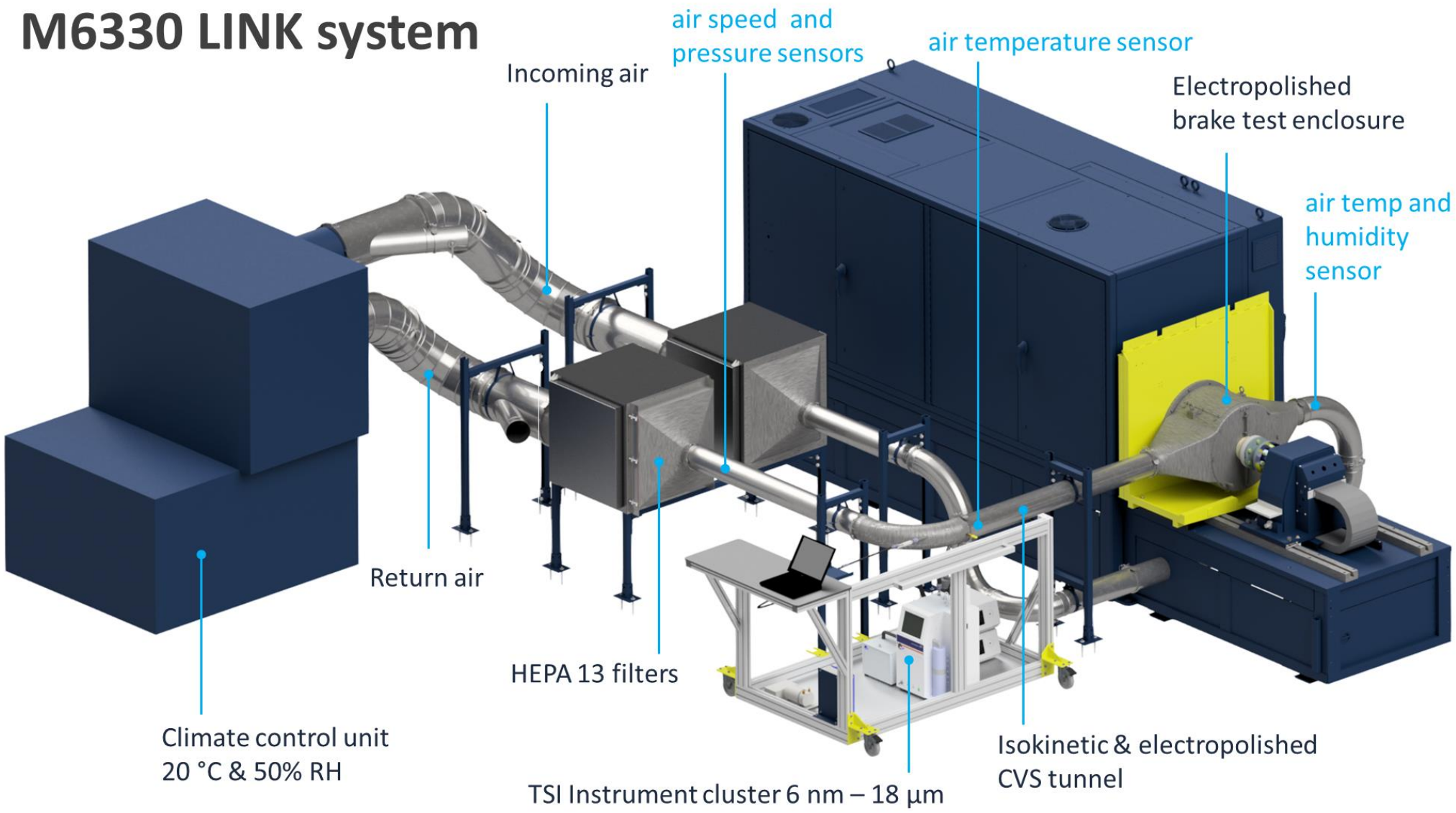
Brake Emissions LINK System

Link Testing Laboratories, Dearborn MI

01/30/2020

Brake emissions testing service accredited to ISO 17025:2015

Engineering, lab processes, and fully-integrated test reports



Validation with industry standards

The current systems reflect several design and experimental iterations

While we have taken steps to ensure the accuracy of this Internet version of the document, it is not the official version. Please refer to the official version in the FR publication, which appears on the Government Printing Office's eCFR website: (http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&pl=/ecfrbrowse/Title40/40cfr60_main_02.tpl).

