

Independent Verification of the Proposed Tracking Model to Measure Progress against Auto GHG MOU Targets

Final Report

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Executive Summary

Natural Resources Canada (NRCan) retained ENVIRON EC (CANADA), INC. (ENVIRON) to carry out the independent verification of the proposed Motor Vehicle Greenhouse Gas (GHG) Accounting Model. This tracking model has been developed to measure progress in reducing GHG emissions relative to interim goals and the final target set in the 2005 Memorandum of Understanding (MOU) between the Government of Canada and the Canadian Auto industry.

This MOU established an annual reduction target of 5.3 megatonnes (Mt) for GHG emissions from automobiles and light-duty trucks for the year 2010 relative to a benchmark/reference level. The tracking model compares GHG emissions calculated in a Performance Case (actual level) to those calculated in a Reference Case (benchmark level) using a series of Microsoft Excel spreadsheets. The inputs to the model include Canadian data from existing federal and provincial government data collection systems, data that are publically available or that can be purchased, as well as data from recognized international bodies. No attempt has been made to update these inputs with data available at the time of this verification.

The objectives of the verification were to:

- Evaluate the choice and sources of data used to populate the tracking model;
- Evaluate the calculation methodology; and
- Evaluate the accuracy of the calculation algorithms and results within the tracking model.

The key inputs to this tracking model are as follows:

- vehicle stock and fuel consumption by class (passenger car and light truck) and model year;
- vehicle kilometres travelled by class and model year;
- vehicle fuel type (gasoline or diesel);
- adjustment factor between lab tested and actual on road fuel consumption; and
- GHG emission factors by class, fuel type and model year.

Following review of the proposed tracking model and supporting documentation provided by NRCan to measure progress against auto GHG MOU targets, ENVIRON has the following to report:

- The tracking model methodology and input data have been verified using the references in files that make up the tracking model, and supporting documentation;
- In general the structure and implementation of the tracking model is supported by the references provided, and relies on the best available data;
- There were no assumptions reported in the methodology or implicit in the tracking model structure that would misrepresent the final result; and
- No calculation errors were found in the excel spreadsheets that were provided.

Therefore the output of the tracking model provides an appropriate method of measuring the progress against auto GHG MOU targets.

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1 Introduction

1.1 Background

Natural Resources Canada (NRCan) retained ENVIRON EC (CANADA), INC. (ENVIRON) to carry out the independent verification of the proposed Motor Vehicle Greenhouse Gas (GHG) Accounting Model. This tracking model has been developed to measure progress in reducing GHG emissions relative to interim goals and the final target set in the 2005 Memorandum of Understanding (MOU) between the Government of Canada and the Canadian Auto industry.

This MOU established an annual reduction target of 5.3 megatonnes (Mt) for GHG emissions from automobiles and light-duty trucks for the year 2010 relative to a benchmark/reference level. The benchmark/reference level was based on the 2010 forecast in the 1999 Transportation Report (Study 3) on Climate Change, the assumptions for which were drawn from NRCan's 1999 emissions forecast *Canada's Emissions Outlook: An Update, Analysis and Modelling Group, National Climate Change Process, December 1999*, and the detailed tables in the Annex to the Outlook.

The tracking model compares GHG emissions calculated in a Performance Case (actual level) to those calculated in a Reference Case (benchmark level) using a series of Microsoft Excel spreadsheets. The inputs to the model include Canadian data from existing federal and provincial government data collection systems, data that are publically available or that can be purchased, as well as data from recognized international bodies.

1.2 Scope of Work

This report provides the independent verification of the proposed tracking model to measure progress against auto GHG MOU targets. The objectives of this project were to:

- Task 1: Evaluate the choice and sources of data used to populate the tracking model;
- Task 2: Evaluate the calculation methodology;
- Task 3: Evaluate the accuracy of the calculation algorithms and results within the tracking model; and
- Task 4: Write a report.

This verification evaluates the inputs that were used in the model to calculate the 2007 interim target set in this MOU. No attempt has been made to update these inputs with data available at the time of this verification.

2 Verification of the Proposed Tracking Model

The Motor Vehicle GHG Tracking Model was developed to track the Canadian Automotive Industry's progress towards 3 interim targets and a final goal set in the MOU. This tracking model enables GHG emissions from the Canadian light-duty vehicle fleet to be calculated on an annual basis. The key inputs to this tracking model are as follows:

- vehicle stock and fuel consumption by class (passenger car and light truck) and model year;
- vehicle kilometres travelled by class and model year;
- vehicle fuel type (gasoline or diesel);
- adjustment factor between lab tested and actual on road fuel consumption; and
- GHG emission factors by class, fuel type and model year.

