

Workshop Tehran – December 14th/15th 2016

DPF Inspection & Maintenance

PART I: INSPECTION

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Maintenance must be a periodic routine
and
emission control must become part of
maintenance

→ **Guarantees emission stability**

→ **Preserves the engine in optimum condition**

→ **Reduces overall costs**

(by preventive repair, avoidance of operation interruptions etc.)

Emission stability of Diesel Engines

- Classic diesel engines without aftertreatment:

Deterioration by aging, wear etc. is limited:

▶ **emissions: + 20 ÷ 50%**

- Diesel engines with aftertreatment:

Deterioration by aging, poisoning, manipulation, failures etc.

▶ **emissions: + 100x ÷ 1000x**

Technical Requirements

- The vehicles are equipped with **certified filters** ($\eta > 97\%$) and **wireless dataloggers**
- Certified **PN***) **measurement devices**, portable, low cost and highly sensitive are **available**
- The **obligation** for **periodical particle emission checks** and its documentation is defined by a **mandatory regulation**

*) PN = Particulate Number

Potential of PN-Measurement

- Fast, portable, accurate PN-measurement for:
 - Roadside measurement
 - Official periodic emission checks
 - Fleet maintenance and control

allow

- to verify filter efficiency
- to detect small repairable DPF defects
- may indicate the need for filter exchange
- to detect engine malfunctions

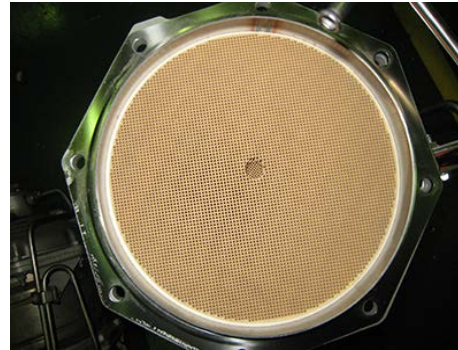
Portable Particle Emission Analyser

Condensation nucleus counter by TSI - NPET

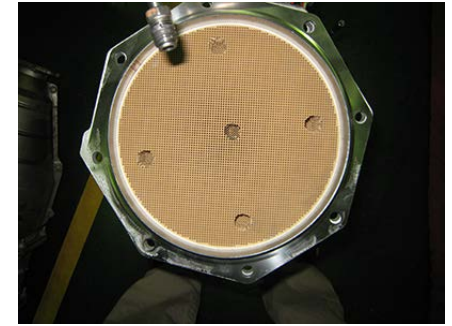


Diffusion charging
by TESTO - PEPA

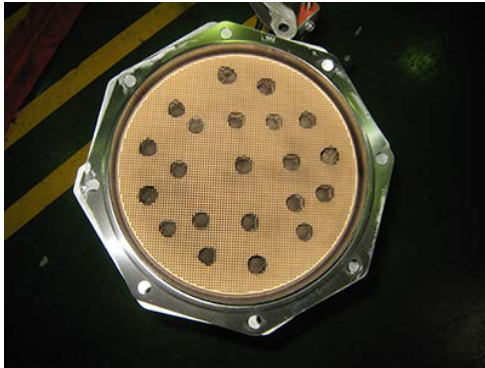
Can small failures be detected by PN at low idle ?



1 hole (0.5%)



5 holes (2.7%)



17 holes (9.3%)



