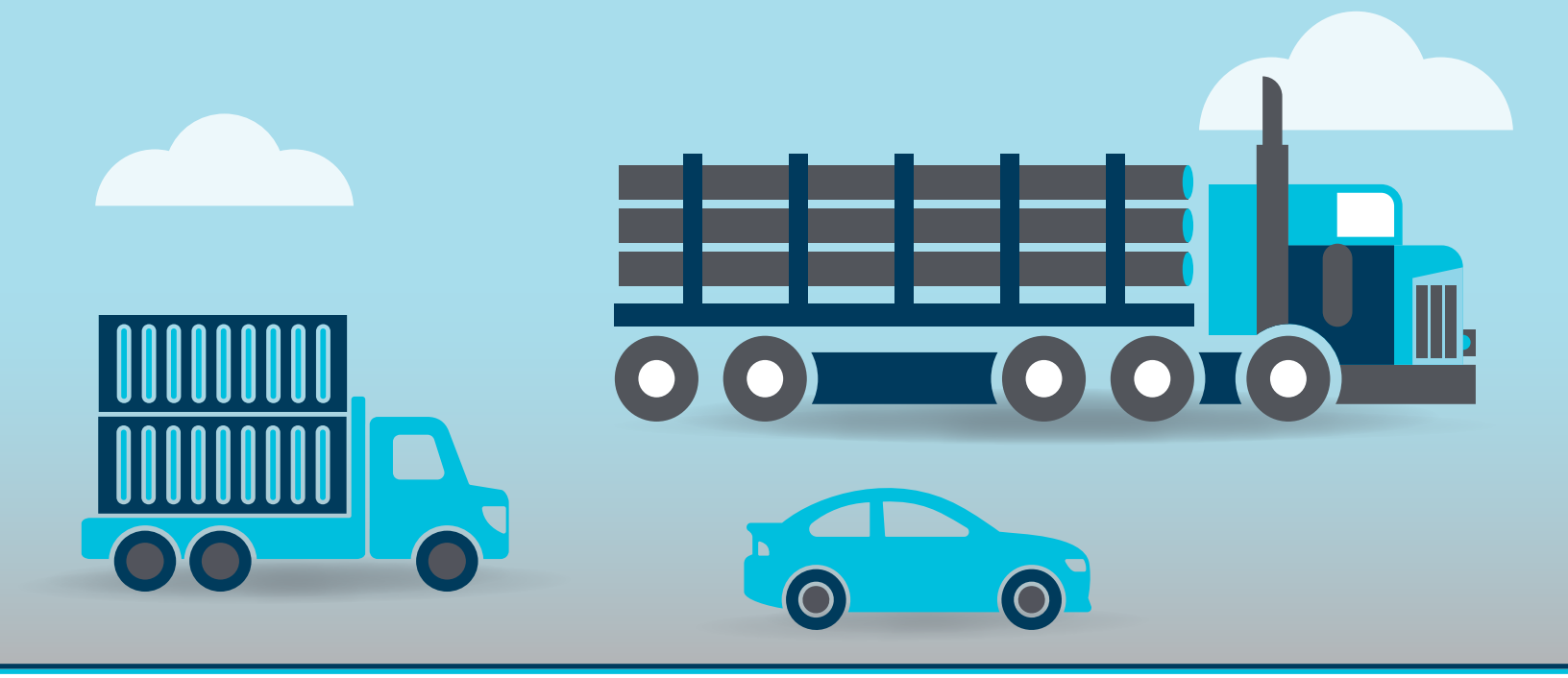

Understanding Vehicle Emission Control System Tampering in Alberta

Project Report

Clean Air Strategic Alliance

July 2026

About the Clean Air Strategic Alliance

The Clean Air Strategic Alliance (CASA) is a registered not-for-profit Society under the Alberta Societies Act and its operations were supported by a grant provided by Alberta Environment and Protected Areas.

CASA is composed of representatives from interested and affected industries, governments, non-government organizations, and Samson Cree Nation. All members have one or more of the following interests: an economic stake in air quality management, responsibility for human health and/or air quality, and representing environmental interests likely to be directly affected by air quality. CASA contributes to strategic air quality management for Alberta by identifying priority issues and developing action plans, evidence-based recommendations, information, and tools that weigh environmental, health, and economic consequences and expected outcomes. CASA's 32-year commitment to using a consensus decision making process to achieve consensus whenever possible has created a unique and trusted forum for air issue discussions and resolutions. We recognize the value in striving for consensus, even if it is not always reached.

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Acknowledgements

CASA would like to acknowledge the Canadian Fuels Association and Alberta Motor Transport Association who went above and beyond in helping the team complete their work. Canadian Fuels Association provided a generous cash donation that was critical to the team's success and was an important leader when project team needed to adapt to evolving circumstances. Alberta Motor Transport Association demonstrated their willingness and capability to adapt to the needs of the project team on short timelines to deliver a report that helped the team achieve objectives that would have otherwise been out of reach. The dedication and contributions of Canadian Fuels Association, Alberta Motor Transportation Association, and all the project team members to completing this work and supporting improvement of air quality management through this project is admirable and was greatly appreciated.

Acronyms

CASA	Clean Air Strategic Alliance
DOC	Diesel oxidation catalyst
DPF	Diesel particulate filter
EPA	Alberta Environment and Protected Areas
EGR	Exhaust gas recirculation
GoA	Government of Alberta
HDDV	Heavy-duty diesel vehicle
HDV	Heavy-duty vehicle
LDGV	Light-duty gasoline vehicle
LDV	Light-duty vehicle
NO_x	Nitrogen Oxides
OBD	On-board diagnostics
ROVER	Roadside Optical Vehicle Emissions Reporter
SCR	Selective catalytic reduction
U.S. EPA	United States Environmental Protection Agency

1. Background

Alberta strives to manage air emissions to achieve air quality standards and objectives. Alberta's Renewed Clean Air Strategy (2012) recognizes the need for management actions on non-point sources of air emissions, such as transportation. The transportation sector is one of the largest emission sources of nitrogen oxides in the province. In addition to emitting nitrogen oxides, vehicle emissions also contain other air contaminants that can be associated with health impacts, such as particulate matter and volatile organic compounds.

While there is no explicit prohibition of vehicle emission control system tampering for in-use vehicles at a federal level in Canada, it is prohibited in most1 Canadian provinces. At the time of writing, the Government of Alberta does not have legislation, regulations, or policies aimed at preventing tampering or prohibiting the manufacture, sale, or installation of emission control defeat devices. While Alberta's Commercial Vehicle Inspection program requires safety inspections for vehicles exceeding 11,794 kilograms, this inspection does not include emission control equipment. Alberta's *Traffic Safety Act* also does not prohibit tampering with vehicle emission control systems. Vehicles that do not have functioning emission control systems may emit many times more emissions than vehicles that do.

For more information on anti-tampering legislation in Canada, see Appendix F.

1.1 CASA's Roadside Optical Vehicle Emissions Reporter Project Series

In 1998, CASA began the Roadside Optical Vehicle Emissions Reporter (ROVER) project, and since then there have been two more iterations with ROVER II in 2006 and ROVER III in 2024. These projects collected emissions data from on-road in-use vehicles in Alberta using remote sensing technology to develop a profile of provincial vehicle emissions characteristics. The first two projects focused on light-duty vehicles (LDVs), where the last project was focused on heavy-duty vehicles, which was a gap from the earlier studies.

Throughout the series of projects, the remote sensing technology advanced and enabled collection of a greater range of data. In ROVER I, the only parameter tested was carbon monoxide. ROVER II added nitric oxide, particulate matter, hydrocarbons, and carbon dioxide. Then in ROVER III, the data gathered included the parameters from ROVER I and II along with volatile organic compounds and nitrogen dioxide. Beginning with ROVER II, the project teams were also able to access registration information for vehicles through agreements with Service Alberta and Red Tape Reduction (Service Alberta at the time the agreements were signed)2, allowing for much more detailed vehicle emissions profiles.

The results of all three projects showed a similar trend in that a relatively small proportion of vehicles were responsible for most of the recorded emissions. Each project made a series of recommendations aimed at reducing emissions from the small proportion of high emitters, which ranged from recommendations for anti-tampering legislation, scrappage programs to incentivize owners to retire older vehicles, and repeated ROVER projects to continue monitoring transportation emissions through time.

1 Table 1 Anti-Tampering Legislation in Each Canadian Province or Territory (Ordered by Population) from Heavy-duty emissions control tampering in Canada - International Council on Clean Transportation

2 CASA's agreement with Service Alberta included provisions to ensure personally identifiable information was protected while allowing emissions data to be paired with vehicle characteristics.

The ROVER III project found that up to 30% of the heavy-duty diesel-fuelled vehicles and 10% of the light-duty gasoline-fuelled vehicles measured had emissions that were at least 10 times higher than emissions benchmarks. Emissions that are much higher than expected indicate the vehicle's emission control system is malfunctioning or has been tampered with. As the ROVER III project did not include vehicle inspections, the project team identified the magnitude and sources of vehicle emission control system tampering and the reliability of emission control technology in Alberta's climate as information gaps. They made the following recommendation to help address those gaps:

> *"CASA to establish an expedited project team to undertake a comprehensive study to a) identify the magnitude and sources of vehicle tampering, including gathering information about manufacturers, sellers, and installers of defeat devices, and b) understanding the reliability of installed emissions control devices."*

The recommendation led to the initiation of the Understanding Vehicle Emission Control System Tampering in Alberta Project.

2. About this Project

The project had a clearly defined goal, scope, and objectives which are detailed in this section. This information is taken from the project terms of reference, which can be found in Appendix B.

2.1 Strategic Intent (Goal)

The project's strategic intent was to complete a comprehensive study that:

- identifies the magnitude and sources of vehicle emission control system tampering, including information gathered about manufacturers, sellers, and installers of defeat devices
- includes an assessment of the economic impact of vehicle emission control system tampering
- improves understanding of the reliability of factory-installed emission control devices

2.2 Scope

The scope of work was to include:

- both light- and heavy-duty vehicles
- compilation of data and information from existing sources on vehicle emission control system tampering and its economic impacts (e.g., operational cost savings for vehicle fleet owners, increased healthcare costs due to excess emissions, and others), and reliability of factory-installed emission control systems that are applicable to Alberta's environmental, economic, and regulatory contexts
- collection of new data and information on vehicle emission control system tampering, economic impacts, and reliability via stakeholder engagement (e.g., surveys, interviews)
- advice on future data collection to address data gaps that could not be addressed through this project due to time or resource constraints
- advice to support the Government of Alberta in their identification of actions or programs to reduce vehicle emission control system tampering that take Alberta's context into consideration

Direct collection of vehicle emissions data or conducting vehicle inspections were outside the scope of the project. The project also aimed to provide advice to support air quality management, but formal regulatory or policy recommendations were also out of scope.

2.3 Objectives

Project objectives and their supporting key tasks are described below.

Objective 1: A common understanding of vehicle emission control systems, tampering, and maintenance requirements

The project team will gain a common understanding of the types of vehicle emission control systems for light- and heavy-duty vehicles, methods of tampering with those emission controls, and the maintenance practices required to maintain their function.

Key Task 1: Define key terms and concepts and how they will be used throughout the project, including but not limited to:

- heavy-duty vehicles vs. light-duty vehicles and regulatory requirements that impact each (e.g., weight thresholds for commercial vehicle inspections)
- vehicle emission control system tampering
- vehicle emission control system malfunction
- vehicle emission control system manufacturer defect

Key Task 2: Review existing reference material on the following topics, and others as appropriate:

- types of vehicle emission control systems and their functions
- common methods of defeating or tampering with vehicle emission control systems
- methods and tools used to detect vehicle emission control system tampering in Alberta and other jurisdictions
- manufacturer recommended maintenance schedules for vehicle emission control systems

Objective 2: Compilation of information on vehicle emission control system tampering and reliability in Alberta

Review existing sources of information on the prevalence and sources of emission control system tampering, including sellers and manufacturers of defeat devices, and the reliability of factory-installed vehicle emission control systems in Alberta's climate.

Key Task 1: Complete a literature review on vehicle emission control system tampering that includes but is not limited to the following topics:

- legislation or regulations in other jurisdictions that prohibit vehicle emission control system tampering, and maintenance and inspection programs that include vehicle emission control systems
- costs associated with maintenance and repairs of vehicle emission control systems, and the perceived and real economic impacts of tampering
- availability of vehicle emission control system tampering services in Alberta and the frequency that those services are performed
- manufacturers and sellers of defeat devices that are available in Alberta
- enforcement measures taken by the U.S. EPA against Alberta-based companies for providing defeat devices or services, and a comparison of the U.S. and Alberta regulatory environments related to vehicle emission control system tampering
- the extent of vehicle emission control system tampering in light-duty vs. heavy-duty sectors, and the rates of tampering for generally higher-emitting vehicle fleets or sectors (e.g., dump trucks)
- emissions information for Alberta-registered vehicles travelling to other jurisdictions (e.g., other provinces or countries which have regulations prohibiting tampering)
- rates of catalytic converter theft in Alberta and statistics on their replacement (e.g., insurance claims for catalytic converter replacement)

Key Task 2: Complete a literature review on the reliability of factory-installed vehicle emission controls that includes but is not limited to the following topics:

- rates of manufacturer defects in factory-installed vehicle emission control systems
- impacts of Alberta's climate on the performance of vehicle emission control systems
- comparison of ambient air monitoring data near roadways in Alberta or other jurisdictions under different temperature and weather conditions

Objective 3: Identification of remaining information gaps and methods to address them

After completion of objectives 1 and 2, assess the information that has been collected and determine any remaining information gaps and how those information gaps might be addressed.

Key Task 1A: Develop a scope of work for project team members or a consultant to gather additional information to help address any identified information gaps related to vehicle emission control system tampering based on available resources and information sources. Data gathering could include:

- online, phone, or in-person surveys of mechanics who provide vehicle emission control system tampering services to determine the services they offer, the frequency they perform those services, and repairs for vehicles after catalytic converter theft
- surveys of vehicle owners and operators on maintenance, reliability, and tampering of emission control systems administered through transportation associations (e.g., Alberta Motor Transport Association, Alberta Motor Association)
- information on statistics of tampered vehicles in the market (e.g., information from vehicle sellers such as auction companies or dealerships on inspections completed before sale and whether emissions control systems are noted as part of that process)
- workshops or other engagement with people in the trucking industry who are willing to speak about their motivations for vehicle emission control system tampering and the impact it has on their operations

- workshops or other engagement with subject matter experts and researchers in Alberta and other jurisdictions who have information on the sources, impacts, and motivations for vehicle emission control tampering.
- information from provincial police services on rates of catalytic converter theft and from insurance companies on claims to replace stolen catalytic converters.

Key Task 1B: Develop a scope of work for project team members or a consultant to gather additional information to help address any identified information gaps on the reliability of factory-installed vehicle emission control systems based on available resources and information sources. Data gathering could include:

- online, phone, or in-person surveys of mechanics about vehicle emission control system reliability and repair options
- information from ongoing studies assessing the performance of vehicle emission control systems under different weather conditions

Specific data-gathering actions will depend on which gaps have been identified.

Objective 4: Collect additional information as identified in objective 3

Undertake the scope of work identified in objective 3, either through the resources available through the project team members and their organizations, or through a contract with a consultant.

Key Task 1A: Complete a Request for Proposal process to identify an appropriate consultant to complete the scope of work developed in objective 3, with the following potential deliverables:

- survey or engagement session results
- a report detailing the information gathered by the consultant and any advice they have for information gaps they could not address, or longer-term information gathering methods that would yield more robust data

Key Task 1B: If the project team decides to proceed without a consultant, project team members will work with CASA staff to implement as much of the scope of work as possible, document the process and results, and provide advice for filling data gaps that could not be addressed with the resources of the project team.

Objective 5: Summary of results and advice for transportation emission management

Information from all other objectives should be compiled into a final project team report for consideration by the CASA board.

Key Task 1: Write a final report that contains the following information:

- background information on vehicle emission control systems, types and methods of tampering, and tampering detection methods (objective 1)
- information on the reliability of factory-installed emission control systems (objective 2 and 3)
- information on the prevalence and sources of vehicle emission control system tampering in Alberta (objective 2 and 3)
- the information gaps identified, methods used to gather additional information, and the results of that process (objective 3 and 4)

Key Task 2: From the information gathered, provide advice on what actions or programs could be implemented to manage emissions from the transportation sector in Alberta.

Key Task 3: From the information gathered, provide advice on methods of gathering additional relevant information that could not be obtained during the project due to time or resource constraints.

Objective 6: Communications plan

Develop and implement a strategy and action plan for communicating the work of the project team. This objective will need to be considered at project outset and on an ongoing basis as the work progresses.

Key Task 1: Develop a communication plan that includes the following elements:

- the information to be communicated, including key messages on vehicle emission control system tampering and reliability in Alberta
- the appropriate audience, how it will be communicated, and when
- existing communication channels that can be leveraged to share project information
- communication tools such as message maps, factsheets, or presentations
- messaging on the outcomes of each project objective for project team members to communicate relevant information to their constituents

2.4 Deliverables

The project deliverables were planned to be as follows:

- a consultant report detailing the results of their jurisdictional scan and stakeholder engagement activities
- any collected data sets, including survey results
- a project team report summarizing the information collected and containing advice to support air quality management in Alberta
- a communications plan outlining the project team's approach to communicating about the work and its outcomes

Any raw data, particularly that contain personally identifiable information (e.g., survey results) were to be kept confidential, with the reports containing only aggregated information to protect the anonymity of the people engaged through the project.

2.5 Budget & Timeline

The project began in mid-2025 and was expected to be complete by December 2026. The project budget was estimated at $91,500 and is detailed in Table 1. Costs were estimated based on approximately 10 meetings per year for two years, where 80% of meetings were held remotely and 20% were in person. Core funds were provided by CASA from the organization's operational budget, and project costs were to be fundraised by the project team.

Table 1 Estimated Project Budget

Item	Estimated Cost
Core Funds	
Stakeholder Support & Travel/Accommodation	$25,000
Hosting	$1,500
Communications (final report preparation)	$5,000
Total Estimated Core Funds	$31,500
Project Costs	
Consultant to complete objective 4 (address data gaps)	$50,000
Stakeholder engagement for objective 4 (workshop, surveys, interviews)	$5,000
Communication tools	$5,000
Total Estimated Project Costs	$60,000

3. Project Status

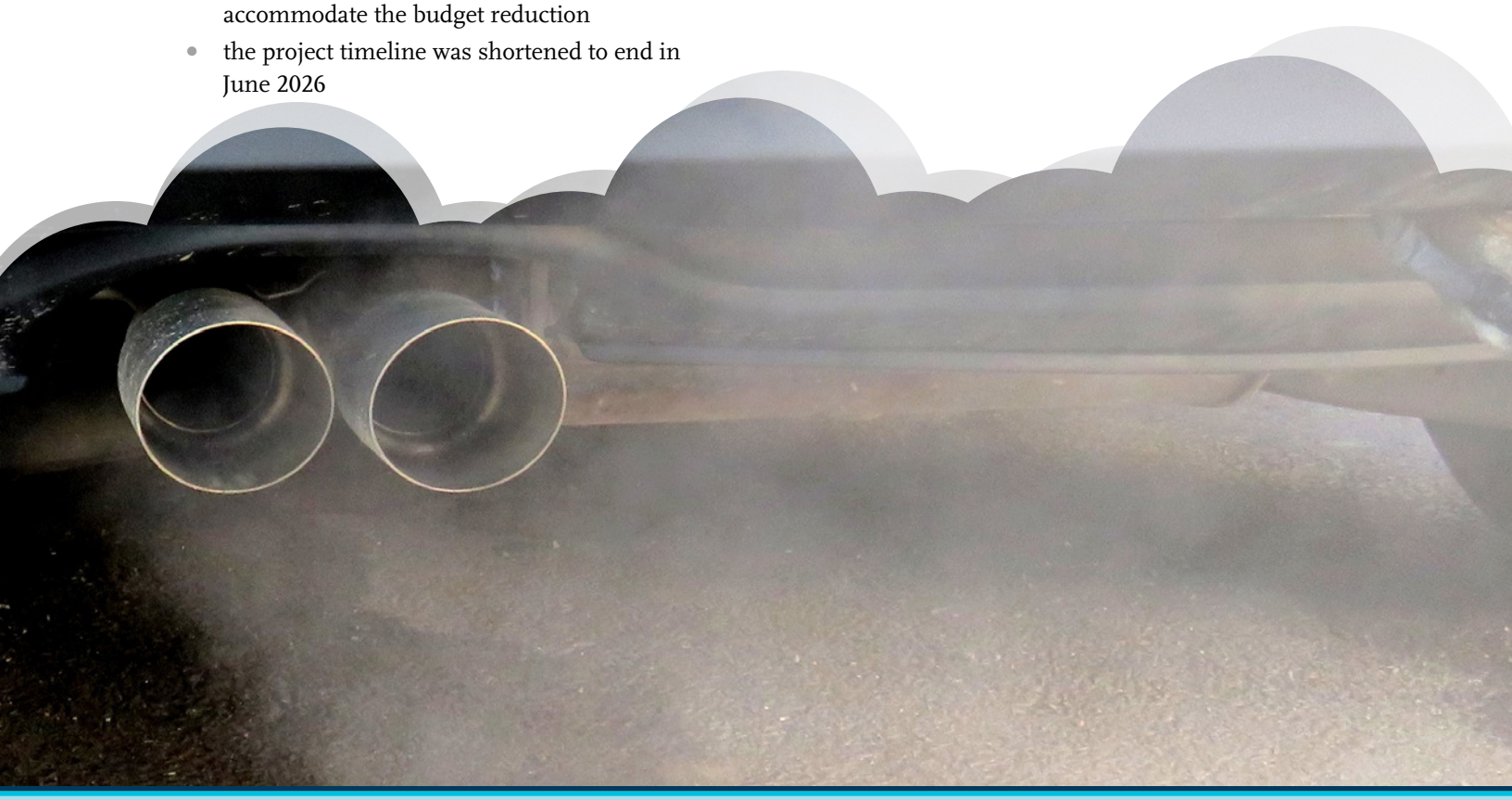
During the course of the project, a change in CASA's available operational funding necessitated a shift in project approach to accommodate reduced resources and a shortened timeline. The remaining sections of the report document the work that the project team was able to complete.

3.1 Overview of team's change in approach

The original project budget called for $60,000 to hire a consultant and the project end date was December 2026. The team had sourced $20,000 through a donation from the Canadian Fuels Association and was actively fundraising for the remaining project funds. The workplan and budget were revised in March in response to CASA's changed circumstances and the revisions included:

- the consultant budget was reduced from $60,000 to $20,000 based on what was immediately available for the team's use from Canadian Fuels Association
- the consultant's scope of work for Objective 4: Collect Additional Information was narrowed to accommodate the budget reduction
- the project timeline was shortened to end in June 2026

These changes were largely accommodated through a change in approach for Objective 4, which is detailed in Section 7.0, and omission of Objective 6 (communications plan). The project team did not develop a communications plan as CASA's operational timeline would not allow for communication of the project work beyond distributing the final materials to CASA members and supporters and publishing it to the CASA website.



4. Objective 1 – Common Understanding

A key initial step for all CASA projects is ensuring that project team members have a common understanding of the topic at hand. For this project, that included seeking information presentations on relevant topics and researching frequently used terminology and deciding how these will be used for the project work.

4.1 Summary of information presentations received by the project team

In July 2025 the project team held a full-day in-person meeting in Edmonton that served both as a project team member orientation to CASA procedures and processes, and an information session. The information session provided background information on the ROVER III project, which was the predecessor of the current project, modelling work completed by the International Council on Clean Transportation (ICCT) using the ROVER III data, and vehicle emission control systems and methods used to tamper or defeat them. These presentations are summarized below and included in Appendix C.

Roadside Optical Vehicle Emissions Reporter (ROVER) III

The project team received information on the approach and methodology used in the ROVER III project, along with details on site selection, the agreement in place with Service Alberta (now Service Alberta and Red Tape Reduction) that allowed CASA to access vehicle registration information, and a summary of the results for both heavy- and light-duty vehicles. More information on the ROVER series of projects can be found in Section 1.1.

Vehicle Emission Control Systems and Tampering

This presentation summarized some foundational information on vehicles, including the products of fossil fuel combustion, emission regulations in different jurisdictions, how emissions are tested, and how technology has advanced over time to lower emissions through vehicle emission control technologies.

In addition to the available technologies to reduce vehicle emissions, the presentation also covered the ways which people circumvent those technologies, including physical removal of the emission control components from the vehicles and software bypasses.

Real World NO_x Emissions and Associated Health Impacts from Tampered or Malfunctioning Vehicles in Alberta

Following the completion of the ROVER III project, ICCT was provided the anonymized ROVER III dataset as part of CASA's agreement with Service Alberta (now Service Alberta and Red Tape Reduction). ICCT then used the data to estimate the rates of tampered or malfunctioning heavy-duty vehicles and modelled the potential impacts of the excess pollution on public health.

The presentation summarized the methodologies and results of the work, which is available in the report[3] released by ICCT in 2025.

4.2 Important concepts & definitions

The project team identified the key concepts and terms that would be used throughout the project and agreed on the definitions below.

Heavy Duty Vehicle (HDV)

The Government of Alberta's Vehicle Inspection Regulation defines commercial vehicles as any vehicle greater than 11,794kg when operating intra-provincially, and >4,500kg when operating extra-provincially. The project team adopted the 11,794kg threshold for HDVs.

