California Environmental Protection Agency
AIR RESOURCES BOARD

CALIFORNIA EVALUATION PROCEDURE FOR NEW AFTERMARKET DIESEL PARTICULATE FILTERS INTENDED AS MODIFIED PARTS FOR 2007 THROUGH 2009 MODEL YEAR ON-ROAD HEAVY-DUTY DIESEL ENGINES

NOTE: This is a new Evaluation Procedure. For clarity the final text is shown in normal type.

Adopted: October 3, 2016

Note: This document is incorporated by reference in section 2222(k), title 13, California Code of Regulations. It contains the criteria the Air Resources Board (ARB) will use to evaluate whether new aftermarket diesel particulate filters intended as modified parts for 2007-2009 model year on-road heavy-duty diesel engines qualify for exemptions from California Vehicle Code section 27156. An ARB exemption is required before any new aftermarket diesel particulate filter can be installed, sold, offered for sale, or advertised on a 2007-2009 model year on-road heavy-duty diesel engine operating in California.

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(a) APPLICABILITY

This evaluation procedure (Procedure) applies to manufacturers and installers of new aftermarket diesel particulate filters (DPF) that are designed or intended for use on 2007 through 2009 model year on-road heavy duty diesel engines originally equipped with DPFs.

This Procedure is not applicable to DPFs approved by the *Verification Procedure, Warranty, and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines* (Title 13, California Code of Regulations (CCR) Sections 2700-2711), DPFs that are in all material respects identical to the original equipment DPFs they are replacing, used DPFs, or to new aftermarket DPFs intended to replace original equipment manufacturer (OEM) DPFs that are constructed with metal substrates.

(b) DEFINITIONS

The definitions in Title 13, California Code of Regulations, Section 1900(b)[1], are hereby incorporated by reference herein. The following definitions shall govern the provisions of this Procedure:

"Advertise" and "Advertisement" include, but are not limited to, any notice, announcement, information, publication, catalog, listing for sale, or other statement concerning a product or service communicated to the public for the purpose of promoting the awareness or sale of the product or service.

"Alternative Diesel Fuel" means any fuel used in a diesel engine that is not commonly or commercially known, sold, or represented by the supplier as diesel fuel No. 1-D or No. 2-D, pursuant to the specifications in American Society for Testing and Materials (ASTM) D975-81, "Standard Specification for Diesel Fuel Oils," as modified in May 1982[2], which is hereby incorporated by reference herein, and does not require engine or fuel system modifications for the engine to operate, although minor modifications (e.g., recalibration of the engine fuel control) may enhance performance. Examples of alternative diesel fuels include, but are not limited to, biodiesel and biodiesel blends not meeting the definition of California Air Resources Board (CARB) diesel fuel; Fischer-Tropsch fuels; emulsions of water in diesel fuel; and fuels with a fuel additive.

[1] *Motor Vehicle Pollution Control Devices,* Title 13, CCR, §1900(b), October 8, 2015.
[2] American Society for Testing and Materials (ASTM), ASTM D975-81, *Standard Specification for Diesel Fuel Oils*, ASTM International, West Conshohocken, PA, May 1982.

"Applicant" means the entity that has applied for or has been granted an ARB approved exemption for the aftermarket DPF under this Procedure.

"Auxiliary Emission Control Device" (AECD) means any element of design which senses temperature, vehicle speed, engine revolutions per minute (RPM), transmission gear, manifold vacuum, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission control system.

"Average" means the arithmetic mean.

"Backpressure Monitor" means a device that includes a sensor for measuring the engine backpressure upstream of a hardware-based aftermarket DPF or component thereof installed in the exhaust system and an indicator to notify the operator when the backpressure exceeds specified high and in some cases low backpressure limits, as defined by the engine manufacturer or the aftermarket DPF manufacturer.

"Cold Start" means an engine transient cycle emission test following either natural or forced cool-down periods described in Sections 86.1334-84[3] and 86.1335-90[4] of the Code of Federal Regulations (CFR), Title 40, Part 86, as they existed on January 18, 2001 and September 5, 1997, respectively.

"Common ownership fleet" means on-road vehicles owned or managed day to day by the same person, corporation, partnership, or association. Vehicles managed by the same directors, officers, or managers, or by corporations controlled by the same majority stockholders are considered to be under common ownership or control even if their title is held by different business entities.

"Days" when computing any period of time, means normal working days on which ARB is open for business unless otherwise noted.

"Denied Warranty Claim" means a request from an end user to the installer or manufacturer for an inspection, repair, replacement, adjustment, or modification of a specific part or component of a new aftermarket DPF, or a claim that a vehicle or engine, due to a problem originating from a new aftermarket DPF needs inspection, repair, adjustment, or modification within the warranty period which is determined not to be a warrantable condition.

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[3] *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1334-84, January 18, 2001

[4] *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1335-90, September 5, 1997

"Diesel Engine" means an internal combustion engine with operating characteristics significantly similar to the theoretical diesel combustion cycle. The primary means of controlling power output in a diesel cycle engine is by limiting the amount of fuel that is injected into the combustion chambers of the engine. A diesel cycle engine may be petroleum-fueled (i.e., diesel-fueled) or alternative-fueled.

"Emission control group" means a set of diesel engines and applications determined by parameters that affect the performance of a particular new aftermarket DPF, including, but not limited to, certification levels of engine emissions, engine displacement, aspiration, horsepower rating, duty cycle, exhaust temperature profile, and fuel composition. The emission control groups are listed in the APPENDIX 1 of this Procedure.

"End user" means any individual or entity that has purchased a new aftermarket DPF for purposes other than resale or that owns or operates a vehicle powered by a 2007-2009 model year on-road heavy-duty engine equipped with a new aftermarket DPF.

"Engine Manufacturer Diagnostic (EMD) System" means a diagnostic system that complies with the requirements of title 13, CCR section 1971, "Engine Manufacturer Diagnostic System Requirements - 2007 and Subsequent Model Year Heavy-Duty Engines".

"Executive Officer" means the Executive Officer of the Air Resources Board or the Executive Officer's designee.

"Executive Order (EO)" is the document issued by ARB to exempt a new aftermarket DPF from the prohibitions of California Vehicle Code section 27156 if ARB's Executive Officer has determined that the new aftermarket DPF complies with the criteria specified in this evaluation procedure. An EO is required before new aftermarket DPFs may be legally advertised, sold, offered for sale, or installed on emission-controlled engines or vehicles. Each EO contains a unique number to allow for proper identification and verification of applicability.

"Good faith repair or replacement" means warranty repairs or replacement made solely for customer satisfaction purposes.

"Heavy-duty vehicle" means any motor vehicle having a gross vehicle weight rating greater than 14,000 pounds.

"Hot Start" means an engine emission test after starting a warmed-up engine. The first hot start Federal Test Procedure test run should be initiated 20 minutes after the cold

start for Federal Test Procedure testing following Section 86.1327-90[5] of the Code of Federal Regulations, Title 40, Part 86 as it existed on September 5, 1997.

"Independent test facility" means a laboratory or test facility that is not wholly or partially owned, controlled, or operated by the manufacturer seeking an exemption for new aftermarket DPFs or by any of its suppliers.

"Installer" or "Authorized Installer" means any individual or entity that equips or services any vehicle, engine or equipment with a modified part, and has the authorization of the party that holds the certification for the modified part pursuant to section (j)(2). All installers must be authorized by the applicant.

"Malfunction Indicator Light(MIL)" means a light that notifies the operator of a heavy-duty vehicle that the EMD system has detected a malfunction and that complies with the requirements of title 13, CCR, Section 1971(d)(2).

"Market-ready" means ready for introduction into commerce. A market-ready aftermarket DPF is not a prototype and requires no design modifications, part changes, or other changes prior to being sold to end users for commercial use. All components that are necessary for a market-ready aftermarket DPF to function properly are also commercially available.

"New aftermarket DPF" means a modified part that is constructed of all new materials that is intended to replace the OEM DPF which is designed and used primarily for the reduction of emissions on 2007 through 2009 model year on-road heavy-duty diesel engines.

"On-road heavy-duty diesel engine" means an engine and related aftertreatment components certified to the requirements of title 13, CCR, section 1956.8.

"Original Equipment Manufacturer (OEM) DPF" is a new DPF that is originally installed in a new on-road heavy-duty diesel engine's certified emission control system.

"Quarterly" refers to the following calendar periods: January 1 – March 31; April 1 – June 30; July 1 – September 30; October 1 – December 31.

[5] U.S. EPA, *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1327-90, September 5, 1997

“Recall” means an inspection, repair, replacement, adjustment, or modification program required by the Executive Officer and initiated and conducted by the applicant or its agent or representative for which direct notification of the end user is necessary.

“Regeneration” means the periodic or continuous combustion of collected particulate matter that is trapped in a particulate filter through an active or passive mechanism. Active regeneration requires a source of heat other than the exhaust itself to regenerate the particulate filter. Examples of active regeneration strategies include, but are not limited to, engine management and the use of fuel burners. Passive regeneration does not require a source of heat for regeneration other than the exhaust stream itself. Examples of passive regeneration strategies include, but are not limited to, the catalyst-coated particulate filter.

“Secondary emissions” means air pollutants that are not directly emitted but form as a result of reactions between emitted pollutants.

“Swapping” means the movement of same type aftermarket DPFs (same size and under same Executive Order) between different vehicles/engines covered by the governing Executive Order within common ownership fleet for cleaning purpose.

“Ultimate purchaser” means the first person who in good faith purchases a DPF for purposes other than resale.

“Used DPF” means any DPF that is not a new aftermarket DPF, a new replacement DPF as defined in title 13, CCR, section 1900(b)(20), or an original equipment manufacturer DPF that has been introduce into commerce.

“Warrantable Condition” means any condition of the new aftermarket DPF, vehicle, or engine which triggers the responsibility of the manufacturer or installer to take corrective action pursuant to this regulation.

“Warranty Claim” means a request from an end user to the manufacturer or installer for an inspection, repair, replacement, adjustment, or modification of a specific part or component of the new aftermarket DPF, vehicle, or engine within the warranty period.

(c) REQUIREMENTS FOR EXEMPTION

An applicant seeking an exemption from the prohibitions of California Vehicle Code section 27156 for its new aftermarket DPFs for 2007 through 2009 model year on-road heavy-duty diesel engines must submit sufficient information to substantiate that such

DPFs comply with the emissions performance, durability, and other requirements as set forth below.

(d) APPLICATION PROCESS

(1) Overview. Before submitting a final application for exempting a new aftermarket DPF for 2007 through 2009 model year on-road heavy-duty diesel engines from the prohibitions of California Vehicle Code section 27156, an applicant must submit a preliminary application (pursuant to section (d)(3)) in the format shown in section (d)(7). Only one emission control group can be included in a single application. An application must provide the information specified below in sections (1) (A) through (I):

(A) The new aftermarket DPF must rely on the use of sound principles of science and engineering.

(B) The new aftermarket DPF must not result in potentially harmful secondary emissions and must not pose a safety risk.

(C) The new aftermarket DPF must be constructed of materials that are equivalent to those used in the OEM DPF (e.g., mullite for mullite, cordierite for cordierite, silicon carbide for silicon carbide, aluminum titanate for aluminum titanate, etc.). The Executive Officer shall determine whether the materials are equivalent based on all information submitted by the applicant and based on good engineering judgment. The new aftermarket DPF must additionally possess equivalent physical dimensions (e.g., diameter, length, width), segmentation (e.g., segmented versus unsegmented), and shape (e.g., oval versus round) to the OEM DPF.

(D) Specifications of cells per square inch (CPSI), wall thickness, segmentation pattern, and porosity must be similar enough to the original part such that back pressure profiles, structural integrity, thermal tolerances, thermal shock parameter and filtration efficiency are not negatively impacted.