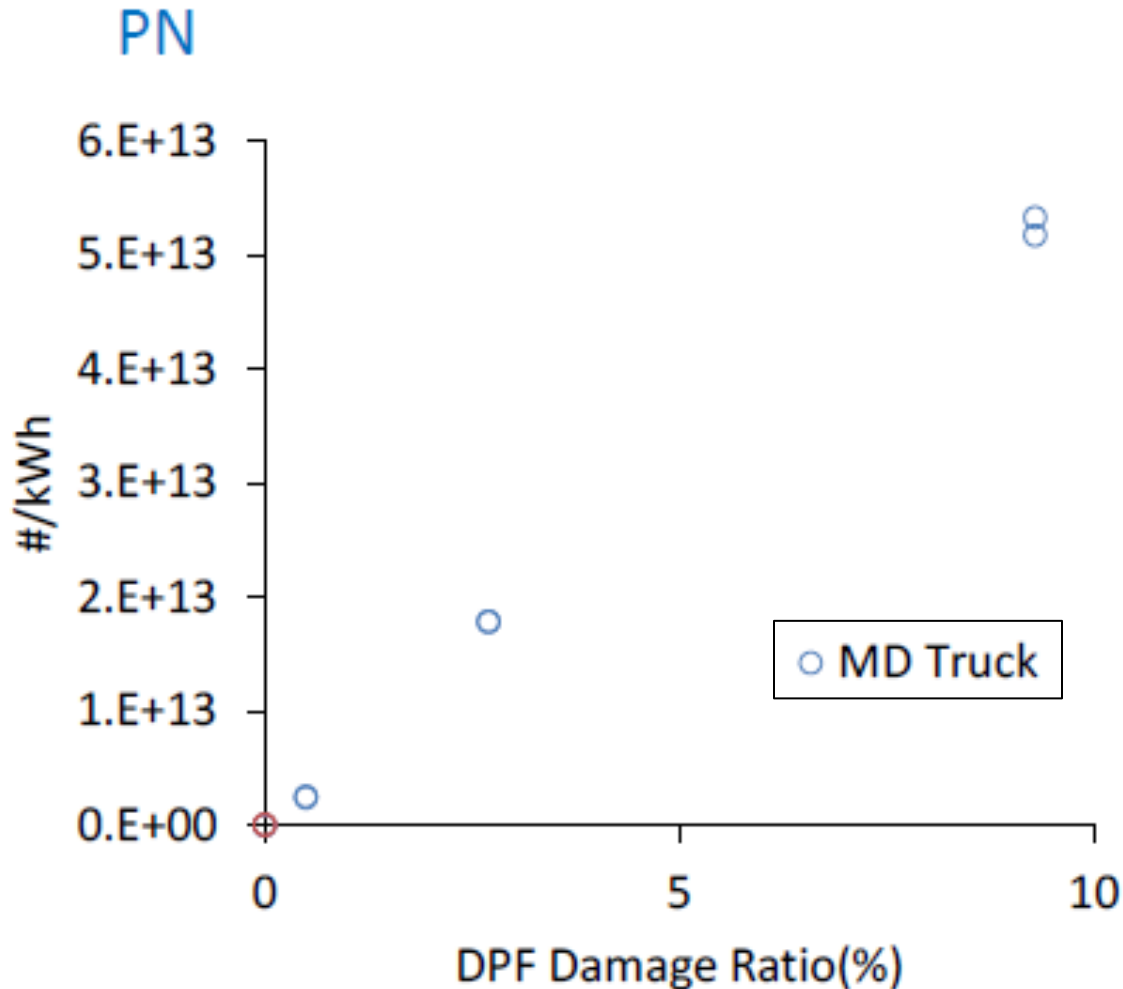
41 holes (22.5%)



Completely (100%)

Source: Yamada, ETH-NPC 2015

PN Increase vs. DPF Damage



Measured at low idle

Source: Yamada, ETH-NPC 2015

I&M Organization

Run by:

**Test-only-
or PTI-stations (A)**

- Authorities
- Accredited private organizations

Test+repair-stations/shops (B)