The verification of the tracking model was based on the following reports and files provided by NRCan as listed below:

1. Canadian Transportation Table Study 3: Road Vehicle and Fuels Technology Measures Analysis - Final Report, Canadian Transportation Issue Table Vehicle Efficiency Technologies Category, Public Works and Government Services Canada, Science Directorate, Science Informatics and Professional Services Sector, Hull, Quebec, Canada, September 1999.
2. Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999.
3. Canada's Emission Outlook: An Update, Analysis and Modelling Group, National Climate Change Process, December 1999.
4. AIR. 2004. Memorandum: Impacts of Tier 2 and Low Sulfur Fuel on N2O Emissions and GHGs in Canada.
5. Environment Canada. 2006. Fleet Average NOx Emission Performance of Model Year 2004 Light-Duty Vehicles, Light-Duty Trucks and Medium-Duty Passenger Vehicles.
6. Environment Canada. 2007. Fleet Average NOx Emission Performance of Model Year 2005 Light-Duty Vehicles, Light-Duty Trucks and Medium-Duty Passenger Vehicles.
7. Environment Canada. 2008. Fleet Average NOx Emission Performance of Model Year 2006 Light-Duty Vehicles, Light-Duty Trucks and Medium-Duty Passenger Vehicles.
8. National Inventory Report 1990 – 2006: Greenhouse Gases Sources and Sinks in Canada
9. Excel files
 - a. CH4 Factors Table by MY – Performance
 - b. CH4 Factors Table by MY – Reference
 - c. N2O Factors Table by MY – Performance
 - d. N2O Factors Table by MY – Reference
 - e. With FFV Credit Final 2007

f. Without FFV Credit Final 2007

10. Word file: Parameters and Methodologies.

2.1 Evaluation of the Choice and Sources of Data Used to Populate the Tracking Model

This section summarizes the verification of the data used in the tracking model. ENVIRON's focus was to evaluate the credibility of the data sources selected to populate the tracking model. The various data sources used in the tracking model considered for review are discussed below.

2.1.1 Registered Vehicles ($\leq 8,500$ lbs)

The motor vehicle fleet can be divided into two main categories: light-duty and heavy-duty vehicles. The light duty vehicles are defined as vehicles with gross vehicle weight (GVW) ratings less than and including 8,500 lb, and medium and heavy-duty vehicles as vehicles with GVW ratings more than 8,500 lb.

The Canadian Vehicle in Operation Census (CVIOC) provided to NRCan by DesRosiers Automotive Consultants (DAC) consists of all vehicles up to 10,000 lbs that are registered in Canada on an annual basis. The MOU only addresses light-duty passenger cars and light trucks (up to 8,500 lbs), therefore vehicles of class 2B (8,501-10,000 lbs) had to be removed.

The approach used to remove class 2B vehicles was as follows:

- The CVIOC data was divided into passenger cars (P) and light-trucks (LT) according to the coding in the CVIOC database;
- The light-truck file was further broken down into two groups according to their weight class LT up to 6,000 lbs (LDT1 and LDT2) and LT over 6,000 lbs (LDT3 and LDT4);
- The list of light-trucks over 6,000 lbs (LDT3, LDT4 and Class 2B), was then cross-referenced to those light-trucks contained in the Vehicle Fuel Economy Information System (VFEIS) to determine which vehicles were under 8,501 lbs; and
- A complete listing of all vehicles for Class 2B was generated and reviewed by Canadian Automotive manufacturers to verify the accuracy of NRCan's segmentation.

In view of the availability of data and data sources, this approach provides the light-duty fleet ($\leq 8,500$ lbs) targeted by this MOU and required for the tracking model.

2.1.2 New Vehicle Sales ($\leq 8,500$ lbs)

New vehicle sales used to populate the tracking model were obtained from the Vehicle Fuel Economy Information System (VFEIS). VFEIS is a database designed to capture motor vehicle fuel consumption and engine technology information from the automobile manufacturers that market various classes of vehicles in Canada.

VFEIS is a good source to provide new vehicle sales of the light-duty fleet on a model year basis which is consistent with the reporting in CVIOC.