(E) The new aftermarket DPF must not allow exhaust emissions to bypass or circumvent the DPF or other OEM certified emission control device.

(F) The new aftermarket DPF may include an independent engine control unit (ECU) (i.e., not OEM engine ECU) or datalogger, additional sensors, wiring and the ECU components provided they do not adversely affect the OEM engine's ECU function.

(G) Applicant must obtain an approved test plan. See section (d)(3)(G) for more details on the test plan requirements. Additional requirements can be found in sections (e) through (h) of this Procedure. If the applicant's test plan meets all requirements, the Executive Officer will issue a test plan approval letter.

(H) Applicants must submit all test results (pursuant to sections (e), (f), (g), and (h)), along with comments and other information (pursuant to sections (i), (j), (k) and (l)), in a final exemption application to the Executive Officer, in the format

shown in section (d)(7). Submitted data must include all files recorded in its raw format as well as compiled and analyzed in a manner specified by the Procedure. The applicant must provide all data for the emission testing, laboratory aging, field service accumulation and compatibility demonstrations. All data collected from initial development of the product to apply aftermarket DPF exemption shall be submitted upon request.

(I) If the Executive Officer exempts a new aftermarket DPF from the prohibitions of Vehicle Code section 27156, the Executive Officer will issue an Executive Order for the device and identify any terms and conditions that are necessary to support the exemption.

(J) Applicants must not change part numbers for the same product or product components after obtaining an exemption. If an applicant wishes to change a part number, it must provide a part change request to ARB per section (d)(13).

(2) Emission Control Group. An application must be restricted to an emission control group and must include details regarding engine design criteria or engine programming which may vary across the group as well as a clear explanation of how the aftermarket DPF is appropriate for all engines and engine configurations within the emission control group. Duty cycle differences must also be addressed.

(A) The emission control group for any aftermarket DPF may only consist of engines from a single engine manufacturer and follow ARB determined emission control groups in APPENDIX 1.

(B) An applicant must not have multiple aftermarket DPF designs corresponding to a single emission control group.

(C) Engines or applications which are dissimilar or unrepresentative of other engines or applications within the proposed group, or that the part may be incompatible with an engine or duty cycle, cause atypical emissions (certified or secondary), pose a safety risk, impact engine durability, or be affected by the engine (e.g., durability of the part) may be excluded by the Executive Officer.

(3) Preliminary Exemption Application Requirements.

(A) Before formally submitting a final application for exemption of a new aftermarket DPF, the applicant must submit a preliminary application.

(B) The Executive Officer reserves the right to require the applicant to submit a fully-functional sample of the aftermarket DPF that is identical in all material respects to the new aftermarket DPF for which an exemption is requested. If such a request is made by the Executive Officer, the applicant must supply the fully-functional sample within 15 calendar days or the preliminary application will be terminated.

1. For new aftermarket DPFs that include multiple sizes, the Executive Officer will specify which size must be submitted.
2. The Executive Officer shall return, at the applicant's expense, the fully functional sample of the new aftermarket DPF after the request for exemption is either granted, denied, or withdrawn.

(C) The preliminary application must describe the aftermarket DPF and all associated components (e.g., backpressure monitors, sensors, electronic control units).

(D) No changes to the aftermarket DPF or all associated components, including materials, catalyst loadings and formulations, and control logic and algorithms are permitted. An applicant must submit a new preliminary application if the Executive Officer determines such changes no longer accurately represent the aftermarket DPF described in the initially described application for exemption. In making this determination, the Executive Officer will base his or her determination upon all information submitted by the applicant and based on good engineering judgment.

(E) The Executive Officer shall use the information in the preliminary application to determine whether the new aftermarket DPF meets the requirements specified in this Procedure and the need for additional analyses.

(F) The preliminary application must follow the format shown in section (d)(7) and include the information specified in (G) below.

(G) Test Plan Requirements.

1. The test plan must include test engines and testing conditions that are representative of the least favorable conditions within the requested emission control group for the aftermarket DPF. The least favorable conditions will be determined based on the aftermarket DPF design and target emission control group and using good engineering judgement. This will include, but is not limited to: the product's failure modes, impact on engine, impact on regeneration, impact on emissions profile of the engine, potential for secondary emissions, engine characteristics (e.g., including but not limited to displacement, horsepower, operating temperature, engine configuration, emissions profile, NOx emission levels, EGR operation, infrequent regeneration events, other aftertreatment components, other engine design characteristics, etc.), and application differences.
2. Detailed information supporting how the least favorable testing conditions are determined. The effects on the engine, other aftertreatment emission control systems or components (including exhaust gas recirculation systems), and the new aftermarket DPF must be provided.

3. The effects of emission profiles, exhaust backpressure, control logic, sizing and displacement, duty cycle, regeneration strategies, auxiliary emissions control devices, infrequent regeneration events, must be provided.
4. Any data collected prior to the issuance of the test plan approval letter must comply with all requirements of this Procedure, be formally submitted as part of the preliminary application (not a stand-alone submission), and must not have been generated prior to the approval of this Procedure. These prior data may not comprise the core of the application but may add breadth to data collected after the test plan approval. In addition, prior data may not be used to address any concerns ARB may have regarding the generation of secondary emissions.

(4) Signed Statement of Compliance.

(A) The applicant must submit a signed statement by the Chief Executive Officer or President of the applicant's company that all testing was completed in accordance with the requirements of this Procedure and the test plan approval letter. The statement must also affirm that all required data has been submitted and the applicable quality assurance and quality control has been verified to comply with the requirements of this Procedure, and the test plan approval letter. The statement must also attest to the fact that all testing, information, and data was obtained from a system matching the description in the application and test plan approval letter and that the description provided was comprehensive and did not omit or misrepresent any aspect of system design, function or emission control group information. Any omission or misrepresentation by an applicant, including the description of a new aftermarket DPF's construction, operation, potential to pose safety risks or emit deleterious secondary emissions will justify the Executive Officer to disapprove the application and terminate the application process.

(B) The applicant must also provide a statement that it acknowledges and agrees to:

1. Comply with the warranty requirements of section (l), including all recordkeeping and reporting requirements, including reporting if and when a 4 percent trigger is reached, and provide a description as to how it will comply with the reporting requirements. The warranty must be included in the final application package.
2. Comply with the quality control, audit, and recall provisions of section (j) including any recordkeeping requirements.

3. Keep records for no less than six years beyond the required warranty period, that contains the information required per section (d)(11).
4. Provide all maintenance information for the aftermarket DPF to the owner pursuant to section (j)(9)(B).

(5) All applications, correspondence, and reports, must be submitted in writing to:

CHIEF, IN-USE PROGRAMS BRANCH
AIR RESOURCES BOARD
9480 TELSTAR AVENUE, SUITE 4
EL MONTE, CALIFORNIA 91731

(6) Treatment of Confidential Information. Information submitted to the Executive Officer by an applicant may be claimed as confidential, in accordance with the procedures specified in Title 17, CCR, sections 91000-91022. The Executive Officer may consider such confidential information in reaching a decision on an aftermarket DPF exemption application.

(7) Application Format. The preliminary and final exemption applications must be submitted in writing to the address shown in subsection (5) above. Electronic mail and verbal submissions do not constitute acceptable application formats and will not be accepted. The preliminary and final exemption applications for a new aftermarket DPF must follow the format shown below. Final exemption applications must include all of the information provided in the preliminary exemption application as described in section (d)(3), including any additional information, updates, or changes, and all additional information shown below. Any substantive changes or modifications between documents or revisions of a document must be clearly identified (e.g., highlighted) and the applicant must attest in writing to the fact that no other product change, emission control group, or testing changes were made.

1. *Introduction*
   1.1 Identification of applicant, manufacturer of the market-ready aftermarket DPF, and general description of the aftermarket DPF.
      1.1.1 The applicant information must include the entity legally responsible for complying with all the requirements of the Procedure as well as any designated representative. To prevent confusion and misinformation, an applicant may only designate one authorized representative at a time.

1.1.2 A valid business address, telephone number(s), email, and any other information which assists in the identification of the applicant and allows ARB to easily contact it.

1.1.3 List of all manufacturers of all components of the aftermarket DPF as well as the combined system. If the applicant will allow subcontractors it must address this and ARB may request detailed information regarding these entities as well as quality control and quality assurance information on how the applicant controls this.

1.1.4 A general description of the aftermarket DPF.

1.2 Description of the OEM DPF.

1.2.1 Complete description of the OEM DPF including but not limited to part number, size(s)/dimensions of the DPF core itself as well as the canned part, core type (e.g., cordierite, silicon carbide, etc.), porosity, maximum soot loading capacity, median pore size, pore size distribution, cell density, wall thickness, method of sealing or plugging cell ends (e.g., pinched versus plugged), channel shape and symmetry, method of canning including type of matting used, grade and specification of can material, soot holding capacity, thermal expansion/shock, and melting temperature. Applicant must also include the catalyst coating/composition and/or washcoat information (e.g., composition and loadings) including how the OEM DPF is coated (e.g., zone) if applicable.

1.2.2 Identification by engine family name and engine model and/or calibration the engines on which the OEM DPF are found.

1.3 Description of emission control group selected including differences in engine configurations, sizes, regeneration strategies, exhaust components, identification of other exhaust components by part number which may vary over the emission control group, etc.

1.3.1 Information on engine platforms where another part is necessary for successful operation (e.g., upstream diesel oxidation catalyst (DOC)). Identify part numbers for these parts across the emission control group and explain if the part changes or is different for any engine configuration within the emission control group.

1.4 Description of intended applications (examples of in-use vehicles or equipment, typical duty cycles, fuel requirements, etc.) if the engines in the emission control group can go into diverse applications.

1.4.1 Description of any changes or modifications to the engine regeneration events for different applications if applicable.

2. *Aftermarket DPF Information*

2.1 Description of the aftermarket DPF.

2.1.1 Complete description of the new aftermarket DPF. Factors pertinent in determining that the new aftermarket DPF will not reduce the effectiveness of any required pollution control device or cause emissions to exceed applicable standards, including but not limited to part number, size(s)/dimensions of the DPF core itself as well as the canned part, core type (e.g., cordierite, silicon carbide etc.), porosity, median pore size, pore size distribution, maximum soot loading capacity, cell density, wall thickness, method of sealing or plugging cell ends (e.g., pinched versus plugged), channel shape and symmetry, method of canning including type of matting used, grade and specification of can material, catalyst coating/composition and/or washcoat information (e.g., composition and loadings), coating formulations (catalyst, washcoat etc.) including how the part is coated (e.g., zone), soot holding capacity, thermal expansion/shock, and melting temperature.

2.1.1.1 Comparison of new aftermarket DPF and OEM DPF.

2.1.1.2 Detailed information including data for the aftermarket DPF catalyst light-off testing. Applicant may include the OEM DPF catalyst light-off testing for the comparison if applicable.

2.1.1.3 Detailed information including data or other engineering support addressing at a minimum how differences between the OEM DPF and new aftermarket DPF will not negatively impact engine or aftertreatment performance, emissions certification compliance of the engine, engine (or component part) durability, ECU performance or behavior, secondary emissions, AECDs, and infrequent regeneration events and will not trigger warning codes or MILs.

2.1.2 Detailed discussion of the aftermarket DPF's principles of operation, the part's function within the engine's emissions control system and overall engine emission control operation highlighting any differences from OEM operation.

2.1.3 Schematics depicting the operation, installation, and location of the aftermarket DPF and all associated parts (including diagrams of relative positioning for the aftermarket DPF, associated parts and OEM components, air flow throughout the engine, exhaust flow through filter substrates, electrical diagrams, fuel flow diagrams, etc.).