- Private workshops
- Users/fleet owners

Supervision on-road/on-sites

Authorities

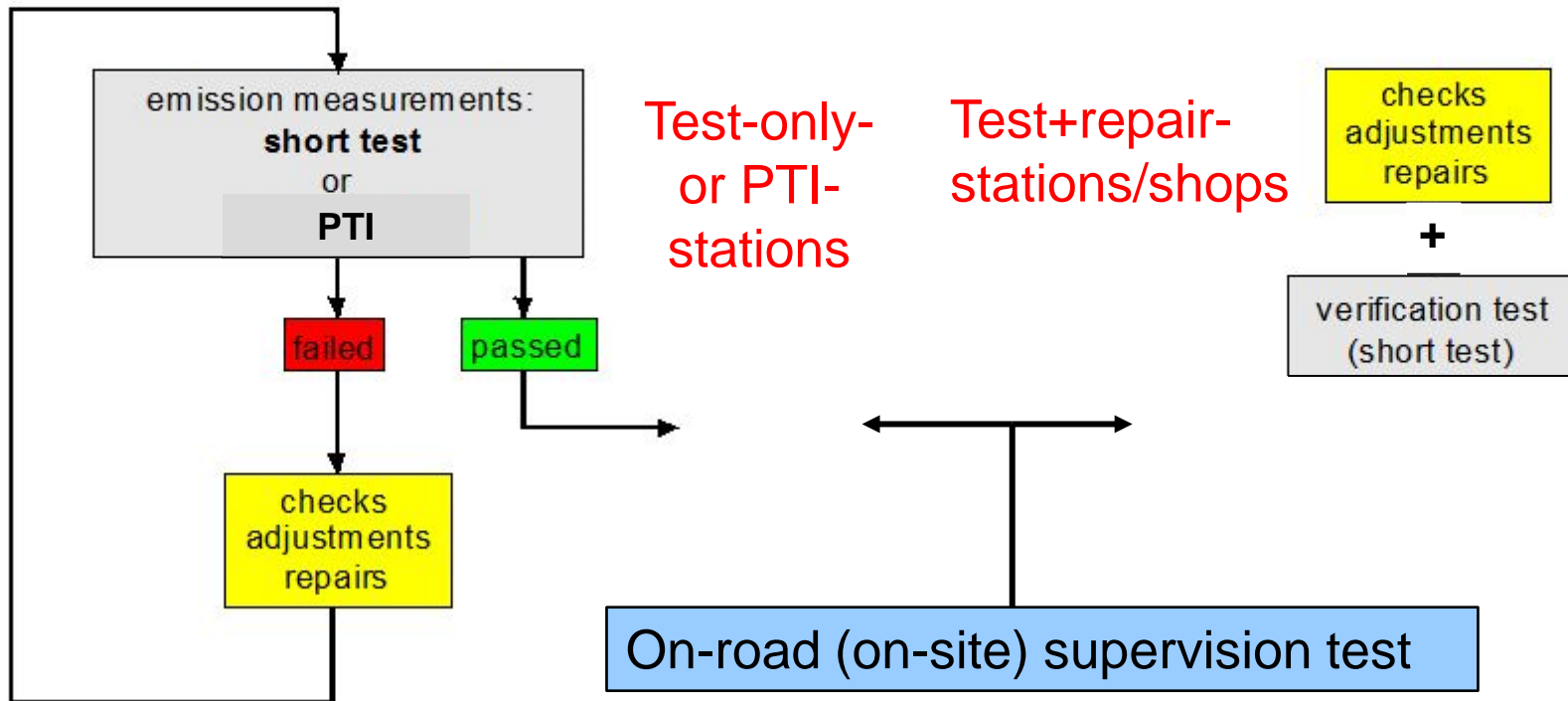
2 General I&M Strategies

A

**EFFECTIVENESS TEST
of EMISSION CONTROL SYSTEM
or PTI**

B

**PERIODIC
EMISSION CONTROL SYSTEM
MAINTENANCE**



I&M Concept Elements (1)

(to be defined)

- **Vehicle categories liable to I&M**
- **I&M concept**
- **I&M procedures:**
 - checks
 - tests etc.
- **I&M intervalls**
- **Quality criteria for I&M performers:**
 - personnel
 - equipment
- **Certification of I&M performers**

I&M Concept Elements (2)

- **Costs**
- **Data collection / individual documentation**
- **Quality control of I&M performers:** e.g. test equipment (periodical calibration)
- **Enforcement by on-road tests:**
 - procedure
 - crew training
 - equipment
 - financing
 - fines

etc.

