

ASSESSING THE IMPACT OF GROSS EMITTING VEHICLES

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1. Introduction

Road-side vehicle emission monitoring using a remote sensing device (RSD) technology is recognised internationally as a useful and cost-effective method of collecting large amounts of real-world vehicle emission data. Beginning in 2003 there have been five RSD monitoring campaigns in New Zealand with the last campaign being completed in Auckland, in 2015. At present, there are over 120,000 valid light duty vehicle emission measurements in the RSD database. The on-road emission measurements are linked to individual vehicles using the vehicle's licence plate and data contained in the Motor Vehicle Registry.

Previous remote sensing campaigns undertaken have confirmed the increasing age of New Zealand's on-road vehicle fleet, and identified that a small number of high "gross emitting vehicles" (GEVs) have a disproportionate impact on total fleet emissions. The profiling of GEVs enables the identification of possible interventions for these vehicles.

Integrating the information extracted from the RSD database on GEVs with the data contained in the motor vehicle register (including vehicle age, mileage, engine size, and emissions control), provides a powerful investigative tool. Aligning these two sources of data, allows us to advance our understanding of GEVs by identifying:

- How many GEVs there are likely to be in New Zealand?
- How long they stay in the on-road vehicle fleet?
- How far they travel each year?
- What is their impact on total emissions?

The New Zealand Transport Agency have funded a project which aims to provide answers to each of these questions and can be used to evaluate potential interventions (e.g., scrappage schemes, in-service vehicle testing) to reduce the impact of emissions from gross emitters. The Project considers harmful pollutants carbon monoxide (CO), hydrocarbons (HC), nitrogen monoxide (NO) and uvSmoke (a proxy for particulate emissions). This paper describes the development of a method used to assess the impacts of GEVs with respect to harmful pollutants. In this paper, CO is used as an example.

2. Definition of Gross Emitters

To date, when considering New Zealand's RSD data base, GEV's have been defined as those vehicles that have emissions above the 90th percentile value. Those vehicles that have emissions below the 90th percentile value are classified as typical emitting vehicles (TEVs).

In the method development stage of this project GEVs have been defined as the top 3 % emitting vehicles. However, the definition of GEVs may be refined as the project progresses toward the end goals. Figure 1 compares CO emissions from GEVs and TEVs as measured in the 2015 RSD data set.

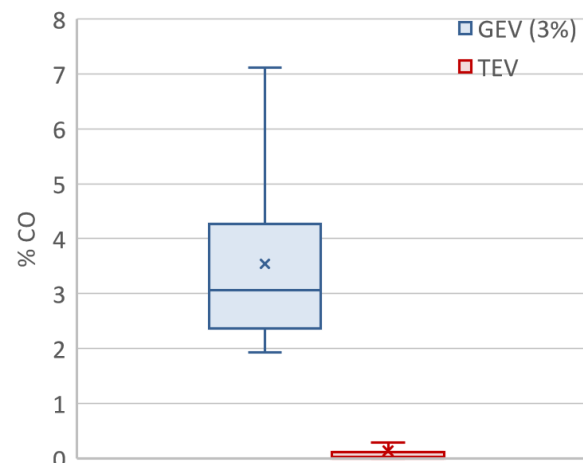


Figure 1. Box and whisker plot of CO emissions from GEVs and TEVs (2015 RSD data set).

3. Method for Assessing the Impact of GEVs

To quantify the impacts of CO discharged by GEVs and TEVs the following steps are followed:

- 1) Obtain CO concentration measurement from 2015 RSD data.
- 2) Convert the CO concentration measurement to a g/kg fuel emission factor.
- 3) Convert the CO g/kg emission factor into a g/km emission factor by applying the relevant fuel consumption rate.

- 4) Calculate the total amount of CO discharged by multiplying the CO g/km emission factor by the distance travelled by the vehicle.

A flow chart showing the process used to quantify the impacts of CO discharged by GEVs is shown in Figure 2.

