Railway Association of Canada

LOCOMOTIVE EMISSIONS MONITORING PROGRAM | 2014

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Review Notice

This report has been reviewed and approved by the Technical Review and Management Committees of the Memorandum of Understanding between Transport Canada and the Railway Association of Canada for reducing locomotive emissions.

This report has been prepared with funding support from the Railway Association of Canada and Transport Canada.

Executive Summary

The Locomotive Emissions Monitoring Program (LEM) data filing for 2014 has been completed in accordance with the terms of the 2011–2015 Memorandum of Understanding (2011–2015 MOU) signed on April 30, 2013, between the Railway Association of Canada (RAC) and Transport Canada (TC) concerning the emissions of greenhouse gases (GHGs) and criteria air contaminants (CACs) from locomotives operating in Canada. This is the fourth report prepared under the 2011–2015 MOU.

This report highlights that Canadian railways are well placed to meet their GHG reduction targets by 2015 by incorporating more fuel-efficient locomotives and fuel management technologies and policies, particularly within the Class I freight railways. GHG emissions from all railway operations in Canada totalled 6,640.97 kilotonnes (kt), up 4.3% from 6,367.68 kt in 2013. In absolute terms, railway-generated GHG emissions have not substantially increased relative to increases in traffic.

The following table presents the GHG emission intensity targets for 2015 and the actual emissions from 2010 to 2014, expressed as kilograms (kg) of carbon dioxide equivalent (CO_{2e}) per productivity unit[1]:

Railway Operation	% Reduction Target (by 2015)	2010	2011	2012	2013	2014	2015 Target	Productivity Unit
Class I Freight	6% reduction from 2010	16.51	16.24	15.88	15.03	14.51	15.52	kg CO_{2e} per 1,000 revenue tonne kilometres
Intercity Passenger	6% reduction from 2010	0.124	0.123	0.110	0.101	0.101	0.117	kg CO_{2e} per passenger kilometre
Regional & Short Lines	3% reduction from 2010	15.28	14.95	13.51	13.65	11.22	14.82	kg CO_{2e} per 1,000 revenue tonne kilometres

Note All values above, including the 2015 targets, have been calculated based on the new emission factors and global warming potentials. Historical values have been updated from previous reports. As a result, the updated factors caused the baseline 2010 GHG emission intensity values to change, resulting in the 2015 target values differing from the original MOU.

CACs emissions from all railway operations decreased, with NO_x emissions decreasing to 94.21 kt in 2014 as compared to 95.43 kt in 2013. The total freight NO_x emissions intensity was 0.21 kg/1,000 revenue tonne kilometres (RTK) in 2014, compared to 0.23 kg/1,000 RTK in 2013 and down from 0.52 kg/1,000 RTK in 1990.

1 The CO_2 emission factor and the global warming potentials for CH_4 and N_2O were updated in the 2013 United Nations Framework Convention on Climate Change (UNFCCC) Reporting Guidelines that reflect the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines. These changes are documented in *Environment and Climate Change Canada's National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada*. All GHG emissions included in this report have been calculated based on these updated factors and potentials. Refer to Section 5 and Appendix F for the updated GHG potentials. GHG data in previous LEM reports were calculated on the previous global warming potentials — the emissions have therefore been updated using the new GWPs.

LEM 2014 Additional Key Findings

Railway Traffic

Freight Traffic

Gross Tonne-Kilometres (GTK): In 2014, the railways handled over 812.25 billion GTK of traffic as compared to 743.17 billion GTK in 2013, an increase of 9.3%. GTK traffic is 87.7% higher than for 1990, the reference year, having increased by an average annual rate of 3.7%. Class I GTK traffic accounted for 92.9% of the total GTK hauled in 2014.

Revenue Tonne-Kilometres (RTK): In 2014, the railways handled 428.93 billion RTK of traffic as compared to 395.81 billion RTK in 2013, an increase of 8.4%. RTK traffic is 83.7% higher than for 1990, the reference year, having risen by an average annual rate of 3.5%. Of the freight RTK traffic handled in 2014, Class I freight railways were responsible for 93.1% of the total traffic.

Intermodal Traffic

Intermodal tonnage increased 5.6% to 37.23 million tonnes in 2014 from 35.26 million tonnes in 2013. Overall, intermodal tonnage comprising both container-on-flat-car and trailer-on-flat-car traffic has risen 191.1% since 1990, equating to an average annual growth of 8.0%. Class I railway intermodal traffic increased from 95.82 billion RTK in 2013 to 99.46 billion RTK in 2014, an increase of 3.8%. Of the total freight car loadings in 2014, intermodal led at 26.3%.

Passenger Traffic

Intercity passenger traffic in 2014 by all carriers totalled 4.09 million passengers compared to 4.19 million in 2013, a decrease of 2.2%. VIA Rail Canada transported 3.80 million passengers, which equates to 92.8% of the intercity traffic.

Commuter rail traffic increased from 70.27 million passengers in 2013 to 71.83 million in 2014, an increase of 2.2%. This is up from 41 million passengers in 1997, when the RAC first started collecting commuter statistics, an increase of 75.2%.

In 2014, ten RAC member railways reported Tourist and Excursion traffic totalling 371 thousand passengers, an increase of 74.6% above the 213 thousand passengers transported in 2013. This increase was due to the addition of the White Pass and Yukon railway, which joined the RAC in 2014.

Fuel Consumption Data

Fuel Consumption: Overall, the fuel consumed in railway operations in Canada increased by 4.3% from 2,107.42 million litres in 2013 to 2,197.87 million litres in 2014.

Of the total fuel consumed by all railway operations, Class I freight train operations consumed 87.3% and Regional and Short Lines consumed 5.0%. Yard switching and work train operations consumed 3.3%, and passenger operations accounted for 4.4%.

For freight operations, the overall fuel consumption in 2014 was 2,100.71 million litres, 4.5% above the corresponding figure for 2013.

For total freight operations, fuel consumption per productivity unit (litres per 1,000 RTK) in 2014 was 4.90 litres per 1,000 RTK as compared to 5.08 litres per 1000 RTK in 2013, an improvement in efficiency of 3.6%. This is down from 8.40 litres per 1,000 RTK in 1990, an improvement of 41.7%.

For total passenger operations, the overall fuel consumption in 2014 was 97.16 million litres, 0.1% above corresponding figure for 2013.

Diesel Fuel Properties: In 2014, the sulphur content of railway diesel fuel was 15 parts per million (ppm) for both freight and passenger operations. This is a decrease from 1,275 ppm in 2006, 500 ppm in 2007, and 40.1 ppm in 2012. In 2013, the Canadian railway weighted average was 15 ppm, demonstrating that railways standardized the use of Ultra-Low Diesel (ULSD) fuel since 2013.

Locomotive Inventory

Locomotive Fleet: The number of diesel-powered locomotives and diesel mobile units (DMUs) in active service in Canada belonging to RAC member railways totalled 2,700 in 2014 versus 3,063 in 2013. The locomotive decrease is explained by the increased system velocity which allowed for the placement of less fuel efficient locomotives into long term storage.

For freight operations, 2,461 locomotives are in service, of which 1,647 are on Class I Mainline, 314 are on Class I Road Switching service, 107 are owned by regional railways and 181 are owned by Short Lines. A further 212 are in Switching and Work Train operations, of which 114 are in Class I service and 98 in Regional and Short lines.

A total of 235 locomotives and DMUs are in passenger operations, of which 83 are in VIA Rail Canada intercity services, 2 are in intercity-other services, 111 in Commuter, 39 in Tourist and Excursion services. There are 4 locomotives in Passenger Switching operations, of which 2 are in VIA Rail Canada service and 2 are in Tourist and Excursion Services.

Locomotives Compliant with USEPA Emission Limits: In 2014, 79.9% of the total fleet subject to USEPA regulations met the USEPA Tier 0, Tier 0+, Tier 1, Tier 1+, Tier 2, Tier 2+, and Tier 3 emissions standards. A total of 3 Tier 3 high-horsepower locomotives were added to the Class I line-haul fleet in 2014 and 117 locomotives upgraded to Tier 0+, Tier 1+, or Tier 2+. Older and lower-horsepower locomotives continue to be retired, and in 2014, 9 medium-horsepower locomotives manufactured between 1973 and 1999 were taken out of active duty.

Locomotives Equipped with Anti-Idling Devices: The number of locomotives in 2014 equipped with a device to minimize unnecessary idling, such as an AESS system or APU, decreased to 1,684, which represents 62.4% of the fleet, compared with 2,179 in 2013. The variation from the 2013 fleet is mainly explained by the storing of less fuel efficient locomotives by an RAC member due to operating longer and heavier trains. Additionally, due to increased system velocity allowed for additional removals of older less fuel efficient locomotives from the fleet. In the case of this specific RAC member it was able to remove of 40 locomotives for every mile-per-hour increase in system velocity.

Tropospheric Ozone Management Areas (TOMA): Of the total Canadian rail sector fuel consumed and corresponding GHG emitted in 2014, 2.2% occurred in the Lower Fraser Valley of British Columbia, 14.6% in the Windsor-Québec City Corridor, and 0.2% in the Saint John area of New Brunswick. Similarly, NO_x emissions for the three TOMA were, respectively, 2.2%, 14.6%, and 0.2%.

Emissions Reduction Initiatives by Railways: Railways continue to implement a number of initiatives outlined in the *Locomotive Emissions Monitoring Program 2011–2015 Action Plan for Reducing GHG Emissions*. This action plan presents a variety of initiatives for railways, governments, and the RAC to implement in an effort to achieve the expected outcomes of the 2011–2015 MOU.

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1 Introduction/Background

This report contains the LEM data filing for 2014 in accordance with the terms of the MOU signed on April 30, 2013, between the RAC and TC concerning voluntary arrangements to limit GHGs and CACs emitted from locomotives operating in Canada. This MOU establishes a framework through which the RAC, its member companies (as listed in Appendix A), and TC will address emissions of GHGs and CACs from railway locomotives operating in Canada. The 2011–2015 MOU includes measures, targets, and actions that will further reduce GHG and CAC emission intensities from rail operations to help protect the health and environment for Canadians and address climate change. The 2011–2015 MOU is posted on the RAC website. This is the fourth report prepared under the MOU.

GHG Commitments:

As stated in the 2011–2015 MOU, the RAC will encourage all of its members to make every effort to reduce the GHG emission intensity from railway operations. The GHG emission targets for 2015 and the actual emissions from 2010 to 2014, expressed as kilograms (kg) of carbon dioxide equivalent (CO_{2e}) per productivity unit, for the rail industry are outlined in the following table:

Railway Operation	% Reduction Target (by 2015)	2010	2011	2012	2013	2014	2015 Target	Productivity Unit
Class I Freight	6% reduction from 2010	16.51	16.24	15.88	15.03	14.51	15.52	kg CO_{2e} per 1,000 revenue tonne kilometres
Intercity Passenger	6% reduction from 2010	0.124	0.123	0.110	0.101	0.101	0.117	kg CO_{2e} per passenger kilometre
Regional & Short Lines	3% reduction from 2010	15.28	14.95	13.51	13.65	11.22	14.82	kg CO_{2e} per 1,000 revenue tonne kilometres

Note All values above, including the 2015 targets, have been revised to reflect the new emission factors and global warming potentials introduced by the IPCC in 2006. Historical values have been updated from previous reports. As a result, the updated factors caused the baseline 2010 GHG emission intensity values to change, resulting in the 2015 target values differing from the original MOU.

CAC Commitments:

As stated in the 2011-2015 MOU, until such time that new Canadian regulations to control CAC emissions are introduced, the RAC will encourage all of its members to conform to USEPA emission standards (Title 40 of the Code of Federal Regulations of the United States, Part 1033).

For the duration of the MOU, the RAC will encourage all members to:

- Adopt operating practices aimed at reducing CAC emissions; and
- Conform to appropriate CAC emission standards and/or Canadian Regulations for the duration of the 2011–2015 MOU.

Conversely, TC will undertake compliance promotion activities with affected stakeholders, including education and outreach related to the regulatory requirements.

In accordance with the RAC LEM protocol, annual data for this report was collected via a survey sent to each member railway of the RAC. An overview of the survey methodology is available upon request to the RAC. Based on this data, the GHG and CAC emissions produced by in-service locomotives in Canada were calculated. The GHG emissions in this report are expressed as CO_{2e}, the constituents of which are CO_2, CH_4, and N_2O. CAC emissions include NO_x, PM, CO, HC, and SO_x. The SO_x emitted is a function of the sulphur content of the diesel fuel and is expressed as SO_2. The calculation methodology document is available upon request to the RAC.

This report provides an overview of 2014 rail performance including traffic, fuel consumption, fleet inventory, and GHG and CAC emissions. Also included is a section on initiatives being taken or examined by the sector to reduce fuel consumption and, consequently, all emissions, particularly GHGs.

In addition, this report contains data on the fuel consumed and emissions produced by railways operating in three designated Tropospheric Ozone Management Areas (TOMA): the Lower Fraser Valley in British Columbia, the Windsor–Québec City Corridor, and the Saint John area in New Brunswick. Data for winter and summer operations have been segregated.

For the most part, data and statistics by year for traffic, fuel consumption, and emissions are listed for the period starting with 2006. For historical comparison purposes, the year 1990 has been set as the reference year and has also been included. LEM statistics for the Canadian railway sector dating from 1995 can be found in the 1995–2010 LEM Reports.[2]

Unless otherwise specified, metric units are used and quantities are expressed to two significant figures (intercity passenger emissions intensity was shown to the third significant digit to demonstrate year to year differences), while percentages are expressed to one significant figure. To facilitate comparison with American railway operations, traffic, fuel consumption, and emissions data in US units have been made available upon request.