Typical I&M Procedure - Checks

INSPECTION

- ① Regular inspection (e.g. busses every 6 month, accredited *institution*)
- ② Supervision on-road (on-site) (*authorities*)

MAINTENANCE (Part II)

Periodical maintenance of emission relevant components (*user, workshop*)

Typical I&M Procedure - Checks

- ① Regular inspection (e.g. busses every 6 month, accredited *institution*)
- ② Supervision on-road (on-site) (authorities)

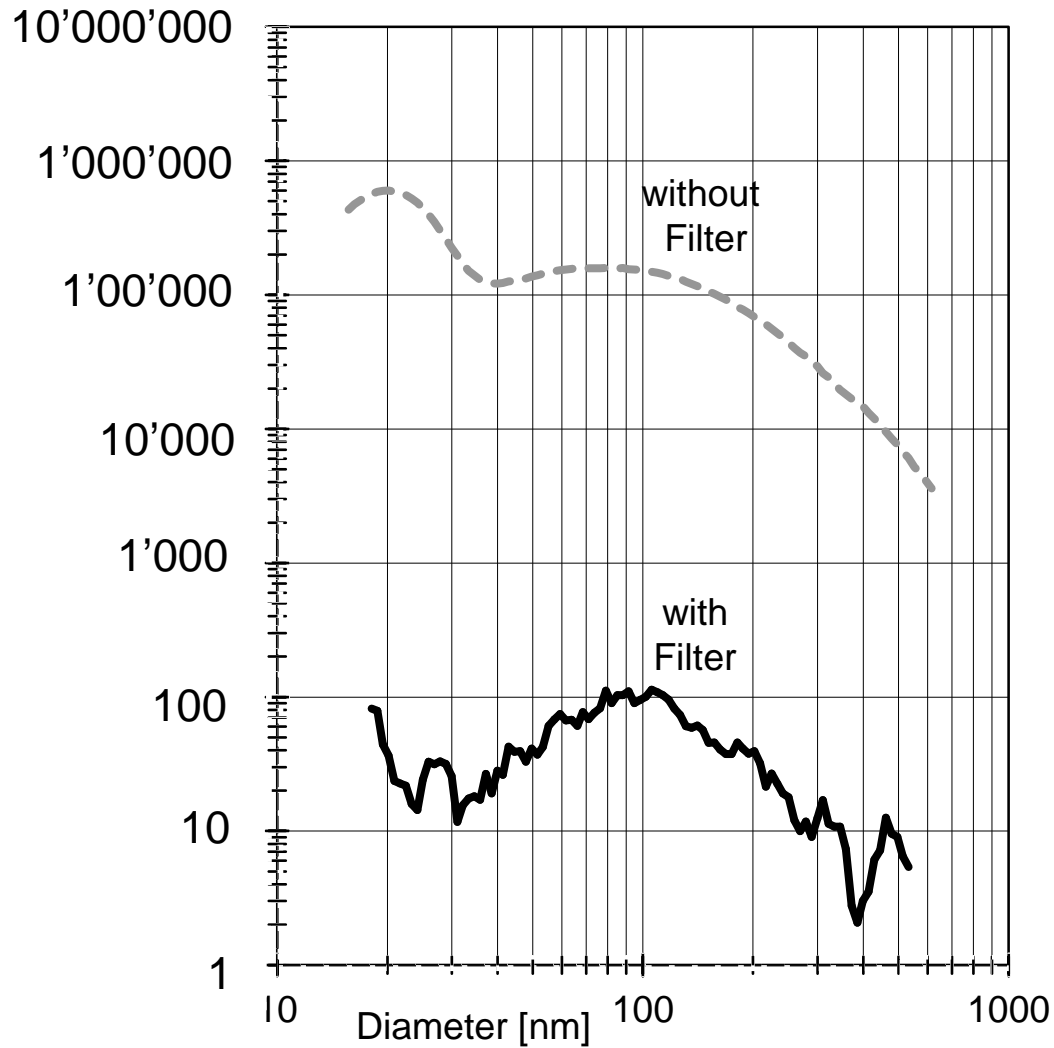
Regular Inspection – Inspection Scope

①

- Identification of the vehicle, engine, DPF
- Visual inspections: engine, DPF system
- OBD check
- Measurement of PN at **low idle** (end pipe)
 - PN < 250'000/cc → filter system OK **pass**
 - PN > 250'000/cc → filter or engine failure **fail**
- **Confirmation** in the inspection document
 - ▶ In case of failure of short test or PTI: A regular **engine** and **DPF system maintenance** and a retest are mandatory