In common language, HDVs are often defined by the presence of air brakes. When communicating with the public or vehicle owners, care is needed to ensure there is an understanding of what is meant by "HDV."

Diesel-fuelled HDVs are the primary focus of this project and differentiating based on fuel type as well as size is important.

3 Real-world NO_X emissions and health impacts from tampered and malfunctioning heavy-duty vehicles in Alberta, Canada - International Council on Clean Transportation

Light Duty Vehicle

Light-duty vehicles are generally those that weigh approximately 4,500kg or less. For the purposes of this project, all vehicles less than the 11,794kg threshold for heavy-duty vehicles will be considered light-duty vehicles. They are typically cars, mini-vans, pickup trucks, and SUVs that are gasoline-fuelled, but light-duty vehicles can also be diesel-fueled.

On-Road Vehicle

A vehicle equipped with design features that enable it to be normally operated and to mix with regular traffic on public roads, including highways, streets, bridges, etc.

Off-Road Vehicle

A vehicle designed primarily for recreational use or for the transportation of property or equipment exclusively on undeveloped road rights of way, marshland, open country, or other unprepared surfaces.

Vehicle Emission Control System or Devices

A network of components designed to reduce pollutants released into the atmosphere from a vehicle's exhaust. These systems work to minimize the release of pollutants like hydrocarbons, carbon monoxide, and nitrogen oxides, which are byproducts of the combustion process. Common types of emission controls include diesel particulate filters (DPF) and selective catalytic reduction (SCR).

Diesel Particulate Filter (DPF)

A device installed in the exhaust system of diesel vehicles to reduce harmful particulate matter (PM) emissions generated during diesel engine combustion. Exhaust passes through the DPF, and the porous structure of the filter traps the PM. Over time, the filter can become clogged, and the DPF undergoes a process called regeneration where the soot is burned off. This occurs either passively (through exhaust heat) or actively (by injecting extra fuel to increase exhaust temperature). Cleaning is also required as part of periodic maintenance. See the table below for an example of DPF maintenance requirements.

Table 2 Diesel Particulate Filter Maintenance Frequency

Engine Usage Type	Passive Regeneration Frequency	Active Regeneration Frequency	Manual Cleaning Interval (Recommended)
Long-haul highway driving	Frequent (occurs naturally at highway speeds)	Occasional (as needed by the engine control module)	Every 160,000-240,000km or 1,500-2,000 hours
Regional/Short haul	Moderate (varies based on load and speed)	More frequent (due to mixed driving conditions)	Every 120,000-160,000km or 1,200-1,800 hours
Urban stop-and-go	Rare (insufficient heat generation)	Frequent (due to low-speed operation)	Every 80,000-120,000km or 800-1,200 hours
Construction/ Agricultural equipment	Rare (low speed, high idle operations)	Very frequent (due to soot buildup)	Every 6 months or 600-1,000 hours
Heavy-duty industrial vehicles	Rare (constant low speed operations)	Very frequent (requires manual intervention)	Every 3-6 months or 400-800 hours

Diesel Oxidation Catalyst

A diesel oxidation catalyst (DOC) is an after-treatment component designed specifically for diesel engines. Its purpose is to convert harmful pollutants like carbon monoxide, hydrocarbons and particulate matter into less harmful substances. It is particularly effective in converting carbon monoxide into carbon dioxide and water.

Exhaust Gas Recirculation Systems

An exhaust gas recirculation system (EGR) is a device used for pollution control that recirculates a portion of the exhaust from an engine back into the engine's cylinders to reduce emissions of nitrogen oxides (NO_x). The peak combustion temperature is the primary cause of NO_x emissions so by mixing the exhaust gas with fresh air, the peak combustion temperature will be lowered, which results in a reduction of NO_x emissions. The EGR valve is responsible for controlling the flow of the exhaust into the system so that it can be cooled.

Selective Catalytic Reduction (SCR)

Emission control technology that is primarily used in diesel engines and significantly reduces nitrogen oxides (NO_x) emissions. It works by injecting a reductant, such as Diesel Exhaust Fluid (DEF), into the exhaust stream, which then reacts with the NO_x in the presence of a catalyst (typically vanadium or zeolite) to produce nitrogen and water or carbon dioxide.

SCRs require DEF to be refilled, maintenance to manage the catalyst, and tuning to ensure an efficient NO_x reduction and reduction in ammonia slip (ammonia passing through the SCR unreacted). Temperature is also a limitation of SCR; maintaining exhaust gas temperature within an optimal window is needed for maximizing NO_x removal, which can be challenging in cold climates.

Maintenance of SCR systems includes the following:

- regular inspections of the SCR system and replacing components such as filters and sensors when needed
- monitoring diesel exhaust fluid levels and quality
- monitoring catalyst efficiency

The frequency of SCR maintenance is affected by operating conditions and engine size and type. For example, for light-duty diesel-fuelled vehicles, DEF replenishment occurs around the time of a recommended oil change, but for heavy-duty vehicles the refill interval will depend on hours used, miles traveled, load factors, and other considerations.

Vehicle Emission Control System Tampering

Tampering, as defined by the Canadian Council of Ministers of the Environment[4], includes:

- removing, bypassing, defeating, or rendering inoperative any emission control system or device installed in or on a vehicle or engine, including software designed to monitor or control vehicle or engine emissions, or
- modifying the vehicle or engine in any way that results in increased emissions from the level to which it was originally designed or certified by the manufacturer or importer of the vehicle or engine.

This definition was also used in the ROVER III project and was continued to this work for consistency across the project series.

4 https://ccme.ca/en/res/tamperingdescription_e.pdf

Tampering Detection Methods

Vehicle emission control tampering can be detected in several ways:

- physical examination of emission control hardware and related components
- review of on-board diagnostics (OBD) data to look for evidence that emission control hardware or related components were disabled, or that OBD functions associated with these systems were disabled or bypassed
- emissions testing to identify abnormally high emissions based on vehicle type and model year (e.g., remote sensing, portable emission measurement system)

When vehicles are identified as potentially tampered based on their emissions, further investigation is needed to determine if the vehicle has been tampered or if the emission control system is malfunctioning or underperforming for another reason (e.g., manufacturer defect, malfunction due to lack of maintenance).

Vehicle Emission Control System Malfunction

The failure of an emission control system or device to function in a normal or satisfactory manner. Malfunctions can be caused by components failing over time with use, or because maintenance requirements have not been met (e.g., filters are clogged, or catalysts have not been replaced).

Vehicle Emission Control System Manufacturer Defect

A manufacturer's defect is a problem with the emission control system that is not caused by components failing through use or by user error. They can include:

- a flaw in the design of the emission control system or device that causes it to malfunction
- the system or device is not made according to its design
- the system or device does not come with proper warnings or instructions

5. Objective 2 – Compilation of Information

This section summarizes the outcomes of Objective 2: Compilation of Information on Vehicle Emission Control System Tampering and Reliability in Alberta. The project team was tasked with reviewing existing sources of information on the prevalence and sources of emission control system tampering, including sellers and manufacturers of defeat devices, and the reliability of factory-installed vehicle emission control systems in Alberta's climate. Information was gathered from the following sources:

- keyword searches in online search engines
- review of transportation-related news sites, blogs, and forums
- engaging contacts in the transportation sector, including the U.S. Environmental Protection Agency
- review of related CASA projects and supporting documentation (e.g., Impacts of Reduced Transportation on Air Quality Associated with COVID-19, ROVER III)
- engaging with academic institutions undertaking work on transportation emissions

The purpose of this exercise was to identify what information was available, and what gaps exist in the available data to guide the remainder of the project towards data collection needs and a deeper understanding of tampering of emission control systems in Alberta and their impacts on air quality.

The types of information sources collected through this objective include:

- scholarly articles
- academic non-fiction books
- legal publications
- editorials and opinion pieces
- government information
- data and statistics
- popular articles
- trade articles
- grey literature

Descriptions of the types of documents found in each category can be found in the University of Alberta Libraries' How to Research subject guide.[5] Figure 1 shows the number and type of references compiled for this objective.

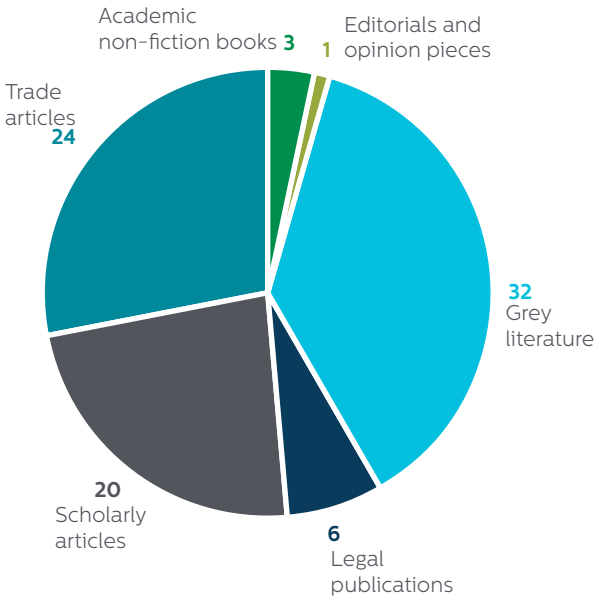


Figure 1 Number and type of references compiled for objective 2

5.1 Summary of reference documents

The project team found and reviewed 86 resources, which were categorized into the following categories:

- air monitoring and emissions data
- economic impacts of vehicle emission control system tampering
- government policy, regulations, and guidance on vehicle emissions and vehicle emission control systems
- health impacts of vehicle emissions
- impacts of emission control systems on vehicle operation or performance

5 Types of Information Sources - How to Research - Subject Guides at University of Alberta Libraries

- types of emission control systems and maintenance requirements
- vehicle emission control system tampering methods, services, and detection
- viewpoints on emission controls and tampering

The number of references for each category is summarized in Figure 2. Some references were applicable to multiple categories and were included in the count for each.

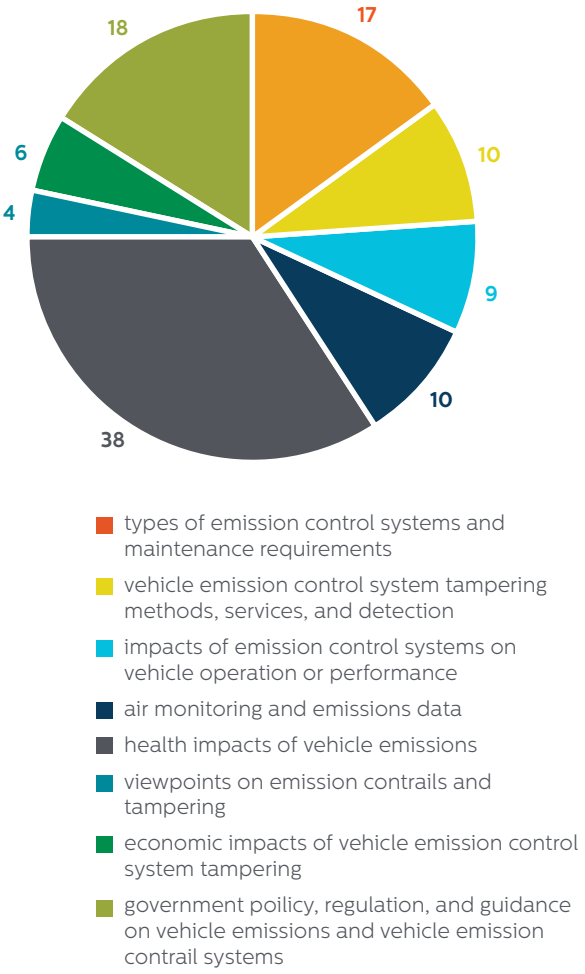


Figure 2 Number of references for each category

The information found for each category is summarized in the following sections. A full reference list can be found in Appendix D.

Category: Air Monitoring and Emissions Data

Topics in this category include:

- air monitoring near roadways
- on-road vehicle emissions data in Alberta and other jurisdictions
- non-point source air emissions sources in Alberta air zones and recommendations for addressing them
- the impact of tampering with emission control systems on vehicle emissions

Data collection methods varied across the references, including both ambient air monitoring and remote sensing, as well as modelling of the impacts of emissions on human health. This category also includes two projects completed by CASA, and the study completed by the International Council on Clean Transportation using the data collected during ROVER III.

Category: Economic Impacts of Vehicle Emission Control System Tampering

Data on the economic impact of tampering is sparse. Although some information was available on costs for maintenance and repairs of emission control system components, no information was found on the operational cost impacts of maintaining or repairing emission controls in comparison to the costs to bypass or remove them. As the relative costs of tampering vs. maintaining these systems are likely part of the decision-making process for vehicle fleet owners or operators who are choosing to tamper with emission control systems, this category was a significant information gap.

Category: Health Impacts of Vehicle Emissions

The human health impacts of vehicle exhaust are well researched, and many resources were available in this category. Studies looked at the impacts of different fuel types (gasoline, diesel, and biodiesel), the impacts of individual exhaust components (e.g., nitrogen dioxide, fine particulate matter), and different exposure populations such as children, adults, and people living in proximity to roadways. Health impacts included in the references were various cancers, dementia, cognitive decline, atherosclerosis, and asthma, among others. Due to the large amount of information available on this topic, this was not considered an information gap requiring further research.

Category: Impacts of Emission Control Systems on Vehicle Operation or Performance

Information in this category covers whether emission control systems, either their presence on the vehicle or their removal, impact factors such as vehicle handling, braking, speed, fuel mileage, or component lifespan. Some information was found on the impact of diesel exhaust fluid on engine performance, but this topic was largely an information gap.

Category: Government Policy, Regulations, and Guidance on Vehicle Emissions and Vehicle Emission Control Systems

The project team did not complete a thorough jurisdictional scan on this topic but did compile readily available information on existing policy and regulation on vehicle emissions, vehicle emission control systems, and tampering. Additionally, this topic also includes reports prepared for governments that provide advice on approaches for managing emissions from the transportation sector.

Category: Types of Emission Control Systems and Maintenance Requirements

A significant amount of information was available on the types of vehicle emission control systems, along with common issues experienced by vehicle owners or operators and how to fix them, as well as preventative maintenance schedules. The emission control systems and components covered were primarily those used on heavy-duty vehicles, and included:

- diesel exhaust fluid
- diesel exhaust fluid pumps
- diesel oxidation catalyst
- diesel particulate filters
- exhaust gas recirculation
- selective catalytic reduction

Category: Vehicle Emission Control System Tampering Methods, Services, and Detection

This category included the definition of tampering, different methods of tampering or defeating emission control systems and how they are detected, and common tampering or defeat services available to vehicle owners in Alberta.

The range of tampering actions discussed included:

- complete removal of components such as diesel particulate filters or selective catalytic reduction filters from the exhaust
- physical blocking of exhaust gas recirculation systems
- inserting a spacer between the exhaust and the exhaust temperature sensor to reduce diesel exhaust fluid injection
- installation of a urea emulator to provide false signals to the engine control module

Many of these actions also included modifications to the vehicle electronic control unit software to prevent engine malfunction indicator lights, change on-board diagnostic functionality, alter the functioning of emission control systems, tune the engine calibration for positive fuel consumption or power, disable sensors, or change targets and timings for different processes.

While much information was available on how tampering is done and how it can be detected, little was available on the types of vehicles that are tampered or the frequency with which it occurs.

Category: Viewpoints on Emissions Controls and Tampering

The project team wished to gain an understanding of the public sentiment toward vehicle emission control systems and tampering. While there were articles providing reasons for vehicle owners and operators not to bypass their emission controls, there were few references in this category, so it is likely not representative of the general population. One opinion piece had a very negative view of emission controls, and another presented removing emission controls as a way to improve vehicle performance.

6. Objective 3 – Gap Analysis

This section summarizes the outcome of Objective 3: Identification of Remaining Information Gaps and Methods to Address Them. This objective builds on the outcomes of Objectives 1 and 2 and served as a foundation for development of a scope of work for a consultant to assist in addressing those gaps.

The project team developed their list of information gaps over the course of several meetings, using the following steps:

1. Review of the existing reference materials that had been gathered by team members in the preceding weeks.
2. A brainstorming exercise to identify the information types that had not yet been gathered, and potential sources for this information.
3. Refining the list of brainstormed gaps based on the following criteria:
    a. Is the gap within the scope of work of the project?
    b. Is the information available through research or engagement?
    c. Can the information be gathered with the resources available to the project team (both cost and time)?
4. Sorting the refined list of information gaps based on high-level themes.

The team acknowledged that while they desired to address all of the information gaps they had identified, it would be unlikely that a consultant could address them all and some gaps would likely remain after the project was complete.

6.1 Information gaps

The information gaps identified by the project team and potential methods to address them are described below.

Theme 1: Number of Tampered Vehicles

Rates of tampering in Alberta, including tampering completed by vehicle owners and operators and services completed by technicians.

Information Gaps

a) How frequently are tampering services performed by mechanics in Alberta?

b) How many vehicle owners or operators are tampering with their own vehicles?

c) Are there differences in tampering rates for different sized operations (e.g., fleets from 2-20 vehicles compared to fleets with greater than 20 vehicles)?

Suggested Methods & Sources

Consultant:

- Surveys, interviews, or other appropriate tools/ methods to engage with mechanics and vehicle operators/owners

Project Team:

- Survey of, or other engagement with, CASA members and partners

Theme 2: Profile of Tampered Vehicles

Types of vehicles that are being tampered (e.g., type, age, vehicle fleet size, region of the province).

Information Gaps

- Is there a difference in tampering rates or types of tampering performed on vehicles that are staying in Alberta vs. those that are driving to other jurisdictions where inspection and maintenance programs include emission control devices or emission testing?
- Are vehicles tampered at a specific vehicle age, or are vehicles of certain model year ranges more likely to be tampered?

- Are certain types of emission control devices more likely to be defeated than others due to failure rates, repair costs, maintenance requirements, replacement part availability, or other reasons?
- Are there regional differences in transportation emissions (e.g., rural vs. urban, and would actions or programs to reduce tampering have more impact if they are targeted at different areas)?

Suggested Methods & Sources

Consultant:

- Surveys, interviews, or other appropriate tools/methods to engage with mechanics and vehicle operators/owners.
- Literature review for Canada and the U.S. or other jurisdictions

Project Team:

- Survey of, or other engagement with, CASA members and partners

Theme 3: Economic Impacts of Tampering

Economic impacts of tampering for those who own or operate tampered vehicles.

Information Gaps

- What are the costs associated with maintaining emission control systems, and have those costs changed over time (e.g., cost of DEF)?
- Does tampering with emission control systems impact operating costs (e.g., changes in fuel consumption or engine life)?
- Does tampering impact the competitiveness of an operator when compared to other operators in Alberta, Canada, and the U.S.?
- What is the cost range for tampering or defeating an emission control system vs. replacing or repairing one that is defective or malfunctioning?
- What is the downtime for maintenance vs. tampering services (e.g., removing devices and defeating software in comparison to routine maintenance requirements or repairs for these systems) over the life of the vehicle?
- As a vehicle depreciates, does the cost to replace or repair emission control systems become higher (both absolute cost and relative to the value of the vehicle)?
- What is the role of older heavy-duty vehicles in different sectors or in smaller fleets vs. being diverted to waste (e.g., do glider kits circumvent new vehicle purchases and avoid emission controls or are smaller fleets more likely to purchase used vehicles)?

Suggested Methods & Sources

Consultant:

- Surveys, interviews, or other appropriate tools/methods to engage with mechanics and vehicle owners
- Scan of retailers for emission control replacement components and related materials (e.g., filters, diesel exhaust fluid, catalyst)
- Reports on existing inspection and maintenance program design and their results

Project Team:

- Scan of Alberta-based service providers for public information on costs for tampering services and delete kits/defeat devices.
- Information sources already identified will be sent to the consultant (e.g., document on California Air Resources Board vehicle inspection and maintenance program that includes cost estimates).

Theme 4: Emission Control System Effectiveness & Vehicle Performance

Factors impacting the functioning of emissions controls and vehicle or engine performance (e.g., handling, braking, speed, fuel mileage, component lifespan). Factors could include extreme high or low temperatures, any related manufacturer defects, or adherence to manufacturer recommended maintenance schedules.

Information Gaps

a) Is the effectiveness or performance of emissions controls impacted by extreme heat or cold, and if so, can it be quantified?

b) What is the environmental impact of emissions controls when the full life cycle of the devices is considered (e.g., is there a net reduction in NO_x when production of diesel exhaust fluid is considered)?

c) Have there been recalls on emission control devices and if so, what is their resolution rate (e.g., vehicle owners addressing the issue)?

d) What is the life expectancy of an emission control system with regular maintenance and without?

e) What role (if any) does tampering play in prolonging or reducing the life of the vehicle?

f) What role (if any) does tampering play in improving or reducing vehicle performance?

g) What (if any) is the change in vehicle noise levels from different tampering methods?

Suggested Methods & Sources

Consultant

- Literature review – work in other jurisdictions that has begun or been completed on this topic, including work completed by research organizations (example 1, example 2)
- Review of manufacturer documentation and engagement with other appropriate resources such as the Truck and Engine Manufacturers Association
- Alberta examples via survey, interview, or other appropriate tools/methods
- Review of vehicle recalls due to problems with emission control systems

Project Team

- Survey of or other engagement with CASA members and partners for their experiences with vehicle operation in extreme temperatures or in remote areas, including changes in maintenance requirements or impacts to processes such as pumping diesel exhaust fluid.

Theme 5: Perceptions and Beliefs Around Tampering

Current beliefs and perspectives on tampering held by the public or people who are in the transportation sector, and whether those views have changed over time.

Information Gaps

- Has there been a change in perceptions around tampering over time?
- Are vehicle owners and operators aware of the impacts of excess vehicle emissions on human health and the environment and does it factor into decision-making around tampering?
- What are non-monetary or perceived vehicle performance improvement motives for tampering (e.g., modifying a vehicle to intentionally increase noise)?

Suggested Methods & Sources

Consultant

- Jurisdictional scan of changes in regulatory approach to vehicle emissions or tampering in the last decade.
- Scan media and opinion pieces on vehicle emissions and tampering (e.g., articles, social media posts, forum posts) for changes in sentiment through time, with a focus on opinions of people in the transportation sector.

Project Team

- Provide the consultant with information and references collected by the project team to date.

As described in Section 7, the scope of work based on the above identified information gaps was modified due to a reduction in the time and resources available to the project team. The gaps that were not addressed remain outstanding.

7. Objective 4 – Collect Additional Information

This objective to address the information gaps that were identified in Objective 3, and as described in the previous section, was completed through a contract with AMTA. The original project terms of reference estimated this task would take five months to complete and would cost approximately $60,000. Due to the need to expedite the task and the reduction in available resources, AMTA completed the work in two months and for a $20,000 budget, which was generously provided by Canadian Fuels Association.

As AMTA was given significantly less time and fewer resources than was originally intended to be available for this project objective, the scope of the contract was narrowed. While heavy-duty commercial vehicles were always intended to be the project focus, other vehicle types were not excluded should information on them be easily accessible. AMTA's scope of work included only heavy-duty vehicles. Additionally, their work was to address approximately 80% of the information gaps identified by the project team; *Theme 4: Emission Control System Effectiveness & Vehicle Performance*, was not addressed.

The work described below in Section 7.1 summarizes AMTA's approach, engagement results, and suggestions for next steps. These suggestions are those of AMTA and are not endorsed by the project team nor do they represent the views of CASA, the project team members, or CASA's board of directors.

The full report from AMTA can be found in Appendix E.

7.1 Summary of AMTA's Work

AMTA developed a contact list of 92 mechanics and repair shops from their list of AMTA members and non-members, in addition to researching mechanics in the Alberta region that service Class 8 vehicles. AMTA staff engaged with these mechanics through a combination of phone calls, e-mails, and in-person visits. Of the 92 businesses contacted, 60 responded and provided information that was included in AMTA's report. All participants were informed that their information would remain confidential and their participation would not result in any negative consequences or actions in the future, as this was only an information gathering exercise.

Some highlights from the engagement were:

- 93% of respondents indicated that they do not complete deletions or tampering services unless there are extenuating circumstances (e.g., the systems cannot be repaired, or a repair would be extremely cost prohibitive), with the remaining 7% indicating they frequently perform tampering services to improve vehicle performance.
- 47% said that many vehicle owners or operators have tampered vehicles
- 95% said that smaller fleets (2-20 vehicles) are tampered more often than larger ones (greater than 20 vehicles), and 98% said that vehicles which are staying within Alberta are more likely to be tampered than those that cross into other jurisdictions
- 77% said older vehicles are tampered more frequently than newer ones
- 100% said that tampering reduces fleet operating costs and 96% said that tampering improves competitiveness compared to owners or operators who do not tamper their vehicles

- 83% said that it is substantially less costly to tamper emissions controls than to replace or repair systems that are defective or malfunctioning
- 96% said that tampered vehicles have much less down time over the life of the vehicle compared to those which are not tampered and have maintenance or repair requirements for emission control systems
- 95% said that as a vehicle depreciates, the absolute and relative cost to replace or repair emission controls becomes much higher

AMTA also developed suggestions to address tampering with vehicle emission control systems based on the outcomes of the engagement. The suggestions ranged from actions by original equipment manufacturers (OEMs) to use technological barriers to limit the ability for operators to tamper with emissions controls, to increasing remote sensing programs and research, and increasing the scope of Periodic Motor Vehicle Inspections to allow inclusion of emission controls. It is their belief that tampering is a complex issue and will require a combination of coordinated efforts on different fronts to help reduce emission control tampering. It should be noted that some of these suggestions would require changes to Alberta's regulatory framework around vehicle emission control systems before they could be implemented.

