	Minimum	Volume Weighted Average	Volume (m3)	Maximum	Minimum	Volume Weighted Average
Atlantic	1,315,392	82	52	60.9	1,590,106	84	32	32.1
Quebec	4,963,652	89	48	56.4	5,202,717	84	37	46.2
Ontario	6,342,660	99	27	63.3	6,522,469	94	27	49.8
West	6,496,529	92	41	56.0	6,784,990	85	34	44.0
Canada	19,118,233	99	27	58.9	20,100,282	94	27	45.5

Table A5.3 : Reported Data for Sulphur: Maximum, Minimum and Yearly Pool Averages (% by weight)

Region	Maximum	Minimum	Volume Weighted Average
Atlantic	0.0680	0.0029	0.0231
Quebec	0.0878	0.0122	0.0280
Ontario	0.0965	0.0003	0.0399
West	0.0763	0.0001	0.0213
Canada	0.0965	0.0001	0.0292

Table A5.4 : Reported Data for Olefins: Maximum, Minimum and Yearly Pool Averages (% by volume)

Region	Maximum	Minimum	Volume Weighted Average
Atlantic	27.9	1.2	17.4
Quebec	43.3	9.0	14.1
Ontario	31.0	1.3	10.5
West	36.9	0.0	10.9
Canada	43.3	0.0	12.1

Table A5.5 : Reported Data for Aromatics: Maximum, Minimum and Yearly Pool Average  
(% by volume)

Region	Maximum	Minimum	Volume Weighted Average
Atlantic	48.2	22.6	25.9
Quebec	52.8	17.7	25.2
Ontario	52.0	23.0	27.6
West	51.2	17.8	23.5
Canada	52.8	17.7	25.5

Table A5.6 : Reported Data for E200: Maximum, Minimum and Yearly Pool Averages  
(% by volume)

Region	Maximum	Minimum	Volume Weighted Average
Atlantic	66.1	39.6	49.3
Quebec	87.0	41.1	49.8
Ontario	63.4	36.6	50.0
West	83.7	40.5	50.1
Canada	87.0	36.6	49.9

Table A5.7 : Reported Data for E300: Maximum, Minimum and Yearly Pool Averages  
(% by volume)

Region	Maximum	Minimum	Volume Weighted Average
Atlantic	95.8	58.7	83.8
Quebec	97.0	74.5	83.8
Ontario	98.0	63.2	82.3
West	95.8	79.0	85.9
Canada	98.0	58.7	84.0

Table A5.8 : Reported Data for Vapor Pressure: Maximum, Minimum and Yearly Pool Average (kPa)

Region	Winter (1st and 4th Quarters)				Summer (2nd and 3rd Quarters)			
	Volume (m3)	Maximum	Minimum	Volume Weighted Average	Volume (m3)	Maximum	Minimum	Volume Weighted Average
Atlantic	1,315,392	106	77	98.9	1,590,106	103	45	73.1
Quebec	4,963,652	109	59	101.2	6,522,469	107	56	68.1
Ontario	6,342,660	108	51	97.1	5,202,717	105	48	65.6
West	6,496,529	110	59	97.7	6,784,990	105	52	71.3
Canada	19,118,233	110	51	98.5	20,100,282	107	45	68.9

# **Appendix 6**

## Company Reported Data





Table A6.1: Averages and Maxima Reported for Benzene (% by volume)

	<b>Company</b>	<b>Average</b>	<b>Maximum</b>
<b>Refiners</b>	Chevron Canada	0.3	1.0
	Consumer's Co-op	0.4	0.0
	Husky Oil	0.9	1.4
	Imperial Oil - Dartmouth	0.9	1.3
	Imperial Oil - Nanticoke	0.9	1.3
	Imperial Oil- Sarnia	0.8	1.1
	Imperial Oil - Strathcona	0.8	1.4
	Irving Oil	0.8	1.2
	North Atlantic	0.7	0.9
	Parkland - Bowden	0.8	1.0
	Petro-Canada - Edmonton	0.8	1.4
	Petro-Canada - Montreal	0.6	1.5
	Petro-Canada - Oakville	0.8	1.0
	Shell - Montreal	0.6	1.3
	Shell - Sarnia	0.8	1.1
	Shell - Scotford	0.5	1.2
Sunoco	0.7	1.4	
Ultramar - St-Romuald	0.8	1.2	
<b>Blender</b>	Robbins Feed and Fuel	0.5	0.7
<b>Importers</b>	BP (Arco)	0.9	1.3
	CAMI	0.7	1.0
	Ford	0.6	1.4
	GM	0.4	1.2
	Honda	1.0	1.0
	Imperial Oil-BC	0.5	0.9
	Mackenzie Petroleum	0.9	0.9
	Neste Petroleum	0.8	0.9
	North 60 Petro	0.9	0.9
	Northern Transportation	0.5	0.5
	Olco - ON	0.9	0.9
	Parkland - YK	0.9	0.9
	Petro-Canada - BC	0.7	0.9
	Petroles Norcan	0.6	0.9
	Ultramar - NF	0.9	1.1
Ultramar - QC	0.7	1.2	