Method 1A—Sample and Velocity Traverses for Stationary Sources With Small Stacks or Ducts

Note: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling) essential to its performance. Some material is incorporated by reference from other methods this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test method: Method 1.

1.0 Scope and Application

1.1 Measured Parameters. The purpose of the method is to provide guidance for the selection of sampling ports and traverse points at which sampling for air pollutants will be performed pursuant to regulations set forth in this part.

1.2 Applicability. The applicability and principle of this method are identical to Method 1, except its applicability is limited to stacks or ducts. This method is applicable to flowing gas streams in ducts, stacks, and flues of less than about 0.30 meter (12 in.) in diameter, or 0.071 m^2 (113 $in.^2$) in cross-sectional area, but equal to or greater than about 0.10 meter (4 in.) in diameter, or 0.0081 m^2 (12.57 $in.^2$) in cross-sectional area. This method cannot be used when the flow is cyclonic or swirling.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method

2.1 The method is designed to aid in the representative measurement of pollutant emissions and/or total volumetric flow rate from a stationary source. A measurement site or a pair of measurement sites where the effluent stream is flowing in a known direction is (are) selected. The cross-section of the stack is divided into a number of equal areas. Traverse points are then located within each of these equal areas.

...meter stacks or ducts, the conventional Method 5 stack assembly ...ached to a sampling probe, equipped with a nozzle and ...-section of the duct and causes inaccurate ...mall stacks or ducts, the gas ...sampling site.

Pt. 1065 40 CFR Ch. I (7–1–12 Edition)

PART 1065—ENGINE-TESTING PROCEDURES

Subpart A—Applicability and General Provisions

Sec.
1065.1 Applicability.
1065.2 Submitting information to EPA under this part.
1065.5 Overview of this part 1065 and its relationship to the standard-setting part.
1065.10 Other procedures.
1065.12 Approval of alternate procedures.
1065.15 Overview of procedures for laboratory and field testing.
1065.20 Units of measure and overview of calculations.
1065.25 Recordkeeping.

Subpart B—Equipment Specifications

1065.101 Overview.
1065.110 Work inputs and outputs, accessory work, and operator demand.
1065.120 Fuel properties and fuel temperature and pressure.
1065.122 Engine cooling and lubrication.
1065.125 Engine intake air.
1065.127 Exhaust gas recirculation.
1065.130 Engine exhaust.
1065.140 Dilution for gaseous and PM constituents.
1065.145 Gaseous and PM probes, transfer lines, and sampling system components.
1065.150 Continuous sampling.
1065.170 Batch sampling for gaseous and PM constituents.
1065.190 PM-stabilization and weighing environments for gravimetric analysis.
1065.195 PM-stabilization environment for in-situ analyzers.

Subpart C—Measurement Instruments

1065.201 Overview and general provisions.
1065.202 Data updating, recording, and control.
1065.205 Performance specifications for measurement instruments.

MEASUREMENT OF ENGINE PARAMETERS AND AMBIENT CONDITIONS

1065.210 Work input and output sensors.
1065.215 Pressure transducers, temperature sensors, and dewpoint sensors.

FLOW-RELATED MEASUREMENTS

1065.220 Fuel flow meter.
1065.225 Intake-air flow meter.
1065.230 Raw exhaust flow meter.
1065.240 Dilution air and diluted exhaust flow meters.
1065.245 Sample flow meter for batch sampling.
1065.248 Gas divider.

CO AND CO_2 MEASUREMENTS

1065.250 Nondispersive infrared analyzer.

HYDROCARBON MEASUREMENTS

1065.260 Flame ionization detector.
1065.265 Nonmethane cutter.
1065.267 Gas chromatograph with a flame ionization detector.

NO_X AND N_2O MEASUREMENTS

1065.270 Chemiluminescent detector.
1065.272 Nondispersive ultraviolet analyzer.
1065.275 N_2O measurement devices.

O_2 MEASUREMENTS

1065.280 Paramagnetic and magnetopneumatic O_2 detection analyzers.

AIR-TO-FUEL RATIO MEASUREMENTS

1065.284 Zirconia (ZrO_2) analyzer.

PM MEASUREMENTS

1065.290 PM gravimetric balance.
1065.295 PM inertial balance for field-testing analysis.

Subpart D—Calibrations and Verifications

1065.301 Overview and general provisions.
1065.303 Summary of required calibration and verifications.
1065.305 Verifications for accuracy, repeatability, and noise.
1065.307 Linearity verification.
1065.308 Continuous gas analyzer system-response and updating-recording verification—for gas analyzers not continuously compensated for other gas species.
1065.309 Continuous gas analyzer system-response and updating-recording verification—for gas analyzers continuously compensated for other gas species.