More information on AMTA's engagement results and their suggestions for action is included in AMTA's final report, in Appendix E.

8. Conclusion and Next Steps

Despite challenging circumstances, the project team was able to complete significant work on their project objectives. The team provided a platform for information sharing and collaboration and allowed for consolidation of a large breadth of knowledge on emission control tampering and its impacts, as well as identification of information gaps that they hope will support future work on this topic. While the project was not completed as it was originally intended, the team is grateful that AMTA was able to complete a portion of the project's scope to support them in making some progress on the important topic of vehicle emission control systems and tampering in Alberta. Information gaps remain, but this project has served to collect some important information on tampering in Alberta for heavy-duty vehicles, a class of vehicles which, based on previous work completed by CASA and ICCT, are contributing significantly to transportation emissions in the province. While CASA can no longer continue its series of transportation projects, the team would like to provide some advice for any groups who would like to further work on this topic and has outlined potential next steps below.

Additional Vehicle Types

The project's original scope included both light-duty and off-road vehicles in addition to heavy-duty on-road vehicles. The work the team was able to complete included only heavy-duty on-road vehicles, and time was not available to assess what information is currently available for other vehicle types and whether it would be feasible to collect additional information. While these vehicle types may have a smaller impact on air quality than commercial vehicles, that data was not gathered or assessed through this work.

Emission Control Effectiveness and Vehicle Performance

One of the information gap themes identified through the project was on emission control effectiveness and vehicle performance. This included both performance of the emissions controls themselves under various conditions, and performance of vehicles when they have emissions controls installed compared to when they have been removed. This area was not included in the scope of work of AMTA's contract, and as such was not addressed. Given Alberta experiences extreme temperatures that impacts vehicle functions, this is an important information gap that should be assessed in the future.

Gather Information on Who is Performing Tampering Services

AMTA gathered information from mechanics and shops that provide services to Class 8 vehicles. The majority of respondents indicated that they perform tampering services rarely, and only when circumstances make repairing or replacing emission control system components impossible or extremely cost-prohibitive. However, many of the respondents also felt that many truck owners and operators have tampered vehicles.

Any approach taken to reduce tampering would benefit from being appropriately targeted, and understanding who is completing the majority of tampering services would be beneficial. Therefore, anyone wishing to further work in this area should consider finding ways to both identify who is performing the services most frequently and then gathering information from them on how often tampering services are performed and the motivations of fleet owners and operators who are seeking tampering services for their vehicles.

In addition to the above noted information gaps, an additional consideration for anyone wishing to work on tampering and emissions controls in Alberta is that people who perform tampering services may be reluctant to share information on their work or on their clients. While Alberta does not have anti-tampering regulation, the U.S. Environmental Protection Agency has acted against and fined companies in Alberta in the past for providing delete kits and tampering services for vehicles which were operated within the United States. While the team discussed this issue at length, and AMTA was up front to their survey participants that the information collected would not be used to target them for any enforcement action in the future, it remained a challenge for this project and would likely continue to be a challenge for anyone working on this topic.

There is more work to be done, and it is the hope of the project team that other organizations will see the value in the work completed to date and that it can be used to support future work that aims to support management of transportation emissions in the province for the benefit of all Albertans.

Appendix A – Project Team Membership

CASA acknowledges the contributions of the following project team members, alternates, and observers who volunteered their time and expertise on this project, along with their member organizations for supporting their participation.

Name	Organization
Andrew Barnes (co-chair)	Alberta Motor Transport Association
Ruth Yanor (co-chair)	Mewassin Community Council
Allison Moeller	Alberta Newsprint Company
Ann Baran	Southern Alberta Group for the Environment
Ashley Goddard	Environment and Climate Change Canada
Ashley Hadley	Rural Municipalities of Alberta
Bailey Doepker	Alberta Environment and Protected Areas
Briana Yee	Rural Municipalities of Alberta
Chris Yanitski	Alberta Transportation & Economic Corridors
Curt Horning	Alberta Environment and Protected Areas
Danlin Su	Prairie Acid Rain Coalition
David Spink	Prairie Acid Rain Coalition
Heather Feil	City of Calgary
Holly Johnson-Rattlesnake	Samson Cree Nation
Jennifer Silverthorn	City of Calgary
Joseph Kay	Rural Municipalities of Alberta
Kaylyn Buffalo	Samson Cree Nation
Mandeep Dhaliwal	Alberta Airsheds Council
Maude Godbout	Environment and Climate Change Canada
Melissa Brown	City of Edmonton
Melody Garner-Skiba	Intensive Livestock Working Group
Michelle Meyer	International Council on Clean Transportation
Rhonda Lee Curran	Alberta Environment and Protected Areas
Rob Hoffman	Canadian Fuels Association
Rupesh Patel	City of Edmonton
Sahaj Kaur	Rural Municipalities of Alberta
Sarah Cicchini	City of Edmonton
Sharon Willianen	Alberta Environment and Protected Areas
Vahid Hosseini	Simon Fraser University

CASA Staff who supported the project:
Katherine Duffett, Katrina Calon, Alec Carrigy

Appendix B – Terms of Reference

Understanding Vehicle Emission Control System Tampering in Alberta Project Team

Terms of Reference

Approved by the Clean Air Strategic Alliance on: **April 3, 2025**

Context

Alberta strives to manage air emissions to achieve air quality standards and objectives. Alberta's Renewed Clean Air Strategy (2012) recognizes the need for management actions on non-point sources of air emissions, such as transportation. The transportation sector is one of the largest sources of nitrogen oxide emissions in the province. In addition to emitting nitrogen oxides, vehicle emissions also contain other air contaminants that can be associated with health impacts, such as particulate matter and volatile organic compounds.

While there is no explicit prohibition of vehicle emission control system tampering at a federal level in Canada, it is prohibited in most Canadian provinces. The Government of Alberta does not currently have legislation, regulations, or policies aimed at preventing tampering or prohibiting the manufacture, sale, or installation of emission control defeat devices. While Alberta's Commercial Vehicle Inspection program requires safety inspections for vehicles exceeding 11,794 kilograms, this inspection does not include emission control equipment. Alberta's *Traffic Safety Act* also does not prohibit tampering with vehicle emission control systems. Vehicles that do not have functioning emission control systems may emit many times the emissions of vehicles that do.

CASA has made several recommendations related to vehicle emission control system tampering. The ROVER I (1998) and Non-Point Source (2017) projects both recommended the Government of Alberta establish or amend provincial legislation to prohibit tampering. The Non-Point Source project also recommended that emission control systems be included in the annual safety inspections required by the Commercial Vehicle Inspection Program. While there many have been discussions on the issues related to these recommendations within the Government of Alberta, CASA has not received any formal update on the status of these recommendations or their implementation.

In September 2024, the CASA board approved the final report and recommendations from the Roadside Optical Vehicle Emissions Reporter (ROVER) III project. The ROVER III project involved the collection of emissions data from 49,747 light-duty vehicles and 6,339 heavy-duty vehicles in Alberta. The data showed that up to 30% of the heavy-duty diesel-fuelled vehicles and 10% of light-duty gasoline-fuelled vehicles measured had emissions that were at least 10 times higher than emissions benchmarks. Emissions that are much higher than expected indicate the vehicle's emission control system is malfunctioning or has been tampered[6] with. As the ROVER III project did not include vehicle inspections, the project team identified the magnitude and sources of vehicle emission control system tampering and the reliability of emission control technology in Alberta's climate as data gaps. They made the following recommendation three in their report to help address those gaps:

6 ROVER III data was used by the International Council on Clean Transportation to calculate an estimated tampering prevalence for heavy-duty diesel vehicles. The estimated prevalence was 38.5% and will be used to update modelling inputs for their work on the impacts of vehicle emission tampering in Canada.

> *"CASA to establish an expedited project team to undertake a comprehensive study to a) identify the magnitude and sources of vehicle tampering, including gathering information about manufacturers, sellers, and installers of defeat devices, and b) understand the reliability of installed emissions control devices."*

This project intends to fulfill this recommendation, and its outcome is intended to support recommendation four from the ROVER III project report:

> *"The Government of Alberta, upon receipt of the comprehensive study report on emissions controls and tampering in Alberta (recommendation 3), should identify actions or initiatives as needed to address the findings of the study, and assess how their implementation could support and further any existing work in this area. This assessment would include determining the key measures and corresponding monitoring and reporting mechanisms required to track the progress and validate the success of identified actions and initiatives."*

The ROVER III project did not include a feasibility assessment for which programs or actions would be appropriate for implementation in Alberta, and CASA recognizes that measures aimed at reducing rates of tampering with vehicle emission control systems can have varying structures or supports needed for implementation. However, actions undertaken in other jurisdictions could provide guidance for how programs could be implemented in Alberta.

The project team will operate in a manner that is consistent with the rules, policies and procedures adopted by the CASA, including the use of consensus to make decisions in a multi-stakeholder process.

Strategic Intent (Goal)

The project's strategic intent is to complete a comprehensive study that:

- identifies the magnitude and sources of vehicle emission control system tampering, including information gathered about manufacturers, sellers, and installers of defeat devices
- includes an assessment of the economic impact of vehicle emission control system tampering
- improves understanding of the reliability of factory-installed emissions control devices

Project Scope

The scope of this work includes:

- both light- and heavy-duty vehicles
- compilation of data and information from existing sources on vehicle emission control system tampering and its economic impacts (e.g., operational cost savings for vehicle fleet owners, increased healthcare costs due to excess emissions, and others), and reliability of factory-installed emission control systems that are applicable to Alberta's environmental, economic, and political contexts
- collection of new data and information on vehicle emission control system tampering, economic impacts, and reliability via stakeholder engagement (e.g., surveys, interviews)
- advice on future data collection to address data gaps that could not be addressed through this project due to time or resource constraints
- advice to support the Government of Alberta in their identification of actions or programs to reduce vehicle emission control system tampering that take Alberta's context into consideration

Direct collection of vehicle emissions data or conducting vehicle inspections are outside the scope of this project.

This project aims to provide advice to support air quality management in Alberta but will not make formal regulatory or policy recommendations.

Objectives And Key Tasks

Project objectives and their supporting key tasks are described below.

Objective 1: A Common Understanding of Vehicle Emission Control Systems, Tampering, and Maintenance Requirements

The project team will gain a common understanding of the types of vehicle emission control systems for light- and heavy-duty vehicles, methods of tampering with those emission controls, and the maintenance practices required to maintain their function.

Key Task 1: Define key terms and concepts and how they will be used throughout the project, including but not limited to:

- Heavy-duty vehicles vs. light-duty vehicles and regulatory requirements that impact each (e.g., weight thresholds for commercial vehicle inspections)
- Vehicle emission control system tampering
- Vehicle emission control system malfunction
- Vehicle emission control system manufacturer defect

Key Task 2: Review existing reference material on the following topics, and others as appropriate:

- Types of vehicle emission control systems and their functions
- Common methods of defeating or tampering with vehicle emission control systems
- Methods and tools used to detect vehicle emission control system tampering in Alberta and other jurisdictions
- Manufacturer recommended maintenance schedules for vehicle emission control systems

Objective 2: Compilation of Information on Vehicle Emission Control System Tampering and Reliability in Alberta

Review existing sources of information on the prevalence and sources of emission control system tampering, including sellers and manufacturers of defeat devices, and the reliability of factory-installed vehicle emission control systems in Alberta's climate.

Key Task 1: Complete a literature review on vehicle emission control system tampering that includes but is not limited to the following topics:

- Legislation or regulations in other jurisdictions that prohibit vehicle emission control system tampering, and maintenance and inspection programs that include vehicle emission control systems.
- Costs associated with maintenance and repairs of vehicle emission control systems, and the perceived and real economic impacts of tampering.
- Availability of vehicle emission control system tampering services in Alberta and the frequency that those services are performed.
- Manufacturers and sellers of defeat devices that are available in Alberta.
- Enforcement measures taken by the U.S. EPA against Alberta-based companies for providing defeat devices or services, and a comparison of the U.S. and Alberta regulatory environments related to vehicle emission control system tampering.
- The extent of vehicle emission control system tampering in light-duty vs. heavy-duty sectors, and the rates of tampering for generally higher-emitting vehicle fleets or sectors (e.g., dump trucks).
- Emissions information for Alberta-registered vehicles travelling to other jurisdictions (e.g., other provinces or countries which have regulations prohibiting tampering).
- Rates of catalytic converter theft in Alberta and statistics on their replacement (e.g., insurance claims for catalytic converter replacement)

Key Task 2: Complete a literature review on the reliability of factory-installed vehicle emission controls that includes but is not limited to the following topics:

- Rates of manufacturer defects in factory-installed vehicle emission control systems
- Impacts of Alberta's climate on the performance of vehicle emission control systems
- Comparison of ambient air monitoring data near roadways in Alberta or other jurisdictions under different temperature and weather conditions, for example:

- ***Near Road Monitoring Study (Winter 2020):*** EPA completed a near-road ambient air quality monitoring-focused study in winter 2020 at a central location in Edmonton.
- ***Near Road Air Monitoring Station (in progress, 2024):*** EPA is working with Environment and Climate Change Canada to plan for a near-road ambient air monitoring station in Calgary as part of the National Atmospheric Pollutant Surveillance (NAPS) Program to further understand the impact of vehicle emissions on ambient air quality near roadways.

Objective 3: Identification of Remaining Information Gaps and Methods to Address Them

After completion of objectives 1 and 2, assess the information that has been collected and determine any remaining information gaps and how those information gaps might be addressed.

Key Task 1A: Develop a scope of work for project team members or a consultant to gather additional information to help address any identified information gaps related to vehicle emission control system tampering based on available resources and information sources. Data gathering could include:

- Online, phone, or in-person surveys of mechanics who provide vehicle emission control system tampering services to determine the services they offer the frequency they perform those services, and repairs for vehicles after catalytic converter theft.
- Surveys of vehicle owners and operators on maintenance, reliability, and tampering of emission control systems administered through transportation associations (e.g., Alberta Motor Transport Association, Alberta Motor Association)
- Information on statistics of tampered vehicles in the market (e.g., information from vehicle sellers such as auction companies or dealerships on inspections completed before sale and whether emissions control systems are noted as part of that process).
- Workshops or other engagement with people in the trucking industry who are willing to speak about their motivations for vehicle emission control system tampering and the impact it has on their operations.
- Workshops or other engagement with subject matter experts and researchers in Alberta and other jurisdictions who have information on the sources, impacts, and motivations for vehicle emission control tampering.
- Information from provincial police services on rates of catalytic converter theft and from insurance companies on claims to replace stolen catalytic converters.

Key Task 1B: Develop a scope of work for project team members or a consultant to gather additional information to help address any identified information gaps on the reliability of factory-installed vehicle emission control systems based on available resources and information sources. Data gathering could include:

- Online, phone, or in-person surveys of mechanics about vehicle emission control system reliability and repair options.
- Information from ongoing studies assessing the performance of vehicle emission control systems under different weather conditions, for example.
  - ***Future of Transportation in Cold Climate Cities (in progress):*** A project being completed through a collaboration between the University of Alberta and Simon Fraser University to develop necessary tools and methodologies for analyzing, understanding, and developing transportation decarbonization pathways in cold climate cities. Project leads are Professor Bob Koch and Professor Mahdi Shahbakhti, University of Alberta, and Professor Vahid Hosseini, Simon Fraser University.
  - ***Reduction of Emissions from In-Service Medium- and Heavy-Duty Vehicles in British Columbia (future project):*** A project awarded by Metro Vancouver to Ramboll Canada. Details on the project scope has not yet been released but may be relevant for this work.

Specific data-gathering actions will depend on which gaps have been identified.

Objective 4: Collect Additional Information as Identified in Objective 3

Undertake the scope of work identified in objective 3, either through the resources available through the project team members and their organizations, or through a contract with a consultant.

Key Task 1A: Complete a Request for Proposal process to identify an appropriate consultant to complete the scope of work developed in objective 3, with the following potential deliverables:

- Survey or engagement session results
- A report detailing the information gathered by the consultant and any advice they have for information gaps they could not address, or longer-term information gathering methods that would yield more robust data.

Key Task 1B: If the project team decides to proceed without a consultant, project team members will work with CASA staff to implement as much of the scope of work as possible, document the process and results, and provide advice for filling data gaps that could not be addressed with the resources of the project team.

Objective 5: Summary of Results and Advice for Transportation Emission Management

Information from all other objectives should be compiled into a final project team report for consideration by the CASA board.

Key Task 1: Write a final report that contains the following information:

- Background information on vehicle emission control systems, types and methods of tampering, and tampering detection methods (objective 1)
- Information on the reliability of factory-installed emission control systems (objective 2 and 3)
- Information on the prevalence and sources of vehicle emission control system tampering in Alberta (objective 2 and 3)
- The information gaps identified, methods used to gather additional information, and the results of that process (objective 3 and 4)

Key Task 2: From the information gathered, provide advice on what actions or programs could be implemented to manage emissions from the transportation sector in Alberta.

Key Task 3: From the information gathered, provide advice on methods of gathering additional relevant information that could not be obtained during the project due to time or resource constraints.

Objective 6: Communications Plan

Develop and implement a strategy and action plan for communicating the work of the project team. This objective will need to be considered at project outset and on an ongoing basis as the work progresses.

Key Task 1: Develop a communication plan that includes the following elements:

- The information to be communicated, including key messages on vehicle emission control system tampering and reliability in Alberta.
- The appropriate audience, how it will be communicated, and when.
- Existing communication channels that can be leveraged to share project information.
- Communication tools such as message maps, factsheets, or presentations.
- Messaging on the outcomes of each project objective for project team members to communicate relevant information to their constituents.

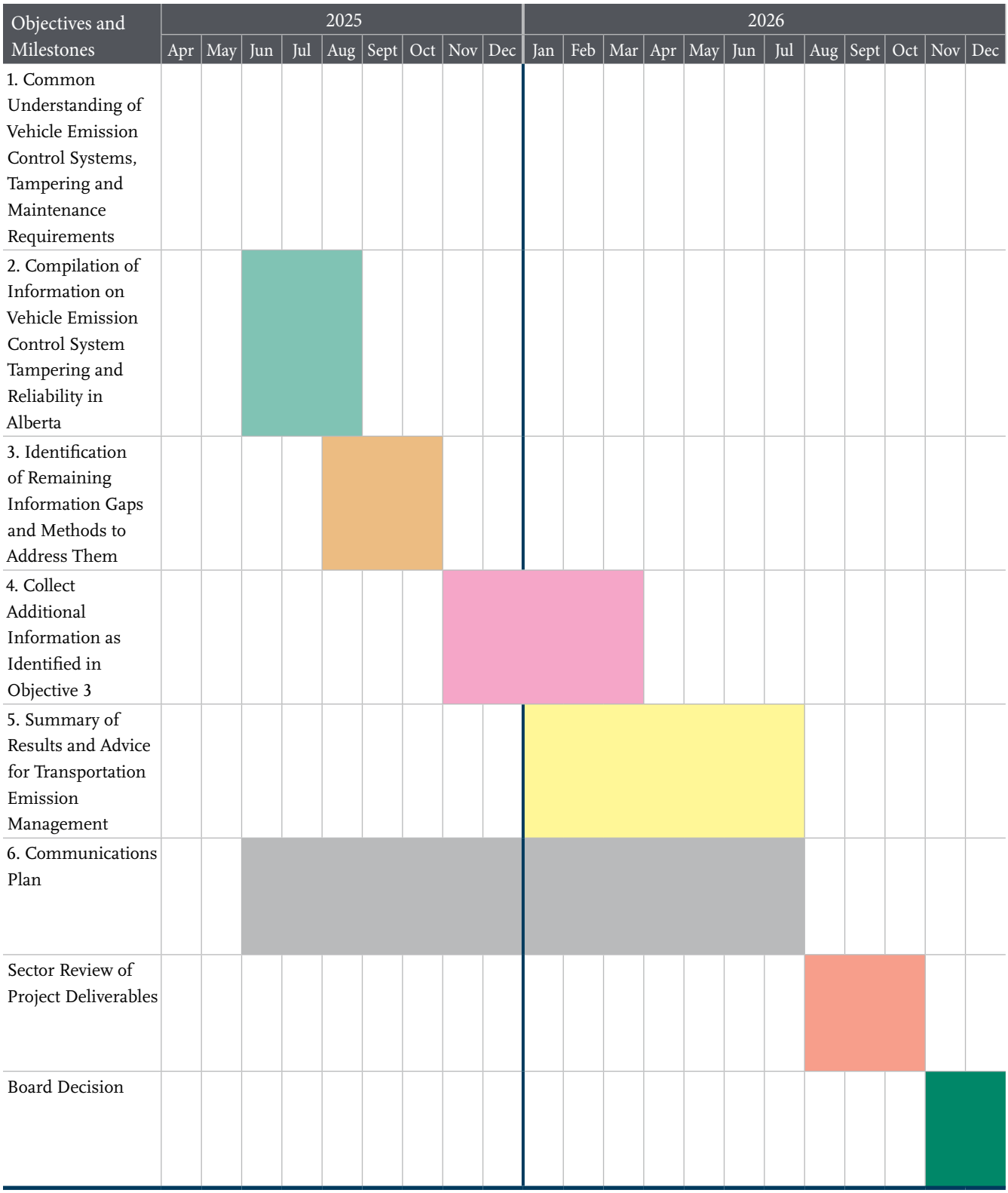
Deliverables

The project deliverables are:

- A consultant report detailing the results of their jurisdictional scan and data collection, if applicable.
  - Any collected data sets, including survey results, should be provided to CASA by the consultant
- A project team report summarizing the information collected and containing advice to support air quality management in Alberta.
- A communications plan outlining the project team's approach to communicating about the work and its outcomes.

Project Schedule

The project is expected to start in April 2025 and be complete by December 2026.
The Gantt chart below shows the timeline broken down by objective.



Projected Resources and Costs

The project budget is estimated at $31,500 in core funding and $60,000 of project costs for a total project budget of $91,500. The table below includes a breakdown of the estimated costs.

Item	Estimated Cost
Core Funds	
Stakeholder Support & Travel/Accommodation*	$25,000
Hosting	$1,500
Communications (final report preparation)	$5,000
Total Estimated Core Funds	$31,500
Project Costs	
Consultant to complete objective 4 (address data gaps)**	$50,000
Stakeholder engagement for objective 4 (workshop, surveys, interviews)	$5,000
Communication tools	$5,000
Total Estimated Project Costs	$60,000

*Based on ten meetings per year for two years, where 80% are held remotely and 20% are in person, and four team members are eligible for stakeholder support.

**Optional cost dependent on whether the project team members decide they can complete this task without consultant support.

Membership

The working group has identified the following individuals or organizations who should be engaged in the project in some manner, either as project team members or through targeted engagement.

Individual or Organization	Possible Interests, Concerns, or Involvement
Provincial Regulators (e.g., Environment and Protected Areas, Transportation and Economic Corridors, Service Alberta)	• Responsible for ensuring achievement of air quality objectives and standards and provincial policy. • Interested in environmental protection and the health of Albertans as well as ensuring sustainable economic prosperity. • Involved in education/awareness initiatives.
Federal Government (e.g., Environment and Climate Change Canada, Transport Canada)	• Interested in ensuring achievement of Canadian Ambient Air Quality Standards and effectiveness of and alignment with federal policies.
Municipalities	• Involved in education and awareness initiatives. • Interested in the health of their constituents which is impacted by the concentration of transportation emissions in urban areas.
First Nations and Metis	• Interested in ensuring the health of communities. • Interested in protecting the environment.
Trucking Companies or Associations (e.g., Alberta Motor Transport Association, Independent Trucking Association)	• Interested in fairness across the sector. • Concerns regarding possible impacts of potential actions related to transportation emissions management. • Concerns on how actions to reduce transportation sector emissions relate to current regulation or policies.

Individual or Organization	Possible Interests, Concerns, or Involvement
Industry	• Interested in management actions to reduce nitrogen oxide emissions that include both industrial and non-industrial emission sources.
Health, Environmental, and Transportation-Related Non-Government Organizations	• Interested in ensuring the health of Albertans. • Interested in protecting the environment.
Airshed Organizations	• Involved in education and awareness initiatives. • May be involved in implementation of actions to manage transportation emissions.
Agriculture Organizations (e.g., Alberta Canola Producers, Alberta Beef Producers)	• Interested in fairness across the sector. • Concerns regarding possible impacts of potential management actions. • Concerns on how actions to reduce transportation sector emissions relate to current regulations or policies (e.g., AOPA)
Academia or Research Councils (e.g., Simon Fraser University, University of Alberta Centre of Smart Transportation)	• Interested in data collection and potential research implication of project results, or possible concurrent studies.

Other stakeholders may become apparent as the work progresses. The project team will need to regularly evaluate whether the appropriate stakeholders are engaged.