2 LEM Reports from 1995 to 2010 are available by request. Please contact the RAC.

2 Traffic Data

2.1 Freight Traffic Handled

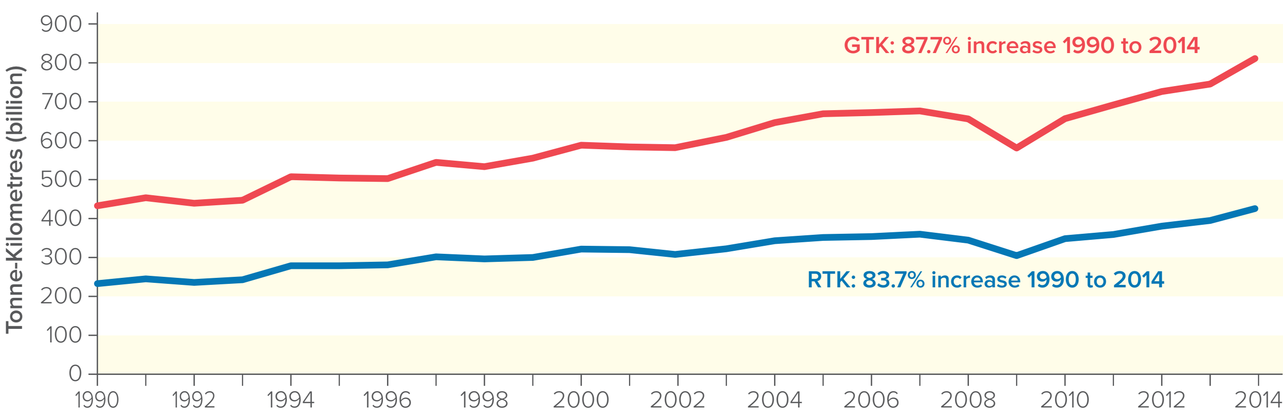
As shown in Table 1 and Figure 1, traffic in 2014 handled by Canadian railways totalled 812.25 billion gross tonne-kilometres (GTK) compared with 743.17 billion GTK in 2013, an increase of 9.3%, and 432.74 billion GTK for 1990 (the reference year) for an increase of 87.7%. Similarly, revenue traffic in 2014 increased to 428.93 billion revenue tonne-kilometres (RTK) from 395.81 billion RTK in 2013, and is up from 233.45 billion RTK in 1990—increases of 8.4% and 83.7%, respectively. Since 1990, the average annual growth was 3.5% for GTK and 3.3% for RTK.

Table 1. Total Freight Traffic, 1990, 2006–2014 in Tonne-kilometres (billion)

	1990	2006	2007	2008	2009	2010	2011	2012	2013	2014
GTK										
Class I		629.93	638.66	621.90	549.17	620.16	644.75	674.62	695.58	754.24
Regional + Short Line		41.07	37.77	34.92	30.82	32.47	44.94	47.74	47.59	58.02
Total	**432.74**	**671.00**	**676.43**	**656.82**	**579.99**	**652.63**	**689.69**	**722.35**	**743.17**	**812.25**
RTK										
Class I		330.96	338.32	324.99	288.82	327.81	337.90	356.91	371.77	399.47
Regional + Short Line		24.87	23.30	21.46	19.06	21.33	21.79	23.96	24.04	29.46
Total	**233.45**	**355.83**	**361.62**	**346.46**	**307.88**	**349.14**	**359.69**	**380.87**	**395.81**	**428.93**
Ratio of RTK/GTK	**0.54**	**0.53**	**0.53**	**0.53**	**0.53**	**0.53**	**0.52**	**0.53**	**0.53**	**0.53**

Note: No data is available separating Class I and Short Line traffic for the reference year, 1990.

Figure 1. Total Freight Traffic, 1990–2014



In 2014, Class I GTK traffic increased by 8.4% to 754.24 billion from 695.58 billion in 2013 (Table 1), accounting for 92.9% of the total GTK hauled. Similarly, Class I RTK traffic increased 7.5% in 2014 to 399.47 billion from 371.77 billion in 2013, accounting for 93.1% of the total RTK. Of the total freight traffic, Regional and Short Lines were responsible for 58.02 billion GTK (or 7.1%) and 29.46 billion RTK (or 6.9%). In 2014, Regional and Short Lines traffic experienced a 22.5% increase in RTK compared to 2013.

2.1.1 Freight Carloads by Commodity Grouping

The total 2014 freight carloads for 11 commodity groups are shown in Figure 2 and Table 2 below.

Figure 2. Canadian Rail Originated Freight by Commodity Grouping, 2014

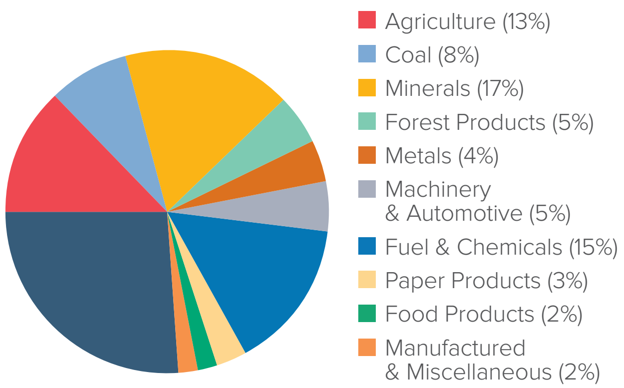


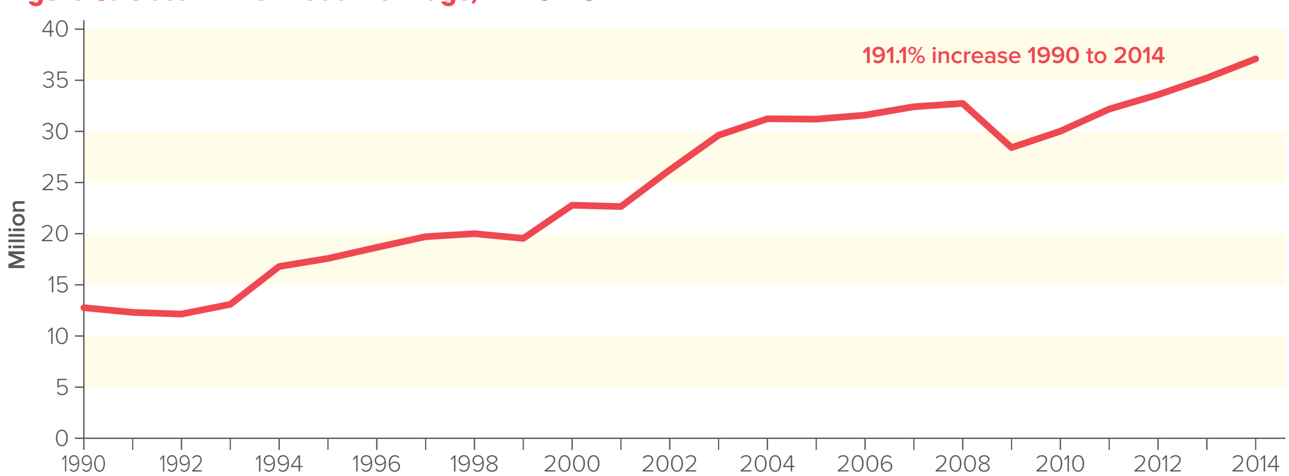
Table 2. Canadian Rail Originated Freight by Commodity Grouping, 2014 (Carloads)

Agriculture	547,040
Coal	336,632
Minerals	671,841
Forest Products	211,071
Metals	156,681
Machinery & Automotive	193,294
Fuel & Chemicals	592,266
Paper Products	139,109
Food Products	61,993
Manufactured & Miscellaneous	94,636
Intermodal	1,072,278
Total	**4,076,840**

2.1.2 Class I Intermodal Traffic

Of the total freight carloads in 2014, intermodal led at 26.3%, as illustrated by Figure 2 and Table 2 above. The number of intermodal carloads handled by the Class I railways in Canada rose to 1,069,764 from 984,890 in 2013, an increase of 8.6%. Intermodal tonnage rose 5.6% to 37.23 million tonnes from 35.26 million tonnes in 2013. Overall since 1990, intermodal tonnage, comprising both container-on-flat-car and trailer-on-flat-car traffic, has risen 191.1%, equating to an average annual growth of 8.0%, as illustrated in Figure 3.

Figure 3. Class 1 Intermodal Tonnage, 1990–2014



Class I intermodal RTK totalled 99.46 billion in 2014 versus 95.82 billion for 2013, an increase of 3.8%. Of the 399.47 billion RTK transported by the Class I railways in 2013, intermodal accounted for 24.9%.

Intermodal service growth is an indication that the Canadian railways have been effective in partnering with shippers and other elements of the transportation supply chain, such as trucking, to move more goods by rail.

2.2 Passenger Traffic Handled

2.2.1 Intercity Passenger Services

Intercity passenger traffic in 2014 totalled 4.09 million, as compared to 4.19 million in 2013, a drop of 2.2%. The carriers were VIA Rail Canada, CN / Algoma Central, Ontario Northland Railway, Amtrak, and Tshiuetin Rail Transportation. Of the total, 92.8% (3.80 million) was transported by VIA Rail Canada (Figure 4). This was a 2.3% decrease from the 3.89 million transported in 2013, and an increase of 9.8% from 3.46 million in 1990.

The total revenue passenger-kilometres (RPK) for intercity passenger traffic totalled 1,342.96 million. This is a decrease of 3.1% as compared to 1,386.02 million in 2013. RPK for VIA Rail Canada for 2014 were 1,300.68 million, versus 1,339.53 million for 2013, a decrease of 2.9%. This is up from 1,263.00 million in 1990, a rise of 3.0% (Figure 5).

Figure 4. VIA Rail Canada Passenger Traffic, 1990–2014

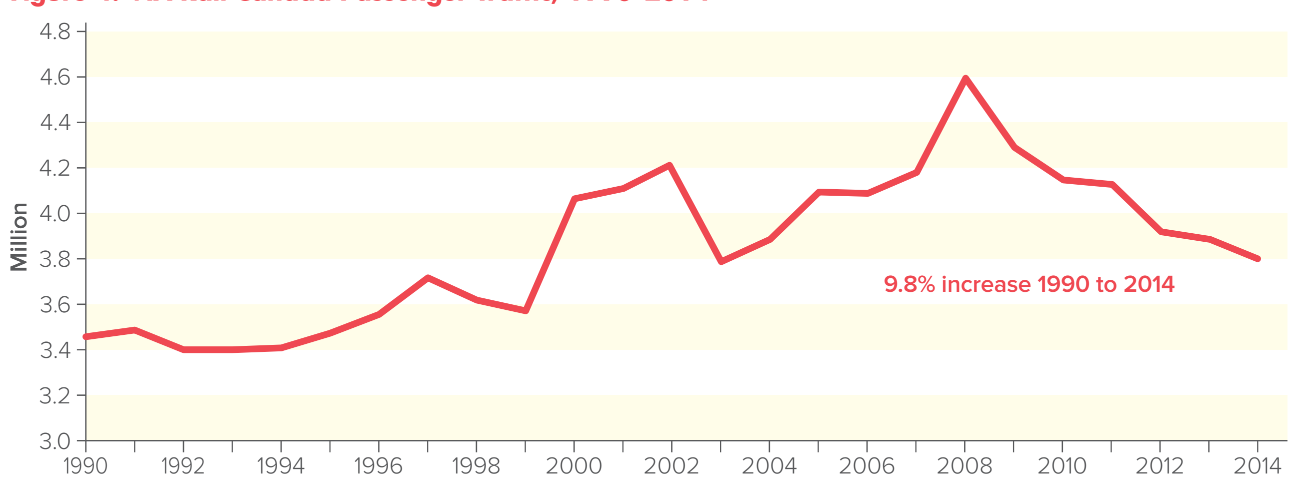
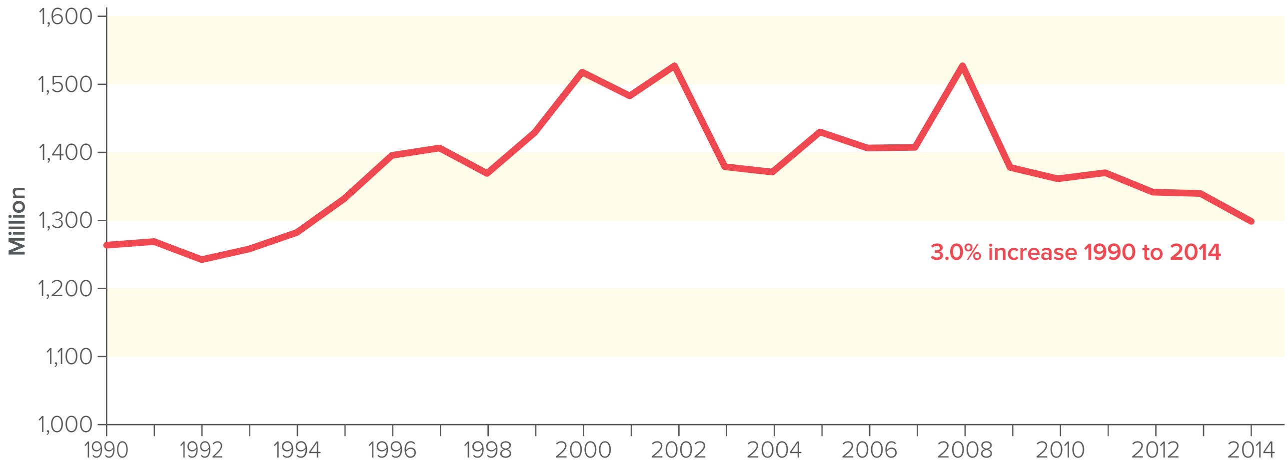
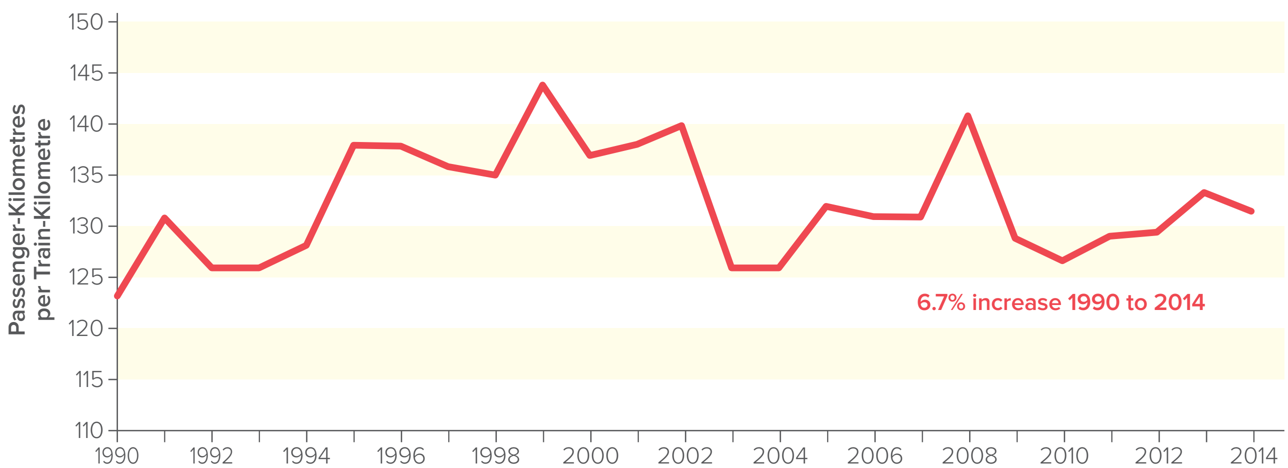


Figure 5. VIA Rail Canada Revenue Passenger-Kilometres, 1990–2014



Intercity train efficiency is expressed in terms of average passenger-kilometres (km) per train-km. As shown in Figure 6, VIA's train efficiency in 2014 was 131 passenger-km per train-km, 133 in 2013, and 123 in 1990. As a percentage, train efficiency in 2014 was 6.7% above that in 1990.

