CZECH TECHNICAL UNIVERSITY IN PRAGUE

Faculty of Mechanical Engineering

Department of Automotive, Internal Combustion Engines and Rail Vehicles

Study Program: Master of Automotive Engineering

Field Study: Advanced Powertrains

<u>Detection Of High Emitters Through Roadside Sampling</u>

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MASTER'S THESIS ASSIGNMENT

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II. Master's thesis details

Master's thesis title in English:

Detection of high emitters through roadside sampling: Comparative analysis of particle metrics and vehicle operating conditions and spacing

Master's thesis title in Czech:

Detekce nadměrných emisí částic dálkovým měřením - vliv odstupů, jízdních režimů a měřítka částic

Guidelines:

The thesis addresses the design of a roadside setup for detection of high emitters - vehicles with excessively high emissions due to malfunction, wear, or tampering. Based on an evaluation of data from over 1000 passages of test vehicles through a roadside setup within a controlled experiment conducted within the H2020 City Air Remote Sensing project, different particle metrics, portions of particle size distribution, instrument time resolution, vehicle speed and acceleration, spacing between the vehicles, and other factors are to be examined in light of the associated limits of detection, uncertainty of particle emissions factors expressed per kg of fuel, and, primarily, their anticipated suitability for the detection of high emitters. Passages of high emitting vehicles are to be identified and practical recommendations as to the test design are to be discussed.

Bibliography / sources:

(1) Preble, C.V., et al., Environ. Sci. Technol. 2015, 49, 8864–8871. // (2) Preble, C.V., Harley, R.A., Kirchstetter, T.W., 2019. Measuring Real-world Emissions From the On-road Heavy-duty Truck Fleet. Report for the California Air Resources Board, Contract No. 12-315. University of California Berkeley Online at. https://ww3.arb.ca.gov/research/apr/past/12-315.pdf. // (3) Bishop et al., Environ. Sci. Technol. 2015, 49, 1639–1645)

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Date of master's thesis assignment: **05.11.2021** Deadline for master's thesis submission: **05.01.2022**

Assignment valid until: ____________

prof. Michal Vojtíšek, M.S., Ph.D. Supervisor's signature	doc. Ing. Oldřich Vítek, Ph.D. Head of department's signature	prof. Ing. Michael Valášek, DrSc. Dean's signature

III. Assignment receipt

The student acknowledges that the master's thesis is an individual work. The student must produce his thesis without the assistance of others, with the exception of provided consultations. Within the master's thesis, the author must state the names of consultants and include a list of references.

15-11-2021
Date of assignment receipt

Student's signature

Declaration of Authorship

I hereby declare that the following thesis is my independent work and to the best of my knowledge. All information has been acknowledged in the text with list of reference.

In Prague: 21-01-2022 ___________________

Pratyush Subhasit

Abstract

This master thesis deals with detection of high nitrogen oxide (NO_X) and particulate matter emitting passages from vehicles of different types (heavy-duty vehicle, light-commercial vehicles, and two-wheeler vehicles) and different fuel type (diesel and gasoline) by remote sensing method. The study made in this thesis is to analyze the data from the experiment (H2020 City Air Remote Sensing Project) performed by two universities- Czech Technical University (CTU) and Czech University of Life Sciences (CZU) from two different sampling point locations. Emission factors of individual vehicle passages are calculated per kg of fuel based on NO/CO_2 and PN/CO_2 ratios determined by linear regression method and the data are analyzed considering limit of detection, limit of quantification, threshold limit and the correlation of detected concentration of pollutants with respect to concentration of CO_2. The results of the analysis are summarized to get sampling point location, suitability of instruments and vehicle spacing in determining the high emitters in real driving world by remote sensing method.

Keywords: Diesel Engine, Gasoline Engine, Light Commercial Vehicle (LCV), L- Category Vehicle (two-wheeler), Heavy-duty Vehicle (truck), Nitrogen Oxides (NO_X), Particulate Matter, Particulate Mass (PM), Particulate Number (PN), Emission Factor, High Emitter, Low Emitter, Sampling points

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Pratyush Subhasit

Content

1. Introduction

Road Transport Vehicles are one of the major factors contributing in polluting atmosphere. This is caused by the high emission of pollutants from these vehicles that could happen due to malfunction or tampering of exhaust after treatment devices and could be also from excessive wear of brakes and tyres. It is necessary to diagnose these high emitting vehicles and propose for possible repair or removal from the transportation fleet depending on the type of damage and emission standard legislation which is an effective approach in improvement of the air quality.

The presence of harmful pollutants in the atmosphere which makes the air impure (bad air quality) affects human health and environment. To avoid these pollutants their concentrations and subsequent impacts are to be studied and analyzed. Road transport vehicles are significant source of emission of nitrogen oxide (NO_X) and particulate matter which is a great concern in urban areas where huge population are exposed to it. To improve the air quality and reduce the concentrations of the pollutants in air caused by road transport vehicles, EU emission standards for exhaust emissions have imposed emission limits with introducing new technological solutions, both for light-duty and heavy-duty vehicles.

To know the real emissions, measurement methods like portable emissions measurement system (PEMS) and remote sensing were developed. Chassis-dynamometer testing is one of the common techniques to measure emissions which is operated in a controlled environment. PEMS, which is one of the most expensive and time-consuming technique, is used to measure emission of vehicle in a variety of situations. Remote sensing is the most effective measurement method where a large number of vehicles can be measured in a short interval of time. In this experiment, remote sensing measurement method was adopted for analyzing the test vehicles which were tampered during certain passages.

1.1. Pollutants on road & Impacts

Under EU road transport legislation, there are some ‘regulated’ pollutants [1]-

- **Hydrocarbons (HC)**, produced from incomplete or partial combustion. These are considered as volatile organic compounds (VOC) as it contributes to ground level ozone which affects human health by irritations in skin, eyes, and respiratory problems. It also creates photochemical smog in the atmosphere which is a serious concern.
- **Carbon Monoxide (CO)**, produced from incomplete or partial combustion, in a condition where the carbon is partially oxidized leading in formation of CO due to insufficient O_2. Contact with CO could lead to reduction in flow of O_2 in bloodstream. It is a colorless, odorless, and highly toxic gas.
- **Carbon dioxide (CO_2)**, produced from complete combustion of fuel along with water. It is the most significant green-house gases that influences climate change, ultimately affecting health and environment.
- **Nitrogen oxides (NO_X)**, produced during the combustion of fuel in presence of air inside the engine. NO_X comprises of two compounds- Nitric Oxide (NO), a colorless gas which is not harmful up to a certain concentration in the air and Nitrogen dioxide (NO_2) which is toxic and reddish brown in color having hazardous impact on health as well as environment. NO_X is very predominant in newer diesel cars.
- **Particulate Matter**, are very tiny particles that are produced due to incomplete combustion or due to wear of brakes and tyres. These are hazardous to human health as these can enter respiratory system causing cardiovascular and lungs diseases and often leads to cancer.

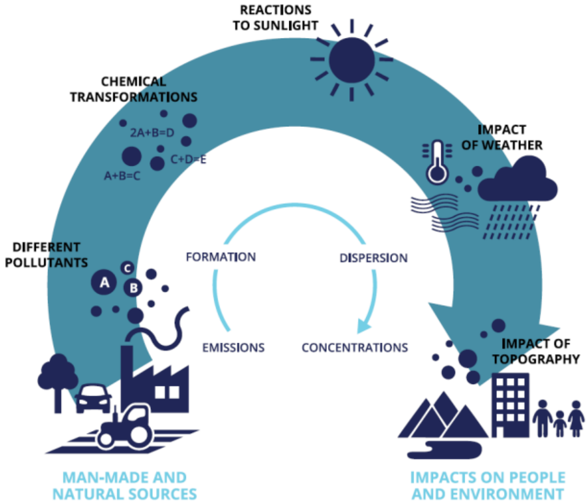

Fig 1A: Process of impact of emission [1]

NO_X has an adverse effect on the respiratory system. This causes inflammation in the airways of the respiratory system resulting in decrease in lung function, infections and increase in response to allergens. Not only health, high amount of NO_X is also responsible in damaging the environment. The vegetation becomes more prone to disease and frost damage. This makes the leaves damage, and the growth of the plants gets reduced. NO_X reacts with other pollutants in presence of sunlight, forming ozone which is very harmful for the vegetation [2].

Exposure to particulate matter for a long period of time can cause damage to heart and lungs. This can cause premature deaths, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function and respiratory infections. The smaller the particle size, the more probability of entering the human body and cause damage. The presence of particulate matter in atmosphere reduces visibility. These are sometimes carried by wind and then settle on ground and water which can make the water bodies acidic, depleting the nutrients of the soil, damaging crops, and forming acid rain [3].

1.2. Formation of Nitrogen Oxide (NO_X)

Majority of NO_X is produced by the road transportation vehicles, railways, shipping, airways, industries, and some from agriculture using nitrate fertilizers [4].

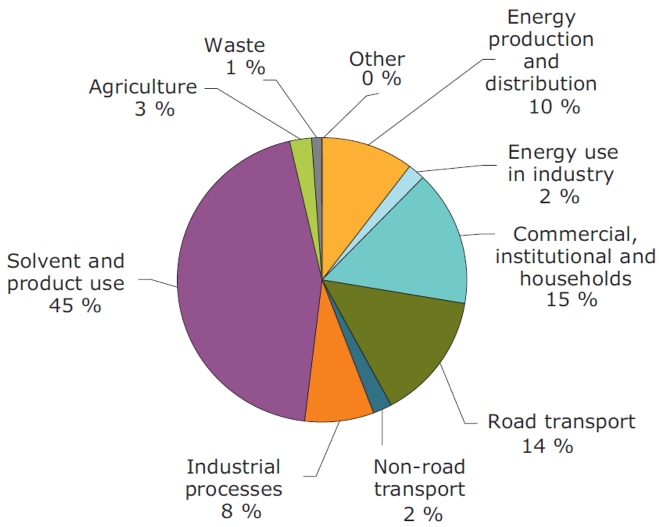

Fig 1B: Sources of NOX producers [4]

NO_X is formed at higher temperatures, more than 1800K where oxygen and nitrogen dissociates into their atomic state. This has been shown by Zeldovich extended mechanism in three equations-

$$N_2 + O = NO + N$$

$$N + O_2 = NO + O$$

$$N + OH = NO + H$$

The first two equations for NO formation was proposed by Zeldovich and the third equation was added by Lavoie [5]. Similarly, NO_2 is also considered as harmful which is released from the exhaust from diesel engines. NO_2 is formed from NO at high temperature in the flame region. Formation of NO_2 is shown below-

$$NO + HO_2 = NO_2 + OH$$

$$NO_2 + O = NO + O_2$$

In the second equation, NO_2 is dissociated to NO in presence of atomic oxygen due to local quenching and cooling [5].

Higher temperature and presence of oxygen are the key factors for formation of NO. Mostly, rate of formation of NO_X happens at the kinetic phase of combustion where the mixing of air and fuel takes place triggering combustion rapidly and thus, resulting in high temperature. Similarly, due to longer combustion duration, there is formation of NO_X but in higher concentrations with respect to the high temperature condition.

1.3. Particulate Matter & Diesel Soot Particle

Particulate Matters are the pollutants which are composed of particles with various sizes and chemical compositions. There is a broad classification of particulate matter on their different sizes. The sizes are divided in two different categories- PM_{10} and $PM_{2.5}$. Particles with size diameter 10µm or smaller referred to as aerodynamic diameter are categorized as PM_{10} and particles with size diameter 2.5µm or smaller are categorized as $PM_{2.5}$. PM_{10} and$PM_{2.5}$ are very fine particles which can be inhaled. Details about the sizes and classifications are provided in the figure 1C [6] [7].

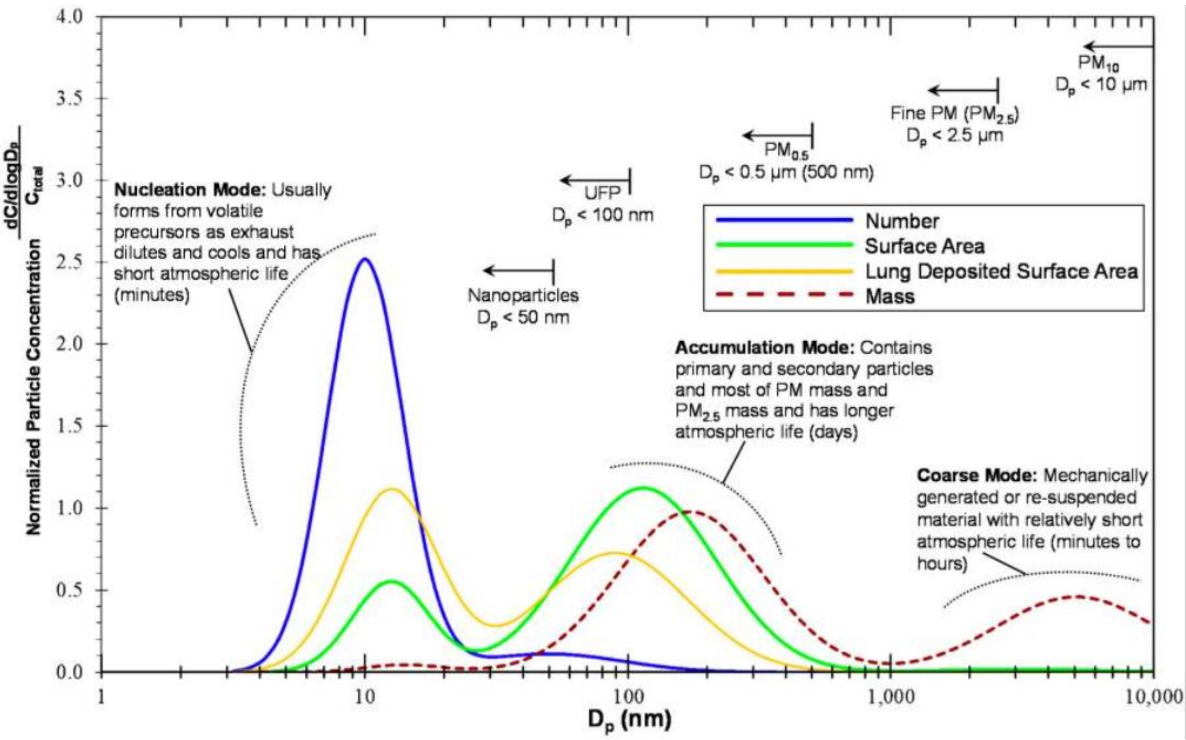

Fig 1C: Size distribution of particulate matter [8]

Soot particles are the pollutants from the diesel engines for which it is termed as diesel soot particles. These are formed at a temperature of 1000K to 2500K with pressure of 50atm to 100atm in presence of sufficient air for complete burning of fuel. Formation of soot happens in four phases- nucleation, growth, agglomeration and adsorption and condensation.

In nucleation phase, the condensed materials from the fuel are produced by oxidation or pyrolysis products, mainly composed of unsaturated hydrocarbons and polycyclic aromatic hydrocarbons. This reaction generates smallest recognizable particle of size diameter less than 2nm, referred to as nuclei.

Next is growth phase, where the particle size increases. In this phase, the size of solid carbon core increases forming concentric shells.

Then occurs agglomeration phase, where cluster formation of carbon molecules takes place. This happens due to interparticle collision leading to coagulation of the molecules resulting in increased size but decreased number of particles as they get connected to form a sphere.

In the final phase, adsorption, and condensation phase, UHC gets adsorbed on the solid carbon cluster due to chemical forces or physical forces. These UHC comes from unburnt fuel that are trapped in the crevices of the compression ring which gets back into the engine cylinder in expansion stoke, and also from cylinder oil film where the flame cannot reach which is termed as flame quenching. Then happens condensation which occurs in exhaust stroke when the vapor pressure of hydrocarbons exceeds its saturated vapor pressure [5].

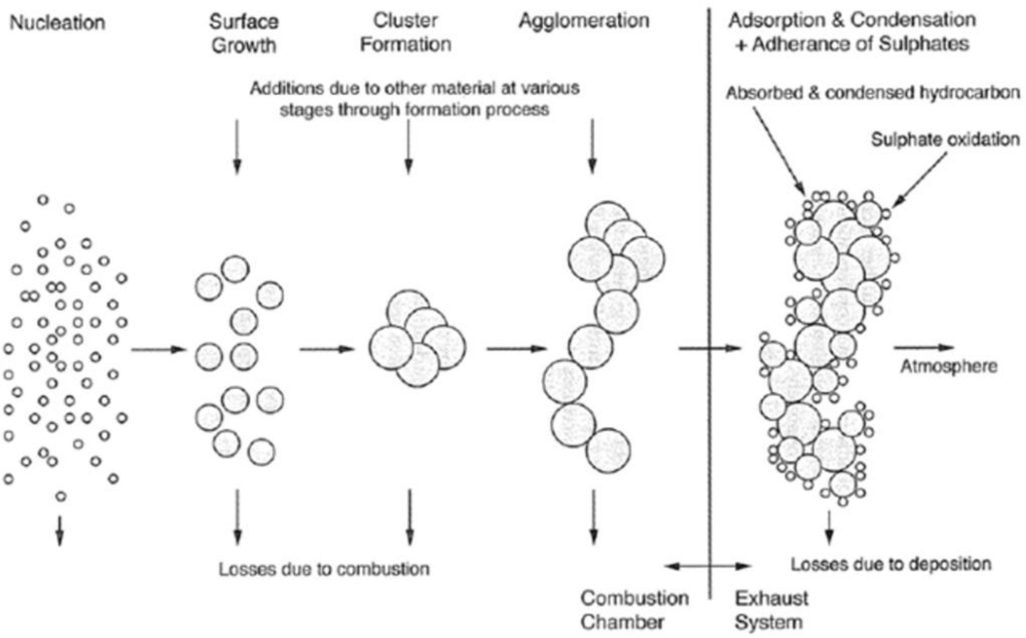

Fig 1D: Phases of formation of diesel soot particles [9]

1.4. Types of Emission

Vehicle emissions can be categorized in 3 ways [1] -

- **Exhaust Emissions-** Emissions caused by combustion of petroleum fuel such as petrol, diesel, natural gas, and LPG, which are mixtures of different hydrocarbons. There is no such engine which is perfect that produces no pollutants.
- **Abrasion Emissions-** Emissions caused by mechanical abrasion and vehicle part corrosion. It is responsible for emission of particulate matter. This phenomenon happens from the mechanical abrasion of tyres, brake and clutch, road surface wear, corrosion of chassis and other vehicle components.
- **Evaporative Emissions-** Emissions caused due to evaporation of vapours from the fuel of vehicle. This happens with the use of VOCs. Whether the vehicle is at stop with engine turned off or in running condition when the engine is turned on, petrol fuel vapours which contains different hydrocarbons tries to escape from fuel in the tank.

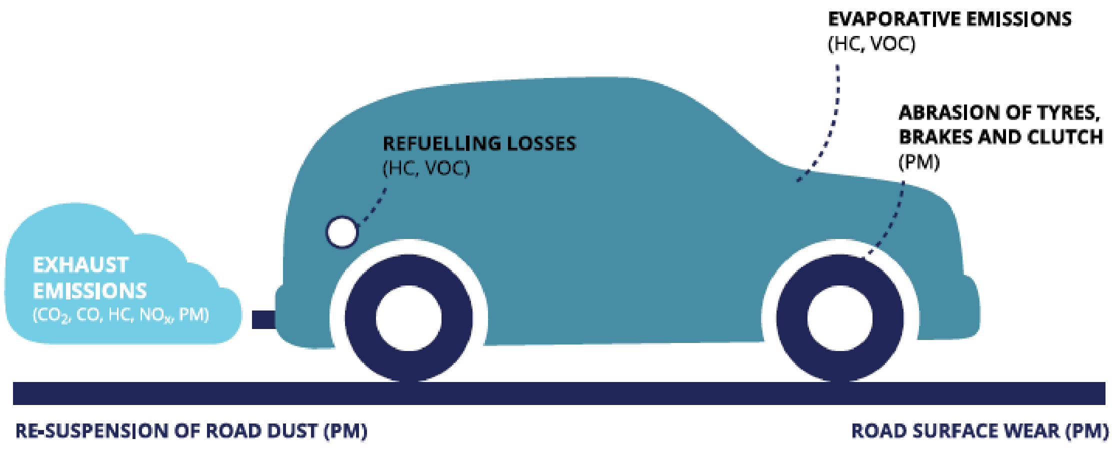

Fig 1E: Types of emissions from vehicles [1]

1.5. Methods of Reduction of Pollutants

NO_X can be reduced in two different ways-

a. Inside the cylinder of engine-

The main factors for production of NO_X are combustion temperature and combustion duration. Reducing the peak temperature decreases the amount of NO_X formation which eventually affects the rate of reaction and formation of other pollutants like CO and UHC. Some techniques like Low Temperature Combustion (LTC), Homogeneous Charge Compression Ignition (HCCI), Homogeneous Charge Late Injection (HCLI), Highly Premixed Late Injection (HPLI), Reaction Controlled Compression Ignition (RCCI) and Premixed Charged Compression Ignition (PCCI) were developed by research and experiments on engines. Another way is by introducing Exhaust Gas Recirculation (EGR) inside the engine which decreases the in-cylinder temperature, hence reducing NO_X formation but increases other pollutants like CO and HC [9].

b. Using Exhaust after-treatment devices-

- Lean NO_X Trap (LNT), where catalysts play a vital role in reduction of NO_X. This catalyst has three main components- first is noble metals like Platinum, Rhodium and Palladium performs oxidation and reduction reactions, second is Barium Oxide for NO_X storage and the third is support which is the surface area composed of oxides. Platinum oxidizes NO to NO_2 which are stored and reduced to N_2 [9].

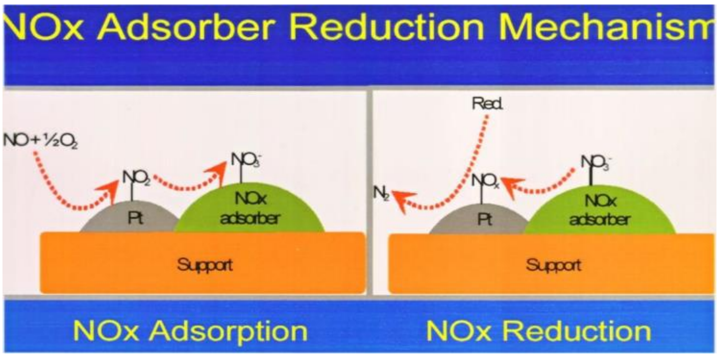

Fig 1F: LNT Mechanism [9]

- Selective Catalytic Converter (SCR), which reduces NO_X to N_2 by injection of water-urea solution where urea is converted to ammonia. Nowadays, SCR is common exhaust after-treatment device used in diesel engines. The water-urea solution otherwise known as Diesel Exhaust Fluid (DEF) or Ad-blue which is injected in the exhaust gases gets decomposed to ammonia (NH_3) and latter converts the exhaust gases to N_2. Below are the chemical reactions of conversion [9].

$$4NO + 3NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

$$2NH_3 + NO + NO_2 \rightarrow 2N_2 + 3H_2O$$

$$6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_2O$$

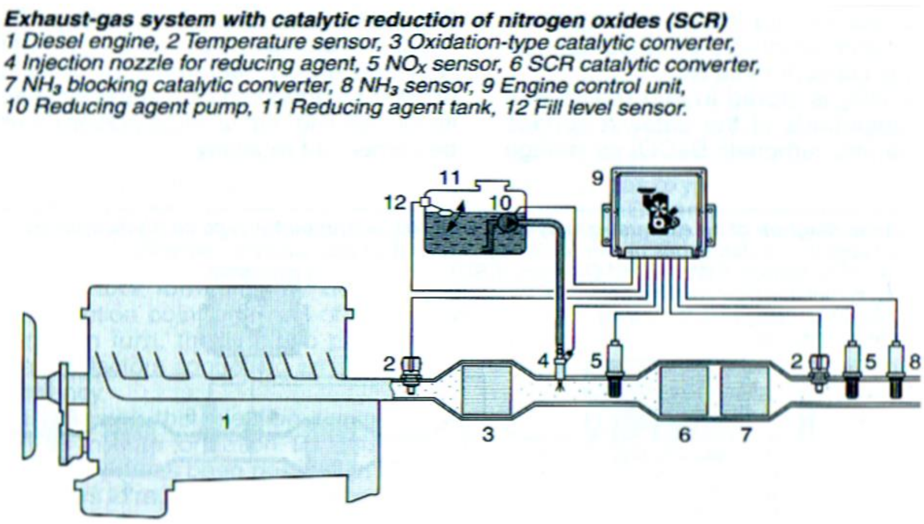

Fig 1G: SCR System [9]

For reduction of particulate matter, one of the widely used exhaust after-treatment device used in diesel engines is Diesel Particulate Filter (DPF) which is about 90% effective in trapping the particulate matter. DPF is a honeycomb structured filter which can be fitted on or after catalytic converter that traps the particulate matter emitted from the exhaust of diesel engine. It requires high temperature for operation for which it is mostly placed after the turbocharger. When there is excess amount of particulate matter in DPF causing a blockage, the ECU detects it and burns the excess amount of particulate matter to clear the filter by introducing post injection resulting in rise of the exhaust temperature. This is called the regeneration phase. During the regeneration phase number of nanoparticles are released which are very less compared to the amount of particulate matter released directly from the engine exhaust [9] [10].

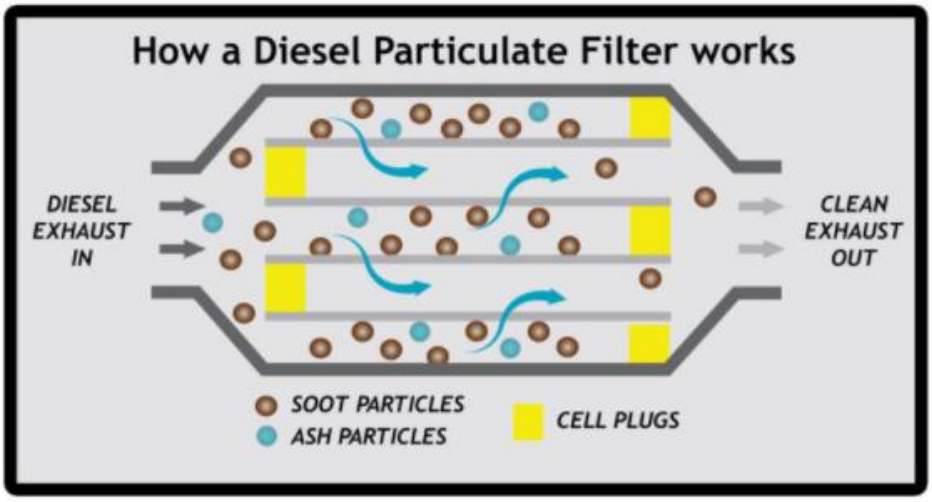

Fig 1H: DPF Mechanism [11]

1.6. High Emitters

The main cause of vehicles emitting high amount of pollutants is (possible only when there is) a malfunction or tampering of the exhaust after-treatment devices. Malfunction is a very rare problem that can happen, but tampering is the main reason. The old cars running on the road is also a contributor to high emitting vehicles because they are not equipped with the exhaust after-treatment devices according to the new emission standards. In case of the new cars which are according to current emission standards, the owners use emulators or tampering devices which are after-market products, so as to increase performance, fuel economy or even to decrease repairing and operation cost.

Mostly, EGR is tampered mechanically inside the bonnet- one by blocking the exhaust recirculating tube and other by sealing the hose to vacuum actuator. Or else, by plugging an external black box behind EOBD socket.

SCR tampering is an electronic process. It can be done by removing the fuse from SCR system, disconnecting the circuit and match it with ECU or it can also be done with adjustments to the ad-blue and reagent tank gauges that shows different level than the actual level.

In case of DPF, either it can be removed or by bypassing its function to the ECU or by replacing manufacturer installed DPF with after-market DPF with straight exhaust tubing. A faulty DPF can increase the amount of particle counts in several order of magnitudes.

These high emitting vehicles are the major source of environmental damage causing harm to human health for which emission legislation are enforced by the government organizations [12] [13].

1.7. Emission Standards

1.7.1. Air Quality Standards

It is very important to maintain the purity of air quality that we live in. If air quality gets poor or polluted, it has an adverse effect on climate change, environment, and human health. In response to this, EU has enforced legislation, setting the standards and limit for improvement of air quality. Below is the table for the standards [14]-

Table I: Air quality standards for $PM_{2.5}$, PM_{10}, NO_2 [14]

Pollutant	Concentration	Averaging Period	Permitted exceedances each year
$PM_{2.5}$	20µg/m^3	1 year	-NA-
PM_{10}	50µg/m^3	1 day	35
	40µg/m^3	1 year	-NA-
NO_2	200µg/m^3	1 hour	18
	40µg/m^3	1 year	-NA-

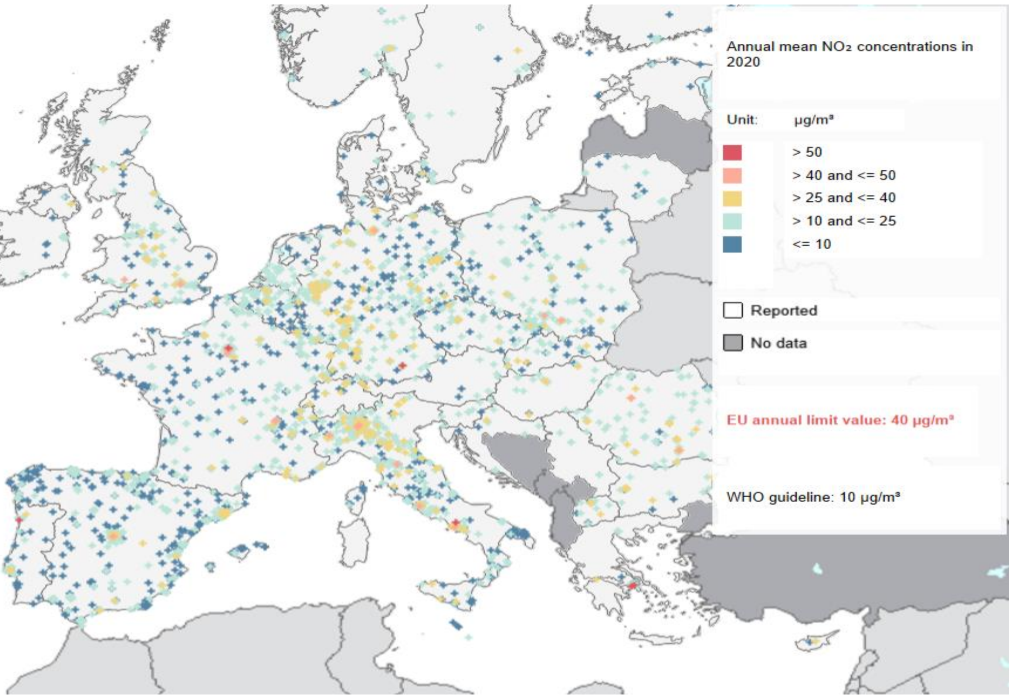

Fig 1I: Annual mean concentrations of NO_2 in 2020 [15]

The above figure shows the annual concentrations of NO_2 in year 2020 for 33 countries. The annual limit set by EU was 40µg/m^3 but WHO recommended limit was 10µg/m^3. It was observed that the countries exceeding above the EU limit which are presented in red and orange dots in above figure 1I, were negligible with respect to the countries within the limit. As per the report from European Environment Agency (EEA), the United Kingdom and 8 EU countries exceeded the annual limit value of NO_2, also all these 33 countries exceeded the WHO limit except Malta [15].

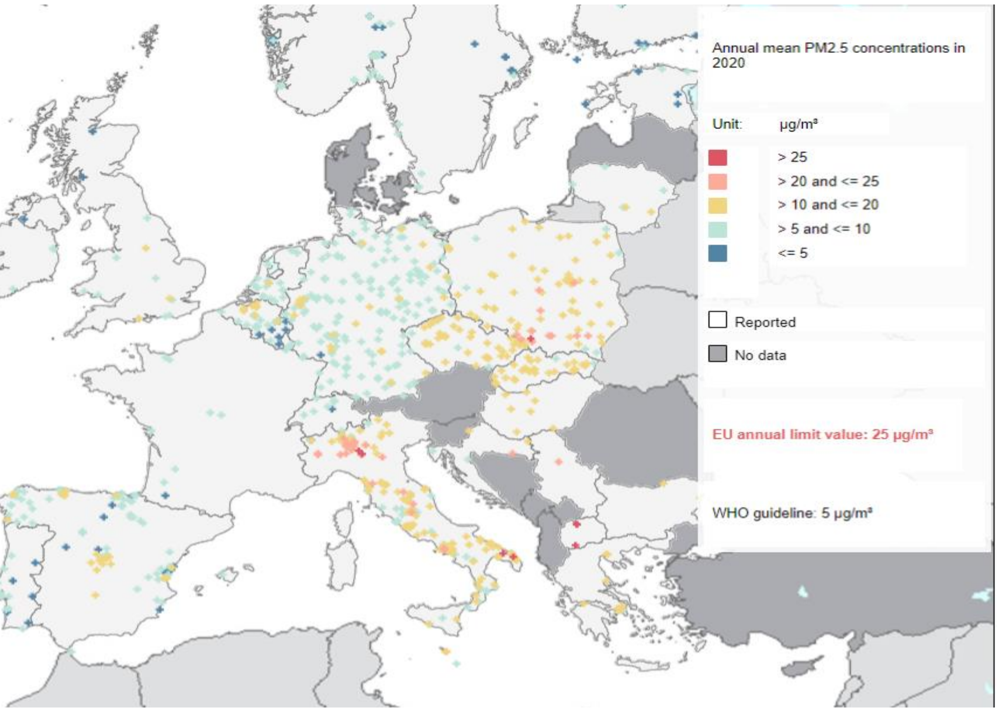

Fig 1J: Annual mean concentrations of $PM_{2.5}$ in 2020 [15]

The above figure 1J, shows the annual concentrations of $PM_{2.5}$ in year 2020 for 27 countries. The annual limit for $PM_{2.5}$ set by EU was 20µg/m^3 but in figure 1J the annual limit value was not updated according to the current limit value and WHO recommended limit was 5µg/m^3. It was observed that the countries exceeding the EU limit (red dots) were comparatively less than the countries within the limit. As per the report by EEA, 4 countries including 2 EU countries exceeded the annual limit of $PM_{2.5}$, also all the 27 countries were above WHO limit [15].

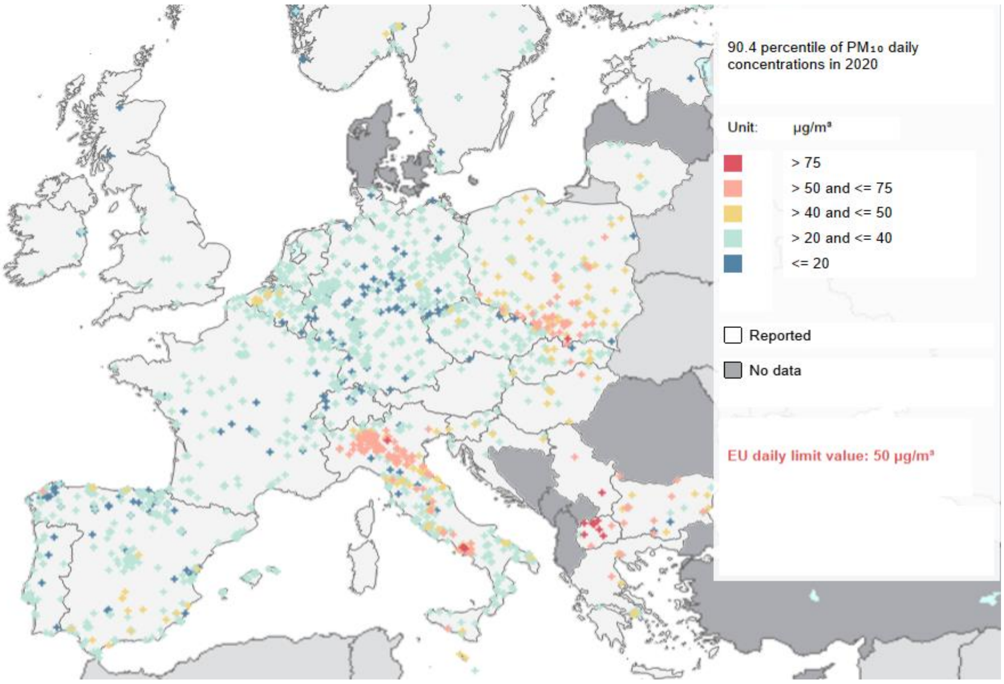

Fig 1K: Daily concentrations of PM_{10} in 2020 [15]

The above figure 1K, shows the daily concentrations of 90.4% of PM_{10} in year 2020 for 37 countries. The daily limit of PM_{10} set by the EU was 50µg/m^3. It was observed that countries exceeding the EU limit (red and pink dots) were recognizable than the countries under the limit. As per the report of EEA, 10 countries including 8 EU countries exceeded the daily limit of PM_{10} and 4 countries including 2 EU countries exceeded the annual limit. WHO has recommended limit of 15µg/m^3 in 2019 which was same in 2020, and based on this limit, except Iceland all other 36 countries exceeded the limit [15].

The reports of 2020 when compared with the reports of the preceding years, it was found that the concentrations of NO_2, $PM_{2.5}$ and PM_{10} were getting less. This was all due to the restrictions imposed on movement during the outbreak of COVID-19 pandemic.

1.7.2. European Legislations

The European commission has set standards for emission of pollutants from the vehicle considering air pollution level which should be followed by the vehicle manufacturers. Below are the emission standards for heavy duty in g/kWh and light commercial vehicles in g/km [16] [17].

Table II: EU standards for heavy-duty diesel engines in steady-state testing [17]

Stage	Date	Test	CO	HC	NOx	PM	PN	Smoke
			g/kWh				1/kWh	1/m
Euro I	1992, ≤ 85 kW	ECE R-49	4.5	1.1	8	0.612		
	1992, > 85 kW		4.5	1.1	8	0.36		
Euro II	1996.1		4	1.1	7	0.25		
	1998.1		4	1.1	7	0.15		
Euro III	1999.10 EEV only	ESC & ELR	1.5	0.25	2	0.02		0.15
	2000.1		2.1	0.66	5	0.10		0.8
Euro IV	2005.1		1.5	0.46	3.5	0.02		0.5
Euro V	2008.1		1.5	0.46	2	0.02		0.5
Euro VI	2013.01	WHSC	1.5	0.13	0.4	0.01	8.0×10^{11}	

Table III: EU standards for heavy-duty diesel and gasoline engines in transient testing [17]

Stage	Date	Test	CO	NMHC	CH4a	NOx	PM	PN
			g/kWh					1/kWh
Euro III	1999.10 EEV only	ETC	3	0.4	0.65	2	0.02	
	2000.1		5.45	0.78	1.6	5	0.16	
Euro IV	2005.1		4	0.55	1.1	3.5	0.03	
Euro V	2008.1		4	0.55	1.1	2	0.03	
Euro VI	2013.01	WHTC	4	0.16	0.5	0.46	0.01	6.0×10^{11}

Table IV: EU standards for passenger cars [14]

Stage	Date	CO	HC	HC+NOx	NOx	PM	PN
		g/km					#/km
Positive Ignition (Gasoline)							
Euro 1	1992.07	2.72 (3.16)	-	0.97 (1.13)	-	-	-
Euro 2	1996.01	2.2	-	0.5	-	-	-
Euro 3	2000.01	2.3	0.2	-	0.15	-	-
Euro 4	2005.01	1	0.1	-	0.08	-	-
Euro 5	2009.09	1	0.10	-	0.06	0.005	-
Euro 6	2014.09	1	0.10	-	0.06	0.005	6.0×10^{11}
Compression Ignition (Diesel)							
Euro 1	1992.07	2.72 (3.16)	-	0.97 (1.13)	-	0.14 (0.18)	-
Euro 2, IDI	1996.01	1	-	0.7	-	0.08	-
Euro 2, DI	1996.01	1	-	0.9	-	0.1	-

Euro 3	2000.01	0.64	-	0.56	0.5	0.05	-
Euro 4	2005.01	0.5	-	0.3	0.25	0.025	-
Euro 5a	2009.09	0.5	-	0.23	0.18	0.005	-
Euro 5b	2011.09	0.5	-	0.23	0.18	0.005	6.0×10^{11}
Euro 6	2014.09	0.5	-	0.17	0.08	0.005	6.0×10^{11}

Table V: EU standards for Light commercial gasoline vehicles [14]

Category	Stage	Date	CO	HC	HC+NOx	NOx	PM	PN
		g/km						#/km
Positive Ignition (Gasoline)								
N1, Class I	Euro 1	1994.1	2.72	-	0.97	-	-	-
≤1305 kg	Euro 2	1997.01	2.2	-	0.5	-	-	-
	Euro 3	2000.01	2.3	0.2	-	0.15	-	-
	Euro 4	2005.01	1	0.1	-	0.08	-	-
	Euro 5	2009.09	1	0.10	-	0.06	0.005	-
	Euro 6	2014.09	1	0.10	-	0.06	0.005	6.0×10^{11}
N1, Class II	Euro 1	1994.1	5.17	-	1.4	-	-	-
1305-1760 kg	Euro 2	1998.01	4	-	0.65	-	-	-
	Euro 3	2001.01	4.17	0.25	-	0.18	-	-
	Euro 4	2006.01	1.81	0.13	-	0.1	-	-
	Euro 5	2010.09	1.81	0.13	-	0.075	0.005	-
	Euro 6	2015.09	1.81	0.13	-	0.075	0.005	6.0×10^{11}
N1, Class III	Euro 1	1994.1	6.9	-	1.7	-	-	-
>1760 kg	Euro 2	1998.01	5	-	0.8	-	-	-
	Euro 3	2001.01	5.22	0.29	-	0.21	-	-
	Euro 4	2006.01	2.27	0.16	-	0.11	-	-
	Euro 5	2010.09	2.27	0.16	-	0.082	0.005	-
	Euro 6	2015.09	2.27	0.16	-	0.082	0.005	6.0×10^{11}
N2	Euro 5	2010.09	2.27	0.16	-	0.082	0.005	-
	Euro 6	2015.09	2.27	0.16	-	0.082	0.005	6.0×10^{11}

Table VI: EU standards for Light commercial diesel vehicles [14]

Category	Stage	Date	CO	HC	HC+NOx	NOx	PM	PN
		g/km						#/km
Compression Ignition (Diesel)								
N1, Class I	Euro 1	1994.1	2.72	-	0.97	-	0.14	-
≤1305 kg	Euro 2 IDI	1997.01	1	-	0.7	-	0.08	-
	Euro 2 DI	1997.01	1	-	0.9	-	0.1	-
	Euro 3	2000.01	0.64	-	0.56	0.5	0.05	-
	Euro 4	2005.01	0.5	-	0.3	0.25	0.025	-
	Euro 5a	2009.09	0.5	-	0.23	0.18	0.005	-
	Euro 5b	2011.09	0.5	-	0.23	0.18	0.005	6.0×10^{11}
	Euro 6	2014.09	0.5	-	0.17	0.08	0.005	6.0×10^{11}
N1, Class II	Euro 1	1994.1	5.17	-	1.4	-	0.19	-

1305-1760 kg	Euro 2 IDI	1998.01	1.25	-	1	-	0.12	-
	Euro 2 DI	1998.01	1.25	-	1.3	-	0.14	-
	Euro 3	2001.01	0.8	-	0.72	0.65	0.07	-
	Euro 4	2006.01	0.63	-	0.39	0.33	0.04	-
	Euro 5a	2010.09	0.63	-	0.295	0.235	0.005	-
	Euro 5b	2011.09	0.63	-	0.295	0.235	0.005	6.0×10^{11}
	Euro 6	2015.09	0.63	-	0.195	0.105	0.005	6.0×10^{11}
N1, Class III	Euro 1	1994.1	6.9	-	1.7	-	0.25	-
>1760 kg	Euro 2 IDI	1998.01	1.5	-	1.2	-	0.17	-
	Euro 2 DI	1998.01	1.5	-	1.6	-	0.2	-
	Euro 3	2001.01	0.95	-	0.86	0.78	0.1	-
	Euro 4	2006.01	0.74	-	0.46	0.39	0.06	-
	Euro 5a	2010.09	0.74	-	0.35	0.28	0.005	-
	Euro 5b	2011.09	0.74	-	0.35	0.28	0.005	6.0×10^{11}
	Euro 6	2015.09	0.74	-	0.215	0.125	0.005	6.0×10^{11}
	Euro 5a	2010.09	0.74	-	0.35	0.28	0.005	-
N2	Euro 5b	2011.09	0.74	-	0.35	0.28	0.005	6.0×10^{11}
	Euro 6	2015.09	0.74	-	0.215	0.125	0.005	6.0×10^{11}

Under the EURO 5 standards, L-category vehicles which includes vehicles like two- and three-wheel mopeds, two- and three-wheel motorcycles, tricycles, and light and heavy quadricycles, are not allowed to have emissions not more than 1000mg/km of CO, 100mg/km of total HC, 68mg/km of non-methane HC, 60mg/km of NO_X and 4.5mg/km of PM [18].