2.1.3 Fleet Average Fuel Consumption by Model Year (Laboratory Tested Values)

Car and light truck fleet average fuel consumption values (both gasoline and diesel) are incorporated into the tracking model on a model year basis.

The fleet average fuel consumption values in the reference case were taken directly from the benchmark/reference values used in the *Canadian Transportation Table Study 3: Road Vehicle and Fuels Technology Measures Analysis - Final Report, Canadian Transportation Issue Table Vehicle Efficiency Technologies Category, Public Works and Government Services Canada, Science Directorate, Science Informatics and Professional Services Sector, Hull, Quebec, Canada, September 1999*.

The fleet average fuel consumption values in the performance case are the same as in the reference case for model years 1980 – 1999 inclusive. The performance case values for model year 2000 and newer are obtained from the VFEIS database. This data was verified for the calculations and incorporated in the model correctly.

The data sources and choice of the data used in the tracking model are appropriate.

2.1.4 Vehicle Kilometre Travelled (VKT) Data

The primary source of information used is a database of the average annual VKT collected from the Ontario Drive Clean Program. These data are presented for LDGV, LDDV, LDGT, and LDDT by vehicle age from 1 to 25 years old. The Ontario annual VKT estimates by model year are calibrated to National levels using total annual sales of taxed fuel.

In the absence of primary observations of age distributed VKT for all of Canada, the estimates used in the tracking model which are consistent with the *National Inventory Report 1990-2006: Greenhouse Gases Sources and Sinks in Canada* represent the best available estimate of VKT appropriate for use in the tracking model.

2.1.5 Adjustment for Actual On-road Fuel Consumption

This VFEIS fuel consumption data are obtained using standard lab test cycles performed on a dynamometer to ensure fair comparison of vehicles and is therefore adjusted in the tracking model with an on road factor to represent the difference between the testing cycle and on road conditions.

The source for the adjustment for actual on-road fuel consumption is the *National Inventory Report 1990-2006: Greenhouse Gases Sources and Sinks in Canada*, which is a good source for this data.

2.1.6 Greenhouse Gas (GHG) Emission Factors

Greenhouse gases were calculated in the tracking model based on the emission of Carbon Dioxide (CO₂), Methane (CH₄), and Nitrous Oxide (N₂O). Emissions of CH₄ and N₂O were not included for diesel vehicles. Since the emission rate from diesel combustion is small relative to the rate from gasoline combustion, and the size of the diesel vehicle fleet is small relative to the gasoline vehicle fleet, this will not impact conclusions derived from the output of the model.

2.1.6.1 CO₂ Emission Factors

The CO₂ emission factors referenced in the excel sheets and the word document “Parameters and Methodologies” were collected from the *National Inventory Report 1990-2006: Greenhouse Gases Sources and Sinks in Canada* and are shown in the Table 1 below.

Table 1: Carbon Dioxide (CO₂) Emission Factors

Parameter	Sources	Value	ENVIRON Notes:
Carbon dioxide emission factors (CO ₂) (Same in both Reference and Performance Case)	Reference Case: <i>National Inventory Report 1990-2006: Greenhouse Gases Sources and Sinks in Canada</i>	2.289 kg/L (gasoline) 2.663 kg/L (diesel)	Excel Files Reviewed: With FFV Credit Final 2007.xls Without FFV Credit Final 2007.xls Values found in Sheets: Output Values Verified in Reference: Table A12-11
	Performance Case: <i>National Inventory Report 1990-2006: Greenhouse Gases Sources and Sinks in Canada</i>	2.289 kg/L (gasoline) 2.663 kg/L (diesel)	Same as above

The values reported in the word document “Parameters and Methodologies” were verified using the source above, and were then verified against those used in the excel files for calculation. No discrepancies were found.

2.1.6.2 N₂O Emission Factors

The N₂O emission factors referenced in the excel sheets and the word document “Parameters and Methodologies” are shown, along with their sources, in Table 2 below.