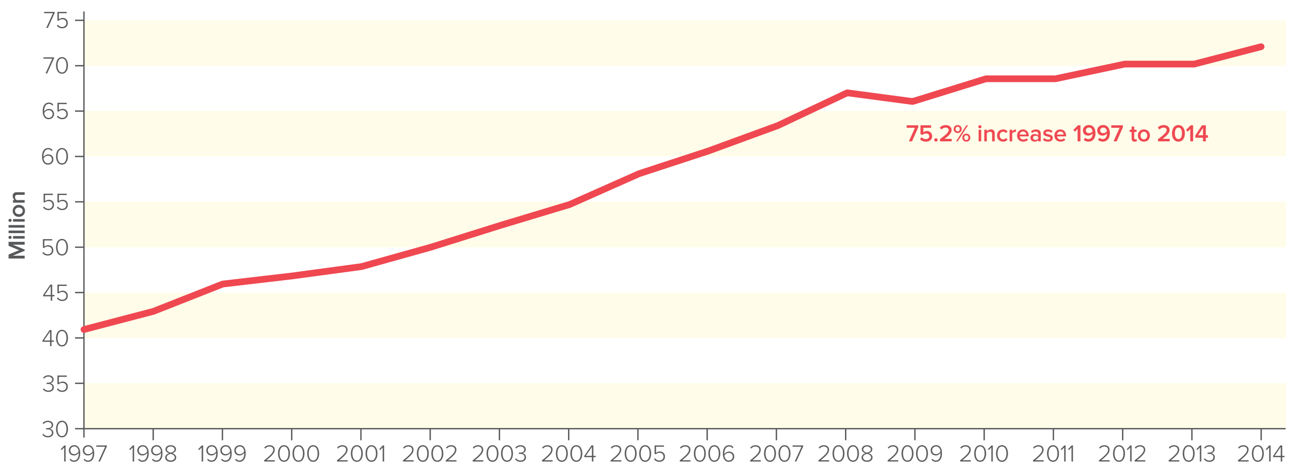
Figure 6. VIA rail Canada Train Efficiency, 1990–2014



2.2.2 Commuter Rail

In 2014, commuter rail passengers totalled 71.83 million (Figure 7). This is up from 70.27 million in 2013, an increase of 2.2%. As shown in Figure 7, by 2014, commuter traffic increased 75.2% over the 1997 base year of 41.00 million passengers when the RAC first started to collect commuter rail statistics. This is an average annual growth rate of 3.1% since 1997. The four commuter operations in Canada using diesel locomotives are Agence métropolitaine de transport (serving the Montréal-centred region), Capital Railway (serving Ottawa), Metrolinx (serving the Greater Toronto Area), and West Coast Express (serving the Vancouver-Lower Fraser Valley region).

Figure 7. Commuter Rail Passenger, 1997–2014



2.2.3 Tourist and Excursion Services

In 2014, the ten RAC member railways offering tourist and excursion services transported 371 thousand passengers as compared to 213 thousand in 2013, an increase of 74.6%. The railways reporting these services were Alberta Prairie Railway Excursions, CN/Algoma Central (which also operates a scheduled passenger service), CP/Royal Canadian Pacific, Great Canadian Railtour Company, Ontario Northland Railway (which also operates a scheduled passenger service), Prairie Dog Central Railway, South Simcoe Railway, Tshiuetin Rail Transportation (which also operates a scheduled passenger service), Train Touristique Charlevoix and White Pass & Yukon[3].

3 White Pass and Yukon joined the RAC in 2014 – the passenger and fuel data from this railway had not been included in the previous LEM reports.

3 Fuel Consumption Data

As shown in Table 3, total rail sector fuel consumption increased to 2,197.87 million litres in 2014 from 2,107.42 million litres in 2013 and increased from 2,063.55[4] million litres in 1990. As a percentage, fuel consumption in 2014 was 4.3% higher than in 2013 and 6.5% higher than the 1990 level. The higher fuel consumption in 2014 relative to 2013 reflects increases in total freight traffic in 2014, which offset fuel efficiency improvements made to the locomotive fleet, such as more fuel-efficient, high-horsepower locomotives and optimizing in-train locomotive power with traffic weight. Of the total fuel consumed by all railway operations, freight train operations consumed 92.3%, yard switching and work train operations consumed 3.3%, and passenger operations accounted for 4.4%. For total freight train operations, Class I railways accounted for 91.3%, Regional and Short Lines 5.2%, and yard switching and work trains 3.5%.

4 Total freight operations fuel consumption for 1990 was revised after a review of historical fuel consumption data for the 2012 LEM report.

Table 3. Canadian Rail Operations Fuel Consumption, 1990, 2006–2014 in Litres (million)

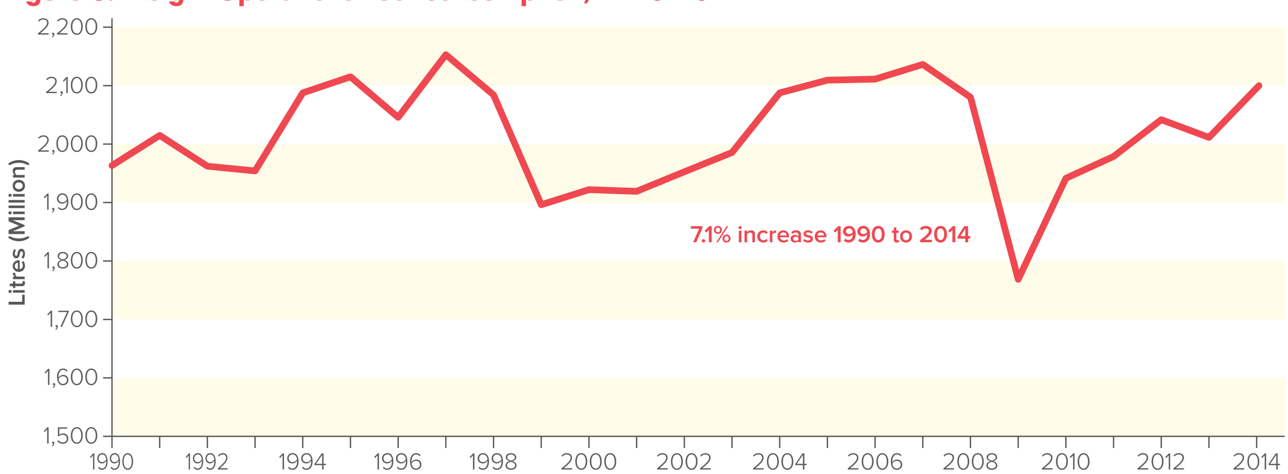
	1990	2006	2007	2008	2009	2010	2011	2012	2013	2014
Class I	1,825.05	1,914.92	1,948.75	1,902.88	1,626.47	1,791.11	1,816.44	1,875.85	1,849.57	1,918.27
Regional and Short Line	n/a*	122.13	117.89	113.12	90.01	107.88	107.78	107.08	108.58	109.36
Total Freight Train	**1825.05**	**2,037.05**	**2,066.64**	**2,016.00**	**1,716.48**	**1,898.99**	**1,924.22**	**1,982.93**	**1,958.15**	**2,027.63**
Yard Switching	120.13	64.67	62.20	55.52	40.73	35.70	45.15	47.05	41.94	62.28
Work Train	15.67	7.49	6.09	7.60	5.97	7.06	7.72	8.77	10.30	10.80
Total Yard Switching and Work Train	**135.80**	**72.16**	**68.29**	**63.13**	**46.70**	**42.76**	**52.87**	**55.81**	**52.24**	**73.08**
TOTAL FREIGHT OPERATIONS	**1,960.85**	**2,109.21**	**2,134.92**	**2,079.13**	**1,763.18**	**1,941.76**	**1,977.09**	**2,038.74**	**2,010.39**	**2,100.71**
VIA Rail Canada	n/a*	58.75	58.97	59.70	57.43	52.16				
Intercity – Non-VIA Rail Canada	n/a*	5.50	5.06	4.57	6.07	5.93				
Intercity – Total	n/a*	64.25	64.03	64.27	63.50	58.09	58.32	50.99	46.17	44.89
Commuter	n/a*	34.23	35.94	37.85	42.68	46.92	49.81	50.22	48.61	49.67
Tourist Train & Excursion	n/a*	2.81	2.33	3.87	1.82	2.05	2.19	2.27	2.25	2.61
Total Passenger Operations	**102.70**	**101.29**	**102.30**	**105.99**	**108.00**	**107.06**	**110.32**	**103.48**	**97.03**	**97.16**
TOTAL RAIL OPERATIONS	**2,063.55**	**2,210.50**	**2,237.24**	**2,185.12**	**1,871.18**	**2,048.82**	**2,087.41**	**2,142.22**	**2,107.42**	**2,197.87**

*n/a = not available

3.1 Freight Operations

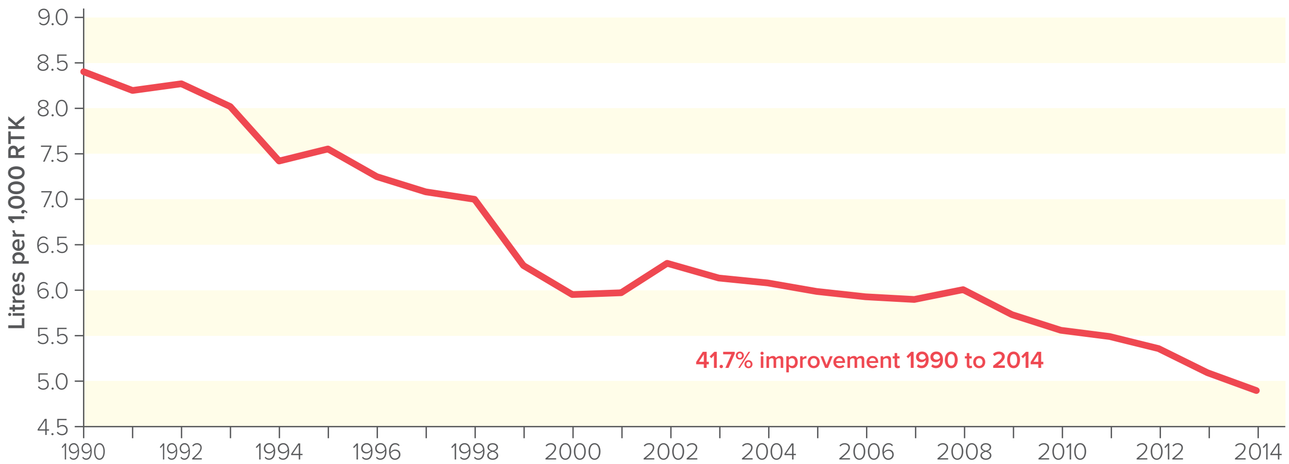
The volume of fuel consumption since 1990 in overall freight operations is shown in Figure 8. Fuel consumption in 2014 for all freight train, yard switching, and work train operations was 2,100.71 million litres, an increase of 4.5% from the 2,010.39 million litres consumed in 2013 and an increase of 7.1% from the 1990 level of 1,960.85 million litres. Given total traffic moved by railways in Canada, this means that Canadian railways moved a tonne of freight over 200 kilometres on just one litre of fuel.

Figure 8. Freight Operations Fuel Consumption, 1990–2014



A measure of freight traffic fuel efficiency is the amount of fuel consumed per 1,000 RTK. As shown in Figure 9, the value in 2014 for overall rail freight traffic was 4.90 litres per 1,000 RTK. Compared to 5.08 litres per 1,000 RTK in 2013, it is a 3.6% improvement, and is 41.7% below the 1990 level of 8.04 litres per 1,000 RTK. The improvement since 1990 shows the ability of the Canadian freight railways to accommodate traffic growth while reducing fuel consumption per unit of work.

Figure 9. Freight Fuel Consumption per 1,000 RTK, 1990–2014



Member railways have implemented many practices to improve fuel efficiency. Improved fuel efficiency has been achieved primarily by replacing older locomotives with modern, fuel-efficient, USEPA-compliant locomotives. Additionally, operating practices that reduce fuel consumption are being implemented, and new strategies are emerging to accommodate specific commodities, their respective weight, and destination. Section 7 provides details on a number of initiatives railways implemented in 2014 to reduce their fuel consumption. A comprehensive list of emerging technologies and management options available to the railways can be viewed in the Locomotive Emissions Monitoring Program 2011-2015 Action Plan for Reducing GHG Emissions available on the RAC's website.

3.2 Passenger Services

Overall rail passenger fuel consumption—that is the sum of intercity, commuter, and tourist and excursion train operations—was 97.16 million litres in 2014, up from 97.03 million litres in 2013, an increase of 0.1%. The breakdown and comparison with previous years are shown on Table 3.

Intercity passenger's fuel consumption of 44.89 million litres in 2014 decreased by 2.8% from 46.17 million litres in 2013. Fuel consumption for commuter rail of 49.67 million litres in 2014 increased 2.2% from 48.61 million litres in 2013. Finally, tourist rail excursion fuel consumption increased by 16.1% to 2.61 million litres in 2014 from 2.25 million litres in 2013.

3.3 Diesel Fuel Properties

Effective June 1, 2007, amendments to Environment and Climate Change Canada's (ECCC's) *Sulphur in Diesel Fuel Regulations* came into force limiting the sulphur content of railway diesel fuel to 500 ppm (or 0.05%). A further reduction came into force June 1, 2012, limiting sulphur content in diesel fuel produced or imported for use in locomotives to 15 ppm (or 0.0015%)—referred to as ultra-low sulphur diesel (ULSD) fuel.

Previous RAC surveys demonstrated that the use of ULSD has been standardized since 2013 for all railways. In 2014 the weighted average sulphur content was calculated to be 15.0 ppm. This is down from the average of 1,275 ppm in 2006, 500 ppm in 2007, and 40.1 ppm in 2012. The lower sulphur content of the fuels used in 2014 results in a decrease in the emission factor for the calculation of the amount of SO_x (expressed as SO_2) compared to previous years. The reduced sulphur content in 2014 resulted in a significant reduction in SO_2 emissions (see Section 5.2.2).

4 Locomotive Inventory

Table 4 presents an overview of the active fleet of diesel and non-diesel locomotives in Canada for freight and passenger railways. The detailed locomotive fleet inventory is presented in Appendix B.

Table 4. Canadian Locomotive Fleet Summary, 2014

Freight Operations	
Locomotives for Line Haul Freight	
Mainline	1,647
Regional	107
Short line	181
Locomotives for Freight Switching Operations	
Yard	212
Road Switching	314
Total — Freight Operations	**2,461**
Passenger Operations	
Passenger Train	232
DMUs	3
Yard Switching	4
Total — Passenger Operations	**239**
TOTAL — PASSENGER & FREIGHT OPERATIONS	**2,700**

4.1 Locomotives Compliant with United States Environmental Protection Agency Emissions Limits

The MOU indicates that RAC member railways are encouraged to conform to all applicable emission standards, which includes the current USEPA standards that are listed in Appendix D.