Appendix 1: Working Group Membership

Name	Role	Organization
Members		
Ann Baran	Co-Chair	Southern Alberta Group for the Environment
Rob Hoffman	Co-Chair	Canadian Fuels Association
Andrew Barnes	Member	Alberta Motor Transport Association
Bailey Doepker	Member	Environment and Protected Areas
Chris Yanitski	Member	Transportation and Economic Corridors
Kamran Faisal	Member	City of Calgary
Mandeep Dhaliwal	Member	Peace Airshed Zone Association
Melissa Brown	Member	City of Calgary
Michael Spiess	Member	Environment and Climate Change Canada
Ruth Yanor	Member	Mewassin Community Council
Vahid Hosseini	Member	Simon Fraser University
Yoann Bernard	Member	International Council on Clean Transportation
Héline Chow	Alternate	Environment and Climate Change Canada
Michelle Meyer	Alternate	International Council on Clean Transportation
Geoff Johnson	Observer	Environment and Climate Change Canada
Curt Horning	Corresponding Member	Environment and Protected Areas
Douglas Thrussell	Corresponding Member	Environment and Protected Areas
Sharon Willianen	Corresponding Member	Environment and Protected Areas
CASA Staff		
Katie Duffett	Project Manager	Clean Air Strategic Alliance
Alec Carrigy	Project Manager	Clean Air Strategic Alliance
Claire Poirier	Project Manager	Clean Air Strategic Alliance

Appendix 2: Reference Materials

The project team should review the following materials in preparation for project initiation:

- Recommendations to Reduce Non-Point Source Air Emissions in Alberta (CASA, 2018)
- Roadside Optical Vehicle Emissions Reporter (ROVER) III Project Report for the CASA Board (CASA, 2024)
- Roadside Optical Vehicle Emissions Reporter III: A Survey of On-Road Light and Heavy-Duty Vehicle Emissions (Opus, 2023)
- Heavy-Duty Emissions Control Tampering in Canada (International Council on Clean Transportation, 2022)

Appendix C – Information Presentations

Vehicle Emission Control System and Tampering

Vahid Hosseini, PhD, PEng
Associate Professor of Sustainable Energy Engineering, Simon Fraser University, Vancouver, BC, Canada

SFU FACULTY OF APPLIED SCIENCES | SUSTAINABLE ENERGY ENGINEERING

Clean Air Strategic Alliance (CASA) Workshop
July 3, 2025 - Edmonton, Alberta

Sustainable Energy Engineering at SFU

Downtown Surrey, British Columbia, Canada

+Multi-disciplinary engineering program, focal points:
  + Sustainable food & water
  + Manufacturing & materials
  + Renewable energy and power grids
  + Clean transportation
  + Regional/global energy flows
+BEng, MEng, MASc, PhD programs
+21 Professors, 11 research labs

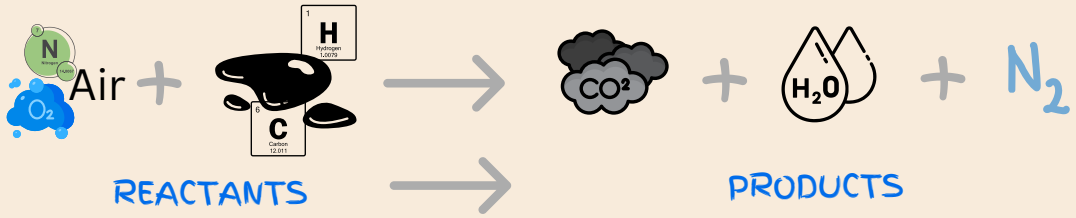
Collaborative Research on Energy, Air Pollution, Transportation and Environment (CREATE)

- Exploring and developing innovative strategies for motorized and electrified transport, mobility-as-a-service, bike and car sharing, and active mobility solutions.
- Equipping cities with analytical tools for low-carbon, future-ready transportation systems
- Integrated modeling using CMAQ, WRF, MOVES, SMOKE
- Transportation planning in cold-climate cities

Learn about our projects

The source of energy for fossil fuel cars : COMBUSTION

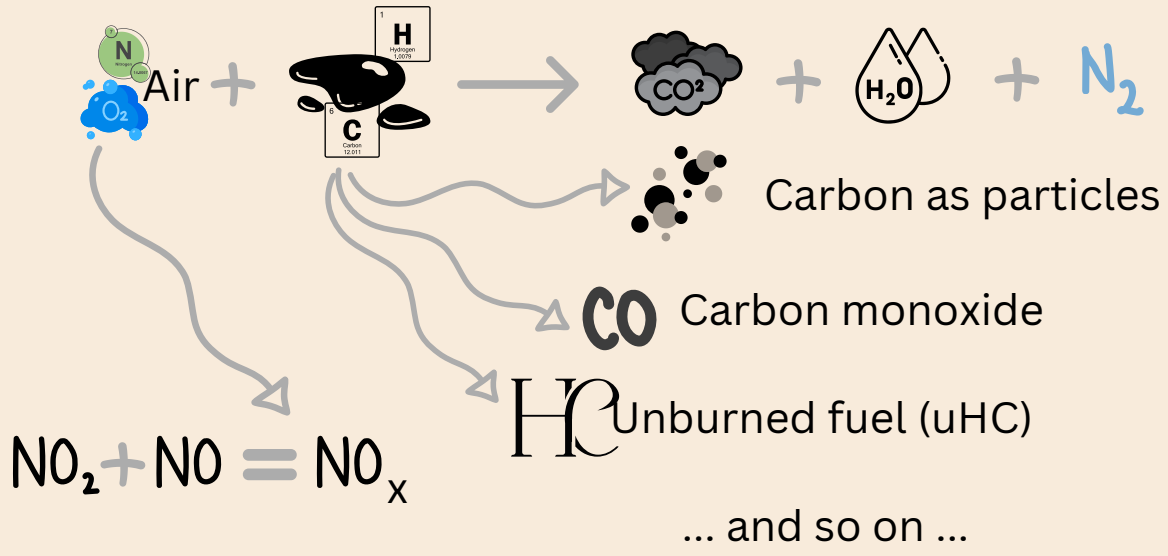
Ideal Combustion



Why all the fuss about pollution from burning fossil fuels?

The source of energy for fossil fuel cars : COMBUSTION

Actual Combustion



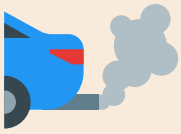
Photochemical smog in many cities around the world has increased awareness of air pollution caused by fossil fuel-powered vehicles.

Photo Credit: Business Insider

- 1950's - Los Angeles faced serious smog problems
- It lead to establishment of air pollution regulations in US EPA, California Air Resources Board (CARB), emission regulations ... in 1970's and after ward

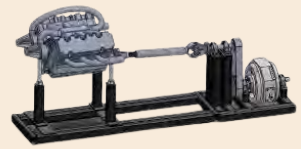
SMOG or **Sm**oke + F**og** is a toxic cocktail of multiple substances, formed under the sunlight and reactant coming from combustion sources, primarily consists of **ozone (O3)** and **NO2**

So, what have we done as a society to control and reduce harmful emissions from fossil fuel cars?



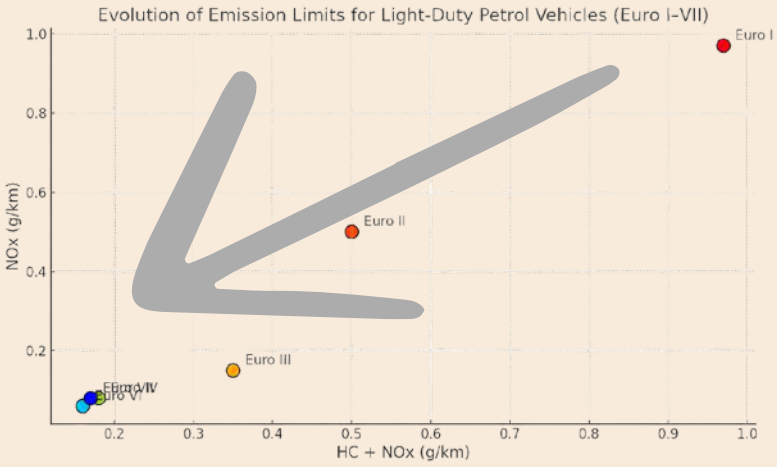
We've introduced **regulations**, set pollutant **limits**, and **enforced** compliance to mitigate their impact.

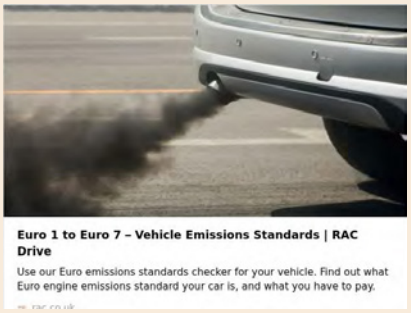
Emission Regulations



- Varies by jurisdictions: US EPA, CARB, European Union, Japan, India, China, …
- Varies by technology and fuel
  - Gasoline
  - Diesel
  - Light duty
  - Heavy duty
  - …
- Different test methods : Engine Dynamometer , chassis dynamometer, …
- In Canada, we follow US EPA and customize them : Environment and Climate Change Canada (ECCC)

Example: Light Duty Gasoline Emission Limits in Europe

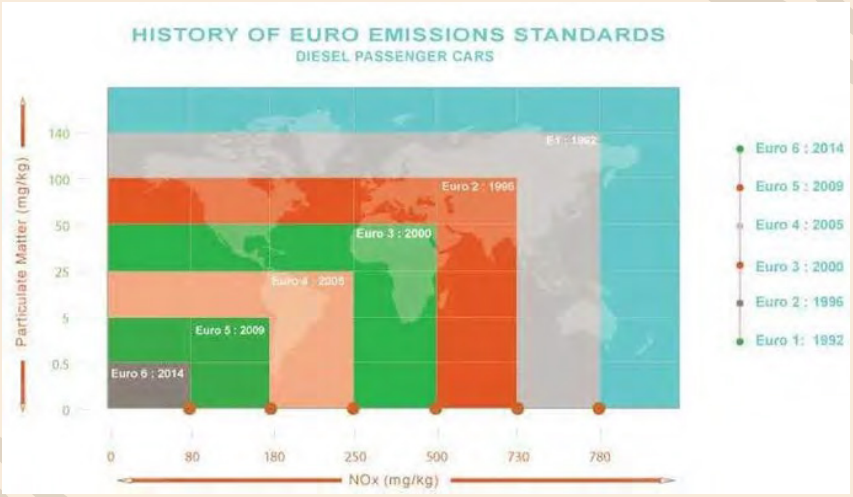




Euro 1 to Euro 7 – Vehicle Emissions Standards | RAC Drive

Use our Euro emissions standards checker for your vehicle. Find out what Euro engine emissions standard your car is, and what you have to pay.

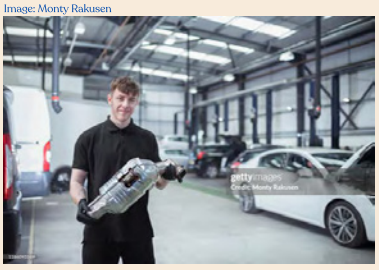
Example: Light Duty Diesel Emission Limits in Europe



The Road to Ultra-Low Emissions: What Made It Possible?

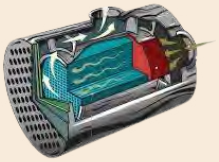
For gasoline cars : Three-Way Catalytic Converter (TWC)

Image: Monty Rakusen

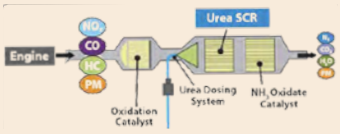


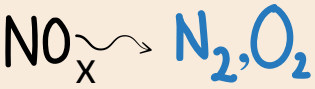
For diesel trucks: Diesel Particulate Filter (DPF) and Secretive Reduction (SCR)

DPF

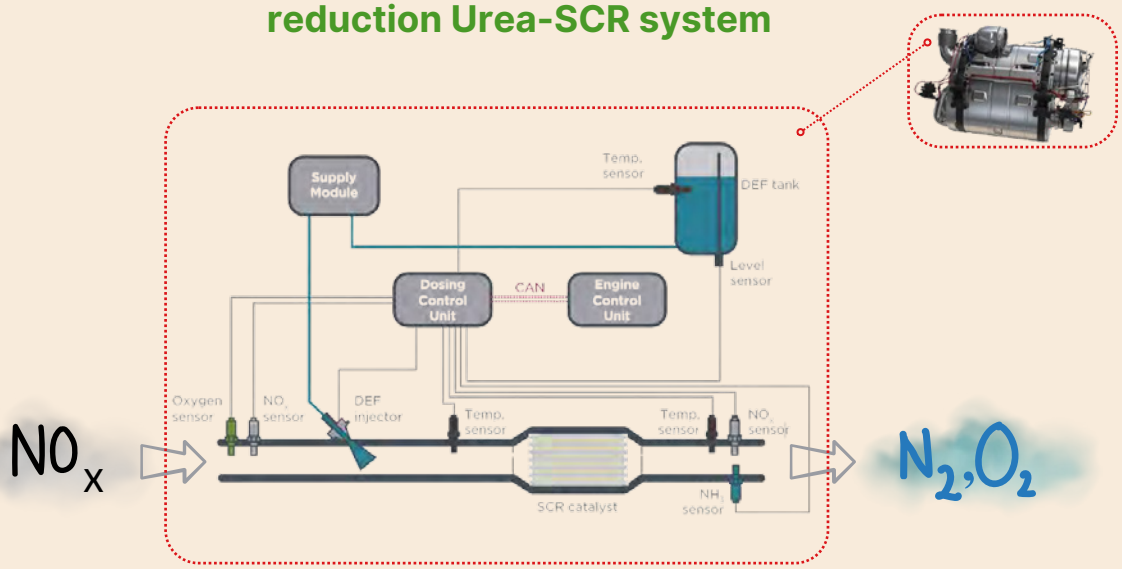


SCR





Example: The complexity of a NOx reduction Urea-SCR system



Caleb Braun, Huzeifa Badshah, Vahid Hosseini, Lingzhi Jin, Josh Miller, Felipe Rodríguez, "Emission tampering among heavy-duty vehicles in Canada," International Council on Clean Transportation (ICCT), Mar. 2022

With near-zero emissions under today's regulations, why are we still discussing transport-related pollution?

Closing the Transportation Climate Pollution Gap

We highlight innovative transportation actions states can take to ensure they meet or surpass their climate targets.

RMI / Dec 2, 2024

Problem: Emission Cheating

- Emission tests are conducted in **controlled** laboratory conditions using predefined drive cycles.
- These cycles are strictly executed and predictable, making it easy for a **vehicle's onboard computer to detect when it's being tested**.
- In response, the vehicle may switch to a low-emission "test mode", while reverting to a higher-emission mode in real-world driving.
- A key example is **Dieselgate (2015)**, where **Volkswagen** was found to have used defeat devices to pass emission tests.
- Real-world emissions were up to **20 times higher** than regulatory limits.
- Despite major penalties for VW, millions of non-compliant vehicles were sold globally.

Solution: PEMS

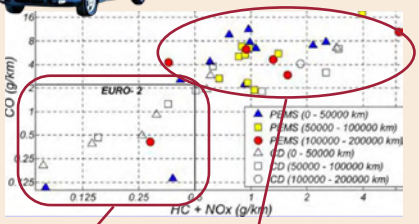
- In response to Dieselgate scandal and to be able to capture Real-World Driving Emissions (RDE), a new test procedure was proposed and implemented : Portable Emission Measurement System (PEMS).

https://www.aip-automotive.de/en/Products/Emission-Technology/Portable-Emission-Measurement

https://www.bosmal.eu/defence/pems-testing-exhaust-emissions-under-real-driving-conditions-and-from-non-road-mobile-machinery-under-actual-operating-conditions/

Problem: Vehicles emit more emissions in real world

Banitalebi, E.; Hosseini, V. Development of Hot Exhaust Emission Factors for Iranian-Made Euro-2 Certified Light-Duty Vehicles. Environ. Sci. Technol. 2016, 50 (1), 279–284

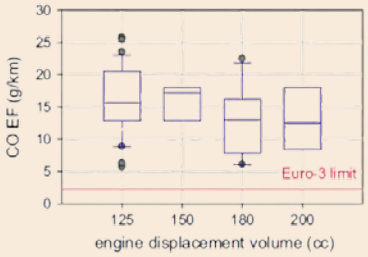


All cars were Euro-2 certified and supposed to be placed in the red rectangle

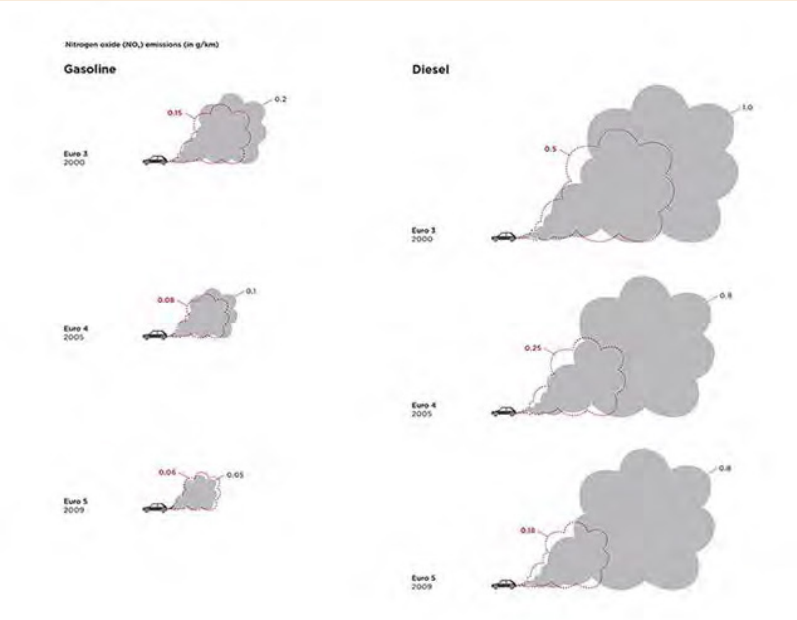
Real-World Emissions: The Gap Widens Over Time

- Actual vehicle emissions are often much higher than certified lab results.
- As vehicles age, their emission control systems degrade, reducing effectiveness.
- Poor fuel quality and lack of proper maintenance further increase real-world emissions.

Hassani, Amir, and Vahid Hosseini. 2016. "An Assessment of Gasoline Motorcycle Emissions Performance and Understanding Their Contribution to Tehran Air Pollution." Transportation Research Part D: Transport and Environment 47: 1–12

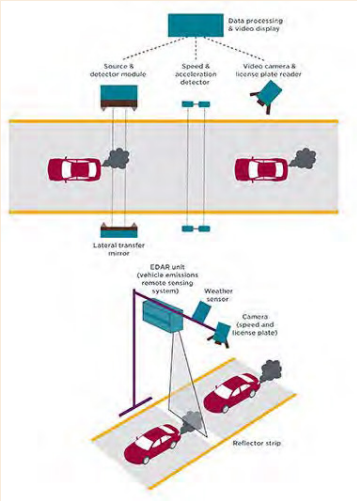


Problem: Vehicles emit more emissions in real world

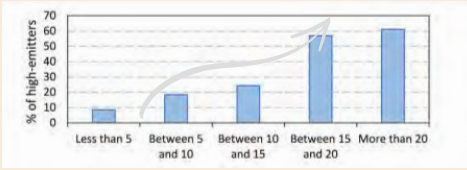


Badshah, Huzeifa, Felipe Rodríguez, and Uwe Tietge. "Laboratory versus Real-World Discrepancies in NO_x Emissions in the EU." International Council on Clean Transportation (ICCT), March 7, 2023.

Solution: Market surveillance - Remote sensing

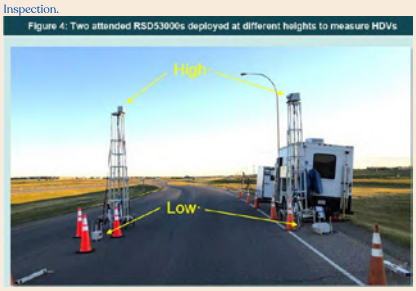


Hassani, Amin, Seyed Reza Safavi, and Vahid Hosseini. 2021. "A Comparison of Light-Duty Vehicles' High Emitters Fractions Obtained from an Emission Remote Sensing Campaign and Emission Inspection Program for Policy Recommendation." Environmental Pollution 286: 117396.



Vehcile Age

Klausmeier de la Torre, Rob, and Niranjan Vescio. 2023. Roadside Optical Vehicle Emissions Reporter III: A Survey of On-Road Light and Heavy-Duty Vehicle Emissions. Final Report. Prepared for CASA, Klausmeier Consulting, Inc. and Opus Inspection.



Solution: Regular emission inspction

- Emissions testing in Alberta has been limited to voluntary pilots and insurance/out-of-province requirements, but no mandatory smog test program has ever been rolled out provincially.
- In British Columbia, AirCare Emissions Testing Program started: 1992 and ended: December 31, 2014. It was mandatory for light-duty vehicles: Year ⩽ 1991: biannual inspection, Year ⩾ 1992: annual or biennial depending on age.
- In Ontario, Drive Clean (Light-Duty Vehicles) launched: 1999 as a mandatory emissions inspection and maintenance program for passenger vehicles more than 3 years old, later changed to 7years old . Initially, vehicles 3+ years old required tests every 2 years. From 2011 onward, only vehicles 7+ years old required testing. On September 28, 2018, Ontario's government announced the discontinuation of Drive Clean for light-duty vehicles.

Problem: Tampering

Caleb Braun, Huzeifa Badshah, Vahid Hosseini, Lingzhi Jin, Josh Miller, Felipe Rodríguez, "Emission tampering among heavy-duty vehicles in Canada," International Council on Clean Transportation (ICCT), Mar. 2022

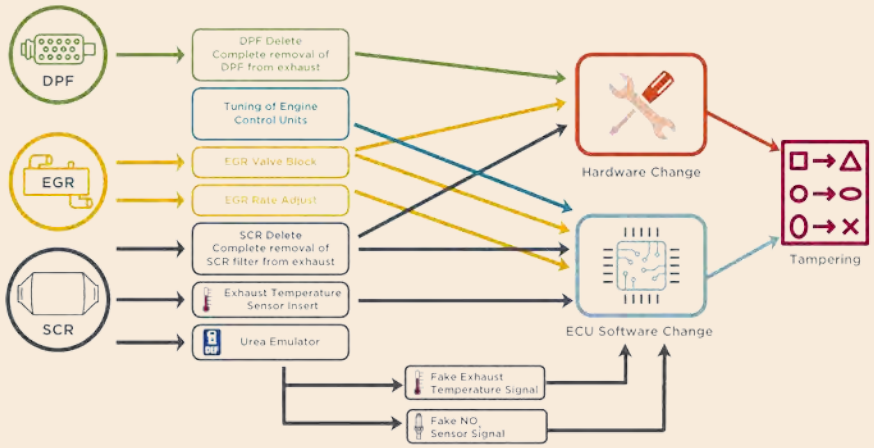


Figure 3. Schematic representation of possible tampering approaches.

Tampering

- Regulations primarily target vehicle manufacturers, **not operators**.
- Operator behavior—such as poor maintenance or **intentional modification**—can undermine emission performance.
- Tampering is defined as the **removal, bypassing, or deactivation** of emissions controls or related software.
- In the U.S., tampering or falsifying emissions controls is illegal under the Clean Air Act (EPA, 2017).
- Several Canadian provinces lack anti-tampering laws or do not enforce them effectively.
- The scale of tampering, its impact on pollutant emissions, and health consequences remain largely unquantified.
- There is a need for research to understand the scope of the issue and identify policy responses.

Tampering elsewhere

- Over 500,000 diesel pickup trucks had emissions controls removed (EPA, 2020).
- Emission increases after tampering:
  - NO_x: 30–300×
  - NMHC: >1,000×
  - CO: >100×
  - PM: 15–40×
- Lifetime impact:
  - Equivalent to 9 million compliant trucks

- Germany (2018):
  - 35% of Euro V and 25% of Euro VI trucks exceeded NO_x limits
- Multi-country (2020):
  - 50% of Euro V and 43% of Euro VI trucks were high emitters
- Czech Republic (2020):
  - 10–25% of Euro V/VI trucks were high emitters
  - ~10–15% had non-functional SCR systems
- Scotland (2017):
  - Euro VI vehicles emitted 4–5× higher NO_x than certified
  - 8% of HDVs identified as high emitters
- Denmark (2018):
  - Non-Danish trucks emitted 31–50% more NO_x than Danish fleet
  - Estimated <25% had tampered SCR systems

Caleb Braun, Huzeifa Badshah, Vahid Hosseini, Lingzhi Jin, Josh Miller, Felipe Rodríguez, "Emission tampering among heavy-duty vehicles in Canada," International Council on Clean Transportation (ICCT), Mar. 2022

WHAT MOTIVATES EMISSION CONTROL TAMPERING?