MEASUREMENT OF ENGINE PARAMETERS AND AMBIENT CONDITIONS

1065.310 Torque calibration.
1065.315 Pressure, temperature, and dewpoint calibration.

FLOW-RELATED MEASUREMENTS

1065.320 Fuel-flow calibration.
1065.325 Intake-flow calibration.
1065.330 Exhaust-flow calibration.
1065.340 Diluted exhaust flow (CVS) calibration.
1065.341 CVS and batch sampler verification (propane check).
1065.342 Sample dryer verification.
1065.345 Vacuum-side leak verification.

CO AND CO_2 MEASUREMENTS

1065.350 H_2O interference verification for CO_2 NDIR analyzers.

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INTERNATIONAL STANDARD **ISO 9096**

Third edition 2017-09

Stationary source emissions — Manual determination of mass concentration of particulate matter

Émissions de sources fixes — Détermination manuelle de la concentration en masse de poussières

Reference number ISO 9096:2017(E)

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INTERNATIONAL STANDARD **ISO 12103-1**

Second edition 2016-03-01

Road vehicles — Test contaminants for filter evaluation —
Part 1: Arizona test dust

Véhicules routiers — Poussière pour l'essai des filtres — Partie 1: Poussière d'essai d'Arizona

Reference number ISO 12103-1:2016(E)

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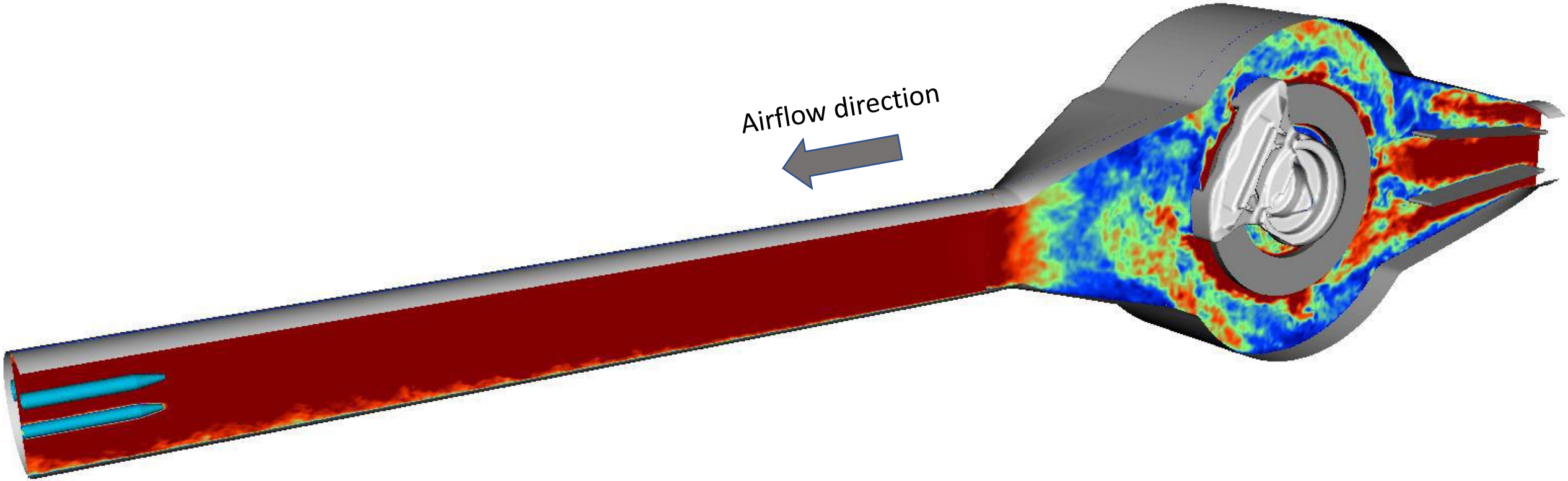
Particle sampling (SIMULATED)