The CAC and GHG emissions intensity for the Canadian fleet is projected to decrease as the railways continue to introduce new locomotives, retrofit high-horsepower and medium-horsepower in-service locomotives when remanufactured, and retire non-compliant locomotives.

Table 5 shows the total number of in-service locomotives meeting Tier 0, Tier 0+, Tier 1, Tier 1+, Tier 2, Tier 2+, and Tier 3 standards compared to the total number of freight and passenger line-haul diesel locomotives. Excluded were steam locomotives, non-powered slug units, and Electrical Multiple Units (EMUs) as they do not contribute diesel combustion emissions.

Table 5. Locomotives in Canadian Fleet Meeting USEPA Emissions Limits, 2000, 2006–2014

	2000	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total number of line-haul locomotives subject to regulation[a]	1,498	2,319	2,216	2,051	1,898	2,196	2,112	2,290	2,293	1,925
Total number of locomotives not subject to regulation[b]	1,578	680	811	772	829	752	866	802	770	775
Number of locomotives meeting USEPA emissions limits	80	914	1,023	1,042	1,094	1,209	1,317	1,512	1,631	1,538

a Includes locomotives which are subject to Title 40 of the United States Code of Federal Regulations, part 1033, "Control of Emissions from Locomotives."

b Includes locomotives which are not subject to Title 40 of the United States Code of Federal Regulations, part 1033, "Control of Emissions from Locomotives."

In 2014, 79.9% of the total line-haul fleet (1,538 locomotives) subject to USEPA regulations on emissions met the USEPA Tier 0, Tier 0+, Tier 1, Tier 1+, Tier 2, Tier 2+, and Tier 3 emissions standards. The USEPA emission standards are phased in over time and are applicable only to "new" locomotives (i.e., originally manufactured and remanufactured locomotives). Locomotives manufactured prior to 1973 and that have not been upgraded and locomotives below 1,006 horsepower (hp) are not required to meet the USEPA emission standards. The remaining locomotive fleet is not required to meet the standards until the time of its next remanufacture. Table 6 provides an overview of the 2014 locomotive fleet and includes details about the number of locomotives meeting each tier level.

Table 6. Locomotive Fleet Breakdown By USEPA Tier Level, 2014

Not subject to regulation[a]	775
Subject to regulation — Non Tier-Level Locomotives	387
Tier 0	158
Tier 0+	535
Tier 1	28
Tier 1+	295
Tier 2	304
Tier 2+	155
Tier 3	63
TOTAL	2,700

a Includes locomotives which are not subject to the regulations because of exclusions. Regulations refer to Title 40 of the United States Code of Federal Regulations, part 1033, "Control of Emissions from Locomotives."

Table 7 provides a summary of the fleet changes by emissions tier level for the overall fleet with the Class I Freight Line-Haul fleet noted in parenthesis.

In 2014, 3 Tier 3 high-horsepower locomotives were added to the Class I Freight Line-haul fleet; a total of 117 Class I Freight Line-haul locomotives were upgraded to Tier 0+, Tier 1+,Tier 2+; 9 medium-horsepower locomotives manufactured between 1973 and 1999 were retired from Class I; and 1 was retired from other operations.

An RAC-initiative for member railways is the installation of anti-idling devices on locomotives — these devices reduce emissions by ensuring that the locomotive engines are shut-down after extended periods of inactivity, reducing engine activity and therefore emissions. The number of locomotives in 2014 equipped with a device to minimize unnecessary idling such as an Automatic Engine Stop-Start (AESS) system or Auxiliary Power Unit (APU) was 1,684 compared with 2,179 in 2013. This represents 62.4% of the total in-service fleet in 2014 versus 71.1% in 2013. This reduction in locomotives with anti-idling devices is primarily due to the reduction in active locomotives in 2014 compared to 2013.

Table 7. Changes in Locomotive Fleet by Tier Level, 2014

	Added	Retired	Remanufactured	Locomotives with anti-idling devices
Not upgraded		9(8)		220(102)
Tier 0				122(104)
Tier 0+			48(48)	476(476)
Tier 1				36(27)
Tier 1+			42(42)	294(294)
Tier 2				318(304)
Tier 2+			27(27)	155(155)
Tier 3	3(3)			63(63)
TOTAL	**3(3)**	**9(8)**	**117(117)**	**1,684(1,525)**

5 Locomotive Emissions

5.1 Emission Factors

Emission Factors for Greenhouse Gases

The emission factors (EFs) used to calculate the three GHGs emitted from diesel locomotive engines (i.e. CO_2, CH_4, and N_2O) are those used in Environment and Climate Change Canada's *National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada* submitted annually to the UNFCCC.[5]

The EFs for GHGs can be found in Appendix F, "Conversion Factors Related to Railway Emissions."

Emission Factors for Criteria Air Contaminant Emissions:

New CAC EFs for 2014 have been calculated in grams per litre (g/L) of fuel consumed for NO_x, PM, CO, HC, and SO_x for each category of operation (i.e., freight, switch, and passenger operations). The EF's are based on the amount of fuel consumed and the locomotive utilization profile. The methodology document describing the calculation of these emission factors is available upon request.

The EFs to calculate emissions of SO_x (calculated as SO_2) are based on the sulphur content of the diesel fuel. As noted in Section 3.3 of this report, the new regulations in 2007 and 2013 have contributed to the widespread use of ULSD fuel in the Canadian locomotive fleet.

5 *National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada,* Environment and Climate Change Canada, 2016. https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=83A34A7A-1

The CAC EFs are listed in Table 8 for 1990 and 2006–2014. EFs for years prior to 2005 are available upon request.

Table 8. CAC Emissions Factors for Diesel Locomotives 1990, 2006–2014 (g/L)

	Year	NO_x	PM	CO	HC	SO_2
Total Freight	2014	41.40	0.90	7.07	1.81	0.02
	2013	44.41	1.01	7.05	2.00	0.02
	2012	46.09	1.09	7.05	2.13	0.07
	2011	47.50	1.15	7.03	2.21	0.17
	2010	49.23	1.23	7.06	2.38	0.21
	2009	50.41	1.31	7.07	2.47	0.18
	2008	51.19	1.38	7.32	2.74	0.24
	2007	52.74	1.44	7.35	2.79	0.82
	2006	55.39	1.50	6.98	2.53	2.10
	1990	71.44	1.59	7.03	2.64	2.47
Total Yard Switching	2014	68.93	1.50	7.35	3.99	0.02
	2013	68.79	1.50	7.35	4.01	0.02
	2012	69.19	1.52	7.35	4.03	0.07
	2011	69.64	1.53	7.35	4.06	0.17
	2010	69.65	1.54	7.35	4.06	0.21
	2009	69.42	1.53	7.35	4.04	0.18
	2008	69.88	1.54	7.35	4.06	0.24
	2007	69.88	1.57	7.35	4.06	0.82
	2006	69.88	1.63	7.35	4.06	2.10
	1990	69.88	1.65	7.35	4.06	2.47
Total Passenger	2014	54.58	1.14	7.03	2.18	0.02
	2013	51.64	1.06	7.03	2.03	0.02
	2012	54.04	1.13	7.03	2.17	0.07
	2011	54.94	1.16	7.02	2.19	0.18
	2010	56.23	1.18	7.03	2.23	0.21
	2009	62.60	1.29	7.03	2.40	0.18
	2008	62.37	1.29	7.03	2.39	0.24
	2007	70.69	1.47	7.03	2.62	0.82
	2006	71.44	1.57	7.03	2.64	2.10
	1990	71.44	1.59	7.03	2.64	2.47

5.2 Emissions Generated

5.2.1 Greenhouse Gases

In 2014, GHG emissions produced by the railway sector as a whole (expressed as CO_{2e}) were 6,640.97 kt, an increase of 4.3% as compared to 6,367.68 kt in 2013 and 6,235.13 kt in 1990. This is an increase of 6.5% since 1990, with a corresponding rise in RTK traffic of 83.7%. The GHG emissions intensities for freight traffic decreased in 2014 to 14.80 kg per 1,000 RTK from 15.35 kg in 2013, and decreased from 25.38 kg in 1990. As a percentage, the 2014 GHG emissions intensity for total freight was 3.6% below the level for 2013 and 41.7% below that for 1990. Table 9 displays the GHG emissions produced in the reference year (1990) and annually since 2006 for the constituent railway operations. The GHG emissions for years prior to 2006 are available upon request to the RAC.

Table 9. GHG Emissions and Emission Intensities by Railway Service in Canada 1990, 2006–2014 (in kilotonnes unless otherwise specified)

	1990	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total Railway										
CO_{2e}	6,235.13	6,679.14	6,759.92	6,602.45	5,653.87	6,190.60	6,307.21	6,472.83	6,367.68	6,640.97
CO_2	5,550.96	5,946.25	6,018.17	5,877.97	5,033.48	5,511.32	5,615.13	5,762.58	5,668.97	5,912.27
CH_4	7.74	8.29	8.39	8.19	7.02	7.68	7.83	8.03	7.90	8.24
N_2O	676.43	724.60	733.37	716.28	613.37	671.60	684.25	702.22	690.81	720.46
Passenger - Intercity, Commuter, Tourist/Excursion										
CO_{2e}	310.31	306.05	309.11	320.26	326.33	323.49	333.34	312.67	293.18	293.59
CO_2	276.26	272.47	275.19	285.12	290.52	287.99	296.76	278.36	261.01	261.37
CH_4	0.39	0.38	0.38	0.40	0.40	0.40	0.41	0.39	0.36	0.36
N_2O	33.67	33.20	33.53	34.74	35.40	35.09	36.16	33.92	31.81	31.85
Freight-Line Haul										
CO_{2e}	5,514.47	6,155.05	6,244.47	6,091.45	5,186.42	5,737.90	5,814.13	5,991.52	5,916.64	6,126.57
CO_2	4,909.37	5,479.66	5,559.27	5,423.04	4,617.33	5,108.29	5,176.16	5,334.08	5,267.42	5,454.31
CH_4	6.84	7.64	7.75	7.56	6.44	7.12	7.22	7.44	7.34	7.60
N_2O	598.25	667.74	677.45	660.85	562.66	622.49	630.76	650.00	641.88	664.66
Yard Switching and Work Train										
CO_{2e}	410.35	218.04	206.35	190.74	141.12	129.21	159.74	168.64	157.86	220.81
CO_2	365.32	194.12	183.71	169.81	125.63	115.04	142.21	150.14	140.53	196.58
CH_4	0.51	0.27	0.26	0.24	0.18	0.16	0.20	0.21	0.20	0.27
N_2O	44.52	23.65	22.39	20.69	15.31	14.02	17.33	18.30	17.13	23.96
Total Freight Operations										
CO_{2e}	5,924.81	6,373.09	6,450.82	6,282.19	5,327.54	5,867.12	5,973.87	6,160.16	6,074.50	6,347.39
CO_2	5,274.69	5,673.78	5,742.98	5,592.86	4,742.96	5,223.33	5,318.37	5,484.21	5,407.95	5,650.90
CH_4	7.35	7.91	8.01	7.80	6.61	7.28	7.41	7.65	7.54	7.88
N_2O	642.77	691.40	699.83	681.54	577.97	636.51	648.09	668.30	659.01	688.61
Emissions Intensity — Total Freight (kg/1,000 RTK)										
CO_{2e}	25.38	17.91	17.84	18.14	17.30	16.80	16.61	16.17	15.35	14.80
CO_2	22.59	15.95	15.88	16.14	15.41	14.96	14.79	14.40	13.66	13.17
CH_4	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
N_2O	2.75	1.94	1.94	1.97	1.88	1.82	1.80	1.75	1.66	1.61

Table 9. GHG Emissions and Emission Intensities by Railway Service in Canada 1990, 2006–2014 (in kilotonnes unless otherwise specified) *(continued)*

	1990	2006	2007	2008	2009	2010	2011	2012	2013	2014
Emissions Intensity — Class I Freight Line-Haul (kg/1,000 RTK)										
CO_{2e}	n/a*	17.48	17.40	17.69	17.02	16.51	16.24	15.88	15.03	14.51
Emissions Intensity — Regional and Short Line Freight (kg/1,000 RTK)										
CO_{2e}	n/a*	14.84	15.29	15.92	14.27	15.28	14.95	13.51	13.65	11.22
Emissions Intensity — Intercity Passenger (kg/Passenger-km)										
CO_{2e}	n/a*	0.133	0.132	0.122	0.133	0.124	0.123	0.110	0.101	0.101
Emissions Intensity — Commuter Rail (kg/Passenger)										
CO_{2e}	n/a*	1.71	1.71	1.71	1.96	2.07	2.20	2.17	2.09	2.09

*n/a = indicates not available

The 2011–2015 MOU between the RAC and TC sets out targets to be achieved by 2015 for GHG emissions intensities by category of railway operation. In relation to the 2015 targets, Table 10 shows the GHG emissions intensity levels for Class I freight, Intercity passenger, and Regional and Short Lines for 2014.

Table 10[a]. GHG Emissions Intensities by Category of Operation, 2010–2014

Railway Operation	Units	2010	2011	2012	2013	2014	MOU 2015 Target
Class I Freight	kg CO_{2e}/1,000 RTK	16.51	16.24	15.88	15.03	14.51	15.52
Intercity Passenger	kg CO_{2e}/passenger-km	0.124	0.123	0.110	0.101	0.101	0.117
Regional and Short Lines	kg CO_{2e}/1,000 RTK	15.28	14.95	13.51	13.65	11.22	14.82

a All values above, including the 2015 targets, have been calculated based on the new emission factors and global warming potentials. Historical values have been updated from previous reports. As a result, the updated factors caused the baseline 2010 GHG emission intensity values to change, resulting in the 2015 target values differing from the original MOU.

In 2014, the Class I freight railways were able to better match available locomotive power to freight traffic, which was a factor in the decrease of 3.5% in the Class I freight GHG emission intensity below the 2013 value.

Intercity Passenger operations were not able to successfully match locomotive power with fluctuating traffic levels, and therefore the Intercity Passenger GHG emissions intensity slightly increased relative to 2013 by 0.3%. As previously stated, commuter railways do not have a GHG emissions intensity target under the MOU 2015 target.

Regional and Short Lines saw a fortuitous shift in their traffic mix, resulting in a decrease in the GHG intensity relative to the 2013 value of 17.8%. Specifically, shortlines and regional railways carried more high-density commodities such as metals and minerals relative to other commodities. That shift compounded the successful matching of locomotive power to traffic.