01 Operational Cost Savings Avoiding DEF (CA$1,500–CA$3,000/year); avoiding DPF cleaning costs

02 Harsh climates (like Canada's) further increase maintenance burdens, incentivizing system deactivation.

03 Fuel Consumption Concerns EGR and DPF can slightly reduce fuel efficiency; SCR avoids this

04 Risk of clogging, fire, and engine damage

Tampering Scenarios in Canada - NOx

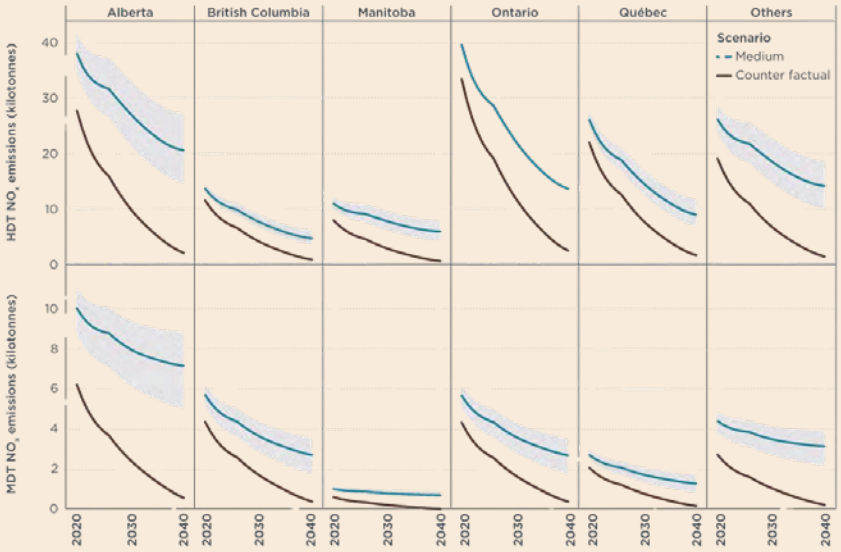
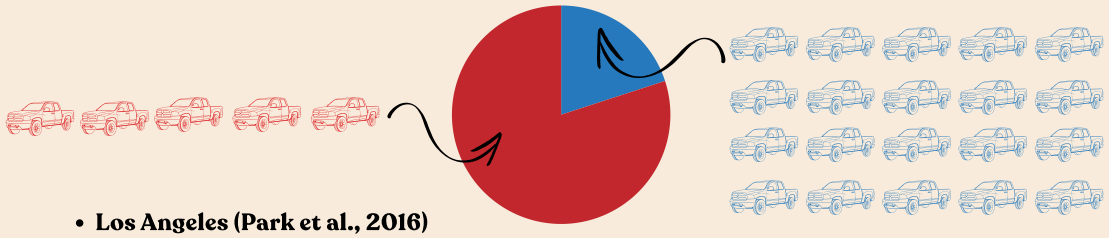


Figure 17. NO_x emissions by vehicle type, scenario, and province, 2020-2040. Uncertainty bounds show the range given by the Low and High scenarios.

Caleb Braun, Huzeifa Badshah, Vahid Hosseini, Lingzhi Jin, Josh Miller, Felipe Rodríguez, "Emission tampering among heavy-duty vehicles in Canada," International Council on Clean Transportation (ICCT), Mar. 2022

Contribution of High Emitters to Emissions



- **Los Angeles (Park et al., 2016)**
  - A roadside study of 350+ light-duty gasoline vehicles in LA found:
  - 12% of vehicles emitted >5× the fleet average, labeled "real-world super-emitters."
  - 15% of vehicles were responsible for >50% of total NO_x and black carbon emissions
- **Remote Sensing Analysis (2021)**
  - A European remote sensing campaign of light-duty vehicles discovered about 20% of the fleet were high-emitting vehicles, responsible for roughly 50% of CO, HC, and NO emissions
- **Historical High-Emitter Study (Bishop et al., 2012)**
  - Research found that in the late 1980s, just 1% of vehicles accounted for 10% of total fleet emissions

Roadside Optical Vehicle Emissions Reporter III

Figure 56: Distribution of HDV NO_x emissions (g/hp-hr) 2010 and newer models

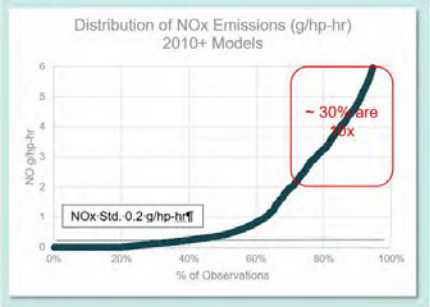
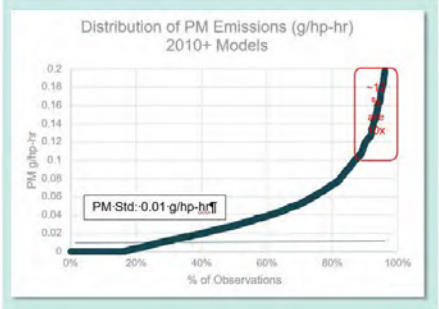


Figure 57: Distribution of HDV PM emissions (g/hp-hr) 2010 and newer models



Klausmeier de la Torre, Rob, and Niranjan Vescio. 2023. Roadside Optical Vehicle Emissions Reporter III: A Survey of On-Road Light and Heavy-Duty Vehicle Emissions. Final Report. Prepared for CASA, Klausmeier Consulting, Inc. and Opus Inspection.

Roadside Optical Vehicle Emissions Reporter III

Figure 60: HDV NO_x distribution—Alberta vs. California

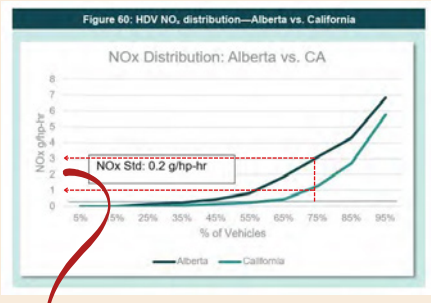
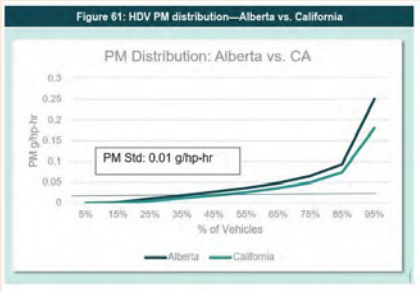


Figure 61: HDV PM distribution—Alberta vs. California



Klausmeier de la Torre, Rob, and Niranjan Vescio. 2023. Roadside Optical Vehicle Emissions Reporter III: A Survey of On-Road Light and Heavy-Duty Vehicle Emissions. Final Report. Prepared for CASA, Klausmeier Consulting, Inc. and Opus Inspection.

In California, 75% of the fleet emit less than 1 g/hp-hr, in Alberta, 75% of the fleet emit 3 times more, 3 g/hp-hr

Remote Sensing Caveats and Constraints

1. The emission measurement is only a snap shot. It is not a representative of true emission over a real world cycle.

2. Many assumptions are involved to convert units from NOx/CO2 to mass NOx/energy unit. The same for other pollutants.

3. It does not differentiate between a high-emitter vs. tampered vehicle.

Moving Forward

1. A study that is statistically significant, covers many # of vehicles of different classes.
2. It is backed up by parallel measurements, namely, PEMS/RDE for selected vehicles
3. Uses inspections and targeted measurement to differentiate between high-emitter vs. tampered.
4. Delivers an understanding of impact of tampering on emission factors.
5. Integrated with other studies : dispersion modeling, emission inventory, source apportionment, roadside studies

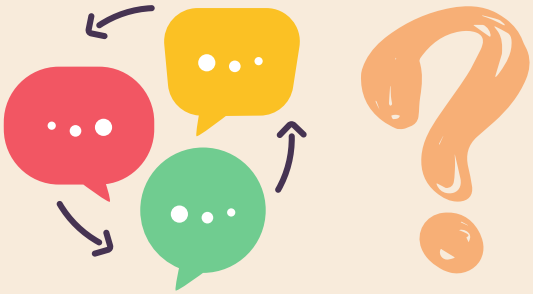
Concluding Remarks

1. Near-zero emissions are achievable for fossil fuel vehicles, thanks to advanced after-treatment systems such as TWC (Three-Way Catalysts), DPF (Diesel Particulate Filters), and SCR (Selective Catalytic Reduction).
2. Despite strict regulations, real-world emissions often exceed laboratory test results, revealing a persistent compliance gap in actual vehicle performance.
3. Exhaust tampering is a known issue, undermining the effectiveness of emission control technologies and contributing disproportionately to pollution.
4. There is a need for further investigation to quantify the prevalence of tampering, differentiate it from naturally high-emitting vehicles, and identify root causes, whether technical, behavioral, or regulatory.
5. Effective communication with stakeholders, including vehicle owners, inspectors, regulators, and enforcement agencies, is essential to ensure policy uptake and lasting behavioral change.

I would like to express my sincere gratitude to the many individuals and organizations who have supported my work:

- My graduate students at the CREATE Research Lab, the School of Sustainable Energy Engineering at Simon Fraser University.
- The nearly 60 MASc and PhD students I've had the privilege of supervising.
- CASA for the kind invitation and the opportunity to share this work.
- The Government of Alberta for supporting my research and related activities in Alberta.
- Environment and Climate Change Canada (ECCC) and NSERC for providing funding.
- The ROVER III project team for their invaluable work, collaboration, and commitment to advancing emission measurement science.

Questions, discussions, contact



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Roadside Optical Vehicle Emission Reporter (ROVER) III

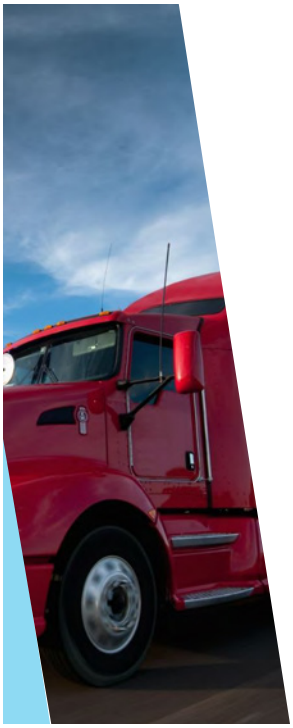
Clean Air Strategic Alliance

Presentation Outline

- About the ROVER Series of Projects
- Data Collection Methodology
- Analysis Results
- Recommendations

About the ROVER series of Projects

- Roadside Optical Vehicle Emissions Reporter
- ROVER I (1998)
  - 42,295 light-duty vehicles in Edmonton, Calgary, Red Deer, Canmore
  - Measured CO emissions: 7% of vehicles “gross emitters”
  - Recommended anti-tampering legislation, scrappage programs, additional ROVER projects
- ROVER II (2008)
  - 66,002 light-duty vehicles in Edmonton, Calgary, Red Deer, Canmore
  - Obtained registration information (vehicle characteristics)
  - Measured CO_2, CO, NO, PM, hydrocarbons: 5% of vehicles “gross emitters”
  - Recommended a program using remote sensing technology to identify high emitters and encourage repairs/scrappage



ROVER III Project Goal & Scope

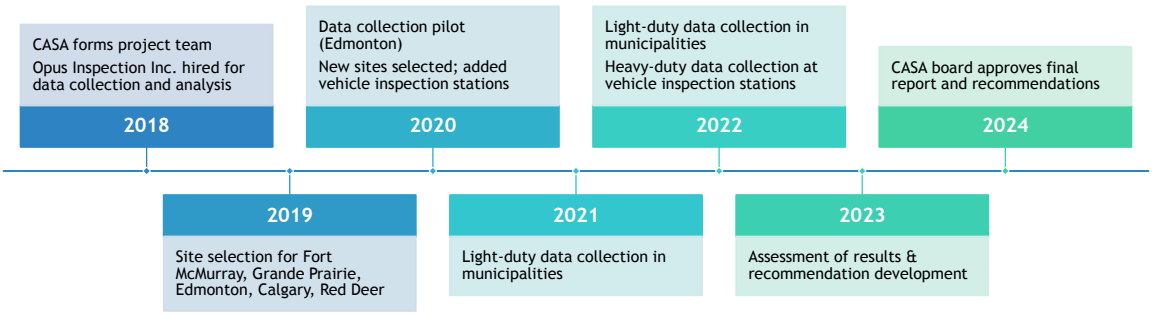
Goal

To measure emissions from the in-use on-road transportation sector, particularly diesel-fueled trucks, to inform management actions and/or next steps for transportation emissions management to help achieve the Canadian Ambient Air Quality Standards in Alberta.

Scope

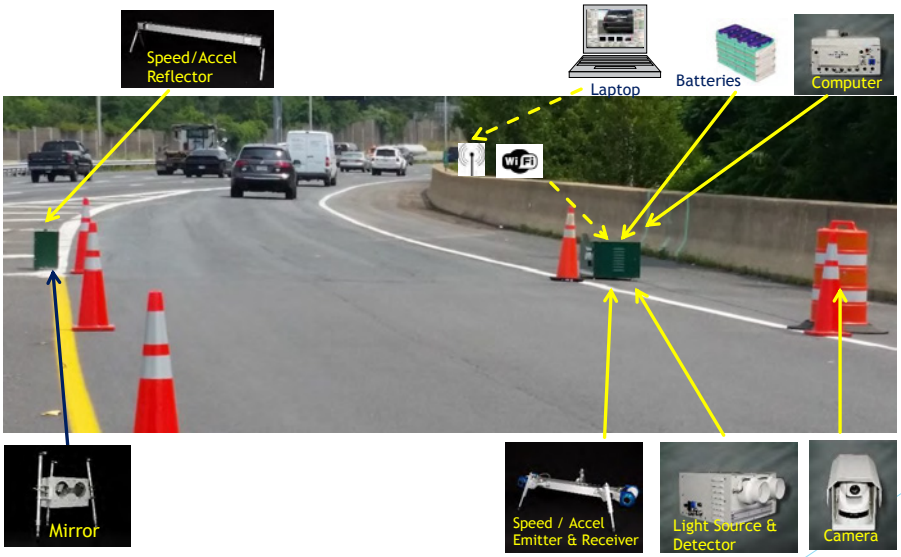
The scope is limited to using remote sensing technology to test emissions from the in-use on-road vehicle fleet, including heavy-duty and light-duty vehicles, and making recommendations on managing emissions from the on-road transportation sector.

Emissions of focus: NO_x, VOCs, CO, CO_2, and PM

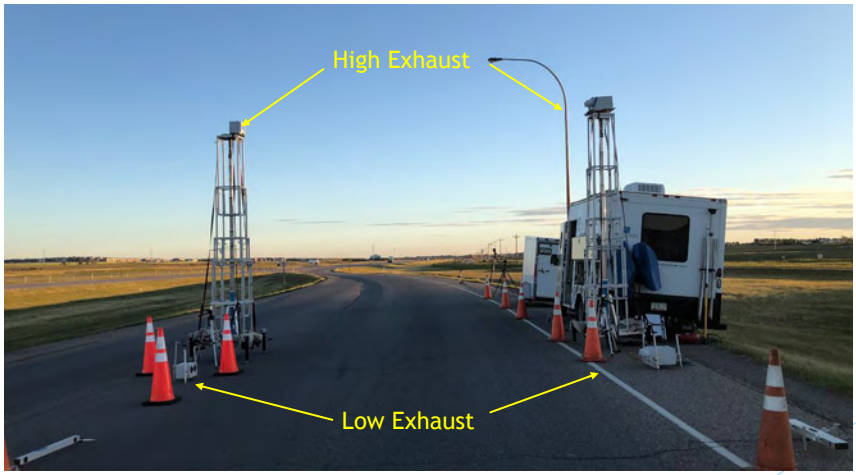


Project Timeline

Data Collection: Light-Duty

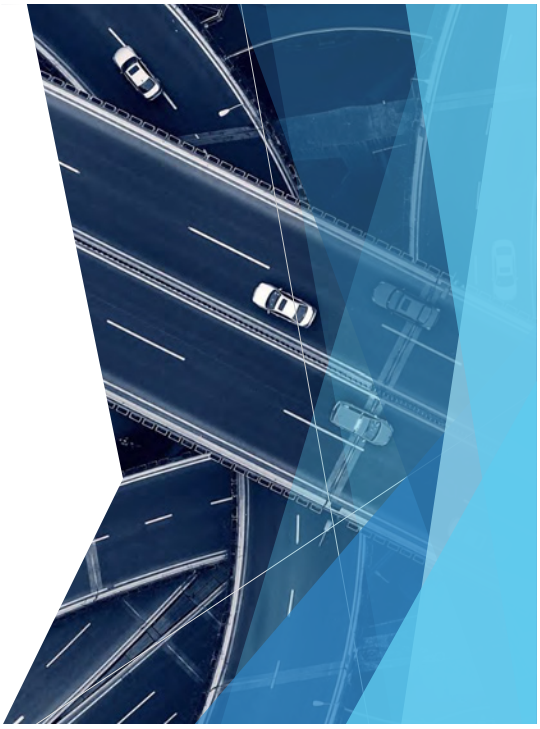


Data Collection: Heavy-Duty



Service Alberta

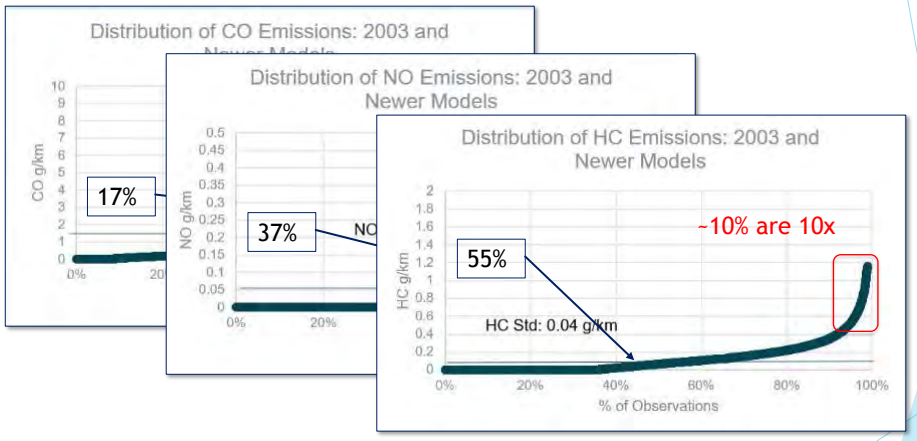
- License plates captured during emissions testing
- Agreement in place between CASA and Service Alberta to obtain vehicle characteristic information
  - Vehicle year
  - Vehicle model
  - Vehicle make
  - Fuel type
  - Gross vehicle weight
  - Body style
  - VIN
- Dataset deidentified before being sent to Opus for analysis



Analysis Results: Light-Duty

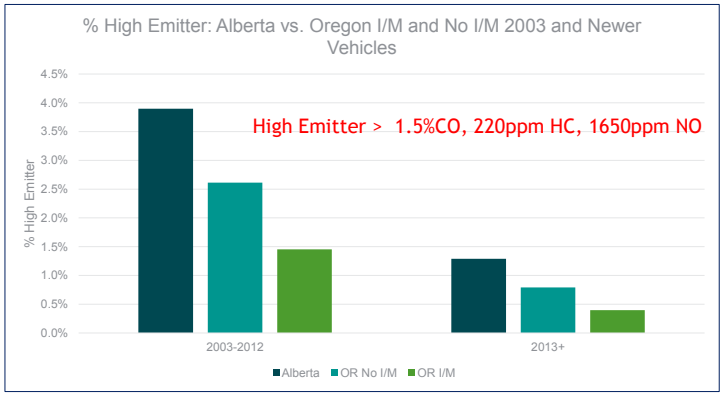
- Fort McMurray, Grande Prairie, Edmonton, Red Deer, Calgary
- 49,747 vehicle measurements
- 95% gasoline
- 99.4% Alberta-registered
- 2/3rd light-duty trucks (pickups, SUVs, vans)

Analysis Results: Light-Duty



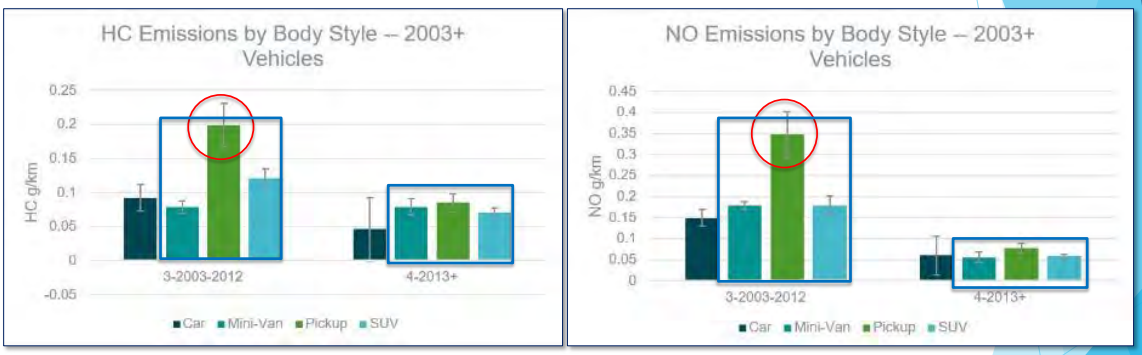
2003+ model year gasoline vehicles represent 97% of vehicle kilometers travelled and Account for 75% and 90% of fleet's NO & HC emissions

Analysis Results: Light-Duty



- Comparison to Oregon, which has inspection and maintenance programs
  - Alberta has significantly higher rates of high emitters
- Largest difference for HC and NO
- Significant at 95% confidence interval for CO, HC, and NO

Analysis Results: Light-Duty

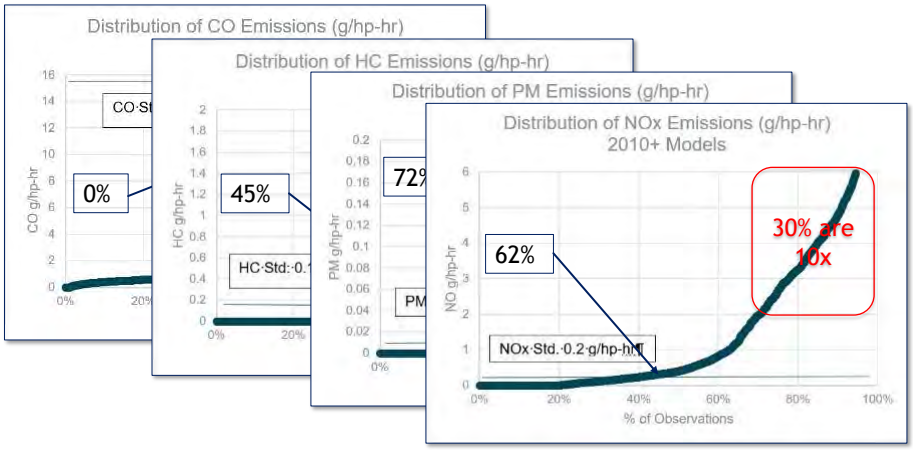


- Trucks (pickups, SUVs, vans) are higher emitters than cars
- Older, middle-age pickups (2003-2012) are significantly higher

Analysis Results: Heavy-Duty

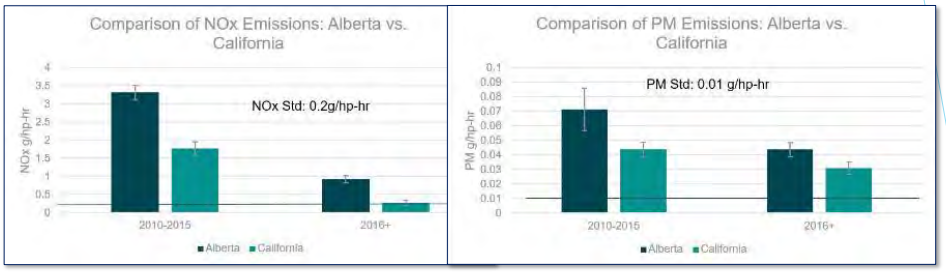
- VIS: Coutts, Airdrie, Leduc, Whitecourt, Atmore, Demmitt
- 6,339 vehicle measurements
- 97% diesel-fueled
- 83% Alberta-registered
- 73% tractor-trailers

Analysis Results: Heavy-Duty



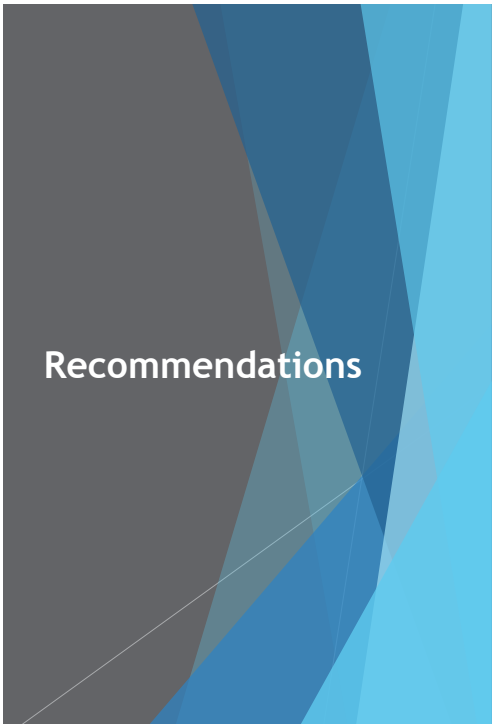
- Analysis limited to 2010+ model years (83% of observations)
- PM & NOx are the greatest concern; majority of measurements above benchmark
- 30% of observations for NOx are ≥10x the benchmark – suspected malfunctioning or tampered emissions controls

Analysis Results: Heavy-Duty



- California has opacity-inspected HDVs since 1998; OBD-inspection starts 2024
- For 2010+ models, all vehicles should have latest emission control devices (SCR and DPF)
- Measured at VIS at similar temperatures with similar technology
- Average Alberta emissions much higher than average California emissions

- ROVER IV
- Increase ambient air monitoring
- Tampering project
- Communicate and educate
  - Tampering impacts
  - Improvements to emission controls
- Provide incentives for high-emitters to lower emissions
- Support collaboration and information sharing
- Use the ROVER III results to update modelled tampering impacts



Assessment of the real-world NOx emissions and associated health impacts from tampered or malfunctioning HDVs in Alberta, Canada

July 2025

The Real Urban Emissions Initiative (TRUE) supports cities worldwide to develop effective air quality and climate policies with independent real- world vehicle emissions data, technical analysis, and expert advice.