2.1.4 A detailed part list for all parts of the aftermarket DPF and a unique part number for all parts which are not from the same supplier. Each

part must be identified by common name and all related part numbers associated with a common part name must be provided. If certain parts are only found in groupings with other parts this must be clearly indicated.

2.1.5 If applicable, the addition of an ECU and associated hardware (e.g., sensors) for the purposes of, for example, protection in case of a warranty claim, may be proposed. A schematic detailing how the ECU and associated hardware will integrate with or add to the OEM components must be submitted with the application along with a statement of the purpose of the ECU. The parts must be warranted and tested for durability and compatibility as part of the entire system and the applicant must provide a detailed description of potential factors which may cause adverse interactions between the ECU and OEM components.

2.1.6 Indication if the OEM configuration is designed for a unidirectional part (DPF). The aftermarket DPF must be unidirectional if it is replacing a unidirectional OEM DPF. All aftermarket DPFs must clearly identify the correct direction of exhaust flow via an arrow imprinted on or affixed to the aftermarket DPF which is clearly visible, legible, and durable. Detailed information addressing potential unidirectionality issues, including how its system is designed to account for this, and provide a picture, diagram, or schematic of the arrow indicating direction.

2.2 Description of regeneration method.

2.2.1 Aftermarket DPF's effect on OEM engine regeneration on an emission control group basis.

2.2.2 Description of the OEM engine's regeneration.

2.2.2.1 Operating condition requirements for regeneration.

2.2.2.2 A description of thresholds and control logic to activate regeneration.

2.2.2.3 A description of sensors and monitors involved for an active regeneration.

2.2.2.4 A description of typical regeneration intervals under certain duty cycles.

2.2.2.5 A description of how often the engine is expected to rely on active regeneration as compared to passive regeneration.

2.2.3 Complete description of the aftermarket DPF's effect on OEM engine regeneration if applicable.

2.2.3.1 Any difference in operating condition requirements for the OEM engine equipped with the aftermarket DPF regarding regeneration.

2.2.3.2 A detailed description of any thresholds and control logic changes to activate regeneration for the OEM engine equipped with the aftermarket DPF.

2.2.3.3 A detailed description of any regeneration interval change due to the aftermarket DPF.

2.3 Favorable operating conditions for the aftermarket DPF and associated parts.

2.4 Unfavorable operating conditions for the aftermarket DPF and associated parts including associated reductions in performance.

2.5 Fuel and lubricating oil requirements and misfueling considerations.

2.6 Identification of the aftermarket DPF's failure modes and associated consequences.

2.6.1 Discussion in context of potential safety issues, engine usability issues, emissions compliance issues and address what influence the failure of the aftermarket DPF may have on the OEM engine including all exhaust emission control components.

2.6.2 All installations of the aftermarket DPF must conform to applicable industrial safety requirements including but not limited to Federal Motor Carrier Safety Administration, Subpart G, *Miscellaneous Parts and Accessories*, Section 393.83 *Exhaust Systems*[6].

2.7 Analysis of the aftermarket DPF's potential safety and catastrophic failure issues (e.g., uncontrolled regeneration, lack of proper maintenance, unfavorable operating conditions, use of inappropriate fuel, high exhaust temperatures, substrate failure, sensor failure, etc.), including a description of the mitigation strategies employed by the aftermarket DPF and associated parts for each potential safety and catastrophic failure issue.

2.8 Complete description of the aftermarket DPF's and associated parts installation procedures.

2.8.1 A detailed installation manual which fully describes correct installation practices.

2.9 Pre-installation assessment procedures for the new aftermarket DPF.

2.9.1 Guidelines for assessing the OEM engine to ensure the aftermarket DPF is not installed on an inappropriate engine (e.g., non-complaint with the aftermarket DPF's Executive Order), an engine which is in non-compliance with its certification (e.g. non-approved aftermarket

[6] Federal Motor Carrier Safety Administration (FMCSA). *Parts and Accessories Necessary for Safe Operation*, Subpart G Section393.83 *Exhaust Systems*. Washington DC; (December 7, 1988)

modifications), or which is not in a proper state of maintenance (e.g., active MILs, error/fault codes, etc.).

2.10 Maintenance requirements.

2.10.1 Detailed description of all normal maintenance requirements for the aftermarket DPF and associated parts.

2.10.1.1 There should not be any deviations between maintenance requirements of the aftermarket DPF and associated parts and the OEM DPF that would be less stringent than OEM (e.g., less frequent maintenance) but more proactive maintenance may be proposed for the aftermarket DPF and associated parts.

2.10.1.2 Discussion of the potential ramifications of not following maintenance requirements for the aftermarket DPF. This must address the potential ramifications for the aftermarket DPF as well as for the engine or other OEM engine components or follow the maintenance procedures for the original part.

2.10.2 Objective criteria for the aftermarket DPF's ash removal (pressure drop across the filter, maximum clean filter weight, pre-installation filter weight comparison, etc.) for determination if the aftermarket DPF is "clean".

2.10.3 A copy of the language that will instruct the end user of proper handling of spent components and/or materials cleaned from the aftermarket DPF, identify any hazardous materials. Ensure that cleaning methods do not allow for the release of hazardous materials into the environment or allow for workplace exposure. Directions consistent with the OEM engine manufacturer's directions such that ECU and error codes are appropriately handled, if routine maintenance cleaning is allowed.

2.11 Description of noise level control compliance for the aftermarket DPF.

3. *Emission Control Group Compatibility*

3.1 Compatibility with the engine.

3.1.1 Discussion of calibrations and design features that may vary from engine to engine.

3.1.2 Effect on overall engine performance.

3.1.3 Effect on engine backpressure.

3.1.4 Additional load on the engine.

3.1.5 Effect on fuel consumption.

3.1.6 Engine oil consumption considerations.

3.1.7 Effect on infrequent regeneration events.

3.1.8 Effect on other emission control components.

3.1.9 AECD interactions.

3.1.10 Identification of the worst case engine configuration within the emission control group from the perspective of the effects of the engine configuration on the aftermarket DPF. Information, data, and engineering justifications for this determination shall be provided. It must include, but is not limited to, potential durability ramifications as well as the effect on emission compliance (certified and secondary).

3.1.11 Identification of worst case engine configuration within the emission control group from the perspective of the effects of the aftermarket DPF on the engine/engine parts (including but not limited to other emission control components, ECU behavior, and active regeneration components). Information, data, and engineering justifications for this determination shall be provided. It must include, but is not limited to, potential durability ramifications as well as the effect on emission compliance (certified and secondary).

3.2 Compatibility with the vehicle application.

3.2.1 Dependence of calibration and other design features on application characteristics.

3.2.2 Presentation of typical exhaust temperature profiles and other relevant field-collected data from representative applications within the emission control group.

3.2.3 Comparison of field-collected application data with operating conditions suitable for the aftermarket DPF.

3.2.4 Identification of the worst case application within the emission control group from the perspective of the effects of the aftermarket DPF on the engine/engine parts (including but not limited to other emission control components, ECU behavior, and active regeneration). Information, data, and engineering justifications supporting this determination. It must include, but is not limited to, potential durability ramifications as well as the effect on emission compliance (certified and secondary). It must address AECD and infrequent regeneration events.

3.2.5 Identification of the worst case application within the emission control group from the perspective of the effects of the engine configuration on the aftermarket DPF. Information, data, and engineering justifications supporting this determination. It must include, but is not limited to, potential durability ramifications as well as the effect on

emissions compliance (certified and secondary). It must address AECD and infrequent regeneration events.

4. *Testing Information*

4.1 Emission testing.

4.1.1 Test facility identification including capabilities and identification of all analytical instruments.

4.1.2 Detailed description of engines (engine serial number, engine family name, engine make, engine model, engine model year, engine code, engine configuration, horsepower, PM and oxides of nitrogen (NOx) certification levels, etc.) used to support the application.

4.1.3 For the preliminary application a statement indicating that the applicant understands that the test engine must be in a proper state of maintenance, is complaint with certification emission levels, and is in the OEM configuration. For the final application, testing and data must be provided which demonstrates compliance with these requirements.

4.1.4 Analysis and description of test fuel (fuel analysis, where it was purchased, purchase volume, etc.).

4.1.5 All engine diagnostic codes, warnings, illuminated MILs observed and other engine parameters monitored, measured, and recorded during testing.

4.1.5.1 Device warnings or error codes if the new aftermarket DPF includes an associated control or monitoring system.

4.1.6 Test procedure description (pre-conditioning period, test cycle, etc.).

4.1.7 Test results and comments.

4.1.8 Incomplete, failed, voided, and invalid test data and explanations.

4.1.9 All test results must be provided to ARB and be clearly labeled and identified, including appropriate units. Data must be provided in an electronic format with all data clearly and accurately identified. Data should be provided in a spreadsheet format compatible with Microsoft excel and all columns must be clearly and accurately labeled and include units. All raw data must be provided.

4.2 OEM DPF and Aftermarket DPF Degreening Processes.

4.2.1 Test facility identification including capabilities and identification of all analytical instruments.

4.2.2 Detailed description of engines (engine serial number, engine family name, engine make, engine model, engine model year, engine code,

engine configuration, horsepower, PM and NOx certification levels, etc.) used to support the application.

4.2.3 Analysis and description of test fuel (fuel analysis, where it was purchased, purchase volume, etc.).

4.2.4 All engine diagnostic codes, warnings, illuminated MILs observed and other engine parameters monitored, measured, and recorded during testing.

4.2.4.1 Device warnings or error codes if the new aftermarket DPF includes an associated control or monitoring system.

4.2.5 Test procedure description (pre-conditioning period, test cycle, etc.).

4.2.6 Test results and comments.

4.2.7 Incomplete, failed, voided, and invalid test data and explanations.

4.2.8 All test results must be provided to ARB and be clearly labeled and identified, including appropriate units. Data must be provided in an electronic format with all data clearly and accurately identified. Data should be provided in a spreadsheet format compatible with Microsoft excel and all columns must be clearly and accurately labeled and include units. All raw data must be provided.

4.3 Durability testing.

4.3.1 Detailed description of the aging in the laboratory and the field performed to demonstrate the aftermarket DPF's durability and compatibility with the emission control group.

4.3.2 Laboratory durability demonstration.

4.3.2.1 Test facility identification including capabilities and identification of all analytical instruments.

4.3.2.2 Detailed description of all vehicles and engines (engine serial number, engine family name, engine model, engine make, engine model year, engine configuration, engine code, horsepower, PM and NOx certification levels, etc.) used to support the application request.

4.3.2.3 Information demonstrating the test engines and vehicles are in a proper state of maintenance, or if they have been rebuilt or modified from the OEM configuration.

4.3.2.4 Description of test fuel (type of fuel, where it was purchased, purchase volume, etc.) and detailed analysis of durability test fuel.

4.3.2.5 Detailed description of the test procedures (field or bench, test cycle, etc.).

4.3.2.6 Detailed description of the test procedure for demonstrating functionality of any monitoring, storage or notification systems associated with a new aftermarket DPF.

4.3.2.7 Description of maintenance performed during the durability demonstration.

4.3.2.7.1 Allowable maintenance is prescribed in CFR, Title 40, Part 86, Subpart A, Section 86.004-25[7] – *Maintenance*, as it existed on February 13, 2016, which is hereby incorporated by reference herein,

4.3.2.7.2 All engine diagnostic codes, warnings, illuminated MILs observed and other engine parameters monitored, measured, and recorded during testing.

4.3.2.8 Test results and comments. Description of failed, voided, invalid, and incomplete tests.

4.3.2.9 All test results including units, raw data and summarized data.

4.3.3 Field durability demonstration.

4.3.3.1 Identification of application owner (company name, company contact person, address, phone number, etc.).

4.3.3.2 Description of test vehicle and engine (engine serial number, engine family name, engine make, engine model, engine model year, engine configuration, engine model, engine code, horsepower, PM and NOx certification levels, etc.).