1.8. <u>Remote Sensing Method</u>

Remote Sensing method is a contactless emission testing method used to identify vehicles with high emission levels. The basic idea for this method of identification of high emitters in the real-world scenario was to reduce the complexness of technologies through combination of technology development, new analysis techniques, proof-of-concept demonstrations and extensive distribution of results, findings, and guidance. This method is a practical and cost-effective technique that can help monitoring and enforcing pollutant limits and improve air quality in urban areas [19]. Remote Sensing is one of the effective methods for measuring large number of vehicles in short period of time. This method is capable to measure emissions of vehicles in real driving conditions without being detected and avoided by the vehicle [20].

1.9. Objective

The goal of this thesis is to analyze data from remote sensing measurement campaign to detect high emitting passages for the test vehicles due to malfunction, wear or tampering. Analysis is based on particle metrics, instrument time resolution, vehicle acceleration and spacing between the vehicles. Emission factors of each individual passages are to be calculated per kg of fuel based on NO/CO_2 and PN/CO_2 ratios which are determined by linear regression method. Considering limit of detection, limit of quantification, threshold limit and concentration ratios of vehicle passages, high emitting passages are to be identified and further evaluate the data to determine the suitability of instruments, sampling location and vehicle spacing in real driving environment by remote sensing method.

2. Experimental Setup

2.1. Field Measurement Setup

The experiment was conducted in Lelystad test circuit in Netherlands from 22.06.2021 till 25.06.2021. The test circuit selected was close to the Airport of Lelystad. This sampling site was selected because it was a controlled environment for testing, there was no interference of vehicles or traffic other than the test vehicles used and for the controlled spacing between the vehicles.

To know the concentrations of the pollutants, it is necessary to place the sampling lines in the right location from where the exhaust samples from the vehicles can be collected correctly. In this experiment it was done by two approaches- first was by placing the sampling channel on the middle of the road over which the test vehicles were allowed to pass; and the second was by placing the sampling channel at the side of the road. The first approach was done because most of the exhaust tail pipes are located at the rear bottom of the vehicle and the second approach was done because it is an effective way in collecting data without any physical disturbance to the sampling line caused by the passing vehicles, but it was known that there could be difference in recorded data from instrument to the real data because of the distance and weather conditions.

In this experiment, instruments from two universities were kept in use with two different location of sampling lines as stated earlier. For Czech Technical University (CTU), sampling lines were placed on the middle of the road while for Czech University of Life Sciences (CZU), sampling lines were placed on the side of the road. The collected samples from individual sampling line were then sent to their respective computers for storing and analyzing the data.

Below are the pictures of the instrument setup.

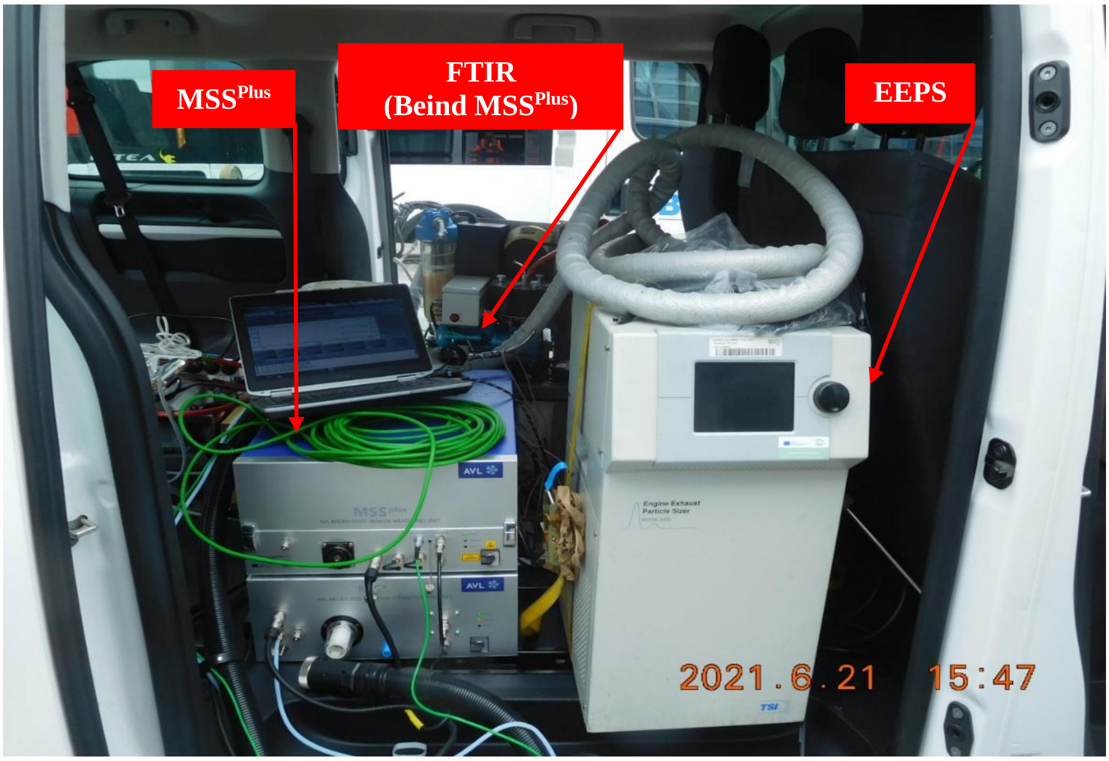

Fig 2A: Arrangement of instruments inside van [21]

Fig 2B: Test track [21]

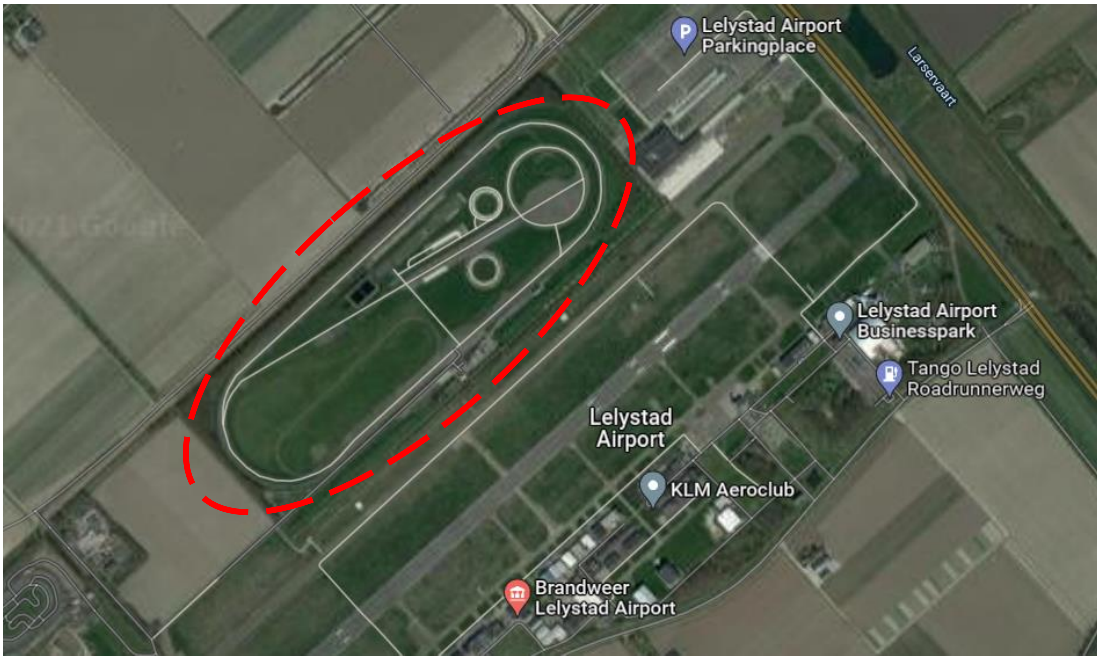

Fig 2C : Map view of test track

2.2. Measuring Instruments

Instruments that were used in this experiment were high-end portable devices- Engine Exhaust Particle Size (EEPS), Fourier Transform Infrared Spectrum (FTIR) and AVL Micro Soot Sensor^{plus} (MSS^{plus}). Each set of instruments were packed in different Vans, for both CTU and CZU.

2.2.1. Engine Exhaust Particle Size Spectrometer (EEPS)

This instrument is used for the measurement of the lower concentration of exhaust particles in diluted exhaust. It is considered as a fast-response and high-resolution instrument. It is manufactured by TSI Incorporated with a time resolution of 10 Hz. EEPS measures size distribution and number of concentrations of exhaust sample.

- **Operating principle of EEPS**

  In this method, exhaust gas which are positively charged particles is fed continuously with the help of corona charger. The charged particles are then sent to high voltage electrode column which are transported down by HEPA filtered sheath air and then positive voltage is applied to the electrodes creating opposite charge with respect to particles which makes them repel outwards according to electrical mobility. This repel makes the particle to strike electrometer in order – higher concentrations strike top electrometer and lower concentrations strike at the bottom electrometer. Electrometers are used for high sensitivity and for continuous measurement of particle sizes. For synchronizing the time delay between electrometers, variability in particle charge, image charge and size distribution with respect to time, EEPS has a built-in Digital Signal Processor (DSP) [22].

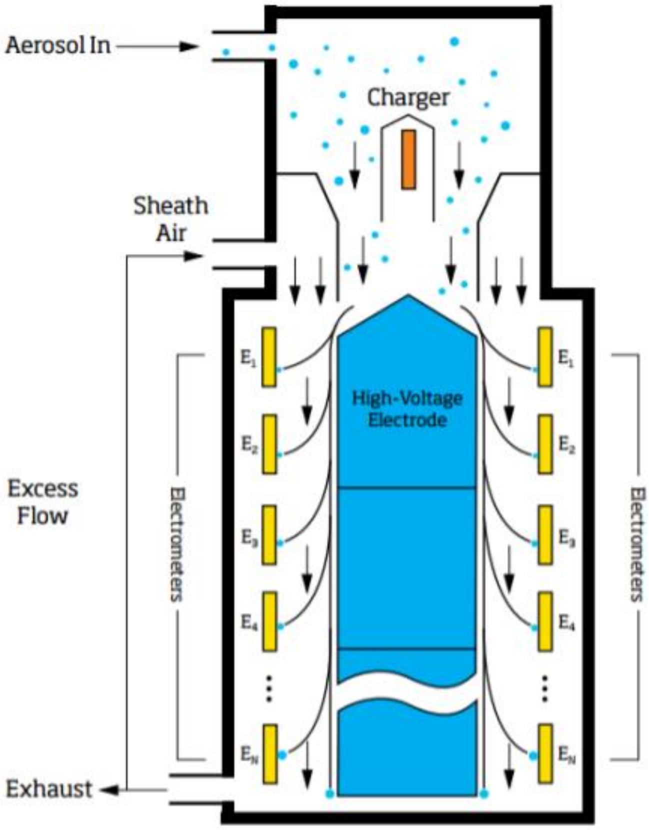

Fig 2D: Schematic diagram of EEPS operation [23]

2.2.2. Fourier Transform Infrared Spectrometer (FTIR)

This instrument is used for identification of variety of chemical compounds by absorption of Infra-Red Spectra. This instrument is an optical measuring device which detects the compounds by absorption of light by the individual compounds. The FTIRs used were assembled in the respective university. Compounds like HC, CO, CO_2, and NO are detected by this instrument.

- **Operating Principle of FTIR**

  FTIR works on the basic concept of gases absorbing light of different wavelengths. The IR spectra is obtained by Fourier Transform of light intensity. This is done by principle of superposition of two light beams of varying path length which is passed through an optical cell with sampled gas. The molecular bonds of the compound vibrate in different frequencies and this light energy absorption excites the molecules. Molecular structure which is the difference between the initial state and excited state is given by the wavelength of light absorbed by the sample [24].

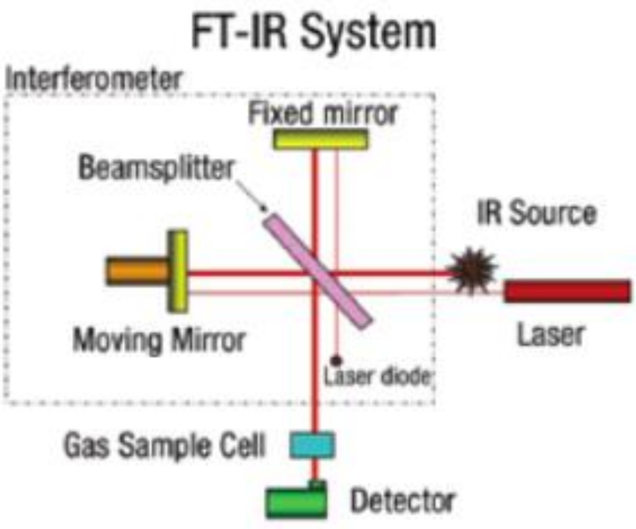

Fig 2E: Schematic diagram of FTIR working [24]

2.2.3. AVL Micro Soot Sensor^{plus} (MSS^{plus})

This instrument is used for the measurement of only soot particles from the exhaust gases sample. It is manufactured by AVL LIST GmbH with 1µg/m^3 (manufacturer specifications) as detection limit in a closed environment. When subjected to open environment such as the testing site which had huge interference of wind, there is a change in the limit obtained than the real limit (refer section 3.2). MSS^{plus} is based on the principle of Photo-acoustic measurement.

- **Photo-acoustic Measurement Principle**

  In this method, the sample exhaust gas with soot particles is exposed to light. As the soot particles are exposed to light, the particles start absorbing light and periodically warms and cools, resulting in expansion and contraction of the sample gas which behaves as sound waves that is detected by the piezoelectric detectors [25].

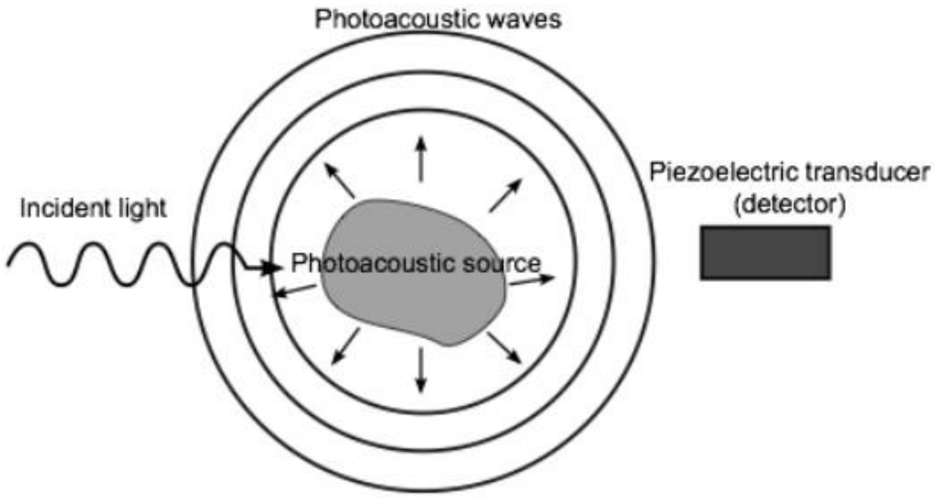

Fig 2F: Schematic diagram of MSS working [26]

2.3. Test Vehicles Used

In this experiment 7 selected test vehicles were used. These vehicles were of different categories and different fuel types. Below are the details of the individual vehicles.

Table VII: Test vehicles used

Notations	Model	Fuel Type	Category
T	Ford F-Max (Truck)	Diesel	Heavy-duty
TR	VW Transporter	Diesel	LCV
TN	VW Touran	Gasoline	LCV
C	VW Caddy	Diesel	LCV
S	Yamaha N-Max (Scooter)	Gasoline	L
MB	Yamaha MT-07 (Motorbike)	Gasoline	L
P	VW Crafter (Plume Chaser)	Diesel	LCV

3. Experimental Setup Characteristics

The raw data from the instruments were collected for each test days and it was observed that-

- **a.** Data from EEPS measures particle number per cm^3 of air in $\#/cm^3$ unit.
- **b.** Data from FTIR measures concentrations of gaseous pollutants in ppm (parts per million) unit.
- **c.** Data from MSS^{plus} measures mass of soot per m^3 of air in mg/m^3 unit.
- **d.** Data collected on 24.06.2021 and 25.06.2021 were used for analysis.
- **e.** There was always the presence of some amount of background concentrations.
- **f.** Overlapping of data during low spacing between vehicles.
- **g.** Data accuracy depending on position of sampling point and position of exhaust tail pipe.

3.1. Background Concentrations

Estimation of background concentrations is a complicated task in a road-side measurement because of frequent change in background with respect to time. This change in background happens due to-

a. The impact of wind, which changes the dilution ratio.

b. Interference of exhaust gases from passing vehicles.

c. Change in concentration of gases.

Background concentrations could also be called as the blank signals obtained during no passage of vehicles. The signals were carefully observed and was found that-

a. The data obtained from the instruments were shifted due to presence of background concentrations.

b. The peak time and settling time were different for different time frame. This could be basically due to wind speed and change in wind direction.

c. The peak time was shorter than the settling time during the testing.

Peak time is the time in seconds to reach the peak point of the signal from steady state whereas, settling time is the time in seconds to reach steady state from peak point of signal. For correction to the background concentrations, a shift was used in the formulation depending on the rise of steady state signals. Background concentrations are inevitable if the tests are conducted in open environment. In general, net value of the signal can be calculated by removing estimated background from the recorded value. These background concentrations are often referred as ‘noise’ or the ‘disturbance’ in the signal. Noise can be divided in two categories- one, is Internal Noise which is associated with its own components; and the other is External Noise which is associated with the vibration or any physical disturbance to the instrument [27] [28].

3.2. <u>Limit of Detection & Limit of Quantification</u>

Limit of Detection (LOD) is defined as the minimum value from which it is possible to deduce the presence of concentration with reasonable statistical certainty. Whereas Limit of Quantification (LOQ) is defined as least content of concentrations which can be measured with reasonable statistical certainty [29]. For estimating LOD and LOQ, two types of error must be considered-

a. Type I error, α, which is error due to false positive (detect which is not present)

b. Type II error, β, which is error due to false negative (undetected which is present).

It is recommended to consider the errors as low as possible because the uncertainty of instruments is considered low. So, the values of α and β were chosen 5% = 0.05, respectively [29] [30].

LOD is numerically equal to 3 times the standard deviation of blank (no concentrations) sample and if accuracy and precision are constant around LOD then LOQ is numerically equal to 6 times the standard deviation of blank (no concentrations) sample.

So, the formula is given as-

$$\mathrm{LOD} = 3\,\sigma$$

$$\mathrm{LOQ} = 6\,\sigma$$

where, σ is standard deviation of blank (no concentrations) sample.

As the experiment was conducted in open environment, there was presence of atmospheric content, so, it was assumed that the standard deviation of the blank sample corresponds to the sample without vehicle emission.

Below are the calculated LOD and LOQ of the instruments used in the test.

Table VIII: Calculated LOD and LOQ for instruments

Instruments		LOD	LOQ	Units
MSS[Plus]	**PM**	1.1	2.2	µg/m^3
VAN EEPS	**PN**	5014	10028	#/cm^3
CTU EEPS	**PN**	2012	4024	#/cm^3
CZU FTIR	**CO_2**	4	8	ppm
	CO	0.5	0.3	ppm
	NO	0.6	1.2	ppm
CTU FTIR	**CO_2**	22.1	44.3	ppm
	CO	0.5	1	ppm
	NO	0.4	0.9	ppm

3.3. Instrument Time Response

Time Response or Rise Time is the time in seconds that takes a signal to rise from 10% to 90% of its maximum absolute value [31]. This time is an important factor that should be considered for identifying the behavior of measurements. To calculate the Rise Time, an unit step response was given as input. This was verified with the instruments which were given an unit step response by disconnecting and again connecting in a time interval of 30 seconds each to get the peak from base signal (0%) to highest peak (100%) from where the time rise between 10% of peak to 90% of peak was estimated. The estimation was done by averaging four rise periods of the signals of instruments. It was also observed that rise time were different to each signal.

Below are the estimated response time of the instruments and graphs-

Table IX: Estimated Response Time for instruments

Instruments	Response Time (sec)
EEPS	1.8
FTIR	1.4
MSS[plus]	9.6

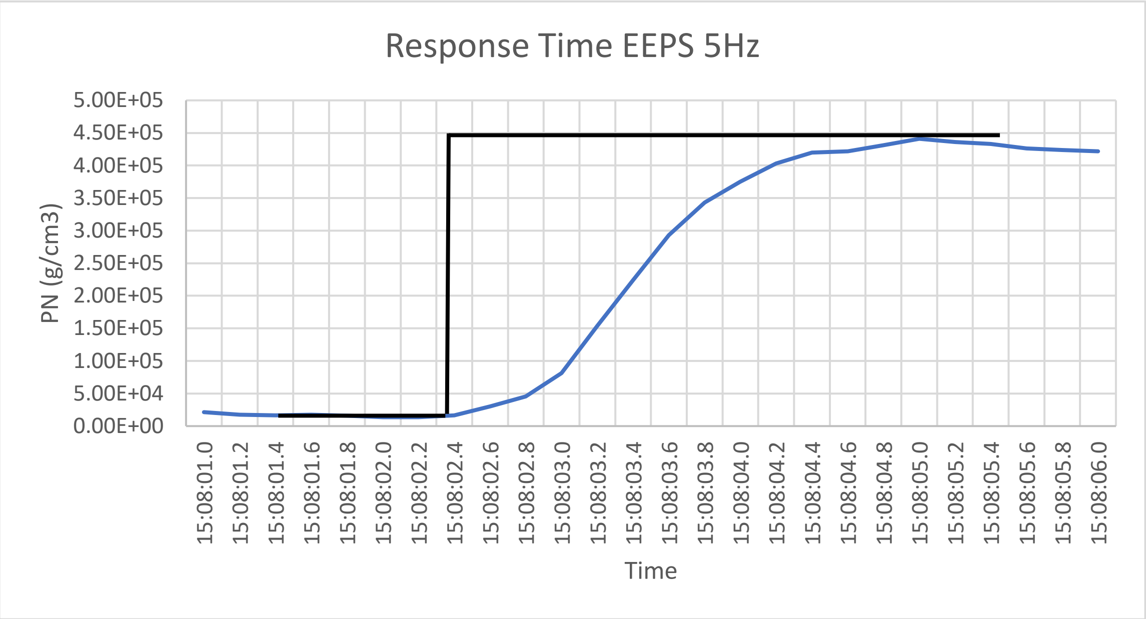

Fig 3A: Response Time for EEPS in 5Hz

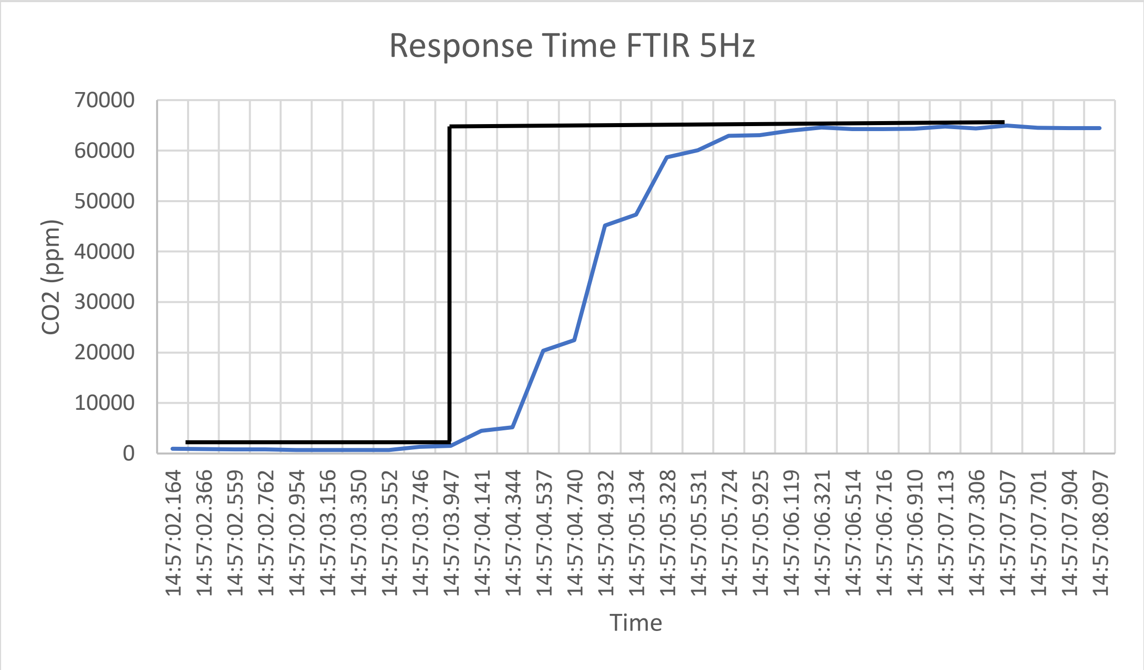

Fig 3B: Response Time for FTIR in 5Hz

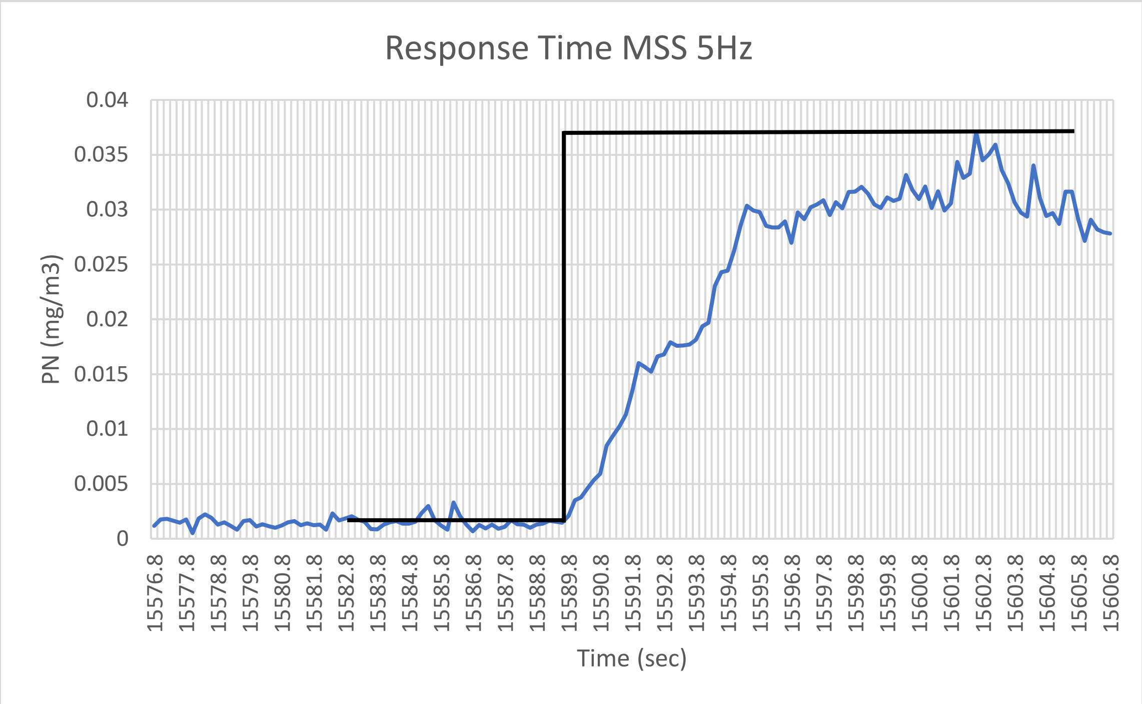

Fig 3C: Response Time for MSS^{Plus} in 5Hz

3.4. Resolution of Time for Instruments

The data from the instruments were recorded for 4 different dates (22.06.2021 to 25.06.2021) with different frequencies. So, to time-match the instrument readings, it was essential to convert frequencies of the instruments to a common frequency. The method used to synchronize the frequencies of instrument was linear interpolation. In the experiment conducted in Lelystad, Netherlands, all the instruments were resampled to 5Hz because 5Hz was the lowest obtainable frequency from all the instruments. CTU FTIR was running in 1Hz which was not sensitive enough for narrow spikes and CZU instruments were running in 10Hz which did not bring any added value (processes of mixing were rather slow), for which 5Hz was a good trade-off offering good resolution which allows to distinguish between individual peaks. Below are the details of frequencies of recorded data as well as resampled frequencies for the instruments-

Table X: List of recorded frequency to resampled frequency

Instrument	Recorded Frequency (Hz)		Resampled Frequency (Hz)
	24.06.2021	25.06.2021	
VAN EEPS	10	10	5
CTU EEPS	10	10	5
CZU FTIR	5	5	5
CTU FTIR	1	1	5
MSS^{plus}	5	5	5

3.5. Particle Size Distribution

3.5.1. Properties

Particles emitted from the vehicle exhaust is divided into 2 categories-

a. Monodisperse- Particles with uniform diameter and mass

b. Polydisperse- Particles with different diameter and mass

The physical properties of the particles have a strong dependency on particle sizes. For monodisperse, only particle diameter is considered [32].

The instruments used for detection of particles are EEPS and MSS^{plus}. MSS^{plus} is the instrument that gives the total concentrations of all the soot particles; but EEPS gives concentrations according to different particle size distribution. The separation of particle numbers in EEPS is done by electrical mobility which can be defined as the ability of charged particles getting attracted to the electric field in a medium [33]. EEPS has 32 channels of particle size distribution ranging from 6.04nm to 523.3nm.

3.5.2. Particle Mass from Particle Number in EEPS

The value obtained from each channel in EEPS from the measurement represents number of particles per cm^3. Generally, exhaust particles are polydisperse in nature and the effective density of the particle decreases with increase in particle size ranging from $1.5 g/cm^3$ to $0.1 g/cm^3$ [34]. For calculation, the shape of the particle was assumed to be sphere and effective density is assumed as $1 g/cm^3$ [33] and concentrations from 25 channels ranging from 6.04nm to 191.1nm were considered.

The formula was given as-

$$V = \frac{1}{6} * \pi * D^3$$

$$M = \rho_{eff} * V$$

where, V is Volume of Particle of each channel

D is Diameter of Particle of each channel

M is Particle Mass of each channel

ρ_{eff} is Effective Density

To find the total Particle Mass of all channels, below formula was used-

$$M_{total} = \sum_{i} (n_i * M_i)$$

where, i is Channel Size

n is Particle Number

Below table indicates the particle mass measured from particle number for passage of scooter when both VAN EEPS and CTU EEPS were active-

Table XI: Calculated particulate mass from particulate number for Scooter

Vehicle	Scooter	
Date / Time	24.06.2021 / 14:48:44	
	VAN EEPS	**CTU EEPS**
PN ($\#/m^3$)	1.39E+10	5.78E+09
PM (mg/m^3)	1.26E-04	3.64E-04

Following graphs indicates the particle size distribution in terms of particle number and particle mass of each channel size for both VAN EEPS and CTU EEPS for the above-mentioned passage-

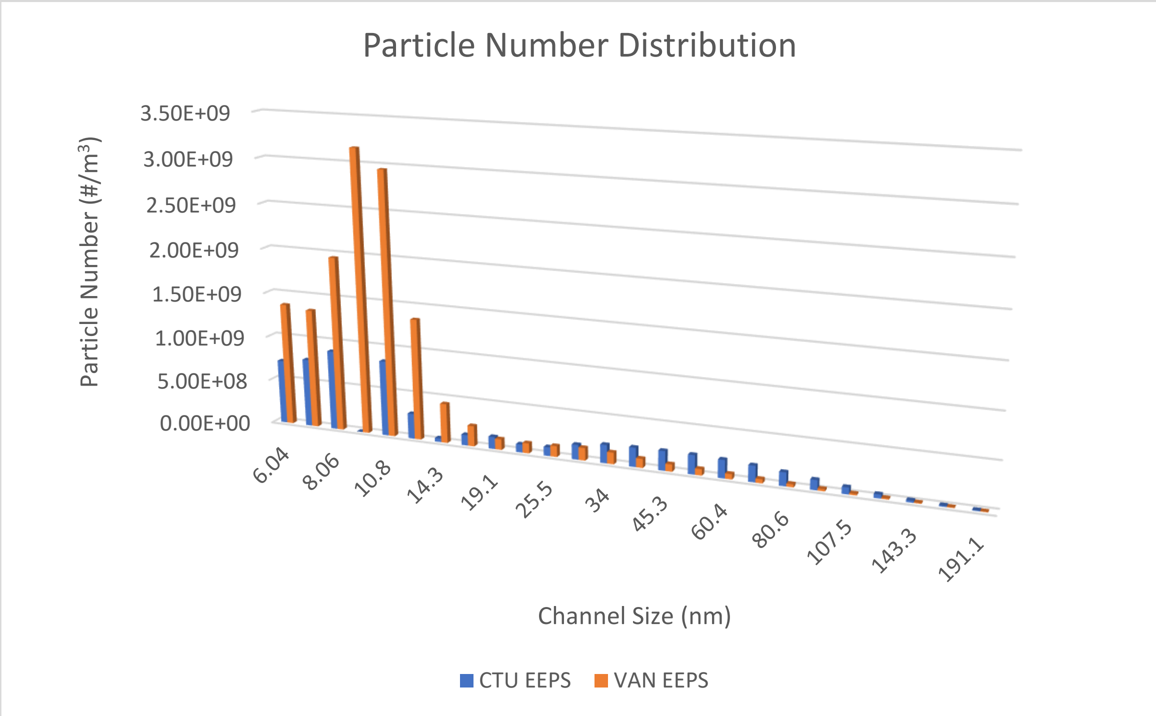

Fig 3D: Particle Number Distribution for each channel of CTU EEPS and VAN EEPS for Scooter on 24.06.2021 at 14:48:44

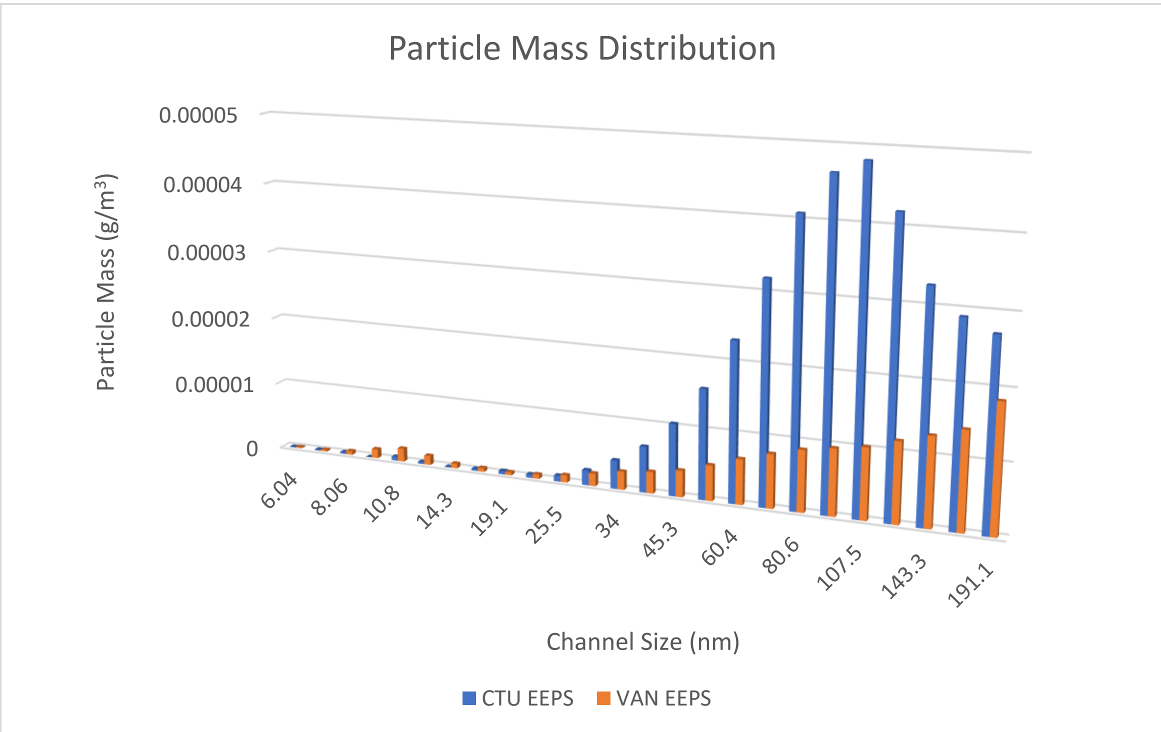

Fig 3E: Particle Mass Distribution for each channel of CTU EEPS and VAN EEPS for Scooter on 24.06.2021 at 14:48:44

From the above graphs it was observed that with increase in particle size, particle concentrations decreases and particle mass increases. It was also observed that from high particle number concentrations were detected by VAN EEPS as the channel size decreases whereas high particle mass concentrations were detected by CTU EEPS as the channel size increases.

3.6. <u>Emission Factor</u>

Emission Factor or Fuel Specific Emission Factor can be defined as the quantity of pollutants released from the vehicles to the atmosphere associated with pollutants level. The test vehicles used were of different fuel types as mentioned in section 2.3. In ideal combustion process, the amount of CO is considerably low to that from CO_2 in diesel engines but in gasoline amount of CO is considerable to that of CO_2. But in reality, both engines produce considerable amount of CO and CO_2.

For the calculation of Emission Factor, certain parameters were considered-

a. Carbon content in fuels were assumed to be 0.862 for both diesel and gasoline.

b. Presence of CO and CO_2 for both diesel and gasoline were assumed.

c. Molecular volume of gas was assumed as 22400cm^3/mol.

The formulae for finding the Emission Factors in terms of CO, CO_2 and NO are stated below-

$$\mathrm{EF_{NO}} = \frac{\mathrm{m_{NO}}}{\mathrm{m_{fuel}}} = \frac{[\mathrm{C}] * \mathrm{C_{NO}} * \mathrm{M_{NO}}}{\mathrm{M_C} * \mathrm{C_{CO_2}} * \left(1 + \frac{\mathrm{C_{CO}}}{\mathrm{C_{CO_2}}}\right)}$$

$$\mathrm{EF_{PN}} = \frac{\mathrm{N_{PM}}}{\mathrm{m_{fuel}}} = \frac{[\mathrm{C}] * \mathrm{V_m} * \mathrm{C_{PN}}}{\mathrm{M_C} * \mathrm{C_{CO_2}} * \left(1 + \frac{\mathrm{C_{CO}}}{\mathrm{C_{CO_2}}}\right)}$$

where, EF_{NO} = Emission Factor of NO in g/kg_{fuel}

EF_{PN} = Emission Factor of PM in #/kg_{fuel}

[C] = Carbon content in Fuel = 0.862(no units)

C_{CO} = Concentration of CO measured from FTIR

C_{CO2} = Concentration of CO_2 measured from FTIR

C_{NO} = Concentration of NO measured from FTIR

C_{PN} = Concentration of PM measured from EEPS

V_m = Molecular Volume of gas = 22400cm^3/mole

M_C = Molecular Weight of Carbon

M_{NO} = Molecular Weight of NO

The molecular weight of carbon is 12g/mol and NO is 30.01g/mol but in this calculation the molecular weight of NO was considered as molecular weight of NO_2 which is 46g/mol because as NO is released to the atmosphere it interacts with oxygen and covert to NO_2. Below are the lists of calculated Emission Factors for individual instruments-

Table XII: Calculated Emission Factor for CTU FTIR and CTU EEPS

Vehicle	VW Crafter				
Date / Time	24.06.2021 / 14:44:34				
Peak Concentrations			**Linear Regression**		
CTU FTIR					
CO_2 (ppm)	**CO (ppm)**	**NO (ppm)**	**CO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**
39.15	0.22	0.09	0.008	0.003	7.27
CTU EEPS					
CO_2 (ppm)	**CO (ppm)**	**PN (#/cm^3)**	**CO/CO_2**	**PN/CO_2**	**EF_{PN} (#/kg_{fuel})**
39.15	0.22	104770	0.008	1762.12	2.81E+15

Table XIII: Calculated Emission Factor for CZU FTIR and VAN EEPS

Vehicle	VW Crafter				
Date / Time	24.06.2021 / 14:44:34				
Peak Concentrations			**Linear Regression**		
CZU FTIR					
CO_2 (ppm)	**CO (ppm)**	**NO (ppm)**	**CO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**
14.51	0.03	0.37	0.0006	0.0033	84.65
VAN EEPS					
CO_2 (ppm)	**CO (ppm)**	**PN (#/cm^3)**	**CO/CO_2**	**PN/CO_2**	**EF_{PN} (#/kg_{fuel})**
14.51	0.03	159654	0.01	3062.75	4.93E+15

In the above tables XII and XIII, the concentrations of CO_2, CO, NO and PN are the peak concentrations, and the ratios CO/CO_2, NO/CO_2 and PN/CO_2 were the slope factor obtained from linear regression. Detail list of emission factor are presented in the Appendix 10.3.

3.7. Synchronizing Passages of Vehicles with resolved data

For synchronization of vehicle with the data received from the instrument, were matched according to the timing. The passages of the vehicles were obtained by optical system (light barrier) and were noted in the computer with respect to the time. The synchronization has been obtained by changing the time offset or in other words time shift.

Time shift from instrument was considered in this experiment to get the best possible arrangements of the passages with its peak. The concentrations recorded from the instruments were collected and stored in the computer and matched with each vehicle passages accordingly.