Air pollution in Canada and Alberta

- On-road diesel HDVs in Canada released approximately 120,000 tons of NO_x and 3,400 tons of $PM_{2.5}$ in 2022, Alberta ranks as the second-highest emitter of diesel HDV NOx emissions among Canadian provinces
- 48% of Alberta's population reside within one kilometer of a high-traffic roadway, exposing communities to tailpipe emissions and increasing potential health risks

CASA ROVER III data & ICCT study overview

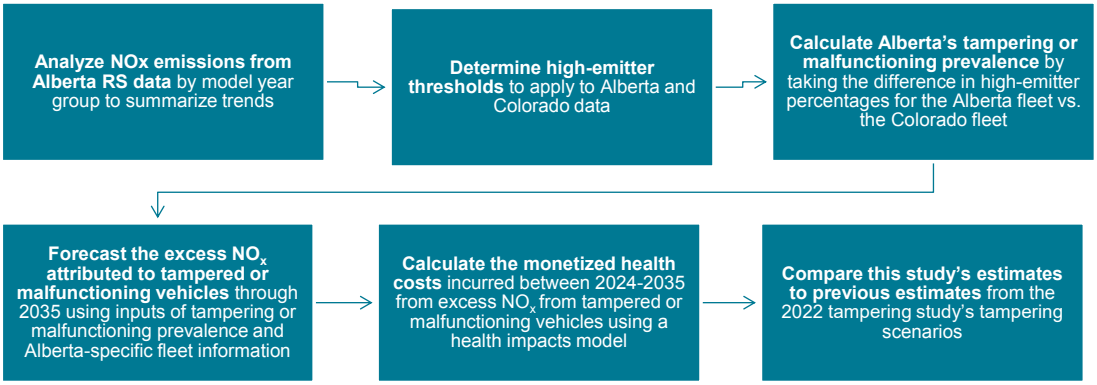
- ICCT team analyzed real-world HDV emissions data from CASA's ROVER III to update ICCT's last Canada HDV tampering & health impacts report published in 2022.
- Conducts a comparative analysis between Alberta and Colorado NOx emissions to determine tampering or malfunctioning prevalence
  - Alberta represents a fleet with high emitters due to tampering or malfunctions
  - Colorado represents a relatively clean fleet undergoing regular inspection and maintenance (I&M) and subject to federal anti-tampering legislation
- Reports new estimates for excess NOx emissions and the public health consequences associated with HDV tampering

Data Overview

Dataset	Valid Counts	Valid counts w/ vehicle info
Alberta 2022 RS Data	7,320	**2,343**
Colorado 2019-2023 RS Data	4,198	**3,451**

Overview of the Alberta and Colorado datasets used for our analysis of HDV emissions in Alberta. *Data were filtered so both have similar ambient and driving conditions.*

Tampering study methodology overview



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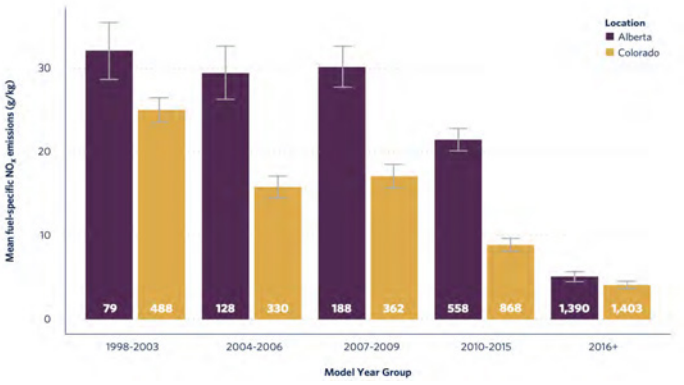
Average emissions in Alberta are significantly higher than in Colorado for pre-MY 2016 vehicles

- Average NO_x emissions in Alberta are 76% to 142% higher than in Colorado for MY groups 2004-2006, 2007-2009, and 2010-2015
- Smaller emission discrepancies between the MY 2016+ group across both regions suggest that differences in operating conditions alone do not explain the emissions gap
- Tampering often occurs between 4-7 years of age and malfunctions are typically more common with older vehicles. This could explain the higher emissions among MY 2010–2015 vs. MY 2016+ Alberta vehicles



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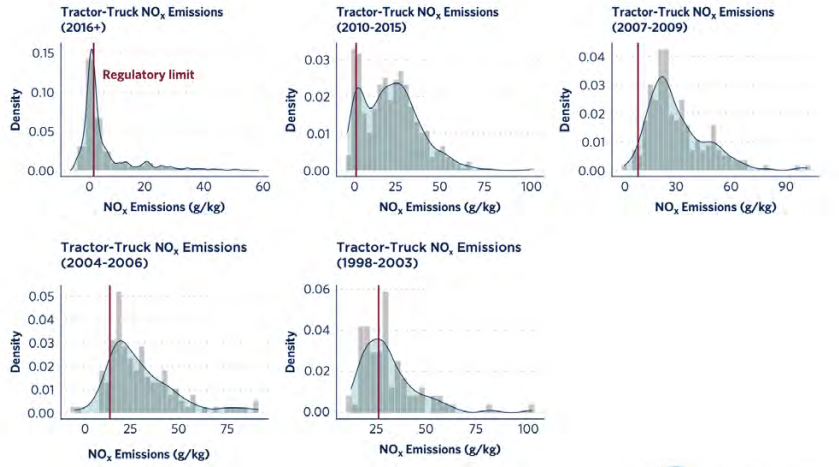
2010-2015 model year group exhibits emissions distribution suggestive of the presence of tampered or malfunctioning vehicles

- MY 2010-2015 demonstrates a subgroup of vehicles emitting around **~19x emissions limit**.
- This subgroup exhibits NOx levels comparable to emissions from older vehicles and suggests potential tampering or malfunctions in vehicle emissions control systems.
- This trend is not specific to certain vehicle makes, models, or engine types but rather reflects a broader issue across the entire fleet.



Identifying high-emitting vehicles to indicate potential instances of vehicle malfunctions or tampering

1. **Define high-emitter thresholds**

For MYs 2010+:

- Threshold: The upper 95% confidence interval of cold-start emission rates reported in a CARB study on MY 2010 and 2011 vehicles (**21.0 g NOx/kg fuel**)
- Cold starts represent the "worst case" scenario for NOx emissions from a clean vehicle

For MYs 2004-2009:

- Threshold: The ICCT Roadmap model emission factor for MY 1998 vehicles (**34.4 g NOx/kg fuel**), represents vehicles without emission control systems

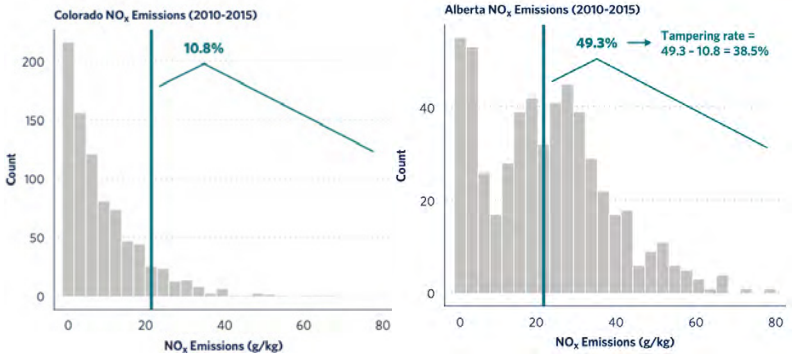
2. **Compare NO_x emissions from the Alberta fleet to a comparatively clean fleet:**

- Colorado diesel tractor truck remote sensing data serves as a benchmark for emissions from a clean fleet.

Calculating tampering prevalence in Alberta

Colorado high-emitter percentage: This value represents the percentage of measurements from clean vehicles taken during instances of elevated emissions (e.g. cold starts)

Alberta high-emitter percentage: This value represents a mixture of normally occurring elevated emissions from clean vehicles and emissions from tampered or malfunctioning vehicles.



Tampering/Malfunctioning prevalence calculation method: Subtract the percentage of high emitters in Colorado from the percentage of high emitters in Alberta to derive the tampering/malfunction rate.

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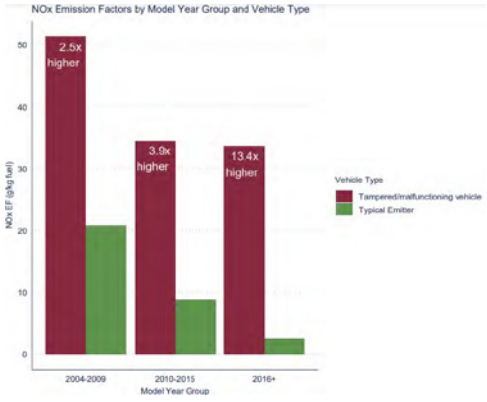
Estimates from 2022 RS data indicate 38.5% of the on-road HDVs in the MY 2010-2015 group are tampered or malfunctioning

	Model Year Group		
	2004-2009	2010-2015	2016+
Percentage of high-emitters in Alberta	29.7%	49.3%	8.3%
Percentage of high-emitters in Colorado	8.5%	10.8%	3.6%
Alberta tampering or malfunction prevalence	**21.2%**	**38.5%**	**4.7%**

Final or maximum tampering/malfunctioning prevalence (all vehicles have aged beyond the 7-year "useful life" period)

Newer vehicles have lower tampering/ malfunctioning prevalence but are modeled to increase between ages 4 and 7



Emission factors developed using the remote sensing data

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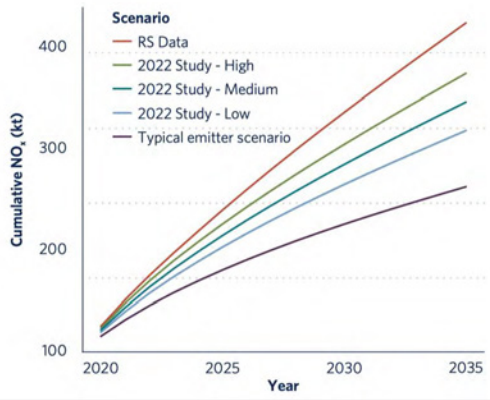
Roadmap model NO_x emissions

Roadmap Model: Global transportation emissions model used to assess the emissions impacts of different policy options (in this case tampering/malfunctioning incidence)

Modeled 2020-2035 NOx emissions under several scenarios:

- RS data scenario (uses latest CASA data)
- High, medium, and low scenarios from the 2022 study (assigned as 2-19% tampering rates, not based on concrete evidence)



By 2035, emissions projected using the remote sensing data are **31% higher** than in the 2022 study's Medium scenario, or 105 kt of NOx higher.

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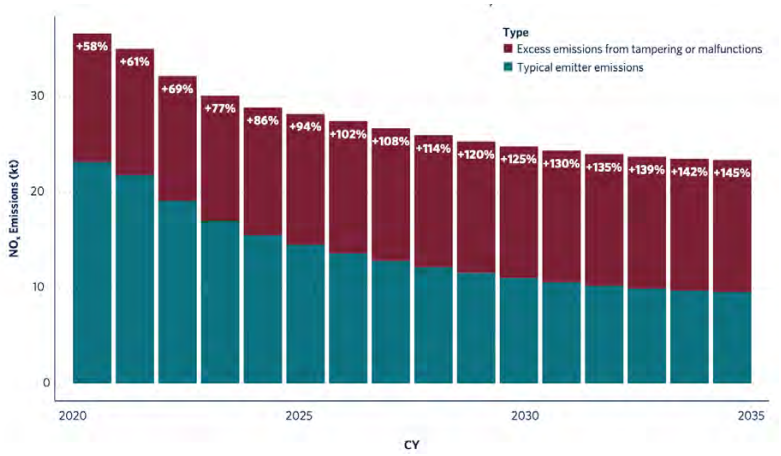
Excess NO_x emissions due to tampering/ malfunctions



- By 2035, the RS data scenario shows that **excess emissions result in a 145% increase in total emissions compared to baseline emissions.**
- Due to tampering and malfunctions, projected decline in NO_x emissions from 2025 to 2035 is modest (~17%) despite the introduction of progressively more stringent emissions standards

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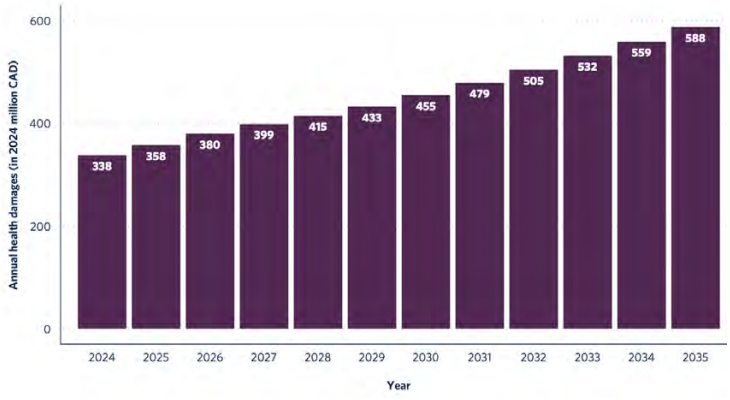
Health impacts of tampering

FATE Model: health impact model which estimates premature deaths from transport-related air pollution ($PM_{2.5}$ and O_3) due to stroke, ischemic heart disease, COPD, lower respiratory infection, lung cancer, and diabetes mellitus 2.

Modeled the monetized impact from premature deaths between 2024 – 2035 resulting from diesel HDV-related excess NO_x emissions in Alberta, using the Value of Statistical Life.

Between 2024 and 2035, the cumulative excess health damages from premature deaths is projected to reach **$5.4 billion (in 2024 CAD), representing 419 total premature deaths.**



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Summary of main findings

- **38% of models from 2010 to 2015** show evidence of tampering or malfunctions.
- By 2035, tampered or malfunctioning vehicles are estimated to **increase total NOx emissions by 145%** compared to a properly functioning fleet.
- The health impact of these excess emissions is estimated to include 419 preventable deaths and **CAD $5.4 billion in health-related costs** in Alberta between 2024 and 2035.
- Policies to address tampering and malfunctions can **reduce overall tractor truck NOx emissions by 59% annually through 2035**.

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Recommendations from the study

- Explicitly prohibiting all tampering at a federal level in Canada is an important step to address the issue of tampering.
- Alberta can instate an I&M program to monitor vehicle emissions for continual compliance, similar to programs in other Canadian provinces or states in the US.
- Remote sensing technology can serve as an effective tool for robust market surveillance of high- emitting vehicles, providing valuable insights into emissions trends in the Alberta fleet over time

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Thank you!
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Appendix D – References

The below references are those gathered for project Objective 2: Compilation of Information on Vehicle Emission control System Tampering and Reliability in Alberta. Where references were applicable to multiple topics, the reference is repeated across all relevant categories.

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Appendix E – Objective 4 Report (Alberta Motor Transport Association)

UNDERSTANDING VEHICLE EMISSION CONTROL SYSTEM TAMPERING IN ALBERTA

AMTA Report for CASA

Prepared By:

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Understanding Vehicle Emission Control System Tampering in Alberta

AMTA Report for CASA

Contents

1.0 Introduction from AMTA (Alberta Motor Transport Association)

Development of the Report

The Alberta Motor Transport Association (AMTA) is a province-wide, not-for-profit industry association that represents and supports the commercial transportation industry in Alberta.

This report is the culmination of AMTA's detailed market research, jurisdictional scans, one-on-one interviews and surveys conducted with 60 mechanics in the Alberta region that service Class 8 vehicles, including AMTA members and numerous other mechanics and shops throughout the region. We reached out to over 90 mechanics and shops in the Alberta region, emphasizing that any information gathered will not incriminate or implicate anyone and that this is merely a data-collection exercise.

We encouraged precision and citing of specific examples wherever possible, connecting with individuals through a combination of telephone, email, and in-person interactions. Through our communications, we were able to conduct surveys and one-on-one interviews with 60 mechanics and shops in the Alberta region. Unfortunately, even though we were able to identify some specific shops that are performing tampering and deletion services, it is possible that those specific shops were hesitant to participate in the surveys and interviews.

We believe that some shops' unwillingness to participate was because they were performing tampering and deletion services, although we were sure to emphasize that we would not incriminate or "name names". Some of the mechanics surveyed were able to provide us with specific shops they are aware of that are performing tampering/deletion services; however, the identified shops declined to speak with us, even "off the record". We continued to emphasize that any information gathered would not be used against them and that they would remain anonymous with any disclosures.

Limited use of artificial intelligence (AI) was made in drafting this report, primarily for language refinement and formatting support. All key ideas, interpretations, and findings reflect the independent work and judgment of the author(s).

All references included in this report were carefully vetted for relevance, credibility, and accuracy. Sources were selected based on their authority in the field of heavy-duty trucking and tampering, regulatory compliance, and equipment integrity, with priority given to peer-reviewed studies, government publications, and reputable industry reports. Information

related to tampering incidents was cross-verified across multiple sources, where possible, to ensure reliability.

The following report will be broken into two main sections: our findings for each of the identified questions as laid out in the scope of work, and our suggestions for next steps moving forward. These are by no means recommendations for industry; however, there may be certain steps that could be taken to contribute to a lower rate of tampering and deletions throughout Alberta.

Please note that AMTA undertook a portion of the questions identified in the Vehicle Emission Controls in Alberta Request for Proposals (CASA Understanding Vehicle Emission Control System Tampering in Alberta Project). AMTA identified which themes and questions we could sufficiently answer and chose to omit some questions as a result.

Theme I – Number of Tampered Vehicles
Questions A-C
- This theme was answered by reaching out to as many mechanics and shops in the Alberta region as possible to conduct interviews and surveys.

Theme II – Profile of Tampered Vehicles
Questions A-D
- This theme was answered by reaching out to as many mechanics and shops in the Alberta region as possible to conduct interviews and surveys. In addition, a literature review for Canada, the U.S. and other jurisdictions was conducted, with supporting information from corroborating websites.

Theme III – Economic Impacts of Tampering
Questions A-F
- This theme was answered by reaching out to as many mechanics and shops in the Alberta region as possible to conduct interviews and surveys.

Theme IV – Emissions Control System Effectiveness and Vehicle Performance
Questions A-F
- *This theme was not undertaken by AMTA*.

Theme V – Perceptions and Beliefs Around Tampering
Questions A-C
- This theme was answered by completing a jurisdictional scan of changes in regulatory approaches to vehicle emissions or tampering in the last decade. AMTA also scanned

media and opinion pieces on vehicle emissions and tampering for changes in sentiment through time.

This report contains information that has been prepared for the Clean Air Strategic Alliance (CASA). CASA's processes do not require consultant reports to be reviewed or approved by its Board of Directors, and as such, any conclusions or recommendations in this report are those of the report's authors, and the contents of this report do not necessarily reflect the views of CASA, its Board of Directors, or its members.

2.0 Forward from CASA (Clean Air Strategic Alliance)

Understanding Vehicle Emission Control System Tampering in Alberta – Project Summary

The Clean Air Strategic Alliance (CASA) is a not-for-profit society that contributes to the strategic air quality management for Alberta by identifying priority issues and developing action plans, evidence-based recommendations, information, and tools that weigh environmental, health, and economic consequences and expected outcomes.

The transportation sector is one of the largest air emission sources of nitrogen oxides (NOx) in the province. Vehicle emissions also contain particulate matter and volatile organic compounds, all of which are air contaminants associated with health impacts, and CASA has had a long-standing series of projects in this area.

CASA began the Roadside Optical Vehicle Emissions Reporter (ROVER) project in 1998, with additional iterations ROVER II and ROVER III in 2006 and 2024, respectively. The results of all three projects showed a similar trend, that a small proportion of vehicles was responsible for most of the recorded emissions. With ROVER III results showing that approximately 30% of heavy-duty diesel-fueled vehicle emission measurements were ten times the NOx emissions benchmarks, the focus of CASA's current project was to explore emission control system tampering and the reliability of emission control technology in Alberta's climate.

The project's strategic intent was to complete a comprehensive study that:

- identifies the magnitude and sources of vehicle emission control system tampering, including information gathered about manufacturers, sellers, and installers of defeat devices
- includes an assessment of the economic impact of vehicle emission control system tampering
- improves understanding of the reliability of factory-installed emissions control devices

After the project began, CASA's financial situation changed so that it could not continue to work towards fulfilling the project's scope of work as originally intended. With less time and fewer resources, the project team prioritized data collection via a contract with the Alberta Motor Transportation Association (AMTA), who were able to address approximately 80% of the information gaps identified for heavy-duty on-road vehicles.

The following report summarizes the work carried out by AMTA on behalf of CASA. Future opportunities to carry this work forward could include filling remaining information gaps (for vehicle types other than on-road heavy-duty vehicles, emission control effectiveness and vehicle performance), gathering data from those that refused to participate in AMTA's surveys, and engaging with owners/operators who may do their own private tampering.

It is hoped that the important work supporting management of transportation emissions in Alberta can continue to move forward to the benefit of all Albertans.

3.0 Acronyms, Abbreviations and Terms

AMTA – Alberta Motor Transport Association

CASA – Clean Air Strategic Alliance

CCME – Canadian Council of Ministers of the Environment

Class 8 – Heavy-duty vehicle. This refers to a commercial vehicle above the Government of Alberta's registered weight of 11,794kg for a vehicle combination.

CEPA – Canadian Environmental Protection Act

CVIP – Commercial Vehicle Inspection Program. This is a mandatory inspection program in Canada, specifically in Alberta, designed to ensure that commercial vehicles, including trucks, are safe and compliant with provincial standards.

DEF – Diesel Exhaust Fluid. It is used to reduce emissions from diesel engines by converting nitrous oxide into water and nitrogen.

Deleting – Deleting a truck refers to the modification or removal of factory-installed emissions control systems, typically to improve performance or reduce maintenance issues. These systems typically include:

- DPF (Diesel Particulate Filter)
- EGR (Exhaust Gas Recirculation)
- DEF / SCR systems

Derating – Derating a heavy-duty truck refers to the intentional reduction of the vehicle's Gross Vehicle Weight Rating (GVWR) and/or Gross Axle Weight Ratings (GAWR), as recognized for regulatory, registration, or operational purposes. This establishes a new, lower maximum allowable weight for the vehicle, and may affect:

- Registration weight
- Compliance category
- Licensing or regulatory requirements

DOC – Diesel Oxidation Catalyst. This is a crucial component in diesel engines designed to reduce harmful emissions by converting carbon monoxide and hydrocarbons into less harmful substances like carbon dioxide and water.

DPF – Diesel Particulate Filter. It is a device used in the exhaust system of trucks to trap particulate matter, such as soot, from diesel engine emissions.

DriveON – Ontario's digital-based initiative for vehicle safety and emissions inspections, replacing the traditional paper-based Motor Vehicle Inspection Stations (MVIS) program.

ECU – Electronic Control Unit. This is a microprocessor-based device that manages and coordinates various electronic systems within a truck, ensuring optimal performance and safety.

EGR – Exhaust Gas Recirculation. This is a system in diesel trucks that recirculates a portion of exhaust gases back into the engine to reduce nitrogen oxide (NOx) emissions and control combustion temperature.

EPA – Environmental Protection Agency. This is the U.S. federal agency responsible for regulating vehicle emissions and environmental standards.

ESG – Environmental, Social, and Governance. ESG reporting helps assess a company's impact on the environment, its social responsibilities, and its governance practices.

HDV – Heavy-Duty Vehicle. This refers to a commercial vehicle above the Government of Alberta's registered weight of 11,794kg for a vehicle combination.

LDV – Light-Duty Vehicle. This refers to private vehicles and commercially registered vehicles with a registered weight of less than 11,794kg.

MVIS – Motor Vehicle Inspection Stations

NOx – Nitrogen Oxides. These are pollutants generated from the combustion of diesel engines.

NSC11 – National Safety Code, Standard 11. This focuses on the Periodic Motor Vehicle Inspections (PMVI). This standard outlines the minimum performance standards for the safe operation of commercial vehicles, including trucks, and is designed to ensure the mechanical fitness of vehicles on the road.

OBD – On-Board Diagnostics. This system is essential for monitoring and diagnosing a vehicle's performance and health.

OEM – Original Equipment Manufacturer. OEMs are companies that produce parts, components, or systems used in a company's end product.

PM – Particulate Matter. This refers to small particles in the air that can be harmful to health and the environment.

PMVI – Periodic Motor Vehicle Inspection Program. This program is designed to ensure that commercial vehicles are safe for operation and must undergo regular inspections to maintain compliance with safety standards.

SCR – Selective Catalytic Reduction. This is an emissions control technology used in diesel engines to reduce nitrogen oxide (NOx) emissions from exhaust gases.

Tampering – As described by the Canadian Council of Ministers of the Environment (CCME), tampering with vehicles or engine emission controls includes:

- Removing, bypassing, defeating, or rendering inoperative any emission control system device installed in or on a vehicle or engine, including software designed to monitor or control vehicle emissions
- Modifying the vehicle or engine in any way that results in increased emissions from the level to which it was originally designed or certified by the manufacturer or importer of the vehicle or engine

4.0 Findings

4.1 Theme I | Number of Tampered Vehicles

a) How frequently are tampering services performed by mechanics in Alberta?

Never	14/60 respondents	23% of respondents
Rarely – only when absolutely necessary	42/60 respondents	70% of respondents
Frequently	4/60 respondents	7% of respondents

Out of 60 respondents to this question, 14 responded that their shops and mechanics will never perform tampering or deletion services on heavy-duty vehicles.

42 of the respondents were more "on the fence" about performing these services, indicating that they will perform them "when necessary". The situations where they deemed these services necessary were almost entirely financially related, when costs to remedy the emission control systems on the truck became cost-prohibitive.

40 of the 42 respondents who indicated they "rarely" perform tampering services indicated that financial motivations are when they deem tampering necessary. The other two did not specify specific scenarios in which they deem tampering necessary.