Table 2: Nitrous Oxide (N₂O) Emission Factors

Parameter	Sources	Value		ENVIRON Notes
Nitrous oxide emission factors (N ₂ O) in g/mi (Calculated for gasoline vehicles only in both reference and performance Case)	Reference Case: <i>Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999</i> for all emission control technologies	Gasoline Cars: Tier 2, LEV (0.0255) Tier 1 (0.034) Tier 0 (0.092) Ox. Cat (0.033) Non-Cat (0.009)	Gasoline Trucks: Tier 2, LEV (0.0668) Tier 1 (0.089) Tier 0 (0.223) Ox. Cat (0.045) Non-Cat (0.011)	<p>Excel Files Reviewed: N₂O Factors Table by MY – Reference.xls</p> <p>Values found in Sheets: N₂O Factors to 2003 MY</p> <p>Values Verified in Reference: Calculation using Tables C6a and 2.3.2-1 (Ref: <i>Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999</i>)</p> <p>N₂O emissions from vehicles with model year 2004 or greater are conservatively estimated to be 25% lower (Ref: <i>Canada's Emission Outlook: An Update, Analysis and Modelling Group, National Climate Change Process, December 1999</i>)</p> <p>Values verified in table 14 (Ref: <i>Impacts of Tier 2 and Low Sulphur Fuel on N₂O Emissions on GHGs in Canada, Air Improvement Resources, Inc., 2004</i>)</p>
	Performance Case: <i>Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999</i> for emission control technologies up to and including Tier 1 and <i>AIR. 2004. Memorandum: Impacts of Tier 2 and Low Sulphur Fuel on N₂O Emissions and GHGs in Canada</i> for LEV and Tier 2 (until these values become available by EC)	Gasoline Cars: High Sulphur Tier 2 (0.026) LEV (0.026) Low Sulphur Tier 2 (0.006) LEV (0.006)	Gasoline Trucks: High Sulphur Tier 2 (0.026) LEV (0.064) Low Sulphur Tier 2 (0.006) LEV (0.016)	<p>Excel Files Reviewed: N₂O Factors Table by MY – Performance.xls</p> <p>Values found in Sheets: N₂O Factors to 2003 MY</p> <p>Values Verified in Reference: Values verified in table 14 (Ref: <i>AIR. 2004. Memorandum: Impacts of Tier 2 and Low Sulphur Fuel on N₂O Emissions and GHGs in Canada</i>)</p>

The values reported in the word document “Parameters and Methodologies” were verified using the sources above, which were verified against those used in the excel files for calculation. No discrepancies were found.

2.1.6.3 CH₄ Emission Factors

The CH₄ emission factors referenced in the excel sheets and the word document “Parameters and Methodologies” are shown along with their sources in Table 3.

Table 3: Methane (CH₄) Emission Factors

Parameter	Sources	Value		ENVIRON NOTES:
Methane emission factors (CH ₄) in g/L (Calculated for gasoline vehicles only in both reference and performance Case)	Reference Case: <i>Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999</i> for all emission control technologies	Gasoline Cars: Tier 2, LEV (0.25) Tier 1 (0.25) Tier 0 (0.32) Oxidation Cat (0.42) Non-Cat (0.52)	Gasoline Trucks: Tier 2, LEV (0.19) Tier 1 (0.19) Tier 0 (0.41) Oxidation Cat (0.44) Non-Cat (0.56)	Excel Files Reviewed: CH ₄ Factors Table by MY – Reference.xls Values found in Sheets: CH ₄ Factors Values Verified in Reference: Table C6a (Ref: <i>Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999</i>)
	Performance Case: <i>Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999</i> for emission control technologies up to and including Tier 1 and Tier 1 value for LEV and Tier 2 <i>National Inventory Report 1990-2006: Greenhouse Gases Sources and Sinks in Canada</i>	Gasoline Cars: Tier 2, LEV (0.12)	Gasoline Trucks: Tier 2, LEV (0.13)	Excel Files Reviewed: CH ₄ Factors Table by MY – Performance.xls Values found in Sheets: CH ₄ Factors Values Verified in Reference: Table C6a (Ref: <i>Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999</i>) Table A12-11 (Ref: <i>National Inventory Report 1990-2006: Greenhouse Gases Sources and Sinks in Canada</i>)

The values reported in the word document “Parameters and Methodologies” were verified using the sources above, which were verified against those used in the excel files for calculation. No discrepancies were found.

2.1.7 Global Warming Potential

The global warming potential (GWP) used in the tracking model were taken from *Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends, Environment Canada, April, 1999*. The GWP potential for Carbon Dioxide equivalent (CO₂e) CO₂, CH₄ and N₂O is 1, 21 and 310, respectively. The data source used in the tracking model is acceptable, and the values correspond to generally accepted GWP.