4. Analysis

4.1. Significance of NO/CO_2 & PN/CO_2 ratios

The most important term in identifying the amount of pollutants released to the amount of fuel consumed assuming all carbon present in the fuel is oxidized to CO_2 are the ratio of concentrations of NO to CO_2 and PN to CO_2. But in reality, not all carbon is converted to CO_2.

$$\text{Assumed } EF_{NO} = {}^{NO}/_{CO_2} = \frac{\text{Concentration of NO}}{\text{Concentration of } CO_2}$$

$$\text{Assumed } EF_{PN} = {}^{PN}/_{CO_2} = \frac{\text{Concentration of PN}}{\text{Concentration of } CO_2}$$

where, concentration of NO and CO_2 are in ppm

concentration of PN is in $\#/cm^3$

The above-mentioned ratios are obtained by correlating the signals of individual concentrations to the concentrations of CO_2 by linear regression method. The slope of the correlation (ratio) obtained gives the ratio of the concentrations of pollutants with respect to concentrations of CO_2 from which high and low emitters can be identified. The correlating factor (R2) obtained gives an understanding of how well the detected concentrations of pollutant was correlated with the concentrations of CO_2 detected at that vehicle passage which is shown in section 4.3.

4.2. Conversion of Emission Factors to Emission Standards

In this experiment, there were seven vehicles out of which four vehicles were diesel powered and three vehicles were gasoline powered. The truck used for testing comes in category of heavy-duty vehicles; scooter and motorbike used comes in L-category; and all other vehicles comes in category of Light-commercial vehicles.

In case of heavy-duty vehicles, the Emission standards were calculated in g/kWh and for all other vehicles Emission standards were calculated in g/km.

4.2.1. g/kg_{fuel} / #/kg_{fuel} to g/kWh / #/kWh

To calculate the Emission Factors for trucks in terms of g/kWh for gaseous pollutants or #/kWh for number of particulate pollutants, brake specific fuel consumption was assumed according to the type of acceleration. In general, as the acceleration increases, BSFC increases [35]. So, during normal mode of acceleration BSFC was assumed to be 250g/kWh and during sporty acceleration BSFC was assumed to be 280g/kWh. Below are the formula of conversion-

$$\mathrm{EF}\left(\frac{\mathrm{g}}{\mathrm{kWh}}\right) = \frac{\mathrm{EF}\left(\frac{\mathrm{g}}{\mathrm{kg_{fuel}}}\right)}{1000} * \mathrm{BSFC}$$

$$\mathrm{EF}\left(\frac{\#}{\mathrm{kWh}}\right) = \frac{\mathrm{EF}\left(\frac{\#}{\mathrm{kg_{fuel}}}\right)}{1000} * \mathrm{BSFC}$$

where, BSFC is Brake Specific Fuel Conversion.

For the Truck which was Ford F-Max, the calculated Emission factors according to EU standards are presented below considering BSFC as 250g/kWh in normal acceleration-

Table XIV: Calculated EF/kWh for CTU FTIR and CTU EEPS

Vehicle	Truck	
Date / Time	24.06.2021 / 14:52:24	
CTU FTIR		
NO (ppm)	**EF_{NO} (g/kg$_{fuel}$)**	**EF_{NO} (g/kWh)**
1.67	18.38	4.6
CTU EEPS		
PN (#/cm^3)	**EF_{PN} (#/kg$_{fuel}$)**	**EF_{PN} (#/kWh)**
2518	2.06E+13	5.15E+12

Table XV: Calculated EF/kWh for CZU FTIR and VAN EEPS

Vehicle	Truck	
Date / Time	24.06.2021 / 14:52:24	
CZU FTIR		
NO (ppm)	**EF_{NO} (g/kg$_{fuel}$)**	**EF_{NO} (g/kWh)**
0.37	9.01	2.25
VAN EEPS		
PN (#/cm^3)	**EF_{PN} (#/kg$_{fuel}$)**	**EF_{PN} (#/kWh)**
1002	8.33E+13	2.08E+13

In the above tables XIV and XV, the concentrations of NO and PN are the peak concentrations.

4.2.2. g/kg$_{fuel}$ / #/kg$_{fuel}$ to g/km / #/km

To calculate the Emission Factor for the L-category and light-commercial vehicle in terms of g/km for gaseous pollutants or #/km for number of particulate pollutants, certain factors need to be considered as the individual details about the vehicles were not recorded during test run-

a. Density of gasoline- 0.755 kg/l

b. Density of diesel- 0.85 kg/l

c. Vehicle fuel consumption in l/100km

d. With increase in acceleration, Fuel consumption increases [35]

So, the formula that has been derived are mentioned below-

$$EF\left(\frac{g}{km}\right) = \frac{EF\left(\frac{g}{kg_{fuel}}\right)}{100} * FC * D_{fuel}$$

$$EF\left(\frac{\#}{km}\right) = \frac{EF\left(\frac{\#}{kg_{fuel}}\right)}{100} * FC * D_{fuel}$$

where, FC is Fuel Consumption according to manufacturer

D_{fuel} is Density of fuel

For VW Transporter which runs in diesel fuel, the calculated Emission factors according to EU standards are presented below, considering density of diesel fuel as 0.85kg/l, fuel consumption as 7.5l/100km for normal acceleration (official fuel consumption range is 7 to 8.7 l/100km)-

Table XVI: Calculated EF/km for CTU FTIR and CTU EEPS

Vehicle	VW Transporter	
Date / Time	24.06.2021 / 14:55:55	
CTU FTIR		
NO (ppm)	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
0.48	15.98	1.02
CTU EEPS		
PN (#/cm^3)	**EF_{PN} (#/kg_{fuel})**	**EF_{PN} (#/km)**
12554	3.84E+14	2.45E+13

Table XVII: Calculated EF/km for CZU FTIR and VAN EEPS

Vehicle	VW Transporter	
Date / Time	24.06.2021 / 14:55:55	
CZU FTIR		
NO (ppm)	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
0.37	208.76	13.31
VAN EEPS		
PN (#/cm^3)	**EF_{PN} (#/kg_{fuel})**	**EF_{PN} (#/km)**
15120	9.60E+14	6.12E+13

In the above tables XVI and XVII, the concentrations of NO and PN are the peak concentrations.

4.3. Detection of High Emitters and Low Emitters

4.3.1. Considerations

Before analyzing the passage of the vehicle when it was high emitting or low emitting, certain factors need to be considered-

a. Slopes (ratio) and correlating factors (R2) for NO/CO_2 and PN/CO_2 ratios were calculated by linear regression method.

b. LOD and LOQ of pollutants and threshold limit of detection of CO_2 concentrations.

c. EURO standards of the vehicles according to vehicle manufacturer were to be noted.

d. Emission Factors in terms of EURO standard units were calculated according to their type of vehicle and type of fuel.

In this experiment, no details about the test vehicles were presented; but on observing the type of manufacturer, model, and condition of individual vehicles, it was predicted that all the vehicles could be of EURO 5 or more. So, for reference, EURO 5 was considered for LCV and L-category vehicles and EURO 6 was considered for heavy-duty vehicle. Also, the data from EEPS and FTIR were used for analysis. The data received from MSS^{plus} for soot particles were very inconsistent as compared with the data received from the CTU EEPS (Refer Section 4.4.3) for which during the experiment a muffler was used for improvising the signals, but it was of no use; so, MSS^{Plus} was not considered for the analysis.

4.3.2. Shortlisting of Vehicle Passages

The data used for analysis was from 24.06.2021 and during morning of 25.06.2021 because on these days the testing was done in a controlled way. In total 629 passages were analyzed.

The calculated Emission Factors in g/kg_{fuel} was shortlisted based on LOD of pollutants and threshold limit of CO_2. The logic used to shortlist the vehicle passages-

- When peak concentration of CO_2 was higher than its threshold limit and peak concentration of pollutants was less than its LOD, then it was considered as '<LOD' which means the pollutants were very low.
- When peak concentration of CO_2 was lower than its threshold limit, then it was considered as 'Weak Signal'.

This 'shortlisting' procedure helps to determine the passages which corresponding to weak signal, passages corresponding to low concentrations pollutants from which low emitters were identified and the remaining detected passages from which high emitters were identified.

4.3.3. Detection

Once, the shortlisting of vehicles were done with all the considered variables. The comparison was done with their corresponding correlating factor (R2), slope factor (ratio) and peak concentrations for detection of vehicle passages producing high emission in the passage or in other words detection of passages where the exhaust after-treatment of vehicles were tampered. In this procedure, first, the correlating factors were observed and values greater than or equal to 0.90 or 90% was considered as it implies the high detection of pollutants with respect to detected CO_2 concentration; second, higher value of slope factors considering concentrations of pollutants if greater than its LOQ limit. To determine the low emitting vehicle passages the same procedure was followed but instead of greater values of correlating factor, lower values- less than or equal to 0.20 or 20% was considered as it implies low detection of pollutants with respect to CO_2 and lower value of slope factors considering pollutants if less than its LOD limit.

As per the experiment, NO_X emission was considered for detection of high emitting NO_X passage for truck because the SCR system was turned off for certain passages and for all other diesel-powered vehicles, PN emissions were considered for detection of high emitting PN passages because DPF was bypassed for certain passages. Out of 629 passages, 210 passages were shortlisted which were detected by either of the instruments or by both instruments from same sampling point location, and by all instruments. Further the detected passages were shortlisted according to individual vehicles for conversion of emission factor in terms of respective emission standards. Below sections 4.3.3.1 and 4.3.3.2 represents the shortlisted passages that were detected high emitting or low emitting according to the position of the sampling points.

4.3.3.1. CTU Instruments (Sampling point was on middle of the road)

Table XVIII: Detected NO_X emission passage by CTU FTIR

CTU FTIR	Peak Conc.	lin.reg	R2	
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**
24.06.2021, 4, 09:48:35, veh: C, 12a 9	0.10	0.000	0.02	3.36
24.06.2021, 18, 09:57:54, veh: C, 12a 9	0.80	0.005	0.95	20.69
24.06.2021, 25, 10:02:35, veh: C, 12a 9	0.54	0.006	0.84	17.62
24.06.2021, 28, 10:03:04, veh: TN, 12a 9	0.71	0.009	0.82	22.83
24.06.2021, 29, 10:03:05, veh: P, 12a 9	0.74	0.011	0.74	22.12
24.06.2021, 35, 10:07:36, veh: T, 12a 9	1.86	0.006	0.96	20.83
24.06.2021, 42, 10:11:42, veh: T, 12b 9	1.15	0.006	0.95	17.98
24.06.2021, 43, 10:11:46, veh: TN, 12b 9	1.11	0.008	0.94	19.36
24.06.2021, 44, 10:11:48, veh: MB, 12b 9	0.89	0.006	0.89	22.31
24.06.2021, 50, 10:15:49, veh: TN, 12b 9	-0.35	-0.008	0.78	-4.93
24.06.2021, 56, 10:20:04, veh: P, 12b 9	0.77	-0.011	0.91	9.77
24.06.2021, 57, 10:20:05, veh: TN, 12b 9	0.71	-0.011	0.90	8.72
24.06.2021, 58, 10:20:09, veh: MB, 12b 9	-0.21	-0.009	0.79	-2.75
24.06.2021, 63, 10:24:00, veh: TN, 12b 9	0.12	-0.004	0.75	1.95
24.06.2021, 64, 10:24:02, veh: P, 12b 9	0.09	-0.012	0.90	0.92
24.06.2021, 65, 10:24:04, veh: MB, 12b 9	0.26	-0.003	0.45	3.65
24.06.2021, 68, 10:28:28, veh: P, 12c 9	0.46	0.001	0.03	15.06
24.06.2021, 69, 10:28:31, veh: TR, 12c 9	0.41	0.003	0.40	11.60
24.06.2021, 77, 10:32:08, veh: T, 12c 9	0.88	0.004	0.91	14.73
24.06.2021, 78, 10:32:11, veh: TN, 12c 9	1.32	0.005	0.93	16.90
24.06.2021, 79, 10:32:13, veh: MB, 12c 9	1.05	0.005	0.96	16.71
24.06.2021, 80, 10:35:28, veh: S, 12c 9	0.92	0.006	0.83	17.66
24.06.2021, 81, 10:35:29, veh: C, 12c 9	0.91	0.006	0.81	18.07
24.06.2021, 82, 10:35:30, veh: TR, 12c 9	0.96	0.005	0.78	18.49
24.06.2021, 85, 10:35:40, veh: TN, 12c 9	0.01	0.002	0.34	0.18
24.06.2021, 86, 10:35:42, veh: MB, 12c 9	0.33	0.000	0.01	3.54
24.06.2021, 87, 10:39:14, veh: S, 12c 9	0.67	0.003	0.59	21.10
24.06.2021, 88, 10:39:15, veh: C, 12c 9	0.65	0.003	0.30	20.34
24.06.2021, 90, 10:39:21, veh: T, 12c 9	0.80	0.005	0.92	22.24
24.06.2021, 91, 10:39:25, veh: TN, 12c 9	1.09	0.005	0.91	13.97
24.06.2021, 92, 10:39:26, veh: P, 12c 9	1.01	0.003	0.80	15.25
24.06.2021, 93, 10:39:28, veh: MB, 12c 9	0.71	0.004	0.89	12.74
24.06.2021, 98, 10:58:24, veh: TN, 13a 9	1.26	0.005	0.97	20.17
24.06.2021, 102, 11:02:16, veh: T, 13a 9	3.40	0.005	0.99	15.10
24.06.2021, 105, 11:02:34, veh: TN, 13a 9	0.16	-0.003	0.29	1.71
24.06.2021, 111, 11:06:46, veh: TN, 13a 9	-0.50	-0.008	0.55	-6.14
24.06.2021, 112, 11:06:47, veh: P, 13a 9	-0.52	-0.013	0.66	-4.47
24.06.2021, 115, 11:11:23, veh: T, 13a 9	2.35	0.005	0.99	16.33
24.06.2021, 117, 11:11:42, veh: TN, 13a 9	-0.76	-0.005	0.35	-7.31
24.06.2021, 121, 11:17:02, veh: T, 13b 9	0.69	0.005	0.95	13.73
24.06.2021, 125, 11:17:17, veh: C, 13b 9	-0.53	-0.008	0.95	-9.45
24.06.2021, 127, 11:20:48, veh: T, 13b 9	2.05	0.005	0.98	15.67
24.06.2021, 128, 11:20:53, veh: TR, 13b 9	0.69	0.005	0.84	15.20
24.06.2021, 134, 11:24:41, veh: T, 13b 9	1.96	0.005	0.99	15.26
24.06.2021, 135, 11:24:47, veh: TR, 13b 9	0.99	0.005	0.93	21.30
24.06.2021, 137, 11:24:54, veh: P, 13b 9	-0.84	-0.014	0.91	-10.38
24.06.2021, 141, 11:29:52, veh: T, 13b 9	1.61	0.005	0.98	14.78
24.06.2021, 150, 11:34:19, veh: TR, 13c 9	0.72	0.005	0.85	18.72
24.06.2021, 151, 11:34:21, veh: TN, 13c 9	0.90	0.005	0.77	18.72

24.06.2021, 152, 11:34:23, veh: C, 13c 9	0.92	0.005	0.95	17.69
24.06.2021, 153, 11:34:25, veh: S, 13c 9	0.55	0.006	0.93	16.30
24.06.2021, 157, 11:38:11, veh: P, 13c 9	1.00	-0.010	0.95	12.06
24.06.2021, 158, 11:38:13, veh: TN, 13c 9	0.80	-0.010	0.91	8.47
24.06.2021, 159, 11:38:15, veh: C, 13c 9	-0.49	-0.009	0.76	-4.28
24.06.2021, 160, 11:38:17, veh: S, 13c 9	0.16	-0.006	0.85	2.07
24.06.2021, 163, 11:41:56, veh: TR, 13c 9	0.49	-0.010	0.97	8.89
24.06.2021, 164, 11:41:58, veh: TN, 13c 9	0.41	-0.010	0.96	6.76
24.06.2021, 165, 11:42:00, veh: P, 13c 9	-0.25	-0.013	0.64	-3.41
24.06.2021, 170, 11:46:16, veh: TR, 13c 9	0.19	-0.002	0.13	3.86
24.06.2021, 171, 11:46:18, veh: TN, 13c 9	0.13	0.004	0.37	3.13
24.06.2021, 172, 11:46:19, veh: C, 13c 9	0.14	0.005	0.56	3.56
24.06.2021, 173, 11:46:21, veh: P, 13c 9	0.46	-0.003	0.10	6.96
24.06.2021, 174, 11:46:24, veh: S, 13c 9	0.59	0.003	0.66	12.57
24.06.2021, 175, 12:02:21, veh: MB, 14a 9	0.43	0.002	0.46	11.89
24.06.2021, 176, 12:02:35, veh: T, 14a 9	2.16	0.004	0.98	15.16
24.06.2021, 177, 12:02:38, veh: P, 14a 9	2.33	0.005	0.97	14.97
24.06.2021, 190, 12:10:28, veh: T, 14a 9	0.83	0.004	0.39	26.92
24.06.2021, 196, 12:13:55, veh: MB, 14a 9	0.14	-0.004	0.58	2.25
24.06.2021, 197, 12:14:07, veh: T, 14a 9	1.13	0.005	0.94	19.24
24.06.2021, 199, 12:14:18, veh: P, 14a 9	0.71	0.007	0.90	21.72
24.06.2021, 13, 14:19:44, veh: P, 15a 9	0.61	0.005	0.46	18.40
24.06.2021, 41, 14:36:51, veh: P, 15b 9	0.59	0.003	0.18	17.59
24.06.2021, 71, 14:52:27, veh: TN, 15c 9	1.02	0.006	0.94	19.43
24.06.2021, 81, 14:59:52, veh: C, 15c 9	0.46	0.004	0.79	14.11
24.06.2021, 82, 14:59:54, veh: TR, 15c 9	0.58	0.002	0.09	15.62
24.06.2021, 102, 15:30:05, veh: T, 16a 9	0.92	0.004	0.92	15.98
24.06.2021, 105, 15:30:24, veh: P, 16a 9	0.40	0.004	0.16	10.76
24.06.2021, 111, 15:34:23, veh: TN, 16a 9	0.57	0.003	0.86	12.42
24.06.2021, 123, 15:42:53, veh: T, 16b 9	0.91	0.004	0.89	13.98
24.06.2021, 147, 15:55:09, veh: TN, 16c 9	0.53	0.004	0.41	17.24
24.06.2021, 148, 15:55:11, veh: C, 16c 9	0.62	0.003	0.37	20.30
24.06.2021, 151, 15:58:56, veh: T, 16c 9	2.14	0.005	0.99	17.39
24.06.2021, 152, 15:59:00, veh: TR, 16c 9	1.89	0.005	0.95	15.98
24.06.2021, 158, 16:02:44, veh: T, 16c 9	0.82	0.005	0.92	15.08
24.06.2021, 167, 16:06:30, veh: TN, 16c 9	0.58	0.005	0.92	15.57
24.06.2021, 168, 16:06:31, veh: C, 16c 9	0.63	0.005	0.84	16.58
24.06.2021, 169, 16:06:33, veh: P, 16c 9	0.77	0.004	0.42	16.74
24.06.2021, 170, 16:06:34, veh: S, 16c 9	0.80	0.004	0.41	15.87
24.06.2021, 176, 16:16:55, veh: T, 17a 9	0.96	0.007	0.78	19.72
24.06.2021, 187, 16:24:12, veh: TR, 17a 9	0.48	0.005	0.87	14.95
24.06.2021, 197, 16:40:03, veh: TR, 18a 9	0.88	0.006	0.85	17.69
25.06.2021, 7, 10:06:54, veh: T, 19a 9.8	0.29	0.001	0.03	8.55
25.06.2021, 20, 10:13:35, veh: TN, 19a 9.8	-0.31	-0.006	0.79	-5.42
25.06.2021, 22, 10:17:47, veh: T, 19b 9.8	0.36	0.002	0.51	8.22
25.06.2021, 23, 10:17:59, veh: TR, 19b 9.8	0.37	0.002	0.33	11.27
25.06.2021, 24, 10:18:00, veh: P, 19b 9.8	0.38	-0.001	0.07	10.70
25.06.2021, 27, 10:20:37, veh: T, 19b 9.8	0.31	0.002	0.17	7.96
25.06.2021, 28, 10:20:38, veh: TR, 19b 9.8	0.24	0.005	0.47	7.76
25.06.2021, 34, 10:23:28, veh: TN, 19b 9.8	0.36	0.002	0.10	5.95
25.06.2021, 35, 10:23:29, veh: P, 19b 9.8	0.38	0.001	0.19	5.89
25.06.2021, 36, 10:23:39, veh: C, 19b 9.8	0.38	0.003	0.28	10.39
25.06.2021, 37, 10:25:53, veh: T, 19b 9.8	0.31	0.000	0.01	8.70
25.06.2021, 44, 10:28:44, veh: TN, 19b 9.8	0.02	-0.004	0.51	0.35
25.06.2021, 45, 10:28:55, veh: C, 19b 9.8	0.77	0.009	0.91	14.73
25.06.2021, 46, 10:28:56, veh: P, 19b 9.8	0.74	0.007	0.84	12.99
25.06.2021, 47, 10:31:22, veh: T, 19b 9.8	0.23	0.002	0.08	7.18
25.06.2021, 48, 10:31:23, veh: TR, 19b 9.8	0.22	0.002	0.18	6.60

25.06.2021, 52, 10:33:54, veh: T, 19b 9.8	0.26	0.003	0.93	6.49
25.06.2021, 55, 10:34:15, veh: TN, 19b 9.8	-0.05	-0.005	0.94	-0.83
25.06.2021, 58, 10:36:49, veh: P, 19b 9.8	0.25	0.001	0.02	8.15
25.06.2021, 59, 10:36:50, veh: TR, 19b 9.8	0.18	0.000	0.00	5.67
25.06.2021, 62, 10:43:34, veh: C, 20a 9.8	0.46	0.003	0.58	13.88
25.06.2021, 65, 10:44:03, veh: T, 20a 9.8	0.48	0.004	0.82	8.05
25.06.2021, 66, 10:44:12, veh: TN, 20a 9.8	0.55	0.002	0.82	9.10
25.06.2021, 67, 10:46:53, veh: C, 20a 9.8	0.22	0.003	0.52	6.08
25.06.2021, 68, 10:46:54, veh: P, 20a 9.8	0.21	0.002	0.50	6.21
25.06.2021, 75, 10:52:07, veh: T, 20a 9.8	1.98	0.018	0.89	26.49
25.06.2021, 76, 10:52:16, veh: TN, 20a 9.8	0.45	0.001	0.22	10.93
25.06.2021, 83, 10:58:45, veh: TR, 20b 9.8	0.35	0.001	0.31	5.03
25.06.2021, 84, 10:58:55, veh: T, 20b 9.8	0.13	0.001	0.16	4.00
25.06.2021, 86, 10:59:05, veh: TN, 20b 9.8	0.25	0.001	0.38	6.18
25.06.2021, 87, 11:01:45, veh: C, 20b 9.8	0.26	0.000	0.19	7.94
25.06.2021, 88, 11:01:46, veh: TR, 20b 9.8	0.27	0.001	0.18	7.65
25.06.2021, 89, 11:01:47, veh: T, 20b 9.8	0.28	0.001	0.27	7.28
25.06.2021, 90, 11:01:48, veh: P, 20b 9.8	0.17	0.004	0.53	4.94
25.06.2021, 95, 11:05:10, veh: TN, 20b 9.8	0.48	0.003	0.84	7.84
25.06.2021, 96, 11:05:11, veh: P, 20b 9.8	0.38	0.002	0.78	6.30
25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	0.38	0.003	0.14	11.63
25.06.2021, 101, 11:07:55, veh: P, 20b 9.8	0.24	0.001	0.09	7.10
25.06.2021, 104, 11:16:43, veh: T, 20c 9.8	2.08	0.008	0.74	29.91
25.06.2021, 105, 11:16:47, veh: P, 20c 9.8	0.59	0.005	0.95	9.30
25.06.2021, 118, 11:25:13, veh: TR, 20c 9.8	0.41	0.002	0.75	7.55
25.06.2021, 119, 11:25:14, veh: T, 20c 9.8	0.44	0.002	0.53	7.65
25.06.2021, 126, 11:28:18, veh: TN, 20d 9.8	0.76	0.006	0.92	11.91
25.06.2021, 127, 11:30:46, veh: C, 20d 9.8	0.37	0.003	0.88	8.73
25.06.2021, 128, 11:30:47, veh: TR, 20d 9.8	0.38	0.003	0.88	8.24
25.06.2021, 129, 11:30:48, veh: T, 20d 9.8	0.39	0.003	0.80	7.66
25.06.2021, 136, 11:33:45, veh: TN, 20d 9.8	0.88	0.004	0.71	12.77
25.06.2021, 163, 12:39:01, veh: TR, 21a 10	0.12	0.001	0.35	2.86
25.06.2021, 164, 12:39:02, veh: TN, 21a 10	0.10	0.001	0.29	2.29
25.06.2021, 165, 12:39:03, veh: C, 21a 10	0.19	0.001	0.12	4.11
25.06.2021, 166, 12:39:04, veh: P, 21a 10	0.25	-0.001	0.04	5.14
25.06.2021, 168, 12:44:21, veh: P, 21b 10	0.29	0.001	0.25	8.98
25.06.2021, 169, 12:44:23, veh: TN, 21b 10	0.26	0.001	0.28	7.49
25.06.2021, 170, 12:44:25, veh: C, 21b 10	0.21	0.002	0.45	5.84
25.06.2021, 200, 13:11:00, veh: TN, 21d 10	0.26	0.004	0.78	6.40
25.06.2021, 201, 13:11:01, veh: C, 21d 10	0.26	0.003	0.73	5.72
25.06.2021, 202, 13:11:02, veh: P, 21d 10	0.25	0.003	0.69	5.43

	High Emitter Passage
	Low Emitter Passage
	Negative Values

The above table XVIII represents the vehicle passages that were detected by the CTU FTIR. Rows highlighted in orange color represents high NO_X emitting passages and rows highlighted in green color represents low NO_X emitting passages. It can also be seen that, there were negative values (highlighted in pink color) of slope factor (ratio), peak concentration and emission factor. This was due to poor correlation happened due to mismatch of signals that resulted in negative slope factor, or the instrument detected negative concentration of NO due to distortion. As the slope factors and concentration of NO were used in calculation of emission factors, eventually the values for emission factor were negative. There were some passages which were text highlighted in blue color as shown in table. These passages have correlation factor (R2) greater than 0.9, slope factor (ratio) were high as well as emission factors were high; but the concentration of NO were less than its LOQ. On further investigation except for passages corresponding to date- 24.06.2021 at times- 11:34:25 and 16:06:30 which were in a time gap of 2 seconds with their respective previous vehicle, all other highlighted passages were in a time gap of more than 3 seconds with their previous passages. So, these could be high emitters but does not satisfy the condition for concentrations higher than LOQ.

Table XIX: High NO_X emission passage detection for heavy-duty vehicle by CTU FTIR

CTU FTIR	**Peak Conc.**	**lin.reg**	**R2**		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/kWh)**
FORD F-MAX TRUCK (Diesel)					
24.06.2021, 35, 10:07:36, veh: T, 12a 9	1.86	0.006	0.96	20.83	5.21
24.06.2021, 42, 10:11:42, veh: T, 12b 9	1.15	0.006	0.95	17.98	4.50
24.06.2021, 102, 11:02:16, veh: T, 13a 9	3.40	0.005	0.99	15.10	3.77
24.06.2021, 115, 11:11:23, veh: T, 13a 9	2.35	0.005	0.99	16.33	4.08
24.06.2021, 127, 11:20:48, veh: T, 13b 9	2.05	0.005	0.98	15.67	3.92
24.06.2021, 134, 11:24:41, veh: T, 13b 9	1.96	0.005	0.99	15.26	3.81
24.06.2021, 141, 11:29:52, veh: T, 13b 9	1.61	0.005	0.98	14.78	3.70
24.06.2021, 176, 12:02:35, veh: T, 14a 9	2.16	0.004	0.98	15.16	4.25
24.06.2021, 197, 12:14:07, veh: T, 14a 9	1.13	0.005	0.94	19.24	5.39
24.06.2021, 102, 15:30:05, veh: T, 16a 9	0.92	0.004	0.92	15.98	3.99
24.06.2021, 151, 15:58:56, veh: T, 16c 9	2.14	0.005	0.99	17.39	4.35

From the above table XIX, it was found out that 11 passages were detected where the possible tampering of the SCR system was done. On further investigation of the passages, it was found out that the time gap between the previous vehicle passage and the detected high emission passages were in between 4 seconds to 12 seconds. So, there was no possibility of interference of exhaust gases from the previous vehicle passages with the detected high emission vehicle passages. Among the high emitters, passage corresponding to date- 24.06.2021 at time- 12:14:07 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (g/kWh) was the highest. It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 6 (0.46g/kWh) standards.

Table XX: High NO_X emission passage detection for LCV (Diesel) by CTU FTIR

CTU FTIR	Peak Conc.	lin.reg	R2		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
VW CADDY (Diesel)					
24.06.2021, 152, 11:34:23, veh: C, 13c 9	0.92	0.005	0.94	17.69	0.90
VW TRANSPORTER (Diesel)					
24.06.2021, 135, 11:24:47, veh: TR, 13b 9	0.99	0.010	0.93	21.30	1.36
24.06.2021, 152, 15:59:00, veh: TR, 16c 9	1.89	0.005	0.95	15.98	1.02
VW CRAFTER (Diesel)					
24.06.2021, 177, 12:02:38, veh: P, 14a 9	2.33	0.005	0.97	14.97	1.68
24.06.2021, 199, 12:14:18, veh: P, 14a 9	0.71	0.007	0.90	21.72	2.44

The above table XX shows the high NO_X detection passages for VW Caddy, VW Transporter and VW Crafter. One passage of VW Caddy (text highlighted in green color) was detected as high emitter of NO_X but on further investigation it was found out that it was in a time gap of 2 seconds with its previous vehicle. VW Transporter was detected emitting high NO_X in 2 passages and there no sign of interference of exhaust gases from their respective previous vehicles, but the passage corresponding to date- 24.06.2021 at time- 15:59:00 was following the truck corresponding to date-24.06.2021 at time- 15:58:56 which was detected as a high emitting passage in table XIX. Though the time gap is 4 seconds in between them, but there could a chance of interference of exhaust gases because high amount of NO concentrations was detected from the truck. Among the high emitters, passage corresponding to date- 24.06.2021 at time- 11:24:47 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (g/km) was the highest. 2 passages of VW Crafter (text highlighted in green color) were detected as high emitter passage were clear evidence of interference of exhaust gases with the previous vehicle passage because the time gap between the passages were 2 seconds, respectively though they were detected as high emitting passages. It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 5b (0.28g/km) standards.

Table XXI: High NO_X emission passage detection for Gasoline Vehicles by CTU FTIR

CTU FTIR	Peak Conc.	lin.reg	R2		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
VW TOURAN (Gasoline)					
24.06.2021, 43, 10:11:46, veh: TN, 12b 9	1.11	0.008	0.94	19.36	0.95
24.06.2021, 78, 10:32:11, veh: TN, 12c 9	1.32	0.005	0.93	16.90	0.83
24.06.2021, 91, 10:39:25, veh: TN, 12c 9	1.09	0.005	0.91	13.97	0.69
24.06.2021, 98, 10:58:24, veh: TN, 13a 9	1.26	0.005	0.97	20.17	0.99
24.06.2021, 71, 14:52:27, veh: TN, 15c 9	1.02	0.006	0.94	19.43	0.95
YAMAHA MT07 (Gasoline)					
24.06.2021, 79, 10:32:13, veh: MB, 12c 9	1.05	0.01	0.96	16.71	0.53

From the above table XXI, VW Touran was possibly producing high NO_X because out of the 5 detected high NO_X emission passage, 3 passages had time gap between 4 seconds to 10 seconds for which there is no sign of interference of exhaust gases from the previous vehicle passages. But there was a possibility of interference of exhaust gases for the passage corresponding to date- 24.06.2021 at times- 10:32:11 and 14:52:27 (text highlighted in green color) because the time gap was 3 seconds with the previous passage. Among the remaining high emitters, passage corresponding to date- 24.06.2021 at time- 10:58:24 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (g/km) was the highest. It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 5 (0.08g/km) standards.

For Yamaha MT07 (text highlighted in green color), it was a clear scene of interference of exhaust gases with the previous vehicle passage because the time gap between them was 2 seconds. It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 5 (0.07g/km) standards.

Table XXII: Low NO_X emission passage detection by CTU EEPS

CTU FTIR	Peak Conc.	lin.reg	R2		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/kWh)**
FORD F-MAX TRUCK (Diesel)					
25.06.2021, 7, 10:06:54, veh: T, 19a 9.8	0.29	0.001	0.03	8.55	2.14
25.06.2021, 27, 10:20:37, veh: T, 19b 9.8	0.31	0.002	0.17	7.96	1.99
25.06.2021, 37, 10:25:53, veh: T, 19b 9.8	0.31	0.000	0.01	8.70	2.17
25.06.2021, 47, 10:31:22, veh: T, 19b 9.8	0.23	0.002	0.08	7.18	1.80
25.06.2021, 84, 10:58:55, veh: T, 20b 9.8	0.13	0.001	0.16	4.00	1.00
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
VW CADDY (Diesel)					
24.06.2021, 4, 09:48:35, veh: C, 12a 9	0.10	0.000	0.02	3.36	0.17
25.06.2021, 87, 11:01:45, veh: C, 20b 9.8	0.26	0.000	0.19	7.94	0.40
25.06.2021, 165, 12:39:03, veh: C, 21a 10	0.19	0.001	0.12	4.11	0.21
VW TRANSPORTER (Diesel)					
25.06.2021, 48, 10:31:23, veh: TR, 19b 9.8	0.22	0.002	0.18	6.60	0.42
25.06.2021, 59, 10:36:50, veh: TR, 19b 9.8	0.18	0.000	0.00	5.67	0.36
25.06.2021, 88, 11:01:46, veh: TR, 20b 9.8	0.27	0.001	0.18	7.65	0.49
VW CRAFTER (Diesel)					
25.06.2021, 35, 10:23:29, veh: P, 19b 9.8	0.38	0.001	0.19	5.89	0.66
25.06.2021, 58, 10:36:49, veh: P, 19b 9.8	0.25	0.001	0.02	8.15	0.69
25.06.2021, 101, 11:07:55, veh: P, 20b 9.8	0.24	0.001	0.09	7.10	0.60
VW TOURAN (Gasoline)					
25.06.2021, 34, 10:23:28, veh: TN, 19b 9.8	0.36	0.002	0.10	5.95	0.31
25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	0.38	0.003	0.14	11.63	0.57
YAMAHA MT07 (Gasoline)					
24.06.2021, 86, 10:35:42, veh: MB, 12c 9	0.33	0.000	0.01	3.54	0.11

The above table XXII represents low NO_X emission passages of truck and VW Caddy. There were no low NO_X emitting passages detected by CTU FTIR for Yamaha N-Max vehicles. Among the low emitters, passages highlighted in grey color were the lowest emitting passage according to vehicles because the value to emission factor according to their respective standards were lowest.

Table XXIII: Detected PN emission passage by CTU EEPS

CTU EEPS	Peak Conc.	lin.reg	R2	
Vehicle Passage	**PN (#/cm^3)**	**PN/CO_2**	**PN/CO_2**	**EF_{PN} (#/kg_{fuel})**
24.06.2021, 4, 09:48:35, veh: C, 12a 9	8.18E+03	61	0.88	9.78E+13
24.06.2021, 18, 09:57:54, veh: C, 12a 9	2.01E+07	192715	0.99	3.10E+17
24.06.2021, 25, 10:02:35, veh: C, 12a 9	2.32E+07	185524	0.98	2.98E+17
24.06.2021, 28, 10:03:04, veh: TN, 12a 9	9.89E+04	762	0.89	1.23E+15
24.06.2021, 29, 10:03:05, veh: P, 12a 9	9.92E+04	1512	0.81	2.43E+15
24.06.2021, 35, 10:07:36, veh: T, 12a 9	6.28E+03	21	0.88	3.36E+13
24.06.2021, 42, 10:11:42, veh: T, 12b 9	1.20E+04	27	0.85	4.32E+13
24.06.2021, 43, 10:11:46, veh: TN, 12b 9	9.51E+05	7655	0.89	1.23E+16
24.06.2021, 44, 10:11:48, veh: MB, 12b 9	9.52E+05	6648	0.94	1.07E+16
24.06.2021, 50, 10:15:49, veh: TN, 12b 9	8.83E+05	13189	0.87	1.31E+16
24.06.2021, 56, 10:20:04, veh: P, 12b 9	1.81E+06	23225	0.98	2.02E+16
24.06.2021, 57, 10:20:05, veh: TN, 12b 9	1.80E+06	19502	0.99	1.70E+16
24.06.2021, 58, 10:20:09, veh: MB, 12b 9	1.81E+06	20833	0.90	1.92E+16
24.06.2021, 63, 10:24:00, veh: TN, 12b 9	1.00E+06	4709	0.97	5.38E+15
24.06.2021, 64, 10:24:02, veh: P, 12b 9	1.00E+06	8229	0.64	7.71E+15
24.06.2021, 65, 10:24:04, veh: MB, 12b 9	4.49E+05	7711	0.83	9.08E+15
24.06.2021, 68, 10:28:28, veh: P, 12c 9	3.83E+04	361	0.49	5.95E+14
24.06.2021, 69, 10:28:31, veh: TR, 12c 9	1.07E+04	109	0.91	1.73E+14
24.06.2021, 77, 10:32:08, veh: T, 12c 9	1.11E+04	47	0.93	7.59E+13
24.06.2021, 78, 10:32:11, veh: TN, 12c 9	9.99E+05	4456	0.60	7.15E+15
24.06.2021, 79, 10:32:13, veh: MB, 12c 9	1.00E+06	6402	0.94	1.03E+16
24.06.2021, 80, 10:35:28, veh: S, 12c 9	2.83E+04	173	0.94	2.80E+14
24.06.2021, 81, 10:35:29, veh: C, 12c 9	2.57E+04	176	0.94	2.85E+14
24.06.2021, 82, 10:35:30, veh: TR, 12c 9	2.58E+04	180	0.93	2.91E+14
24.06.2021, 85, 10:35:40, veh: TN, 12c 9	9.24E+05	2901	0.93	3.99E+15
24.06.2021, 86, 10:35:42, veh: MB, 12c 9	9.34E+05	5681	0.96	7.71E+15
24.06.2021, 87, 10:39:14, veh: S, 12c 9	4.61E+04	320	0.96	4.98E+14
24.06.2021, 88, 10:39:15, veh: C, 12c 9	4.63E+04	238	0.88	3.67E+14
24.06.2021, 90, 10:39:21, veh: T, 12c 9	7.35E+03	32	0.97	5.16E+13
24.06.2021, 91, 10:39:25, veh: TN, 12c 9	8.08E+05	4140	0.91	6.54E+15
24.06.2021, 92, 10:39:26, veh: P, 12c 9	1.43E+06	4466	0.66	7.04E+15
24.06.2021, 93, 10:39:28, veh: MB, 12c 9	1.47E+06	2012	0.26	3.20E+15
24.06.2021, 98, 10:58:24, veh: TN, 13a 9	6.91E+05	2199	0.86	3.48E+15
24.06.2021, 102, 11:02:16, veh: T, 13a 9	1.51E+04	14	0.93	2.27E+13
24.06.2021, 105, 11:02:34, veh: TN, 13a 9	9.22E+05	2574	0.90	3.04E+15
24.06.2021, 111, 11:06:46, veh: TN, 13a 9	8.06E+05	4573	0.67	4.57E+15
24.06.2021, 112, 11:06:47, veh: P, 13a 9	8.07E+05	8163	0.80	6.37E+15
24.06.2021, 115, 11:11:23, veh: T, 13a 9	1.14E+04	17	0.95	2.79E+13
24.06.2021, 117, 11:11:42, veh: TN, 13a 9	9.76E+05	5654	0.77	5.74E+15
24.06.2021, 121, 11:17:02, veh: T, 13b 9	8.63E+03	37	0.93	5.97E+13
24.06.2021, 125, 11:17:17, veh: C, 13b 9	2.59E+05	4759	0.99	4.47E+15
24.06.2021, 127, 11:20:48, veh: T, 13b 9	1.88E+04	30	0.86	4.82E+13
24.06.2021, 128, 11:20:53, veh: TR, 13b 9	5.11E+03	-16	-0.84	-2.64E+13
24.06.2021, 134, 11:24:41, veh: T, 13b 9	2.90E+04	48	0.85	7.67E+13
24.06.2021, 135, 11:24:47, veh: TR, 13b 9	5.33E+03	-15	-0.81	-2.46E+13
24.06.2021, 137, 11:24:54, veh: P, 13b 9	7.57E+05	7282	0.81	6.17E+15
24.06.2021, 150, 11:34:19, veh: TR, 13c 9	1.35E+07	173554	0.59	2.79E+17
24.06.2021, 151, 11:34:21, veh: TN, 13c 9	9.66E+06	81967	0.61	1.32E+17
24.06.2021, 157, 11:38:11, veh: P, 13c 9	7.60E+06	64916	0.75	5.77E+16
24.06.2021, 158, 11:38:13, veh: TN, 13c 9	7.62E+06	53309	0.80	4.85E+16
24.06.2021, 159, 11:38:15, veh: C, 13c 9	2.10E+06	15844	0.92	1.41E+16
24.06.2021, 160, 11:38:17, veh: S, 13c 9	5.54E+05	1270	0.57	1.41E+15