Of the four respondents who indicated they frequently tamper, they indicated that they do it to improve the heavy-duty vehicle's overall performance.

Theme I | Number of Tampered Vehicles

b) How many vehicle owners or operators are tampering with their own vehicles?

Many/Numerous	28/60 respondents	47% of respondents
Very Few	21/60 respondents	35% of respondents
Don't know/ Unsure	11/60 respondents	18% of respondents

This question seemed to really create a division with the answers we received. 28 of the respondents stated that, to their knowledge, owners and operators are often tampering with their own vehicles (over 50% of the time was the average number cited), although 21 respondents indicated just the opposite and said that operators typically don't know how to perform these services without the assistance of a mechanic shop to support them.

11 of the respondents were completely unsure or did not want to commit to an answer either way.

Theme I | Number of Tampered Vehicles

c) Are there differences in tampering rates for different-sized operations (e.g. fleets from 2-20 vehicles compared to fleets with greater than 20 vehicles)?

Yes – smaller fleets tamper more often	57/60 respondents	95% of respondents
No – there is no difference	1/60 respondents	2% of respondents
Don't know/ Unsure	2/60 respondents	3% of respondents

This question was almost unanimous amongst our respondents. 57 of the 60 people interviewed claimed that tampering is more prevalent in small fleets than in larger fleets. Only one person responded that they weren't aware of any difference. And two were unsure.

4.2 Theme II | Profile of Tampered Vehicles

a) Is there a difference in tampering rates or types of tampering performed on vehicles that are staying in Alberta vs. those that are driving to other jurisdictions where inspection and maintenance programs include emission control devices or emission testing?

Yes – within Alberta more often	59/60 respondents	98% of respondents
Don't know/ Unsure	1/60 respondents	2% of respondents

When assessing the perceptions surrounding tampering, it is important to understand how Alberta compares to other provinces and even the U.S. when it comes to enforcement. The literature reviewed has been cited, as well as some websites that back up the included information.

Alberta vs Ontario vs U.S. — enforcement intensity

Alberta: weakest enforcement structure (historically and currently)

The core reality is that there are no dedicated provincial anti-tampering regulations or inspection programs for heavy-duty trucks. [theicct]

Enforcement relies mostly on general safety inspections (which are not designed to detect deletes).

The practical implications of this mean that there is a very low probability of detection in day-to-day operations in Alberta, due to no routine emissions testing to trigger enforcement, and limited roadside capability focused on emissions compliance.

This gap is evidenced by the fact that Alberta is explicitly identified as lacking inspection and maintenance programs, as well as enforcement mechanisms to identify tampered trucks. [theicct]

This means that tampering has historically been low-risk locally, which is why prevalence is relatively high (around 20% across all vehicles and 38% among vehicles at least seven years old). (There is no regulatory risk; however, certain dealerships may refuse to work on a tampered truck or refuse warranty work, which is an identified risk factor). [theicct]

Ontario: structured, active enforcement

Ontario has built a multi-layered enforcement system, with three primary components [theicct]:

1) Mandatory rules & legal framework

- Vehicles must:
  - retain original emissions systems
  - operate without fault codes or visible emissions [canlii.org], [ontario.ca]

2) Active enforcement mechanisms

- DriveON program (inspection & compliance system)
- Roadside enforcement expanded (2021–2025)**:**
    - on-board diagnostic (OBD) checks
    - opacity testing
    - visual checks for tampering [trucknews.com]

3) Real enforcement actions

- Thousands of inspections and hundreds of tickets issued
- Repair orders averaging over $12,000 per truck
- Inspections include out-of-province vehicles [ontruck.org]

In Ontario, this means that tampering is detectable, penalized, and increasingly risky, even for passing-through trucks.

United States: strongest enforcement

The U.S. has had the most aggressive enforcement regime in North America, with two primary components:

1) Federal prohibition + active enforcement

- The Clean Air Act bans tampering, selling, and installing delete kits
- EPA has run a national enforcement initiative targeting defeat devices [epa.gov]

2) Real penalties & scale

- 2020–2023:
    - 172 civil cases
    - $55.5 million in fines
    - criminal prosecutions with jail time [epa.gov]
- Individual cases:
    - $100k+ fines for small fleets (multi-vehicle deletes) [overdriveonline.com]

An important nuance to take note of in the U.S., is the 2026 shift, where the Department of Justice (DOJ) stopped pursuing criminal charges. However, civil penalties are still fully enforced, and state enforcement remains aggressive. [truckinginfo.com], [carscoops.com]

This means that in the U.S., they have fostered a strong inspection, audit and enforcement ecosystem, leading to a high financial risk associated with tampering or deletions.

Key comparison

Feature	Alberta	Ontario	United States
Anti-tampering enforcement	Weak	Moderate–strong	Strong
Inspection program	None (HD trucks)	Yes	Yes
Roadside emissions checks	Limited	Active & expanding	Extensive
Out-of-province enforcement	Minimal	Active	Active
Financial penalties	Rare in practice	Regular	Severe
Criminal enforcement	No	No	Yes (reduced in 2026)

What happens when Alberta trucks leave the province?

Entering Ontario (immediate enforcement exposure)

Ontario explicitly inspects out-of-province trucks and has found approximately 60% of those inspected were non-compliant. [ontruck.org]

The risks for an Alberta truck at a roadside stop include the detection of missing diesel particular filters (DPF)/ diesel exhaust fluid (DEF) / exhaust gas recirculation (EGR), bad on-board diagnostics (OBD) data, and/or visible smoke. Consequences include fines, repair orders, and potential vehicle restrictions. So even if a truck is "legal" in Alberta, it can become non-compliant instantly in Ontario.

Crossing into the United States

A deleted truck may physically cross into the U.S., however, the risk shifts from essentially none to financially severe. Firstly, U.S. Customs and EPA will inspect the vehicle at the border and can detect any missing emissions systems. Any violations have triggered fines (e.g., $41,000+ penalty for a single imported tampered truck). [epa.gov]

In terms of legal requirements, the vehicle must meet original emissions configurations from the time of manufacture. This applies even to used vehicles and Canadian imports. [epa.gov]

On-road enforcement after entry from an EPA and state regulator level includes audits, inspections and even fleet investigations. The risks include fines per vehicle and in extreme cases, fleet-level enforcement actions.

Bottom line for operators

A deleted truck operating only in Alberta is historically low risk. That same truck in Ontario carries a moderate, immediate enforcement risk. In the U.S., that same truck carries high financial and regulatory risk.

This is why industry perception is shifting. There are concerns around whether or not the truck is "legal", but also, "where will this truck operate?"

Alberta can be more relaxed in terms of enforcement than other provinces (such as Ontario), with fewer regulations than the U.S. It was common in our interviews to hear from respondents that their drivers don't worry about operating a tampered vehicle in Alberta, but more so if it has to leave the province, and particularly if it has to go to the U.S.

Obviously, we don't have specific numbers as to how many tampered and deleted vehicles exist in Alberta, as opposed to other provinces, but our research indicates that most tampered and deleted vehicles in Alberta are staying in Alberta to avoid any negative repercussions.

b) Are vehicles tampered with at a specific vehicle age, or are vehicles of certain model years more likely to be tampered with?

Yes – older vehicles, but not a specific age	46/60 respondents	77% of respondents
Yes – vehicles more than five years old	8/60 respondents	13% of respondents
No	2/60 respondents	3% of respondents
Don't know/ Unsure	4/60 respondents	7% of respondents

According to research, truck age and model year are among the strongest predictors of whether a heavy-duty diesel has been tampered with. There's a very clear pattern tied to how emissions systems evolved. This information is more Alberta-specific, and could vary between provinces and throughout the U.S.

The breakdown below outlines which vehicles are more prone to tampering and deletions, and why.

The highest-risk group: ~2010–2015 model years

- About 38% of model year 2010–2015 tractor trucks show signs of tampering or malfunction. [theicct], [trueinitiative.org], [trucknews.com]
- This group produces nearly half of the total NOx emissions despite being a minority of the fleet. [trueinitiative.org]

According to research, this is the peak tampering window.

Why are these trucks most likely to be deleted?

1) These are the first generation of complex emissions systems

- 2007–2010 introduced:
  - DPF (diesel particulate filter)
  - EGR (already present but expanded)
- 2010 tightened NOx → forced adoption of SCR + DEF systems [ttnews.com], [dpfguys.com]

These early systems were more failure-prone, less refined and expensive to repair.

2) They're old enough that the warranty no longer matters

- Deletes typically happen ~3+ years after purchase [greencarreports.com]
- By now (2024–2026), 2010–2015 trucks:
  - are well out of warranty
  - still have usable life

This means that they fall into the perfect window for high repair costs, no warranty protection, and a strong incentive to "solve it permanently".

3) They're heavily used in working fleets

These trucks are often workhorses (Class 8 tractors, oilfield trucks, etc.), and often high mileage. Emissions components wear out, which means there are repeated failures.

Second-highest risk: 2007–2009 (early emissions era)

Why do these trucks get deleted?

These were the first trucks with DPF systems. Early DPF systems had poor regeneration performance and clogging issues. They are simpler than later trucks, in that there is no SCR or DEF yet in many cases. There was also a big drop in fuel economy compared to pre-2007 trucks. [drivingline.com]

This means that many were deleted early in their life cycle, and a significant portion may still be running today in deleted form.

Moderate risk: 2016–2019

What changes with these trucks?

Emissions technology improved, allowing for better SCR reliability, improved fuel economy, and fewer catastrophic failures.

There are still some deletes, but these vehicles tend to be less driven by severe reliability issues, and more influenced by cost avoidance and performance. These trucks are less likely to be tampered with and deleted than 2010–2015 model years, but they are still present in the tampered pool.

Lower risk: 2020+ (newer trucks)

Why are deletes in these vehicles less common?

Many of these vehicles are still under warranty (or recently out). They have much better emissions system integration and more electronic integration, which makes it more difficult to tamper cleanly.

It should be noted that deletes still occur in these vehicles, however, they are less common and more well-hidden and cautious.

Very low risk: pre-2007

Why are these vehicles so low risk?

These trucks had minimal emissions controls, often with no DPF/SCR to remove. So technically, these trucks are not “deleted”, but they emit at levels similar to newer deleted trucks. Also, many of these trucks are no longer on the road, so there is obviously a lower prevalence of tampering.

c) Are certain types of emission control devices more likely to be defeated than others due to failure rates, repair costs, maintenance requirements, replacement part availability, or other reasons?

Yes – Diesel Particulate Filter (DPF)	3/60 respondents	5% of respondents
Yes – Selective Catalytic Reduction (SCR)	7/60 respondents	11% of respondents
Yes – more than one device/system	49/60 respondents	82% of respondents
Don't know/ Unsure	1/60 respondents	2% of respondents

When questioning the mechanics and shops, some responded that certain devices (such as DPF or SCR) are more likely to be defeated. Most respondents stated that a combination of more than one device was most common. The most common answer we received was that these devices are often the diesel particulate filter (DPF), exhaust gas recirculation (EGR), and the diesel exhaust fluid (DEF).

Some emissions components are much more likely to be defeated than others, and the pattern is very consistent across fleets. It does not seem random: it seems to directly reflect which systems fail most often, cost the most, and disrupt operations the most.

The components most likely to be removed are the ones that combine high failure rates, high repair costs, and the ability to shut the truck down, which is why DPF, EGR, and SCR systems are almost always targeted together.

The systems and devices most likely to be defeated are:

1. Diesel Particulate Filter (DPF)
2. Exhaust Gas Recirculation (EGR) (almost always paired with DPF delete)
3. Selective Catalytic Reduction (SCR)/ Diesel Exhaust Fluid (DEF) (in full deletes, especially problem-prone trucks)

Most commonly defeated: Diesel Particulate Filter (DPF)

Why the DPF gets removed most often:

1) It fails frequently

- DPF issues are often reported as the #1 aftertreatment problem in heavy-duty trucks [truckclub.com]
- It clogs with soot and ash over time, especially in:
    - stop-and-go work
    - cold weather
    - high-idle conditions [truckclub.com]

2) It directly causes downtime

Requires regeneration cycles (burning off soot). If regeneration fails, the truck can lose power and go into "derate" mode [truckclub.com]

3) Repair/replacement is expensive

- Cleaning: ~$300–$600
- Replacement: $3,000–$6,000+ (often up to $10,000 with related parts) [truckclub.com]

4) It impacts performance directly

- Creates exhaust backpressure
- Reduces fuel economy and power when clogged [explosivediesels.com]

In summary, the DPF is the single biggest driver of deletes because it is high-maintenance, failure-prone, and directly disruptive to operations.

Very commonly defeated: Exhaust Gas Recirculation (EGR)

Why EGR is frequently deleted (usually removed along with DPF):

1) Carbon buildup issues

- Recirculates dirty exhaust back into the engine
- Leads to:
    - clogged intake
    - valve sticking
    - cooler failures [diezeltuner.com]

2) Reliability and engine wear concerns

It introduces soot and heat stress into engine components, and can reduce efficiency and increase maintenance.

3) Frequent failure points

Common issues include stuck valves, plugged coolers, and sensor faults. [drivingline.com]

4) Strong link to other failures

EGR problems increase soot, which accelerates DPF clogging. This means that EGR is often removed together with the DPF because it contributes to the same root problem (soot and clogging).

Increasingly targeted: Selective Catalytic Reduction (SCR) / Diesel Exhaust Fluid(DEF) System

Why SCR/DEF systems get defeated:

1) Operational complexity

The SCR/DEF system has become a growing source of frustration (particularly after 2010) because it requires DEF fluid supply, injectors, heaters, pumps and sensors. More components equate to more failure points. [explosivediesels.com]

2) Sensor and system failures

- Common problems:
  - NOx sensor failures
  - DEF crystallization
  - injector clogging [jsdequipment.com]

3) Severe derate consequences

This is one of the biggest operator frustrations – a small sensor issue can effectively shut down the truck. If the SCR/DEF system fails, the truck may limit speed drastically or become inoperable. [epa.gov]

4) Logistics issues (important in Alberta)

DEF availability can be a problem in remote oilfield areas and rural operations. [diezeltuner.com]

All of these factors contribute to a combination of complexity, derates, and fluid dependence, which result in operational risk.

Systems are usually removed together (not individually)

In practice, most "full deletes" remove DPF, EGR, SCR/DEF, and require electronic control unit (ECU) reprogramming to avoid fault codes. [diezeltuner.com]

These are often removed together, or "all at once", because these systems are tightly integrated, and failures in one often trigger failures in others. [semitrailernews.com]

Factor	Effect on deletion likelihood
Frequent clogging (DPF, EGR)	Very high
High repair cost	Very high
Causes derate/downtime	Very high
Adds operational complexity (SCR)	High
Hard to maintain in real conditions	High

Less commonly targeted components

These are rarely deleted on their own, but fail often:

DOC (Diesel Oxidation Catalyst)

- Supports DPF regeneration
- Failure contributes to DPF issues
- Usually replaced, not deleted independently [truckclub.com]

Sensors (NOx, pressure, temperature)

- Very common failure points
- Trigger fault codes and derates
- Not "deleted" directly—but often bypassed in tuned systems [jsdequipment.com]

d) Are there regional differences in transportation emissions (e.g. rural vs. urban), and would actions or programs to reduce tampering have more impact if they are targeted at different areas?

Yes – city driving causes higher emissions	27/60 respondents	45% of respondents
Yes – programs would need to target fleets	9/60 respondents	15% of respondents
Yes	19/60 respondents	32% of respondents
Don't know/ Unsure	5/60 respondents	8% of respondents

Anti-tampering efforts are most effective when urban programs target exposure hotspots and rural programs target high-emitting fleets, because emissions harms are distributed very differently across regions.

How emissions differ: rural vs urban

1) Urban areas: concentrated exposure + stop-and-go emissions

What's happening

- Urban freight systems produce:
  - high NOx and particulate concentrations during peak hours [mdpi.com]
- A large share of the population is exposed:
  - e.g., ~50% of Albertans live within 1 km of major roadways [theicct]

Key characteristics

- Stop-and-go driving leads to poor combustion and higher NOx spikes
- Lower speeds lead to DPF systems struggling to regenerate properly
- Dense population means that emissions have direct health impacts (there is a higher concentration of traffic-related pollutants)

What this means is that even a small number of high-emitting (tampered) trucks can have large public health impacts.

2) Rural/highway areas: higher total emissions, lower exposure concentration

What's happening

- Highway and long-haul driving:
  - produces large total emissions due to distance and fuel use [mdpi.com]
- Trucks operate at higher speeds and under more stable loads [nlr.com]

Key characteristics

- Better combustion efficiency (lower per-km emissions spikes)
    - But there is a much higher total emissions volume, and fewer people exposed per km

Rural/freight corridors are where most emissions are generated, but not where the highest exposure risk occurs.

Where tampering matters most

Tampering dramatically increases emissions:

- Can raise pollution by orders of magnitude (10×–1000× depending on system) [cleanair.epa.gov], [mdpi.com]

But its impact varies by location**:**

Urban impact of tampering = HIGH (health-driven)

- Tampered trucks in cities:
    - expose large populations directly
    - worsen air quality hotspots
- Alberta analysis shows:
    - a minority of trucks (many likely tampered/malfunctioning) produce a disproportionate share of NOx emissions [theicct]

This results in each tampered truck having an outsized health and policy impact in urban areas.

Rural impact of tampering = HIGH (volume-driven)

- Tampered trucks in rural/highway settings:
    - contribute heavily to total emissions inventory
- This is especially important in:
    - long-haul trucking
    - oilfield/resource sectors

This results in bigger climate and regional air pollution effects, even if fewer people are directly exposed.

Why regional targeting matters for enforcement

There's a critical insight from emissions research indicating that vehicle emissions are highly skewed—a small fraction of vehicles (often tampered or malfunctioning) produce a large share of pollution. [nature.com]

That means targeted programs could be very effective.

What could work best in different regions

Urban-focused strategies (high impact per truck)

Some of the tools that could be impactful in these regions include focusing on high-traffic corridors with:

- Roadside remote sensing, which would identify high emitters in dense traffic
- Targeted roadside inspections
- Low-emission zones or access restrictions

These would theoretically work because:

- High traffic density would ensure it was easier to detect violators
- High population exposure allows for a strong justification
- Repeat vehicle patterns help point out offenders (e.g. delivery fleets)

This would allow Alberta to remove the worst offenders where they do the most harm.

Rural / corridor-focused strategies (fleet-level impact)

Some of the tools that could be impactful in these regions include focusing on long-haul trucks and older fleets with:

- Weigh-scale inspections
- Fleet compliance audits
- Interprovincial/cross-border enforcement
- Industry-focused programs (oilfield, long-haul)

These would theoretically work because:

- Trucks travelling long distances allow for predictable checkpoints
- Fewer inspection opportunities mean there is a need for strategic placement
    - Operators often run older, higher-risk trucks that are more likely to be tampered with

This would allow Alberta to reduce total emissions volumes across the system.

Factor	Urban	Rural / Highway
Emission concentration	High	Lower
Total emissions volume	Moderate	High
Population exposure	Very high	Low
Tampering impact	Health-driven	Volume-driven
Best intervention	Detection & restriction	Fleet compliance & checkpoints

4.3 Theme III | Economic Impacts of Tampering

a) What are the costs associated with maintaining emission control systems, and have those costs changed over time (e.g. cost of DEF)?

$800 - $1,000	9/60 respondents	15% of respondents
$1,000 - $5,000	9/60 respondents	15% of respondents
Yes – costs have increased over time	40/60 respondents	67% of respondents
Don't know/ Unsure	2/60 respondents	3% of respondents

When asked about the costs associated with maintaining emission control systems and whether or not those costs have changed over time, a majority of the respondents (40/60) were certain that costs have increased over time. 18 respondents were more specific and identified a specific price range for that increase. Nine respondents cited a cost of around $800 - $1,000 for a heavy-duty vehicle (although they did not explicitly state whether these were one-time costs or costs over the duration of ownership). Nine additional respondents cited maintenance costs of $1,000 - $5,000. Two respondents were unsure or couldn't speak to specific increases.

Theme III | Economic Impacts of Tampering

b) Does tampering with emission control systems impact operating costs (e.g. changes in fuel consumption or engine life)?

Yes	60/60 respondents	100% of respondents

This was our only 100% unanimous question that was asked of respondents. Every person polled agreed that tampering with emission control systems impacts operating costs. Most subtly indicated or referred to tampering being done to decrease the lifetime costs of a heavy-duty vehicle. None of the respondents indicated that tampering would increase costs over time – many were of the opinion that it lowers costs over the life of ownership.

c) Does tampering impact the competitiveness of an operator when compared to other operators in Alberta, Canada, and the U.S.?

Yes	58/60 respondents	96% of respondents
No	1/60 respondents	2% of respondents
Don't know/ Unsure	1/60 respondents	2% of respondents

This question was also a "landslide" amongst respondents – an overwhelming 96% said that tampering does impact the competitiveness of an operator when compared to other operators in Alberta, Canada, and the U.S.

Only one respondent disagreed, and one was unsure. A large majority of the 58 respondents who said yes referred to the fact that tampering is much more accepted for heavy-duty vehicles remaining in the province of Alberta. There are strict fines and penalties depending on where the truck is going once it leaves Alberta, and most respondents agreed that this wasn't a risk they would be willing to take.

d) What is the cost range for tampering or defeating an emission control system vs. replacing or repairing one that is defective or malfunctioning?

$4,000 - $6,000	4/60 respondents	7% of respondents
50% less for tampering	4/60 respondents	7% of respondents
Substantially less for tampering	50/60 respondents	83% of respondents
Don't Know/ Unsure	2/60 respondents	3% of respondents

Respondents were hesitant to identify a specific cost range for tampering or defeating an emission control system vs. replacing or repairing one that is defective or malfunctioning. 50 out of the 60 respondents would only say that the cost range is substantially less for tampering with a vehicle. Eight respondents provided more specificity, with four actually stating a price range between $4,000 and $6,000. Four others were willing to state that tampering would reduce costs by around 50%. And as we have seen with a number of the questions so far, there is a small percentage of respondents who just said they didn't know or were unsure.

Theme III | Economic Impacts of Tampering

e) What is the downtime for maintenance vs. tampering services (e.g. removing devices and defeating software in comparison to routine maintenance requirements or repairs for these systems) over the life of the vehicle?

Much less downtime for tampering	58/60 respondents	96% of respondents
About the same	1/60 respondents	2% of respondents
Don't Know/ Unsure	1/60 respondents	2% of respondents

This is another question where respondents weren't willing to provide a high level of specificity. 58 out of the 60 mechanics and shops polled were relatively certain that there is substantially less downtime for tampering services vs. maintenance over the life of the vehicle. One outlier stated that the time is about the same, and one said they were unsure.

f) As a vehicle depreciates, does the cost to replace or repair emission control systems become higher (both absolute cost and relative to the value of the vehicle)?

Yes, much higher	57/60 respondents	95% of respondents
Yes, a little bit higher	3/60 respondents	5% of respondents

All respondents agreed that as a vehicle depreciates, the cost to replace or repair emission control systems becomes higher. Nobody was able to state a specific number, but it was still a resounding yes to this question. The only division of opinions came to whether or not these costs were substantially higher, or just negligibly higher.

4.4 Theme IV | Emission Control System Effectiveness and Vehicle Performance

AMTA did not undertake this portion of the work.

4.5 Theme V | Perceptions and Beliefs Around Tampering

a) Has there been a change in perceptions around tampering over time?

There has been a noticeable shift over time in how emissions "tampering" (e.g., deletes, defeating systems) on heavy-duty trucks is perceived in Canada, and Alberta is a particularly interesting case. The change isn't just cultural—it's tied to evolving regulation, enforcement gaps, economic pressures, and more recent public-health framing.

Below is a clear breakdown of how perceptions have changed.

Earlier period (2000s–mid-2010s): tolerated, practical workaround

Key perception:

Tampering was often seen as practical, even rational, especially in Alberta's trucking culture.

- Modern emissions systems (DPF, EGR, SCR) were introduced mainly starting around 2007–2010.
- Many operators found them expensive, unreliable, and poorly suited to real-world use (especially in cold climates and with heavy workloads).
- This led to a widespread belief that "deleting":
    - improved reliability
    - reduced maintenance costs
    - increased fuel economy or power [kohout.com]

Regulatory context mattered heavily:

- Alberta historically lacked strong anti-tampering rules or enforcement systems, unlike provinces such as Ontario or BC. [theicct]
- Inspection programs that could detect tampering were limited or absent. [theicct]

The result is tampering was often perceived as low-risk and socially normalized in parts of the industry.

Late 2010s–early 2020s: awareness grows, but enforcement still weak

Key perception:

During this time period, tampering becomes more controversial, but still common. During this period:

- Governments began tightening emissions standards to meet climate targets. [mehmi.com]
- Industry discussions increasingly framed deletes as:
    - non-compliant
    - risky for resale and inspections

- But the economic motivations didn't disappear:
    - high repair costs (thousands of dollars for emissions components)
    - downtime concerns
    - small operators feeling squeezed

At the same time, research highlighted gaps:

- Canada lacked robust data on how widespread tampering was. [theicct.org]
- Enforcement mechanisms were still limited, especially in Alberta.

The result is that perception then splits: regulators & environmental groups saw this as a growing concern, while many operators were still pragmatically accepting this.

Mid-2020s (recent shift): public-health and economic impacts change the narrative

Key perception:

Tampering is increasingly seen as a serious public-health and policy issue, not just a mechanical or compliance choice.