2.2 Evaluation of Calculation Methodology

The tracking model calculates the greenhouse gas emissions of the light duty vehicle fleet to 2010 by accounting for parameters discussed in section 2.1. There were two versions of the tracking model provided, one that includes the credit for flexible fuel vehicles (FFV) that is incorporated into the Company Average Fuel Consumption (CAFC) calculations, and one that does not. Each version has a separate Excel file which consists of number of sheets as follows:

- Intro;
- Reference Case;
- Actual Performance;
- Output;
- Reference N₂O;
- Performance N₂O;
- Reference CH₄;
- Performance CH₄;
- Car Stock & Sales;
- LDT Stock & Sales; and
- Car & LDT VKT.

The data and calculation methods used in the tracking model were evaluated in each sheet and summarized below. An additional subheading describing the differences between the Excel files with names *Without FFV Credit Final 2007.xls* and *With FFV Credit Final 2007.xls* was provided.

2.2.1 Intro

The "Intro" sheet introduces the GHG tracking model. There are no calculations in this sheet. There is a brief description of the other sheets in the tracking model.

2.2.2 Reference Case

In the "Reference Case" sheet, fuel consumption data is presented for new vehicles in the following categories:

- Car - motor gasoline;
- Light truck - motor gasoline;
- Car – diesel; and
- Light truck – diesel.

The fuel consumption data for each new vehicle is multiplied by an adjustment factor to convert it from the lab tested value to one that better represents on road fuel consumption. These data were populated from the *Canadian Transportation Table Study 3*.

The “Reference Case” sheet presents the stock, annual average vehicle kilometres travelled, and calculates the fuel consumed for model years prior to 1981 (one group), then individual model years 1981 through to 2010:

- Car - motor gasoline;
- Light truck - motor gasoline;
- Car – diesel; and
- Light truck – diesel.

2.2.3 Actual Performance

The performance case calculations depend on external factors and the internal factors. The internal factors, such as fleet average fuel consumption by model year, on road adjustment factors, and emission factors, can be directly controlled by industry while external factors, such as vehicle sales and sales mix, scrappage of vehicles, and annual kilometres, cannot be directly controlled by the automotive industry.

The “Actual Performance” sheet consists of the same information as the “Reference Case” except for the fuel consumption data. Fuel consumption data is the same as the “Reference Case” until model year 2000, where the forecast fuel consumption as predicted in Study 3 on Climate Change is replaced with CAFC values reported in VFEIS data administered by Transport Canada.

Using the same Stock and VKT data in both the reference and performance scenarios ensures that only the impact of internal factors are captured in the calculated change in emissions.

2.2.4 Difference between With and Without FFV Credit

The only difference in the two estimation methods occurs with respect to the fuel consumption data reported for the years 2000 – 2007 for gasoline fuelled cars and trucks in the performance case where VFEIS data is used. Fuel consumption credits are provided to manufacturers who produce alternative fuel vehicles. This credit is applied to alternative fuel capable vehicles in the calculation of the fleet average fuel consumption under the CAFC program. However, these credits do not represent a real reduction in fuel use and therefore do not result in real GHG emission reductions. The difference in fuel consumption with and without this credit generates a difference of 0.3 Mt CO₂e in the final emission reduction for 2007.

2.2.5 Output

The “Output” sheet calculates CO₂, CH₄, N₂O and CO₂e emission rates for Reference Case and Actual Performance, and the difference represents the progress towards the reduction target of 2.4Mt CO₂e for 2007.

The CO₂ is calculated for passenger cars and light duty trucks fuelled by gasoline and diesel using the following equation:

$$CO_2 = \left(\sum_{t=pre-1981}^{2007} Stock_t \times Average\ VKT_t \times Fleet\ Average\ Fuel\ Consumption_t \right) \times EF_{CO_2}$$

For the purpose of this calculation the Vehicle Stock, average VKT, and the fuel specific emission factor are the same for the actual and performance cases, while the Fleet Average Fuel Consumption is different for Model years 2000 – 2007, based on actual Fleet Average Fuel Consumption values surpassing those forecast in Study 3.

N₂O and CH₄ emissions are presented as line items in the “Output” sheet, with units of CO₂e, but are calculated in separate sheets.

The total progress toward the 2.4 Mt CO₂e reduction target is provided at the bottom of the output sheet as the sum of performance case emissions minus the sum of the reference case emissions.