Number/Size-Distribution

Number of particles / cm³
per size class (60)



Source: IBIDEN

Individual Documentation

- Content:**
- Vehicle main data
 - Filter main data, fitting date
 - Datalogger
 - Engine main data:
 - low idle speed
 - PN before and after filter at low idle speed
 - rubrics for inspection confirmations

CH Inspection Document (Example)

ABGAS-WARTUNGSDOKUMENT
FICHE D'ENTRETIEN DU SYSTÈME ANTIPOLLUTION
DOCUMENTO SULLA MANUTENZIONE RELATIVA AI GAS DI SCARICO
<p>Diesel</p> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: 80%;"> Muss stets im Fahrzeug mitgeführt werden Doit toujours rester dans le véhicule Il presente documento deve sempre accompagnare il veicolo </div> <div style="margin: 10px auto; width: 40px; text-align: center;"> </div> <p style="font-size: small;">Gesetzliche Vorschriften auf Seite 6 und 7 Voir prescriptions légales aux pages 6 et 7 Prescrizioni legali, vedere pagine 6 e 7</p>

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 VSBM-Sekretariat, c/o VSIÖ, Postfach 656, CH-4010 Basel

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① Fahrzeugdaten / Données du véhicule / Dati del veicolo
<ul style="list-style-type: none"> • Marke Marche Marca • Fahrzeugtyp Type du véhicule Tipo veicolo • Fahrgestell-Nr. No du châssis Telajo no • Motor-Kennzeichen Identification du moteur Identificazione motore
② Messbedingungen / Conditions de mesure / Condizioni di misurazione
<ul style="list-style-type: none"> • Motor auf Betriebstemperatur bringen. - Alle elektrischen Verbraucher ausschalten. - Erfolgt die Messung in grösseren Höhen als 600 m ü. M., so sind bei Fahrzeugen ohne Druckkorrektur zur Berücksichtigung des Höheneinflusses vom gemessenen Wert, je 0,25 m⁻¹ bzw. 0,5 Bacharach pro 400 m grössere Höhe abzuziehen. Es ist der korrigierte Wert einzutragen. - Weitere Angaben des Herstellers beachten. • Chausser le moteur à sa température de marche. - Déclencher tous les consommateurs électriques. - Pour tenir compte de l'influence de l'altitude sur les véhicules sans correction de pression, lorsque des mesures sont effectuées à des altitudes excédant 600 m, on déduira respectivement 0,25 m⁻¹ ou 0,5 indice de noircissement Bacharach par tranche de 400 m au-dessus. - Il y a lieu d'inscrire la valeur corrigée sur la fiche d'entretien. - Consulter attentivement les indications du constructeur. • Portare il motore a temperatura di marcia. - Staccare tutti i consumatori di elettricità. - Per poter tener conto dell'influenza barometrica esercitata sui veicoli senza correttore di pressione, nel caso di misurazioni effettuate ad altitudini superiori a m. 600, si dedurrà rispettivamente 0,25 m⁻¹ o 0,5 indice di opacizzazione Bacharach per fasce supplementari di 400 m. - Solo il valore corretto viene registrato sul foglio di manutenzione. - Attenersi alle indicazioni del costruttore.