Table A6.2: Averages and Maxima Reported for BEN

	Company	Winter (1st and 4th Quarters)		Summer (2nd and 3rd Quarters)	
		Average	Maximum	Average	Maximum
<b>Refiners</b>	Chevron	50.3	71	38.4	70
	Co-op	51.5	73	42.2	80
	Husky	57.3	76	42.6	73
	IOL - Dartmouth	63.1	82	51.6	84
	IOL - Nanticoke	66.3	86	51.5	90
	IOL - Sarnia	71.0	85	60.9	85
	IOL - Strathcona	59.0	71	46.6	70
	Irving	57.7	63	43.3	61
	North Atlantic	54.6	60	33.0	36
	Parkland - Bowden	53.9	56	42.7	56
	PC - Edmonton	56.1	71	44.5	68
	PC - Montreal*	51.4	82	44.7	75
	PC - Oakville*	66.1	83	49.5	75
	Shell - Montreal*	63.0	79	49.3	78
	Shell - Sarnia*	70.0	99	52.1	94
	Shell - Scotford	55.5	70	43.5	70
	Sunoco	47.0	93	38.0	80
Ultramar - St-Romuald	54.3	70	45.6	84	
<b>Blender</b>	Robbins Feed and Fuel	60.7	74	52.8	66
<b>Importers</b>	BP (Arco)	72.0	84	59.3	84
	CAMI	33.0	36	27.4	31
	Ford	54.6	63	34.1	43
	GM	49.7	56	39.5	42
	Honda	-	-	34.6	35
	Imperial Oil - BC	-	-	37.1	43
	Mackenzie	80.1	85	65.1	58
	North 60	-	-	51.3	51
	Northern Transp.	-	-	63.5	66
	Neste Petroleum	67.2	71	47.6	53
	Olco - ON	66.9	71	45.7	53
	Parkland - YK	80.1	92	62.8	85
	Petro-Canada - BC	56.0	64	42.0	56
	Petroles Norcan	59.0	59	39.1	47
	Ultramar - NF	-	-	47.9	73
	Ultramar - QC	65.8	89	46.4	58

Note:

Primary suppliers that are shaded and marked with an asterisk had an alternative limit for the BEN.

Table A6.3: Averages and Maxima Reported for Aromatics (% by volume)

	<b>Company</b>	<b>Average</b>	<b>Maximum</b>
<b>Refiners</b>	Chevron Canada	23	47
	Consumer's Co-op	22	38
	Husky Oil	20	43
	Imperial Oil - Dartmouth	25	48
	Imperial Oil - Nanticoke	28	46
	Imperial Oil- Sarnia	30	37
	Imperial Oil - Strathcona	22	30
	Irving Oil	28	36
	North Atlantic	28	34
	Parkland - Bowden	25	29
	Petro-Canada - Edmonton	20	32
	Petro-Canada - Montreal	21	53
	Petro-Canada - Oakville	27	35
	Shell - Montreal	30	50
	Shell - Sarnia	30	48
	Shell - Scotford	31	48
Sunoco	24	52	
Ultramar - St-Romuald	24	47	
<b>Blender</b>	Robbins Feed and Fuel	31	43
<b>Importers</b>	BP (Arco)	38	43
	CAMI	26	32
	Ford	30	40
	GM	29	40
	Honda	25	25
	Imperial Oil-BC	29	36
	Mackenzie Petroleum	39	42
	Neste Petroleum	29	35
	North 60 Petro	35	35
	Northern Transportation	26	27
	Olco - ON	28	33
	Parkland - YK	42	51
	Petro-Canada - BC	31	36
	Petroles Norcan	25	38
	Ultramar - NF	25	39
Ultramar - QC	28	52	