4.3.3.3 Pre-installation evaluation including engine/vehicle check, identification of OEM configuration and all exhaust system components (including part numbers).

4.3.3.4 Description and analysis of fuel used during the field demonstration (specifically identify each different type of fuel i.e. ultra low sulfur, low sulfur, summer or winter blends, etc.).

4.3.3.5 Analysis of a fuel sample drawn from the field demonstration vehicle during the durability test.

4.3.3.6 Description of application usage during field demonstration (application operation, region of operation, route, etc.).

4.3.3.7 Test results and comments.

4.3.3.8 Summary of evaluative comments from third-party (e.g., driver or fleet operator).

[7] *Maintenance,* CFR, Title 40, Part 86, Subpart A, §86.004-25, as it existed on February 13, 2016.

4.3.3.9 Description of failed, voided, invalid, and incomplete tests.

4.3.3.10 All test results must be provided to ARB and be clearly labeled and identified, including appropriate units. Data must be provided in an electronic format with all data clearly and accurately identified. Data should be provided in a spreadsheet format compatible with Microsoft excel and all columns must be clearly and accurately labeled and include units. All raw data must be provided.

5. *References*

6. *Appendices*

A. All test results must be provided to ARB and be clearly labeled and identified, including appropriate units. Data must be provided in an electronic format with all data clearly and accurately identified. Data should be provided in a spreadsheet format compatible with Microsoft excel and all columns must be clearly and accurately labeled and include units. All raw data must be provided.

A.1 Actual emissions test data. Raw, real-time data gathered by the laboratory's data acquisition system during emissions testing in electronic format on a compact disc. These are the raw data from which emissions test results are derived (e.g., analyzer voltage readings recorded at a frequency of 1 Hertz (Hz)).

A.2 All engine diagnostic codes, warnings, illuminated MILs observed and other engine parameters which occurred over the course of testing.
(1) Proof that the device did not alter normal ECU operation

A.3 Plots of engine backpressure and exhaust temperature over time.

A.4 Quality assurance and quality control information.

A.5 Testing equipment information and indications that testing equipment meets specifications and calibrations required by sections (e), (f), (g) and (h) as appropriate.

B. Durability information. All testing data including units, raw data and summarized data.

B.1 Engine speed, backpressure and exhaust temperature data (as described in sections (g) and (h)).

B.2 Original copies of third-party letters or questionnaires describing in-field performance.

B.3 All engine diagnostic codes, warnings, illuminated MILs observed and other engine parameters which occurred over the course of testing.
(1) Proof that the device did not alter normal ECU operation.

C. Copy of the Owner's Manual (as described in section (j)(6)).

D. Copy of the Installation Manual (as described in section (j)(7)).
E. Sample scale drawings of the aftermarket DPF label (see section (j)(1)).
F. Swapping Policy (as described in section (j) (10)).
G. Other supporting documentation.

(8) Preliminary Application Review and Approval.

(A) The Executive Officer shall notify the applicant in writing within 45 days of receiving the preliminary application if it is determined that the preliminary application does not contain sufficient information to constitute a complete preliminary application.

(B) An applicant's failure to supply information needed to address identified deficiencies within 60 days from the date of the letter will result in the application being terminated.

(C) The applicant may resubmit a new preliminary aftermarket DPF exemption application no earlier than 60 days from the date of the suspension notification letter.

(9) Final Application Review Process. A final application for exemption is reviewed as follows:

(A) The Executive Officer shall not review a final application unless the applicant has conducted testing according to an ARB approved test plan.

(B) The Executive Officer shall conduct a review of the final application and will determine within 45 days whether the final application is complete. If the final application is not complete, the Executive Officer shall request additional information from the applicant. The applicant must respond within 60 days.

1. If, after requesting missing or additional information three times, the Executive Officer determines that the final application is still not complete or accurate, the application will be terminated.

(C) Compliance Review. Within 60 days of determining that the final application is complete, the Executive Officer shall determine whether all information, data, testing, and supporting materials are consistent with the product described in the preliminary application process and test plan approval, and demonstrates that the new aftermarket DPF complies with the requirements of this Procedure. ARB shall issue an EO exempting a new aftermarket DPF from the prohibitions of Vehicle Code section 27156 if the Executive Officer determines that the information submitted in the preliminary and final applications for exemption sufficiently satisfy the criteria of this Evaluation Procedure. The EO for a new aftermarket DPF is only valid for the new aftermarket DPF as described in the final application for exemption. Any changes or deviations from the submitted information (e.g., filter materials, precious metal loadings, and physical

specifications) must be submitted to ARB for review and approval in a new or revised application for exemption for the new aftermarket DPF. New aftermarket DPFs may only be sold, leased, offered for sale, offered for lease, or installed in the on-road heavy-duty engines listed in the issued exemption EO for those new aftermarket DPFs. An applicant may not use the EO as an endorsement by ARB.

(10) Application Termination. If at any point during the review process an application is terminated, the Executive Officer will cease review of all materials regarding the new aftermarket DPF and associated application. The applicant may submit a new, revised application per section (d)(7) a minimum of 60 days after the date of the termination notification. This time is intended to allow the applicant to correct any deficiencies in the application. If the preliminary application was terminated, a resubmitted preliminary application will be reviewed as a new application. The re-submission must address the concerns that caused the termination and must not be identical to the terminated application.

(11) Recordkeeping Requirements. Applicants are responsible for keeping records as described below.

(A) Applicants that obtain an exemption must keep records that have valid end user contact information (name, address, phone number), a description of the vehicles the new aftermarket DPFs are installed in (type of vehicle, make, model year, vehicle identification number, pre-installation assessment), a description of the engines the units are applied to (make, model, model year, engine serial number, engine family name, horsepower, engine configuration, hours/miles at time of installation), and information, including serial number, of the new aftermarket DPF installed and the reason for DPF replacement as well as date of installation and the installer.

(B) The applicants must keep these records for each new aftermarket DPF for a period of no less than six years after the expiration of the warranty and must submit these records within 30 days of a request by ARB for such records. Applicants must keep all pre-installation assessment records as described in section (j) for a period of no less than six years from the date of installation of the new aftermarket DPF and must provide a copy of these records to the end user at the time of installation of the new aftermarket DPF. The applicants must provide these records within 30 days of a request by ARB.

(C) Applicants are responsible for maintaining all records pursuant to the warranty requirements of section (l).

(D) Applicants are responsible for maintaining quality control documentation as described in section (j). These reports must be submitted within 15 days of written request by ARB.

(12) Applicants that obtain an exemption must demonstrate sales or the active pursuit of sales of their new aftermarket DPF in California or the Executive Officer may revoke the Executive Order. The Executive Officer may at any time with respect to any new aftermarket DPF sold, leased, offered for sale, intended for sale, or manufactured for sale in California, order the applicant to submit records pertaining to the new aftermarket DPF, at the applicant's expense, to a location specified by the Executive Officer.

(13) If an applicant wishes to change a part number, it must provide a part change request to ARB in the form of a written application. It must provide a detailed comparison of the originally approved part and the proposed new part delineating all differences between the parts. ARB will review the request. Major differences in a part may be grounds for ARB to determine the change is significant enough to require the part to hold a new Executive Order, requiring appropriate testing and support per this Procedure. Changes in physical characteristics of the part (e.g., DPF, size, porosity/CPSI, materials, catalyst or washcoat composition, coating type/method, etc.) will be considered as requiring a new Executive Order. Non-substantive parts changes will be approved on a case by case basis and ARB will determine if the parts must be reported discretely (e.g., each part type/number if a part is changed or altered over time) or as a combined part type (e.g., a company uses 3 intumescent matting suppliers having equivalent product) for warranty reporting purposes. In making such a determination, ARB will rely on information submitted by the applicant and good engineering judgment.

(14) The Executive Officer may revoke the exemption status of a new aftermarket DPF, cease review of an application in progress, or suspend all review of pending exemption applications if the Executive Officer determines that there are errors, omissions, inaccurate information, fraudulent submittals, or a deficiency of required submittals, in the application for exemption, supporting information, warranty report, recall plan, or proof of pursuit of sales, or if the new aftermarket DPF fails audit testing, or if the applicants fails to satisfactorily demonstrate the safety of the new aftermarket DPF, follow quality control and recordkeeping reporting requirements, or follow the provisions of the Executive Order.

(e) TESTING SPECIFICATIONS

(1) Test Fuel and Lubricant Oil

(A) Emission Testing including Degreening

1. The test fuel must meet the specifications in the CCR (Sections 2280 through 2283 of Title 13). The Executive Officer may approve test fuel(s) that do not comply with CCR (Sections 2280 through 2283 of Title 13) if the fuel(s) are determined to be, based on information submitted by a manufacturer and good engineering judgment, representative of commercially available fuel typically used for the intended applications.

2. The same test fuel must be used throughout the entire set of testing including engine qualification testing and installed aftermarket DPF emission testing.

3. The test fuel (or batch of fuel purchased) must be analyzed using American Society for Testing and Materials (ASTM) test methods listed in the Table 1-1, which are hereby incorporated by reference herein. At a minimum, sulfur content, aromatic content, polycyclic aromatic hydrocarbons, nitrogen content, and cetane number must be reported. The Executive Officer may ask for additional properties to be reported if evidence suggests those properties may affect functioning of the aftermarket DPF or influence potential secondary emissions and/or air toxics.

Table 1-1: Diesel Fuel Test Methods

Property	*ASTM Test Method*
Sulfur Content	D5453-93[8]
Aromatic Hydrocarbon Content, Vol. %	D5186-03(2009)[9]
Polycyclic Aromatic Hydrocarbon Content, Wt. %	D5186-03(2009)[10]
Nitrogen Content	D4629-96[11]
Natural Cetane Number	D613-84[12]
Gravity, API	D287-82[13] or D4052-96(2002)[14]
Viscosity at 40°C, cSt	D445-83[15]
Flash point, °F	D93-80[16]
Distillation, °F	D86-96[17]

(B) Laboratory Aging

1. The test fuel must meet the specifications in the CCR (Sections 2280 through 2283 of Title 13) or U.S. EPA diesel fuel compliant with standards set forth in Title 40, CFR, Part 80, Subpart I, as it existed on February 12, 2016[18] and hereby incorporated by reference herein. The Executive Officer may

[8] *American Society of Testing and Materials* (ASTM), *Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Motor Fuels and Oils by Ultraviolet Fluorescence,* ASTM D5453-93, West Conshohocken, PA (September 15, 1993)

[9] ASTM, *Standard Test Method for Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels and Aviation Turbine Fuels by Supercritical Fluid Chromatography*, ASTM D5186-03(2009), West Conshohocken, PA (April 15, 2009)

[10] Ibid

[11] ASTM, *Standard Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection*, ASTM D4629-96, West Conshohocken, PA (April 10, 1996)

[12] ASTM, *Standard Test Method for Ignition Quality of Diesel Fuels by the Cetane Method*, ASTM D613-84, West Conshohocken, PA (January 3, 1984)

[13] ASTM, *Standard Test API Gravity of Crude Petroleum and Petroleum Products*, ASTM D287-82, Philadelphia, PA (August 27,1982)

[14] ASTM, *Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter*, ASTM D4052-96(2002), West Conshohocken, PA (May 2002)

[15] ASTM. *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)*, ASTM D445-83, Philadelphia, PA (October 28, 1983)

[16] ASTM, *Standard Test Method for Flash Point by Pensky-Martens Closed Tester*, ASTM D93-80, Philadelphia, PA (August 29, 1980)

[17] ASTM, *Standard Test Method for Distillation of Petroleum Products*, ASTM D86-96, West Conshohocken, PA (April 10, 1996)

[18] Motor Vehicle Diesel Fuel; Nonroad, Locomotive, and Marine Diesel Fuel; and ECA Marine Fuel, Title 40, CFR, Part 80, Subpart I, as it existed on February 12, 2016

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approve test fuel(s) that do not comply with CCR (Sections 2280 through 2283 of Title 13) or in Title 40, CFR Part 80 Subpart I[19] if the fuel(s) are determined to be, based on information submitted by a manufacturer and good engineering judgment, representative of commercially available fuel typically used for the intended applications

2. The test fuel (or batch of fuel purchased) must be analyzed using the methods specified above in section (e)(1)(A)3.

3. The lubricant oil must meet OEM engine lubricant oil specifications.

4. The same lubricant oil must be used throughout the laboratory aging for the aftermarket DPF.

(C) Field Service Accumulation and Additional Field Demonstrations

1. The test fuel must meet the specifications in the CCR (Sections 2280 through 2283 of Title 13) or U.S. EPA diesel fuel compliant with standards set forth in Title 40, CFR, Part 80, Subpart I, as it existed on February 12, 2016.[20] The Executive Officer may approve test fuel(s) that do not comply with CCR (Sections 2280 through 2283 of Title 13)or in Title 40, CFR Part 80 Subpart I[21] if the fuel(s) are determined to be, based on information submitted by a manufacturer and good engineering judgment, representative of commercially available fuel typically used for the intended applications.