24.06.2021, 163, 11:41:56, veh: TR, 13c 9	4.66E+05	8313	0.97	7.73E+15
24.06.2021, 164, 11:41:58, veh: TN, 13c 9	2.84E+05	3049	0.96	2.77E+15
24.06.2021, 165, 11:42:00, veh: P, 13c 9	2.15E+06	9423	0.75	8.37E+15
24.06.2021, 170, 11:46:16, veh: TR, 13c 9	2.07E+05	8261	0.97	9.79E+15
24.06.2021, 171, 11:46:18, veh: TN, 13c 9	1.99E+05	1387	0.85	2.03E+15
24.06.2021, 172, 11:46:19, veh: C, 13c 9	2.04E+05	1575	0.80	2.42E+15
24.06.2021, 173, 11:46:21, veh: P, 13c 9	2.06E+05	1975	0.97	2.36E+15
24.06.2021, 174, 11:46:24, veh: S, 13c 9	1.80E+04	330	0.98	4.68E+14
24.06.2021, 175, 12:02:21, veh: MB, 14a 9	5.88E+04	428	0.91	6.11E+14
24.06.2021, 176, 12:02:35, veh: T, 14a 9	4.91E+03	11	0.94	1.69E+13
24.06.2021, 177, 12:02:38, veh: P, 14a 9	5.90E+03	24	0.88	3.81E+13
24.06.2021, 190, 12:10:28, veh: T, 14a 9	8.51E+03	65	0.93	1.06E+14
24.06.2021, 196, 12:13:55, veh: MB, 14a 9	3.66E+04	209	0.92	2.37E+14
24.06.2021, 197, 12:14:07, veh: T, 14a 9	7.58E+03	33	0.91	5.27E+13
24.06.2021, 199, 12:14:18, veh: P, 14a 9	6.24E+03	53	0.85	8.60E+13
24.06.2021, 13, 14:19:44, veh: P, 15a 9	2.33E+03	44	0.85	7.15E+13
24.06.2021, 41, 14:36:51, veh: P, 15b 9	5.07E+03	90	0.73	1.44E+14
24.06.2021, 71, 14:52:27, veh: TN, 15c 9	1.49E+05	-474	-0.61	-7.62E+14
24.06.2021, 81, 14:59:52, veh: C, 15c 9	2.00E+04	283	0.97	4.56E+14
24.06.2021, 82, 14:59:54, veh: TR, 15c 9	2.02E+04	190	0.85	3.02E+14
24.06.2021, 102, 15:30:05, veh: T, 16a 9	9.45E+03	28	0.80	4.45E+13
24.06.2021, 105, 15:30:24, veh: P, 16a 9	2.88E+05	4641	0.89	6.86E+15
24.06.2021, 111, 15:34:23, veh: TN, 16a 9	5.60E+05	2860	0.89	4.53E+15
24.06.2021, 123, 15:42:53, veh: T, 16b 9	1.51E+04	51	0.95	8.21E+13
24.06.2021, 147, 15:55:09, veh: TN, 16c 9	9.03E+04	1221	0.98	1.96E+15
24.06.2021, 148, 15:55:11, veh: C, 16c 9	9.04E+04	1233	0.97	1.98E+15
24.06.2021, 151, 15:58:56, veh: T, 16c 9	2.50E+04	45	0.87	7.25E+13
24.06.2021, 152, 15:59:00, veh: TR, 16c 9	1.76E+04	230	0.95	3.70E+14
24.06.2021, 158, 16:02:44, veh: T, 16c 9	1.08E+04	43	0.88	7.00E+13
24.06.2021, 167, 16:06:30, veh: TN, 16c 9	9.52E+04	737	0.84	1.19E+15
24.06.2021, 168, 16:06:31, veh: C, 16c 9	9.58E+04	1169	0.92	1.88E+15
24.06.2021, 169, 16:06:33, veh: P, 16c 9	9.68E+04	832	0.92	1.34E+15
24.06.2021, 170, 16:06:34, veh: S, 16c 9	8.44E+04	761	0.94	1.22E+15
24.06.2021, 176, 16:16:55, veh: T, 17a 9	7.46E+03	78	0.79	1.25E+14
24.06.2021, 187, 16:24:12, veh: TR, 17a 9	4.59E+03	24	0.56	3.79E+13
24.06.2021, 197, 16:40:03, veh: TR, 18a 9	6.19E+03	29	0.81	4.65E+13
25.06.2021, 7, 10:06:54, veh: T, 19a 9.8	6.46E+04	880	0.79	1.42E+15
25.06.2021, 20, 10:13:35, veh: TN, 19a 9.8	1.45E+05	888	0.84	1.04E+15
25.06.2021, 22, 10:17:47, veh: T, 19b 9.8	1.00E+04	50	0.75	8.07E+13
25.06.2021, 23, 10:17:59, veh: TR, 19b 9.8	5.96E+03	33	0.45	5.31E+13
25.06.2021, 24, 10:18:00, veh: P, 19b 9.8	3.03E+03	10	0.14	1.58E+13
25.06.2021, 27, 10:20:37, veh: T, 19b 9.8	1.36E+04	52	0.46	8.35E+13
25.06.2021, 28, 10:20:38, veh: TR, 19b 9.8	1.34E+04	6	0.05	9.92E+12
25.06.2021, 34, 10:23:28, veh: TN, 19b 9.8	1.02E+05	375	0.80	5.36E+14
25.06.2021, 35, 10:23:29, veh: P, 19b 9.8	1.03E+05	934	0.78	1.35E+15
25.06.2021, 36, 10:23:39, veh: C, 19b 9.8	8.25E+03	31	0.71	5.04E+13
25.06.2021, 37, 10:25:53, veh: T, 19b 9.8	1.13E+04	80	0.87	1.29E+14
25.06.2021, 44, 10:28:44, veh: TN, 19b 9.8	9.60E+04	485	0.95	6.43E+14
25.06.2021, 45, 10:28:55, veh: C, 19b 9.8	1.15E+04	72	0.87	1.15E+14
25.06.2021, 46, 10:28:56, veh: P, 19b 9.8	1.22E+04	126	0.91	2.03E+14
25.06.2021, 47, 10:31:22, veh: T, 19b 9.8	1.27E+04	180	0.78	2.89E+14
25.06.2021, 48, 10:31:23, veh: TR, 19b 9.8	1.27E+04	161	0.82	2.60E+14
25.06.2021, 52, 10:33:54, veh: T, 19b 9.8	5.69E+04	309	0.79	4.96E+14
25.06.2021, 55, 10:34:15, veh: TN, 19b 9.8	1.10E+05	546	0.93	6.77E+14
25.06.2021, 58, 10:36:49, veh: P, 19b 9.8	1.08E+04	116	0.64	1.85E+14
25.06.2021, 59, 10:36:50, veh: TR, 19b 9.8	1.08E+04	216	0.93	3.46E+14
25.06.2021, 62, 10:43:34, veh: C, 20a 9.8	1.13E+04	110	0.99	1.77E+14
25.06.2021, 65, 10:44:03, veh: T, 20a 9.8	1.24E+04	64	0.90	1.03E+14

25.06.2021, 66, 10:44:12, veh: TN, 20a 9.8	9.16E+04	305	0.88	4.90E+14
25.06.2021, 67, 10:46:53, veh: C, 20a 9.8	4.15E+05	4350	0.78	7.00E+15
25.06.2021, 68, 10:46:54, veh: P, 20a 9.8	4.12E+05	7835	0.95	1.26E+16
25.06.2021, 76, 10:52:16, veh: TN, 20a 9.8	6.70E+04	349	0.93	5.63E+14
25.06.2021, 83, 10:58:45, veh: TR, 20b 9.8	2.42E+07	83563	0.94	1.25E+17
25.06.2021, 84, 10:58:55, veh: T, 20b 9.8	3.89E+04	289	0.86	4.64E+14
25.06.2021, 86, 10:59:05, veh: TN, 20b 9.8	2.24E+04	191	0.91	3.06E+14
25.06.2021, 87, 11:01:45, veh: C, 20b 9.8	7.52E+05	4742	0.91	7.64E+15
25.06.2021, 88, 11:01:46, veh: TR, 20b 9.8	7.63E+05	4847	0.90	7.81E+15
25.06.2021, 89, 11:01:47, veh: T, 20b 9.8	7.52E+05	5937	0.88	9.55E+15
25.06.2021, 90, 11:01:48, veh: P, 20b 9.8	6.10E+05	11561	0.97	1.86E+16
25.06.2021, 95, 11:05:10, veh: TN, 20b 9.8	7.98E+04	301	0.74	4.83E+14
25.06.2021, 96, 11:05:11, veh: P, 20b 9.8	7.99E+04	611	0.79	9.81E+14
25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	1.87E+04	441	0.90	7.09E+14
25.06.2021, 101, 11:07:55, veh: P, 20b 9.8	1.84E+04	254	0.88	4.10E+14
25.06.2021, 163, 12:39:01, veh: TR, 21a 10	3.09E+04	171	0.89	2.75E+14
25.06.2021, 164, 12:39:02, veh: TN, 21a 10	3.09E+04	180	0.88	2.90E+14
25.06.2021, 165, 12:39:03, veh: C, 21a 10	3.08E+04	228	0.91	3.68E+14
25.06.2021, 166, 12:39:04, veh: P, 21a 10	2.70E+04	485	0.95	7.81E+14
25.06.2021, 168, 12:44:21, veh: P, 21b 10	7.96E+03	63	0.87	1.02E+14
25.06.2021, 169, 12:44:23, veh: TN, 21b 10	7.91E+03	68	0.87	1.10E+14
25.06.2021, 170, 12:44:25, veh: C, 21b 10	5.57E+03	182	0.84	2.91E+14
25.06.2021, 200, 13:11:00, veh: TN, 21d 10	8.51E+03	67	0.94	1.09E+14
25.06.2021, 201, 13:11:01, veh: C, 21d 10	7.68E+03	56	0.89	8.99E+13
25.06.2021, 202, 13:11:02, veh: P, 21d 10	6.31E+03	42	0.74	6.81E+13

	High Emitter Passage
	Negative Values

The above table XXIII represents the vehicle passages that were detected by the CTU EEPS. Rows highlighted in orange color represents high PN emitting passages. It can also be seen that, there were negative values (highlighted in pink color) of slope factor (ratio), correlating factor (R2) and emission factor. This was due to poor correlation that resulted in negative slope factor. As the slope factor was used in calculation of emission factor, eventually the value for emission factor was negative. There was no low PN emitting passages detected by CTU EEPS.

Table XXIV: High PN emission passage detection for LCV (Diesel) by CTU EEPS

CTU EEPS	Peak Conc.	lin.reg	R2		
Vehicle Passage	**PN (#/cm³)**	**PN/CO₂**	**PN/CO₂**	**EF$_{PN}$ (#/kg$_{fuel}$)**	**EF$_{PN}$ (#/km)**
VW CADDY (Diesel)					
24.06.2021, 18, 09:57:54, veh: C, 12a 9	2.01E+07	192715	0.99	3.10E+17	1.58E+16
24.06.2021, 25, 10:02:35, veh: C, 12a 9	2.32E+07	185524	0.98	2.98E+17	1.52E+16
24.06.2021, 81, 10:35:29, veh: C, 12c 9	2.57E+04	176	0.94	2.85E+14	1.45E+13
24.06.2021, 125, 11:17:17, veh: C, 13b 9	2.59E+05	4759	0.99	4.47E+15	2.28E+14
24.06.2021, 159, 11:38:15, veh: C, 13c 9	2.10E+06	15844	0.92	1.41E+16	7.18E+14
24.06.2021, 81, 14:59:52, veh: C, 15c 9	2.00E+04	283	0.97	4.56E+14	2.32E+13
24.06.2021, 148, 15:55:11, veh: C, 16c 9	9.04E+04	1233	0.97	1.98E+15	1.01E+14
24.06.2021, 168, 16:06:31, veh: C, 16c 9	9.58E+04	1169	0.92	1.88E+15	9.60E+13
25.06.2021, 62, 10:43:34, veh: C, 20a 9.8	1.13E+04	110	0.99	1.77E+14	9.02E+12
25.06.2021, 87, 11:01:45, veh: C, 20b 9.8	7.52E+05	4742	0.91	7.64E+15	3.90E+14
25.06.2021, 165, 12:39:03, veh: C, 21a 10	3.08E+04	228	0.91	3.68E+14	1.88E+13
VW TRANSPORTER (Diesel)					
24.06.2021, 69, 10:28:31, veh: TR, 12c 9	1.07E+04	109	0.91	1.73E+14	1.10E+13
24.06.2021, 82, 10:35:30, veh: TR, 12c 9	2.58E+04	180	0.93	2.91E+14	1.85E+13
24.06.2021, 163, 11:41:56, veh: TR, 13c 9	4.66E+05	8313	0.97	7.73E+15	4.93E+14
24.06.2021, 170, 11:46:16, veh: TR, 13c 9	2.07E+05	8261	0.97	9.79E+15	6.24E+14
24.06.2021, 152, 15:59:00, veh: TR, 16c 9	1.76E+04	230	0.95	3.70E+14	2.36E+13
25.06.2021, 59, 10:36:50, veh: TR, 19b 9.8	1.08E+04	216	0.93	3.46E+14	2.21E+13
25.06.2021, 83, 10:58:45, veh: TR, 20b 9.8	2.42E+07	83563	0.94	1.25E+17	7.97E+15
25.06.2021, 88, 11:01:46, veh: TR, 20b 9.8	7.63E+05	4847	0.90	7.81E+15	4.98E+14
VW CRAFTER (Diesel)					
24.06.2021, 56, 10:20:04, veh: P, 12b 9	1.81E+06	23225	0.98	2.02E+16	1.72E+15
24.06.2021, 173, 11:46:21, veh: P, 13c 9	2.06E+05	1975	0.97	2.36E+15	2.01E+14
24.06.2021, 169, 16:06:33, veh: P, 16c 9	9.68E+04	832	0.92	1.34E+15	1.14E+14
25.06.2021, 46, 10:28:56, veh: P, 19b 9.8	1.22E+04	126	0.91	2.03E+14	2.28E+13
25.06.2021, 68, 10:46:54, veh: P, 20a 9.8	4.12E+05	7835	0.95	1.26E+16	1.07E+15
25.06.2021, 90, 11:01:48, veh: P, 20b 9.8	6.10E+05	11561	0.97	1.86E+16	1.58E+15
25.06.2021, 166, 12:39:04, veh: P, 21a 10	2.70E+04	485	0.95	7.81E+14	6.64E+13

The above table XXIV represents the high PN detection passages for VW Caddy, VW Transporter and VW Crafter. For VW Caddy, 11 passages were detected with high emission of PN where tampering of DPF could be possible. On further investigation it was found out that among the 6 high PN emission passages (text highlighted in green color) had time gaps less than 3 seconds with their previous vehicle passage. So, there was possibility of interference of the exhaust gases in between the vehicles. Among the remaining high emitters, passage corresponding to date- 24.06.2021 at time- 10:02:35 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (#/km) was the highest.

For VW Transporter, out of 18 detected passages, 8 passages were detected with high emission of PN where tampering of DPF could be possible. On further investigation 3 passages (text highlighted in green color) had time gaps of less than 4 seconds. Passages corresponding to date- 24.06.2021 at time- 10:35:30 was following VW Caddy corresponding to date- 24.06.2021 at time- 10:35:29, which was already detected as high emitter and passage corresponding to date- 25.06.2021 at time- 11:01:46 was following VW Caddy corresponding to date- 25.06.2021 at time- 11:01:45 was also detected as high emitter. So, for these 3 passages, it was evident that there was interference of exhaust gases with their respective previous vehicle. Among the remaining high emitters, passage corresponding to date- 24.06.2021 at time- 11:46:16 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (#/km) was the highest.

For VW Crafter, 7 passages were detected with high emission of PN where tampering of DPF could be possible. 6 passages (text highlighted in green color) showed possibility of interference of the exhaust gases because the time gap with their previous vehicles were less than 3 seconds. But the passage corresponding to date- 24.06.2021 at time- 10:20:04 was in a time gap of 4 seconds which shows that there was no such interference of exhaust gases and was the highest emitting passage (text highlighted in yellow color). On further investigation it was found out that VW Crafter corresponding to dates- 24.06.2021 and 25.06.2021 at times- 16:06:33 and 12:39:04, respectively were following VW Caddy on the same dates at times- 16:06:31 and 12:39:03, respectively were already detected as high emitters.

It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 5b (6.00E+11g/km) standards.

Table XXV: High PN emission passage detection for Gasoline Vehicles by CTU EEPS

CTU EEPS	Peak Conc.	lin.reg	R2		
Vehicle Passage	**PN (#/cm^3)**	**PN/CO_2**	**PN/CO_2**	**EF_{PN} (#/kg_{fuel})**	**EF_{PN} (#/km)**
VW TOURAN (Gasoline)					
24.06.2021, 57, 10:20:05, veh: TN, 12b 9	1.80E+06	19502	0.99	1.70E+16	8.36E+14
24.06.2021, 63, 10:24:00, veh: TN, 12b 9	1.00E+06	4709	0.97	5.38E+15	2.64E+14
24.06.2021, 85, 10:35:40, veh: TN, 12c 9	9.24E+05	2901	0.93	3.99E+15	1.96E+14
24.06.2021, 91, 10:39:25, veh: TN, 12c 9	8.08E+05	4140	0.91	6.54E+15	3.21E+14
24.06.2021, 105, 11:02:34, veh: TN, 13a 9	9.22E+05	2574	0.90	3.04E+15	1.49E+14
24.06.2021, 164, 11:41:58, veh: TN, 13c 9	2.84E+05	3049	0.96	2.77E+15	1.36E+14
24.06.2021, 147, 15:55:09, veh: TN, 16c 9	9.03E+04	1221	0.98	1.96E+15	1.04E+14
25.06.2021, 44, 10:28:44, veh: TN, 19b 9.8	9.60E+04	485	0.95	6.43E+14	3.40E+13
25.06.2021, 55, 10:34:15, veh: TN, 19b 9.8	1.10E+05	546	0.93	6.77E+14	3.58E+13
25.06.2021, 76, 10:52:16, veh: TN, 20a 9.8	6.70E+04	349	0.93	5.63E+14	2.76E+13
25.06.2021, 86, 10:59:05, veh: TN, 20b 9.8	2.24E+04	191	0.91	3.06E+14	1.50E+13
25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	1.87E+04	441	0.90	7.09E+14	3.48E+13
25.06.2021, 200, 13:11:00, veh: TN, 21d 10	8.51E+03	67	0.94	1.09E+14	5.33E+12
YAMAHA MT07 (Gasoline)					
24.06.2021, 44, 10:11:48, veh: MB, 12b 9	9.52E+05	6648	0.94	1.07E+16	3.40E+14
24.06.2021, 58, 10:20:09, veh: MB, 12b 9	1.81E+06	20833	0.90	1.92E+16	6.10E+14
24.06.2021, 79, 10:32:13, veh: MB, 12c 9	1.00E+06	6402	0.94	1.03E+16	3.27E+14
24.06.2021, 86, 10:35:42, veh: MB, 12c 9	9.34E+05	5681	0.96	7.71E+15	2.45E+14
24.06.2021, 175, 12:02:21, veh: MB, 14a 9	5.88E+04	428	0.91	6.11E+14	2.77E+13
24.06.2021, 196, 12:13:55, veh: MB, 14a 9	3.66E+04	209	0.92	2.37E+14	1.07E+13
YAMAHA N-Max (Gasoline)					
24.06.2021, 80, 10:35:28, veh: S, 12c 9	2.83E+04	173	0.94	2.80E+14	4.86E+12
24.06.2021, 87, 10:39:14, veh: S, 12c 9	4.61E+04	320	0.96	4.98E+14	8.64E+12
24.06.2021, 174, 11:46:24, veh: S, 13c 9	1.80E+04	330	0.98	4.68E+14	8.12E+12
24.06.2021, 170, 16:06:34, veh: S, 16c 9	8.44E+04	761	0.94	1.22E+15	2.12E+13

From the above table XXV, it was found out that the passages highlighted in green color (text highlighted) had possibility of interference of exhaust gases from their respective previous vehicles because the time gaps were less than 4 seconds. Passage of VW Touran corresponding to date- 24.06.2021 at time- 10:20:05 was following VW Crafter corresponding to date- 24.06.2021 at time- 10:20:04 was detected as high emitting passage in table XXIV and passage corresponding to date- 24.06.2021 at time- 15:55:09 (text highlighted in green color) was followed by VW Caddy corresponding to date- 24.06.2021 at time- 15:55:11 (text highlighted in green color) shown in table XXIV. Both these vehicles were in a time gap of 2 seconds which shows possibility of interaction of exhaust gases. Among the remaining high emitters, passage corresponding to date- 24.06.2021 at time- 10:34:25 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (#/km) was the highest.

Similarly, Yamaha MT07 corresponding to date- 24.06.2021 at time- 10:35:42 (text highlighted in green color) was following the VW Touran which was detected as high emitter in table XXV. Among the remaining high emitters, passage corresponding to date- 24.06.2021 at time- 12:02:21 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (#/km) was the highest.

For Yamaha N-Max, passages corresponding to date- 24.06.2021 at times- 11:46:24 and 16:06:34 (text highlighted in green color) were following VW Crafter which were already detected as high emitters in table XXIV. Among the remaining high emitters, passage corresponding to date- 24.06.2021 at time- 10:39:14 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (#/km) was the highest.

Table XXVI: High PN emission passage detection for heavy-duty vehicle by CTU EEPS

CTU EEPS	**Peak Conc.**	**lin.reg**	**R2**		
Vehicle Passage	**PN (#/cm³)**	**PN/CO_2**	**PN/CO_2**	**EF_{PN} (#/kg_{fuel})**	**EF_{PN} (#/kWh)**
FORD F-MAX TRUCK (Diesel)					
24.06.2021, 77, 10:32:08, veh: T, 12c 9	1.11E+04	47	0.93	7.59E+13	1.90E+13
24.06.2021, 90, 10:39:21, veh: T, 12c 9	7.35E+03	32	0.97	5.16E+13	1.29E+13
24.06.2021, 102, 11:02:16, veh: T, 13a 9	1.51E+04	14	0.93	2.27E+13	5.68E+12
24.06.2021, 115, 11:11:23, veh: T, 13a 9	1.14E+04	17	0.95	2.79E+13	6.99E+12
24.06.2021, 121, 11:17:02, veh: T, 13b 9	8.63E+03	37	0.93	5.97E+13	1.49E+13
24.06.2021, 176, 12:02:35, veh: T, 14a 9	4.91E+03	11	0.94	1.69E+13	4.75E+12
24.06.2021, 190, 12:10:28, veh: T, 14a 9	8.51E+03	65	0.93	1.06E+14	2.97E+13
24.06.2021, 197, 12:14:07, veh: T, 14a 9	7.58E+03	33	0.91	5.27E+13	1.48E+13
24.06.2021, 123, 15:42:53, veh: T, 16b 9	1.51E+04	51	0.95	8.21E+13	2.05E+13
25.06.2021, 65, 10:44:03, veh: T, 20a 9.8	1.24E+04	64	0.90	1.03E+14	2.57E+13

The above table XXVI represents the high PN emitting passage for truck. On further investigation it was found that all the mentioned passages were in time gaps of more than 3 seconds ranging till 15 seconds. So, no possibility of exhaust gases interaction. Among the high emitters, passage corresponding to date- 24.06.2021 at time- 12:10:28 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (#/kWh) was the highest. . It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 6 (6.00E+11g/km) standards.

4.3.3.2. **CZU Instruments** (Sampling Point was to side of road)

Table XXVII: Detected NO_X emission passage by CZU FTIR

CZU FTIR	Peak Conc.	lin.reg	R2	
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**
24.06.2021, 7, 09:48:59, veh: TR, 12a 9	2.14	0.0175	0.93	67.19
24.06.2021, 14, 09:53:55, veh: T, 12a 9	1.58	0.0089	0.69	35.99
24.06.2021, 18, 09:57:54, veh: C, 12a 9	0.16	0.0050	0.26	15.57
24.06.2021, 20, 09:58:15, veh: T, 12a 9	4.22	0.0162	0.79	72.71
24.06.2021, 21, 09:58:19, veh: P, 12a 9	4.16	0.0230	0.99	78.23
24.06.2021, 25, 10:02:35, veh: C, 12a 9	0.29	0.0015	0.02	20.72
24.06.2021, 27, 10:02:55, veh: T, 12a 9	2.40	0.0172	0.94	65.35
24.06.2021, 35, 10:07:36, veh: T, 12a 9	1.44	0.0156	0.57	56.80
24.06.2021, 42, 10:11:42, veh: T, 12b 9	4.38	0.0139	0.83	51.89
24.06.2021, 55, 10:20:00, veh: T, 12b 9	6.31	0.0243	0.96	90.38
24.06.2021, 56, 10:20:04, veh: P, 12b 9	0.26	-0.0005	0.07	3.76
24.06.2021, 57, 10:20:05, veh: TN, 12b 9	0.31	-0.0002	0.01	4.54
24.06.2021, 58, 10:20:09, veh: MB, 12b 9	0.58	0.0033	0.41	14.67
24.06.2021, 61, 10:23:46, veh: TR, 12b 9	0.37	0.0040	0.08	33.95
24.06.2021, 62, 10:23:55, veh: T, 12b 9	5.34	0.0234	0.98	82.54
24.06.2021, 63, 10:24:00, veh: TN, 12b 9	0.58	0.0099	0.50	58.62
24.06.2021, 65, 10:24:04, veh: MB, 12b 9	0.23	0.0044	0.04	36.31
24.06.2021, 66, 10:28:26, veh: S, 12c 9	0.15	0.0040	0.08	12.41
24.06.2021, 67, 10:28:27, veh: C, 12c 9	0.05	0.0063	0.20	4.50
24.06.2021, 69, 10:28:31, veh: TR, 12c 9	8.80	0.0293	1.00	99.18
24.06.2021, 70, 10:28:34, veh: T, 12c 9	9.66	0.0304	1.00	96.71
24.06.2021, 76, 10:32:04, veh: P, 12c 9	0.81	0.0147	0.91	40.03
24.06.2021, 77, 10:32:08, veh: T, 12c 9	0.76	0.0147	0.90	39.47
24.06.2021, 80, 10:35:28, veh: S, 12c 9	4.85	0.0211	0.99	68.98
24.06.2021, 81, 10:35:29, veh: C, 12c 9	4.44	0.0211	0.99	69.82
24.06.2021, 82, 10:35:30, veh: TR, 12c 9	3.94	0.0211	0.99	68.31
24.06.2021, 83, 10:35:34, veh: T, 12c 9	5.62	0.0213	0.99	69.95
24.06.2021, 84, 10:35:36, veh: P, 12c 9	5.64	0.0213	0.99	70.57
24.06.2021, 90, 10:39:21, veh: T, 12c 9	0.54	0.0132	0.64	85.41
24.06.2021, 91, 10:39:25, veh: TN, 12c 9	0.68	0.0143	0.56	72.77
24.06.2021, 95, 10:58:03, veh: T, 13a 9	8.05	0.0216	0.98	71.26
24.06.2021, 109, 11:06:27, veh: T, 13a 9	10.40	0.0302	0.74	115.31
24.06.2021, 114, 11:11:12, veh: MB, 13a 9	0.21	0.0059	0.24	26.47
24.06.2021, 120, 11:16:54, veh: MB, 13b 9	1.39	0.0392	0.81	139.06
24.06.2021, 121, 11:17:02, veh: T, 13b 9	17.14	0.0215	0.98	71.82
24.06.2021, 122, 11:17:07, veh: P, 13b 9	0.74	0.0200	0.82	76.62
24.06.2021, 123, 11:17:09, veh: TR, 13b 9	0.72	0.0155	0.77	71.64
24.06.2021, 124, 11:17:13, veh: TN, 13b 9	0.38	0.0047	0.47	15.83

24.06.2021, 125, 11:17:17, veh: C, 13b 9	0.47	0.0030	0.12	11.55
24.06.2021, 130, 11:21:00, veh: TN, 13b 9	0.10	0.0029	0.12	8.20
24.06.2021, 134, 11:24:41, veh: T, 13b 9	0.32	0.0100	0.37	44.07
24.06.2021, 147, 11:34:08, veh: MB, 13c 9	10.11	0.0119	0.98	38.27
24.06.2021, 148, 11:34:12, veh: T, 13c 9	10.07	0.0117	0.98	37.74
24.06.2021, 149, 11:34:17, veh: P, 13c 9	1.16	0.0059	0.96	16.46
24.06.2021, 150, 11:34:19, veh: TR, 13c 9	1.58	0.0111	0.98	38.64
24.06.2021, 151, 11:34:21, veh: TN, 13c 9	1.76	0.0122	0.93	36.72
24.06.2021, 152, 11:34:23, veh: C, 13c 9	1.86	0.0119	0.93	36.27
24.06.2021, 153, 11:34:25, veh: S, 13c 9	0.34	0.0038	0.06	32.29
24.06.2021, 154, 11:38:00, veh: MB, 13c 9	14.78	0.0197	1.00	65.41
24.06.2021, 155, 11:38:04, veh: T, 13c 9	14.87	0.0193	1.00	65.25
24.06.2021, 156, 11:38:09, veh: TR, 13c 9	0.19	-0.0003	0.00	5.24
24.06.2021, 157, 11:38:11, veh: P, 13c 9	0.16	0.0001	0.00	3.97
24.06.2021, 158, 11:38:13, veh: TN, 13c 9	0.18	0.0018	0.15	3.64
24.06.2021, 159, 11:38:15, veh: C, 13c 9	0.19	-0.0035	0.27	8.06
24.06.2021, 160, 11:38:17, veh: S, 13c 9	0.26	0.0025	0.10	16.26
24.06.2021, 161, 11:41:47, veh: MB, 13c 9	8.05	0.0232	0.99	76.04
24.06.2021, 162, 11:41:52, veh: T, 13c 9	8.15	0.0238	0.99	76.79
24.06.2021, 163, 11:41:56, veh: TR, 13c 9	0.23	-0.0043	0.19	18.28
24.06.2021, 164, 11:41:58, veh: TN, 13c 9	0.18	-0.0036	0.13	18.71
24.06.2021, 165, 11:42:00, veh: P, 13c 9	0.17	-0.0004	0.00	10.98
24.06.2021, 166, 11:42:02, veh: C, 13c 9	0.44	0.0047	0.10	27.05
24.06.2021, 167, 11:42:03, veh: S, 13c 9	0.46	0.0067	0.29	27.50
24.06.2021, 168, 11:46:09, veh: MB, 13c 9	14.74	0.0195	1.00	64.07
24.06.2021, 169, 11:46:12, veh: T, 13c 9	15.13	0.0194	1.00	64.85
24.06.2021, 170, 11:46:16, veh: TR, 13c 9	0.43	0.0027	0.68	5.40
24.06.2021, 171, 11:46:18, veh: TN, 13c 9	0.67	0.0030	0.70	7.56
24.06.2021, 172, 11:46:19, veh: C, 13c 9	0.76	0.0035	0.82	8.19
24.06.2021, 173, 11:46:21, veh: P, 13c 9	0.94	0.0034	0.84	9.74
24.06.2021, 174, 11:46:24, veh: S, 13c 9	0.33	0.0109	0.51	31.14
24.06.2021, 7, 14:15:45, veh: T, 15a 9	1.52	0.0270	0.91	102.97
24.06.2021, 10, 14:19:26, veh: S, 15a 9	0.26	-0.0052	0.06	30.80
24.06.2021, 13, 14:19:44, veh: P, 15a 9	0.52	0.0055	0.61	20.16
24.06.2021, 14, 14:19:56, veh: T, 15a 9	0.66	0.0015	0.34	7.00
24.06.2021, 41, 14:36:51, veh: P, 15b 9	0.30	0.0026	0.06	26.24
24.06.2021, 44, 14:37:05, veh: MB, 15b 9	0.26	0.0070	0.12	24.19
24.06.2021, 49, 14:40:46, veh: P, 15b 9	0.37	-0.0032	0.08	24.93
24.06.2021, 50, 14:40:49, veh: TN, 15b 9	0.29	-0.0023	0.08	15.99
24.06.2021, 55, 14:44:28, veh: T, 15b 9	0.31	-0.0011	0.07	6.19
24.06.2021, 58, 14:44:39, veh: MB, 15b 9	0.29	0.0025	0.05	25.10
24.06.2021, 61, 14:48:47, veh: P, 15c 9	0.33	0.0143	0.46	56.44
24.06.2021, 62, 14:48:49, veh: TR, 15c 9	0.30	-0.0012	0.18	6.02
24.06.2021, 64, 14:48:56, veh: TN, 15c 9	0.35	0.0002	0.00	13.66
24.06.2021, 65, 14:48:58, veh: MB, 15c 9	0.28	0.0051	0.15	20.29
24.06.2021, 68, 14:52:18, veh: TR, 15c 9	0.28	0.0053	0.34	28.35
24.06.2021, 69, 14:52:20, veh: P, 15c 9	0.32	0.0038	0.40	20.16
24.06.2021, 71, 14:52:27, veh: TN, 15c 9	0.21	-0.0005	0.05	5.97
24.06.2021, 76, 14:55:59, veh: T, 15c 9	0.27	-0.0028	0.46	9.23
24.06.2021, 84, 15:00:02, veh: TN, 15c 9	0.15	0.0114	0.11	15.76
24.06.2021, 85, 15:00:04, veh: P, 15c 9	0.15	-0.0026	0.07	11.86
24.06.2021, 86, 15:00:05, veh: MB, 15c 9	0.15	-0.0019	0.04	10.35
25.06.2021, 3, 10:03:51, veh: TR, 19a 9.8	0.62	0.0106	0.71	32.77
25.06.2021, 5, 10:04:01, veh: TN, 19a 9.8	0.17	-0.0019	0.07	13.52
25.06.2021, 9, 10:07:16, veh: TN, 19a 9.8	0.33	0.0003	0.00	8.15
25.06.2021, 10, 10:07:17, veh: P, 19a 9.8	0.30	0.0015	0.05	7.53
25.06.2021, 14, 10:10:26, veh: TN, 19a 9.8	0.30	-0.0002	0.00	6.76
25.06.2021, 15, 10:10:36, veh: C, 19a 9.8	0.58	0.0141	0.81	51.33

25.06.2021, 18, 10:13:16, veh: P, 19a 9.8	0.82	0.0239	0.71	88.46
25.06.2021, 20, 10:13:35, veh: TN, 19a 9.8	0.19	0.0004	0.00	6.60
25.06.2021, 25, 10:18:09, veh: TN, 19b 9.8	0.28	-0.0025	0.10	10.64
25.06.2021, 26, 10:18:20, veh: C, 19b 9.8	0.35	0.0070	0.24	26.24
25.06.2021, 34, 10:23:28, veh: TN, 19b 9.8	0.75	0.0086	0.54	28.00
25.06.2021, 35, 10:23:29, veh: P, 19b 9.8	0.70	0.0094	0.68	26.86
25.06.2021, 44, 10:28:44, veh: TN, 19b 9.8	0.15	-0.0018	0.04	9.30
25.06.2021, 45, 10:28:55, veh: C, 19b 9.8	0.51	0.0061	0.02	47.65
25.06.2021, 46, 10:28:56, veh: P, 19b 9.8	0.53	0.0093	0.09	52.11
25.06.2021, 55, 10:34:15, veh: TN, 19b 9.8	0.25	-0.0005	0.01	6.86
25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	0.22	0.0007	0.00	20.79
25.06.2021, 101, 11:07:55, veh: P, 20b 9.8	0.24	0.0017	0.01	26.30
25.06.2021, 106, 11:16:57, veh: TN, 20c 9.8	0.34	0.0030	0.24	14.26
25.06.2021, 127, 11:30:46, veh: C, 20d 9.8	0.70	0.0153	0.82	52.40
25.06.2021, 128, 11:30:47, veh: TR, 20d 9.8	0.70	0.0153	0.82	53.46

	High Emitter Passage
	Low Emitter Passage
	Negative Values

The above table XXVII represents the vehicle passages that were detected by the CZU FTIR. Rows highlighted in orange color represents high NO_X emitting passages and rows highlighted in green color represents low NO_X emitting passages. It can also be seen that, there were negative values (highlighted in pink color) of slope factor (ratio). This was due to poor correlation happened due to mismatch of signals that resulted in negative slope factor. There were 2 passages which were text highlighted in blue color as shown in table. These passages have correlation factor (R2) greater than 0.9, slope factor (ratio) were high as well as emission factors were high; but the concentration of NO were less than its LOQ. On further investigation except for passages corresponding to date- 24.06.2021 at time- 10:32:04 was in a time gap of 2 seconds with its previous vehicle, the other highlighted passage was in a time gap of 4 seconds with its previous passages. So, these could be high emitters but does not satisfy the condition for concentrations higher than LOQ.

Table XXVIII: High NO_X emission passage detection for heavy-duty vehicle by CZU FTIR

CZU FTIR	Peak Conc.	lin.reg	R2		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/kWh)**
FORD F-MAX TRUCK (Diesel)					
24.06.2021, 27, 10:02:55, veh: T, 12a 9	2.40	0.0172	0.94	65.35	16.34
24.06.2021, 55, 10:20:00, veh: T, 12b 9	6.31	0.0243	0.96	90.38	22.6
24.06.2021, 62, 10:23:55, veh: T, 12b 9	5.34	0.0234	0.98	82.54	20.63
24.06.2021, 70, 10:28:34, veh: T, 12c 9	9.66	0.0304	1	96.71	24.18
24.06.2021, 83, 10:35:34, veh: T, 12c 9	5.62	0.0213	0.99	69.95	17.49
24.06.2021, 95, 10:58:03, veh: T, 13a 9	8.05	0.0216	0.98	71.26	17.81
24.06.2021, 121, 11:17:02, veh: T, 13b 9	17.14	0.0215	0.98	71.82	17.96
24.06.2021, 148, 11:34:12, veh: T, 13c 9	10.07	0.0117	0.98	37.74	9.44
24.06.2021, 155, 11:38:04, veh: T, 13c 9	14.87	0.0193	1	65.25	16.31
24.06.2021, 162, 11:41:52, veh: T, 13c 9	8.15	0.0238	0.99	76.79	19.2
24.06.2021, 169, 11:46:12, veh: T, 13c 9	15.13	0.0194	1	64.85	16.21
24.06.2021, 7, 14:15:45, veh: T, 15a 9	1.52	0.0270	0.91	102.97	25.74

The above table XXVIII shows high NO_X detected passages for the truck. 12 passages were detected with high emission of NO_X (row highlighted in orange color) where tampering of SCR was possible. Out of the 10 passages, 2 passages corresponding to date- 24.06.2021 at times- 10:28:34 and 11:46:12 were found to be the case of interference of exhaust gases from the previous vehicle passages as the time gap between the vehicles were 3 seconds, respectively. The remaining 10 passages were in time gap of 4 seconds to 12 seconds from their respective previous passages. Among the remaining high emitters, passage corresponding to date- 24.06.2021 at time- 14:15:45 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (g/kWh) was the highest. It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 6 (0.46g/kWh) standards.

Table XXIX: High NO_X emission passage detection for LCV diesel by CZU FTIR

CZU FTIR	Peak Conc.	lin.reg	R2		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
VW CADDY (Diesel)					
24.06.2021, 81, 10:35:29, veh: C, 12c 9	4.44	0.0211	0.99	69.82	3.56
24.06.2021, 152, 11:34:23, veh: C, 13c 9	1.86	0.0119	0.93	36.27	1.85
VW TRANSPORTER (Diesel)					
24.06.2021, 7, 09:48:59, veh: TR, 12a 9	2.14	0.0175	0.93	67.19	4.28
24.06.2021, 69, 10:28:31, veh: TR, 12c 9	8.80	0.0293	1	99.18	6.32
24.06.2021, 82, 10:35:30, veh: TR, 12c 9	3.94	0.0211	0.99	68.31	4.35
24.06.2021, 150, 11:34:19, veh: TR, 13c 9	1.58	0.0111	0.98	38.64	2.46
VW CRAFTER (Diesel)					
24.06.2021, 21, 09:58:19, veh: P, 12a 9	4.16	0.0230	0.99	78.23	6.65
24.06.2021, 84, 10:35:36, veh: P, 12c 9	5.64	0.0213	0.99	70.57	6

The above table XXIX represents the detected passage for high emission of NO_X for diesel powered LCV. It was found out that VW Transporter corresponding to date- 24.06.2021 at time- 09:48:59 was in time gap of 10 seconds from its previous passage vehicle and VW Crafter corresponding to date- 24.06.2021 at time- 09:58:19 was in time gap of 4 seconds from its previous vehicle, which indicates as the passages of highest emission of NO_X (text highlighted in yellow color). The remaining passages (text highlighted in green color) in the above table had possibility of interference of exhaust gases from their respective previous vehicles as the time gap between the vehicles were less than or equal to 3 seconds. The passage of VW Caddy corresponding to date- 24.06.2021 at time- 11:34:23 was already detected by the CTU FTIR which was shown in table XX which had low spacing with its previous vehicle.

Table XXX: High NO_X emission passage detection for Gasoline Vehicles by CZU FTIR

CZU FTIR	Peak Conc.	lin.reg	R2		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
VW TOURAN (Gasoline)					
24.06.2021, 151, 11:34:21, veh: TN, 13c 9	1.76	0.0122	0.93	36.72	1.80
YAMAHA MT07 (Gasoline)					
24.06.2021, 147, 11:34:08, veh: MB, 13c 9	10.11	0.0119	0.98	38.27	1.21
24.06.2021, 154, 11:38:00, veh: MB, 13c 9	14.78	0.0197	1	65.41	2.07
24.06.2021, 161, 11:41:47, veh: MB, 13c 9	8.05	0.0232	0.99	76.04	2.41
24.06.2021, 168, 11:46:09, veh: MB, 13c 9	14.74	0.0195	1	64.07	2.03
YAMAHA N-MAX (Gasoline)					
24.06.2021, 80, 10:35:28, veh: S, 12c 9	4.85	0.0211	0.99	68.98	1.2

From the above table XXX, the passages detected as high emission of NO_X for the L-category vehicles had no possibility of interference of exhaust gases because these were the starting passages of each test cycle for vehicle passages. For VW Touran (text highlighted in green color) had the possibility of interference of exhaust gases from its previous vehicle which was VW Transporter corresponding to date- 24.06.2021 at time- 11:94:19 because the time gap between the two vehicles was 2 seconds. This VW Transporter passage was already identified as high emitting passage in table XXIX. Among the high emitters of Yamaha MT07, passage corresponding to date- 24.06.2021 at time- 11:41:47 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (g/km) was the highest. For Yamaha N-Max only one passage was detected as high emitter.

Table XXXI: Low NO_X emission passage detection by CZU EEPS

CTU FTIR	Peak Conc.	lin.reg	R2		
Vehicle Passage	**NO (ppm)**	**NO/CO_2**	**NO/CO_2**	**EF_{NO} (g/kg_{fuel})**	**EF_{NO} (g/km)**
VW CADDY (Diesel)					
24.06.2021, 25, 10:02:35, veh: C, 12a 9	0.29	0.0015	0.02	20.72	1.06
24.06.2021, 67, 10:28:27, veh: C, 12c 9	0.05	0.0063	0.20	4.50	0.23
24.06.2021, 125, 11:17:17, veh: C, 13b 9	0.47	0.0030	0.12	11.55	0.59
24.06.2021, 166, 11:42:02, veh: C, 13c 9	0.44	0.0047	0.10	27.05	1.38
25.06.2021, 45, 10:28:55, veh: C, 19b 9.8	0.51	0.0061	0.02	47.65	3.04
VW TRANSPORTER (Diesel)					
24.06.2021, 61, 10:23:46, veh: TR, 12b 9	0.37	0.0040	0.08	33.95	2.16
VW CRAFTER (Diesel)					
24.06.2021, 157, 11:38:11, veh: P, 13c 9	0.16	0.0001	0.00	3.97	3.97
24.06.2021, 41, 14:36:51, veh: P, 15b 9	0.30	0.0026	0.06	26.24	26.24
25.06.2021, 10, 10:07:17, veh: P, 19a 9.8	0.30	0.0015	0.05	7.53	7.53
25.06.2021, 46, 10:28:56, veh: P, 19b 9.8	0.53	0.0093	0.09	52.11	52.11
25.06.2021, 101, 11:07:55, veh: P, 20b 9.8	0.24	0.0017	0.01	26.30	26.30
VW TOURAN (Gasoline)					
24.06.2021, 130, 11:21:00, veh: TN, 13b 9	0.10	0.0029	0.12	8.20	0.40
24.06.2021, 158, 11:38:13, veh: TN, 13c 9	0.18	0.0018	0.15	3.64	0.18
24.06.2021, 64, 14:48:56, veh: TN, 15c 9	0.35	0.0002	0.00	13.66	0.67
24.06.2021, 84, 15:00:02, veh: TN, 15c 9	0.15	0.0114	0.11	15.76	0.77
25.06.2021, 9, 10:07:16, veh: TN, 19a 9.8	0.33	0.0003	0.00	8.15	0.43
25.06.2021, 20, 10:13:35, veh: TN, 19a 9.8	0.19	0.0004	0.00	6.60	0.35
25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	0.22	0.0007	0.00	20.79	1.02
YAMAHA MT07 (Gasoline)					
24.06.2021, 65, 10:24:04, veh: MB, 12b 9	0.23	0.0044	0.04	36.31	1.15
24.06.2021, 44, 14:37:05, veh: MB, 15b 9	0.26	0.0070	0.12	24.19	0.77
24.06.2021, 58, 14:44:39, veh: MB, 15b 9	0.29	0.0025	0.05	25.10	0.80
24.06.2021, 65, 14:48:58, veh: MB, 15c 9	0.28	0.0051	0.15	20.29	0.64
YAMAHA N-MAX (Gasoline)					
24.06.2021, 66, 10:28:26, veh: S, 12c 9	0.15	0.0040	0.08	12.41	0.22
24.06.2021, 153, 11:34:25, veh: S, 13c 9	0.34	0.0038	0.06	32.29	0.56
24.06.2021, 160, 11:38:17, veh: S, 13c 9	0.26	0.0025	0.10	16.26	0.28

The above table XXXI represents low NO_X emitted passages detected by VAN EEPS for LCV and L-category vehicles. There were no passages detected as low NO_X passages for heavy-duty vehicle. Among the low emitters, passages highlighted in grey color were the lowest emitting passage according to vehicles because the value to emission factor according to their respective standards were lowest.