Table A6.4: Averages and Maxima Reported for Olefins (% by volume)

	<b>Company</b>	<b>Average</b>	<b>Maximum</b>
<b>Refiners</b>	Chevron Canada	13	28
	Consumer's Co-op	19	23
	Husky Oil	19	27
	Imperial Oil - Dartmouth	21	28
	Imperial Oil - Nanticoke	14	22
	Imperial Oil- Sarnia	10	18
	Imperial Oil - Strathcona	12	19
	Irving Oil	12	18
	North Atlantic	7	16
	Parkland - Bowden	0	1
	Petro-Canada - Edmonton	11	20
	Petro-Canada - Montreal	16	43
	Petro-Canada - Oakville	11	27
	Shell - Montreal	9	20
	Shell - Sarnia	13	31
	Shell - Scotford	1	2
Sunoco	4	21	
Ultramar - St-Romuald	15	22	
<b>Blender</b>	Robbins Feed and Fuel	8	11
<b>Importers</b>	BP (Arco)	8	13
	CAMI	4	6
	Ford	2	4
	GM	2	3
	Honda	6	6
	Imperial Oil-BC	7	18
	Mackenzie Petroleum	0	0
	Neste Petroleum	18	25
	North 60 Petro	0	0
	Northern Transportation	36	37
	Olco - ON	21	25
	Parkland - YK	0	0
	Petro-Canada - BC	10	26
	Petroles Norcan	19	27
	Ultramar - NF	21	27
Ultramar - QC	20	31	

Table A6.5: Averages and Maxima Reported for Sulphur (% by weight)

	<b>Company</b>	<b>Average</b>	<b>Maximum</b>
<b>Refiners</b>	Chevron Canada	0.017	0.040
	Consumer's Co-op	0.019	0.039
	Husky Oil	0.022	0.040
	Imperial Oil - Dartmouth	0.036	0.068
	Imperial Oil - Nanticoke	0.038	0.097
	Imperial Oil- Sarnia	0.061	0.082
	Imperial Oil - Strathcona	0.030	0.065
	Irving Oil	0.004	0.011
	North Atlantic	0.004	0.007
	Parkland - Bowden	0.000	0.000
	Petro-Canada - Edmonton	0.025	0.061
	Petro-Canada - Montreal	0.038	0.083
	Petro-Canada - Oakville	0.046	0.094
	Shell - Montreal	0.029	0.069
	Shell - Sarnia	0.046	0.091
	Shell - Scotford	0.005	0.005
	Sunoco	0.018	0.058
Ultramar - St-Romuald	0.019	0.051	
<b>Blender</b>	Robbins Feed and Fuel	0.031	0.048
<b>Importers</b>	BP (Arco)	0.009	0.021
	CAMI	0.003	0.003
	Ford	0.002	0.003
	GM	0.002	0.003
	Honda	0.004	0.004
	Imperial Oil-BC	0.008	0.044
	Mackenzie Petroleum	0.024	0.026
	Neste Petroleum	0.038	0.088
	North 60 Petro	0.023	0.023
	Northern Transportation	0.076	0.076
	Olco - ON	0.032	0.053
	Parkland - YK	0.024	0.028
	Petro-Canada - BC	0.003	0.010
	Petrols Norcan	0.023	0.040
	Ultramar - NF	0.022	0.059
	Ultramar - QC	0.037	0.088

Table A6.6: Averages and Maxima Reported for Oxygen (% by weight)