5.2.2 Criteria Air Contaminants

Table 11 displays the CAC emissions produced annually by locomotives in operation in Canada for the reference year (1990) and annually from 2006 to 2014, namely NO_x, PM, CO, HC, and SO_x. The values presented are for both absolute amounts and intensities per productivity unit. The emissions and intensities for years previous to 2006 are available upon request to the RAC.

The CAC of key concern for the railway sector is NO_x. As shown in Table 11, the Canadian railway-generated NO_x emissions in 2014 totalled 94.21 kt. Freight operations accounted for 94.4% of railway-generated NO_x emissions in Canada.

The Total Freight NO_x emissions intensity (i.e., the quantity of NO_x emitted per unit of productivity) was 0.21 kg per 1,000 RTK in 2014. This was 9.3% lower than the 2013 figure (0.23 kg per 1,000 RTK) and is down from 0.52 kg per 1,000 RTK in 1990, a 60.2% reduction.

Table 11. Locomotive CAC Emissions, 1990, 2006–2014
in kilotonnes, unless otherwise noted

Operation	Year	NO_x	PM	CO	HC	SO_2 (tonnes)
Total Freight	2014	83.94	1.82	14.34	3.66	49.97
	2013	86.96	1.98	13.81	3.91	48.26
	2012	89.88	2.13	13.59	4.18	126.97
	2011	91.40	2.22	13.52	4.26	336.10
	2010	93.49	2.34	13.40	4.52	403.08
	2009	86.52	2.25	12.13	4.24	310.67
	2008	103.15	2.78	14.76	5.51	487.40
	2007	109.00	2.97	15.20	5.76	1,700.23
	2006	112.83	3.06	14.22	5.15	4,273.51
	1990	130.38	2.91	12.84	4.81	4,504.32
Total Yard Switching	2014	5.04	0.11	0.54	0.29	1.80
	2013	3.59	0.08	0.38	0.21	1.29
	2012	3.86	0.08	0.41	0.22	3.68
	2011	3.68	0.08	0.39	0.21	7.67
	2010	2.98	0.07	0.31	0.17	9.08
	2009	3.24	0.07	0.34	0.19	8.45
	2008	4.39	0.10	0.46	0.26	15.21
	2007	4.77	0.11	0.50	0.28	56.18
	2006	5.04	0.12	0.53	0.29	151.38
	1990	9.49	0.22	1.00	0.55	335.18
Total Passenger(1)	2014	5.24	0.11	0.68	0.21	2.37
	2013	4.88	0.10	0.67	0.19	2.36
	2012	5.51	0.12	0.72	0.22	6.72
	2011	5.98	0.13	0.76	0.24	19.12
	2010	5.94	0.12	0.74	0.24	22.43
	2009	6.65	0.14	0.75	0.25	19.24
	2008	6.56	0.14	0.74	0.25	25.45
	2007	7.19	0.15	0.72	0.27	83.64
	2006	7.18	0.16	0.71	0.27	210.90
	1990	7.35	0.16	0.72	0.27	253.80

(1) Passenger data does not take into account Amtrak due to the definition of active locomotive fleet used to calculate CAC emissions.

Table 11. Locomotive CAC Emissions, 1990, 2006–2014 in kilotonnes, unless otherwise noted *(continued)*

Operation	Year	NO_x	PM	CO	HC	SO_2 (tonnes)
Total Freight Operations[2]	2014	88.98	1.93	14.88	3.95	51.77
	2013	90.55	2.06	14.19	4.12	49.55
	2012	93.71	2.22	14.00	4.40	130.57
	2011	95.08	2.30	13.91	4.47	343.78
	2010	96.47	2.40	13.27	4.69	412.15
	2009	89.76	2.32	12.47	4.43	315.85
	2008	107.54	2.88	15.22	5.77	502.60
	2007	113.78	3.08	15.70	6.03	1,756.41
	2006	117.88	3.18	14.75	5.44	4,424.89
	1990	139.87	3.13	13.84	5.36	4,839.50
Total Railway Operations[3]	2014	94.21	2.04	15.55	4.16	54.14
	2013	95.43	2.16	14.86	4.31	51.91
	2012	99.22	2.33	14.71	4.62	137.28
	2011	101.06	2.43	14.67	4.71	363.16
	2010	102.41	2.53	14.46	4.92	434.58
	2009	96.41	2.46	13.22	4.68	338.36
	2008	114.10	3.01	15.96	6.02	528.05
	2007	120.96	3.23	16.41	6.30	1,840.05
	2006	125.06	3.34	15.46	5.71	4,635.79
	1990	147.21	3.30	14.56	5.64	5,093.30
Total Freight Emissions Intensity (kg/1000 RTK)	2014	0.21	0.00	0.03	0.01	0.00
	2013	0.23	0.01	0.04	0.01	0.00
	2012	0.25	0.01	0.04	0.01	0.00
	2011	0.26	0.01	0.04	0.01	0.00
	2010	0.28	0.01	0.04	0.01	0.00
	2009	0.29	0.01	0.04	0.01	0.00
	2008	0.31	0.01	0.04	0.02	0.00
	2007	0.31	0.01	0.04	0.02	0.00
	2006	0.33	0.01	0.04	0.02	0.01
	1990	0.52	0.01	0.05	0.02	0.02

(2) Freight Operations = Freight + Yard Switching

(3) Total Railway Operations = Freight + Yard Switching + Passenger

6 Tropospheric Ozone Management Areas

6.1 Data Derivation

The three Tropospheric Ozone Management Areas (TOMA) relate to air quality for the Lower Fraser Valley in British Columbia, the Windsor-Québec City Corridor, and the Saint John area in New Brunswick:

TOMA No. 1: The Lower Fraser Valley in British Columbia represents a 16,800-km^2 area in the southwestern corner of the province averaging 80 km in width and extending 200 km up the Fraser River Valley from the mouth of the river in the Strait of Georgia to Boothroyd, British Columbia. Its southern boundary is the Canada/United States (US) international boundary, and it includes the Greater Vancouver Regional District.

TOMA No. 2: The Windsor-Québec City Corridor in Ontario and Québec represents a 157,000-km^2 area consisting of a strip of land 1,100 km long and averaging 140 km in width stretching from the City of Windsor (adjacent to Detroit in the US) in Ontario to Québec City. The Windsor-Québec City Corridor TOMA is located along the north shore of the Great Lakes and the St. Lawrence River in Ontario and straddles the St. Lawrence River from the Ontario/Québec border to Québec City. It includes the urban centres of Windsor, London, Hamilton, Toronto, Ottawa, Montréal, Trois-Rivières, and Québec City.

TOMA No. 3: The Saint John TOMA is represented by the two counties in southern New Brunswick—Saint John County and Kings County. The area covers 4,944.67 km^2.

Fuel Consumption and Emissions

The fuel consumption in each TOMA region is derived from the total traffic in the area as provided by the railways. Table 12 shows the fuel consumption and the GHG emissions in the TOMA regions as a percentage of the total fuel consumption for all rail operations in Canada. Table 13 shows NO_x emissions in the TOMA regions as a percentage of the total NO_x emissions for all rail operations.

Table 12. TOMA Total Fuel Consumption and GHG Emissions as Percentage of All Rail Operations in Canada, 1999, 2006–2014

	1999	2006	2007	2008	2009	2010	2011	2012	2013	2014
Lower Fraser Valley, B.C.	4.2	2.8	3.0	2.8	3.0	3.1	3.0	2.8	2.9	2.2
Windsor-Québec City Corridor	17.1	16.8	17.4	17.1	15.7	15.3	14.8	14.2	14.1	14.6
Saint John, N.B.	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Table 13. TOMA Total NO_x Emissions as Percentage of All Rail Operations in Canada, 1999, 2006–2014

	1999	2006	2007	2008	2009	2010	2011	2012	2013	2014
Lower Fraser Valley, B.C.	4.4	2.8	2.9	2.8	2.9	3.1	3.0	3.1	2.9	2.2
Windsor-Québec City Corridor	17.8	17.4	16.6	16.8	15.1	15.3	14.8	15.7	14.1	14.6
Saint John, N.B.	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2

The emissions of GHGs for the three TOMA regions were calculated using the respective GHG emissions factors as discussed in Section 5.1 and the fuel consumption data available for each TOMA region.

The CAC and GHG emission factors and emissions for the TOMA regions were calculated based on the total fuel usage for each region. The CAC emission factors reflect a weighted average of the Freight, Switch, and Passenger EFs presented in Section 5.1, and Passenger and Freight fuel usage. Since the Freight fuel usage includes both the Freight Train fuel usage and the Switching fuel usage, the percentage of fuel allocated for these TOMA regions to Switching was based on the percentage of fuel used Canada-wide. The emissions for each CAC were then calculated by multiplying the EFs by the fuel usage for each TOMA region.

6.2 Seasonal Data

The emissions in each TOMA have been split according to two seasonal periods:

- Winter (seven months) January to April and October to December, inclusively; and
- Summer (five months) May to September, inclusively

The division of traffic in the TOMA region in the seasonal periods was taken as equivalent to that on the whole system for each railway. The fuel consumption in each of the TOMA was divided by the proportion derived for the traffic on each railway. The 2014 traffic, fuel consumption, and emissions data in the seasonal periods for each railway are summarized in Tables 14 to 16.

Table 14. TOMA No. 1 Lower Fraser Valley, B.C.
Traffic, Fuel and Emissions Data 2014

		Seasonal Split	
	Total 100%	Winter 58%	Summer 42%
TRAFFIC		**Million GTK**	
CN	9,955	5,774	4,181
CP	6,950	4,031	2,919
Southern Rail of BC	305	177	128
TOTAL FREIGHT TRAFFIC	**17,210**	**9,982**	**7,228**
FUEL CONSUMPTION		**Million Litres**	
Freight operations			
Freight Fuel Rate (L/1,000 GTK) = 2.59(1)			
Total Freight Fuel Consumption	**44.51**	**25.82**	**18.69**
Passenger Fuel Consumption			
VIA Rail Canada	0.39	0.22	0.16
Great Canadian Railtours	2.16	1.25	0.91
West Coast Express	1.32	0.76	0.55
Total Passenger Fuel Consumption	**3.87**	**2.24**	**1.62**
TOTAL RAIL FUEL CONSUMPTION	**48.37**	**28.06**	**20.32**
EMISSIONS		**Kilotonnes/Year**	
Emission Factors (g/L)(2)			
NO_x: 42.89	2.07	1.20	0.87
PM: 0.93	0.04	0.03	0.02
CO: 7.08	0.34	0.20	0.14
HC: 1.89	0.09	0.05	0.04
SO_2: 0.02	0.00	0.00	0.00
CO_2: 2,690.00(3)	130.13	75.47	54.65
CH_4: 3.75(3)	0.18	0.11	0.08
N_2O: 327.8(3)	15.86	9.20	6.66
CO_{2e}: 3,021.55(3)	146.17	84.78	61.39

(1) Freight fuel rate has been calculated by dividing the total Canadian freight fuel usage (see Table 3) by the total Canadian freight GTK (see Table 1).

(2) The emission factor used in the emissions calculations is a weighted average of the overall Freight, Switching, and Passenger emissions factor based on the quantity of Freight and Passenger fuel used.

(3) The emission factors for each GHG include their respective global warming potential factor.

Table 15. TOMA No. 2 Windsor-Québec City Corridor Traffic, Fuel and Emissions Data 2014

		Seasonal Split	
	Total 100%	Winter 58%	Summer 42%
TRAFFIC		**Million GTK**	
CN	60,647	35,176	25,472
CP	31,868	18,484	13,385
Essex Terminals	35	20	15
Goderich & Exeter	409	237	172
Norfolk Southern	2	1	1
Ottawa Valley Railway[1]	0	0	0
Québec Gatineau	891	517	374
Southern Ontario	243	141	102
St-Lawrence & Atlantic (Canada)	316	183	133
TOTAL FREIGHT TRAFFIC	**94,412**	**54,759**	**39,653**
FUEL CONSUMPTION		**Million Litres**	
Freight operations			
Freight Fuel Rate (L/1,000 GTK) = 2.59[2]			
Total Freight Fuel Consumption	**244.17**	**141.62**	**102.55**
Passenger Fuel Consumption			
VIA Rail Canada	28.95	16.79	12.16
Commuter Rail	48.36	28.05	20.31
Total Passenger Fuel Consumption	**77.30**	**44.84**	**32.47**
TOTAL RAIL FUEL CONSUMPTION	**321.48**	**186.46**	**135.02**
EMISSIONS		**Kilotonnes/Year**	
Emission Factors (g/L)[3]			
NO_X: 42.89	13.79	8.00	5.79
PM: 0.93	0.30	0.17	0.13
CO: 7.08	2.28	1.32	0.96
HC: 1.89	0.61	0.35	0.26
SO_2: 0.02	0.01	0.00	0.00
CO_2: 2,690.00[4]	864.77	501.57	363.20
CH_4: 3.75[4]	1.21	0.70	0.51
N_2O: 327.80[4]	105.38	61.12	44.26
CO_{2e}: 3,021.55[4]	971.36	563.39	407.97

(1) Ottawa Valley Railway data are included in CP data.

(2) Freight fuel rate has been calculated by dividing the total Canadian freight fuel usage (see Table 3) by the total Canadian freight GTK (see Table 1).

(3) The emission factor used in the emissions calculations is a weighted average of the overall Freight, Switching, and Passenger emissions factor based on the quantity of Freight and Passenger fuel used.

(4) The emission factors for each GHG include their respective global warming potential factor.

Table 16. TOMA No. 3 Saint John Area, New Brunswick Traffic, Fuel and Emissions Data 2014

	Total 100%	Seasonal Split Winter 58%	Summer 42%
TRAFFIC		Million GTK	
CN	885	513	372
New Brunswick Southern Railway	777	451	326
Total Freight Traffic	**1,662**	**964**	**698**
FUEL CONSUMPTION		Million Litres	
Freight Operations			
Freight Fuel Rate (L/1,000 GTK) = 2.59(1)			
Total Freight Fuel Consumption	**4.30**	**2.49**	**1.81**
Passenger Fuel Consumption			
Total Passenger Fuel Consumption	**0.00**	**0.00**	**0.00**
Total Rail Fuel Consumption	**4.30**	**2.49**	**1.81**
EMISSIONS		Kilotonnes/Year	
Emission Factors (g/L)(2)			
NO_X: 42.89	0.18	0.11	0.08
PM: 0.93	0.00	0.00	0.00
CO: 7.08	0.03	0.02	0.01
HC: 1.89	0.01	0.00	0.00
SO_2: 0.02	0.00	0.00	0.00
CO_2: 2,690.00(3)	11.56	6.71	4.86
CH_4: 3.75(3)	0.02	0.01	0.01
N_2O: 327.80(3)	1.41	0.82	0.59
CO_{2e}: 3,021.55(3)	12.99	7.53	5.45

(1) Freight fuel rate has been calculated by dividing the total Canadian freight fuel usage (see Table 3) by the total Canadian freight GTK (see Table 1).