Table XXXII: Detected PN emission passage by VAN EEPS

VAN EEPS	Peak Conc.	lin.reg	R2	
Vehicle Passage	**PN (#/cm³)**	**PN/CO_2**	**PN/CO_2**	**EF_{PN} (#/kg_{fuel})**
24.06.2021, 49, 14:40:46, veh: P, 15b 9	6.01E+03	176	0.54	2.83E+14
24.06.2021, 50, 14:40:49, veh: TN, 15b 9	2.55E+05	1712	0.36	2.75E+15
24.06.2021, 55, 14:44:28, veh: T, 15b 9	6.44E+03	44	0.67	7.14E+13
24.06.2021, 58, 14:44:39, veh: MB, 15b 9	1.89E+04	806	0.91	1.30E+15
24.06.2021, 61, 14:48:47, veh: P, 15c 9	2.65E+04	-67	-0.44	-1.14E+14
24.06.2021, 62, 14:48:49, veh: TR, 15c 9	7.87E+03	47	0.67	7.64E+13
24.06.2021, 64, 14:48:56, veh: TN, 15c 9	8.17E+04	-68	-0.09	-1.09E+14
24.06.2021, 65, 14:48:58, veh: MB, 15c 9	3.03E+05	3224	0.67	5.17E+15
24.06.2021, 68, 14:52:18, veh: TR, 15c 9	2.74E+04	-167	-0.25	-2.78E+14
24.06.2021, 69, 14:52:20, veh: P, 15c 9	2.16E+04	-68	-0.14	-1.11E+14
24.06.2021, 71, 14:52:27, veh: TN, 15c 9	9.85E+03	46	0.33	7.35E+13
24.06.2021, 76, 14:55:59, veh: T, 15c 9	8.40E+02	53	0.62	8.59E+13
24.06.2021, 84, 15:00:02, veh: TN, 15c 9	2.51E+05	-3189	-0.39	-5.17E+15
24.06.2021, 85, 15:00:04, veh: P, 15c 9	2.53E+05	18932	0.91	3.04E+16
24.06.2021, 86, 15:00:05, veh: MB, 15c 9	2.53E+05	15292	0.91	2.45E+16
25.06.2021, 3, 10:03:51, veh: TR, 19a 9.8	1.85E+03	93	0.83	1.49E+14
25.06.2021, 5, 10:04:01, veh: TN, 19a 9.8	3.34E+05	6075	0.97	7.60E+15
25.06.2021, 9, 10:07:16, veh: TN, 19a 9.8	1.55E+05	1466	0.89	1.66E+15
25.06.2021, 10, 10:07:17, veh: P, 19a 9.8	1.56E+05	1643	0.89	1.87E+15
25.06.2021, 14, 10:10:26, veh: TN, 19a 9.8	3.32E+05	4309	0.99	5.19E+15
25.06.2021, 15, 10:10:36, veh: C, 19a 9.8	1.36E+03	219	0.82	3.48E+14
25.06.2021, 18, 10:13:16, veh: P, 19a 9.8	2.90E+03	396	0.91	6.37E+14
25.06.2021, 20, 10:13:35, veh: TN, 19a 9.8	2.94E+05	4965	0.94	5.01E+15
25.06.2021, 25, 10:18:09, veh: TN, 19b 9.8	2.48E+05	5834	0.85	6.42E+15
25.06.2021, 26, 10:18:20, veh: C, 19b 9.8	9.35E+03	305	0.88	4.84E+14
25.06.2021, 34, 10:23:28, veh: TN, 19b 9.8	1.82E+05	2029	0.97	2.99E+15
25.06.2021, 35, 10:23:29, veh: P, 19b 9.8	1.84E+05	3127	0.95	4.63E+15
25.06.2021, 44, 10:28:44, veh: TN, 19b 9.8	2.30E+05	5415	0.99	6.67E+15
25.06.2021, 45, 10:28:55, veh: C, 19b 9.8	6370	301	0.97	4.78E+14
25.06.2021, 46, 10:28:56, veh: P, 19b 9.8	8100	356	0.87	5.58E+14
25.06.2021, 55, 10:34:15, veh: TN, 19b 9.8	319490	3301	0.95	3.94E+15
25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	12580	256	0.81	4.11E+14
25.06.2021, 101, 11:07:55, veh: P, 20b 9.8	12684	335	0.81	5.39E+14
25.06.2021, 106, 11:16:57, veh: TN, 20c 9.8	33125	432	0.99	6.94E+14

	High Emitter Passage
	Negative Values

The above table XXXII represents the vehicle passages that were detected by the VAN EEPS. Rows highlighted in orange color represents high PN emitting passages. It can also be seen that, there were negative values (highlighted in pink color) of slope factor (ratio), correlating factor (R2) and emission factor. This was due to poor correlation that resulted in negative slope factor. As the slope factor was used in calculation of emission factor, eventually the value for emission factor was negative. There was no low PN emitting passages detected by VAN EEPS.

Table XXXIII: High PN emission passage detection for LCV by VAN EEPS

VAN EEPS	Peak Conc.	lin.reg	R2		
Vehicle Passage	PN (#/cm³)	PN/CO_2	PN/CO_2	EF_{PN} (#/kg_{fuel})	EF_{PN} (#/km)
VW CRAFTER (Diesel)					
24.06.2021, 85, 15:00:04, veh: P, 15c 9	2.53E+05	18932	0.91	3.04E+16	2.58E+15
25.06.2021, 35, 10:23:29, veh: P, 19b 9.8	1.84E+05	3127	0.95	4.63E+15	5.19E+14

From the above table XXXIII, no LCV was detected as high PN emission by CZU FTIR. Only, 2 passages for VW Crafter was detected as high emitter but on further investigation it was found out that the time gap between the detected high emitter passage and the previous passage were less than 3 seconds, that shows the possibility of interference of exhaust gases from the vehicles. It can also be seen from the table; all the passages show higher emission factor than the legislated limit for EURO 5b (6.00E+11g/km) standards.

Table XXXIV: High PN emission passage detection for Gasoline Vehicles by VAN EEPS

VAN EEPS	Peak Conc.	lin.reg	R2		
Vehicle Passage	PN (#/cm3)	PN/CO_2	PN/CO_2	EF_{PN} (#/kg_{fuel})	EF_{PN} (#/km)
VW TOURAN (Gasoline)					
25.06.2021, 5, 10:04:01, veh: TN, 19a 9.8	3.34E+05	6075	0.97	7.60E+15	4.01E+14
25.06.2021, 14, 10:10:26, veh: TN, 19a 9.8	3.32E+05	4309	0.99	5.19E+15	2.74E+14
25.06.2021, 20, 10:13:35, veh: TN, 19a 9.8	2.94E+05	4965	0.94	5.01E+15	2.65E+14
25.06.2021, 34, 10:23:28, veh: TN, 19b 9.8	1.82E+05	2029	0.97	2.99E+15	1.58E+14
25.06.2021, 44, 10:28:44, veh: TN, 19b 9.8	2.30E+05	5415	0.99	6.67E+15	3.53E+14
25.06.2021, 55, 10:34:15, veh: TN, 19b 9.8	3.19E+05	3301	0.95	3.94E+15	2.08E+14
25.06.2021, 106, 11:16:57, veh: TN, 20c 9.8	3.31E+04	432	0.99	6.94E+14	3.41E+13
YAMAHA MT07 (Gasoline)					
24.06.2021, 58, 14:44:39, veh: MB, 15b 9	1.89E+04	806	0.91	1.30E+15	4.11E+13
24.06.2021, 86, 15:00:05, veh: MB, 15c 9	2.53E+05	15292	0.91	2.45E+13	7.77E+11

In the above table XXXIV, for VW Touran, the passages detected for high emission of PN were in time gaps of more than 9 seconds with their respective previous vehicles, so there was no scenario of interaction of exhaust gases. Among the high emitters, passage corresponding to date- 25.06.2021 at time-

10:04:01 was the highest emitting passage (text highlighted in yellow color) because the value to emission factor (#/km) was the highest.

2 passages of Yamaha MT07 were detected as high emitter of PN but passage corresponding to date- 24.06.2021 at time- 15:00:05 was detected as high emitting passage for PN. On further investigation it was found out that this motorbike (text highlighted in green color) was following VW Crafter corresponding to date- 24.06.2021 at time-15:00:04 which was detected as high emitter of PN in table XXXIII due to interference of exhaust gases from the previous vehicle. Both vehicles were in a time gap of 1 second. So, there was possibility of further interference of the exhaust gases between the vehicles.

4.3.3.3. Comparison of high emitters

In this section, high emitters detected for truck by both CTU FTIR and CZU FTIR were compared with respect to each other. From tables XIX and XXVIII, it was found that, there were no common high emitting passages detected by both CTU FTIR and CZU FTIR.

CTU FTIR was able to detect 11 high emitting NO_X passages. The emission factors in terms of g/kWh of these high emitting passages were compared with emission factors in terms of g/kWh from CZU FTIR.

Table XXXV: Comparison of high NO_X passages for CTU FTIR with respect to CZU FTIR

24.06.2021	CTU FTIR				CZU FTIR			
Passage Time	**NO (ppm)** [peak conc.]	**NO/CO_2** [lin.reg.]	**NO/CO_2** [R2]	**EF_{NO} (g/kWh)**	**NO (ppm)** [peak conc.]	**NO/CO_2** [lin.reg.]	**NO/CO_2** [R2]	**EF_{NO} (g/kWh)**
10:07:36	1.86	0.006	0.96	5.21	1.44	0.016	0.57	14.20
10:11:42	1.15	0.006	0.95	4.5	4.38	0.014	0.83	14.20
11:02:16	3.4	0.005	0.99	3.77	0.29	-0.033	0.03	178.16
11:11:23	2.35	0.005	0.99	4.08	0.24	0.013	0.21	12.52
11:20:48	2.05	0.005	0.98	3.92	0.24	-0.004	0.01	31.74
11:24:41	1.96	0.005	0.99	3.81	0.32	0.010	0.37	11.02
11:29:52	1.61	0.005	0.98	3.7	0.13	0.073	0.19	51.99
12:02:35	2.16	0.004	0.98	4.25	-NA-	-NA-	-NA-	-NA-
12:14:07	1.13	0.005	0.94	5.39	-NA-	-NA-	-NA-	-NA-
15:30:05	0.92	0.004	0.92	3.99	-NA-	-NA-	-NA-	-NA-
15:58:56	2.14	0.005	0.99	4.35	-NA-	-NA-	-NA-	-NA-

From above table XXXV, it was observed that the emission factors for CTU FTIR were less as compared to emission factors for CZU FTIR. CZU FTIR showed negative slope factor (ratio) for two passages highlighted in pink color and most of the passages showed peak concentrations of NO less than LOD. The remaining passages for CZU FTIR showing values '-NA-' represents that the instrument was not active during that time. Below graph shows the comparison in an illustrative way.

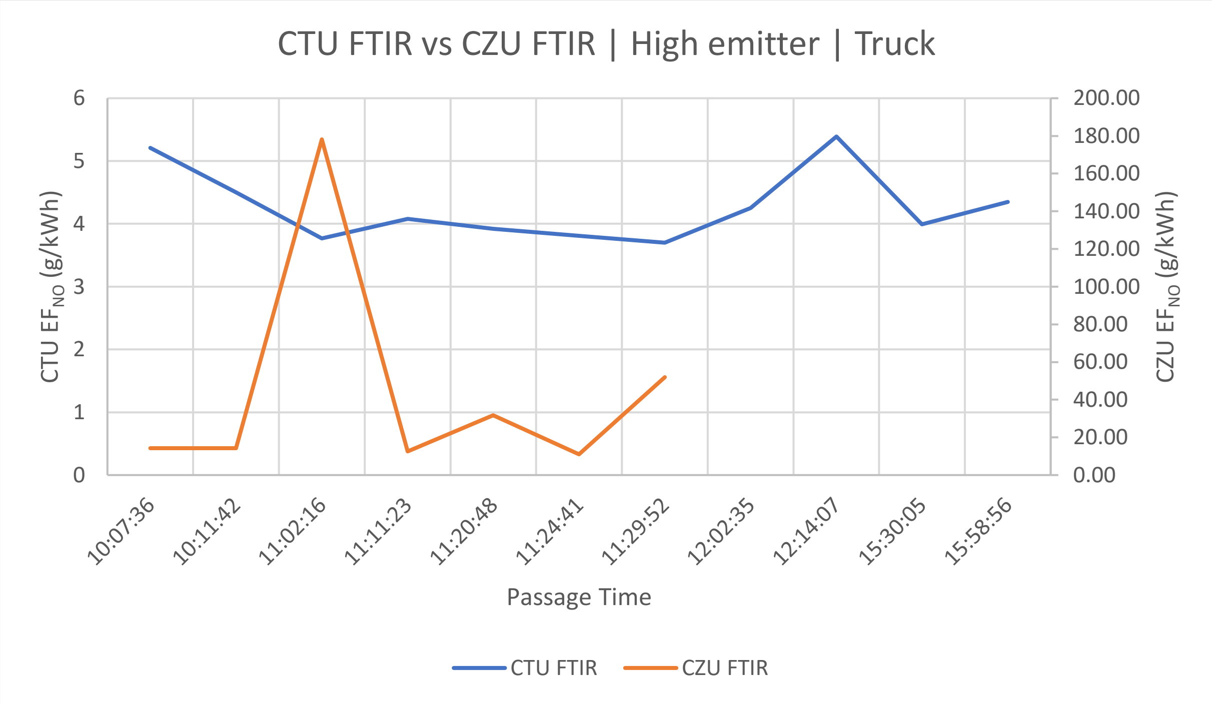

Fig 4A: Comparison of high NO_X passages for CTU FTIR with respect to CZU FTIR

Passage corresponding to date- 24.06.2021 at time- 12:14:07 was the highest emitting passage (text highlighted in yellow color) from CTU FTIR but during that time CZU FTIR was not active. Next highest emitting passage corresponding to date- 24.06.2021 at time- 10:07:36 (text highlighted in yellow color); when compared to the CZU FTIR emission factor, it showed relatively higher emission factor, higher slope factor (ratio) and peak concentration higher than its LOQ but showed correlating factor (R2) lower than 0.9.

CZU FTIR was able to detect 12 high emitting NO_X passages. The emission factors in terms of g/kWh of these high emitting passages were compared with emission factors in terms of g/kWh from CTU FTIR.

Table XXXVI: Comparison of high NO_X passages for CZU FTIR with respect to CTU FTIR

24.06.2021	CZU FTIR				CTU FTIR			
Passage Time	**NO (ppm)** [peak conc.]	**NO/CO_2** [lin.reg.]	**NO/CO_2** [R2]	**EF_{NO} (g/kWh)**	**NO (ppm)** [peak conc.]	**NO/CO_2** [lin.reg.]	**NO/CO_2** [R2]	**EF_{NO} (g/kWh)**
10:02:55	2.4	0.017	0.94	16.34	0.10	-0.012	0.22	7.94
10:20:00	6.31	0.024	0.96	22.6	0.15	-0.010	0.25	-5.88
10:23:55	5.34	0.023	0.98	20.63	0.23	0.010	0.31	-9.72
10:28:34	9.66	0.030	1	24.18	0.09	0.003	0.35	-59.93
10:35:34	5.62	0.021	0.99	17.49	0.56	0.002	0.31	6.86
10:58:03	8.05	0.022	0.98	17.81	0.09	-0.010	0.30	9.26
11:17:02	17.14	0.022	0.98	17.96	0.69	0.005	0.95	3.43
11:34:12	10.07	0.012	0.98	9.44	0.07	0.001	0.00	3.50
11:38:04	14.87	0.019	1	16.31	0.26	-0.001	0.00	13.84
11:41:52	8.15	0.024	0.99	19.2	0.17	0.004	0.41	5.32
11:46:12	15.13	0.019	1	16.21	0.33	0.001	0.00	31.86
14:15:45	1.52	0.027	0.91	25.74	0.27	0.009	0.14	51.50

From above table XXXVI, it was observed that the emission factors for CZU FTIR were higher as compared to emission factors for CTU FTIR. CTU FTIR showed negative slope factor (ratio) and emission factors for passages highlighted in pink color and most of the passages showed peak concentrations of NO less than LOD. Below graph shows the comparison in an illustrative way.

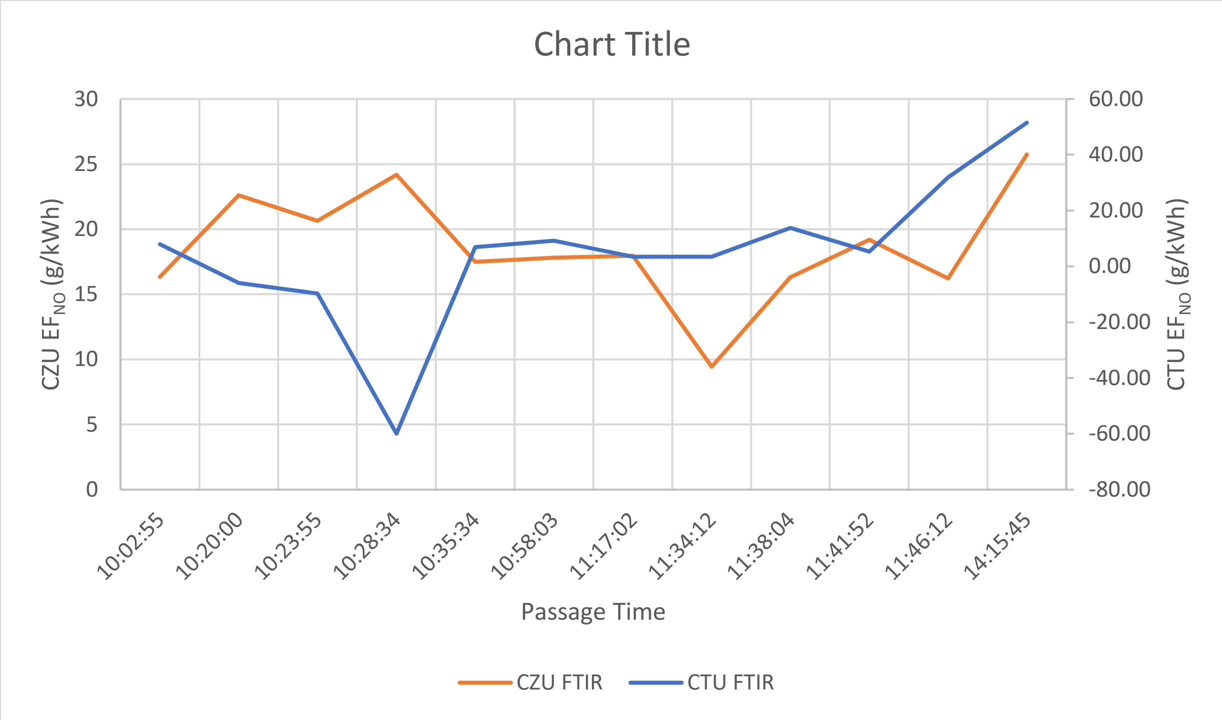

Fig 4B: Comparison of high NO_X passages for CZU FTIR with respect to CTU FTIR

Passage corresponding to date- 24.06.2021 at time- 14:15:45 was the highest emitting passage (text highlighted in yellow color) from CZU FTIR. When compared to the CTU FTIR emission factor, it showed relatively higher emission factor and higher slope factor (ratio) but showed correlating factor (R2) lower than 0.2 and lower peak concentration lower than its LOD.

4.4. Comparison based on Instruments

Two sets of same instruments were used for both CTU and CZU- FTIR and EEPS.

For CTU, both the instruments were from inhouse and for CZU, FTIR was inhouse, but EEPS was from IVL, Sweden operated as part of TNO, Netherland setup, borrowed for measurement which was termed as VAN EEPS. The recording of data for CTU was done from the middle of the road and for CZU was done from the side of the road. From the above section 4.3, it could be found that CTU instruments were capable of detecting more passages than CZU instrument. This could be because of the location of the sampling points and the exhaust tail pipe position which were in bottom rear of the vehicles. The sampling point of MSS^{Plus} which was used to get the mass concentrations per m^3 of soot particles was placed along with the CTU instruments (sampling point on middle of road). In this section, the comparison of these instruments were done based on their detected concentrations of the pollutants when the activation of both comparing instruments were in the same time frame and same environmental conditions. The passages of the vehicles were numbered which are shown in Appendix section. Instead of using the vehicle passages, passage numbers were used in the graphical representation for the comparison.

4.4.1. CTU FTIR vs CZU FTIR

Selection of passages were done for both morning and afternoon recordings for date- 24.06.2021. For morning, vehicle passage number from 15 to 114, in total of 100 passages and for afternoon, vehicle passages from 208 to 291, in total of 84 passages.

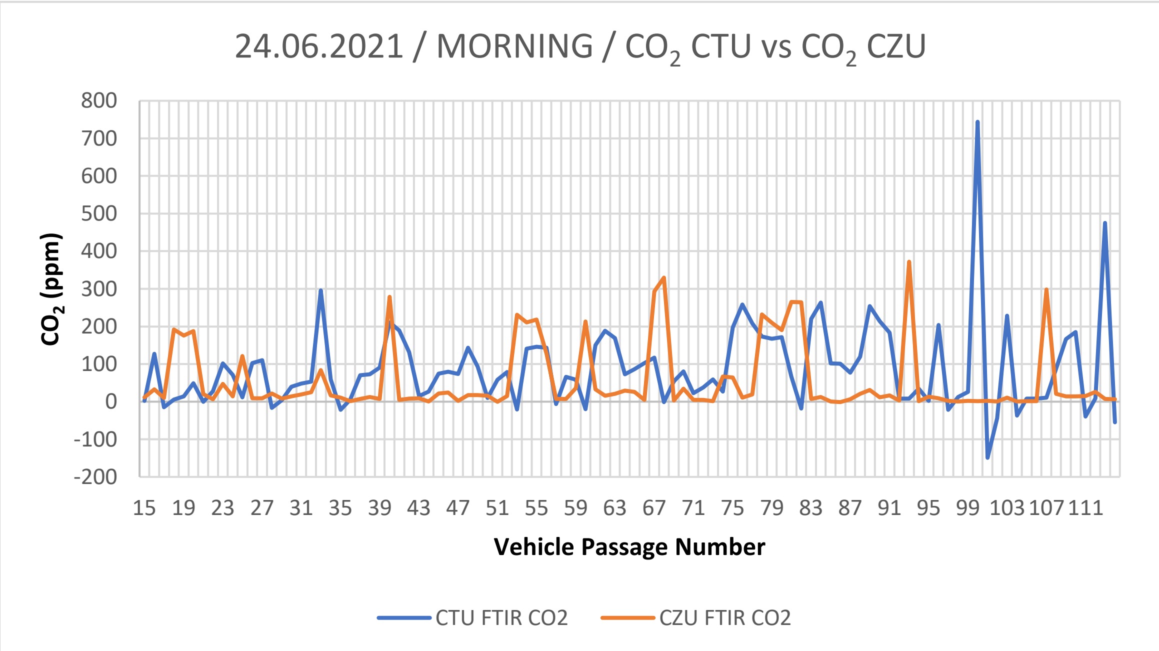

Fig 4C: Comparison of concentrations of CO_2 for CTU and CZU FTIR on 24.06.2021 (morning)

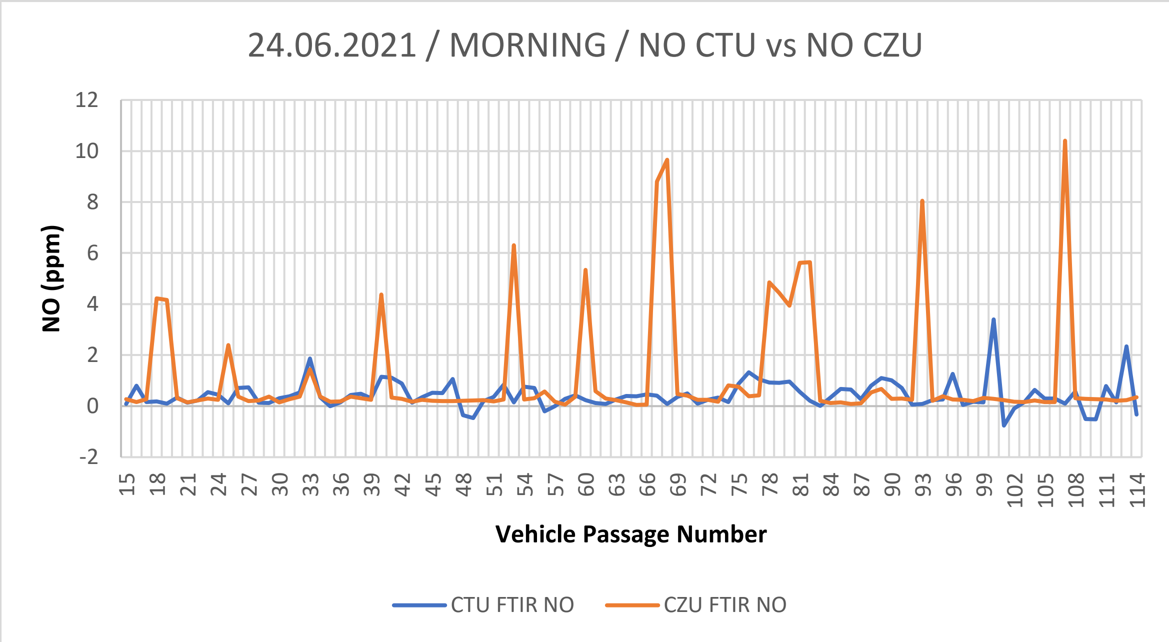

Fig 4D: Comparison of concentrations of NO for CTU and CZU FTIR on 24.06.2021 (morning)

From the above figure 4C and 4D, it was studied that higher concentrations of CO_2 were detected in most of the passages by CTU FTIR with respect to CZU FTIR; but in case of NO concentrations, CZU FTIR was detecting higher concentrations in most of the passages with respect to CTU FTIR. It was also observed that in some passages for both CO_2 and NO were showing negative values for CTU FTIR. From the shape of the graphs, it was clearly evident that FTIRs were detecting different values for the passages during the morning of 24.06.2021.

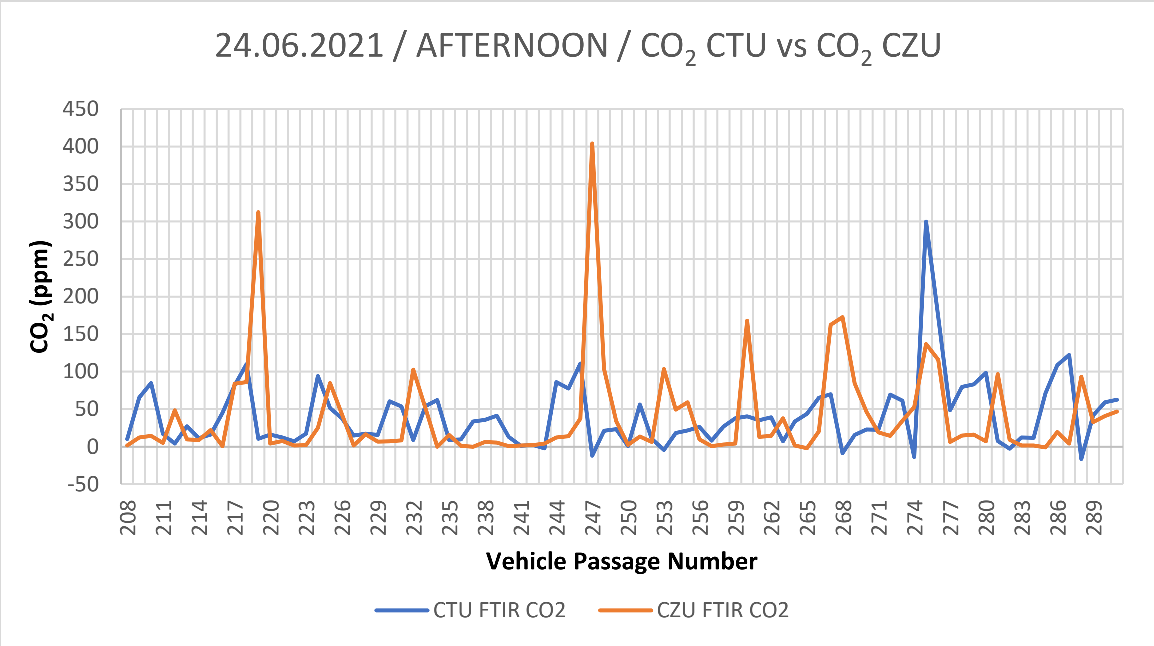

Fig 4E: Comparison of concentrations of CO_2 for CTU and CZU FTIR on 24.06.2021 (afternoon)

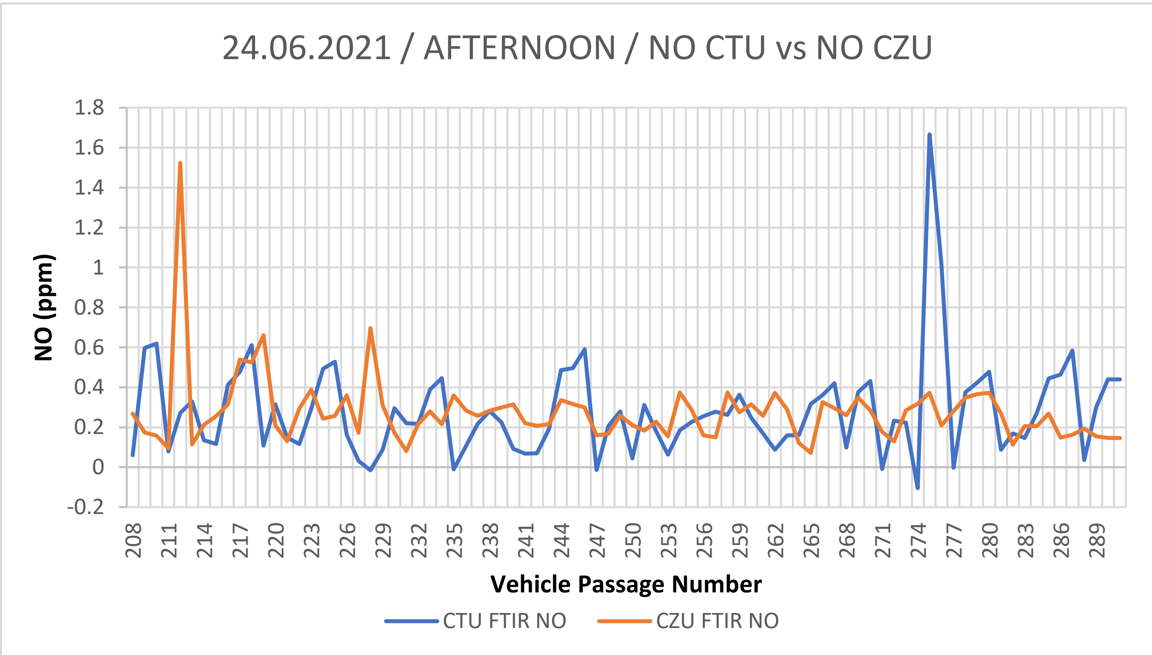

Fig 4F: Comparison of concentrations of NO for CTU and CZU FTIR on 24.06.2021 (afternoon)

During the afternoon of 24.06.2021, CTU FTIR was able to detect higher concentrations of CO_2 for most of the passages with respect to CZU FTIR, but it was the other way round for NO concentrations. It was also observed that

CTU FTIR was producing negative values for some passages. On observing the shape of graphs in figure 4E, it was clear that both FTIRs were detecting different values of CO_2 concentrations. From the figure 4F, it was observed that the shape of the graphs gradually getting different with increase in passage number.

For date- 25.06.2021, both FTIR were activated from passage number 420 to 519, in total of 100 passages.

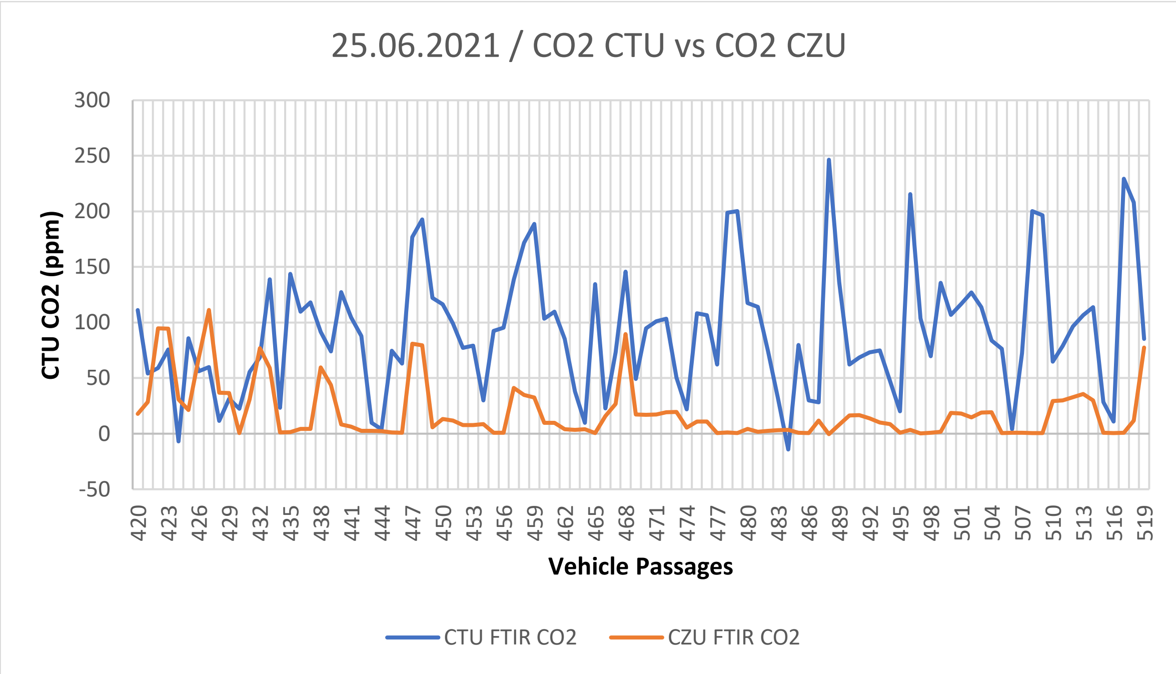

Fig 4G: Comparison of concentrations of CO_2 for CTU and CZU FTIR on 25.06.2021

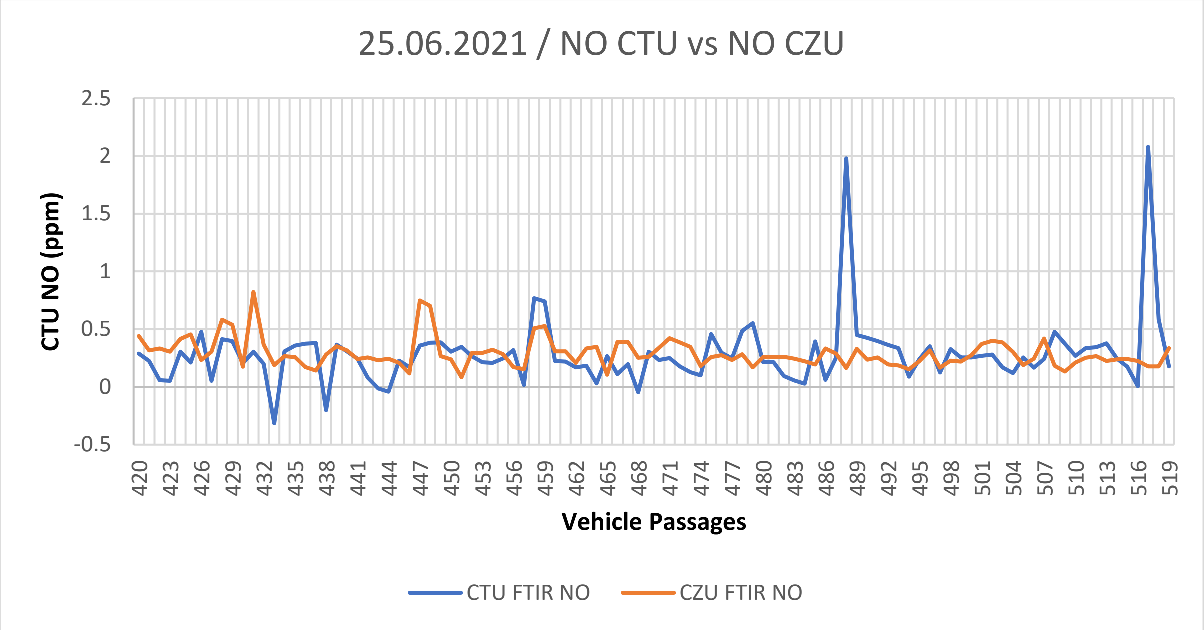

Fig 4H: Comparison of concentrations of NO for CTU and CZU FTIR on 25.06.2021

From the above figures 4G and 4H, it was observed that high concentrations of CO_2 was often detected by CTU FTIR with respect to CZU FTIR and for NO, CTU FTIR was detecting higher concentrations with respect to CZU FTIR in most of the passages. As was previously observed on 24.06.2021, CTU FTIR was showing negative values for some passages, the same thing can be observed on 25.06.2021. But when the shapes of the graphs were observed, the shapes of the peaks of both the FTIRs with similar pattern were rare as well as the concentration values were different.

4.4.2. CTU EEPS vs VAN EEPS

From the recorded data it was observed that the activation time frame for both EEPSs were only in synch from passage number 250 to 291, in total of 42 passages during the afternoon of date- 24.06.2021.

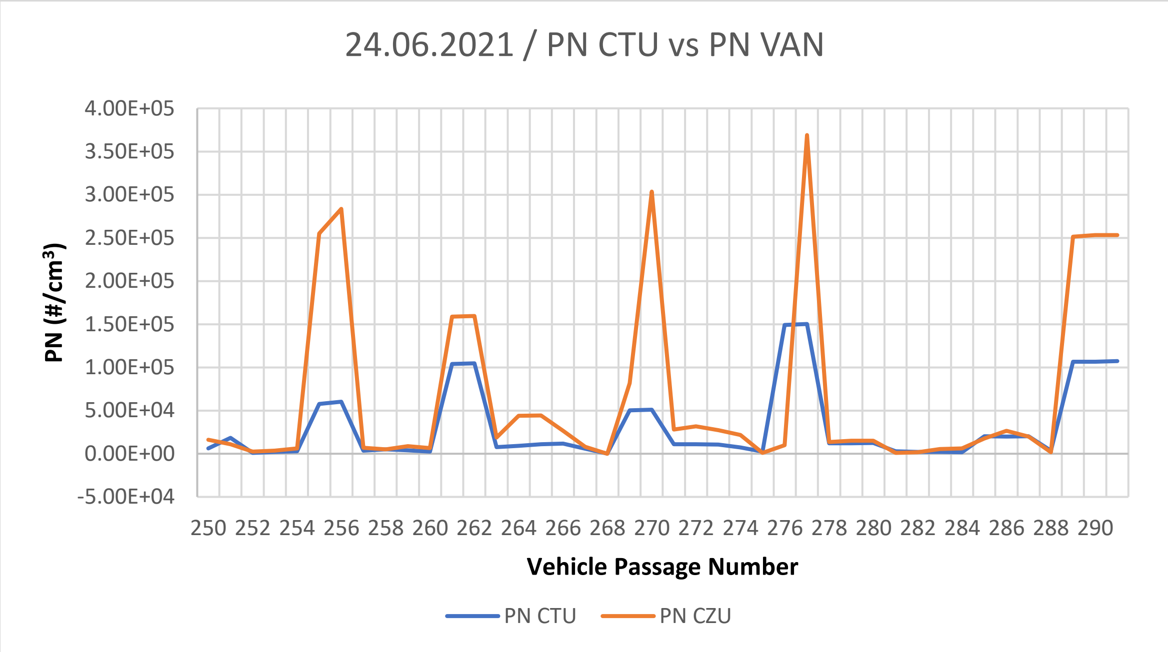

Fig 4I: Comparison of concentrations of PN for CTU and VAN EEPS on 24.06.2021

From the above figure 4I, it was observed that VAN EEPS was detecting higher concentrations of particulate matter with respect to CTU EEPS, but the shape of the graphs were similar in pattern.

For date- 25.06.2021, 99 passages were selected from passage number 416 to 514 for comparison.

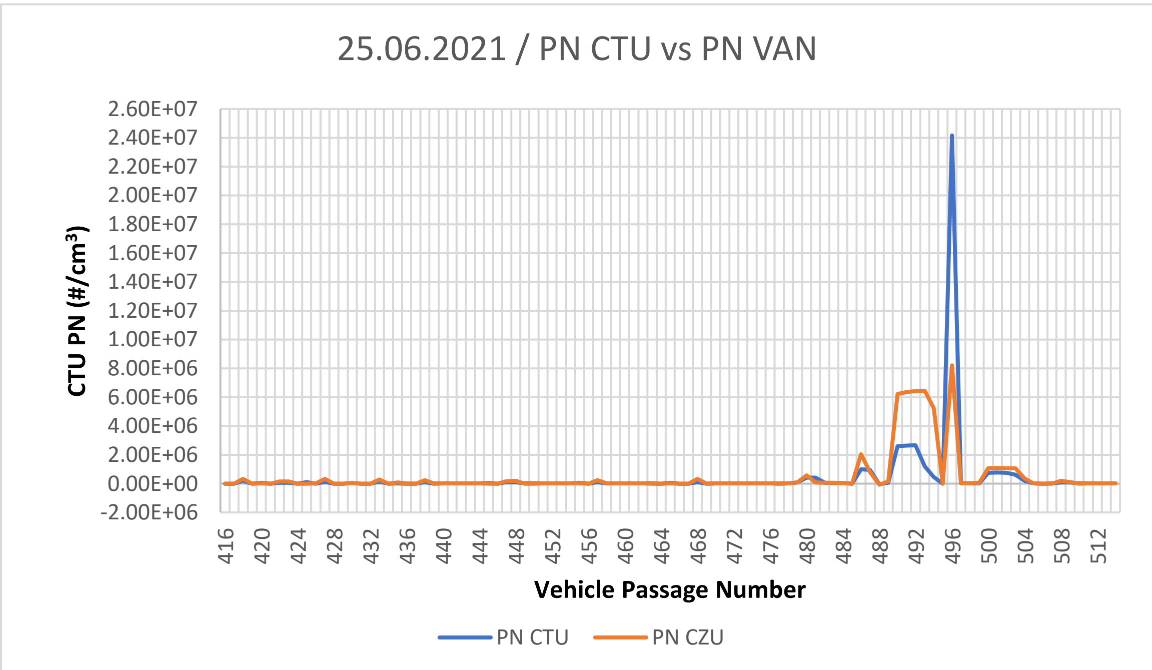

Fig 4J: Comparison of concentrations of PN for CTU and CZU EEPS on 25.06.2021

Similar scenario was observed in figure 4J for date 25.06.2021. VAN EEPS was able to detect higher concentrations of particulate matter with respect to CTU EEPS in most of the passages but as could be seen from the graph for some passages CTU EEPS was showing higher values. On observing the shape of the graphs, both EEPSs were showing similar pattern of the peaks.