2.2.6 Reference N₂O

The sheet “Reference N₂O” calculates the total N₂O emissions for the reference case using the equation:

$$N_2O = \frac{\sum_{t=1980}^{2007} Stock_t \times Average\ VKT_t \times EF_{Ref,t}}{10^{12}}$$

For N₂O in the reference case a weighted emission factor was calculated for each year in the file *N₂O Factors Table by MY – Reference.xls*. The total VKT for the model year “Prior to 1981” is multiplied by the emission factor for 1980. There are N₂O emission factors for years prior to 1980 presented but these are not incorporated into the calculation because stock breakdown was not available for model years prior to 1981.

2.2.7 Performance N₂O

The sheet “Performance N₂O” calculates the total N₂O emissions for the performance case using the equation:

$$N_2O = \frac{\sum_{t=1980}^{2007} Stock_t \times Average\ VKT_t \times EF_{Per,t}}{10^{12}}$$

For the performance case a weighted emission factor was calculated for each year in the file *N₂O Factors Table by MY – Performance.xls*. The difference between the reference and performance cases arises from the difference in emission factors for each scenario. Again the vehicle stock and VKT estimates for each year are the same in both scenarios.

The total VKT for the model year “Prior to 1981” is multiplied by the emission factor for 1980. There are N₂O emission factors for years prior to 1980 presented but these are not incorporated into the calculation because stock breakdown was not available for model years prior to 1981.

2.2.8 Reference CH₄

The sheet “Reference CH₄” calculates the total CH₄ emissions for the reference case using the equation:

$$CH_4 = \frac{\sum_{t=1980}^{2007} Annual\ Fuel \times EF_{Ref,t}}{10^{12}}$$

A weighted emission factor was calculated for each year in the file *CH₄ Factors Table by MY – Reference.xls*. The annual fuel use, for gasoline fuelled cars and light trucks in each vehicle model year in the tracking model, is transferred from the estimate in the sheet “Reference Case”. The fuel use for the model year “Prior to 1981” is multiplied by the emission factor for 1980. There are CH₄ emission factors for years prior to 1980 presented but these are not

incorporated into the calculation because stock breakdown was not available for model years prior to 1981.

2.2.9 Performance CH4

The sheet “Performance CH4” calculates the total CH₄ emissions for the performance case using the same method as the reference case.

A weighted emission factor was calculated for each year in the file *CH4 Factors Table by MY – Performance.xls*. The difference between the reference and performance cases arises from the difference in fuel use and emission factors for each scenario. The annual fuel consumption estimates are the same as those used in the CO₂ calculation.

2.2.10 Car Stock & Sales

The “Car Stock & Sales” sheet provides the original hard coded vehicle stock data for gasoline and diesel fuelled cars. These data are presented on an annual basis from 1981 – 2007 with an additional line for all vehicles that remain in use from model years prior to 1981. These data are transferred to all other sheets that rely on Stock parameter.

2.2.11 LDT Stock & Sales

The “LDT Stock & Sales” sheet provides the original hard coded vehicle stock data for gasoline and diesel fuelled light trucks. These data are presented on an annual basis from 1981 – 2007 with an additional line for all vehicles that remain in use from model years prior to 1981. These data are transferred to all other sheets that rely on Stock parameter.

2.2.12 Car & LDT VKT

The “Car and LDT VKT sheet provides the original hard coded vehicle kilometres travelled (VKT) data for gasoline and diesel fuelled cars and light trucks. These data are presented on an annual average VKT per vehicle for each model year from 1981 – 2007 with an additional line representing all vehicles that remain in use from model years prior to 1981. These data are transferred to all other sheets that rely on VKT parameter.

2.2.13 CH4 Factors Table by MY – Reference.xls

The Excel file *CH4 Factors Table by MY – Reference.xls* calculates a weighted average emission factor for CH₄ emissions from gasoline fuelled cars and light trucks for each model year based upon technology specific emission factors, and the percentage penetration of the technology for that model year.

2.2.13.1 Mobile 6.2C VKmT Fractions

The sheet “Mobile 6.2C VKmT Fractions” presents screen shots of VMT data tables that are referenced to the “AIR Appendix”. The normalized VMT mix for LDGT1 – 4 is used in the calculation of the weighted average emission factors light duty trucks for CH₄ because the technology penetration rate for LDGT1+2 is different than the rate for LDGT3+4.