	<b>Company</b>	<b>Oxygenate</b>	<b>Average</b>	<b>Maximum</b>
<b>Refiners</b>	Chevron Canada	-	0.00	0.00
	Consumer's Co-op	-	0.00	0.00
	Husky Oil	-	0.00	0.00
	Imperial Oil - Dartmouth	MTBE & TAME	0.00	0.40
	Imperial Oil - Nanticoke	-	0.00	0.00
	Imperial Oil- Sarnia	-	0.00	0.00
	Imperial Oil - Strathcona	-	0.00	0.00
	Irving Oil	MTBE	0.52	2.77
	North Atlantic	MTBE	1.99	2.58
	Parkland - Bowden	-	0.00	0.00
	Petro-Canada - Edmonton	MTBE	0.00	0.00
	Petro-Canada - Montreal	Ethanol	0.01	3.70
	Petro-Canada - Oakville	-	0.00	0.00
	Shell - Montreal	MTBE	0.02	0.40
	Shell - Sarnia	-	0.00	0.00
	Shell - Scotford	-	0.00	0.00
Sunoco	Ethanol	2.75	3.70	
Ultramar - St-Romuald	-	0.00	0.00	
<b>Blender</b>	Robbins Feed and Fuel	Ethanol	0.38	3.30
<b>Importers</b>	BP (Arco)	-	0.00	0.00
	CAMI	MTBE	1.40	2.00
	Ford	-	0.00	0.00
	GM	-	0.00	0.00
	Honda	MTBE	2.20	2.20
	Imperial Oil-BC	-	0.00	0.00
	Mackenzie Petroleum	-	0.00	0.00
	Neste Petroleum	MTBE	0.25	1.28
	North 60 Petro	-	0.00	0.00
	Northern Transportation	MTBE, TAME, Methanol & Tertiary Butanol	1.93	1.94
	Olco - ON	-	0.43	1.29
	Parkland - YK	-	0.00	0.00
	Petro-Canada - BC	MTBE	0.00	0.11
	Petroles Norcan	MTBE	0.16	0.57
	Ultramar - NF	-	0.00	0.00
Ultramar - QC	-	0.00	0.00	

Table A6.7: Averages and Maxima Reported for Vapour Pressure (kPa)

	Company	Q1 & Q4		Q2 & Q3	
		Average	Maximum	Average	Maximum
<b>Refiners</b>	Chevron Canada	93.1	108	66.7	97
	Consumer's Co-op	99.3	107	74.1	95
	Husky Oil	100.8	109	76.8	103
	Imperial Oil - Dartmouth	101.3	106	74.4	103
	Imperial Oil - Nanticoke	102.1	107	65.1	96
	Imperial Oil- Sarnia	101.9	108	65.0	87
	Imperial Oil - Strathcona	98.7	107	71.9	103
	Irving Oil	95.3	103	72.6	94
	North Atlantic	78.6	91	56.7	78
	Parkland - Bowden	100.1	103	79.7	103
	Petro-Canada - Edmonton	97.1	110	69.1	87
	Petro-Canada - Montreal	103.2	107	68.3	107
	Petro-Canada - Oakville	83.9	107	66.5	86
	Shell - Montreal	97.1	109	62.7	86
	Shell - Sarnia	103.1	109	65.9	94
	Shell - Scotford	100.3	107	77.0	105
	Sunoco	95.0	108	65.7	108
Ultramar - St-Romuald	105.0	107	75.3	107	
<b>Blender</b>	Robbins Feed and Fuel	105.1	106	71.1	84
<b>Importers</b>	BP (Arco)	86.9	100	58.7	74
	CAMI	52.0	63	53.1	63
	Ford	93.6	97	53.9	65
	GM	82.5	97	52.8	54
	Honda	-	-	48.3	48
	Imperial Oil-BC	-	-	56.4	62
	Mackenzie Petroleum	96.6	99	89.1	87
	Neste Petroleum	90.2	94	60.5	71
	North 60 Petro	-	-	81.4	81
	Northern Transportation	-	-	91.8	93
	Olco - ON	90.1	94	61.0	71
	Parkland - YK	95.4	103	85.6	99
	Petro-Canada - BC	58.8	61	58.1	72
	Petroles Norcan	59.3	59	58.4	61
	Ultramar - NF	-	-	62.2	71
Ultramar - QC	85.0	100	63.7	84	

Table A6.8: Averages and Maxima Reported for E200 (% by volume)