Particles (AZ test dust ISO 12103:2016) collected downstream of enclosure

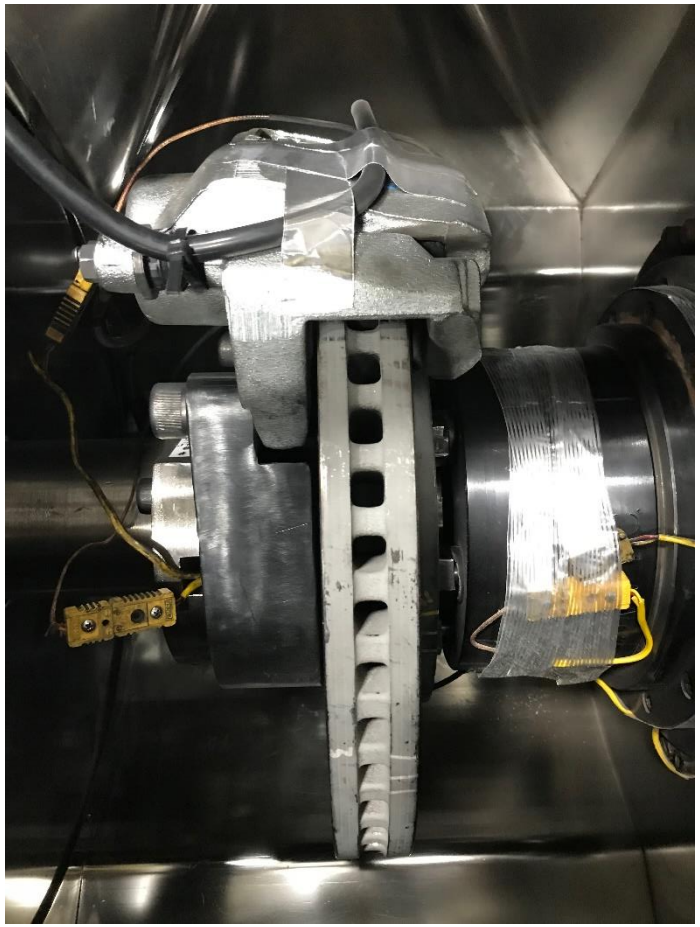


Nozzles 1, 2, 3

Validation with experimental evaluations

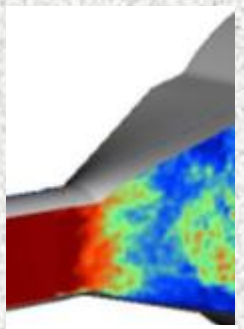
Particles (AZ test dust ISO 12103:2016) injected along rotor tangential direction