2.2.13.2 Emission Tech Fractions

The sheet “Emission Tech Fractions” generates the weighted average CH₄ emission factors for each model year. For gasoline fuelled cars this is accomplished using the equation below:

$$EF_{CH_4,i} = \left(\sum \% \text{ of Tech}_{n,i} \times BF_n \right)$$

Where the emission factor for CH₄ in model year “i” is a function of the penetration of technology “n” in that model year and the emission factor corresponding to that technology.

The calculation is slightly different for light duty trucks, because the penetration rate differs for classes 1 and 2, in comparison to classes 3 and 4. For gasoline fuelled light duty trucks the equation takes the form below:

$$EF_{CH_4,i} = 0.746 \left(\sum \% \text{ of Tech}_{n,i} \times BF_n \right)_{\text{Class 1+2}} + 0.254 \left(\sum \% \text{ of Tech}_{n,i} \times BF_n \right)_{\text{Class 3+4}}$$

Where the emission factor for CH₄ in model year “i” is a function of the penetration of technology “n” in that model year and the emission factor corresponding to that technology for each class group, and the total population of light duty trucks is approximately 75% Class 1+2 and 25% Class 3+4. The distribution of light duty trucks between LDGT1+2 and LDGT3+4 for 2000 – 2005 was used to weight the LDT emission factors, and the factors were used in the model for the years 2000 – 2007.

2.2.13.3 CH4 Factors

The sheet “CH4 Factors” presents the emission factors that are used for each technology type as well as the final emission factors that will be applied to each model year in the emission calculations in Excel files, *Without FFV Credit Final 2007.xls* and *With FFV Credit Final 2007.xls*.

2.2.14 CH4 Factors Table by MY – Performance.xls

The Excel file *CH4 Factors Table by MY – Performance.xls* calculates a weighted average emission factor for CH₄ emissions from gasoline fuelled vehicles for each model year based upon technology specific emission factors, and the percentage penetration of the technology for that model year, using the same method as described for the reference case.

2.2.15 N2O Factors Table by MY – Reference.xls

The Excel file *N2O Factors Table by MY – Reference.xls* calculates a weighted average emission factor for N₂O emissions from gasoline fuelled vehicles for each model year based upon technology specific emission factors, and the percentage penetration of the technology for that model year, using the same method as described for the CH₄ reference case.

2.2.16 N2O Factors Table by MY – Performance.xls

The Excel file *N2O Factors Table by MY – Performance.xls* calculates a weighted average emission factor for N₂O emissions from gasoline fuelled vehicles for each model year based upon technology specific emission factors, and the percentage penetration of the technology for that model year, using the same method as described for the CH₄ reference case, up to model year 2004.

2.2.16.1 N₂O Factors 2004+ MY

The sheet “N₂O Factors 2004+ MY” presents the new method of assigning technology penetration based upon Environment Canada’s Fleet Average NO_x reports, which uses a bin system to designate emission rates for NO_x which is tied to the penetration rate of catalytic converter technology that is tied to the Tiered standards used to estimate N₂O emission rates.

In the case of gasoline fuelled cars the emission rate for LEVs and Tier 2 technology have been applied to 100 % of cars in model years 2001 – 2007.

2.2.17 Summary of Calculation Evaluation

Following review it is apparent that the calculation methodology is scientifically defensible and is implemented in an appropriate manner. Therefore the tracking model represents an estimate of the GHG emissions reduction of the Canadian light duty fleet, based upon the best available data for estimation.

2.3 Accuracy of the Calculation Algorithms and Results within the Tracking Model

ENVIRON evaluated the calculations in each of the excel files provided that make up the tracking model in order to ensure:

- Individual calculations in each work sheet and cell are free of errors;
- Links to individual worksheets are correct;
- That data have been correctly input into individual worksheets; and
- That the final calculated results are correct.

Using these metrics for evaluation of accuracy, following a detailed inspection of the excel files provided, there were no errors found.

3 Summary

ENVIRON has reviewed the proposed tracking model and supporting documentation provided by NRCan to measure progress against auto GHG MOU targets. ENVIRON did not observe any calculation errors in the excel spreadsheets that were provided. The tracking model methodology and input data have been verified using the references in files that make up the tracking model, and supporting documentation. In general the structure and implementation of the tracking model is supported by the references provided, and relies on the best available data. There were no assumptions reported or implicit in the tracking model structure that would misrepresent the final result. Therefore the output of the tracking model is an appropriate method of measuring the progress against auto GHG MOU targets.