	<b>Company</b>	<b>Average</b>	<b>Maximum</b>
<b>Refiners</b>	Chevron Canada	50	84
	Consumer's Co-op	51	59
	Husky Oil	46	57
	Imperial Oil - Dartmouth	50	62
	Imperial Oil - Nanticoke	45	62
	Imperial Oil- Sarnia	55	63
	Imperial Oil - Strathcona	48	58
	Irving Oil	48	65
	North Atlantic	55	63
	Parkland - Bowden	64	68
	Petro-Canada - Edmonton	50	62
	Petro-Canada - Montreal	49	66
	Petro-Canada - Oakville	48	84
	Shell - Montreal	49	67
	Shell - Sarnia	51	62
	Shell - Scotford	56	65
	Sunoco	52	62
Ultramar - St-Romuald	52	67	
<b>Blender</b>	Robbins Feed and Fuel	48	57
<b>Importers</b>	BP (Arco)	52	60
	CAMI	46	48
	Ford	43	50
	GM	44	50
	Honda	47	47
	Imperial Oil-BC	44	52
	Mackenzie Petroleum	49	52
	Neste Petroleum	46	61
	North 60 Petro	46	46
	Northern Transportation	55	55
	Olco - ON	51	61
	Parkland - YK	49	52
	Petro-Canada - BC	45	51
	Petroles Norcan	46	53
	Ultramar - NF	46	66
Ultramar - QC	46	87	



Table A6.9: Averages and Maxima Reported for E300 (% by volume)

	<b>Company</b>	<b>Average</b>	<b>Maximum</b>
<b>Refiners</b>	Chevron Canada	87	95
	Consumer's Co-op	83	87
	Husky Oil	83	93
	Imperial Oil - Dartmouth	87	94
	Imperial Oil - Nanticoke	82	93
	Imperial Oil- Sarnia	86	93
	Imperial Oil - Strathcona	85	96
	Irving Oil	79	92
	North Atlantic	89	96
	Parkland - Bowden	91	93
	Petro-Canada - Edmonton	89	96
	Petro-Canada - Montreal	81	96
	Petro-Canada - Oakville	79	89
	Shell - Montreal	86	95
	Shell - Sarnia	81	90
	Shell - Scotford	84	92
	Sunoco	84	98
Ultramarc - St-Romuald	84	91	
<b>Blender</b>	Robbins Feed and Fuel	85	90
<b>Importers</b>	BP (Arco)	89	92
	CAMI	90	93
	Ford	81	93
	GM	82	93
	Honda	85	85
	Imperial Oil-BC	83	87
	Mackenzie Petroleum	85	89
	Neste Petroleum	87	97
	North 60 Petro	83	83
	Northern Transportation	79	79
	Olco - ON	88	97
	Parkland - YK	85	89
	Petro-Canada - BC	83	90
	Petroles Norcan	83	89
	Ultramarc - NF	85	95
Ultramarc - QC	85	93	