2. The test fuel (or batch of fuel purchased) must be analyzed using the methods specified above in section (e)(1)(A)3.

3. The fuel used during the field service accumulation period should be equivalent to the test fuel, or a fuel with properties less favorable to the durability of the aftermarket DPF. The field service accumulation period may, at the applicant's discretion and with the Executive Officer's approval, include intentional misfueling events so that data on the effects of misfueling may be obtained.

(2) Visual Inspection and Photographic Documentation. The applicant must conduct a visual inspection and submit digital photographs in electronic format.

(A) Laboratory Aging

1. Applicants must conduct a complete visual inspection of the aftermarket DPF after the 300 hours aging and report the results in the final report. The visual inspection includes, but is not limited to:

(i) Front and back face of the DPF and outlet DOC (if the configuration includes a DOC).

[19] Ibid
[20] Ibid
[21] Ibid

(ii) Photographing any indications regarding leaks around the side/matting, exhaust leaks upstream of the DPF, and any indications of canning issues (leaks) or excessive heat (i.e., discoloration of the can) after completing the laboratory aging period.

2. The engine before installation of the aftermarket DPF. Photographs must be taken and clearly show:

(i) The entire engine.

(ii) A close-up of the location in which the aftermarket DPF will be installed.

(iii) All available engine identification including the make, model, serial number, and engine label.

3. The engine after installation of the aftermarket DPF. Photographs must be taken and clearly show:

(i) The entire engine or piece of equipment showing the aftermarket DPF installed.

(ii) A close-up of the installed the aftermarket DPF.

(iii) All available aftermarket DPF identification including labels and logos.

(iv) Additional detailed photographs addressing the visual inspection points listed in section (e)(2)(A)1.

(B) Field Service Accumulation

1. Applicants must conduct a complete visual inspection of the new aftermarket DPF and engine exhaust system after the 500 hour, and two, 200 hour field service accumulation periods and report the results in the final report. The visual inspection includes, but is not limited to:

(i) Front and back face of DPFs, and outlet DOCs (if the configuration includes a DOC), cans, installations and locations.

(ii) Photograph any indications of exhaust leaks around the side/matting, exhaust leaks upstream of the DPF, and any indications of canning issues (leaks) or excessive heat (i.e. discoloration of the can) after completing the field demonstration period.

2. The vehicle before installation of the new aftermarket DPF. Photographs must show:

(i) The entire vehicle.

(ii) A close-up of the location in which the new aftermarket DPF will be installed.

(iii) All available vehicle identification including the make, model, license plate, and vehicle number.

(iv) All available engine identification including the make, model, serial number, and engine label.

3. The vehicle after installation of the new aftermarket DPF. Photographs must show:

(i) The entire vehicle showing the new aftermarket DPF installed, if possible.

(ii) A close-up of the installed new aftermarket DPF.

(iii) All available new aftermarket DPF identification including labels and logos.

4. Applicants must submit the photographic documents specified in section (e)(2)(B)1.

(f) EMISSION TESTING REQUIREMENTS

(1) Testing on an Emission Control Group Basis.

(A) The applicant must test the new aftermarket DPF on an emission control group basis and clearly identify the emission control group as set forth in section (d)(2).

(B) The applicant must select a worst case test engine or engines based on the proposed emission control group (e.g., largest engine displacement, low NOx/PM ratios, etc.) which will be reviewed and approved by the Executive Officer for appropriateness.

(C) The applicant must clearly identify all test engine(s) by providing the engine family name, make, model, displacement, engine code, engine serial number, model year, horsepower, and carbon monoxide (CO), PM and NOx or NOx plus non-methane hydrocarbon (NMHC) certification levels for all test engines.

(D) The applicant must also describe the applications for which the new aftermarket DPF is intended to be used by giving examples of in-use vehicles or equipment, characterizing typical duty cycles, indicating any fuel requirements, and/or providing other application-related information as specified by the Executive Officer.

(E) For a new aftermarket DPF that has the potential to generate secondary emissions, the applicant must identify this potential to the Executive Officer and propose an emissions test engine accordingly. The applicant must provide detailed and comprehensive information showing how the proposed emissions test engine is appropriate and represents a “worst case” engine within the emission control group. ARB requires additional secondary emissions testing for new aftermarket DPFs that potentially could result in the increase of toxic air contaminants, other harmful compounds, or a change in the nature or amount of the emitted particulate matter (PM). Additional testing for secondary emissions is described in section (f)(11).

(2) Emission Testing Sequence.

(A) Applicants shall select an appropriate emission test engine within the emission control group which is in a proper state of maintenance, in its certified configuration, and meeting its original certified emission levels.

(B) Applicant shall conduct, at a minimum, 25 hours laboratory degreening for both the new OEM DPF and the new aftermarket DPF using identical degreening duty cycles on an emission testing engine.

(C) Applicant shall conduct DPF catalytic activities check through either nitrogen dioxide (NO_2) emission test specified in section (f)(5)(B) or soot accumulation test specified in section (f)(5)(C).

(D) Applicant shall conduct emission testing including regeneration emission testing for both the new OEM DPF and the new aftermarket DPF.

(E) Applicants shall conduct, at a minimum, 300 hours laboratory aging for the new aftermarket DPF on an aging engine. The aging engine is defined in section (g)(2)(A) of this Procedure.

(F) Applicants shall conduct emission testing for the laboratory aged aftermarket DPF.

(G) Applicants shall remove the laboratory aged aftermarket DPF and install it on an appropriate field service accumulation vehicle for a minimum of 500 hours. Two, 200 hour field demonstrations must be conducted on different engines and applications within the emission control group, but do not require emissions testing.

(H) Applicants shall remove the field aged aftermarket DPF, reinstall the part on the emission test engine, and conduct additional emission testing.

(3) Test Engine Requirements and Pre-conditioning.

(A) All testing should be performed with the test engine in a proper state of maintenance and meeting its original certified emissions level.

(B) All test engines must be diesel cycle, using diesel fuel, and certified by either ARB or United States Environmental Protection Agency (U.S. EPA).

(C) Test engines must be in the original OEM configuration (i.e., not possess any components not part of the originally certified parts list or certified configuration).

(D) Test engines must have accumulated a minimum of 5,000 miles or 125 hours prior to conducting the engine qualification testing.

(E) Test engines must not have any EMD fault codes prior to conducting the engine qualification testing.

(F) The same test engine must be used for all emission testing steps (engine qualification testing, degreening processes, OEM part emission testing, aftermarket DPF emission testing after laboratory aging, and after field

durability). No test engine substitutions are allowed once testing has commenced.

(4) Emission Test Engine Qualification.

(A) The emission test engine must meet its certified emission levels, be in its original certified configuration, and be flashed in the newest engine calibration.

(B) All engines must be diesel cycle, using diesel fuel, and certified by either ARB or U.S. EPA.

(C) The emission test engine for qualification testing must be with a brand-new OEM replacement DPF with 25 degreening hours, as detailed in section (g)(1) of this procedure. The emission testing engine with a degreened OEM DPF specified in section (f)(5)(B) can be treated as an engine qualification test and shall be in compliance with certified emission levels.

(D) The required test cycles are specified in Table 2-1.

(E) Applicants must conduct emission tests in accordance with applicable provisions of the Code of Federal Regulations, Title 40, Part 86, Subpart N, as they existed on February 12, 2016[22], which is hereby incorporated by reference herein.

(F) Crankcase emissions must be added to the exhaust emission during the engine qualification testing. The details for the crankcase emission are specified by the California Code of Regulations, Title 13, Section 1956.8 a(5).

(G) Engine must not display any illuminated MIL or have any EMD fault codes during the engine qualification testing.

(5) First Stage Testing of the OEM DPF and aftermarket DPF. After both DPFs have been identically degreened for a minimum of 25 hours per section (g) of this Procedure, they must be installed on an appropriate emission test engine.

(A) Installation and Preconditioning.

1. The OEM DPF and aftermarket DPF must be appropriately sized for the emission test engine(s) based on the sizing information provided by the OEM DPF parts list and the aftermarket DPF sizing information provided in the preliminary application.

2. The OEM DPF must be an appropriate part for the engine, engine model, and calibration based on certification information.

3. The OEM DPF and aftermarket DPF must be installed in the test engine in accordance with the test engine manufacturer's instructions or OEM DPF part manufacturer's instructions if applicable.

[22] *Exhaust Test Procedures for Heavy-Duty Engines,* CFR, Title 40, Part 86, Subpart N, as it existed on February 12, 2016

4. The same type of OEM DPF part must be used for all testing. For example, if the OEM offers several different replacement DPFs for the same engine configuration, the applicant must choose one make/configuration. This type would be used for all testing. The applicant should provide an explanation why a particular make/configuration was chosen.

5. No EMD fault codes or warnings shall exist prior to or during the emission testing.

6. The OEM DPF and aftermarket DPF must be, at a minimum, laboratory degreened for 25 hours prior to this emission testing. The 25 hours laboratory degreening for the OEM DPF and aftermarket DPF is detailed in section (g)(1) of this Procedure. The degreening time for the OEM DPF and aftermarket DPF must be exactly the same.

(B) The emission testing of the OEM DPF and aftermarket DPF shall be measured and evaluated as follows:

1. After equipping the emission test engine with a degreened OEM DPF, first perform a forced and complete DPF regeneration for the OEM DPF (per the OEM engine manufacturer's instructions). The applicant must use the regeneration method specified in section (g)(2)(B) of this Procedure if the selected emission testing engine has a DOC plus DPF configuration. Otherwise, the applicant must address how it will achieve regeneration (e.g., "parked" regeneration or manual regeneration, etc.) and provide details regarding the testing and equipment set up. The applicant must also address how it will determine and measure that the regeneration is complete. During the regeneration event, the applicant must record the exhaust temperature and backpressure on a second by second (1 Hz) basis during the entire regeneration event. A complete regeneration must show the exhaust backpressure staying within plus or minus 5% of the average backpressure for the last 5 minutes of the regeneration event.

2. Perform a FTP heavy–duty transient cycle (1 cold start[23],[24] and 3 hot starts[25]). Exhaust temperature, backpressure, and flow rate must be measured and recorded on a second by second (1 Hz) basis. The exhaust temperature and backpressure must be measured upstream of the DPF.

