

Advanced Powertrain Technical Leadership Council: Advanced Evaporative Technical Partnership

USCAR Non-Fuel-Based Evap Hydrocarbon Test Procedure

Introduction

The California Air Resources Board (CARB) and the Environmental Protection Agency (EPA) require all manufacturers to perform evaporative emissions SHED testing to certify vehicles in North America. SHED testing is also required globally in select markets. Evaporative emission SHED testing measures hydrocarbon emissions from all of the vehicle systems and subsystems. This includes fuel based and non-fuel-based hydrocarbon emission sources. This document will focus specifically on non-fuel-based component testing.

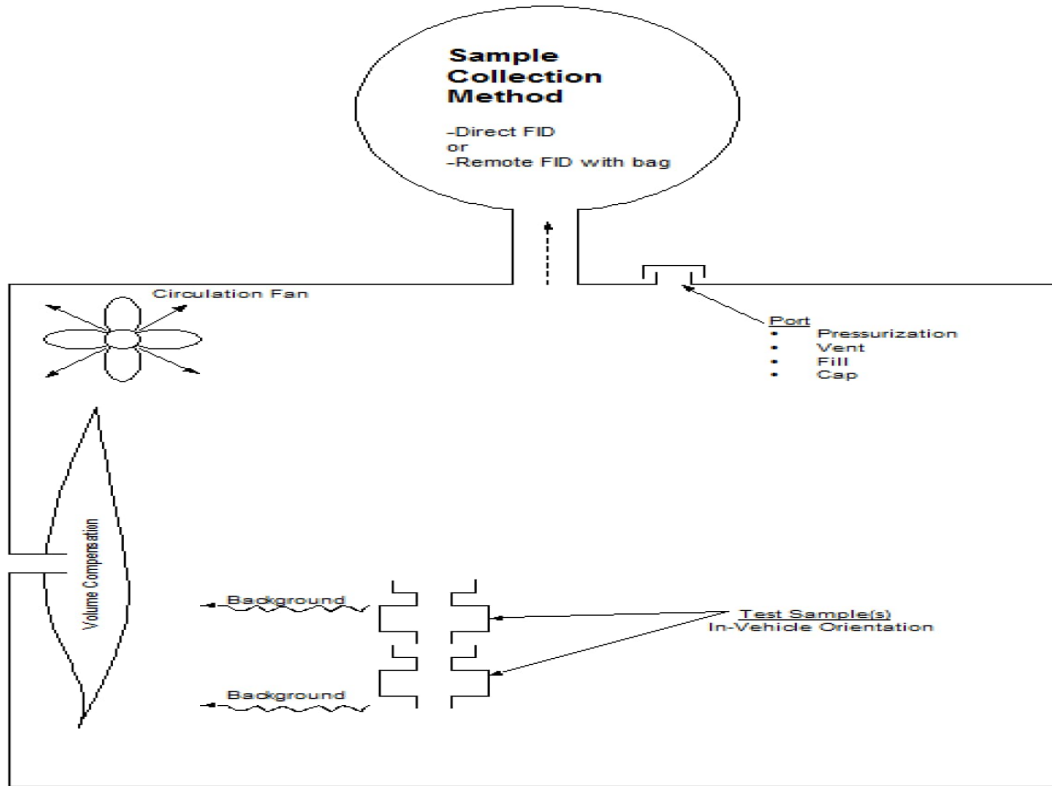
This document will function as a standardized procedure to improve the test accuracy for the non-fuel-based component testing. This procedure can be used by OEMs and the supply base to produce repeatable and reproducible results.

Testing of liquid fluids utilized in the vehicle propulsion system are outside of the scope of these test procedures.