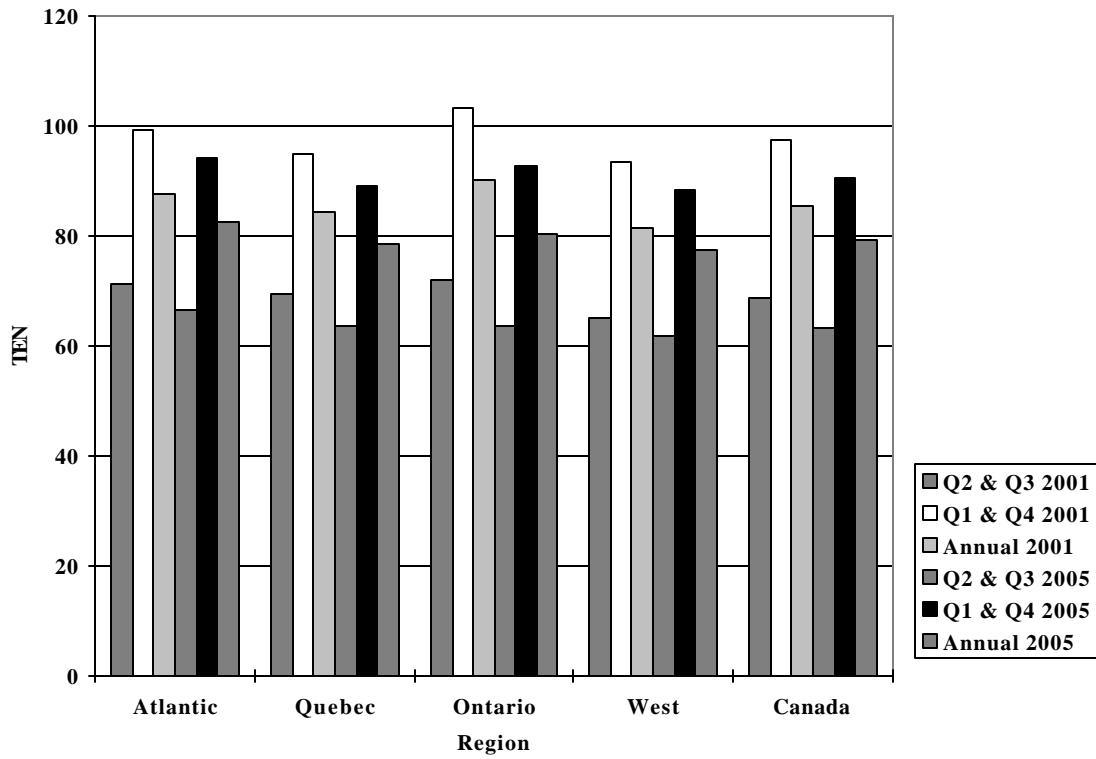


# **Appendix 7**

## **Toxic Emission Number (TEN) Data**



**Figure A7.1 : Average TEN of Canadian Gasoline**



**Table A7.1: Average TEN of Canadian Gasoline**

	Q2 & Q3 2001	Q1 & Q4 2001	Annual 2001	Q2 & Q3 2005	Q1 & Q4 2005	Annual 2005
Atlantic	71	99	88	67	94	83
Quebec	69	95	84	64	89	79
Ontario	72	103	90	64	93	81
West	65	93	82	62	89	77
Canada	69	97	86	63	90	79

Table A7.2: Average TEN

	Company	Year 2001			Year 2005		
		Summer TEN	Winter TEN	Annual TEN	Summer TEN	Winter TEN	Annual TEN
<b>Refiners</b>	Chevron Canada	60	87	76	57	84	73
	Consumer's Co-op	67	95	83	64	90	79
	Husky Oil	68	100	87	65	94	82
	Imperial Oil - Dartmouth	77	103	92	69	95	84
	Imperial Oil - Nanticoke	75	106	93	67	96	84
	Imperial Oil - Sarnia	80	106	95	64	91	80
	Imperial Oil - Strathcona	67	97	85	62	90	78
	Irving Oil	63	94	81	63	93	81
	North Atlantic	55	88	74	55	87	74
	Parkland - Bowden	61	87	76	62	87	77
	Petro-Canada - Edmonton	66	93	81	62	87	76
	Petro-Canada - Montreal	70	93	84	63	85	76
	Petro-Canada - Oakville	71	108	92	63	94	81
	Shell - Montreal	69	98	86	63	91	79
	Shell - Sarnia	74	109	95	65	95	82
	Shell - Scotford	62	89	78	62	89	77
	Sunoco	62	90	78	59	87	75
Ultramar - St-Romuald	69	93	83	65	90	79	
<b>Blender</b>	Robbins Feed and Fuel	69	98	86	62	91	79
<b>Importers</b>	BP (Arco)	74	104	92	73	101	89
	CAMI	56	86	74	56	86	74
	Ford	57	100	82	57	100	82
	GM	61	88	77	61	89	77
	Honda	57	-	N/A	57	-	N/A
	Imperial Oil - BC	60	-	N/A	59	-	N/A
	Mackenzie Petroleum	77	114	99	72	106	92
	Neste Petroleum	72	108	93	65	99	85
	North 60 Petro	73	-	N/A	69	-	N/A
	Northern Transportation	*	-	N/A	*	-	N/A
	Olco - ON	70	108	92	64	99	84
	Parkland - YK	81	115	101	75	106	94
	Petro-Canada - BC	64	93	81	64	93	81
	Petrols Norcan	65	97	84	61	94	80
	Ultramar - NF	69	-	N/A	65	-	N/A
Ultramar - QC	72	105	91	65	95	83	

- \* TEN cannot be calculated due to addition of methanol to gasoline which is not supported by Complex Model calculations.
- N/A indicates that annual TEN cannot be calculated if gasoline was not supplied during both the summer and winter.