TSI 3410L
Dust Aerosol Generator

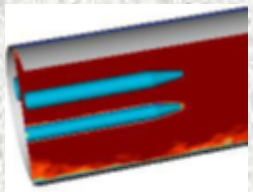


Particle count history in duct using CFD v. Experimental test

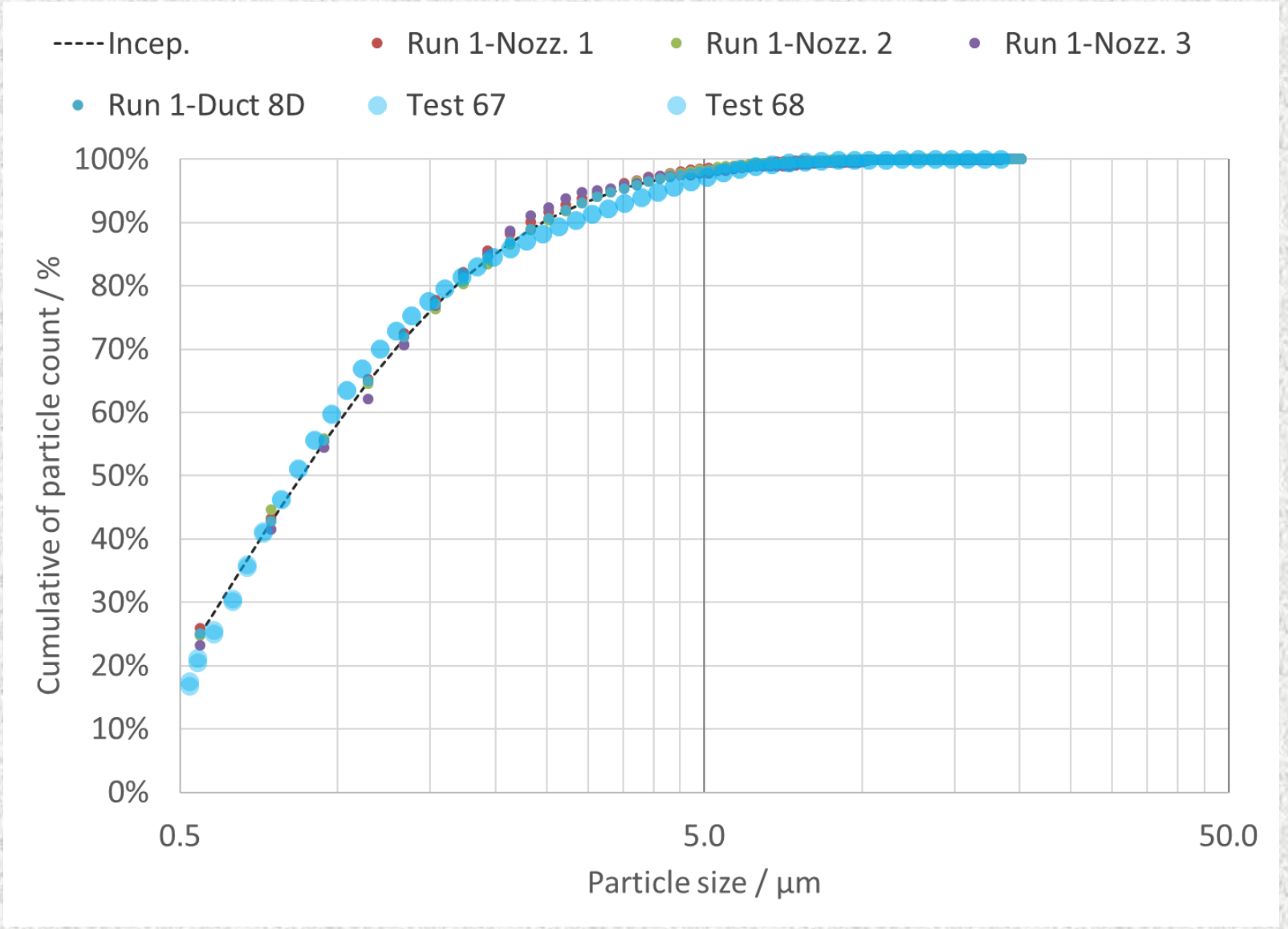
Particle history matches for inception, nozzle CFD simulation, and experimental data