4.4.3. CTU EEPS vs MSS^{Plus}

From the recorded data it was observed that MSS^{Plus} was active all day but as mentioned earlier, the data obtained shows inconsistency in recording. On further investigation it was found that most of the time MSS^{Plus} was detecting very less concentrations of soot particles. As MSS^{Plus} and CTU EEPS were sharing the same sampling line in same location, comparison was based on the particle mass concentrations in mg/m^3 for both the instruments were done. To illustrate this, comparison of diesel LCV passages which were detected as high emitters in table XXIV for CTU EEPS was compared with MSS^{Plus} are represented below-

Table XXXVII: Comparison for CTU EEPS and MSS^{Plus} based on particle mass concentrations

Pass. Nr.	**Vehicle Passage**	**CTU EEPS (mg/m^3)** [calculated PM]	**MSS^{Plus} (mg/m^3)** [Peak Cocnc. PM]
23	24.06.2021, 25, 10:02:35, veh: C, 12a 9	1.22E-01	6.20E-04
54	24.06.2021, 56, 10:20:04, veh: P, 12b 9	1.47E-01	1.02E-03
168	24.06.2021, 170, 11:46:16, veh: TR, 13c 9	2.85E-02	7.90E-04
496	25.06.2021, 83, 10:58:45, veh: TR, 20b 9.8	6.10E-02	1.05E-01
500	25.06.2021, 87, 11:01:45, veh: C, 20b 9.8	5.38E-04	5.26E-02

From the above table XXXVII, the mass concentrations of CTU EEPS was calculated considering each channels peak concentration. For passage numbers 23, 56 and 168, peak mass concentrations detected by MSS^{Plus} were considerably less as compared with the total calculated mass concentrations of

CTU EEPS. But for passage number 496 and 500, MSS^{Plus} was able to detect higher concentration than CTU EEPS.

Below graph shows the values in an illustrative way-

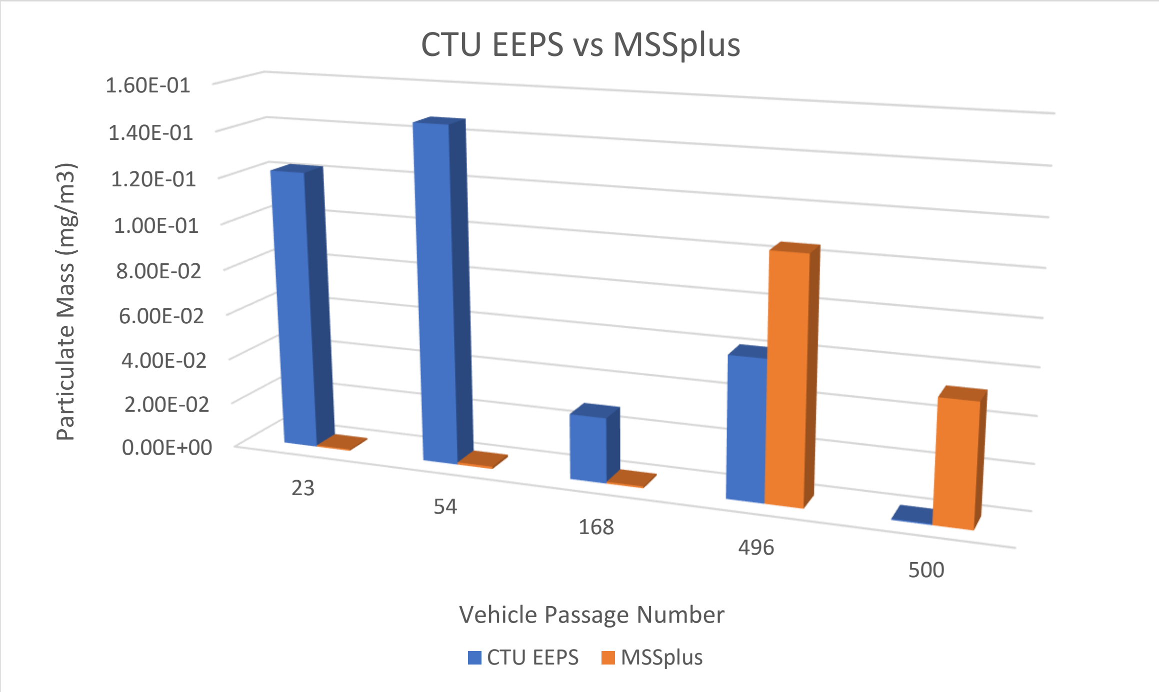

Fig 4K: Graphical comparison for CTU EEPS and MSS^{Plus} based on particle mass concentrations

MSS^{Plus} is a sensitive instrument capable to detect lowest soot concentrations. So, from the above results, it can be said that majority of particles (particle diameter) were more than photo-acoustic wavelength for which it was not able to detect much soot particles for passage number 23, 54 and 168.

4.5. Comparison based on Spacing between vehicles

During the experiment it was well understood that spacing between the vehicles was a key factor in detecting emissions effectively. From the obtained recorded data, all variables were calculated in the same time resolution- 5Hz and then were matched with the vehicle passages. It was observed that there was difficulty in distinguishing between the peaks of the emission with respect to vehicle when the spacing is less than 4 seconds. To illustrate this, comparison based on the detected concentrations of CTU FTIR and CZU FTIR for a set of vehicle passages on date- 25.06.2021 are represented below.

Table XXXVIII: Set of vehicles for comparison based on spacing between vehicles

Pass Nr.	Vehicle	Notations	Time	Time Gap (sec)
485	VW Caddy	C	10:51:45	-
486	VW Transporter	TR	10:52:00	15
487	VW Crafter	P	10:52:02	2
488	Ford F-Max	T	10:52:13	11
489	VW Touran	TN	10:52:22	9

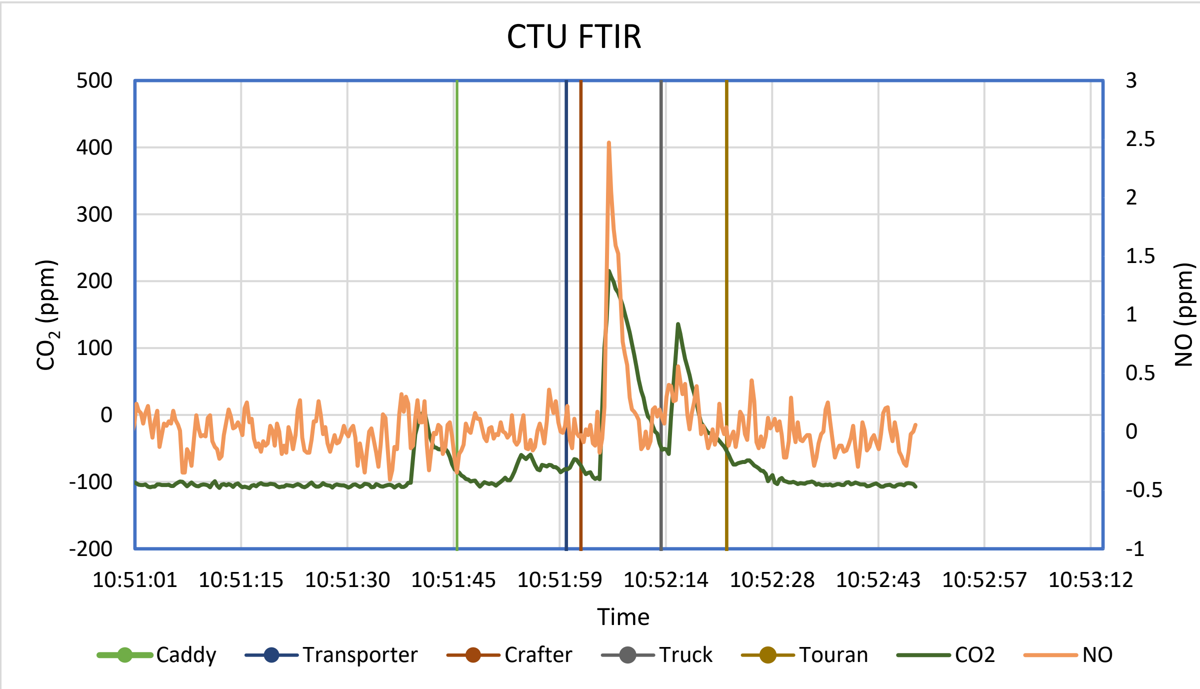

Fig 4L: Graphical representation of CO_2 and NO for CTU FTIR based on spacing

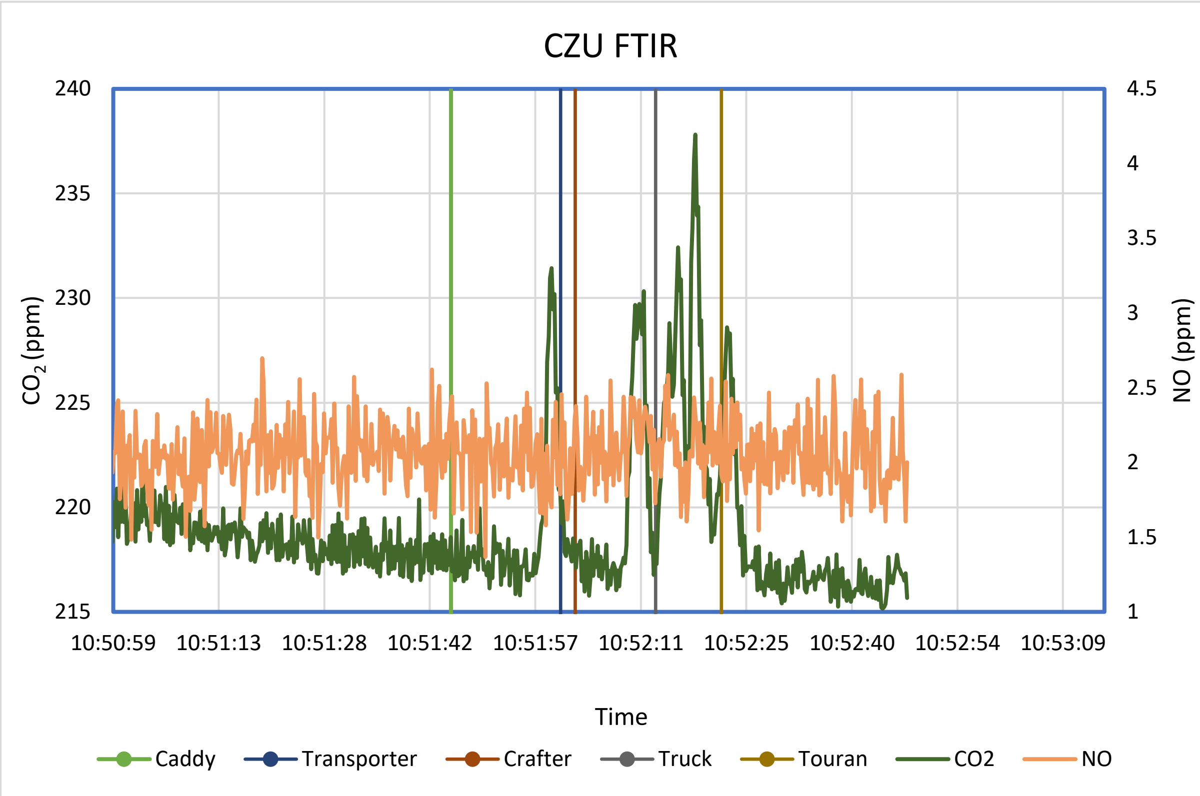

Fig 4M: Graphical representation of CO_2 and NO for CZU FTIR based on spacing

From the above table XXXVI, it was observed that VW Transporter was followed by VW crafter in a time gap of 2 seconds. These detections were plotted in graph and was represented in figures 4J and 4K. From the graph it was evident that there was difficulty in distinguishing peaks for VW Transporter (blue line in graph) and VW Crafter (red line in graph) from both the FTIRs. So, it can be said that there was interaction between the exhaust gases from both the vehicles.

5. Discussions & Conclusions

The main aim of this thesis was to find the high emitting passages with respect to test vehicles used by 'Remote Sensing' method. The pollutants considered in this study were NO_X and particulate matter. The data used for analysis were collected from H2020 project – 'City Air Remote Sensing' which was conducted in Lelystad, Netherlands. In this study, data from 24.06.2021 and 25.06.2021 were analyzed; in total of 629 vehicle passages. The concentration of NO (ppm) was measured from FTIR, and concentration of particulate matter was measured from EEPS ($\#/cm^3$) and MSS^{Plus} (mg/m^3) from two universities- CTU and CZU. The sampling line for CTU was placed on the middle of road on which the vehicle was allowed to pass and for CZU, sampling line was placed to the side of road. Sampling line of MSS^{Plus} was placed along with CTU instruments.

Limit of detection (LOD) and limit of quantification (LOQ) were calculated for each of the gases and particulate matter, described in section 3.2. For, CTU FTIR, the limits were higher to that of CZU FTIR and for CTU EEPS the limits were lower to VAN EEPS. The threshold limit for CO_2 was set based on its LOQ. For CTU, threshold of CO_2 was considered as 100ppm and for CZU, 20ppm. These threshold limit acts as a baseline for eliminating unwanted signals. If any passage shows concentration of CO_2 less than its threshold, it was not considered for analysis.

High emitting vehicle passages were determined from FTIR and EEPS data. MSS^{Plus} data was not considered as the instrument provided very inconsistent data, though it was active at all times. This was because of its sensitivity, sometimes pressure waves were produced when the tire of the vehicle passes over the sampling line which was interpreted as particle response by the microphone. So, to mitigate such effect a muffler has been installed, but the obtained results were not good enough. Also, in most of the vehicle passages MSS^{Plus} was detecting very low peak concentrations which might happen because majority of soot particles (particle size) were more than photo-acoustic wavelength for which it was not able to detect much soot particles for those passages. To understand this, a comparison was done in section 4.4.3 based on same sampling point location for the high emitting passage for diesel LCV. In case of EEPS, 25 channel sizes ranging from 6.04nm to 191.1nm were considered instead of all 32 channels because most of the data about the particles were contained in sizes up to 200nm. As evaluated in section 3.5.2, the particle share decreases as the channel size increases and adding to the fact, lower sizes of particles are a matter of concern because they can easily enter to respiratory system creating health risks.

The recorded data from all the instruments from both the universities were collected in different frequencies for which all data was resampled to 5Hz by linear interpolation method because of CTU FTIR, which was running at 1Hz on both days, it was easier to resample to 5Hz. Resampling to higher frequencies does not bring any added value as the process of mixing are rather slow and resampling to lower frequency could reduce the sensitivity for narrow spikes. So, 5Hz was a good trade-off offering very good resolution.

Emission Factor were calculated in grams per kilogram of fuel considering NO/CO_2 and PN/CO_2 ratios (calculated by linear regression method) which were shown in section 3.6. The calculated emission factors in table XII and XIII were for VW Crafter corresponding to date- 24.06.2021 at time- 14:44:34. Emission factors for NO obtained from CTU FTIR was 7.27g/kg$_{fuel}$ which was considerably less to that obtained from CZU FTIR which was 84.65g/kg$_{fuel}$. Similarly, emission factors for PN obtained from CTU EEPS was 2.81E+15#/kg$_{fuel}$ which was less to that obtained from VAN EEPS which was 4.93E+15#/kg$_{fuel}$. Though the exhaust tail pipe of VW Crafter was to the rear bottom which was supposed to detect higher concentrations of pollutants from CTU instruments (as sampling line was on middle of road), but the higher concentrations of pollutants were detected by CZU instruments (sampling line was to the side of road). In table XIV and XV, Emission factors for NO obtained for Ford F-Max (truck) corresponding to date- 24.06.2021 at time- 14:52:24, from CTU FTIR was 18.38g/kg_{fuel} or 4.6g/kWh which was higher to that obtained from CZU FTIR which was 9.01g/kg_{fuel} or 2.25g/kWh. Similarly, emission factors for PN obtained from CTU EEPS was 2.06E+13#/kg_{fuel} or 5.15E+12#/kWh which was less to that obtained from VAN EEPS which was 8.33E+13#/kg_{fuel} or 2.08E+13#/kWh. Though the exhaust tail pipe of truck was to the side which was supposed to detect higher concentrations of pollutants from CZU FTIR (sampling line was to side of road), higher concentrations of pollutants were detected by CTU instruments (sampling line was on middle of road). In table XVI and XVII, Emission factors for NO obtained for VW Transporter corresponding to date- 24.06.2021 at time- 14:55:55, from CTU FTIR was 15.98g/kg_{fuel} or 1.02g/km which was considerably less to that obtained from CZU FTIR which was 208.76g/kg_{fuel} or 13.31g/km. Similarly, emission factors for PN obtained from CTU EEPS was 3.84E+14#/kg_{fuel} or 2.45E+13#/km which was less to that obtained from VAN EEPS which was 9.60E+14#/kg_{fuel} or 6.12E+13#/km. Though the exhaust tail pipe of VW Transporter was to the rear bottom which was supposed to detect higher concentration of PN from CTU FTIR (sampling line was on middle of road), higher concentration of PN was detected by CZU instruments (sampling line was to side of road). But in case of concentration of NO it was the other way round.

The emission factor results of vehicle passages were evaluated and summarized in section 4.3 to detect high emitting and low emitting passages by the instruments from both universities. CTU FTIR was able to detect 148 passages whereas CZU FTIR was able to detect 111 passages and CTU EEPS was able to detect 135 passages whereas VAN EEPS was able to detect 34 passages. VAN EEPS detected less passages because the instrument was not active in most of the passages which can be seen in section 10.3 (for reference, the values corresponding to 'NA' represents the instrument was not active). Out of the total detected passages from individual instruments, CTU FTIR detected 22 high emitting NO_X passages while CZU FTIR detected 26 high emitting NO_X passages and CTU EEPS detected 59 high emitting PN passages while VAN EEPS detected 11 high emitting PN passages. In case of low emitting NO_X passages, CTU FTIR detected 18 passages while CZU FTIR detected 25 passages. There were no low emitting PN passages detected by both EEPS. From the high emitters it was found that vehicles corresponding to date 24.06.2021 at times- 10:58:24, 11:24:47 and 12:14:07 were the highest emitting passages detected by CTU FTIR; vehicles corresponding to date 24.06.2021 at times- 10:02:35, 10:20:04, 10:34:14, 10:34:25, 11:46:16, 12:02:21 and 12:10:28 were the highest emitting passages detected by CTU EEPS; vehicles corresponding to date 24.06.2021 at times- 09:48:59, 09:58:19, 10:35:28, 11:41:47 and 14:15:45 were the highest emitting passages detected by CZU FTIR; vehicles corresponding to date 24.06.2021 at time- 10:04:01 and date- 25.06.2021 at time- 14:44:39 were the highest emitting passages detected by VAN EEPS.

High emission of NO_X could be due to ineffectiveness of exhaust after-treatment device- SCR or installation of tampering devices or high in-cylinder temperature due to poor functioning of EGR or different operating conditions or poor maintenance of vehicle. For Ford F-Max (truck) switching off the SCR system was done purposefully. High emitting NO_X passages for truck was detected by CZU FTIR in higher values and CTU FTIR was also able to detect but in lower values which was shown in section 4.3.3.3. It was also found that, there were no common high emitting passages detected by both CTU FTIR and CZU FTIR for truck. One passage of VW Caddy corresponding to date-24.06.2021 at time- 11:34:23 was detected as high emitting passage by both CTU FTIR and CZU FTIR and on further investigation it was found out that the vehicle was in a time gap of 2 seconds with its previous vehicle. High emissions of PN could be due to tampering of exhaust after-treatment system-DPF or during cold start or regeneration of DPF , different operating conditions or poor maintenance of vehicle. For diesel LCV, bypassing of DPF was done purposefully. High emitting PN passages for diesel LCV was detected effectively by CTU EEPS rather than VAN EEPS. It was also found that there were no common high emitting passages detected by both CTU EEPS and VAN EEPS. On comparing the concentrations of PN for passages shown in section 4.2, it was observed that VAN EEPS was recording higher concentrations most of the time than CTU EEPS. On comparing the concentrations of NO for passages shown in section 4.1, it can be said that CTU FTIR was very inconsistent in recording the concentrations because was because the signals received were distorted and cannot be repaired.

Location of sampling point plays a very crucial role in detecting high emitters. Sampling point in the middle of the road is practically the best location but is prone to physical disturbances caused by passing vehicles and contact with water during rain, resulting in dilution. Whereas side road sampling point is the most effective way of collecting samples because this location is far away from any physical disturbances, but the problem is large distance between the vehicles tail pipe and sampling point causing probability of not detecting correct emissions. Also, spacing between the vehicle passages is important in determining the correct emissions from the vehicles. Based on this experiment, it was evident that low spacing can cause interference of the exhaust gases from the vehicles. In section 4.5, and it was observed that VW Transporter was followed by VW crafter in a time gap of 2 seconds. These detections were plotted in graph, and it was found that there was difficulty in distinguishing peaks for VW Transporter and VW Crafter from both the FTIRs. So, it can be said that there was interaction between the exhaust gases from both the vehicles.

Almost all the vehicle passages show emissions more than their respective emission standards. This creates a question of whether or not the emission norms as per the legislation were strictly followed by the vehicle manufacturers. In order to reduce air pollution, road transport vehicles should have clean emissions. This can be achieved if the vehicle manufacturers follow the emission standard limits set by the legislative bodies and vehicles on road should be periodically inspected. In addition to this the owner should regularly do necessary maintenance and servicing of their vehicles and not rely on any tampering methods or any after-market devices.

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7. List of Nomenclatures

CO : Carbon Monoxide

CO_2 : Carbon Dioxide

CTU : Czech Technical University

CZU : Czech University of Life Sciences

DEF : Diesel Exhaust Fluid

DPF : Diesel Particulate Filter

DSP : Digital Signal Processor

ECU : Electronic Circuit Unit

EEA : European Environment Agency

EEPS : Engine Exhaust Particle Sizer

EF : Emission Factor

EGR : Exhaust Gas Recirculation

EOBD : European On-Board Diagnostics

EU : European Union

FTIR : Fourier Transform Infrared Spectrum

HC : Hydrocarbon

HCCI : Homogeneous Charge Compression Ignition

HCLI : Homogeneous Charge Late Injection

HEPA : High Efficiency Particulate Air

HO2 : Hydrogen Dioxide

HPLI : Highly Premixed Late Injection

IR : Infrared Ray

LCV : Light-Commercial Vehicle

LNT : Lean NOX Trap

LOD : Limit of Detection

LOQ : Limit of Quantification

LPG : Liquified Petroleum Gas

LTC : Low Temperature Combustion

MSS^{plus} : Micro-Soot Sensor

N : Nitrogen

NA : Not Available

NH_3 : Ammonia

NO	: Nitric Oxide
NO_2	: Nitrogen Dioxide
NO_X	: Nitrogen Oxides
O_2	: Oxygen
OH	: Hydrogen Oxide
PCCI	: Premixed Charged Compression Ignition
PEMS	: Portable Emissions Measurement System
PM	: Particulate Mass
PM_{10}	: Particulate Matter with diameter >10 µm
$PM_{2.5}$	: Particulate Matter with diameter >2.5 µm
PN	: Particulate Number
R2	: Correlating Factor
RCCI	: Reaction Controlled Compression Ignition
SCR	: Selective Catalytic Reduction
UHC	: Unburnt Hydrocarbon
VOC	: Volatile Organic Compounds
WHO	: World Health Organisation

8. List of Tables

9. List of Figures

10. Appendix

10.1. Technical data of EEPS

SPECIFICATIONS	
Particle size range	5.6 to 560 nm
Particle size resolution	16 channels per decade (32 total)
Charger mode of operation	Unipolar diffusion charger
Time resolution	10 size distributions/sec
Sample flow	10 l/min
Sheath air	40 l/min
Inlet sample temperature	10 to 52°C
Operating temperature	0 to 40°C
Storage temperature	-20 to 50°C
Atmospheric pressure correction range	70 to 103 kPa (700 to 1034 mbar)
Humidity	0 to 90% RH (noncondensing)
User interface	Rotary knob and display; EEPS software
Computer requirements	Pentium® 4 processor, 2 GHz speed or better, at least 512 MB RAM
Operating system required	Windows® XP or better
Weight	32 kg
Sample inlet	3/8-in. Outer diameter (without inlet cyclone)
Cyclone inlet	3/8-in. Outer diameter
Exhaust/Outlet	3/8-in. Outer diameter
Power requirements	100 to 240 VAC, 50/60 Hz, 250W

10.2. Technical data of MSS[Plus]

MEASURING UNIT	
Measuring range	0.001 – 50 mg/m3
Measured value concentration of soot (mg/m3, µg/m3)	
Turndown ratio	01:50.0
(min:max concentration)	
Display resolution	0.01 mg/m3
Detection limit	1 µg/ m3
Data rate: digital / analog	up to 10Hz / 100 Hz
Rise time	(t10-t90) < 1 sec
Operation temperature	5°C to 40°C
Sample flow	~ 4 l/min
Interfaces	TCP/IP, RS232 with AK protocol, digital I/O and analog I/O
Power supply	90 - 240 V AC, 50/60 Hz, 400 VA
Laser class	Class 1 laser product
Unit dimensions	W x H x D
measuring unit	~ 19" x 5HU x 530mm
Unit weight measuring unit	~ 20 kg
CONDITIONING UNIT	
(Consists of conditioning unit, pressure reduction unit and dilution cell)	
Dilution ratio (DR)	Adjustable from 2 - 20
The actual DR will be displayed with the accuracy noted below	
Accuracy (DR display)	Max. +/- 2 + (DR*0.5)%
Pressurized air input	1 +/- 0.2 bar gauge pressure required
Flow	Min. 4 l/min
Exhaust gas temperature	Up to 1,000 °C
Exhaust gas back pressure	Up to 2,000 mbar
	(mean pressure)
Pressure pulsation	+/- 1,000 mbar, but max. 50% of exhaust gas back pressure (mean pressure)
Blow by amount of the pressure reduction unit depending on pressure	~ 40 l/min at 1,000 mbar exhaust gas pressure and 25°C
Power supply	90 - 240 V AC, 50/60 Hz, 500 VA
Dimensions conditioning unit	W x H x D
	~ 19" x 4HE x 530 mm
Weight conditioning unit	~15 kg

10.3. Emission Factor data sheet for vehicle passages

Nr.	Vehicle Passages	CTU FTIR EF_{NO} (g/kg_{fuel})	EF_{NO} shortlist	CZU FTIR EF_{NO} (g/kg_{fuel})	EF_{NO} shortlist	VAN EEPS EF_{PN} ($\#/kg_{fuel}$)	EF_{PN} shortlist	CTU EEPS EF_{PN} ($\#/kg_{fuel}$)	EF_{PN} shortlist
1	24.06.2021, 3, 09:48:24, veh: S, 12a 9	63.85	Weak Signal	118.88	Weak Signal	-NA-	Weak Signal	3.25E+13	Weak Signal
2	24.06.2021, 4, 09:48:35, veh: C, 12a 9	3.36	<LOD	359.60	Weak Signal	-NA-	Weak Signal	9.78E+13	9.78E+13
3	24.06.2021, 5, 09:48:47, veh: TR, 12a 9	-22.62	Weak Signal	174.15	Weak Signal	-NA-	Weak Signal	5.83E+12	Weak Signal
4	24.06.2021, 6, 09:48:49, veh: P, 12a 9	9.19	Weak Signal	616.10	Weak Signal	-NA-	Weak Signal	7.97E+13	Weak Signal
5	24.06.2021, 7, 09:48:59, veh: TR, 12a 9	90.10	Weak Signal	67.19	67.19	-NA-	-NA-	2.60E+14	Weak Signal
6	24.06.2021, 8, 09:49:13, veh: TN, 12a 9	-280.85	Weak Signal	232.48	Weak Signal	-NA-	Weak Signal	9.52E+14	Weak Signal
7	24.06.2021, 9, 09:49:25, veh: MB, 12a 9	25.53	Weak Signal	116.57	Weak Signal	-NA-	Weak Signal	1.22E+16	Weak Signal
8	24.06.2021, 10, 09:53:23, veh: S, 12a 9	-NA-	-NA-	33.83	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
9	24.06.2021, 11, 09:53:33, veh: C, 12a 9	-NA-	-NA-	94.97	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
10	24.06.2021, 12, 09:53:42, veh: TR, 12a 9	-NA-	-NA-	65.11	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
11	24.06.2021, 13, 09:53:44, veh: P, 12a 9	-NA-	-NA-	75.82	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
12	24.06.2021, 14, 09:53:55, veh: T, 12a 9	-NA-	-NA-	35.99	35.99	-NA-	-NA-	-NA-	-NA-
13	24.06.2021, 15, 09:54:04, veh: TN, 12a 9	-NA-	-NA-	674.94	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
14	24.06.2021, 16, 09:54:09, veh: MB, 12a 9	-NA-	-NA-	70.60	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
15	24.06.2021, 17, 09:57:47, veh: S, 12a 9	117.18	Weak Signal	72.03	Weak Signal	-NA-	Weak Signal	8.67E+15	Weak Signal
16	24.06.2021, 18, 09:57:54, veh: C, 12a 9	20.69	20.69	15.57	<LOD	-NA-	-NA-	3.10E+17	3.10E+17
17	24.06.2021, 19, 09:58:04, veh: TR, 12a 9	-33.52	Weak Signal	92.41	Weak Signal	-NA-	Weak Signal	9.78E+16	Weak Signal
18	24.06.2021, 20, 09:58:15, veh: T, 12a 9	109.19	Weak Signal	72.71	72.71	-NA-	-NA-	2.32E+14	Weak Signal
19	24.06.2021, 21, 09:58:19, veh: P, 12a 9	22.09	Weak Signal	78.23	78.23	-NA-	-NA-	1.01E+14	Weak Signal
20	24.06.2021, 22, 09:58:24, veh: TN, 12a 9	22.54	Weak Signal	5.45	<LOD	-NA-	-NA-	1.28E+15	Weak Signal
21	24.06.2021, 23, 09:58:30, veh: MB, 12a 9	-980.38	Weak Signal	25.33	<LOD	-NA-	-NA-	9.32E+14	Weak Signal
22	24.06.2021, 24, 10:02:26, veh: S, 12a 9	26.43	Weak Signal	115.55	Weak Signal	-NA-	Weak Signal	4.34E+16	Weak Signal
23	24.06.2021, 25, 10:02:35, veh: C, 12a 9	17.62	17.62	20.72	<LOD	-NA-	-NA-	2.98E+17	2.98E+17
24	24.06.2021, 26, 10:02:44, veh: TR, 12a 9	20.96	Weak Signal	60.36	Weak Signal	-NA-	Weak Signal	1.87E+16	Weak Signal
25	24.06.2021, 27, 10:02:55, veh: T, 12a 9	31.75	Weak Signal	65.35	65.35	-NA-	-NA-	6.16E+14	Weak Signal
26	24.06.2021, 28, 10:03:04, veh: TN, 12a 9	22.83	22.83	133.73	Weak Signal	-NA-	Weak Signal	1.23E+15	1.23E+15
27	24.06.2021, 29, 10:03:05, veh: P, 12a 9	22.12	22.12	70.79	Weak Signal	-NA-	Weak Signal	2.43E+15	2.43E+15
28	24.06.2021, 30, 10:03:11, veh: MB, 12a 9	-27.79	Weak Signal	33.73	<LOD	-NA-	-NA-	3.79E+13	Weak Signal
29	24.06.2021, 31, 10:07:07, veh: S, 12a 9	106.63	Weak Signal	151.02	Weak Signal	-NA-	Weak Signal	1.11E+16	Weak Signal

30	24.06.2021, 32, 10:07:14, veh: C, 12a 9	25.91	Weak Signal	36.48	Weak Signal	-NA-	Weak Signal	6.42E+17	Weak Signal
31	24.06.2021, 33, 10:07:16, veh: P, 12a 9	26.54	Weak Signal	47.62	Weak Signal	-NA-	Weak Signal	8.58E+17	Weak Signal
32	24.06.2021, 34, 10:07:25, veh: TR, 12a 9	32.97	Weak Signal	48.05	<LOD	-NA-	-NA-	4.25E+15	Weak Signal
33	24.06.2021, 35, 10:07:36, veh: T, 12a 9	20.83	20.83	56.80	56.80	-NA-	-NA-	3.36E+13	3.36E+13
34	24.06.2021, 36, 10:07:44, veh: TN, 12a 9	19.49	Weak Signal	74.41	Weak Signal	-NA-	Weak Signal	1.84E+15	Weak Signal
35	24.06.2021, 37, 10:07:50, veh: MB, 12a 9	-0.38	Weak Signal	53.69	Weak Signal	-NA-	Weak Signal	2.17E+14	Weak Signal
36	24.06.2021, 38, 10:11:23, veh: S, 12b 9	90.35	Weak Signal	433.97	Weak Signal	-NA-	Weak Signal	7.91E+13	Weak Signal
37	24.06.2021, 39, 10:11:28, veh: C, 12b 9	20.33	Weak Signal	165.29	Weak Signal	-NA-	Weak Signal	1.78E+14	Weak Signal
38	24.06.2021, 40, 10:11:30, veh: P, 12b 9	21.89	Weak Signal	84.54	Weak Signal	-NA-	Weak Signal	2.85E+14	Weak Signal
39	24.06.2021, 41, 10:11:33, veh: TR, 12b 9	11.47	Weak Signal	113.71	Weak Signal	-NA-	Weak Signal	3.41E+13	Weak Signal
40	24.06.2021, 42, 10:11:42, veh: T, 12b 9	17.98	17.98	51.89	51.89	-NA-	-NA-	4.32E+13	4.32E+13
41	24.06.2021, 43, 10:11:46, veh: TN, 12b 9	19.36	19.36	242.55	Weak Signal	-NA-	Weak Signal	1.23E+16	1.23E+16
42	24.06.2021, 44, 10:11:48, veh: MB, 12b 9	22.31	22.31	109.15	Weak Signal	-NA-	Weak Signal	1.07E+16	1.07E+16
43	24.06.2021, 45, 10:15:23, veh: S, 12b 9	30.59	Weak Signal	57.46	Weak Signal	-NA-	Weak Signal	6.42E+13	Weak Signal
44	24.06.2021, 46, 10:15:30, veh: C, 12b 9	43.41	Weak Signal	1474.27	Weak Signal	-NA-	Weak Signal	5.83E+14	Weak Signal
45	24.06.2021, 47, 10:15:35, veh: TR, 12b 9	23.60	Weak Signal	31.56	<LOD	-NA-	-NA-	4.40E+13	Weak Signal
46	24.06.2021, 48, 10:15:36, veh: P, 12b 9	20.98	Weak Signal	27.69	<LOD	-NA-	-NA-	3.39E+13	Weak Signal
47	24.06.2021, 49, 10:15:44, veh: T, 12b 9	47.68	Weak Signal	321.79	Weak Signal	-NA-	Weak Signal	6.00E+13	Weak Signal
48	24.06.2021, 50, 10:15:49, veh: TN, 12b 9	-4.93	<LOD	40.15	Weak Signal	-NA-	Weak Signal	1.31E+16	1.31E+16
49	24.06.2021, 51, 10:15:51, veh: MB, 12b 9	-11.41	Weak Signal	43.67	Weak Signal	-NA-	Weak Signal	8.60E+15	Weak Signal
50	24.06.2021, 52, 10:19:41, veh: S, 12b 9	64.90	Weak Signal	49.27	Weak Signal	-NA-	Weak Signal	2.98E+13	Weak Signal
51	24.06.2021, 53, 10:19:46, veh: C, 12b 9	20.51	Weak Signal	-783.67	Weak Signal	-NA-	Weak Signal	4.19E+14	Weak Signal
52	24.06.2021, 54, 10:19:51, veh: TR, 12b 9	34.80	Weak Signal	58.99	Weak Signal	-NA-	Weak Signal	3.63E+13	Weak Signal
53	24.06.2021, 55, 10:20:00, veh: T, 12b 9	-23.54	Weak Signal	90.38	90.38	-NA-	-NA-	1.53E+14	Weak Signal
54	24.06.2021, 56, 10:20:04, veh: P, 12b 9	9.77	9.77	3.76	<LOD	-NA-	-NA-	2.02E+16	2.02E+16
55	24.06.2021, 57, 10:20:05, veh: TN, 12b 9	8.72	8.72	4.54	<LOD	-NA-	-NA-	1.70E+16	1.70E+16
56	24.06.2021, 58, 10:20:09, veh: MB, 12b 9	-2.75	<LOD	14.67	<LOD	-NA-	-NA-	1.92E+16	1.92E+16
57	24.06.2021, 59, 10:23:37, veh: S, 12b 9	1.97	Weak Signal	72.70	Weak Signal	-NA-	Weak Signal	1.11E+14	Weak Signal
58	24.06.2021, 60, 10:23:40, veh: C, 12b 9	14.00	Weak Signal	31.17	Weak Signal	-NA-	Weak Signal	7.06E+14	Weak Signal
59	24.06.2021, 61, 10:23:46, veh: TR, 12b 9	24.11	Weak Signal	33.95	<LOD	-NA-	-NA-	5.00E+13	Weak Signal
60	24.06.2021, 62, 10:23:55, veh: T, 12b 9	-38.87	Weak Signal	82.54	82.54	-NA-	-NA-	1.81E+14	Weak Signal
61	24.06.2021, 63, 10:24:00, veh: TN, 12b 9	1.95	<LOD	58.62	<LOD	-NA-	-NA-	5.38E+15	5.38E+15

62	24.06.2021, 64, 10:24:02, veh: P, 12b 9	0.92	<LOD	59.32	Weak Signal	-NA-	Weak Signal	7.71E+15	7.71E+15
63	24.06.2021, 65, 10:24:04, veh: MB, 12b 9	3.65	<LOD	36.31	<LOD	-NA-	-NA-	9.08E+15	9.08E+15
64	24.06.2021, 66, 10:28:26, veh: S, 12c 9	17.72	Weak Signal	12.41	<LOD	-NA-	-NA-	7.28E+14	Weak Signal
65	24.06.2021, 67, 10:28:27, veh: C, 12c 9	14.94	Weak Signal	4.50	<LOD	-NA-	-NA-	9.70E+14	Weak Signal
66	24.06.2021, 68, 10:28:28, veh: P, 12c 9	15.06	15.06	41.11	Weak Signal	-NA-	Weak Signal	5.95E+14	5.95E+14
67	24.06.2021, 69, 10:28:31, veh: TR, 12c 9	11.60	11.60	99.18	99.18	-NA-	-NA-	1.73E+14	1.73E+14
68	24.06.2021, 70, 10:28:34, veh: T, 12c 9	-239.74	Weak Signal	96.71	96.71	-NA-	-NA-	1.35E+14	Weak Signal
69	24.06.2021, 71, 10:28:38, veh: TN, 12c 9	22.02	Weak Signal	453.74	Weak Signal	-NA-	Weak Signal	5.84E+15	Weak Signal
70	24.06.2021, 72, 10:28:40, veh: MB, 12c 9	20.47	Weak Signal	38.97	<LOD	-NA-	-NA-	6.96E+15	Weak Signal
71	24.06.2021, 73, 10:31:59, veh: S, 12c 9	12.96	Weak Signal	158.69	Weak Signal	-NA-	Weak Signal	6.89E+14	Weak Signal
72	24.06.2021, 74, 10:32:00, veh: C, 12c 9	21.55	Weak Signal	165.79	Weak Signal	-NA-	Weak Signal	5.25E+14	Weak Signal
73	24.06.2021, 75, 10:32:02, veh: TR, 12c 9	19.59	Weak Signal	592.42	Weak Signal	-NA-	Weak Signal	4.16E+14	Weak Signal
74	24.06.2021, 76, 10:32:04, veh: P, 12c 9	19.62	Weak Signal	40.03	40.03	-NA-	-NA-	7.44E+13	Weak Signal
75	24.06.2021, 77, 10:32:08, veh: T, 12c 9	14.73	14.73	39.47	39.47	-NA-	-NA-	7.59E+13	7.59E+13
76	24.06.2021, 78, 10:32:11, veh: TN, 12c 9	16.90	16.90	116.80	Weak Signal	-NA-	Weak Signal	7.15E+15	7.15E+15
77	24.06.2021, 79, 10:32:13, veh: MB, 12c 9	16.71	16.71	74.47	Weak Signal	-NA-	Weak Signal	1.03E+16	1.03E+16
78	24.06.2021, 80, 10:35:28, veh: S, 12c 9	17.66	17.66	68.98	68.98	-NA-	-NA-	2.80E+14	2.80E+14
79	24.06.2021, 81, 10:35:29, veh: C, 12c 9	18.07	18.07	69.82	69.82	-NA-	-NA-	2.85E+14	2.85E+14
80	24.06.2021, 82, 10:35:30, veh: TR, 12c 9	18.49	18.49	68.31	68.31	-NA-	-NA-	2.91E+14	2.91E+14
81	24.06.2021, 83, 10:35:34, veh: T, 12c 9	27.42	Weak Signal	69.95	69.95	-NA-	-NA-	1.42E+14	Weak Signal
82	24.06.2021, 84, 10:35:36, veh: P, 12c 9	-38.41	Weak Signal	70.57	70.57	-NA-	-NA-	1.38E+14	Weak Signal
83	24.06.2021, 85, 10:35:40, veh: TN, 12c 9	0.18	<LOD	101.22	Weak Signal	-NA-	Weak Signal	3.99E+15	3.99E+15
84	24.06.2021, 86, 10:35:42, veh: MB, 12c 9	3.54	<LOD	34.65	Weak Signal	-NA-	Weak Signal	7.71E+15	7.71E+15
85	24.06.2021, 87, 10:39:14, veh: S, 12c 9	21.10	21.10	654.01	Weak Signal	-NA-	Weak Signal	4.98E+14	4.98E+14
86	24.06.2021, 88, 10:39:15, veh: C, 12c 9	20.34	20.34	-250.06	Weak Signal	-NA-	Weak Signal	3.67E+14	3.67E+14
87	24.06.2021, 89, 10:39:17, veh: TR, 12c 9	11.27	Weak Signal	55.11	Weak Signal	-NA-	Weak Signal	1.46E+15	Weak Signal
88	24.06.2021, 90, 10:39:21, veh: T, 12c 9	22.24	22.24	85.41	<LOD	-NA-	-NA-	5.16E+13	5.16E+13
89	24.06.2021, 91, 10:39:25, veh: TN, 12c 9	13.97	13.97	72.77	72.77	-NA-	-NA-	6.54E+15	6.54E+15
90	24.06.2021, 92, 10:39:26, veh: P, 12c 9	15.25	15.25	78.69	Weak Signal	-NA-	Weak Signal	7.04E+15	7.04E+15
91	24.06.2021, 93, 10:39:28, veh: MB, 12c 9	12.74	12.74	61.16	Weak Signal	-NA-	Weak Signal	3.20E+15	3.20E+15
92	24.06.2021, 94, 10:57:51, veh: MB, 13a 9	24.89	Weak Signal	238.08	Weak Signal	-NA-	Weak Signal	1.48E+14	Weak Signal
93	24.06.2021, 95, 10:58:03, veh: T, 13a 9	37.05	Weak Signal	71.26	71.26	-NA-	-NA-	3.23E+14	Weak Signal