Recent data has dramatically changed the conversation:

- A 2025 Alberta study found:
    - About 38% of 2010–2015 tractor trucks show evidence of tampering or malfunction [theicct.org]
    - These trucks produce nearly half of NOx emissions from the fleet [theicct.org]
    - Potential impacts:
        - CA$5.4 billion in health damages (2024–2035)
        - hundreds of premature deaths [trucknews.com]

This kind of evidence reframes tampering as:

- not just a compliance issue
- but a major air-quality and public-health driver

There's also more visibility that:

- up to 30% of heavy-duty vehicles may be emitting far above expected levels. [theicct]
- tampering rates are higher than previously estimated [trueinitiative.org]

The result is that public and policy perception is shifting toward this being a "systemic problem needing intervention", not an individual choice.

Policy & enforcement direction (emerging)

Although Alberta still lags in enforcement compared to some regions, momentum is building:

There is increasing pressure for:

- Federal anti-tampering legislation with penalties
- Provincial inspection/maintenance programs
- Roadside emissions monitoring (remote sensing) [trucknews.com]

Broader trends:

- Canada is tightening emissions rules (2025–2027+) [mehmigroup.com]
- There is a push toward zero-emission vehicles and stricter compliance overall [dieselarmy.com]

The results are that tampering is increasingly viewed as legally risky, economically short-sighted, and misaligned with long-term industry direction.

Summary

Yes, perceptions around tampering and deletions have changed significantly—but unevenly over time:

Period	Dominant perception
2000s–mid-2010s	Practical workaround, low stigma
Late 2010s–early 2020s	Legally questionable but still normalized
Mid-2020s (now)	Major environmental & health problem, increasing scrutiny

In short, especially in Alberta, tampering has moved from “common industry practice” to “controversial compliance issue” to “evidence-backed public health concern”.

Most shops will refuse to do this type of work unless there are major financial ramifications for not doing it. Even then, many shops will still refuse to do this work.

b) Are vehicle owners and operators aware of the impacts of excess vehicle emissions on human health and the environment, and does it factor into decision-making around tampering?

Most heavy-duty truck owners/operators are generally aware that emissions affect health and the environment, but this awareness is often broad and abstract. In practice, when it comes to decisions like tampering, economic and operational factors usually outweigh environmental considerations.

Heavy-duty operators usually understand that emissions are harmful, but tampering decisions are overwhelmingly driven by cost, reliability, and downtime—not environmental or health concerns—unless those concerns are reinforced by enforcement or economic incentives.

What operators typically know

There is widespread baseline awareness that:

- Diesel exhaust contains harmful pollutants (NOx, PM)
- These pollutants are linked to:
    - respiratory illness
    - cardiovascular disease
    - premature death [ucs.org]

In fact, truck drivers themselves:

- are heavily exposed to diesel exhaust daily
- experience direct health risks from in-cab pollution [nrdc.org]

Most operators know emissions are "bad," and many understand they can affect health, but awareness is often not detailed or quantified.

What's usually less well understood:

- How large the impact is (e.g., billions of dollars in health damages)
- How much tampered trucks increase emissions (can be 10×–100× higher) [uts.edu.au]
- That a small share of high emitters drives a large share of pollution

If health/environmental awareness strongly influenced decisions, you would expect low tampering rates. But in Alberta:

- Over 20% of all HDVs show tampering/malfunction
- About 38% of 2010–2015 trucks are affected [theicct.org], [trueinitiative.org]

This indicates that awareness alone does not strongly deter tampering behaviour.

Across studies and industry data, operator decisions are dominated by:

Cost pressure

- Emissions system repairs can cost thousands to tens of thousands per event
- Thin margins mean even small cost increases affect viability

Environmental concerns rarely compete with: "Can I keep this truck running affordably?"

Downtime and reliability risk

- Emissions failures can derate the engine and shut the truck down
- Lost time = lost income

Operators prioritize reliability over compliance when forced to choose.

Complexity and frustration

- Modern systems are sensor-heavy and failure-prone (especially older generations)
- Operators often view problems as "system design issues," not environmental trade-offs

Perceived distance of impacts

Environmental/health impacts are often seen as:

- diffuse
- long-term
- affecting "others" (e.g., cities, public)

Whereas costs are immediate and personal. This creates a classic behavioural gap: immediate costs outweigh distant benefits.

Where awareness *does* influence decisions

Awareness isn't irrelevant—it just works indirectly and unevenly. Larger fleets and corporate operators are more likely to factor in ESG goals, brand reputation, and regulatory risk. They are also more likely to avoid tampering altogether.

Some evidence suggests that drivers are increasingly aware of in-cab air quality issues, but this hasn't consistently translated into anti-tampering decisions. This is because drivers often lack control over equipment decisions (fleet-owned trucks). [carexcanada] [researchgate]

c) What are non-monetary or perceived vehicle performance improvement motives for tampering (e.g. modifying a vehicle to intentionally increase noise)?

There are several non-monetary, perception-driven, or performance-identity motives behind heavy-duty truck tampering that go beyond simple cost avoidance. These motives are often rooted in driver experience, control, culture, and perceived vehicle performance, and they can be just as influential as economic factors.
In many cases, operators are trying to make their trucks:

- simpler
- more predictable
- more responsive
- or more aligned with how they believe a truck should behave

—even if that conflicts with emissions compliance.

Perceived performance improvements

Power and throttle response

- Removing emissions systems (especially EGR and DPF) can:
  - reduce exhaust restriction
  - lower intake contamination
- This leads to a perception of stronger acceleration and smoother power delivery

Even when actual horsepower gains are modest, drivers often report:

- "more responsive"
- "less lag"
- "pulls harder under load"

Engine "running cleaner" or cooler (perceived)

- EGR recirculates hot exhaust gases, so some operators believe removing it reduces engine stress
  - Drivers may feel that the engine runs cooler and that there is less "strain" under heavy loads

This reinforces a belief that the engine is healthier or being "treated better".

More predictable behaviour (fewer interruptions)

- Emissions systems introduce regeneration events, derates, and sensor-driven interventions

- Removing them creates a truck that behaves more consistently and doesn't "take control away" from the driver. This is often described as "getting rid of the truck thinking for itself"

Control and autonomy motives

Desire for full mechanical control

Many operators (especially owner-operators) strongly value mechanical simplicity and direct control over the vehicle. Emissions systems are seen as opaque ("black box" systems), and controlled by software and sensors.

Deleting them can feel like reclaiming control from electronics and regulators.

Frustration with automated derates

- One of the strongest non-financial motivations is loss of control when a truck derates or limits speed
- Even minor faults can trigger severe performance restrictions

Identity, culture, and aesthetics

Sound (noise as a deliberate outcome)

- Removing DPF/SCR systems changes exhaust characteristics:
  - louder
  - deeper tone
- Some operators deliberately want:
  - a "traditional diesel sound"
  - audible engine presence

This is similar to aftermarket exhaust culture in pickup trucks and performance identity signaling.

"Old-school diesel" identity

- Pre-2007 trucks are often seen as simpler, stronger, and more "authentic"

Deleting emissions systems can be perceived as making a modern truck behave more like an older one. This reflects a cultural narrative that newer systems equal compromised reliability, while older systems equal "real trucks".

Psychological and experiential motives

Frustration/"rebellion" against regulation

- Regulations may be perceived as disconnected from real-world conditions or designed without operator input

- Tampering can become a form of resistance or pushback, especially in regions like Alberta, where there is a strong culture of independence that amplifies this effect

Belief that emissions systems "don't work right"

Even when not fully accurate, some operators believe emissions systems reduce engine life, increase fuel use, and create more problems than they solve. This leads to "I'm fixing a bad design," rather than breaking rules.

Operational feel and comfort

Smoother operation under real-world conditions

There are no regeneration cycles, which eliminates the need to monitor or adapt driving behavior. There is also no DEF management, which reduces driver workload. The perceived benefit is a simpler, less mentally taxing operation.

Better perceived fit for harsh environments

In cold climates or remote areas, emissions systems can behave unpredictably. Removing them creates a sense of robustness and reliability under extreme conditions.

Social and peer influences

Norms within specific sectors

In some segments (e.g., oilfield, small fleets), tampering may be normalized or widely known. Operators may hear "everyone does it," or "it's the only way these trucks work properly." This creates social reinforcement and reduces perceived stigma.

Word-of-mouth performance claims

Many decisions are influenced by anecdotes and peer recommendations. Claims like better fuel economy, fewer breakdowns, or stronger performance are prevalent. These don't need to be fully accurate to drive behaviour.

Important nuance: perception vs reality

A lot of these motives are perceived benefits, not always objectively true. Some performance gains are real (e.g., reduced backpressure). But others are often exaggerated, dependent on tuning quality, and offset by other risks (engine stress, legal exposure). However, perception is what drives decisions, not engineering reality alone.

5.0 Suggestions

5.1 Suggestion #1

Work with regulators at the provincial and federal levels to update the Canadian PMVI (Periodic Motor Vehicle Inspection) Program so that Alberta inspectors have greater authority to fail trucks based on tampering and deletions.

BACKGROUND

The Canadian PMVI (Periodic Motor Vehicle Inspection) manual does not give Alberta inspectors strong authority to fail a truck solely for being "deleted" or electronically tampered, and Alberta's own inspection/adoption of that standard explicitly limits what inspectors can do with emissions systems.

1) What the Canadian PMVI (NSC 11) says about tampering:

The PMVI (Periodic Motor Vehicle Inspection, National Safety Code Standard 11, which Alberta adopts for commercial inspections) is primarily a mechanical safety inspection standard, not an emissions enforcement document.

- Its purpose is to ensure mechanical roadworthiness (brakes, steering, structure, etc.), not environmental compliance [0901.nccdn.net]
- Across Canada, it includes general language that:
    - Exhaust systems must be intact and not visibly modified in a way that creates a safety issue
    - Components that are required for safe operation must be present

However, the national framework has known gaps around emissions tampering. Even regulators acknowledge that roadside inspectors often can't reliably identify deleted systems without specialized training or tools [raventrans.com]

So while the "spirit" of NSC 11 is that systems shouldn't be tampered with, it doesn't provide a strong, consistent enforcement mechanism for delete kits and tampering.

2) How Alberta modifies/uses the PMVI

Alberta adopts NSC 11 into law through its Vehicle Inspection Regulation and CVIP program [canlii.org]. But in practice, Alberta limits emissions inspection requirements:

- Alberta does not run an emissions inspection program
- It has no dedicated anti-tampering inspection regime
- Inspection manuals and procedures used by technicians are largely safety-focused

Independent research and policy reviews confirm that Alberta has no provincial anti-tampering regulations or inspection/maintenance program to detect deletes. [theicct.org]

Unlike BC, Ontario, or Quebec, inspection programs elsewhere are the only real enforcement tool—and Alberta doesn't have one for emissions. [theicct.org]

3) What inspectors can (and cannot) do in Alberta

What inspectors CAN do

Inspectors in Alberta (CVIP or out-of-province inspections) can document obvious modifications and fail a truck if:

- There is a safety-related defect with the exhaust system (such as leaks, broken mounts, unsafe routing)
- Components are missing, and that creates a safety issue
- The vehicle fails any NSC 11 safety criteria
- If they believe it violates the inspection manual as adopted

What inspectors generally CANNOT do (in Alberta)

They typically cannot fail a truck solely because:

- It has a DPF / DEF / EGR delete
- The ECU has been tuned or reflashed
- Emissions equipment is disabled electronically

Why:

1. Emissions checks are not part of Alberta's inspection scope
2. The PMVI, as applied in Alberta, does not require functional emissions testing

This is why many people say: "Emissions are 'omit' in Alberta inspections"—that reflects how the manuals are practically applied.

4) What this means in real-world inspections

Out-of-province inspections

- Still mainly safety-based
- A deleted truck may pass, unless the inspector interprets missing components as a failure item

CVIP (commercial trucks)

- More strict overall
- But still focused on safety, not emissions functionality

Roadside enforcement

- Enforcement officers may look for smoke / obvious tampering
- But identification of deletes is inconsistent and limited

SUMMARY

- Over 20% (and up to 38%) of heavy-duty trucks in Alberta show signs of tampering or malfunctioning emissions systems [theicct.org], [trueinitiative.org]
- This is largely because:
    - Inspection systems don't target deletes
    - Enforcement tools are weak or absent

So in Alberta today, a deleted truck may still pass inspection as long as it is mechanically safe and doesn't trigger a specific inspection failure item.

5.2 Suggestion #2

Approach the Original Equipment Manufacturers (OEMs) directly and have them enforce restrictions on deletions and tampering, and refuse to work with trucks that have had this work done. *Some OEMs are attempting to put these restrictions into place, but this isn't yet widespread.

BACKGROUND

OEMs already have several levers they can use—and expand—to discourage (or effectively prevent) emissions "deletions" and tampering. The key is combining technical controls, service policy, legal leverage, and ecosystem coordination rather than relying on any single tactic.

1) Refusal of Service Policies

OEMs can formalize policies that:

- Deny warranty coverage for any truck with altered emissions systems
- Refuse non-essential repairs until the truck is returned to compliance
- Require inspection checks (engine control module (ECM) scan, visual emissions audit) before performing work

Practical implementation

- Engine Control Module (ECM) flags for:
  - Diesel Particulate Filter (DPF) removal
  - Diesel Exhaust Fluid (DEF) system disabled
  - Non-OEM calibrations/tunes
- Dealer scan tools automatically detect "non-compliant state"
- Service advisor workflow blocks repair orders unless:
  - Truck is restored to OEM configuration
  - Customer signs compliance agreement

Impact

- Creates a strong deterrent:
  - No dealer support = reduced resale value
  - Harder to maintain fleet uptime
- Especially effective for large fleets (which depend on dealer networks)

2) Software Locks & Secure Electronic Control Unit (ECU) Architecture

OEMs can make tampering technically difficult:

Measures

- Encrypted ECUs & signed firmware

- Secure boot systems (only OEM-approved software runs)
- Backend authentication required for reprogramming
- Telematics validation (cloud checks against expected configurations)

Result

- Unauthorized "delete tunes" become harder to install and easier to detect remotely
- Independent tuners lose access to proprietary calibration pathways

3) Remote Monitoring & Compliance Verification

Connected trucks give OEMs visibility beyond the shop.

Techniques

- Telematics systems flag:
  - Missing emissions regen cycles
  - Implausible DEF consumption
  - Sensor bypass patterns
- Periodic "compliance health scores" assigned to vehicles
- Automated alerts:
  - To fleet managers
  - To dealers before service visits

Outcome

- Early detection
- Pressure applied before major servicing is needed

4) Parts & Service Dependency Strategy

OEMs can design trucks so that:

- Replacement parts require:
  - Electronic Control Unit (ECU) pairing
  - VIN-based authorization
- Key systems won't function correctly unless:
  - Emissions components are present and communicating

Example approach

- Dosing module, (diesel particulate filter) DPF sensors, or turbo calibration tied together
- If the emissions systems are missing:
  - Engine enters derate or restricted mode
  - Certain updates or features cannot be applied

5) Dealer Network Enforcement

Even if the OEM sets policy, dealer compliance is critical.

Actions OEMs can take:

- Audit dealers for:
  - Working on deleted trucks
  - Installing non-compliant parts
- Impose penalties:
  - Loss of franchise status
  - Reduced incentives or support
- Provide:
  - Clear inspection protocols
  - Required documentation for every service

6) Collaboration with Regulators

OEMs can align with regulators to strengthen enforcement:

- Share anonymized tampering trend data
- Support roadside or inspection audits
- Use compliance reporting to:
  - Validate warranty claims
  - Flag repeat offenders

Result

- Raises industry-wide risk for non-compliance
- Shifts the burden away from OEM alone

7) Incentives for Compliance

Pure enforcement can backfire. OEMs can also:

- Offer:
  - Discounted "restore-to-stock" programs
  - Trade-in incentives for compliant vehicles
- Provide:
  - Better reliability improvements in newer emissions systems
  - Training for operators to reduce frustration (a key driver of deletions)

8) Address the Root Cause

Many deletions happen because of:

- Downtime due to emissions faults
- Cost of repairs
- Perceived reliability issues

OEMs can reduce tampering by:

- Improving the durability of:
  - Diesel particulate filter (DPF) systems
  - Selective catalytic reduction (SCR)/ diesel exhaust fluid (DEF) components
- Reducing false fault triggers
- Simplifying maintenance procedures

SUMMARY

While refusing service is powerful, on its own, it has gaps:

- Independent shops may still work on deleted trucks
- Some operators accept the trade-off (especially in off-road or poorly regulated settings)
- Older trucks outside dealer networks are harder to control

That's why the most effective strategy for OEMs is layered: detection, denial of service, technical barriers, and incentives.

OEMs can significantly reduce truck deletions by refusing to work on tampered vehicles—but it's most effective when combined with:

- Secure electronic control unit (ECU) systems
- Mandatory compliance checks
- Dealer enforcement
- Telematics monitoring
- Economic incentives

When those systems work together, tampering becomes more difficult, easier to detect, and more expensive to live with, which is ultimately what changes behaviour at scale.

5.3 Suggestion #3

Implement a robust roadside emissions testing program provincially for Class 8 trucks.

BACKGROUND

Very few Canadian provinces actually do meaningful roadside emissions testing for Class 8 trucks today—and only Ontario has a robust, active program. Effectiveness is mixed: it can work if it's modern (on-board diagnostics + remote sensing), but older smoke/opacity approaches alone often miss tampering.

Alberta could implement a robust roadside emissions testing program for heavy-duty trucks by combining proven tools (used in Ontario, California, and Europe) into a layered, enforcement-plus-screening system. The key is to move from today's limited enforcement to a data-driven, high-throughput detection model focused on high emitters.

Alberta can build a highly effective roadside emissions program by combining remote sensing (mass detection), roadside inspections (targeted enforcement), and mandatory repair compliance—focusing specifically on high emitters and high-risk fleets.

Done correctly, this kind of system could:

- catch tampering in real-world conditions
- minimize burdens on compliant operators
- deliver large emissions reductions at relatively low cost

Focus on "high emitters" (not all trucks)

The most efficient programs target the worst-performing vehicles, not the entire fleet. Remote sensing can identify a smaller fraction of vehicles responsible for a larger percentage of emissions.

Set thresholds (e.g., top 5–10% highest emitters trigger enforcement). And use repeat measurements (require 2–3 high readings before action to reduce false positives).

Address compliance barriers

A program fails if it only enforces without enabling compliance. Alberta should include:

- Clear repair pathways
- Certified repair shops
- Guidance for operators

Optional (but effective):

- temporary incentives for:
    - DPF replacement
    - SCR repair

Key success factors

A robust Alberta program must:

- Be visible
  - Operators must believe “I can get caught anywhere”
- Be targeted
  - Focus on high emitters and high-risk fleets
- Be data-driven
  - Continuous measurement and adjustment
- Be coordinated
  - Align provincial enforcement, federal rules, and cross-border compliance

SUMMARY

The strategy of implementing robust roadside testing must be used alongside other strategies for a more far-reaching impact. There is not one single method that will catch all deleted and tampered vehicles; however, each approach offers its own unique benefits.

5.4 Suggestion #4

Conduct further research to identify specific years, makes and models that undergo the most deletions and tampering. Then, specific strategies could be implemented to target these vehicles.

BACKGROUND

There are certain makes, models and years of Class 8 trucks that undergo higher levels of tampering and deletions. We cannot definitively identify any of those specifically at this point (although we have gathered data that leads us to believe certain years of vehicles are much more prone to tampering), but this data would be beneficial to determine which strategies would best impact those specific vehicles.

A combination of data collection and further driver and mechanic interviews would allow us to collect the necessary data to identify the highest occurrence of "offenders".

SUMMARY

If we can identify those who are habitually deleting or tampering, it will allow us to develop specific strategies and target shops that work most with those vehicles. Certain model years may be more prone to certain failures for instance, and working to identify these vehicles will allow us to take a more targeted approach.

5.5 Suggestion #5

Permit certain exceptions/exemptions to the tampering and deletion regulations for specialized vehicles (such as fire trucks and cranes).

BACKGROUND

Certain specialized vehicles, such as fire trucks and cranes, could be exempt from the rules surrounding tampering and deletions if it makes sense and expands the lifespan of the vehicle. Compliance for some of these vehicles is extremely cost-prohibitive, and in certain instances, it would make sense to have them be exempt.

For instance, if a municipality has one fire truck and it would be cost-prohibitive for it to remain compliant, but the municipality faces a choice of either decommissioning the truck or purchasing a new one (both options would prevent the municipality from having an operational fire truck until the funds can be raised to repair or replace the vehicle). Situations such as these indicate that there are certain instances where exemptions could be made to accommodate those specific circumstances.

SUMMARY

While it is crucial that vehicles comply with regulations set out for them regarding emissions-reduction, it is also important to understand which situations should serve as an exception to the rule. Certain vehicles are in a unique situation where it would be a detriment to decommission them; however, their current standard of operation isn't sufficient given the circumstances.

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Appendix F – Anti-Tampering Legislation in Canada

This is Table 1 from "Heavy-Duty Emissions Control Tampering in Canada," a report from the International Council on Clean Transportation, published in 2022.

Province or territory	Details	Source
Ontario	Anti-tampering legislation is contained in the Ontario Environmental Protection Act. This legislation was in place prior to the implementation in 1999 of Drive Clean, the province's mandatory I/M program for light- and heavy-duty vehicles. A new vehicle emission regulation under the Environmental Protection Act and amendments to the Vehicle Permits Regulation under the Highway Traffic Act is in effect since January 1, 2020 to clarify and strengthen on-road vehicle emissions requirements and set out rules around the testing of emissions from heavy-diesel commercial vehicles.	(Ontario, 2020)
Québec	Québec's anti-tampering legislation is enabled by the powers of the Environment Quality Act. The specific provisions for heavy-vehicles are contained in article 7 of the Regulation Respecting Environmental Standards for Heavy Vehicles. This regulation, in effect since 2006, makes it illegal to remove or tamper with emissions control equipment. It is also the basis of the roadside inspection program. The latter is conducted by Contróle routier Québec (CRQ), a law enforcement agency part of the Ministére des Transports du Québec, with the mandate to enforce these provisions.	(Gouvernement du Québec, 2021)
British Columbia	British Columbia's Motor Vehicle Act Regulations (B.C. Reg. 26/58) explicitly prohibits the operation of diesel heavy-vehicles that do not meet emission standards. The regulation also enables the enforcement of this tampering prohibition through roadside inspections. Peace officers can stop vehicles for a diesel emission inspection, if there's suspicion to believe the vehicle does not meet the pollutant emission standards.	(British Columbia, 2020)
Alberta	Alberta's Commercial Vehicle Inspection Program (CVIP) requires commercial trucks above 11,794 kg to have an annual safety inspection, but it does not include a check of emissions control equipment. Alberta's *Traffic Safety Act* and its regulations do not prohibit tampering with the emission control systems.	(Alberta, 2021)
Manitoba	At present, there is no specific emission control equipment and anti-tampering in the Manitoba Highway Traffic Act (C.C.S.M. c. H60).	(Manitoba, 2019)
Saskatchewan	There is no in-use vehicle, emissions control system, or anti-tampering legislation in Saskatchewan. While the Saskatchewan government does have a safety check for imported vehicles, it does not include a check of emissions control equipment. In 2016, Saskatchewan adopted National Safety Code Standard 11 into regulations that requires all heavy vehicles to meet emission control systems and devices in accordance with that standard.	(Saskatchewan, 2004, 2016)

Province or territory	Details	Source
Nova Scotia	In Nova Scotia, anti-tampering legislation is under the Motor Vehicles Act and is the responsibility of Service Nova Scotia and Municipal Relations. The anti-tampering clause is under the Standards of Vehicle Equipment Regulations made under Section 200 of the Motor Vehicle Act R.S.N.S. 1989, c. 293 O.I.C. 85-216 (March 12, 1985), N.S. Reg. 51/85 as amended up to and including O.I.C. 97-752 (Dec. 2, 1997), N.S. Reg. 165/97 and prohibits any exhaust tampering.	(Nova Scotia, 1997)
New Brunswick	Under their Motor Vehicle Act, New Brunswick has legislation for the inspection of vehicles that is related to tampering with emissions control systems. Changing the muffler or exhaust pipe is prohibited under the Motor Vehicle Act, RSNB 1973, c M-17 act.	(New Brunswick, 1996)
Newfoundland and Labrador	The Highway Traffic Act, Licensing and Equipment Regulations contain anti-tampering provisions. Enforcement of anti-tampering is the responsibility of the Government Services and Lands Department. The province has a mandatory, annual safety inspection for commercial HDVs. Consolidated Newfoundland and Labrador regulation 100/96 under Licensing and Equipment Regulations of the Highway Traffic Act (O.C. 96-211) prohibits any alteration of the vehicle exhaust system.	(Newfoundland and Labrador, Canada, 2015)
Prince Edward Island	Provincial legislation contains an anti-tampering provision related to the presence of the catalytic converter. The province requires both light- and heavy-duty vehicles to undergo an annual inspection. The regulation governing those inspections states that the catalytic converter is one of the components to be inspected annually. The current annual vehicle inspection for renewal of the license plate only covers safety and mechanical parts.	(Prince Edward Island, 2018)
Northwest Territories	There is no current or proposed anti-tampering legislation in the territories.	
Yukon	Air Emission Regulations were developed in 1998 and, because of requests to develop controls for in-use vehicles, an anti-tampering clause was included. The clause is in Air Emissions Regulations, YOIC 1998/207.	(Yukon, 2015)
Nunavut	There is no current or proposed anti-tampering legislation in the territories.	

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