2

Sollwerte des Herstellers	Valeurs du constructeur	Dati del costruttore
③ Kontrollwerte / Indications de réglage / Indicazioni di regolazione		
<ul style="list-style-type: none"> • Leerlaufdrehzahl Régime de ralenti Régime del minimo 		min ⁻¹
<ul style="list-style-type: none"> • Obere Leerlaufdrehzahl Régime maximal à vide Régime massimo, a vuoto 		min ⁻¹
<ul style="list-style-type: none"> • Förderbeginn Commencement du débit Inizio mandata 	<ul style="list-style-type: none"> - statisch statique - dynamisch dynamique 	mm ³
<ul style="list-style-type: none"> • Plomben und/oder Versiegelungen Plombs et/ou sceaux Piombi e/o sigilli 		°/min ⁻¹
④ Rauchemissionswerte / Valeurs des émissions de fumées / Valori delle emissioni di fumo		
<ul style="list-style-type: none"> • Trübungskoeffizient Coefficient d'opacité coefficiente d'opacità 	maximal maximum massimo	m ⁻¹
<ul style="list-style-type: none"> • Schwärzungszahl Degré de noircissement grado di annerimento 	maximal maximum massimo	Bacharach
⑤ Bestätigung / Attestation / Attestazione		
		Datum
		Sign.
<ul style="list-style-type: none"> • Der Unterzeichnende bestätigt, dass die Abgaswartung nach Herstellerantrieb und unter Verwendung der vorgeschriebenen Messgeräte ausgeführt wurde. • Le souigné atteste que le service d'entretien du système antipollution a été exécuté conformément aux indications du constructeur et en utilisant les appareils de mesure prescrits. • Il firmatario attesta che il servizio di manutenzione del sistema anti-inquinamento conformemente alle indicazioni del costruttore e utilizzando gli apparecchi di misura prescritti. 		Stempel / Timbre / Timbro

Typical Inspection Procedures

- ① Regular inspection (e.g. busses every 6 month, *authorized institution*)
- ② **Supervision on-road (on-site) (*authorities*)**

Supervision Test – On-road / On-site

②

- Identification of the vehicle
- Measurement of PN at **low idle** (end pipe)
- If the limit of **250'000/cc** is exceeded:
 - ▶ then the operator of the vehicle is obliged to a regular engine and DPF system maintenance procedure and a retest by an authorized institution
- **Confirmation** in the inspection document