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[23] As specified in U.S. EPA, *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1334-84, January 18, 2001, hereby incorporated by reference herein.

[24] As specified in U.S. EPA, *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1335-90, September 5, 1997, hereby incorporated by reference herein.

[25] As specified in U.S. EPA, *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1327-90, September 5, 1997, hereby incorporated by reference.

3. Emissions testing must include emissions contributions during DPF regeneration events. Applicants must propose an appropriate test method to trigger DPF regeneration and to account for emissions from these events.
4. DPF regeneration emission testing must be part of the approved test plan and should follow U.S. EPA guidance documents CISD-06-17 (issued August 7, 2006)[26] and CISD-06-22 (issued November 6, 2006)[27], which are both hereby incorporated by reference herein, and include factors relevant to the target emission control group including, but not limited to, test cycles, number of test cycles necessary to cover the entire DPF regeneration event, and methods to pre-load the filter, trigger DPF regeneration, measure and record exhaust temperature, exhaust backpressure, and engine speed, and sample and record exhaust flow and criteria pollutants. The DPFs must be appropriately loaded with soot at the time of the regeneration testing.
5. The applicant must also propose a calculation method for adjusting the emission level to account for frequent/infrequent regeneration adjustment factors as specified by the Code of Federal Regulations, Title 40, Part 86, Section 86.004-28(i), as it existed on February 13, 2016[28], which is hereby incorporated by reference herein.
6. The emission testing results must include total PM, NMHC or total hydrocarbons, oxides of nitrogen, nitrogen dioxide, carbon monoxide, and carbon dioxide reported in grams/brake horsepower-hour (g/bhp-hr) and any secondary emissions or air toxics identified in the approved test plan. The instruments/devices for measuring the pollutants listed above must comply with the applicable requirements in the Code of Federal Regulations, Title 40, Part 86, Subpart N, as they existed on February 12, 2016[29].
7. NO_2 emissions are to be quantified by one of the following methods:
    (i) Two chemiluminescence analyzers,
    (ii) A dual-path chemiluminescence analyzer
8. Analyzer configuration and determination of NO_2 emission level. For method (i) and (ii), the analyzers are to be fed from a heated and conditioned sample path. If two chemiluminescence analyzers are employed, they are to be simultaneously fed from a common heated sample path. One instrument (or path) shall be set to NOx mode, while the second shall be set to nitric

[26] U.S. EPA, 2006a. *Heavy-Duty Highway Guidance for Infrequent Regeneration of Diesel Particulate Filters,* Compliance and Innovative Strategies Division (CISD) CISD-06-17, August 7, 2006
[27] U.S. EPA, 2006b. *Alternative Heavy-Duty Highway Guidance for Infrequent Regeneration of Diesel Particulate Filters,* CISD-06-22, November 6, 2006
[28] *Compliance with Emission Standards,* CFR, Title 40, Part 86, Subpart A, §86.004-28(i), as it existed on February 13, 2016.
[29] *Exhaust Test Procedures for Heavy-Duty Engines,* CFR, Title 40, Part 86, Subpart N, as it existed on February 12, 2016.

oxide (NO) mode. The instrument (or path) set to NOx mode receives a sample that has passed through an NO_2-to-NO converter, and the resultant concentration is designated as total NOx ($NO+NO_2$) in the sample. The instrument (or path) that is set to NO mode receives a sample that has not passed through the converter and quantifies the amount of NO only. The difference between NO and NOx is the amount of NO_2 in the sample. Both NO and NOx signals are recorded by an external data acquisition system at 1 Hz. Using the average concentrations of NO and NOx over the entire test cycle, the conventional equation for calculating total NOx (Code of Federal Regulations, Title 40, Part 86, Subpart N, as they existed on February 12, 2016)[30] is then used to generate a gram per mile or g/bhp-hr value for both NO and NOx. The resulting value for NO is then subtracted from that for NOx to determine the gram per mile or g/bhp-hr value for NO_2. The instrument for measuring NO and NOx must be calibrated in accordance with the NOx calibration procedure as described in the Code of Federal Regulations, Title 40, Part 86, Subpart N, as they as it existed on February 12, 2016[31].

9. Remove the OEM DPF, install the new aftermarket DPF in accordance with the manufacturer's installation instructions, then perform the tests as specified in section (f)(5)(B)1-8, but with a degreened aftermarket DPF installed.

(C) The soot accumulation testing of the OEM DPF and the aftermarket DPF shall be measured and evaluated as follows:

1. Weighing a degreened OEM DPF after a complete active regeneration. Regeneration requirements are specified in section (f)(5)(B)1.

2. After equipping the emission test engine with a degreened OEM DPF, continuously perform FTP heavy–duty transient cycle (1 cold start and followed hot starts) for 6 hours. Weigh the DPF at 2 hour, 4 hour and 6 hour.

3. Exhaust temperature, backpressure and flow rate must be measured and recorded on a second by second (1 Hz) basis. The exhaust temperature and backpressure must be measured upstream of the DPF.

4. Weighing the DPF must be at elevated temperature (e.g. 200 Celsius) in order to avoid the water in ambient air absorbed by the DPF and soot. The temperature applied for weighing DPF must be same for the OEM DPF and the aftermarket DPF.

5. Weighing the DPF must use the instrument and method to detect the soot accumulation mass precision within 0.1 gram per liter of DPF volume.

[30] Ibid
[31] Ibid

6. Determination of soot accumulation rate by linear regression of data obtained at 0, 2, 4 and 6 hour of soot accumulation test specified in subsection 1-5 above.

7. Remove the OEM DPF, install a degreened aftermarket DPF in accordance with the manufacturer's installation instructions, then perform the tests as specified in section (f)(5)(C)1-6, but with a degreened aftermarket DPF installed.

(6) Second Stage Emission Testing of the aftermarket DPF. After the aftermarket DPF has been aged for a minimum of 300 hours per section (g) of this Procedure, it must be installed on an appropriate emission test engine.

(A) Installation and Preconditioning.

1. The aftermarket DPF must be installed on the test engine in accordance with the test engine manufacturer's instructions if applicable.

2. No EMD fault codes or warnings shall exist prior to or during the emission testing.

3. The aftermarket DPF must be, at a minimum, laboratory aged for 300 hours prior to this emission testing. The 300 hours laboratory aging for the aftermarket DPF is detailed in section (g) of this Procedure.

(B) The emission testing of the aftermarket DPF shall be measured and evaluated as follows:

1. Perform a forced and complete DPF regeneration per the test engine manufacturer's instructions in accordance with the requirements and listed in section (f)(5)(B)1 prior to conducting any testing.

2. Perform FTP heavy–duty transient cycle (1 cold start and 3 hot starts). Exhaust temperature, backpressure and flow rate must be measured and recorded on a second by second (1 Hz) basis. The exhaust temperature and backpressure must be measured upstream of the DPF. For a DOC plus DPF configuration, this location must be between the DOC and DPF.

3. Emissions testing must include emissions contributions during DPF regeneration events. DPF regeneration testing requirements are specified in sections (f)(5)(B)3-5.

4. The emission testing results and the instruments/devices for pollutants are specified in section (f)(5)(B)6-8.

(7) Third Stage Emission Testing of the aftermarket DPF.

(A) Installation and Preconditioning.

1. After the minimum 500 hours field service accumulation period specified in section (g) of this Procedure, the aftermarket DPF must be removed from the field service engine/vehicle and installed on the approved test engine for

emission testing in accordance with the manufacturer's installation instructions.

2. During the field service accumulation and subsequent emission testing, all EMD fault codes must be recorded and checked. No diagnostic codes shall be stored before proceeding with the second stage of emission testing. If any fault codes are present, applicant shall submit a report to notice the Executive Officer. Under certain conditions and approval by the Executive Officer, the codes shall be reset using a compatible diagnostic scan tool.

(B) Emission testing for the field aged aftermarket DPF shall be measured and evaluated as follows:

1. Perform a forced and complete DPF regeneration per the test engine manufacturer's instructions in accordance with the requirements and listed in section (f)(5)(B)1 prior to conducting any testing.

2. Perform FTP heavy–duty transient cycle (1 cold start and 3 hot starts). Exhaust temperature, backpressure and flow rate must be measured and recorded on a second by second (1 Hz) basis. The exhaust temperature and backpressure must be measured upstream of the DPF. For a DOC plus DPF configuration, this location must be between the DOC and DPF.

3. Emissions testing must include emissions contributions during DPF regeneration events. DPF regeneration testing requirements are specified in sections (f)(5)(B)3-5.

4. The emission testing results and the instruments/devices for pollutants are specified in section (f)(5)(B)6-8.

(8) Test Cycle.

(A) The engine, OEM DPF and aftermarket DPF must be tested using the test cycles indicated in sections (8)(B) and (C) below (summarized in Table 2-1).

(B) Engine qualification testing must consist of one cold start and at least three hot start tests using the Federal Test Procedure (FTP) Heavy-duty Transient Cycle for engines used in on-road applications, in accordance with the applicable provisions in the Code of Federal Regulations, Title 40, Part 86, Subpart N, as they existed on February 12, 2016[32] , and three hot start SET tests, in accordance with the provisions in the Code of Federal Regulations, Title 40, Part 86, Subpart N, as they existed on February 12, 2016[33] . The 2007 ramped modal cycle Supplemental Emissions Test (SET) is applicable to 2007-2009 heavy-duty engines.

[32] Ibid.
[33] Ibid

(C) Engine emission testing must consist of one cold start and at least three hot start tests using the Federal Test Procedure (FTP) Heavy-duty Transient Cycle for engines used in on-road applications, in accordance with the applicable provisions in the Code of Federal Regulations, Title 40, Part 86, Subpart N, as they existed on February 12, 2016.[34]

(D) Regeneration emission test is specified in sections (f)(5)(B) 3-5.

Table 2-1 Test Cycles for Emission Testing

Configuration	Tests
Engine Qualification Testing	1 FTP Heavy-duty Transient Cycle (1 cold start and 3 hot starts) (Engine with 25 hours degreened OEM DPF qualified as engine qualification testing) 1 SET (3 hot starts)
Engine with OEM DPF	1 FTP Heavy-duty Transient Cycle (1 cold start and 3 hot starts) for a 25 hours laboratory degreened unit 1 Regeneration Emission Test*
Engine with Aftermarket DPF	1 FTP 1 FTP Heavy-duty Transient Cycle (1 cold start and 3 hot starts) for a 25 hours laboratory degreened unit 1 FTP Heavy-duty Transient Cycle (1 cold start and 3 hot starts) for a 300 hours laboratory aged unit 1 FTP Heavy-duty Transient Cycle (1 cold start and 3 hot starts) for a 500 hours field service accumulation unit 1 Regeneration Emission Test*

FTP = Federal Test Procedure; SET = Supplemental Emissions Test

* Regeneration emission test is specified in sections (f)(5)(B) 3-5.

(9) Test Run.

The number of tests indicated in Table 2-1 must be run for each emission control group or configuration.

(10) Results.

(A) For all valid emission tests used to support the application, the applicant must report emissions of total PM, NMHC or total hydrocarbons (whichever is used for the relevant engine certification), oxides of nitrogen, nitrogen dioxide, carbon monoxide, and carbon dioxide and all secondary emissions required in the approved test plan.