Equipment & Facilities

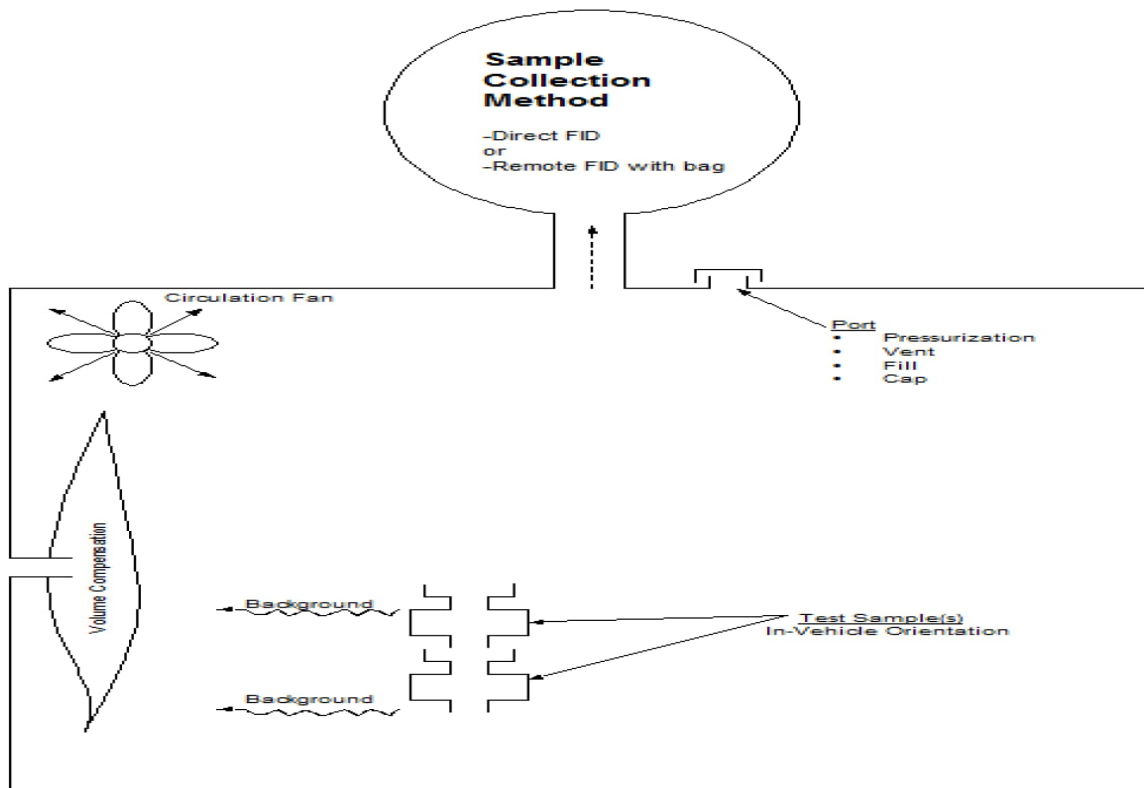
A) Micro/Mini-SHED Method





B) Vehicle SHED Method





The SHED utilized should be selected based on the size of the samples or components and expected hydrocarbon emission levels. Small sized samples or components should be tested in Micro or Mini-SHEDs. Test samples that are expected to have low levels of hydrocarbon emissions (less than 250 mg) should also be tested in Micro or Mini-SHEDs. Large sized samples or components should be tested in a vehicle SHED. Test samples that are expected to have high hydrocarbon emissions levels (greater than 250 mg) should also be tested in a Vehicle SHED.

The SHED size and the volume of component(s) should be selected so that the test sample is within 2 to 8 percent of the total SHED volume. The test requestor can deviate from this guidance for small samples of sealer or adhesive material placed on metal sample test plates.

The test component volume should be calculated and used in the calculation for determining hydrocarbon SHED mass. For full size Vehicle SHED testing of components the 50 cubic foot value (1.42 cubic meters) specified in the EPA 40 CFR §86.143(b)(1)(i) should be utilized.

The example SHED schematics displayed are for variable volume SHEDs. Variable or fixed volume SHEDs can be used. However, it is preferred that variable volume Micro or Mini-SHEDs be used due to the expected low levels of hydrocarbon emissions.

Vehicle SHED testing of components can be either variable or fixed volume SHED designs due to the higher emissions levels expected.

The SHEDs utilized for testing should meet the specifications, operating conditions and calibration requirements outlined in the EPA 40 CFR sections §86.107-96(a), §86.107-98(h) – (j), §86.116-94 and §86.117-96. And include the modifications to the EPA CFR sections outlined in the CARB evaporative emissions test procedures regarding SHED calibration in Part III.B.