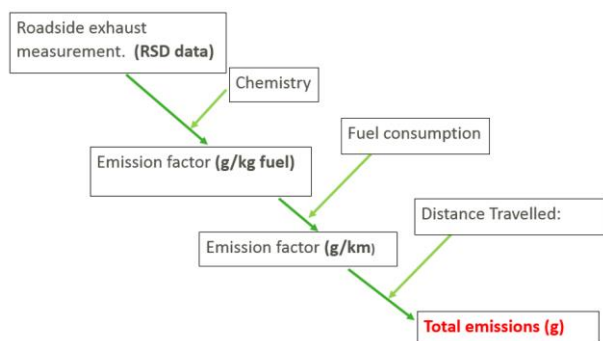


Figure 2. Flow chart - RSD measurement to total GEV/TEV emissions.

4. Example Results for Assessing the impact of GEVs

Table 1 presents example results showing the results of each step in the process of calculating the total amount of CO discharged from the RSD measurements of TEVs and GEVs. In the method development stage of this project it is assumed that both GEV and TEV have equivalent fuel consumption rates. It is acknowledged that in reality this is unlikely to be the case and this issue will be addressed in detail as the project progresses.

Table 1. Example results - RSD measurement for total TEV and GEV emissions.

Vehicle Type	TEVs	GEVs
Vehicle type RSD CO measurement (%)	0.02	2
CO emission factor (g/kg fuel)	3	263
Fuel consumption* (l/100 km)	8.5	8.5
CO emission factor (g/km)	0.2	16.8
Annual VKT (km)	10,000	5,000
Total CO discharged per year (kg)	2	84

Figure 3 compares the total annual CO emissions from a TEV and a GEV.

The benefit (reduction in CO emissions) of replacing a GEV with a TEV can be estimated by subtracting the total annual CO emissions of a TEV from the total annual CO emissions of a GEV. In this example, the GEV emits the equivalent of 108 TEVs on an annual basis.

The methods detailed, and proof of concept results presented in this paper demonstrate that RSD data and supporting information can be used to quantify the impact of harmful pollutant emissions from GEVs and the benefit (pollutant reduction) of replacing GEVs with TEVs. Preliminary Results show the potential benefits of replacing GEVs with TEVs are very large reductions of emissions of CO.

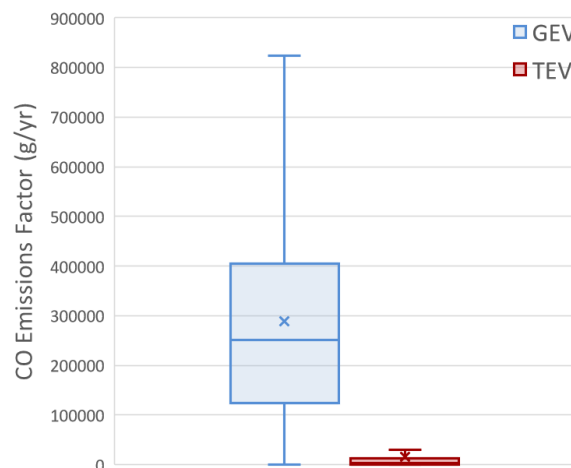


Figure 3. Comparison of total annual CO emissions from a TEV and a GEV.

5. Next Steps

The next stage of the project will utilise the information and techniques described in this paper to investigate the following issues:

1. Prevalence of GEVs.
 - a. What proportion of the fleet are potentially gross emitters?
 - b. How long do GEVs remain in the fleet?
 - c. What distance do gross emitters typically travel in a year?
 - d. What is the regional distribution (geographical spread) of GEVs?
2. Determine the potential impact of gross emitters compared to the emissions from the wider light duty vehicle fleet.
3. Estimate the emission reduction benefit of removing gross-emitting vehicles from the fleet.

The outcomes of this investigation will be presented in a New Zealand Transport Agency research report and published late 2019 on <https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/research-and-information/research-reports/>.

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