94	24.06.2021, 96, 10:58:08, veh: P, 13a 9	21.99	Weak Signal	587.65	Weak Signal	-NA-	Weak Signal	2.59E+13	Weak Signal
95	24.06.2021, 97, 10:58:14, veh: TR, 13a 9	387.25	Weak Signal	94.64	Weak Signal	-NA-	Weak Signal	1.85E+14	Weak Signal
96	24.06.2021, 98, 10:58:24, veh: TN, 13a 9	20.17	20.17	96.42	Weak Signal	-NA-	Weak Signal	3.48E+15	3.48E+15
97	24.06.2021, 99, 10:58:33, veh: C, 13a 9	-7.78	Weak Signal	323.18	Weak Signal	-NA-	Weak Signal	3.77E+14	Weak Signal
98	24.06.2021, 100, 10:58:40, veh: S, 13a 9	48.26	Weak Signal	4193.25	Weak Signal	-NA-	Weak Signal	7.53E+13	Weak Signal
99	24.06.2021, 101, 11:02:05, veh: MB, 13a 9	19.09	Weak Signal	548.45	Weak Signal	-NA-	Weak Signal	4.38E+13	Weak Signal
100	24.06.2021, 102, 11:02:16, veh: T, 13a 9	15.10	15.10	712.64	Weak Signal	-NA-	Weak Signal	2.27E+13	2.27E+13
101	24.06.2021, 103, 11:02:24, veh: TR, 13a 9	16.81	Weak Signal	405.26	Weak Signal	-NA-	Weak Signal	1.08E+14	Weak Signal
102	24.06.2021, 104, 11:02:26, veh: P, 13a 9	6.52	Weak Signal	829.06	Weak Signal	-NA-	Weak Signal	2.09E+14	Weak Signal
103	24.06.2021, 105, 11:02:34, veh: TN, 13a 9	1.71	<LOD	50.08	Weak Signal	-NA-	Weak Signal	3.04E+15	3.04E+15
104	24.06.2021, 106, 11:02:40, veh: C, 13a 9	-39.79	Weak Signal	1179.02	Weak Signal	-NA-	Weak Signal	1.45E+14	Weak Signal
105	24.06.2021, 107, 11:06:16, veh: S, 13a 9	118.64	Weak Signal	445.65	Weak Signal	-NA-	Weak Signal	1.63E+14	Weak Signal
106	24.06.2021, 108, 11:06:16, veh: MB, 13a 9	118.64	Weak Signal	445.65	Weak Signal	-NA-	Weak Signal	1.63E+14	Weak Signal
107	24.06.2021, 109, 11:06:27, veh: T, 13a 9	29.65	Weak Signal	115.31	115.31	-NA-	-NA-	8.03E+13	Weak Signal
108	24.06.2021, 110, 11:06:36, veh: TR, 13a 9	21.86	Weak Signal	48.07	<LOD	-NA-	-NA-	9.80E+13	Weak Signal
109	24.06.2021, 111, 11:06:46, veh: TN, 13a 9	-6.14	<LOD	66.34	Weak Signal	-NA-	Weak Signal	4.57E+15	4.57E+15
110	24.06.2021, 112, 11:06:47, veh: P, 13a 9	-4.47	<LOD	64.98	Weak Signal	-NA-	Weak Signal	6.37E+15	6.37E+15
111	24.06.2021, 113, 11:06:52, veh: C, 13a 9	-50.32	Weak Signal	56.91	Weak Signal	-NA-	Weak Signal	9.40E+13	Weak Signal
112	24.06.2021, 114, 11:11:12, veh: MB, 13a 9	56.99	Weak Signal	26.47	<LOD	-NA-	-NA-	7.57E+13	Weak Signal
113	24.06.2021, 115, 11:11:23, veh: T, 13a 9	16.33	16.33	106.01	Weak Signal	-NA-	Weak Signal	2.79E+13	2.79E+13
114	24.06.2021, 116, 11:11:31, veh: TR, 13a 9	19.78	Weak Signal	167.94	Weak Signal	-NA-	Weak Signal	9.11E+13	Weak Signal
115	24.06.2021, 117, 11:11:42, veh: TN, 13a 9	-7.31	<LOD	-3092.04	Weak Signal	-NA-	Weak Signal	5.74E+15	5.74E+15
116	24.06.2021, 118, 11:11:47, veh: C, 13a 9	-39.38	Weak Signal	111.84	Weak Signal	-NA-	Weak Signal	5.85E+13	Weak Signal
117	24.06.2021, 119, 11:11:49, veh: P, 13a 9	-58.78	Weak Signal	125.51	Weak Signal	-NA-	Weak Signal	2.80E+14	Weak Signal
118	24.06.2021, 120, 11:16:54, veh: MB, 13b 9	20.56	Weak Signal	139.06	139.06	-NA-	-NA-	1.05E+14	Weak Signal
119	24.06.2021, 121, 11:17:02, veh: T, 13b 9	13.73	13.73	71.82	71.82	-NA-	-NA-	5.97E+13	5.97E+13
120	24.06.2021, 122, 11:17:07, veh: P, 13b 9	19.82	Weak Signal	76.62	76.62	-NA-	-NA-	-9.01E+11	Weak Signal
121	24.06.2021, 123, 11:17:09, veh: TR, 13b 9	-179.02	Weak Signal	71.64	71.64	-NA-	-NA-	8.34E+13	Weak Signal
122	24.06.2021, 124, 11:17:13, veh: TN, 13b 9	9.92	Weak Signal	15.83	<LOD	-NA-	-NA-	3.24E+15	Weak Signal
123	24.06.2021, 125, 11:17:17, veh: C, 13b 9	-9.45	<LOD	11.55	<LOD	-NA-	-NA-	4.47E+15	4.47E+15
124	24.06.2021, 126, 11:20:40, veh: MB, 13b 9	24.70	Weak Signal	1001.08	Weak Signal	-NA-	Weak Signal	8.24E+13	Weak Signal
125	24.06.2021, 127, 11:20:48, veh: T, 13b 9	15.67	15.67	126.95	Weak Signal	-NA-	Weak Signal	4.82E+13	4.82E+13

126	24.06.2021, 128, 11:20:53, veh: TR, 13b 9	15.20	15.20	86.49	Weak Signal	-NA-	Weak Signal	-2.64E+13	-2.64E+13
127	24.06.2021, 129, 11:20:55, veh: P, 13b 9	7.84	Weak Signal	-2610.42	Weak Signal	-NA-	Weak Signal	-3.63E+13	Weak Signal
128	24.06.2021, 130, 11:21:00, veh: TN, 13b 9	-4.56	Weak Signal	8.20	<LOD	-NA-	-NA-	3.75E+15	Weak Signal
129	24.06.2021, 131, 11:21:03, veh: C, 13b 9	-2.13	Weak Signal	161.84	Weak Signal	-NA-	Weak Signal	7.97E+15	Weak Signal
130	24.06.2021, 132, 11:21:06, veh: S, 13b 9	573.95	Weak Signal	100.28	Weak Signal	-NA-	Weak Signal	8.09E+14	Weak Signal
131	24.06.2021, 133, 11:24:34, veh: MB, 13b 9	30.23	Weak Signal	211.98	Weak Signal	-NA-	Weak Signal	1.30E+14	Weak Signal
132	24.06.2021, 134, 11:24:41, veh: T, 13b 9	15.26	15.26	44.07	<LOD	-NA-	-NA-	7.67E+13	7.67E+13
133	24.06.2021, 135, 11:24:47, veh: TR, 13b 9	21.30	21.30	122.59	Weak Signal	-NA-	Weak Signal	-2.46E+13	-2.46E+13
134	24.06.2021, 136, 11:24:52, veh: TN, 13b 9	8.02	Weak Signal	23.61	Weak Signal	-NA-	Weak Signal	3.26E+15	Weak Signal
135	24.06.2021, 137, 11:24:54, veh: P, 13b 9	-10.38	<LOD	33.21	Weak Signal	-NA-	Weak Signal	6.17E+15	6.17E+15
136	24.06.2021, 138, 11:24:57, veh: C, 13b 9	31.08	Weak Signal	29.15	Weak Signal	-NA-	Weak Signal	1.16E+15	Weak Signal
137	24.06.2021, 139, 11:24:59, veh: S, 13b 9	-138.22	Weak Signal	24.46	Weak Signal	-NA-	Weak Signal	1.17E+15	Weak Signal
138	24.06.2021, 140, 11:29:45, veh: MB, 13b 9	21.53	Weak Signal	296.15	Weak Signal	-NA-	Weak Signal	2.05E+14	Weak Signal
139	24.06.2021, 141, 11:29:52, veh: T, 13b 9	14.78	14.78	207.96	Weak Signal	-NA-	Weak Signal	2.37E+13	2.37E+13
140	24.06.2021, 142, 11:29:58, veh: TR, 13b 9	27.50	Weak Signal	-1311.43	Weak Signal	-NA-	Weak Signal	-2.04E+13	Weak Signal
141	24.06.2021, 143, 11:30:03, veh: TN, 13b 9	-2.29	Weak Signal	62.56	Weak Signal	-NA-	Weak Signal	2.46E+15	Weak Signal
142	24.06.2021, 144, 11:30:07, veh: C, 13b 9	1.94	Weak Signal	14.87	<LOD	-NA-	-NA-	-2.26E+16	Weak Signal
143	24.06.2021, 145, 11:30:08, veh: P, 13b 9	40.36	Weak Signal	23.74	<LOD	-NA-	-NA-	-1.34E+16	Weak Signal
144	24.06.2021, 146, 11:30:11, veh: S, 13b 9	-88.45	Weak Signal	28.08	<LOD	-NA-	-NA-	5.26E+16	Weak Signal
145	24.06.2021, 147, 11:34:08, veh: MB, 13c 9	38.63	Weak Signal	38.27	38.27	-NA-	-NA-	8.30E+13	Weak Signal
146	24.06.2021, 148, 11:34:12, veh: T, 13c 9	13.99	Weak Signal	37.74	37.74	-NA-	-NA-	1.15E+14	Weak Signal
147	24.06.2021, 149, 11:34:17, veh: P, 13c 9	22.87	Weak Signal	16.46	16.46	-NA-	-NA-	3.09E+17	Weak Signal
148	24.06.2021, 150, 11:34:19, veh: TR, 13c 9	18.72	18.72	38.64	38.64	-NA-	-NA-	2.79E+17	2.79E+17
149	24.06.2021, 151, 11:34:21, veh: TN, 13c 9	18.72	18.72	36.72	36.72	-NA-	-NA-	1.32E+17	1.32E+17
150	24.06.2021, 152, 11:34:23, veh: C, 13c 9	17.69	17.69	36.27	36.27	-NA-	-NA-	-NA-	-NA-
151	24.06.2021, 153, 11:34:25, veh: S, 13c 9	16.30	16.30	32.29	<LOD	-NA-	-NA-	-NA-	-NA-
152	24.06.2021, 154, 11:38:00, veh: MB, 13c 9	1886.50	Weak Signal	65.41	65.41	-NA-	-NA-	1.22E+14	Weak Signal
153	24.06.2021, 155, 11:38:04, veh: T, 13c 9	55.36	Weak Signal	65.25	65.25	-NA-	-NA-	2.15E+14	Weak Signal
154	24.06.2021, 156, 11:38:09, veh: TR, 13c 9	38.89	Weak Signal	5.24	<LOD	-NA-	-NA-	1.53E+17	Weak Signal
155	24.06.2021, 157, 11:38:11, veh: P, 13c 9	12.06	12.06	3.97	<LOD	-NA-	-NA-	5.77E+16	5.77E+16
156	24.06.2021, 158, 11:38:13, veh: TN, 13c 9	8.47	8.47	3.64	<LOD	-NA-	-NA-	4.85E+16	4.85E+16
157	24.06.2021, 159, 11:38:15, veh: C, 13c 9	-4.28	<LOD	8.06	<LOD	-NA-	-NA-	1.41E+16	1.41E+16

158	24.06.2021, 160, 11:38:17, veh: S, 13c 9	2.07	<LOD	16.26	<LOD	-NA-	-NA-	1.41E+15	1.41E+15
159	24.06.2021, 161, 11:41:47, veh: MB, 13c 9	32.45	Weak Signal	76.04	76.04	-NA-	-NA-	3.11E+14	Weak Signal
160	24.06.2021, 162, 11:41:52, veh: T, 13c 9	21.27	Weak Signal	76.79	76.79	-NA-	-NA-	-1.37E+14	Weak Signal
161	24.06.2021, 163, 11:41:56, veh: TR, 13c 9	8.89	8.89	18.28	<LOD	-NA-	-NA-	7.73E+15	7.73E+15
162	24.06.2021, 164, 11:41:58, veh: TN, 13c 9	6.76	6.76	18.71	<LOD	-NA-	-NA-	2.77E+15	2.77E+15
163	24.06.2021, 165, 11:42:00, veh: P, 13c 9	-3.41	<LOD	10.98	<LOD	-NA-	-NA-	8.37E+15	8.37E+15
164	24.06.2021, 166, 11:42:02, veh: C, 13c 9	0.73	Weak Signal	27.05	<LOD	-NA-	-NA-	1.14E+16	Weak Signal
165	24.06.2021, 167, 11:42:03, veh: S, 13c 9	17.90	Weak Signal	27.50	<LOD	-NA-	-NA-	3.49E+16	Weak Signal
166	24.06.2021, 168, 11:46:09, veh: MB, 13c 9	22.68	Weak Signal	64.07	64.07	-NA-	-NA-	1.72E+14	Weak Signal
167	24.06.2021, 169, 11:46:12, veh: T, 13c 9	127.46	Weak Signal	64.85	64.85	-NA-	-NA-	1.30E+14	Weak Signal
168	24.06.2021, 170, 11:46:16, veh: TR, 13c 9	3.86	<LOD	5.40	<LOD	-NA-	-NA-	9.79E+15	9.79E+15
169	24.06.2021, 171, 11:46:18, veh: TN, 13c 9	3.13	<LOD	7.56	7.56	-NA-	-NA-	2.03E+15	2.03E+15
170	24.06.2021, 172, 11:46:19, veh: C, 13c 9	3.56	<LOD	8.19	8.19	-NA-	-NA-	2.42E+15	2.42E+15
171	24.06.2021, 173, 11:46:21, veh: P, 13c 9	6.96	6.96	9.74	9.74	-NA-	-NA-	2.36E+15	2.36E+15
172	24.06.2021, 174, 11:46:24, veh: S, 13c 9	12.57	12.57	31.14	<LOD	-NA-	-NA-	4.68E+14	4.68E+14
173	24.06.2021, 175, 12:02:21, veh: MB, 14a 9	11.89	11.89	-NA-	-NA-	-NA-	-NA-	6.11E+14	6.11E+14
174	24.06.2021, 176, 12:02:35, veh: T, 14a 9	15.16	15.16	-NA-	-NA-	-NA-	-NA-	1.69E+13	1.69E+13
175	24.06.2021, 177, 12:02:38, veh: P, 14a 9	14.97	14.97	-NA-	-NA-	-NA-	-NA-	3.81E+13	3.81E+13
176	24.06.2021, 178, 12:02:49, veh: TR, 14a 9	22.48	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.59E+14	Weak Signal
177	24.06.2021, 179, 12:03:01, veh: TN, 14a 9	4.50	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.53E+15	Weak Signal
178	24.06.2021, 180, 12:03:10, veh: C, 14a 9	55.82	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.66E+14	Weak Signal
179	24.06.2021, 181, 12:03:18, veh: S, 14a 9	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-
180	24.06.2021, 182, 12:06:14, veh: MB, 14a 9	8.30	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.15E+14	Weak Signal
181	24.06.2021, 183, 12:06:26, veh: T, 14a 9	20.63	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.29E+13	Weak Signal
182	24.06.2021, 184, 12:06:36, veh: TR, 14a 9	26.89	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.23E+13	Weak Signal
183	24.06.2021, 185, 12:06:44, veh: TN, 14a 9	-9.03	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.11E+15	Weak Signal
184	24.06.2021, 186, 12:06:46, veh: P, 14a 9	-14.55	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.02E+16	Weak Signal
185	24.06.2021, 187, 12:06:54, veh: C, 14a 9	83.30	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.05E+14	Weak Signal
186	24.06.2021, 188, 12:07:00, veh: S, 14a 9	99.86	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.83E+13	Weak Signal
187	24.06.2021, 189, 12:10:16, veh: MB, 14a 9	-2.24	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.14E+13	Weak Signal
188	24.06.2021, 190, 12:10:28, veh: T, 14a 9	26.92	26.92	-NA-	-NA-	-NA-	-NA-	1.06E+14	1.06E+14
189	24.06.2021, 191, 12:10:38, veh: TR, 14a 9	22.07	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.27E+13	Weak Signal

190	24.06.2021, 192, 12:10:47, veh: TN, 14a 9	-4.55	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.45E+15	Weak Signal
191	24.06.2021, 193, 12:10:54, veh: C, 14a 9	88.90	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.96E+14	Weak Signal
192	24.06.2021, 194, 12:10:56, veh: P, 14a 9	35.57	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.21E+14	Weak Signal
193	24.06.2021, 195, 12:11:04, veh: S, 14a 9	-103.51	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.17E+14	Weak Signal
194	24.06.2021, 196, 12:13:55, veh: MB, 14a 9	2.25	<LOD	-NA-	-NA-	-NA-	-NA-	2.37E+14	2.37E+14
195	24.06.2021, 197, 12:14:07, veh: T, 14a 9	19.24	19.24	-NA-	-NA-	-NA-	-NA-	5.27E+13	5.27E+13
196	24.06.2021, 198, 12:14:16, veh: TR, 14a 9	25.83	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.62E+13	Weak Signal
197	24.06.2021, 199, 12:14:18, veh: P, 14a 9	21.72	21.72	-NA-	-NA-	-NA-	-NA-	8.60E+13	8.60E+13
198	24.06.2021, 200, 12:14:26, veh: TN, 14a 9	-14.41	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.42E+15	Weak Signal
199	24.06.2021, 201, 12:14:34, veh: C, 14a 9	332.39	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.62E+14	Weak Signal
200	24.06.2021, 202, 12:14:48, veh: S, 14a 9	28.89	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.98E+14	Weak Signal
201	24.06.2021, 203, 12:18:16, veh: MB, 14a 9	-1.92	Weak Signal	-NA-	-NA-	-NA-	-NA-	8.61E+13	Weak Signal
202	24.06.2021, 204, 12:18:27, veh: T, 14a 9	27.07	Weak Signal	-NA-	-NA-	-NA-	-NA-	8.36E+13	Weak Signal
203	24.06.2021, 205, 12:18:38, veh: TR, 14a 9	27.86	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.17E+14	Weak Signal
204	24.06.2021, 206, 12:18:46, veh: C, 14a 9	15.82	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.07E+14	Weak Signal
205	24.06.2021, 207, 12:18:47, veh: P, 14a 9	14.91	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.62E+14	Weak Signal
206	24.06.2021, 208, 12:18:54, veh: TN, 14a 9	8.80	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.05E+15	Weak Signal
207	24.06.2021, 209, 12:19:02, veh: S, 14a 9	-196.73	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.10E+14	Weak Signal
208	24.06.2021, 3, 14:15:15, veh: S, 15a 9	19.36	Weak Signal	506.51	Weak Signal	-NA-	Weak Signal	1.93E+14	Weak Signal
209	24.06.2021, 4, 14:15:22, veh: C, 15a 9	30.10	Weak Signal	46.68	Weak Signal	-NA-	Weak Signal	7.46E+14	Weak Signal
210	24.06.2021, 5, 14:15:24, veh: P, 15a 9	24.23	Weak Signal	35.91	Weak Signal	-NA-	Weak Signal	9.33E+14	Weak Signal
211	24.06.2021, 6, 14:15:33, veh: TR, 15a 9	15.33	Weak Signal	60.92	Weak Signal	-NA-	Weak Signal	9.96E+13	Weak Signal
212	24.06.2021, 7, 14:15:45, veh: T, 15a 9	206.00	Weak Signal	102.97	102.97	-NA-	-NA-	2.61E+14	Weak Signal
213	24.06.2021, 8, 14:15:53, veh: TN, 15a 9	39.77	Weak Signal	38.78	Weak Signal	-NA-	Weak Signal	3.99E+15	Weak Signal
214	24.06.2021, 9, 14:15:57, veh: MB, 15a 9	39.10	Weak Signal	78.76	Weak Signal	-NA-	Weak Signal	3.54E+15	Weak Signal
215	24.06.2021, 10, 14:19:26, veh: S, 15a 9	24.00	Weak Signal	30.80	<LOD	-NA-	-NA-	2.33E+14	Weak Signal
216	24.06.2021, 11, 14:19:35, veh: C, 15a 9	30.38	Weak Signal	1496.30	Weak Signal	-NA-	Weak Signal	4.80E+14	Weak Signal
217	24.06.2021, 12, 14:19:42, veh: TR, 15a 9	19.27	Weak Signal	21.26	<LOD	-NA-	-NA-	6.14E+13	Weak Signal
218	24.06.2021, 13, 14:19:44, veh: P, 15a 9	18.40	18.40	20.16	<LOD	-NA-	-NA-	7.15E+13	7.15E+13
219	24.06.2021, 14, 14:19:56, veh: T, 15a 9	33.89	Weak Signal	7.00	7.00	-NA-	-NA-	2.45E+14	Weak Signal
220	24.06.2021, 15, 14:20:03, veh: TN, 15a 9	65.28	Weak Signal	165.17	Weak Signal	-NA-	Weak Signal	1.80E+15	Weak Signal
221	24.06.2021, 16, 14:20:10, veh: MB, 15a 9	39.29	Weak Signal	55.79	Weak Signal	-NA-	Weak Signal	2.07E+14	Weak Signal

222	24.06.2021, 17, 14:23:32, veh: S, 15a 9	53.53	Weak Signal	558.77	Weak Signal	-NA-	Weak Signal	4.03E+14	Weak Signal
223	24.06.2021, 18, 14:23:40, veh: C, 15a 9	55.30	Weak Signal	629.03	Weak Signal	-NA-	Weak Signal	1.37E+14	Weak Signal
224	24.06.2021, 19, 14:23:48, veh: TR, 15a 9	17.33	Weak Signal	32.22	<LOD	-NA-	-NA-	1.33E+13	Weak Signal
225	24.06.2021, 20, 14:24:00, veh: T, 15a 9	34.00	Weak Signal	10.05	<LOD	-NA-	-NA-	9.71E+13	Weak Signal
226	24.06.2021, 21, 14:24:04, veh: P, 15a 9	14.22	Weak Signal	27.38	<LOD	-NA-	-NA-	1.12E+14	Weak Signal
227	24.06.2021, 22, 14:24:09, veh: TN, 15a 9	6.82	Weak Signal	348.29	Weak Signal	-NA-	Weak Signal	1.20E+15	Weak Signal
228	24.06.2021, 23, 14:24:16, veh: MB, 15a 9	-3.12	Weak Signal	140.76	Weak Signal	-NA-	Weak Signal	8.41E+13	Weak Signal
229	24.06.2021, 24, 14:27:47, veh: S, 15a 9	17.88	Weak Signal	139.86	Weak Signal	-NA-	Weak Signal	3.94E+14	Weak Signal
230	24.06.2021, 25, 14:27:55, veh: C, 15a 9	16.15	Weak Signal	78.28	Weak Signal	-NA-	Weak Signal	3.72E+14	Weak Signal
231	24.06.2021, 26, 14:28:02, veh: TR, 15a 9	13.60	Weak Signal	31.99	Weak Signal	-NA-	Weak Signal	5.05E+13	Weak Signal
232	24.06.2021, 27, 14:28:14, veh: T, 15a 9	83.09	Weak Signal	6.92	<LOD	-NA-	-NA-	8.00E+13	Weak Signal
233	24.06.2021, 28, 14:28:21, veh: TN, 15a 9	23.76	Weak Signal	17.94	<LOD	-NA-	-NA-	2.57E+15	Weak Signal
234	24.06.2021, 29, 14:28:23, veh: P, 15a 9	23.81	Weak Signal	-3758.50	Weak Signal	-NA-	Weak Signal	2.26E+15	Weak Signal
235	24.06.2021, 30, 14:28:28, veh: MB, 15a 9	-5.77	Weak Signal	65.88	Weak Signal	-NA-	Weak Signal	3.20E+14	Weak Signal
236	24.06.2021, 31, 14:32:14, veh: S, 15b 9	35.02	Weak Signal	932.82	Weak Signal	-NA-	Weak Signal	8.45E+13	Weak Signal
237	24.06.2021, 32, 14:32:18, veh: C, 15b 9	21.11	Weak Signal	14329.28	Weak Signal	-NA-	Weak Signal	2.25E+14	Weak Signal
238	24.06.2021, 33, 14:32:20, veh: P, 15b 9	25.80	Weak Signal	143.25	Weak Signal	-NA-	Weak Signal	4.21E+14	Weak Signal
239	24.06.2021, 34, 14:32:23, veh: TR, 15b 9	18.12	Weak Signal	173.01	Weak Signal	-NA-	Weak Signal	2.27E+14	Weak Signal
240	24.06.2021, 35, 14:35:32, veh: T, 15b 9	23.85	Weak Signal	1225.76	Weak Signal	-NA-	Weak Signal	1.58E+14	Weak Signal
241	24.06.2021, 36, 14:35:36, veh: TN, 15b 9	176.84	Weak Signal	439.06	Weak Signal	-NA-	Weak Signal	1.28E+14	Weak Signal
242	24.06.2021, 37, 14:35:38, veh: MB, 15b 9	89.45	Weak Signal	370.56	Weak Signal	-NA-	Weak Signal	9.65E+13	Weak Signal
243	24.06.2021, 38, 14:36:40, veh: S, 15b 9	-308.56	Weak Signal	145.47	Weak Signal	-NA-	Weak Signal	1.50E+14	Weak Signal
244	24.06.2021, 39, 14:36:44, veh: C, 15b 9	18.57	Weak Signal	91.01	Weak Signal	-NA-	Weak Signal	2.76E+14	Weak Signal
245	24.06.2021, 40, 14:36:49, veh: TR, 15b 9	21.26	Weak Signal	75.19	Weak Signal	-NA-	Weak Signal	2.62E+13	Weak Signal
246	24.06.2021, 41, 14:36:51, veh: P, 15b 9	17.59	17.59	26.24	<LOD	-NA-	-NA-	1.44E+14	1.44E+14
247	24.06.2021, 42, 14:36:58, veh: T, 15b 9	4.00	Weak Signal	1.31	<LOD	-NA-	-NA-	1.33E+14	Weak Signal
248	24.06.2021, 43, 14:37:03, veh: TN, 15b 9	32.32	Weak Signal	5.35	<LOD	-NA-	-NA-	6.91E+15	Weak Signal
249	24.06.2021, 44, 14:37:05, veh: MB, 15b 9	40.62	Weak Signal	24.19	<LOD	-NA-	-NA-	7.56E+15	Weak Signal
250	24.06.2021, 45, 14:40:26, veh: S, 15b 9	152.07	Weak Signal	248.28	Weak Signal	3.88E+15	Weak Signal	5.10E+14	Weak Signal
251	24.06.2021, 46, 14:40:30, veh: C, 15b 9	18.53	Weak Signal	45.03	Weak Signal	8.18E+14	Weak Signal	3.89E+14	Weak Signal
252	24.06.2021, 47, 14:40:35, veh: TR, 15b 9	57.90	Weak Signal	119.25	Weak Signal	4.93E+14	Weak Signal	5.69E+13	Weak Signal
253	24.06.2021, 48, 14:40:42, veh: T, 15b 9	-49.82	Weak Signal	4.91	<LOD	1.20E+14	No Pollutants	2.70E+14	Weak Signal

254	24.06.2021, 49, 14:40:46, veh: P, 15b 9	33.38	Weak Signal	24.93	<LOD	2.83E+14	2.83E+14	2.05E+14	Weak Signal
255	24.06.2021, 50, 14:40:49, veh: TN, 15b 9	33.92	Weak Signal	15.99	<LOD	2.75E+15	2.75E+15	6.66E+15	Weak Signal
256	24.06.2021, 51, 14:40:51, veh: MB, 15b 9	32.05	Weak Signal	55.35	Weak Signal	2.03E+16	Weak Signal	7.32E+15	Weak Signal
257	24.06.2021, 52, 14:44:11, veh: S, 15b 9	114.23	Weak Signal	792.38	Weak Signal	4.18E+15	Weak Signal	1.41E+14	Weak Signal
258	24.06.2021, 53, 14:44:14, veh: C, 15b 9	32.37	Weak Signal	441.12	Weak Signal	5.51E+14	Weak Signal	2.67E+14	Weak Signal
259	24.06.2021, 54, 14:44:20, veh: TR, 15b 9	31.71	Weak Signal	215.50	Weak Signal	7.23E+13	Weak Signal	6.64E+13	Weak Signal
260	24.06.2021, 55, 14:44:28, veh: T, 15b 9	20.21	Weak Signal	6.19	<LOD	7.14E+13	7.14E+13	7.16E+13	Weak Signal
261	24.06.2021, 56, 14:44:33, veh: TN, 15b 9	15.61	Weak Signal	65.10	Weak Signal	5.20E+15	Weak Signal	3.28E+15	Weak Signal
262	24.06.2021, 57, 14:44:34, veh: P, 15b 9	7.27	Weak Signal	84.65	Weak Signal	4.93E+15	Weak Signal	2.81E+15	Weak Signal
263	24.06.2021, 58, 14:44:39, veh: MB, 15b 9	72.86	Weak Signal	25.10	<LOD	1.30E+15	1.30E+15	3.80E+14	Weak Signal
264	24.06.2021, 59, 14:48:44, veh: S, 15c 9	15.71	Weak Signal	183.51	Weak Signal	1.04E+16	Weak Signal	4.61E+14	Weak Signal
265	24.06.2021, 60, 14:48:45, veh: C, 15c 9	25.88	Weak Signal	-89.15	Weak Signal	1.04E+16	Weak Signal	8.05E+14	Weak Signal
266	24.06.2021, 61, 14:48:47, veh: P, 15c 9	20.33	Weak Signal	56.44	<LOD	-1.14E+14	-1.14E+14	2.34E+14	Weak Signal
267	24.06.2021, 62, 14:48:49, veh: TR, 15c 9	19.68	Weak Signal	6.02	<LOD	7.64E+13	7.64E+13	1.50E+14	Weak Signal
268	24.06.2021, 63, 14:48:53, veh: T, 15c 9	-38.09	Weak Signal	5.00	<LOD	1.16E+14	No Pollutants	1.63E+14	Weak Signal
269	24.06.2021, 64, 14:48:56, veh: TN, 15c 9	81.23	Weak Signal	13.66	<LOD	-1.09E+14	-1.09E+14	2.16E+15	Weak Signal
270	24.06.2021, 65, 14:48:58, veh: MB, 15c 9	63.49	Weak Signal	20.29	<LOD	5.17E+15	5.17E+15	2.26E+15	Weak Signal
271	24.06.2021, 66, 14:52:15, veh: S, 15c 9	-1.46	Weak Signal	28.05	Weak Signal	2.37E+15	Weak Signal	6.42E+14	Weak Signal
272	24.06.2021, 67, 14:52:16, veh: C, 15c 9	12.22	Weak Signal	27.16	Weak Signal	1.52E+15	Weak Signal	2.12E+14	Weak Signal
273	24.06.2021, 68, 14:52:18, veh: TR, 15c 9	13.06	Weak Signal	28.35	<LOD	-2.78E+14	-2.78E+14	2.13E+14	Weak Signal
274	24.06.2021, 69, 14:52:20, veh: P, 15c 9	23.55	Weak Signal	20.16	<LOD	-1.11E+14	-1.11E+14	1.01E+14	Weak Signal
275	24.06.2021, 70, 14:52:24, veh: T, 15c 9	18.38	18.38	9.01	<LOD	8.33E+13	No Pollutants	2.06E+13	2.06E+13
276	24.06.2021, 71, 14:52:27, veh: TN, 15c 9	19.43	19.43	5.97	<LOD	7.35E+13	7.35E+13	-7.62E+14	-7.62E+14
277	24.06.2021, 72, 14:52:29, veh: MB, 15c 9	-0.17	Weak Signal	151.59	Weak Signal	2.72E+16	Weak Signal	3.24E+14	Weak Signal
278	24.06.2021, 73, 14:55:52, veh: S, 15c 9	15.44	Weak Signal	72.47	Weak Signal	1.05E+15	Weak Signal	3.69E+14	Weak Signal
279	24.06.2021, 74, 14:55:53, veh: C, 15c 9	16.79	Weak Signal	83.71	Weak Signal	9.97E+14	Weak Signal	3.77E+14	Weak Signal
280	24.06.2021, 75, 14:55:55, veh: TR, 15c 9	15.98	Weak Signal	208.76	Weak Signal	9.60E+14	Weak Signal	3.84E+14	Weak Signal
281	24.06.2021, 76, 14:55:59, veh: T, 15c 9	37.75	Weak Signal	9.23	<LOD	8.59E+13	No Pollutants	1.95E+14	Weak Signal
282	24.06.2021, 77, 14:56:13, veh: P, 15c 9	-208.10	Weak Signal	39.00	Weak Signal	1.05E+15	Weak Signal	3.27E+14	Weak Signal
283	24.06.2021, 78, 14:57:05, veh: TN, 15c 9	39.52	Weak Signal	468.01	Weak Signal	1.99E+15	Weak Signal	1.99E+14	Weak Signal
284	24.06.2021, 79, 14:57:07, veh: MB, 15c 9	78.31	Weak Signal	464.98	Weak Signal	1.15E+15	Weak Signal	1.19E+14	Weak Signal
285	24.06.2021, 80, 14:59:51, veh: S, 15c 9	20.54	Weak Signal	-777.61	Weak Signal	9.38E+15	Weak Signal	3.21E+14	Weak Signal

286	24.06.2021, 81, 14:59:52, veh: C, 15c 9	14.11	14.11	25.08	Weak Signal	-1.32E+14	Weak Signal	4.56E+14	4.56E+14
287	24.06.2021, 82, 14:59:54, veh: TR, 15c 9	15.62	15.62	131.06	Weak Signal	-1.70E+14	Weak Signal	3.02E+14	3.02E+14
288	24.06.2021, 83, 14:59:58, veh: T, 15c 9	-7.17	Weak Signal	6.81	<LOD	8.28E+13	No Pollutants	7.09E+13	Weak Signal
289	24.06.2021, 84, 15:00:02, veh: TN, 15c 9	23.72	Weak Signal	15.76	<LOD	-5.17E+15	-5.17E+15	2.31E+15	Weak Signal
290	24.06.2021, 85, 15:00:04, veh: P, 15c 9	24.68	Weak Signal	11.86	<LOD	3.04E+16	3.04E+16	3.73E+15	Weak Signal
291	24.06.2021, 86, 15:00:05, veh: MB, 15c 9	23.21	Weak Signal	10.35	<LOD	2.45E+16	2.45E+16	3.73E+15	Weak Signal
292	24.06.2021, 87, 15:20:30, veh: MB, 16a 9	54.82	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.56E+14	Weak Signal
293	24.06.2021, 88, 15:20:41, veh: T, 16a 9	18.51	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.78E+13	Weak Signal
294	24.06.2021, 89, 15:20:45, veh: P, 16a 9	16.61	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.34E+12	Weak Signal
295	24.06.2021, 90, 15:20:50, veh: TR, 16a 9	33.05	Weak Signal	-NA-	-NA-	-NA-	-NA-	8.01E+13	Weak Signal
296	24.06.2021, 91, 15:20:58, veh: TN, 16a 9	9.31	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.01E+15	Weak Signal
297	24.06.2021, 92, 15:21:06, veh: C, 16a 9	79.76	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.17E+15	Weak Signal
298	24.06.2021, 93, 15:21:12, veh: S, 16a 9	193.96	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.88E+13	Weak Signal
299	24.06.2021, 94, 15:25:10, veh: MB, 16a 9	42.61	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.54E+14	Weak Signal
300	24.06.2021, 95, 15:25:21, veh: T, 16a 9	113.66	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.33E+14	Weak Signal
301	24.06.2021, 96, 15:25:29, veh: TR, 16a 9	22.79	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.35E+13	Weak Signal
302	24.06.2021, 97, 15:25:30, veh: P, 16a 9	25.03	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.26E+13	Weak Signal
303	24.06.2021, 98, 15:25:40, veh: TN, 16a 9	37.20	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.78E+15	Weak Signal
304	24.06.2021, 99, 15:25:45, veh: C, 16a 9	23.42	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.14E+15	Weak Signal
305	24.06.2021, 100, 15:25:52, veh: S, 16a 9	-12.88	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.56E+14	Weak Signal
306	24.06.2021, 101, 15:29:54, veh: MB, 16a 9	39.30	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.12E+14	Weak Signal
307	24.06.2021, 102, 15:30:05, veh: T, 16a 9	15.98	15.98	-NA-	-NA-	-NA-	-NA-	4.45E+13	4.45E+13
308	24.06.2021, 103, 15:30:13, veh: TR, 16a 9	18.51	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.56E+13	Weak Signal
309	24.06.2021, 104, 15:30:22, veh: TN, 16a 9	10.79	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.09E+15	Weak Signal
310	24.06.2021, 105, 15:30:24, veh: P, 16a 9	10.76	<LOD	-NA-	-NA-	-NA-	-NA-	6.86E+15	6.86E+15
311	24.06.2021, 106, 15:30:29, veh: C, 16a 9	-20.29	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.18E+14	Weak Signal
312	24.06.2021, 107, 15:30:37, veh: S, 16a 9	288.57	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.10E+14	Weak Signal
313	24.06.2021, 108, 15:33:54, veh: MB, 16a 9	15.30	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.06E+14	Weak Signal
314	24.06.2021, 109, 15:34:04, veh: T, 16a 9	226.27	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.52E+14	Weak Signal
315	24.06.2021, 110, 15:34:13, veh: TR, 16a 9	16.30	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.99E+13	Weak Signal
316	24.06.2021, 111, 15:34:23, veh: TN, 16a 9	12.42	12.42	-NA-	-NA-	-NA-	-NA-	4.53E+15	4.53E+15
317	24.06.2021, 112, 15:34:28, veh: C, 16a 9	-1.71	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.13E+13	Weak Signal

318	24.06.2021, 113, 15:34:30, veh: P, 16a 9	-0.97	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.64E+13	Weak Signal
319	24.06.2021, 114, 15:34:37, veh: S, 16a 9	-69.82	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.68E+14	Weak Signal
320	24.06.2021, 115, 15:38:31, veh: MB, 16b 9	21.57	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.23E+13	Weak Signal
321	24.06.2021, 116, 15:38:38, veh: T, 16b 9	23.12	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.00E+14	Weak Signal
322	24.06.2021, 117, 15:38:42, veh: P, 16b 9	61.21	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.63E+13	Weak Signal
323	24.06.2021, 118, 15:38:44, veh: TR, 16b 9	41.55	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.08E+14	Weak Signal
324	24.06.2021, 119, 15:39:00, veh: TN, 16b 9	3059.00	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.80E+14	Weak Signal
325	24.06.2021, 120, 15:38:53, veh: C, 16b 9	23.14	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.14E+15	Weak Signal
326	24.06.2021, 121, 15:38:56, veh: S, 16b 9	-45.83	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.31E+14	Weak Signal
327	24.06.2021, 122, 15:42:45, veh: MB, 16b 9	35.69	Weak Signal	-NA-	-NA-	-NA-	-NA-	6.35E+13	Weak Signal
328	24.06.2021, 123, 15:42:53, veh: T, 16b 9	13.98	13.98	-NA-	-NA-	-NA-	-NA-	8.21E+13	8.21E+13
329	24.06.2021, 124, 15:42:58, veh: TR, 16b 9	22.39	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.40E+14	Weak Signal
330	24.06.2021, 125, 15:42:59, veh: P, 16b 9	-1.22	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.35E+14	Weak Signal
331	24.06.2021, 126, 15:43:05, veh: TN, 16b 9	26.24	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.26E+15	Weak Signal
332	24.06.2021, 127, 15:43:07, veh: C, 16b 9	15.14	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.91E+15	Weak Signal
333	24.06.2021, 128, 15:43:11, veh: S, 16b 9	-643.98	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.92E+14	Weak Signal
334	24.06.2021, 129, 15:46:49, veh: MB, 16b 9	29.40	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.73E+14	Weak Signal
335	24.06.2021, 130, 15:46:57, veh: T, 16b 9	17.93	Weak Signal	-NA-	-NA-	-NA-	-NA-	6.71E+13	Weak Signal
336	24.06.2021, 131, 15:47:02, veh: TR, 16b 9	26.74	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.76E+14	Weak Signal
337	24.06.2021, 132, 15:47:05, veh: TN, 16b 9	28.68	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.43E+15	Weak Signal
338	24.06.2021, 133, 15:47:06, veh: P, 16b 9	9.77	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.78E+14	Weak Signal
339	24.06.2021, 134, 15:47:12, veh: C, 16b 9	-16.13	Weak Signal	-NA-	-NA-	-NA-	-NA-	-1.37E+12	Weak Signal
340	24.06.2021, 135, 15:47:15, veh: S, 16b 9	239.78	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.08E+14	Weak Signal
341	24.06.2021, 136, 15:50:41, veh: MB, 16b 9	80.72	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.63E+14	Weak Signal
342	24.06.2021, 137, 15:50:48, veh: T, 16b 9	20.72	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.58E+14	Weak Signal
343	24.06.2021, 138, 15:50:54, veh: TR, 16b 9	21.92	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.99E+13	Weak Signal
344	24.06.2021, 139, 15:51:00, veh: TN, 16b 9	12.11	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.61E+15	Weak Signal
345	24.06.2021, 140, 15:51:04, veh: C, 16b 9	24.36	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.18E+14	Weak Signal
346	24.06.2021, 141, 15:51:06, veh: P, 16b 9	33.91	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.57E+14	Weak Signal
347	24.06.2021, 142, 15:51:09, veh: S, 16b 9	22.55	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.53E+14	Weak Signal
348	24.06.2021, 143, 15:54:58, veh: MB, 16c 9	13.00	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.35E+14	Weak Signal
349	24.06.2021, 144, 15:55:02, veh: T, 16c 9	121.22	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.46E+14	Weak Signal