The test component(s) soak and SHED testing areas should be controlled to the temperature and humidity requirements specified in EPA 40 CFR §86.130-96(c) and §86.132-96(h)(1)(ii). If the humidity requirements cannot be met the test laboratory should notify the party requesting the testing. It is also best to avoid rapid and large changes in barometric pressure during SHED testing.

The SHED diurnal test procedures and calculations specified in EPA 40 CFR sections §86.143-96 and §86.133-96 should be followed. The exception to the EPA regulations is that the evaporate test procedure will consist of a single 24-hour diurnal test cycle. And the diurnal temperatures specified in Part III.D.10.1.6 of the CARB evaporative emissions test procedures should be utilized.

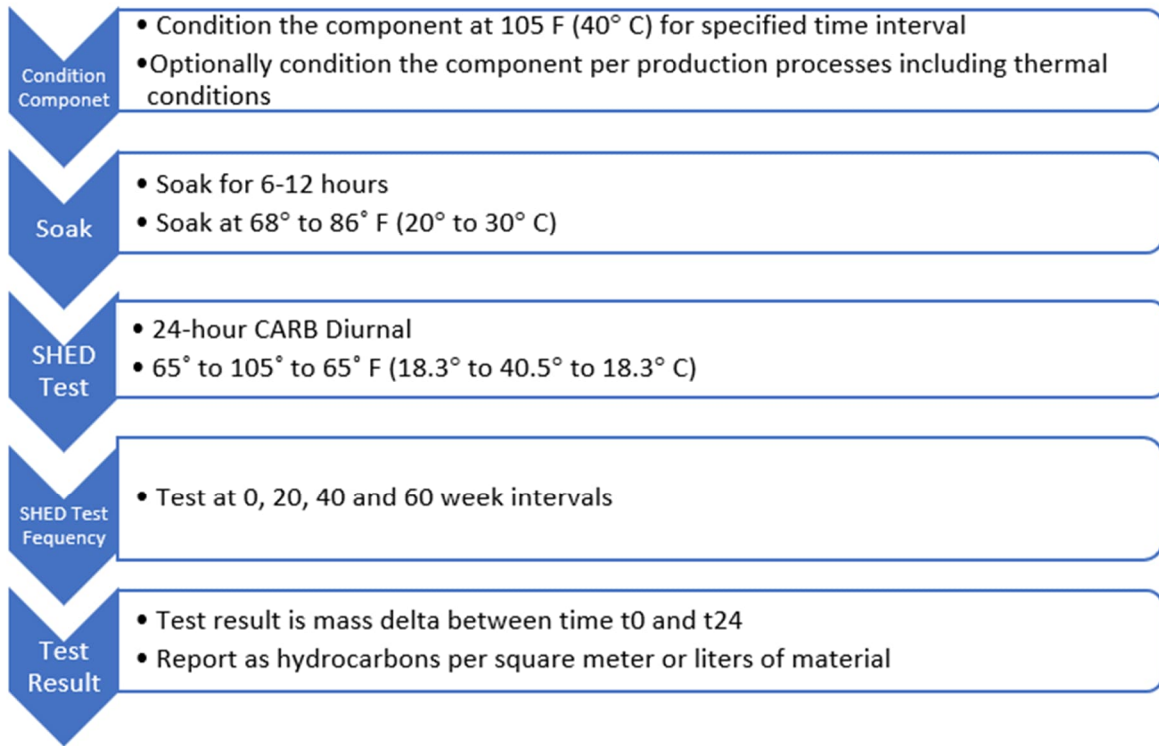
The SHED(s) FID analyzer is used to measure hydrocarbon emissions. Ethanol speciation, gas chromatography or mass spectrometer analysis for individual hydrocarbon contributions is not required but can be utilized as additional reference data.

Test fixtures (i.e., carts, tables or test stands) should be used to support the components to allow for air circulation around the component. Brackets or fixtures may be necessary to elevate the component on the test fixtures. The test fixtures should be clean and metallic for low hydrocarbon contribution. The test fixtures should be tested to confirm the hydrocarbon contribution level. The test fixtures hydrocarbon contribution could be subtracted from component test results. If possible, the test component(s) should be at approximately the vertical midpoint of the Mini-SHED. For Vehicle SHED component testing the component(s) should be positioned at the height of the SHED wall thermocouple(s) or RTD(s). The test components should be positioned in the vehicle orientation.