Inception



Nozzles 1, 2, 3

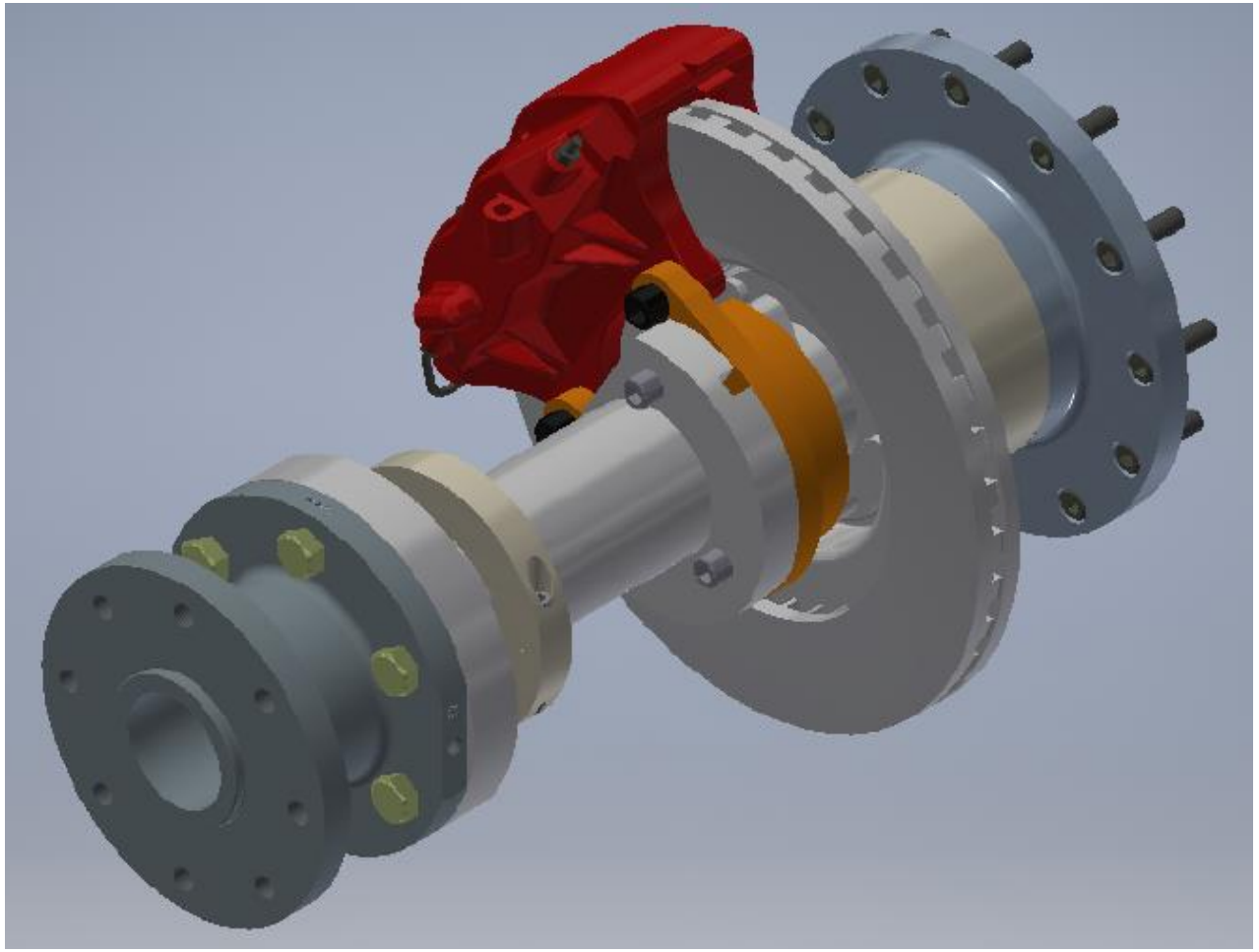


Post (universal) fixture

less turbulent flow

minimize particle retention

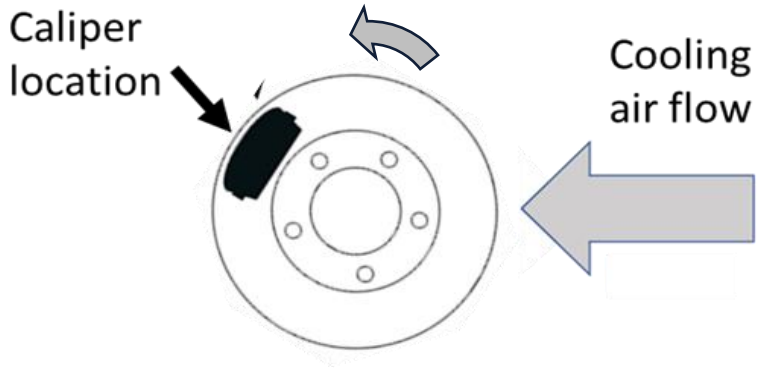
provide predicable interface with enclosure



Other design and test setup considerations

ENCLOSURE

- Avoid abrupt transition in the shape. Transition angle < 30 degree is recommended per [*Aerosol Measurements* – Kulkarni, Baron, and Willeke]
- Employ curved edges to reduce flow recirculation zones
- Enclosure and transport duct designed in a way to have particle residence times less than 3 seconds (preferably < 2 seconds)
  - Electropolished walls for high surface finish
  - Compact enclosure (sizing spec TBD)



TEST SETUP

- Post-style fixtures to achieve better air-tight sealed walls
- Recommended caliper position – Far end of airflow path and at 10 ‘O clock position looking from vehicle drive axle
- Recommended brake rotation – Along the airflow direction (CCW in the figure shown)

LINK

Test Smarter

Brake Emissions LINK System

SAE 2019-01-0059

Design of Experiments for Effects and Interactions During Brake Emissions Testing Using High-Fidelity Computational Fluid Dynamics

SAE 2018-01-1886

Estimation of Transport Efficiency for Brake Emissions Using Inertia Dynamometer Testing