350	24.06.2021, 145, 15:55:05, veh: P, 16c 9	22.49	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.87E+13	Weak Signal
351	24.06.2021, 146, 15:55:07, veh: TR, 16c 9	22.14	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.00E+13	Weak Signal
352	24.06.2021, 147, 15:55:09, veh: TN, 16c 9	17.24	17.24	-NA-	-NA-	-NA-	-NA-	1.96E+15	1.96E+15
353	24.06.2021, 148, 15:55:11, veh: C, 16c 9	20.30	20.30	-NA-	-NA-	-NA-	-NA-	1.98E+15	1.98E+15
354	24.06.2021, 149, 15:55:12, veh: S, 16c 9	24.00	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.93E+15	Weak Signal
355	24.06.2021, 150, 15:58:52, veh: MB, 16c 9	15.28	Weak Signal	-NA-	-NA-	-NA-	-NA-	6.13E+12	Weak Signal
356	24.06.2021, 151, 15:58:56, veh: T, 16c 9	17.39	17.39	-NA-	-NA-	-NA-	-NA-	7.25E+13	7.25E+13
357	24.06.2021, 152, 15:59:00, veh: TR, 16c 9	15.98	15.98	-NA-	-NA-	-NA-	-NA-	3.70E+14	3.70E+14
358	24.06.2021, 153, 15:59:01, veh: P, 16c 9	17.91	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.77E+13	Weak Signal
359	24.06.2021, 154, 15:59:02, veh: TN, 16c 9	18.02	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.35E+14	Weak Signal
360	24.06.2021, 155, 15:59:04, veh: C, 16c 9	-0.45	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.30E+15	Weak Signal
361	24.06.2021, 156, 15:59:05, veh: S, 16c 9	16.36	Weak Signal	-NA-	-NA-	-NA-	-NA-	6.18E+15	Weak Signal
362	24.06.2021, 157, 16:02:40, veh: MB, 16c 9	35.46	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.20E+13	Weak Signal
363	24.06.2021, 158, 16:02:44, veh: T, 16c 9	15.08	15.08	-NA-	-NA-	-NA-	-NA-	7.00E+13	7.00E+13
364	24.06.2021, 159, 16:02:48, veh: TR, 16c 9	40.54	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.59E+14	Weak Signal
365	24.06.2021, 160, 16:02:50, veh: TN, 16c 9	28.61	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.73E+15	Weak Signal
366	24.06.2021, 161, 16:02:51, veh: P, 16c 9	22.63	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.38E+15	Weak Signal
367	24.06.2021, 162, 16:02:53, veh: C, 16c 9	18.14	Weak Signal	-NA-	-NA-	-NA-	-NA-	8.37E+15	Weak Signal
368	24.06.2021, 163, 16:02:54, veh: S, 16c 9	12.62	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.19E+15	Weak Signal
369	24.06.2021, 164, 16:06:21, veh: MB, 16c 9	86.25	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.11E+14	Weak Signal
370	24.06.2021, 165, 16:06:24, veh: T, 16c 9	43.88	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.77E+14	Weak Signal
371	24.06.2021, 166, 16:06:28, veh: TR, 16c 9	82.92	Weak Signal	-NA-	-NA-	-NA-	-NA-	8.46E+13	Weak Signal
372	24.06.2021, 167, 16:06:30, veh: TN, 16c 9	15.57	15.57	-NA-	-NA-	-NA-	-NA-	1.19E+15	1.19E+15
373	24.06.2021, 168, 16:06:31, veh: C, 16c 9	16.58	16.58	-NA-	-NA-	-NA-	-NA-	1.88E+15	1.88E+15
374	24.06.2021, 169, 16:06:33, veh: P, 16c 9	16.74	16.74	-NA-	-NA-	-NA-	-NA-	1.34E+15	1.34E+15
375	24.06.2021, 170, 16:06:34, veh: S, 16c 9	15.87	15.87	-NA-	-NA-	-NA-	-NA-	1.22E+15	1.22E+15
376	24.06.2021, 171, 16:13:34, veh: T, 17a 9	25.05	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.74E+14	Weak Signal
377	24.06.2021, 172, 16:13:37, veh: P, 17a 9	21.85	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.79E+14	Weak Signal
378	24.06.2021, 173, 16:13:46, veh: TR, 17a 9	11.14	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.57E+13	Weak Signal
379	24.06.2021, 174, 16:13:55, veh: TN, 17a 9	-38.95	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.56E+15	Weak Signal
380	24.06.2021, 175, 16:14:04, veh: C, 17a 9	44.67	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.86E+14	Weak Signal
381	24.06.2021, 176, 16:16:55, veh: T, 17a 9	19.72	19.72	-NA-	-NA-	-NA-	-NA-	1.25E+14	1.25E+14

382	24.06.2021, 177, 16:17:03, veh: TR, 17a 9	70.15	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.73E+13	Weak Signal
383	24.06.2021, 178, 16:17:15, veh: TN, 17a 9	34.77	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.38E+15	Weak Signal
384	24.06.2021, 179, 16:17:25, veh: C, 17a 9	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-	-NA-
385	24.06.2021, 180, 16:20:27, veh: T, 17a 9	28.03	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.48E+14	Weak Signal
386	24.06.2021, 181, 16:20:28, veh: P, 17a 9	44.08	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.11E+14	Weak Signal
387	24.06.2021, 182, 16:20:39, veh: TR, 17a 9	21.87	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.44E+13	Weak Signal
388	24.06.2021, 183, 16:20:53, veh: TN, 17a 9	13.57	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.12E+14	Weak Signal
389	24.06.2021, 184, 16:21:05, veh: C, 17a 9	12.19	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.53E+14	Weak Signal
390	24.06.2021, 185, 16:24:01, veh: T, 17a 9	119.08	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.14E+14	Weak Signal
391	24.06.2021, 186, 16:24:03, veh: P, 17a 9	42.73	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.06E+13	Weak Signal
392	24.06.2021, 187, 16:24:12, veh: TR, 17a 9	14.95	14.95	-NA-	-NA-	-NA-	-NA-	3.79E+13	3.79E+13
393	24.06.2021, 188, 16:24:26, veh: TN, 17a 9	14.27	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.25E+15	Weak Signal
394	24.06.2021, 189, 16:24:39, veh: C, 17a 9	23.95	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.36E+14	Weak Signal
395	24.06.2021, 190, 16:36:21, veh: T, 18a 9	37.23	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.86E+14	Weak Signal
396	24.06.2021, 191, 16:36:23, veh: P, 18a 9	20.96	Weak Signal	-NA-	-NA-	-NA-	-NA-	-9.31E+13	Weak Signal
397	24.06.2021, 192, 16:36:37, veh: TR, 18a 9	35.17	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.20E+13	Weak Signal
398	24.06.2021, 193, 16:36:50, veh: TN, 18a 9	5.62	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.77E+15	Weak Signal
399	24.06.2021, 194, 16:37:03, veh: C, 18a 9	25.80	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.25E+14	Weak Signal
400	24.06.2021, 195, 16:39:50, veh: T, 18a 9	29.93	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.32E+14	Weak Signal
401	24.06.2021, 196, 16:39:52, veh: P, 18a 9	39.99	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.11E+13	Weak Signal
402	24.06.2021, 197, 16:40:03, veh: TR, 18a 9	17.69	17.69	-NA-	-NA-	-NA-	-NA-	4.65E+13	4.65E+13
403	24.06.2021, 198, 16:40:16, veh: TN, 18a 9	2.37	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.70E+15	Weak Signal
404	24.06.2021, 199, 16:40:28, veh: C, 18a 9	27.83	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.63E+14	Weak Signal
405	24.06.2021, 200, 16:43:16, veh: T, 18a 9	47.50	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.76E+14	Weak Signal
406	24.06.2021, 201, 16:43:28, veh: TR, 18a 9	23.58	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.46E+13	Weak Signal
407	24.06.2021, 202, 16:43:40, veh: TN, 18a 9	11.98	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.08E+14	Weak Signal
408	24.06.2021, 203, 16:43:41, veh: P, 18a 9	13.90	Weak Signal	-NA-	-NA-	-NA-	-NA-	7.95E+14	Weak Signal
409	24.06.2021, 204, 16:43:52, veh: C, 18a 9	21.92	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.62E+14	Weak Signal
410	24.06.2021, 205, 16:46:54, veh: T, 18a 9	33.04	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.06E+14	Weak Signal
411	24.06.2021, 206, 16:47:02, veh: TR, 18a 9	32.07	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.73E+13	Weak Signal
412	24.06.2021, 207, 16:47:16, veh: TN, 18a 9	3.17	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.37E+15	Weak Signal
413	24.06.2021, 208, 16:47:27, veh: C, 18a 9	30.96	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.61E+14	Weak Signal

414	24.06.2021, 209, 16:47:28, veh: P, 18a 9	30.02	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.60E+14	Weak Signal
415	25.06.2021, 2, 10:03:37, veh: T, 19a	#DIV/0!	Weak Signal	#DIV/0!	Weak Signal	0.00E+00	Weak Signal	0.00E+00	Weak Signal
416	25.06.2021, 3, 10:03:51, veh: TR, 19a 9.8	16.93	Weak Signal	32.77	32.77	1.49E+14	No Pollutants	1.27E+14	Weak Signal
417	25.06.2021, 4, 10:03:53, veh: P, 19a 9.8	16.81	Weak Signal	54.05	<LOD	7.52E+13	No Pollutants	1.30E+14	Weak Signal
418	25.06.2021, 5, 10:04:01, veh: TN, 19a 9.8	8.95	Weak Signal	13.52	<LOD	7.60E+15	7.60E+15	1.95E+15	Weak Signal
419	25.06.2021, 6, 10:04:13, veh: C, 19a 9.8	33.68	Weak Signal	64.26	Weak Signal	2.05E+14	Weak Signal	3.64E+13	Weak Signal
420	25.06.2021, 7, 10:06:54, veh: T, 19a 9.8	8.55	<LOD	81.46	Weak Signal	3.86E+14	Weak Signal	1.42E+15	1.42E+15
421	25.06.2021, 8, 10:07:04, veh: TR, 19a 9.8	13.68	Weak Signal	36.62	<LOD	3.14E+14	No Pollutants	3.58E+13	Weak Signal
422	25.06.2021, 9, 10:07:16, veh: TN, 19a 9.8	2.95	Weak Signal	8.15	<LOD	1.66E+15	1.66E+15	3.12E+15	Weak Signal
423	25.06.2021, 10, 10:07:17, veh: P, 19a 9.8	2.62	Weak Signal	7.53	<LOD	1.87E+15	1.87E+15	2.62E+15	Weak Signal
424	25.06.2021, 11, 10:07:27, veh: C, 19a 9.8	-154.40	Weak Signal	44.07	<LOD	4.21E+14	No Pollutants	2.19E+14	Weak Signal
425	25.06.2021, 12, 10:10:06, veh: T, 19a 9.8	8.09	Weak Signal	70.46	<LOD	8.47E+14	No Pollutants	2.73E+15	Weak Signal
426	25.06.2021, 13, 10:10:16, veh: TR, 19a 9.8	28.21	Weak Signal	11.38	<LOD	1.70E+14	1.70E+14	7.62E+13	Weak Signal
427	25.06.2021, 14, 10:10:26, veh: TN, 19a 9.8	2.22	Weak Signal	6.76	<LOD	5.19E+15	5.19E+15	9.33E+14	Weak Signal
428	25.06.2021, 15, 10:10:36, veh: C, 19a 9.8	119.76	Weak Signal	51.33	<LOD	3.48E+14	No Pollutants	1.33E+14	Weak Signal
429	25.06.2021, 16, 10:10:37, veh: P, 19a 9.8	42.60	Weak Signal	48.02	<LOD	4.16E+14	No Pollutants	1.25E+14	Weak Signal
430	25.06.2021, 17, 10:13:11, veh: T, 19a 9.8	30.49	Weak Signal	827.55	Weak Signal	1.45E+16	Weak Signal	5.11E+14	Weak Signal
431	25.06.2021, 18, 10:13:16, veh: P, 19a 9.8	18.04	Weak Signal	88.46	88.46	6.37E+14	No Pollutants	4.21E+13	Weak Signal
432	25.06.2021, 19, 10:13:25, veh: TR, 19a 9.8	9.66	Weak Signal	15.75	<LOD	6.36E+13	No Pollutants	5.74E+13	Weak Signal
433	25.06.2021, 20, 10:13:35, veh: TN, 19a 9.8	-5.42	<LOD	6.60	<LOD	5.01E+15	5.01E+15	1.04E+15	1.04E+15
434	25.06.2021, 21, 10:13:44, veh: C, 19a 9.8	43.90	Weak Signal	774.51	Weak Signal	2.36E+15	Weak Signal	9.21E+13	Weak Signal
435	25.06.2021, 22, 10:17:47, veh: T, 19b 9.8	8.22	<LOD	623.35	Weak Signal	2.39E+16	Weak Signal	8.07E+13	8.07E+13
436	25.06.2021, 23, 10:17:59, veh: TR, 19b 9.8	11.27	<LOD	134.62	Weak Signal	8.90E+14	Weak Signal	5.31E+13	5.31E+13
437	25.06.2021, 24, 10:18:00, veh: P, 19b 9.8	10.70	<LOD	110.82	Weak Signal	8.90E+14	Weak Signal	1.58E+13	1.58E+13
438	25.06.2021, 25, 10:18:09, veh: TN, 19b 9.8	-5.15	Weak Signal	10.64	<LOD	6.42E+15	6.42E+15	9.29E+14	Weak Signal
439	25.06.2021, 26, 10:18:20, veh: C, 19b 9.8	16.36	Weak Signal	26.24	<LOD	4.84E+14	4.84E+14	1.32E+14	Weak Signal
440	25.06.2021, 27, 10:20:37, veh: T, 19b 9.8	7.96	<LOD	123.69	Weak Signal	2.55E+14	Weak Signal	8.35E+13	8.35E+13
441	25.06.2021, 28, 10:20:38, veh: TR, 19b 9.8	7.76	<LOD	124.09	Weak Signal	-1.68E+14	Weak Signal	9.92E+12	9.92E+12
442	25.06.2021, 29, 10:20:39, veh: P, 19b 9.8	3.02	Weak Signal	313.35	Weak Signal	-4.56E+14	Weak Signal	1.31E+14	Weak Signal
443	25.06.2021, 30, 10:20:40, veh: TN, 19b 9.8	-5.04	Weak Signal	297.13	Weak Signal	3.69E+15	Weak Signal	5.27E+14	Weak Signal
444	25.06.2021, 31, 10:20:41, veh: C, 19b 9.8	-32.89	Weak Signal	333.99	Weak Signal	3.37E+15	Weak Signal	8.11E+14	Weak Signal
445	25.06.2021, 32, 10:23:06, veh: T, 19b 9.8	10.10	Weak Signal	613.73	Weak Signal	1.55E+15	Weak Signal	6.05E+14	Weak Signal

446	25.06.2021, 33, 10:23:17, veh: TR, 19b 9.8	8.99	Weak Signal	487.02	Weak Signal	2.01E+15	Weak Signal	5.33E+13	Weak Signal
447	25.06.2021, 34, 10:23:28, veh: TN, 19b 9.8	5.95	<LOD	28.00	28.00	2.99E+15	2.99E+15	5.36E+14	5.36E+14
448	25.06.2021, 35, 10:23:29, veh: P, 19b 9.8	5.89	<LOD	26.86	26.86	4.63E+15	4.63E+15	1.35E+15	1.35E+15
449	25.06.2021, 36, 10:23:39, veh: C, 19b 9.8	10.39	<LOD	150.89	Weak Signal	8.37E+14	Weak Signal	5.04E+13	5.04E+13
450	25.06.2021, 37, 10:25:53, veh: T, 19b 9.8	8.70	<LOD	58.85	Weak Signal	2.73E+13	Weak Signal	1.29E+14	1.29E+14
451	25.06.2021, 38, 10:25:54, veh: TR, 19b 9.8	11.77	Weak Signal	22.67	Weak Signal	-1.09E+14	Weak Signal	2.09E+13	Weak Signal
452	25.06.2021, 39, 10:25:55, veh: TN, 19b 9.8	11.19	Weak Signal	121.50	Weak Signal	6.56E+13	Weak Signal	-1.40E+14	Weak Signal
453	25.06.2021, 40, 10:25:56, veh: P, 19b 9.8	8.62	Weak Signal	124.40	Weak Signal	1.45E+15	Weak Signal	2.51E+13	Weak Signal
454	25.06.2021, 41, 10:25:57, veh: C, 19b 9.8	22.30	Weak Signal	124.41	Weak Signal	2.30E+15	Weak Signal	3.61E+14	Weak Signal
455	25.06.2021, 42, 10:28:23, veh: T, 19b 9.8	8.81	Weak Signal	1306.67	Weak Signal	7.63E+15	Weak Signal	6.40E+14	Weak Signal
456	25.06.2021, 43, 10:28:34, veh: TR, 19b 9.8	11.05	Weak Signal	605.85	Weak Signal	3.22E+15	Weak Signal	3.24E+13	Weak Signal
457	25.06.2021, 44, 10:28:44, veh: TN, 19b 9.8	0.35	<LOD	9.30	<LOD	6.67E+15	6.67E+15	6.43E+14	6.43E+14
458	25.06.2021, 45, 10:28:55, veh: C, 19b 9.8	14.73	14.73	47.65	<LOD	4.78E+14	4.78E+14	1.15E+14	1.15E+14
459	25.06.2021, 46, 10:28:56, veh: P, 19b 9.8	12.99	12.99	52.11	<LOD	5.58E+14	5.58E+14	2.03E+14	2.03E+14
460	25.06.2021, 47, 10:31:22, veh: T, 19b 9.8	7.18	<LOD	104.05	Weak Signal	2.62E+15	Weak Signal	2.89E+14	2.89E+14
461	25.06.2021, 48, 10:31:23, veh: TR, 19b 9.8	6.60	<LOD	102.66	Weak Signal	2.62E+15	Weak Signal	2.60E+14	2.60E+14
462	25.06.2021, 49, 10:31:24, veh: TN, 19b 9.8	6.63	Weak Signal	179.81	Weak Signal	9.52E+15	Weak Signal	3.99E+14	Weak Signal
463	25.06.2021, 50, 10:31:25, veh: C, 19b 9.8	16.03	Weak Signal	310.07	Weak Signal	4.31E+14	Weak Signal	3.47E+14	Weak Signal
464	25.06.2021, 51, 10:31:26, veh: P, 19b 9.8	10.40	Weak Signal	284.97	Weak Signal	4.04E+14	Weak Signal	8.84E+13	Weak Signal
465	25.06.2021, 52, 10:33:54, veh: T, 19b 9.8	6.49	<LOD	650.97	Weak Signal	2.92E+15	Weak Signal	4.96E+14	4.96E+14
466	25.06.2021, 53, 10:33:58, veh: P, 19b 9.8	16.31	Weak Signal	80.50	Weak Signal	2.63E+15	Weak Signal	3.05E+14	Weak Signal
467	25.06.2021, 54, 10:34:05, veh: TR, 19b 9.8	8.86	Weak Signal	48.05	<LOD	1.69E+14	No Pollutants	7.39E+13	Weak Signal
468	25.06.2021, 55, 10:34:15, veh: TN, 19b 9.8	-0.83	<LOD	6.86	<LOD	3.94E+15	3.94E+15	6.77E+14	6.77E+14
469	25.06.2021, 56, 10:34:26, veh: C, 19b 9.8	20.48	Weak Signal	47.46	Weak Signal	1.40E+15	Weak Signal	8.05E+13	Weak Signal
470	25.06.2021, 57, 10:36:48, veh: T, 19b 9.8	8.07	Weak Signal	65.02	Weak Signal	9.50E+14	Weak Signal	2.89E+14	Weak Signal
471	25.06.2021, 58, 10:36:49, veh: P, 19b 9.8	8.15	<LOD	80.51	Weak Signal	1.74E+15	Weak Signal	1.85E+14	1.85E+14
472	25.06.2021, 59, 10:36:50, veh: TR, 19b 9.8	5.67	<LOD	65.44	Weak Signal	1.78E+15	Weak Signal	3.46E+14	3.46E+14
473	25.06.2021, 60, 10:36:51, veh: TN, 19b 9.8	8.32	Weak Signal	57.85	Weak Signal	1.30E+15	Weak Signal	3.03E+14	Weak Signal
474	25.06.2021, 61, 10:36:52, veh: C, 19b 9.8	15.05	Weak Signal	107.31	Weak Signal	2.24E+15	Weak Signal	5.16E+14	Weak Signal
475	25.06.2021, 62, 10:43:34, veh: C, 20a 9.8	13.88	13.88	77.21	Weak Signal	4.83E+15	Weak Signal	1.77E+14	1.77E+14
476	25.06.2021, 63, 10:43:36, veh: P, 20a 9.8	9.20	<LOD	81.31	Weak Signal	3.43E+15	Weak Signal	2.70E+14	2.70E+14
477	25.06.2021, 64, 10:43:48, veh: TR, 20a 9.8	13.22	Weak Signal	1356.05	Weak Signal	3.44E+15	Weak Signal	5.56E+13	Weak Signal

478	25.06.2021, 65, 10:44:03, veh: T, 20a 9.8	8.05	8.05	809.07	Weak Signal	1.68E+15	Weak Signal	1.03E+14	1.03E+14
479	25.06.2021, 66, 10:44:12, veh: TN, 20a 9.8	9.10	9.10	868.60	Weak Signal	4.12E+16	Weak Signal	4.90E+14	4.90E+14
480	25.06.2021, 67, 10:46:53, veh: C, 20a 9.8	6.08	<LOD	194.07	Weak Signal	1.25E+17	Weak Signal	7.00E+15	7.00E+15
481	25.06.2021, 68, 10:46:54, veh: P, 20a 9.8	6.21	<LOD	515.40	Weak Signal	4.36E+16	Weak Signal	1.26E+16	1.26E+16
482	25.06.2021, 69, 10:46:55, veh: TR, 20a 9.8	4.26	Weak Signal	333.44	Weak Signal	1.88E+16	Weak Signal	4.15E+15	Weak Signal
483	25.06.2021, 70, 10:46:56, veh: T, 20a 9.8	5.87	Weak Signal	259.22	Weak Signal	1.31E+16	Weak Signal	1.29E+15	Weak Signal
484	25.06.2021, 71, 10:46:57, veh: TN, 20a 9.8	-6.77	Weak Signal	210.86	Weak Signal	4.14E+15	Weak Signal	8.19E+14	Weak Signal
485	25.06.2021, 72, 10:51:39, veh: C, 20a 9.8	16.35	Weak Signal	696.95	Weak Signal	3.50E+15	Weak Signal	8.14E+13	Weak Signal
486	25.06.2021, 73, 10:51:54, veh: TR, 20a 9.8	6.67	Weak Signal	1577.99	Weak Signal	3.60E+17	Weak Signal	3.60E+16	Weak Signal
487	25.06.2021, 74, 10:51:56, veh: P, 20a 9.8	29.33	Weak Signal	80.96	Weak Signal	9.85E+16	Weak Signal	1.35E+17	Weak Signal
488	25.06.2021, 75, 10:52:07, veh: T, 20a 9.8	26.49	26.49	-1278.20	Weak Signal	1.61E+16	Weak Signal	1.18E+14	No Pollutants
489	25.06.2021, 76, 10:52:16, veh: TN, 20a 9.8	10.93	10.93	134.19	Weak Signal	1.66E+16	Weak Signal	5.63E+14	5.63E+14
490	25.06.2021, 77, 10:55:04, veh: C, 20a 9.8	22.62	Weak Signal	47.19	Weak Signal	6.55E+17	Weak Signal	1.37E+17	Weak Signal
491	25.06.2021, 78, 10:55:05, veh: TR, 20a 9.8	19.21	Weak Signal	50.64	Weak Signal	6.55E+17	Weak Signal	1.26E+17	Weak Signal
492	25.06.2021, 79, 10:55:06, veh: P, 20a 9.8	16.50	Weak Signal	46.30	Weak Signal	8.66E+17	Weak Signal	8.99E+16	Weak Signal
493	25.06.2021, 80, 10:55:07, veh: T, 20a 9.8	14.94	Weak Signal	61.04	Weak Signal	1.42E+18	Weak Signal	6.64E+16	Weak Signal
494	25.06.2021, 81, 10:55:08, veh: TN, 20a 9.8	6.16	Weak Signal	57.38	Weak Signal	1.65E+18	Weak Signal	3.28E+16	Weak Signal
495	25.06.2021, 82, 10:58:37, veh: C, 20b 9.8	39.20	Weak Signal	814.95	Weak Signal	2.98E+15	Weak Signal	6.57E+13	Weak Signal
496	25.06.2021, 83, 10:58:45, veh: TR, 20b 9.8	5.03	<LOD	302.85	Weak Signal	-1.10E+18	Weak Signal	1.25E+17	1.25E+17
497	25.06.2021, 84, 10:58:55, veh: T, 20b 9.8	4.00	<LOD	2157.99	Weak Signal	3.03E+16	Weak Signal	4.64E+14	4.64E+14
498	25.06.2021, 85, 10:58:58, veh: P, 20b 9.8	15.35	Weak Signal	925.09	Weak Signal	5.16E+15	Weak Signal	3.74E+14	Weak Signal
499	25.06.2021, 86, 10:59:05, veh: TN, 20b 9.8	6.18	<LOD	420.21	Weak Signal	5.85E+16	Weak Signal	3.06E+14	3.06E+14
500	25.06.2021, 87, 11:01:45, veh: C, 20b 9.8	7.94	<LOD	48.19	Weak Signal	6.85E+16	Weak Signal	7.64E+15	7.64E+15
501	25.06.2021, 88, 11:01:46, veh: TR, 20b 9.8	7.65	<LOD	67.47	Weak Signal	5.90E+16	Weak Signal	7.81E+15	7.81E+15
502	25.06.2021, 89, 11:01:47, veh: T, 20b 9.8	7.28	<LOD	89.49	Weak Signal	1.28E+17	Weak Signal	9.55E+15	9.55E+15
503	25.06.2021, 90, 11:01:48, veh: P, 20b 9.8	4.94	<LOD	66.91	Weak Signal	2.13E+17	Weak Signal	1.86E+16	1.86E+16
504	25.06.2021, 91, 11:01:49, veh: TN, 20b 9.8	4.72	Weak Signal	51.92	Weak Signal	8.64E+16	Weak Signal	7.64E+15	Weak Signal
505	25.06.2021, 92, 11:04:43, veh: C, 20b 9.8	10.93	Weak Signal	1177.84	Weak Signal	3.33E+15	Weak Signal	1.35E+14	Weak Signal
506	25.06.2021, 93, 11:04:51, veh: TR, 20b 9.8	143.07	Weak Signal	958.77	Weak Signal	1.34E+15	Weak Signal	2.31E+14	Weak Signal
507	25.06.2021, 94, 11:05:02, veh: T, 20b 9.8	11.10	Weak Signal	1663.49	Weak Signal	2.12E+15	Weak Signal	3.48E+14	Weak Signal
508	25.06.2021, 95, 11:05:10, veh: TN, 20b 9.8	7.84	7.84	949.48	Weak Signal	8.48E+16	Weak Signal	4.83E+14	4.83E+14
509	25.06.2021, 96, 11:05:11, veh: P, 20b 9.8	6.30	<LOD	743.48	Weak Signal	4.67E+16	Weak Signal	9.81E+14	9.81E+14

510	25.06.2021, 97, 11:07:50, veh: C, 20b 9.8	13.65	Weak Signal	23.83	<LOD	1.26E+15	1.26E+15	3.91E+14	Weak Signal
511	25.06.2021, 98, 11:07:51, veh: TR, 20b 9.8	14.04	Weak Signal	27.91	<LOD	9.94E+14	9.94E+14	3.18E+14	Weak Signal
512	25.06.2021, 99, 11:07:52, veh: T, 20b 9.8	11.81	Weak Signal	26.73	<LOD	8.82E+14	8.82E+14	2.58E+14	Weak Signal
513	25.06.2021, 100, 11:07:54, veh: TN, 20b 9.8	11.63	<LOD	20.79	<LOD	4.11E+14	4.11E+14	7.09E+14	7.09E+14
514	25.06.2021, 101, 11:07:55, veh: P, 20b 9.8	7.10	<LOD	26.30	<LOD	5.39E+14	5.39E+14	4.10E+14	4.10E+14
515	25.06.2021, 102, 11:16:20, veh: C, 20c 9.8	20.35	Weak Signal	891.74	Weak Signal	1.89E+15	Weak Signal	-NA-	Weak Signal
516	25.06.2021, 103, 11:16:31, veh: TR, 20c 9.8	1.38	Weak Signal	1333.32	Weak Signal	9.94E+14	Weak Signal	-NA-	Weak Signal
517	25.06.2021, 104, 11:16:43, veh: T, 20c 9.8	29.91	29.91	762.82	Weak Signal	1.37E+16	Weak Signal	-NA-	-NA-
518	25.06.2021, 105, 11:16:47, veh: P, 20c 9.8	9.30	9.30	49.70	Weak Signal	7.54E+14	Weak Signal	-NA-	-NA-
519	25.06.2021, 106, 11:16:57, veh: TN, 20c 9.8	6.91	Weak Signal	14.26	<LOD	6.94E+14	6.94E+14	-NA-	Weak Signal
520	25.06.2021, 107, 11:19:34, veh: C, 20c 9.8	7.23	Weak Signal	204.33	Weak Signal	4.68E+14	Weak Signal	-NA-	Weak Signal
521	25.06.2021, 108, 11:19:35, veh: TR, 20c 9.8	7.09	<LOD	74.12	Weak Signal	6.77E+14	Weak Signal	-NA-	-NA-
522	25.06.2021, 109, 11:19:36, veh: T, 20c 9.8	10.01	<LOD	54.81	Weak Signal	7.55E+15	Weak Signal	-NA-	-NA-
523	25.06.2021, 110, 11:19:38, veh: P, 20c 9.8	7.75	<LOD	35.97	Weak Signal	9.64E+15	Weak Signal	-NA-	-NA-
524	25.06.2021, 111, 11:19:39, veh: TN, 20c 9.8	7.80	<LOD	59.57	Weak Signal	1.19E+16	Weak Signal	-NA-	-NA-
525	25.06.2021, 112, 11:22:04, veh: C, 20c 9.8	25.76	Weak Signal	866.91	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
526	25.06.2021, 113, 11:22:14, veh: TR, 20c 9.8	56.42	Weak Signal	839.49	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
527	25.06.2021, 114, 11:22:26, veh: T, 20c 9.8	14.18	Weak Signal	1880.20	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
528	25.06.2021, 115, 11:22:30, veh: P, 20c 9.8	30.43	Weak Signal	928.06	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
529	25.06.2021, 116, 11:22:40, veh: TN, 20c 9.8	5.91	<LOD	1504.59	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
530	25.06.2021, 117, 11:25:12, veh: C, 20c 9.8	7.87	<LOD	59.73	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
531	25.06.2021, 118, 11:25:13, veh: TR, 20c 9.8	7.55	7.55	95.78	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
532	25.06.2021, 119, 11:25:14, veh: T, 20c 9.8	7.65	7.65	91.26	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
533	25.06.2021, 120, 11:25:16, veh: P, 20c 9.8	7.25	<LOD	86.43	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
534	25.06.2021, 121, 11:25:17, veh: TN, 20c 9.8	8.31	<LOD	73.27	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
535	25.06.2021, 122, 11:27:48, veh: C, 20d 9.8	13.14	Weak Signal	1754.35	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
536	25.06.2021, 123, 11:27:56, veh: TR, 20d 9.8	8.59	Weak Signal	1717.47	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
537	25.06.2021, 124, 11:28:06, veh: T, 20d 9.8	3.66	Weak Signal	861.88	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal

538	25.06.2021, 125, 11:28:10, veh: P, 20d 9.8	14.12	Weak Signal	746.47	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
539	25.06.2021, 126, 11:28:18, veh: TN, 20d 9.8	11.91	11.91	31.61	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
540	25.06.2021, 127, 11:30:46, veh: C, 20d 9.8	8.73	<LOD	52.40	52.40	-NA-	-NA-	-NA-	-NA-
541	25.06.2021, 128, 11:30:47, veh: TR, 20d 9.8	8.24	<LOD	53.46	53.46	-NA-	-NA-	-NA-	-NA-
542	25.06.2021, 129, 11:30:48, veh: T, 20d 9.8	7.66	<LOD	56.77	56.77	-NA-	-NA-	-NA-	-NA-
543	25.06.2021, 130, 11:30:50, veh: P, 20d 9.8	7.50	<LOD	259.02	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
544	25.06.2021, 131, 11:30:51, veh: TN, 20d 9.8	7.13	<LOD	238.56	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
545	25.06.2021, 132, 11:33:16, veh: C, 20d 9.8	7.16	Weak Signal	856.71	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
546	25.06.2021, 133, 11:33:24, veh: TR, 20d 9.8	392.56	Weak Signal	505.27	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
547	25.06.2021, 134, 11:33:34, veh: T, 20d 9.8	9.33	Weak Signal	2200.79	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
548	25.06.2021, 135, 11:33:37, veh: P, 20d 9.8	6.65	Weak Signal	103.28	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
549	25.06.2021, 136, 11:33:45, veh: TN, 20d 9.8	12.77	12.77	2274.24	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
550	25.06.2021, 137, 11:36:15, veh: C, 20d 9.8	6.00	<LOD	50.76	<LOD	-NA-	-NA-	-NA-	-NA-
551	25.06.2021, 138, 11:36:16, veh: TR, 20d 9.8	5.62	<LOD	48.35	<LOD	-NA-	-NA-	-NA-	-NA-
552	25.06.2021, 139, 11:36:17, veh: T, 20d 9.8	5.60	<LOD	78.94	Weak Signal	-NA-	Weak Signal	-NA-	-NA-
553	25.06.2021, 140, 11:36:19, veh: P, 20d 9.8	7.92	Weak Signal	221.90	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
554	25.06.2021, 141, 11:36:20, veh: TN, 20d 9.8	7.91	Weak Signal	658.60	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
555	25.06.2021, 142, 12:21:40, veh: TR, 21a 9.8	21.61	Weak Signal	1707.66	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
556	25.06.2021, 143, 12:21:41, veh: P, 21a 9.8	16.44	Weak Signal	1457.23	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
557	25.06.2021, 144, 12:21:42, veh: TN, 21a 9.8	6.61	Weak Signal	806.23	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
558	25.06.2021, 145, 12:21:43, veh: C, 21a 9.8	3.44	Weak Signal	1126.23	Weak Signal	-NA-	Weak Signal	-NA-	Weak Signal
559	25.06.2021, 147, 12:26:06, veh: TR, 21a 10	135.01	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.75E+14	Weak Signal
560	25.06.2021, 148, 12:26:08, veh: TN, 21a 10	208.40	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.31E+14	Weak Signal
561	25.06.2021, 149, 12:26:09, veh: P, 21a 10	256.86	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.31E+14	Weak Signal
562	25.06.2021, 150, 12:26:11, veh: C, 21a 10	159.94	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.44E+14	Weak Signal
563	25.06.2021, 151, 12:28:36, veh: TR, 21a 10	12.54	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.38E+14	Weak Signal
564	25.06.2021, 152, 12:28:37, veh: TN, 21a 10	9.59	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.36E+14	Weak Signal
565	25.06.2021, 153, 12:28:39, veh: C, 21a 10	15.66	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.51E+14	Weak Signal

566	25.06.2021, 154, 12:28:40, veh: P, 21a 10	19.08	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.38E+14	Weak Signal
567	25.06.2021, 155, 12:32:04, veh: TR, 21a 10	9.70	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.10E+14	Weak Signal
568	25.06.2021, 156, 12:32:05, veh: P, 21a 10	7.46	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.13E+14	Weak Signal
569	25.06.2021, 157, 12:32:07, veh: TN, 21a 10	6.18	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.02E+14	Weak Signal
570	25.06.2021, 158, 12:32:08, veh: C, 21a 10	6.45	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.90E+14	Weak Signal
571	25.06.2021, 159, 12:35:33, veh: TR, 21a 10	5.50	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.56E+14	Weak Signal
572	25.06.2021, 160, 12:35:34, veh: TN, 21a 10	4.60	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.77E+14	Weak Signal
573	25.06.2021, 161, 12:35:35, veh: P, 21a 10	6.87	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.62E+14	Weak Signal
574	25.06.2021, 162, 12:35:36, veh: C, 21a 10	10.79	Weak Signal	-NA-	-NA-	-NA-	-NA-	5.74E+14	Weak Signal
575	25.06.2021, 163, 12:39:01, veh: TR, 21a 10	2.86	<LOD	-NA-	-NA-	-NA-	-NA-	2.75E+14	2.75E+14
576	25.06.2021, 164, 12:39:02, veh: TN, 21a 10	2.29	<LOD	-NA-	-NA-	-NA-	-NA-	2.90E+14	2.90E+14
577	25.06.2021, 165, 12:39:03, veh: C, 21a 10	4.11	<LOD	-NA-	-NA-	-NA-	-NA-	3.68E+14	3.68E+14
578	25.06.2021, 166, 12:39:04, veh: P, 21a 10	5.14	<LOD	-NA-	-NA-	-NA-	-NA-	7.81E+14	7.81E+14
579	25.06.2021, 167, 12:44:19, veh: TR, 21b 10	211.27	Weak Signal	-NA-	-NA-	-NA-	-NA-	-2.15E+13	Weak Signal
580	25.06.2021, 168, 12:44:21, veh: P, 21b 10	8.98	<LOD	-NA-	-NA-	-NA-	-NA-	1.02E+14	1.02E+14
581	25.06.2021, 169, 12:44:23, veh: TN, 21b 10	7.49	<LOD	-NA-	-NA-	-NA-	-NA-	1.10E+14	1.10E+14
582	25.06.2021, 170, 12:44:25, veh: C, 21b 10	5.84	<LOD	-NA-	-NA-	-NA-	-NA-	2.91E+14	2.91E+14
583	25.06.2021, 171, 12:50:01, veh: TR, 21b 10	7.18	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.06E+14	Weak Signal
584	25.06.2021, 172, 12:50:03, veh: TN, 21b 10	5.87	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.12E+14	Weak Signal
585	25.06.2021, 173, 12:50:04, veh: P, 21b 10	8.76	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.62E+14	Weak Signal
586	25.06.2021, 174, 12:50:06, veh: C, 21b 10	24.08	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.09E+14	Weak Signal
587	25.06.2021, 175, 12:55:48, veh: TR, 21b 10	12.09	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.08E+14	Weak Signal
588	25.06.2021, 176, 12:55:49, veh: TN, 21b 10	10.96	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.55E+14	Weak Signal
589	25.06.2021, 177, 12:55:50, veh: C, 21b 10	21.99	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.12E+14	Weak Signal
590	25.06.2021, 178, 12:55:51, veh: P, 21b 10	25.56	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.14E+14	Weak Signal
591	25.06.2021, 179, 12:58:44, veh: TR, 21c 10	11.61	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.19E+14	Weak Signal
592	25.06.2021, 180, 12:58:46, veh: P, 21c 10	8.44	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.06E+14	Weak Signal
593	25.06.2021, 181, 12:58:48, veh: TN, 21c 10	10.18	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.30E+13	Weak Signal
594	25.06.2021, 182, 12:58:50, veh: C, 21c 10	10.26	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.91E+14	Weak Signal
595	25.06.2021, 183, 13:01:28, veh: TR, 21c 10	13.70	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.65E+14	Weak Signal
596	25.06.2021, 184, 13:01:30, veh: TN, 21c 10	9.38	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.08E+14	Weak Signal
597	25.06.2021, 185, 13:01:32, veh: P, 21c 10	11.41	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.10E+14	Weak Signal

598	25.06.2021, 186, 13:01:34, veh: C, 21c 10	7.09	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.37E+13	Weak Signal
599	25.06.2021, 187, 13:04:14, veh: TR, 21c 10	10.61	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.73E+14	Weak Signal
600	25.06.2021, 188, 13:04:16, veh: TN, 21c 10	19.69	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.58E+14	Weak Signal
601	25.06.2021, 189, 13:04:18, veh: C, 21c 10	21.77	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.17E+13	Weak Signal
602	25.06.2021, 190, 13:04:19, veh: P, 21c 10	20.17	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.57E+14	Weak Signal
603	25.06.2021, 191, 13:06:35, veh: TR, 21d 10	15.22	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.85E+14	Weak Signal
604	25.06.2021, 192, 13:06:36, veh: P, 21d 10	17.21	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.25E+14	Weak Signal
605	25.06.2021, 193, 13:06:38, veh: TN, 21d 10	15.63	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.99E+14	Weak Signal
606	25.06.2021, 194, 13:06:39, veh: C, 21d 10	15.96	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.22E+14	Weak Signal
607	25.06.2021, 195, 13:08:47, veh: TR, 21d 10	6.30	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.12E+14	Weak Signal
608	25.06.2021, 196, 13:08:48, veh: TN, 21d 10	4.28	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.57E+14	Weak Signal
609	25.06.2021, 197, 13:08:49, veh: P, 21d 10	2.86	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.06E+14	Weak Signal
610	25.06.2021, 198, 13:08:50, veh: C, 21d 10	4.32	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.53E+14	Weak Signal
611	25.06.2021, 199, 13:10:58, veh: TR, 21d 10	6.73	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.02E+14	Weak Signal
612	25.06.2021, 200, 13:11:00, veh: TN, 21d 10	6.40	<LOD	-NA-	-NA-	-NA-	-NA-	1.09E+14	1.09E+14
613	25.06.2021, 201, 13:11:01, veh: C, 21d 10	5.72	<LOD	-NA-	-NA-	-NA-	-NA-	8.99E+13	8.99E+13
614	25.06.2021, 202, 13:11:02, veh: P, 21d 10	5.43	<LOD	-NA-	-NA-	-NA-	-NA-	6.81E+13	6.81E+13
615	25.06.2021, 203, 13:12:52, veh: TR, 21e 10	21.37	Weak Signal	-NA-	-NA-	-NA-	-NA-	8.32E+15	Weak Signal
616	25.06.2021, 204, 13:12:53, veh: P, 21e 10	17.14	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.13E+15	Weak Signal
617	25.06.2021, 205, 13:12:55, veh: TN, 21e 10	10.32	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.78E+15	Weak Signal
618	25.06.2021, 206, 13:12:57, veh: C, 21e 10	5.72	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.17E+15	Weak Signal
619	25.06.2021, 207, 13:14:36, veh: TR, 21e 10	14.78	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.31E+16	Weak Signal
620	25.06.2021, 208, 13:14:38, veh: TN, 21e 10	15.62	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.40E+16	Weak Signal
621	25.06.2021, 209, 13:14:39, veh: P, 21e 10	14.31	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.50E+16	Weak Signal
622	25.06.2021, 210, 13:14:40, veh: C, 21e 10	14.77	Weak Signal	-NA-	-NA-	-NA-	-NA-	8.45E+15	Weak Signal
623	25.06.2021, 211, 13:16:17, veh: TR, 21e 10	3.15	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.69E+14	Weak Signal
624	25.06.2021, 212, 13:16:19, veh: TN, 21e 10	3.11	Weak Signal	-NA-	-NA-	-NA-	-NA-	1.62E+14	Weak Signal
625	25.06.2021, 213, 13:16:20, veh: C, 21e 10	3.16	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.75E+14	Weak Signal
626	25.06.2021, 214, 13:16:21, veh: P, 21e 10	7.39	Weak Signal	-NA-	-NA-	-NA-	-NA-	4.28E+14	Weak Signal
627	25.06.2021, 215, 13:19:38, veh: TR, 21e 10	45.78	Weak Signal	-NA-	-NA-	-NA-	-NA-	2.79E+13	Weak Signal
628	25.06.2021, 216, 13:19:49, veh: TN, 21e 10	28.02	Weak Signal	-NA-	-NA-	-NA-	-NA-	3.99E+14	Weak Signal
629	25.06.2021, 217, 13:20:22, veh: P, 21e 10	117.03	Weak Signal	-NA-	-NA-	-NA-	-NA-	9.64E+14	Weak Signal