[34] Ibid

(B) The evaluation criteria for comparison of the 25 hours laboratory degreened OEM DPF to aftermarket DPF:

1. Based on NO2 check and emission testing specified in section (f)(5)(B).
   (i) The average exhaust backpressure and DPF inlet and peak bed temperature measured for the aftermarket DPF must be within 10% the average exhaust backpressure and temperature measured for the OEM DPF during the degreening processes and the emission testing processes.
   (ii) Emissions test results of CO, NMHC, NOx or NOx plus NMHC and PM for engine with the OEM DPF must not exceed the applicable new engine certification standards.
   (iii) Emissions test results of CO, NMHC, NOx or NOx plus NMHC and PM for engine with the aftermarket DPF must not exceed the applicable new engine certification standards.
   (iv) Emission of NO2 from the aftermarket DPF must be within 15% of the OEM DPF.
   (v) No EMD fault codes or warnings may occur during the degreening and emission testing. In addition, the aftermarket DPF must not cause the test engine's EMD system to falsely detect a DPF malfunction or other emission related malfunction, and shall also not impair the EMD system from properly detecting a malfunctioning DPF or other emission related component.
2. Based on soot accumulation testing specified in section (f)(5)(C).
   (i) The soot accumulation rate of the aftermarket DPF shall not exceed 20% of the OEM DPF.
   (ii) The average exhaust backpressure and DPF inlet and peak bed temperature measured for the aftermarket DPF must be within 10% the average exhaust backpressure and temperature measured for the OEM DPF during the degreening processes and the soot accumulation testing processes.
   (iii) No EMD fault codes or warnings may occur during the degreening and soot accumulation testing. In addition, the aftermarket DPF must not cause the test engine's EMD system to falsely detect a DPF malfunction or other emission related malfunction, and shall also not impair the EMD system from properly detecting a malfunctioning DPF or other emission related component.

(C) The evaluation criteria for the 300 hours laboratory aged aftermarket DPF based on the emission testing shall be:

1. Emissions test results of CO, NMHC, NOx or NOx plus NMHC and PM for engine with the 300 hours laboratory aged aftermarket DPF must not exceed applicable the new engine certification standards.

2. The average exhaust temperature and backpressure measured for the 300 hours laboratory aged aftermarket DPF must be within 10% of the average exhaust temperature measured for previous 25 hours laboratory degreened aftermarket DPF.

3. Emission of NO_2 from the 300 hours laboratory aged aftermarket DPF must not be greater than 15% below previous 25 hours laboratory degreened aftermarket DPF.

4. No EMD fault codes or warnings may occur during the emission testing. In addition, the aftermarket DPF must not cause the test engine's EMD system to falsely detect a DPF malfunction or other emission related malfunction, and shall also not impair the EMD system from properly detecting a malfunctioning DPF or other emission related component.

(D) The evaluation criteria for comparison of the 500 hours field service accumulation aftermarket DPF to previous emission testing of the 300 hours laboratory aged aftermarket DPF shall be:

1. Emissions test results of CO, NMHC, NOx or NOx plus NMHC and PM for the 500 hours field service accumulation aftermarket DPF must not exceed the new engine certification standards.

2. The average exhaust temperature measured for the 500 hours field service accumulation aftermarket DPF must be within 10% of the average exhaust temperature measured for previous 300 hours laboratory aged aftermarket DPF.

3. The average exhaust backpressure measured for the 500 hours field service accumulation aftermarket DPF must be within 20% of the average exhaust backpressure measured for previous 300 hours laboratory aged aftermarket DPF.

4. Emission of NO_2 from the 500 hours field service accumulation aftermarket DPF must not be greater than 20% below previous 300 hours laboratory aged aftermarket DPF.

5. No EMD fault codes or warnings may occur during the emission testing. In addition, the aftermarket DPF must not cause the test engine's EMD system to falsely detect a DPF malfunction or other emission related malfunction, and shall also not impair the EMD system from properly detecting a malfunctioning DPF or other emission related component.

(11) Additional Analyses.

The Executive Officer may require the applicant to perform additional analyses if he or she has reason to believe that the use of an aftermarket DPF may result in the increase of toxic air contaminants, other harmful compounds, or a change in the nature of the emitted particulate matter.

(A) In his or her determination, the Executive Officer will consider all relevant data, including but not limited to the following:

1. The addition of any substance to the fuel, intake air, or exhaust stream,
2. Whether a catalytic reaction is known or reasonably suspected to increase toxic air contaminants or ozone precursors,
3. Results from scientific literature,
4. Field experience, and
5. Good engineering judgment.

(B) These additional analyses may include, but are not limited to, measurement of the following:

Benzene
1,3-Butadiene
Formaldehyde
Acetaldehyde
Polycyclic aromatic hydrocarbons (PAH)
Nitro-PAH
Dioxins
Furans
Vanadium (V) Oxide, Vanadium (III) Oxide, Manganese and Cerium

(C) Exhaust emissions of formaldehyde, acetaldehyde, benzene, toluene, ethylbenzene, xylenes, butadiene, polycyclic aromatic hydrocarbons, nitro-PAH, dioxins/furans, and certain metals are to be sampled and analyzed by the methods and procedures specified in Table 2-2, which are hereby incorporated by reference herein, for a minimum of three test samples collected from separate emission test repetitions.

(D) The Executive Officer will make the final determination of appropriate testing in the test plan approval letter.

Table 2-2 Toxics sampling/analysis methods

Toxics	Method
Formaldehyde and acetaldehyde	ARB SOP No. MLD 104[35]
Benzene, toluene, ethylbenzene, xylenes, and 1,3-butadiene	ARB SOP No. MLD 102/103[36](quantitative) ARB SOP No. MLD 148[37] (for compound identification, as needed)
Polycyclic aromatic hydrocarbons	40 CFR Part 1065 Subpart L - Methods for Unregulated and Special Pollutants[38]
Nitro-PAH	40 CFR Part 1065 Subpart L - Methods for Unregulated and Special Pollutants[39]
Dioxins/Furans	40 CFR Part 1065 Subpart L - Methods for Unregulated and Special Pollutants[40]
Metals	40 CFR Part 1065 Subpart B[41]

(g) LABORATORY DEGREENING AND AGING PROTOCOL AND FIELD SERVICE ACCUMULATION REQUIREMENTS

Laboratory degreening and aging of the OEM DPF and the aftermarket DPF and field service accumulation of the aftermarket DPF shall be implemented in accordance with this section for each emission control group.

(1) The OEM DPF and Aftermarket DPF New Units Laboratory Degreening Protocol

(A) Selection of Engine. The degreening engine must be the emission test engine specified in section (f)(4). The test engine must be in the same configuration for degreening both the OEM DPF and aftermarket DPF.

(B) Test Cycles. Using the FTP (hot start), or the 13-mode Supplemental Emissions Test (SET) in the Code of Federal Regulations, Title 40, Part 86, Subpart N, as they existed on February 12, 2016[42], operate the engine for 25 hours.

(C) Test Run.

[35] ARB, Standard Operating Procedure (SOP) No. MLD 104: "Standard Operating Procedure for the Determination of Aldehyde and Ketone Compounds in Automotive Source Samples by High Performance Liquid Chromatography," April 1, 2006.
[36] ARB, SOP No. MLD 102/103: "Procedure for the Determination of C2 to C12 Hydrocarbons in Automotive Exhaust Samples by Gas Chromatography," March 15, 2007.
[37] ARB, SOP No. MLD 148: "Procedure for the Analysis of C3 to C12 Hydrocarbons in Automotive Exhaust by Gas Chromatography/ Mass Spectrometry with Pre-Concentration System," March 2009.
[38] *Methods for Unregulated and Special Pollutants,* CFR, Title 40, Part 1065 Subpart L, (As it existed on February 12, 2016)
[39] Ibid
[40] Ibid
[41] *Equipment Specifications.* CFR, Title 40, Part 1065 Subpart B, (As it existed on February 12, 2016))
[42] *Exhaust Test Procedures for Heavy-Duty Engines,* CFR, Title 40, Part 86, Subpart N, as it existed on February 12, 2016

1. DPF Degreening Protocol Multi-point Temperature Measurement Requirements. Applicants must perform the multi-point temperature measurement as specified in APPENDIX 2 during the entire degreening period.
2. Engine backpressure, exhaust DPF inlet and bed temperature, and engine speed must be measured and recorded on a second-by-second basis (1 Hz) for 25 hours or over the entire degreening period including regeneration.
3. The exhaust DPF inlet temperature and backpressure must be measured upstream of the device. For a DOC plus DPF configuration, this location must be between the DOC and DPF. The data must include an accurate date and time stamp that corresponds with periods of actual engine operation.
4. Applicant shall perform the regeneration emission tests during this degreening period and record the regeneration intervals.
5. All test results must be provided to ARB and be clearly labeled and identified, including appropriate units. Data must be provided in an electronic format with all data clearly and accurately identified. Data should be provided in a spreadsheet format compatible with Microsoft excel and all columns must be clearly and accurately labeled and include units. All raw data must be provided.
6. All EMD error or fault codes, the MILs, etc., must be monitored and recorded over the degreening period.

(2) The Aftermarket DPF New Unit Laboratory Aging Protocol

(A) Selection of Engine

1. Subject to the advanced written approval of the Executive Officer, the test engine selected for the aftermarket DPF laboratory aging must be either a 2007-2009 engine certified with an OEM DPF from within the proposed emission control group or an engine appropriate for DPF aging purposes (e.g., a “mule” engine).
2. Non-diesel cycle engines, engines using alternative fuels, or engines that are not certified by either ARB or the U.S. EPA are strictly prohibited.
3. If a mule or surrogate engine is used for aging, an engineering justification for why the engine is appropriate for aging purposes must be provided. The mule engine must have the DOC plus DPF configuration if the OEM engines in the emission control group include a DOC.
4. Test engine description must list the engine family name, make, model, model year, horsepower, displacement, OEM configuration with all exhaust components identified by OEM part number, engine serial number, and PM and NOx certification levels.

5. The test engine must be in the original OEM configuration and must be in a proper state of maintenance.

6. The test engine must have accumulated a minimum of 5,000 miles or 125 operating hours, whichever occurs first.

(B) DPF Regeneration Testing for DOC plus DPF engines

1. For 2007-2009 DOC plus DPF engines, DPF regeneration shall be as follows: the engine shall operate at a steady-state speed and load condition specified in Table 3-1 which provides sufficient exhaust temperature for DOC activity and sufficient flow for DPF regeneration.

2. Using a supplemental fuel injection system, DPF inlet temperature must be ramped to the target inlet temperature within a certain time as specified in Table 3-1.

3. The DOC must be in a proper state of maintenance and perform functionally as a chemical burner to act as a supplemental fuel injection system.

4. The “mule” engine testing must meet the aforementioned active regeneration requirements specified in Table 3-1.

5. The DOC on the test engine must be of the same make and model or part number as described in the new engine certification within the emission control group.

6. Detailed information on the DOC including part number and the engine within the emission control group for which it is a part of the certified engine configuration must be provided.

(C) Active regeneration test protocol must satisfy the temperature and time duration requirements specified in Table 3-1 for all configurations other than DOC plus DPF.

(D) The aftermarket DPF new units must undergo a minimum of 300 effective hours aging.

1. Applicants shall use the ARB-modified aging cycle described in Table 3-1 of this Procedure for the aftermarket DPF new units.

2. DPF Aging Protocol Multi-point Temperature Measurement Requirements. Applicants must perform the multi-point temperature measurement as specified in APPENDIX 2 during the entire aging period.

3. Effective active regeneration aging time. Throughout the active regeneration aging process, the effective aging time is calculated by comparing the actual bed aging temperature to the desired bed aging temperature by using the Arrhenius equation. When the cumulative effective active regeneration aging time equals the target aging time (minimum 100 hours), the aging process is complete, regardless of the actual aging time.

The detailed effective active regeneration aging time is described in APPENDIX 3.