(2) The emission factor used in the emissions calculations is a weighted average of the overall Freight, Switching, and Passenger emissions factor based on the quantity of Freight and Passenger fuel used.

(3) The emission factors for each GHG include their respective global warming potential factor.

7 Emissions Reduction Initiatives

There are multiple approaches for achieving the emission reduction targets outlined in the MOU, with railways and governments playing a critical role in reducing emissions and achieving expected results.

Investments in new technologies, management strategies focused on fuel economy and fluidity training, and research and development programs are effective methods for reducing emissions. The *Locomotive Emissions Monitoring Program 2011–2015 Action Plan for Reducing GHG Emissions* presents a roadmap for railways to reduce their emissions. It includes a comprehensive list of emerging technologies and novel management strategies to be implemented by the railway sector, as appropriate.

Below is a short summary of a few initiatives undertaken by railways and government in 2014 to reduce emissions.

Canada-US Regulatory Cooperation Council

Work continued under the Canada-U.S. Regulatory Cooperation Council (RCC) Locomotive Emissions Initiative — an initiative for Canada and the U.S. to work together to reduce emissions produced by locomotives. The steering committee met throughout the year to discuss and develop the Canada-U.S. Voluntary Action Plan to Reduce Greenhouse Gas Emissions from Locomotives. A technical meeting was held on December 10, 2014 in Washington, DC to bring together technical experts from government, railway associations, Class I railways and industry suppliers to undertake an in-depth analysis of the most promising technical and operational measures that could be included in the Action Plan to support the reduction of GHG emissions from locomotives. This work built upon the findings from the 2012 Technology and Infrastructure Scan prepared by the National Research Council of Canada and the discussions from the 2012 Railroad Workshop held in Urbana, Illinois.

Transport Canada — Clean Rail R&D Projects

As a part of the Government of Canada's efforts to reduce rail sector emissions and support research of new and emerging technologies, Transport Canada launched the Clean Rail Academic Grant Program. Since its inception in 2012–2013, the grant program has provided 20 grants of $25,000 each ($500,000 total) to academic research programs developing emission reduction technologies and practices for the transportation sector that could be applied to the rail industry. The 2013–2014 round of the grant program awarded ten rail-related research and development (R&D) projects. The topics of the projects, completed in 2014, include, alternative fuels, computer simulation, electrical energy storage, filter technology, friction reduction, and lightweighting. Transport Canada also funded a number of new rail R&D projects in 2014, including the assessment of biodiesel mixtures, hydrogen, and hybrid electric technology as alternate fuel sources for locomotives, as well as projects exploring electrical energy storage and lightweighting.

CP – Energy efficiencies

As part of its $1.5 billion capital expenditure program for 2014, CP focused on identifying and implementing operational enhancements to improve network velocity and fuel efficiency. The company invested in longer sidings across its network Additionally, CP made investments to increase system velocity which allowed for the placement of less fuel efficient locomotives into long term storage.

GO Transit – Energy efficiencies and fleet renewal

In 2014 the railway undertook a number of initiatives to improve its fuel economy and as a result lower its emissions. In 2014, 9 Tier 3 locomotives out of an order of 10 were added to the locomotive fleet. They were not included in the locomotive inventory because they were not in active service on December 31st. Additionally, further research was performed to convert Tier 2 locomotives to EPA Tier level 4 locomotives. GO Transit also deployed the IntelliTrain idling reporting technology developed by EMD to increase fleet efficiency. Finally, GO Transit continued to study and initiated planning for the future electrification of their commuter rail operation.

CN –Fuel efficiency technologies and HPTA (Horse Power Tonnage Analyzer)

CN maintains a longstanding commitment to reducing its emissions by investing in innovative fuel efficiency technologies and programs such as the SmartYard optimization system. SmartYard allows CN to make yard inventory adjustments to reduce dwell times, increase train speed and improve fuel efficiency. In 2014 CN further integrated telemetry systems to feed their HPTA (Horse Power Tonnage Analyzer) system which works to optimize a locomotive's horsepower to tonnage ratio. For example, if a train is overpowered, the crew would receive instructions to shut down one of the units or reduce the notch at which it is operating so that it can conserve fuel and as a result produce fewer emissions.

In 2014, CN also retrofitted two high-horsepower mainline locomotives to run on a mix of liquefied natural gas (LNG) and diesel. Four special tender cars were also constructed for the trains to carry the LNG.

8 Summary and Conclusions

The 2014 Locomotive Emissions Monitoring Report highlights that Canadian railways are well placed to meet their GHG reduction targets by 2015.

GHG emissions from all railway operations in Canada totalled 6,640.97 kt, up 4.3% from 6,367.68 kt in 2013. Despite this increase in absolute emissions, railways have continued to see improvements in fuel consumption due to better matching of available locomotive power to freight traffic and implementation of modern technologies and novel management strategies as described in the *Locomotive Emissions Monitoring Program 2011—2015 Action Plan for Reducing GHG Emissions*. In absolute terms, railway-generated GHG emissions have not substantially increased relative to increases in traffic.

For total freight operations, the GHG emissions intensity (in kg of CO_{2e} per 1,000 RTK) decreased by 3.6% from 15.35 in 2013 to 14.80 in 2014. Compared to 25.38 in 1990, 2014 performance is a 41.7% improvement. For Class I freight, the GHG emission intensity (in kg CO_{2e} per 1000 RTK) decreased by 3.5% from 15.03 in 2013 to 14.51 in 2014. For intercity passenger operations, the GHG emissions intensity (in kg of CO_{2e} per passenger kilometre) increased slightly by 0.3% in 2014. Regional and Short Lines lowered their GHG emission intensity (in kg of CO_{2e} per 1,000 RTK) by 17.8% from 13.65 in 2013 to 11.22 in 2014. The CAC emissions from all railway operations decreased, with total locomotive NO_x emissions decreasing to 94.21 kt in 2014 as compared to 95.43 kt in 2013. The total freight NO_x emissions intensity was 0.21 kg/1,000 RTK in 2014, compared to 0.23 kg/1,000 RTK in 2013 and down from 0.52 kg/1,000 RTK in 1990.

In 2014, Canadian railways invested in fleet upgrades with 3 Tier 3 high-horsepower locomotives added to the Class I Freight Line-haul fleet and 117 locomotives upgraded to Tier 0+, Tier 1+, or Tier 2+. Older and lower-horsepower locomotives continue to be retired, and in 2014, 9 medium-horsepower locomotives manufactured between 1973 and 1999 were taken out of active duty. Overall, the Canadian fleet totalled 2,700 units in 2014, of which 1,925 locomotives were subject to the USEPA emissions regulations (of which 79.9% achieved tier level emission standards). The number of locomotives equipped with APUs or AESS systems to minimize unnecessary idling totalled 1,684 or 62.4% of the in-service fleet.

Through implementation of the *Locomotive Emissions Monitoring Program 2011–2015 Action Plan for Reducing GHG Emissions*, Canadian railways and the Government of Canada will continue their efforts to reduce GHG emissions in the railway sector and achieve the expected outcome of the MOU.

This report meets the filing requirements for 2014.

Appendix A

RAC Member Railways Participating in the 2011–2015 MOU by Province

Railway	Provinces of Operation
6970184 Canada Ltd	Saskatchewan
Agence métropolitaine de transport	Québec
Alberta Prairie Railway Excursions	Alberta
Amtrak	British Columbia, Ontario, Québec
ArcelorMittal Mines Canada	Québec
Arnaud Railway Company	Québec
Barrie-Collingwood Railway	Ontario
Battle River Railway	Alberta
BCR Properties	British Columbia
Canadian Pacific	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec
Cape Breton & Central Nova Scotia Railway	Nova Scotia
Capital Railway	Ontario
Carlton Trail Railway	Saskatchewan
Central Manitoba Railway Inc.	Manitoba
Charlevoix Railway Company Inc.	Québec
CN	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia
CSX Transportation Inc.	Ontario, Québec
Eastern Maine Railway Company	(Maine)
Essex Terminal Railway Company	Ontario
Goderich-Exeter Railway Company Ltd.	Ontario
Great Canadian Railtour Company Ltd.	British Columbia
Great Sandhills Railway Ltd.	Saskatchewan
Great Western Railway Ltd.	Saskatchewan
Hudson Bay Railway	Manitoba
Huron Central Railway Inc.	Ontario
Keewatin Railway Company	Manitoba
Kettle Falls International Railway, LLC	British Columbia
Labrador Iron Mines	Newfoundland and Labrador
Metrolinx	Ontario

Railway	Provinces of Operation
New Brunswick Southern Railway Company Ltd.	New Brunswick
Nipissing Central Railway Company	Ontario, Québec
Norfolk Southern Railway	Ontario
Ontario Northland Transportation Commission	Ontario, Québec
Ontario Southland Railway Inc.	Ontario
Ottawa Valley Railway	Ontario, Québec
Prairie Dog Central Railway	Manitoba
Québec Gatineau Railway Inc.	Québec
Québec North Shore and Labrador Railway Company Inc.	Québec, Newfoundland and Labrador
Roberval and Saguenay Railway Company, The	Québec
Romaine River Railway Company	Québec
Société du chemin de fer de la Gaspésie	Québec
South Simcoe Railway	Ontario
Southern Ontario Railway	Ontario
Southern Railway of British Columbia Ltd.	British Columbia
Southern Railway of Vancouver Island	British Columbia
St. Lawrence & Atlantic Railroad (Québec) Inc.	Québec
Sydney Coal Railway	Nova Scotia
Toronto Terminals Railway Company Limited, The	Ontario
Trillium Railway Co. Ltd.	Ontario
Tshiuetin Rail Transportation Inc.	Québec
VIA Rail Canada Inc.	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Québec, New Brunswick, Nova Scotia
Wabush Lake Railway Company, Limited	Newfoundland and Labrador
West Coast Express Ltd.	British Columbia

Appendix B-1
2014 Locomotive Fleet — Freight Train Line-Haul Operations

OEM	Model	US EPA Tier Level	Engine	Cylinders	hp	Year of Manufacture	Year of Remanufac-ture	CN	CP	Total Class 1	Regional	Short Lines	Total Regional and Short Lines	Total Freight Fleet
MAINLINE LOCOMOTIVES														
GM/EMD	GMD-1		567	12V	1200	1958–1960						1	1	1
	RM (EMD-1)		567	12V	1200	1958						3	3	3
	GP9		567	16V	1750	1950–1960	1980–1981					5	5	5
	GP10		567	16V	1800	1967–1977						3	3	3
	GP30		567	16V	2250	1961–1963								
	GP40-3		567	16V	3000	1966–1968	2002					3	3	3
	GP40-3		567	16V	3100							2	2	2
	GMD-1		645	12V	1200	1958–1960								
	GP9		645	16V	1800	1954–1981						9	9	9
	SD38-2		645	16V	2000	1975						3	3	3
	SD38		645	16V	2000	1971–1974						1	1	1
	GP38		645	16V	2000	1970–1986						37	37	37
	GP35-2		645	16V	2000	1963–1966						1	1	1
	GP38-2		645	16V	2000	1972–1986					8	10	18	18
	GP38-3		645	16V	2000	1981–1983						20	20	20
	GP39-2		645	16V	2300	1974–1984						4	4	4
	GP35-3		645	16V	2500	1963–1966						4	4	4
	GP40		645	16V	3000	1975–1987						5	5	5
	GP40-2		645	16V	3000	1972–1986		50		50	3	24	27	77
	SD40-2		645	16V	3000	1972–1990	1994–1995	55	59	114	15	17	32	146
	SD40-3		645	16V	3000	1966–1972		10		10		4	4	14
	SD40-3		567	16V	3100									
	F40-PHR		645E3B	16V	3200	1940								
	SD40		645	16V	3200	1966–1972								
	SD45-2		645	16V	3600	1972–1974						1	1	1
	SD60		710	16V	3800	1985–1989		45		45				45
	SD70		710	16V	4000	1995								
	SD70-MAC		710	16V	4300	2013		3		3				3
	SD70-ACE		710	16V	4000	1995–2000					23		23	23
	SD75-I		710	16V	4300	1996–1999					5		5	5
	SD90-MAC		710	16V	4300	1989–1999								
	SD40-2	Tier 0	645	16V	3000	1978–1985		6		6	2		2	8
	SD60	Tier 0	710	16V	3800	1985–1989	2002–2005	20		20				20
	SD70	Tier 0	710	16V	4000	1995	2001–2005							
	SD75-I	Tier 0	710	16V	4300	1996–1999	2002–2005	63		63				63
	SD90-MAC	Tier 0	710	16V	4300	1998					5		5	5
	SD90-MAC-H	Tier 0	265H	16V	6000	1999								
	GP20	Tier 0+	710	8V	2000	2013–2014								
	SD40-3	Tier 0+	645	16V	3000	1966–1972	2012	14		14				14
	SD40-2	Tier 0+	645	16V	3000	1978–1985	2012	24		24				24
	GP40-2	Tier 0+	645	16V	3000	1972–1986	2012	9		9		1	1	10
	SD60	Tier 0+	710	16V	3800	1985–1989	2002–2012	72		72				72
	SD70	Tier 0+	710	16V	4000	1995	2001–2011							
	SD75-I	Tier 0+	710	16V	4300	1996–1999	2002–2012	99		99				99
	SD70-M2	Tier 2	710	16V	4300	2005–2007		122		122				122
	SD70-M2	Tier 2+	710	16V	4300	2005–2011	2013	51		51				51
GM/EMD Sub-Total								**643**	**59**	**702**	**61**	**158**	**219**	**921**