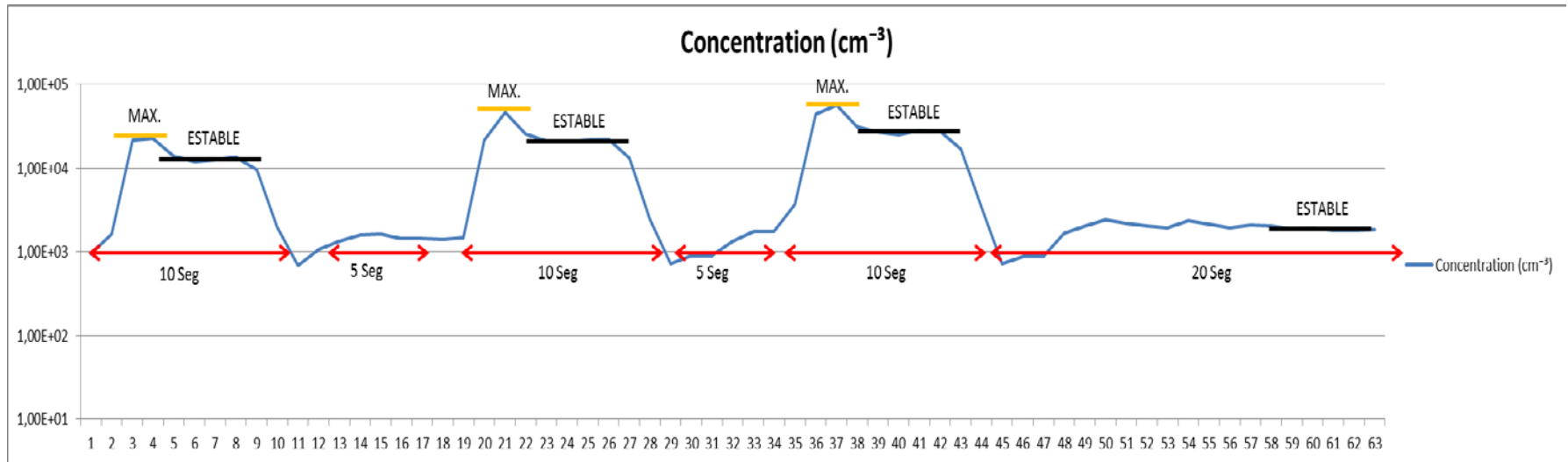
On-road Check

Santiago de Chile,
July 2015

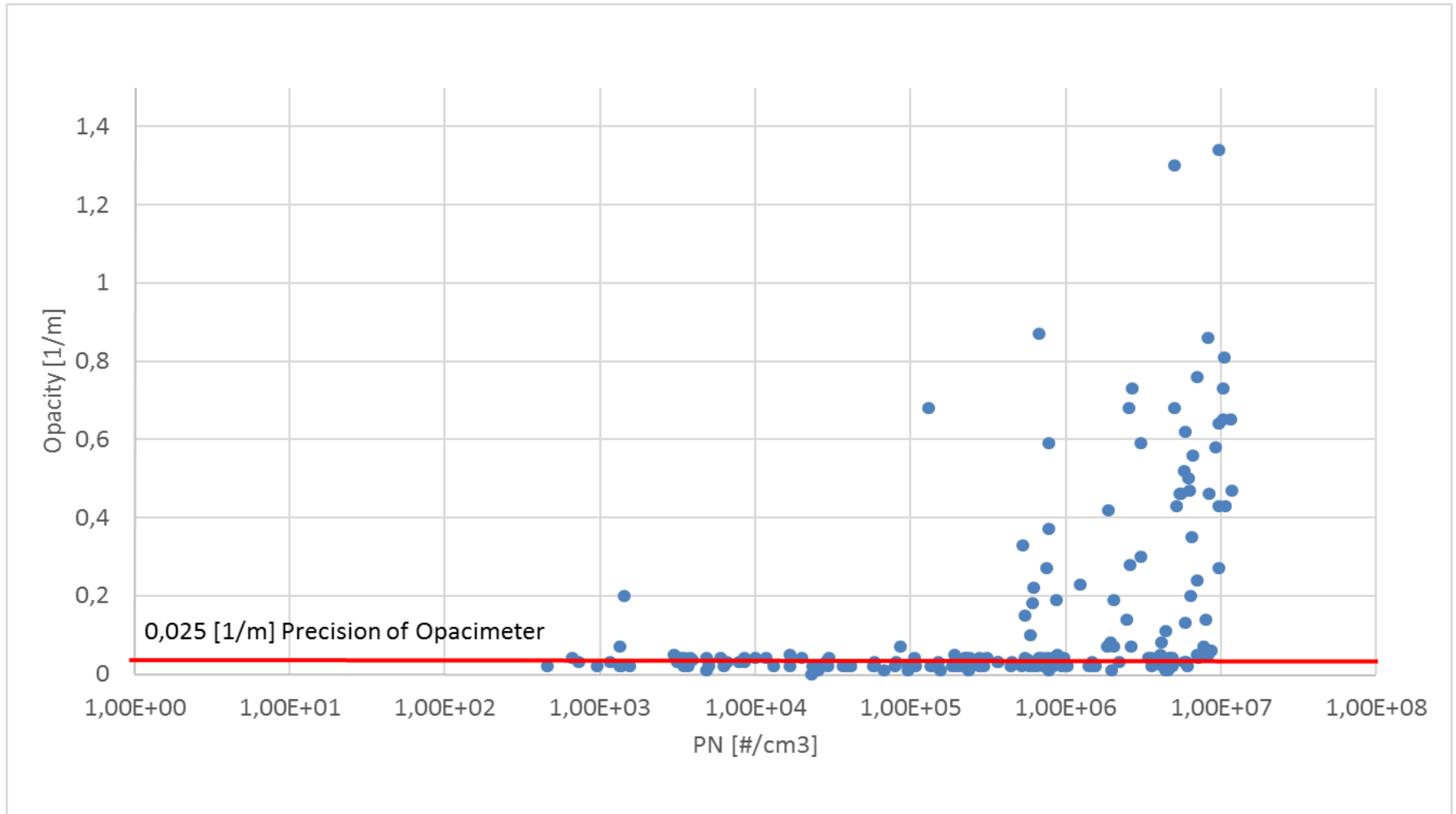
Equipment:
TSI-NPET

On-Road Exhaust Pipe End Measurements

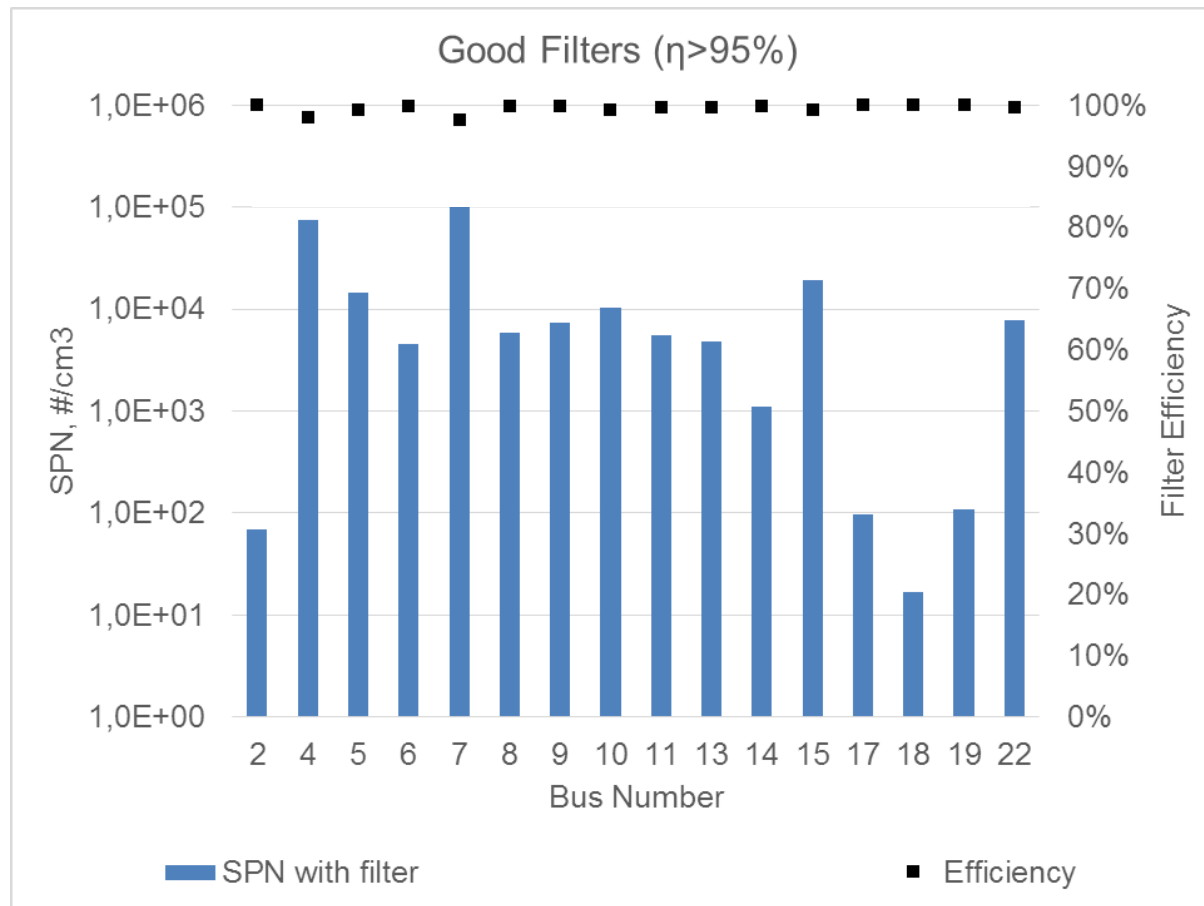
Opacity and particulate number (PN)



Opacity v/s PN Measurement



Low Idle End Pipe PN and DPF Efficiency (Busses)



**Inspecting vehicles does not
reduce pollution,
MAINTAINING / REPAIRING
them does**

Cliff Grove, Automotive Diagnostics,
SPX Corporation, USA 1996