Test Fixture Examples



Test Procedure



The test requestor should specify the time zero test condition of the component to be tested. The component can be tested as received or optionally condition the component(s) per the process used in the production of the component(s) and vehicle. This should include estimated component(s) age and any thermal exposure process such as temperature conditioning.

The standard component conditioning temperature is 105° F (40° C) for the test requestor specified time period. The test requestor can specify a different conditioning temperature based on knowledge of the component and/or available transfer function information.

Prior to the SHED testing the test component(s) should be soaked for a minimum of 6 to 12 hours at normal vehicle temperature and humidity soak conditions (68° to 86° F or 20° to 30° C) and 50 +/- 25 grains of humidity per pound of dry air. This equates to a relative humidity of 34.9% +/- 17.2% at a temperature of 77° F (25° C). The humidity conditions are present to control to a dew point that is lower than the SHED starting temperature of 65° F (18.3° C).

SHED test the component(s) for a single 24-hour diurnal per the EPA CFR and CARB evaporative emissions test procedures regulations referenced above (65° – 105° – 65° F or 18.3° – 40.5° – 18.3° C). The test sample size at each test point should be three tests minimum.

SHED test the component(s) at 0, 20, 40 and 60 week intervals. Longer testing intervals may be required if the component is not stable at the 60 week test point. The test requestor can request different different testing intervals based on the expected response of the material or component.

The test component(s) should be soaked for the weekly testing intervals at normal vehicle temperature and humidity soak conditions per the EPA CFR sections referenced above (68° to 86° F and 34.9% +/- 17.2% relative humidity). Or the standard component conditioning of 105° F (40° C) for the test requestor specified time period. The test requestor can specify a different conditioning temperature based on knowledge of the component and/or available transfer function information.

The component conditioning temperature and duration for each test point should be noted and reported in the data test report.

Prior to SHED testing the test component(s) should be soaked for a minimum of 6 to 12 hours at normal vehicle temperature and humidity soak conditions per the EPA CFR sections referenced above (68° to 86° F or 20° to 30° C) and 50 +/- 25 grains of humidity per pound of dry air.

For solid material or general component(s) testing test individual components, subsystems or systems. Some component systems or subsystems may require that the complete system or subsystem be tested (i.e., charged air conditioning systems). For this test process an adequate amount of the material needs to be tested to avoid test results that are in within the measurement error of the SHED. If the hydrocarbon emission levels are expected to be at a low level larger test sample sizes are desirable. Or the sample size can be increased for smaller components. I.e., a testing a panel 1 m x 2 m (3 foot x 6 foot) may be adequate. But small panels such as 75 mm x 50 mm (3 inches x 2 inches) may be too small. In this case ten samples should be tested and the results divided by ten.

For semi-solid material testing of structural adhesives the test sample should be two 6 mm diameter beads that should be applied the full length to two 300 mm x 100 mm steel plates.

For semi-solid material testing of body sealers three 25 mm wide, 1.5 mm beads should be applied the full length to two 300 mm x 100 mm steel plates.

For fluid materials (i.e., stone chip and corrosion protection material, etc.) material full coverage should be applied to the surface area of two 300 mm x 100 mm steel plates.

Non-fuel-based liquids used for vehicle propulsion are out of scope of these test procedures. Examples are engine oil, power steering pump fluid, engine coolant and transmission fluid.

For small component or material sample testing an adequate amount of the material needs to be tested to avoid test results that are in within the measurement error of the SHED. For Mini-SHEDs the measurement error is +/- 0.31 mg. For test results less than 0.31 mg a value of 0.31 mg should be reported. The SHED background levels should also be at low levels. For a 24-hour background test the SHED FID result for a Mini-SHED should be 1 mg or less. Individual test laboratories should determine the correct measurement error and background values based on SHED size and full scale accuracy of the FID analyzer.