OEM	Model	US EPA Tier Level	Engine	Cylinders	hp	Year of Manufacture	Year of Remanufac-ture	CN	CP	Total Class 1	Regional	Short Lines	Total Regional and Short Lines	Total Freight Fleet
MAINLINE LOCOMOTIVES														
GE	B23-7		7FDL12	12V	2250	1979–1980						2	2	2
	B39-8E		7FDL16	16V	3900	1987–1988						7	7	7
	Dash 8-40CM		7FDL16	16V	4000	1990–1992		6		6		2	2	8
	Dash 8-40CW		7FDL16	16V	4000	1989–1992		12		12				12
	Dash 9-44CW		7FDL16	16V	4400	1996–1999		5		5				5
	Dash 9-44CW	Tier 0	7FDL16	16V	4400	1994–1999	2001–2003				11		11	11
	Dash 9-44CW	Tier 0	7FDL16	16V	4400	2000–2001		24		24				24
	AC4400CW	Tier 0	7FDL16	16V	4400	1995–1999			41	41				41
	AC4400CW	Tier 0	7FDL16	16V	4400	2000–2001					12		12	12
	Dash 8-40CM	Tier 0+	7FDL16	16V	4400	1990–1992	2011–2012	105		105				105
	Dash 8-40CW	Tier 0+	7FDL16	16V	4000	1989–1992		80		80				80
	AC4400CW	Tier 0+	7FDL16	16V	4400	1995–2001								
	Dash 9-44CW	Tier 1	7FDL16	16V	4400	2002–2004		9		9				9
	AC4400CW	Tier 1	7FDL16	16V	4400	2002–2004			19	19	9		9	28
	Dash 9-44CW	Tier 1+	7FDL16	16V	4400	1994–2004	2011–2012	159		159				159
	AC4400CW	Tier 1+	7FDL16	16V	4400	1995–2004			136	136				136
	AC4400CW	Tier 2	7FDL16	16V	4400	2005–2007			1	1	12		12	13
	ES44AC	Tier 2	GEVO12	16V	4360	2005–2011			106	106	2		2	108
	ES44DC	Tier 2	GEVO12	16V	4400	2005–2008		75		75				75
	ES44AC	Tier 2+	GEVO12	16V	4360	2005–2011	2012		59	59				59
	ES44DC	Tier 2+	GEVO12	16V	4400	2005–2008		45		45				45
	ES44AC	Tier 3	GEVO12	16V	4360	2012		35	28	63				63
	ES44DC	Tier 3	GEVO12	16V	4400	2013								
GE Sub-Total								**555**	**390**	**945**	**46**	**11**	**57**	**1002**
MLW	RS-18		251	12V	1800	1954–1958						4	4	4
	M420(W)		251	12V	2000	1971–1975						5	5	5
	M420R (W)		251	12V	2000	1971–1975						2	2	2
	HR412		251	12V	2000	1975						1	1	1
MLW Sub-Total												**12**	**12**	**12**
FREIGHT MAINLINE SUB-TOTAL								**1198**	**449**	**1647**	**107**	**181**	**288**	**1935**
ROAD SWITCHERS														
GM/EMD	GMD-1		645	12V	1200	1958–1960		17		17				17
	SW-1200		567	12V	1200	1955–1962								
	GP9		567	16V	1750	1950–1960	1980–1981							
	GP9		645	16V	1800	1954–1981		21		21				21
	GP38		645	16V	2000	1970–1986			6	6				6
	SD38-2		645E	16V	2000	1975								
	GP38-2		645	16V	2000	1972–1986		70	70	140				140
	SD38-2		645	16V	2000	1975		1		1				1
	GMD-1	Tier 0+	645	12V	1200	1958–1960		1		1				1
	GP38-2	Tier 0	645E	16V	2000	1972–1986	2010–2011		4	4				4
	GP20	Tier 0+	710	8V	2000	2013–2014			62	62				62
	GP38	Tier 0+	645	16V	2000	1970–1986			5	5				5
	GP38-2	Tier 0+	645	16V	2000	1970–1986	2011–2012	5	49	54	0	0	0	54
	SD38-2	Tier 0+	645	16V	2000	1975	2012	2		2	0	0	0	2
	SD30	Tier 0+	710	12V	3000	2013			1	1	0	0	0	1
	GS1B	Tier 2	Cummins		2100	2008								
GM/EMD Road Switchers Sub-Total								**117**	**197**	**314**	**0**	**0**	**0**	**314**
ROAD SWITCHERS SUB-TOTAL								**117**	**197**	**314**	**0**	**0**	**0**	**314**
TOTAL MAINLINE FREIGHT								**1315**	**646**	**1961**	**107**	**181**	**288**	**2249**

Appendix B-2

2014 Locomotive Fleet — Freight Yard Switching & Work Train Operations

OEM	Model	US EPA Tier Level	Engine	Cylinders	HP	Year of Manufacture	Year of Remanu-facture	CN	CP	Total Class 1	Regional	Short Lines	Total Regional and Short Lines	Total Freight Fleet
GM/EMD	SW900		567	8V	900	1954–1965						13	13	13
	SW1200		567	12V	1200	1955–1962						3	3	3
	RM (EMD-1)		567	12V	1200	1958						1	1	1
	SW1500		567	12V	1500	1966–1974						6	6	6
	MP15		567	12V	1500	1976						4	4	4
	GP7		567	16V	1500	1949–1954	1980–1988					4	4	4
	GP9		567	16V	1750	1951–1963	1980–1991				2	5	7	7
	GMD-1		645	12V	1200	1958–1960						4	4	4
	SW14		567	12V	1400	1950						1	1	1
	GP15		645	16V	1500	1981–1984						3	3	3
	GP9		645	16V	1700	1960	1980–1981					1	1	1
	GP9		645	16V	1750	1954–1981	1980–1991				3	3	6	6
	GP9-RM		645	16V	1800	1954–1981	1980–1981	89		89				89
	GP20		567	16V	2000	2000–2001						8	8	8
	GP38		645	16V	2000	1970–1986					3		3	3
	GP38-2		645	16V	2000	1972–1986		15		15				15
	SD40-2		645	16V	3000	1972–1990			3	3				3
	SD40-2	Tier 0	645	16V	3000	1983–1985	2009							
	GP38-2	Tier 0+	645	16V	2000	1972–1986	2012	7		7				7
GM/EMD Sub-Total								**111**	**3**	**114**	**8**	**56**	**64**	**178**
GE	44T		Cummins		300	1947								
	C30-7		7FDL16	16V	3000							12	12	12
	B23-S7		7FDL12	12V	2250	1977–1984						7	7	7
GE Sub-Total								**0**	**0**	**0**	**0**	**19**	**19**	**19**
MLW	S-13		251	6V	1000	1959–1960	1978					5	5	5
	RS-18		251	12V	1800	1954–1958						4	4	4
	RS-23		251	18V	1000	1959–1960						3	3	3
MLW Sub-Total								**0**	**0**	**0**	**0**	**12**	**12**	**12**
ALCO	S-6		251	6V	900	1953						1	1	1
	S-2		539	6V	1000	1944						1	1	1
ALCO Sub-Total								**0**	**0**	**0**	**0**	**2**	**2**	**2**
BUDD	RDC-1		Cummins		600	1947						1	1	1
BUDD Sub-Total								**0**	**0**	**0**	**0**	**1**	**1**	**1**
YARD SWITCHING & WORK TRAIN TOTAL								**111**	**3**	**114**	**8**	**90**	**98**	**212**

Appendix B-3

2014 Locomotive and DMU Fleet — Passenger Train Operations

OEM	Model	US EPA Tier Level	Engine	Cylinders	HP	Year of Manufac-ture	Year of Remanufac-ture	VIA Rail Canada	Non-VIA Rail Intercity Passengers	Commuter	Tourist & Excursion	Total
PASSENGER TRAIN LOCOMOTIVES												
GM/EMD	GP9		645	16V	1800	1967–1978				1	3	4
	FP40-PH2		645	16V	3000	1987–1989		52		14		66
	F40-PH2		645E3C	16V	3000	1976–1981						
	GP40		645	16V	3000	1970–1979					9	9
	GP40-2		645	16V	3000	1974–1976	1993			5		5
	F40-PHR		645	16V	3200	1940			2			2
	F59-PH		710	12V	3000	1988–1994				12		12
	F59-PHI		710	12V	3000	1995	2000–2001			16		16
GM/EMD Sub-Total								**52**	**2**	**48**	**12**	**114**
GE	LL162/162		251		990	1954–1966		21			11	32
	P42DC		7FDL16	16V	4250	2001						
GE Sub-Total								**21**	**0**	**0**	**11**	**32**
Motive Power	MP36PH-3C	Tier 1	645	16V	3600	2006				1		1
	MP40PH-3C	Tier 2	710	16V	4000	2007				59		59
Motive Power Sub-Total								**0**	**0**	**60**	**0**	**60**
Bombardier	MR90		Electric 25kv		1500	1994–1995						
	DMU		BR643		846	2001				3		3
	ALP 45DP	Tier 3	MITRAC TG	12V	3600	2009–2010						
Bombardier Sub-Total								**0**	**0**	**3**	**0**	**3**
R&H	28-ton				165	1950					1	1
CLC	44-ton		H44A3		400	1960					1	1
GE	70-ton		FWL-6T		600	1948					1	1
BUDD	RDC-4		Cummins		600	1956–1958		2				2
BUDD	RDC-1		Cummins		600	1956–1958		3				3
BUDD	RDC-2		Cummins		600	1956–1958		5				5
BUDD	RDC-3		Cummins		600	1956–1958						
ALCO	DL535		251		1200	1989					8	8
Other Sub-Total								**10**	**0**	**0**	**11**	**21**
Baldwin	B280					1920					2	2
Baldwin Steam Engines Sub-Total								**0**	**0**	**0**	**2**	**2**
DUBBS	DUBBS 440					1882					1	1
Other											2	2
Other Steam Engines Sub-Total								**0**	**0**	**0**	**3**	**3**
PASSENGER TRAIN LOCOMOTIVES SUB-TOTAL								**83**	**2**	**111**	**39**	**235**
YARD SWITCHING PASSENGER OPERATIONS												
GM/EMD	SW1000		645	8V	900	1966–1967		2				2
ALCO	DQS18		251		1800	1957					2	2
Yard Switching Passenger Operations Sub-Total								**2**	**0**	**0**	**2**	**4**
DMUS												
Bombardier	DMU		BR643		846	2001						
BUDD	RDC-1		DD6-110		520	1955						
	RDC-1		Cummins		600	1956–1958						
	RDC-2		Cummins		600	1956–1958						
DMUs Sub-Total								**0**	**0**	**0**	**0**	**0**
PASSENGER OPERATIONS TOTAL								**85**	**2**	**111**	**41**	**239**

Appendix C
Railways Operating in Tropospheric Ozone Management Areas

Railway Lines Included in Tropospheric Ozone Management Areas

TOMA Region No. 1: LOWER FRASER VALLEY, BRITISH COLUMBIA

CN

Division	Subdivision
Pacific	Squamish
	Yale

CP

Operations Service Area	Subdivision
Vancouver	Cascade
	Mission
	Page
	Westminster

BCR Properties	All
Southern Railway of BC Ltd	All
Great Canadian Railtour Company	Part
VIA Rail Canada	Part
West Coast Express	All

TOMA Region No. 3: SAINT JOHN AREA, NEW BRUNSWICK

CN

District	Subdivision
Champlain	Denison
	Sussex

TOMA Region No. 2: WINDSOR-QUÉBEC CITY CORRIDOR, ONTARIO AND QUÉBEC

CN

District — **Champlain**

Subdivisions

Becancour	Rouses Point	Bridge
Sorel	Deux-Montagnes	St. Hyacinthe
Drummondville	St. Laurent	Joliette
Valleyfield	Montréal	

District — **Great Lakes**

Subdivisions

Alexandria	Grimsby	Strathroy
Caso	Halton	Talbot
Chatham	Kingston	Uxbridge
Dundas	Oakville	Weston
Guelph	Paynes	York

CP

Operations Service Area — **Montréal**

Subdivisions — All

Operations Service Area — **Southern Ontario**

Subdivisions

Belleville	Hamilton	North Toronto
Canpa	MacTier	St. Thomas
Galt	Montrose	Waterloo
Windsor		

Agence métropolitaine de transport	All
Capital Railway	All
GO Transit	All
VIA Rail Canada	Part
CSX	All
Essex Terminal Railway	All
Goderich – Exeter Railway	All
Norfolk Southern	All
Ottawa Central	All
Ottawa Valley Railway	Part
Québec Gatineau	All
Southern Ontario Railway	All
St. Lawrence & Atlantic	All

Appendix D
Locomotive Emissions Standards in the United States

The **US Environmental Protection Agency (USEPA)** rulemaking promulgated in 1998 contains three levels of locomotive-specific emissions limits corresponding to the date of a locomotive's original manufacture — Tier 0, Tier 1, and Tier 2 (as listed below). The significance of the USEPA regulations for Canadian railways is that the new locomotives they traditionally acquire from the American locomotive original equipment manufacturers (OEM) are manufactured to meet the latest USEPA emissions limits. Hence, emissions in Canada are reduced as these new locomotives are acquired.

Compliance Schedule for USEPA Locomotive-Specific Emissions Limits (g/bhp-hr)

Duty Cycle	HC	CO	NO_x	PM
		Tier 0 (1973–2001)		
Line-haul	1.0	5.0	9.5	0.60
Switching	2.1	8.0	14.0	0.72
		Tier 1 (2002–2004)		
Line-haul	0.55	2.2	7.4	0.45
Switching	1.2	2.5	11.0	0.54
		Tier 2 (2005 and later)		
Line-haul	0.3	1.5	5.5	0.20
Switching	0.6	2.4	8.1	0.24
		Estimated Pre-Regulation (1997) Locomotive Emissions Rates		
Line-haul	0.5	1.5	13.5	0.34
Switching	1.1	2.4	19.8	0.41

Referencing the above-listed limits for locomotives operating in the US, the USEPA in 2008 put into force revisions that tighten the existing Tier 0 to Tier 2 standards. The revisions are now referred to as Tier 0+, Tier 1+, and Tier 2+ standards. As indicated in the tables below, the revised standards also take into account the year of original manufacture of the locomotive. Also, two, new, more stringent standards levels were introduced, designated as Tier 3 and Tier 4. The revised and new standards are to be phased in between 2011 and 2015 for locomotives as they become new (new in this case includes both when locomotives are originally manufactured and when remanufactured). Tier 3 standards have since been implemented for the 2013 reporting year. Elaboration on the USEPA locomotive emissions regulations can be viewed on the website:
http://www.ecfr.gov/cgi-bin/text-idx?SID=7b16072530ff072b457456ea25a641ff&mc=true&node=se40.36.1033_1101&rgn=div8.

Line-Haul Locomotive Emission Standards (g/bhp-hr)

Tier	*MY	Date	HC	CO	NO_x	PM
Tier 0+[a]	1973–1992	2011[c]	1.00	5.0	8.0	0.22
Tier 1+[a]	1993–2004[b]	2011[c]	0.55	2.2	7.4	0.22
Tier 2+[a]	2005–2011	2013[c]	0.30	1.5	5.5	0.10[d]
Tier 3[e]	2013–2014	2013	0.30	1.5	5.5	0.10
Tier 4	2015 or later	2015	0.14[f]	1.5	1.3[f]	0.03

a Tier 0+ to Tier 2+ line-haul locomotives must also meet switch standards of the same Tier.

b 1993–2001 locomotives that were not equipped with an intake air coolant system are subject to Tier 0+ rather than Tier 1+ standards.

c As early as 2008 if approved engine upgrade kits become available.

d 0.20 g/bhp-hr until January 1, 2013 (with some exceptions).

e Tier 3 line-haul locomotives must also meet Tier 2+ switching standards.

f Manufacturers may elect to meet a combined NO_x + HC standard of 1.4 g/bhp-hr.

* MY—Year of original manufacture

Switching Locomotive Emission Standards (g/bhp-hr)

Tier	*MY	Date	HC	CO	NO_x	PM
Tier 0+	1973–2001	2011[b]	2.10	8.0	11.8	0.26
Tier 1+[a]	2002–2004	2011[b]	1.20	2.5	11.0	0.26
Tier 2+[a]	2005–2010	2013[b]	0.60	2.4	8.1	0.13[c]
Tier 3	2011–2014	2011	0.60	2.4	5.0	0.10
Tier 4	2015 or later	2015	0.14[d]	2.4	1.3[d]	0.03

a Tier 1+ and Tier 2+ switching locomotives must also meet line-haul standards of the same Tier.

b As early as 2008 if approved engine upgrade kits become available.

c 0.24 g/bhp-hr until January 1, 2013 (with some exceptions).

d Manufacturers may elect to meet a combined NO_x + HC standard of 1.3 g/bhp-hr.

* MY—Year of original manufacture

Appendix E
Glossary of Terms

Terminology Pertaining to Railway Operations

Class I Railway: This is a class of railway within the legislative authority of the Parliament of Canada that realized gross revenues that exceed a threshold indexed to a base of $250 million annually in 1991 dollars for the provision of Canadian railway services. The three Canadian Class I railways are CN, CP and VIA Rail Canada.

Intermodal Service: The movement of trailers on flat cars (TOFC) or containers on flat cars (COFC) by rail and at least one other mode of transportation. Import and export containers generally are shipped via marine and rail. Domestic intermodal services usually involve the truck and rail modes.

Locomotive Active Fleet: This refers to the total number of all locomotives owned and on long-term lease, including units that are stored but available for use. Not counted in the active fleet are locomotives on short-term lease and those declared surplus or have been retired or scrapped.

Locomotive Power Ranges: Locomotives are categorized as high horsepower (having engines greater than 3,000 hp), medium horsepower (2,000 to 3,000 hp) or low horsepower (less than 2,000 hp).

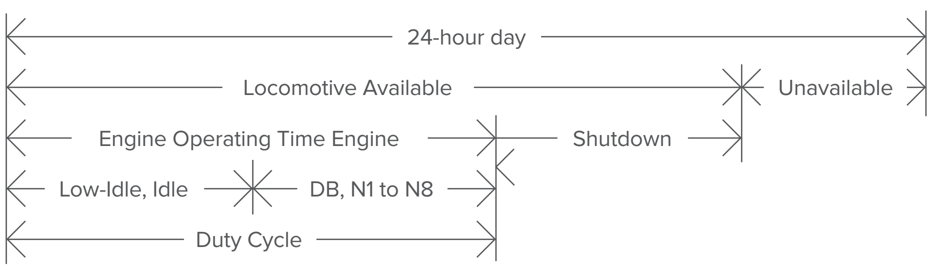
Locomotive Prime Movers: The diesel engine is the prime mover of choice for locomotives in operation on Canadian railways. Combustion takes place in a diesel engine by compressing the fuel and air mixture until auto-ignition occurs. It has found its niche as a result of its fuel-efficiency, reliability, ruggedness, and installation flexibility. Two diesel prime mover installation arrangements are currently in use:

Medium-speed diesel engine: This engine is installed in versions from 8 to 16 cylinders at up to 4,400 hp, with an operating speed of 800 to 1,100 rpm.

Multiple 'GenSet' diesel engines: This "stand alone" generating set (GenSet) is each powered by a 700 hp industrial diesel engine driving separate generators, which are linked electronically to produce up to 2,100 traction horsepower, with an operating speed up to 1,800 rpm. For switching locomotive applications, the advantage of this arrangement is that individual GenSet engines can be started or stopped according to the power required.

Locomotive Remanufacture: The "remanufacture" of a locomotive is a process in which all of the power assemblies of a locomotive engine are replaced with freshly manufactured (containing no previously used parts) or refurbished power assemblies or those inspected and qualified. Inspecting and qualifying previously used parts can be done in several ways, including such methods as cleaning, measuring physical dimensions for proper size and tolerance, and running performance tests to ensure that the parts are functioning properly and according to specifications. Refurbished power assemblies could include some combination of freshly manufactured parts, reconditioned parts from other previously used power assemblies, and reconditioned parts from the power assemblies that were replaced. In cases where all of the power assemblies are not replaced at a single time, a locomotive will be considered to be "remanufactured" (and therefore "new") if all power assemblies from the previously new engine had been replaced within a 5-year period. *(This definition for remanufactured locomotives is taken from the U.S. Federal Register Volume 63, No. 73 April 16, 1998 / Rules and Regulations for the Environmental Protection Agency (USEPA) 40 CFR Parts 85, 89 and 92 (Emission Standards for Locomotives and Locomotive Engines).*

Locomotive Utilization Profile: This is the breakdown of locomotive activity within a 24-hour day (based on yearly averages).



The elements in the above diagram constitute, respectively:

Locomotive Available: This is the time, expressed in % of a 24-hour day, that a locomotive could be used for operational service. Conversely, **Unavailable** is the percentage of the day that a locomotive is being serviced, repaired, remanufactured, or stored. Locomotive available time plus unavailable time equals 100%.

Engine Operating Time: This is the percentage of Locomotive Available time that the diesel engine is turned on. Conversely, **Engine Shutdown** is the percentage of Locomotive Available time that the diesel engine is turned off.

Idle: This is the % of the operating time that the engine is operating at **idle** or **low-idle** setting. It can be further segregated into Manned Idle (when an operating crew is on-board the locomotive) and Isolate (when the locomotive is unmanned).

Duty Cycle: This is the profile of the different locomotive power settings (Low-Idle, Idle, Dynamic Braking, or Notch levels 1 through 8) as percentages of Engine Operating Time.

Railway Productivity Units:

Gross Tonne-Kilometres (GTK): This term refers to the product of the total weight (in tonnes) of the trailing tonnage (both loaded and empty railcars) and the distance (in kilometres) the freight train travelled. It excludes the weight of locomotives pulling the trains. Units can also be expressed in gross ton-miles (GTM).

Revenue Tonne-Kilometres (RTK): This term refers to the product of the weight (in tonnes) of revenue commodities handled and the distance (in kilometres) transported. It excludes the tonne-kilometres involved in the movement of railway materials or any other non-revenue movement. The units can also be expressed in revenue ton-miles (RTM).

Passenger-Kilometres per Train-Kilometre: This term is a measure of intercity train efficiency, which is the average of all revenue passenger kilometres travelled divided by the average of all train kilometres operated.

Revenue Passenger-Kilometres (RPK): This term is the total of the number of revenue passengers multiplied by the distance (in kilometres) the passengers were transported. The units can also be expressed in revenue passenger-miles (RPM).

Terminology of Diesel Locomotive Emissions

Emission Factors (EFs): An emission factor is the average mass of a product of combustion emitted from a particular locomotive type for a specified amount of fuel consumed. The EF units are grams, or kilograms, of a specific emission product per litre of diesel fuel consumed (g/L).

Emissions of Criteria Air Contaminant (CAC): CAC emissions are by-products of the combustion of diesel fuel that impact on human health and the environment. The principal CAC emissions are:

Nitrogen Oxides (NO_x): These result from high combustion temperatures. The amount of NO_x emitted is a function of peak combustion temperature. NO_x reacts with hydrocarbons to form ground-level ozone in the presence of sunlight which contributes to smog formation.

Carbon Monoxide (CO): This toxic gas is a by-product of the incomplete combustion of fossil fuels. Relative to other prime movers, it is low in diesel engines.

Hydrocarbons (HC): These are the result of incomplete combustion of diesel fuel and lubricating oil.

Particulate Matter (PM): This is residue of combustion consisting of soot, hydrocarbon particles from partially burned fuel and lubricating oil and agglomerates of metallic ash and sulphates. It is known as primary PM. Increasing the combustion temperatures and duration can lower PM. It should be noted that NO_x and PM emissions are interdependent such that technologies that control NO_x (such as retarding injection timing) result in higher PM emissions, and conversely, technologies that control PM often result in increased NO_x emissions.

Sulphur Oxides (SO_x): These emissions are the result of burning fuels containing sulphur compounds. For LEM reporting, sulphur emissions are calculated as SO_2. These emissions can be reduced by using lower sulphur content diesel fuel. Reducing fuel sulphur content will also typically reduce emissions of sulphate-based PM.

Emissions of Greenhouse Gases (GHG)

In addition to CACs, GHG emissions are also under scrutiny due to their accumulation in the atmosphere and contribution to global warming. The GHG constituents produced by the combustion of diesel fuel are listed below:

Carbon Dioxide (CO_2): This gas is by far the largest by-product of combustion emitted from engines and is the principal GHG, which due to its accumulation in the atmosphere, is considered to be the main contributor to global warming. It has a Global Warming Potential of 1.0. CO_2 and water vapour are normal by-products of the combustion of fossil fuels.

Methane (CH_4): This is a colourless, odourless, and flammable gas, which is a by-product of incomplete diesel combustion. Relative to CO_2, it has a Global Warming Potential of 25.

Nitrous Oxide (N_2O): This is a colourless gas produced during combustion that has a Global Warming Potential of 298 (relative to CO_2).

The sum of the constituent GHGs expressed in terms of their equivalents to the Global Warming Potential of CO_2 is depicted as CO_{2e}. This is calculated by multiplying the volume of fuel consumed by the emission factors of each constituent, then, in turn, multiplying the product by the respective Global Warming Potential, and then summing them. See Appendix F for conversion values pertaining to diesel fuel combustion.

Emissions Metrics: The unit of measurement for the constituent emissions is grams per brake horsepower-hour (g/bhp-hr).

This is the amount (in grams) of a particular constituent emitted by a locomotive's diesel engine for a given amount of mechanical work (brake horsepower) over one hour for a specified duty cycle. This measurement allows a ready comparison of the relative cleanliness of two engines, regardless of their rated power.

RAC LEM Protocol: This is the collection of financial and statistical data from RAC members and the RAC database (where data is systematically stored for various RAC applications). Data from the RAC database, which is used in this report, include freight traffic revenue tonne kilometres and gross tonne kilometres, intermodal statistics, passenger traffic particulars, fuel consumption, average fuel sulphur content and locomotive inventory. The Class I railways' Annual Reports and Financial and Related Data submissions to Transport Canada also list much of this data.

Appendix F
Conversion Factors Related to Railway Emissions

Emission Factors (in grams or kilograms per litre of diesel fuel consumed)

Emission Factors for the Criteria Air Contaminants (NO_x, CO, HC, PM, SO_x) in g/L are found in Table 10.

Emission Factors for Sulphur Dioxide (SO_2) for 2014:

Freight Railways (15.0 ppm sulphur in fuel)	0.000025 kg / L

Emission Factors for Greenhouse Gases:

Carbon Dioxide	CO_2	2.69000 kg / L
Methane	CH_4	0.00015 kg / L
Nitrous Oxide	N_2O	0.00110 kg / L
Hydrofluorocarbons*	HFC	
Perfluorocarbons*	PFC	
Sulphur hexafluoride*	SF_6	
CO_{2e}† of all six GHGs		3.02155 kg / L
Global Warming Potential for	CO_2	1
Global Warming Potential for	CH_4	25
Global Warming Potential for	N_2O	298

* Not present in diesel fuel

† Sum of constituent Emissions Factors multiplied by their Global Warming Potentials

Conversion Factors Related to Railway Operations

Imperial gallons to litres	4.5461
US gallons to litres	3.7853
Litres to Imperial gallons	0.2200
Litres to US gallons	0.2642
Miles to kilometres	1.6093
Kilometres to miles	0.6214
Metric tonnes to tons (short)	1.1023
Tons (short) to metric tonnes	0.9072
Revenue ton-miles to Revenue tonne-kilometres	1.4599
Revenue tonne-kilometres to Revenue ton-miles	0.6850

Metrics Relating Railway Emissions and Operations

Emissions in this report are displayed both as an absolute amount and as 'intensity,' which is either a ratio that relates a specific emission to productivity or units of work performed. An example of emissions intensity metrics is the ratio NO_x per 1,000 RTK; which is the mass in kilograms of NO_x emitted per 1,000 revenue tonne-kilometres of freight hauled.

Appendix G
Abbreviations and Acronyms used in the Report

Abbreviations of Units of Measure

bhp	Brake horsepower
g	Gram
g/bhp-hr	Grams per brake horsepower hour
g/GTK	Grams per gross tonne-kilometre
g/L	Grams per litre
g/RTK	Grams per revenue tonne-kilometre
hr	Hour
kg/1,000 RTK	Kilograms per 1,000 revenue tonne-kilometres
km	Kilometre
kt	Kilotonne
L	Litre
L/hr	Litres/hour
lb	Pound
ppm	Parts per million

Abbreviations of Emissions and Related Parameters

CAC	Criteria Air Contaminant
CO_2	Carbon Dioxide
CO_{2e}	Carbon Dioxide equivalent of all six Greenhouse Gases
CO	Carbon Monoxide
EF	Emissions Factor
GHG	Greenhouse Gas
HC	Hydrocarbons
NO_x	Nitrogen Oxides
PM	Particulate Matter
SO_x	Sulphur Oxides
SO_2	Sulphur Dioxide
TOMA	Tropospheric Ozone Management Areas

Abbreviations used in Railway Operations

AESS	Automated Engine Start-Stop
APU	Auxiliary Power Unit
COFC	Container-on-Flat-Car
DB	Dynamic Brake
DMU	Diesel Multiple Unit
EMU	Electric Multiple Unit
GTK	Gross tonne-kilometres
LEM	Locomotive Emissions Monitoring
MOU	Memorandum of Understanding
N1, N2 ...	Notch 1, Notch 2... Throttle Power Settings
RDC	Rail Diesel Car
RPK	Revenue Passenger-Kilometres
RPM	Revenue Passenger-Miles
RTK	Revenue Tonne-Kilometres
RTM	Revenue Ton-Miles
TOFC	Trailer-on-Flat-Car
ULSD	Ultra-low Sulphur Diesel Fuel

Acronyms of Organizations

AAR	Association of American Railroads
ALCO	American Locomotive Company
CCME	Canadian Council of the Ministers of the Environment
CN	Canadian National Railway
CP	Canadian Pacific
ECCC	Environment and Climate Change Canada
ESDC	Engine Systems Development Centre of CAD Railway Industries Ltd.
GE	General Electric Transportation Systems
GM/EMD	General Motors Corporation Electro-Motive Division.
MLW	Montreal Locomotive Works
MPI	Motive Power Industries
NRE	National Railway Equipment Co.
OEM	Original Equipment Manufacturer
RAC	Railway Association of Canada
TC	Transport Canada
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
VIA	VIA Rail Canada