For large component(s) or material sample testing an adequate amount of the material needs to be tested to avoid test results that are in within the measurement error of the SHED. For Vehicle SHEDs the measurement error is +/- 15 mg. For test results less than 15 mg the test result value can be reported, but should be footnoted to be within the measurement error of the SHED. The SHED background levels should also be at low levels. For a 24-hour background test the Vehicle SHED FID result should be 5 mg or less. Individual test laboratories should determine the correct measurement error and background values based on SHED size and full scale accuracy of the FID analyzer.

Good engineering judgement should be utilized for component test setup and operation of the SHED test equipment.

The SHED results are the SHED hydrocarbon mass change between the time zero (t₀) and time 24-hours (t₂₄) SHED values. The calculations outlined in EPA 40 CFR §86.143-96(b)(1)(ii) and (iii) should be utilized. The methanol/ethanol emissions are assumed to zero. The term methanol is used in the EPA CFR but methanol or ethanol terms are deemed to be interchangeable in the CFR for evaporative emissions. The time zero (t₀) sample should be normalized to subtract the SHED background reading.

The SHED hydrocarbon mass value should be reported in mass of hydrocarbons per unit volume of square or cubic meters of the component or material tested. The request should determine if surface area or volume should be used based on the component or material being tested.

Since FID analyzers under report the ethanol or methanol emission contribution OEMs may want to use a multiplier to adjust the component or material hydrocarbon mass result.

For investigation to the required vehicle component hydrocarbon allocation the calculated hydrocarbon value per cubic or square meter for vehicle body and interior material can be scaled for the square or cubic meters of the material used on the vehicle.

Test Result Reporting Format

USCAR Non-Fuel Based Hydrocarbon SHED Report						
WRITTEN BY	Joe Smith	DATE	6/29/2023	REPORT NO	CR5758	COMMENTS
TEST PRE-CONDITIONING	2 WKS at 105' F	TEST TYPE	CARB	COMPONENT	BODY SEALER	
VOLUME TESTED	300 ml	TEST DURATION (Wks)	60	COMPONENT P/N	11112222	
TEST POINT (Weeks)		COMPONENT CONDITIONING	TEST RESULT (mass/300 ml)			
TEST POINT	0		TEST RESULT	3		
TEST POINT	0		TEST RESULT	3		
TEST POINT	0		TEST RESULT	3		
TEST POINT	20		TEST RESULT	4		
TEST POINT	20		TEST RESULT	4		
TEST POINT	20		TEST RESULT	4		
TEST POINT	40		TEST RESULT	4		
TEST POINT	40		TEST RESULT	4		
TEST POINT	40		TEST RESULT	6		
TEST POINT	60		TEST RESULT	6		
TEST POINT	60		TEST RESULT	6		
TEST POINT	60		TEST RESULT	6		

Abbreviations & Definitions

CARB – California Air Resources Board. The state government agency that regulates vehicle emissions in California and other states that adopt their regulations.

EPA – Environmental Protection Agency. The federal government agency that regulates vehicle emissions in the United States.

FID – Flame ionization analyzer for detecting hydrocarbon diurnal emissions in the Mini and Vehicle SHED enclosures.

RTD – Resistance temperature detector. The RTD measures temperature based on the relationship between temperature and resistance. The accuracy of RTDs is superior to thermocouples.

SHED – Sealed housing for evaporative determination. Can be a Mini-SHED, Micro-SHED or full size vehicle SHED for evaporative emission testing.

Source Documents

1. CARB CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2026 AND SUBSEQUENT MODEL YEAR PASSENGER CAR, LIGHT-DUTY TRUCK, MEDIUM DUTY VEHICLE AND HEAVY-DUTY VEHICLES
Amended: August 25, 2022
2. EPA Emission Regulations for 1997 and Later Model Year New Light-Duty Vehicles and New Light Duty-Trucks and New Otto-Cycle Heavy-Duty Vehicle: Test Procedures
3. Control of Air Pollution from Motor Vehicles: TIER 3 Motor Vehicle Emission and Fuel Standards; Final Rule.
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<u>Date</u>	<u>Revision</u>
3-21-24	Created the draft copy of the USCAR Non-Fuel Based Evap Hydrocarbon Test Procedure document.
6-26-24	Posted a copy of the test procedures to the USCAR site.