Table 3-1 ARB Modified Aging Cycles

Mode #	Description	Parameters	Specification
1	2007 ramped-modal cycle	Engine Speed & Torque Time Duration	Code of Federal Regulations, Title 40, Part 86, Subpart N[43] 40 minutes
2	2007 ramped-modal cycle	Engine Speed & Torque Time Duration	Code of Federal Regulations, Title 40, Part 86, Subpart N[44] 40 minutes
3	Ramped temperature[1]	Target Temperature (DPF Inlet) Engine Speed & Torque Time Duration	620^{o}C ±20 ^{o}C 2007 ramped-modal cycle Mode A100 2 minutes
4	Active Regeneration	Target Temperature (DPF peak bed) Engine Speed & Torque Time Duration	700^{o}C ±50 ^{o}C 2007 ramped-modal cycle Mode A100 40 minutes
5	Cooling down[2]	Target Temperature Operation Engine Speed & Torque	Back to 2007 ramped-modal cycle Mode A100 exhaust temperature (±20 ^{o}C) Shut off supplemental fuel supply 2007 ramped-modal cycle Mode A100

[1]Temperature ramping period during the aging cycle is not considered as part of the 300 hours aging time.
[2]Cooling down period during the aging cycle is not considered as part of the 300 hours aging time.

4. Lubricant oil exposure requirement. The test plan must account for engine oil consumption during the 300 hours aging period. At a minimum, the engine oil consumption test plan shall include:

[43] Ibid
[44] Ibid

(i) Estimate oil consumption of the test engine over 100,000 miles using observed on-road heavy-duty diesel engine field average oil consumption (0.06% of fuel rate).
(ii) Based on the estimate in 4(i) above, set the oil consumption target for 300 hours laboratory aging period.
(iii) Using oil consumption acceleration options (e.g. engine modification, dosing oil into fuel, etc.) show how the target oil consumption is achieved.
(iv) Specify a method to track the actual oil consumption during the aging process. This method must follow APPENDIX 4.

(E) Test Run.

1. Engine backpressure, exhaust DPF inlet and bed temperature, and engine speed must be measured on a second-by-second basis (1 Hz) for 300 hours or over the entire aging period. Data must be recorded as averages over time intervals of 10 seconds.
2. The exhaust DPF inlet temperature and backpressure must be measured upstream of the device. For a DOC plus DPF configuration, this location must be between the DOC and DPF.
3. The data must include an accurate date and time stamp that corresponds with periods of actual engine operation.
4. All test results must be provided to ARB and be clearly labeled and identified, including appropriate units. Data must be provided in an electronic format with all data clearly and accurately identified. Data should be provided in a spreadsheet format compatible with Microsoft excel and all columns must be clearly and accurately labeled and include units. All raw data must be provided.
5. All EMD error or fault codes, the MILs, etc., must be monitored and recorded over the aging period.

(3) Aftermarket DPF Field Service Accumulation Requirements

(A) Engine Selection and Sizing.

1. The test engine selected for an aftermarket DPF must be a 2007 through 2009 model year engine certified with an OEM DPF. Test engine and vehicle must be identified by the engine family name, make, model, model year, engine serial number, horsepower, PM and NOx certification levels, and vehicle manufacturer, model and vehicle identification number.
2. The test engine must be in the same emission control group of the engine used for emission testing.
3. The test engine must represent the same “worst case” configuration as identified above in (f)(1)(B) for the engine used for emission testing.

4. The test engine must have the same engine displacement as the engine used for emission testing. If the engine used for emission testing is equipped with a DOC, the test engine must be equipped with the same model (or part number) of DOC as the DOC installed on the engine used for emission testing.

(B) Service Accumulation.

1. The aftermarket DPF must accumulate a minimum of 500 hours actual field service accumulation.

2. Service accumulation begins after the first emission test (performed after the 300 hours laboratory aging period).

3. It concludes before the final emission test (at least 500 hours on an appropriate in-field vehicle).

4. It must be under representative duty cycle. For example, field service accumulation from a long haul truck shall be with typical long haul truck duty cycle, field service accumulation from a garbage truck shall stop and go frequently.

(C) Compatibility. At a minimum, an applicant must demonstrate to the Executive Officer that its aftermarket DPF is compatible with the chosen engine and application during the field service accumulation period or the additional field demonstrations as defined in section (h) of this Procedure:

1. Does not cause damage to the engine or cause engine malfunction.

2. Does not cause backpressure or temperature to exceed the engine manufacturer's specified limits or result in any damage to the engine.

3. Does not hinder or detract from the vehicle or equipment's ability to perform its normal functions.

4. Is physically intact and well mounted with no signs of exhaust leakage or other visibly detectable problems.

5. Complies with all emission performance requirements of this Procedure.

6. Demonstrate regeneration frequencies that are consistent with the patterns described in the application for exemption.

7. Does not directly or indirectly cause any EMD fault codes after the installation.

8. Does not cause vehicle or engine to experience failure of any other emission related component during the field service accumulation period including, but not limited to, turbocharger components, injectors, heating elements, sensors, DOCs, etc.

9. Does not cause ECU programing or behavior to be altered.

(D) Parameters to be Monitored/Recorded Over 500 Hours or Entire Field Service Accumulation

1. Temperature and Backpressure Measurement Requirements.

(i) Engine backpressure.

(ii) Exhaust temperature.

(iii) Engine speed.

(iv) Exhaust temperature and backpressure must be measured upstream of the DPF. For a DOC plus DPF configuration if applicable, this location must be between the DOC and DPF.

(v) Measure and record values once every 10 seconds, with recording of averages, minima, and maxima.

(vi) Data must include accurate date and time stamps corresponding with periods of actual engine operation.

(vii) All test results must be provided to ARB and be clearly labeled and identified, including appropriate units. Data must be provided in an electronic format with all data clearly and accurately identified. Data should be provided in a spreadsheet format compatible with Microsoft excel and all columns must be clearly and accurately labeled and include units. All raw data must be provided.

2. All EMD error or fault codes, MILs, etc., must be monitored and recorded over the aging period.

3. Regeneration Interval Requirements.

(i) Regeneration intervals must be reported.

(ii) Regeneration intervals from an OEM engine must be provided for each selected emission control group with similar field operation duty-cycles.

(iii) Information from applicable published literature or similar field demonstrations for OEM engines within the emission control group may be used.

4. Electronic System Codes. Error codes, fault codes, and high backpressure codes that are generated by an engine electronic control system and/or operational monitoring system during the field service accumulation must be submitted with the date and time each code occurs.

(E) Third-Party Statement for Field Service Accumulation.

1. For each aftermarket DPF for 500 hours field service accumulation, including those used for additional 200 hours field demonstration, the applicant must provide a written statement from third party approved by the Executive Officer, such as the owner or operator of the vehicle or engine used, in end of the field service accumulation period.

2. Prepackaged “fill in the blank” letters are not appropriate. Comments must be specific to the actual vehicle.

3. The written statement must include:

(i) Name and contact information of the third party.

(ii) Aftermarket DPF serial number.

(iii) Clearly identified field service accumulation engine and vehicle.

a. Unique identifier (e.g., vehicle identification number, engine serial number).

b. Engine family name.

(iv) Description of overall performance, maintenance required, problems encountered, and any other relevant comments.

4. At the end of the field service accumulation period, a visual inspection of the DPF must be conducted and documented by the third party. The description should include:

a. Comments on whether the aftermarket DPF is physically intact, securely mounted, or exhibits any leaks of fluid or exhaust gases.

b. Any other evaluative observations.

(F) The applicant must provide information per section (g)(3)(D).

(G) Maintenance during Field Service Accumulation. Maintenance of the aftermarket DPF during the field service accumulation period is not allowed. If an engine failure or performance problem occurs during the field service accumulation period, the applicant must immediately notify ARB within 24 hours upon learning of the issue.

(H) Emissions Testing Post Field Service Accumulation. Testing requirements are summarized in the aforementioned Table 2-1. The applicant must perform the specified engine dynamometer-based testing after completion of the service accumulation period.

1. A minimum of one cold start and three hot start tests are required for engine testing.

2. Engine speed, engine backpressure and exhaust temperature must be measured and recorded on a second-by-second basis (1 Hz) during the test run.

(I) Performance Requirements. At a minimum, the aftermarket DPF must meet the following requirements after completion of the field service accumulation:

1. Emissions test results show compliance with section (f)(10)(D).

2. Must maintain its physical integrity. Its physical structure and all of its components not specified for regular replacement during the field service accumulation period must remain intact and fully functional.

3. Does not cause any damage to the engine, vehicle, or equipment.

4. Backpressure caused by the aftermarket DPF should not exceed the engine manufacturer’s specified limits or result in any damage to the engine.

5. Does not cause any EMD fault codes during the field service accumulation period.

6. Does not cause vehicle or engine to experience failure of any other emission related component during the compatibility period including, but not

limited to, turbocharger components, injectors, heating elements, sensors, DOCs, etc.

7. Does not cause ECU programing or behavior to be altered.

8. The regeneration intervals from aftermarket DPF shall approximate that of the OEM DPF during the 500 hours field service accumulation.

(h) ADDITIONAL FIELD DEMONSTRATION REQUIREMENTS

(1) Applicant must demonstrate compatibility of the aftermarket DPF in the field with at least two different engines (other than the 500 hours field service accumulation engine) within the requested emission control group.

(2) Each selected engine must be operated with an aftermarket DPF installed for a minimum period of 200 hours or 10,000 miles, whichever occurs first.

(3) The requirements for this additional field demonstration are the same as in the 500 hours field service accumulation specified in section (g)(3) of this Procedure excluding the duration for testing and emission testing.

(4) The data (exhaust temperature and backpressure, RPM, ECU codes, and regeneration interval, etc.), visual inspection photos and records, field demonstration reports, and third-party statements as specified in sections (e)(2) and (g)(3) of this Procedure must be submitted.

(5) The additional field demonstration units must satisfy the performance (excluding emission testing results) and compatibility requirements specified in section (g)(3), (i), and (k) of this Procedure.

(i) APPROVAL CRITERIA FOR TESTING

(1) The aftermarket DPF test results must demonstrate compliance with all evaluation criteria specified in sections (e), (f), (g), and (h).

(2) The aftermarket DPF must pass the visual inspections specified in section (e). Any signs of soot on the outlet DPF, broken cells, cell plugs, cracks, erosion, leaks around the side/matting, exhaust leaks upstream of the DPF, and any indications of canning issues (leaks), burn through cells, or excessive heat (i.e., discoloration of the can) are considered as failures of the aftermarket DPF.

(3) All incomplete, voided, invalid, and failed tests must be identified and explained. All raw data from these tests must be submitted which clearly identifies the data and/or data columns.

(4) Any incomplete, inconsistent or incorrect data submitted for emission testing, durability and compatibility demonstrations (through laboratory aging and field service accumulations) will result in ARB determining the testing cannot be accepted to support the aftermarket DPF application and the application will be terminated.

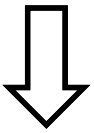
(5) All EMD fault codes must be clearly identified and reported for all runs, including voided, failed, incomplete, and invalid runs.
(6) EMD fault codes, alteration of the EMD/ECU from its certified configuration, or any other change in engine operation inconsistent with its certification shall be grounds for deeming the aftermarket DPF to be incompatible with the engine and emission control group.
(7) An engine failure that compromises or destroys the aftermarket DPF (e.g., turbocharger failure resulting in a fouled emission control system) at any point in testing will be treated as a failed testing demonstration. The application will be suspended and/or terminated barring the existence of a backup unit included and approved in the test plan.
(8) Failure during the field service accumulation or additional field demonstrations.
(A) Engine problem. A detailed analysis of the engine issue and data sufficient to prove the aftermarket DPF did not cause or contribute to the engine problem must be provided. Failure to provide robust data and information in support of the aftermarket DPF will result in the Executive Officer determining the device was incompatible with the engine and application and terminating the application process.
(B) If the aftermarket DPF fails, requires repair or maintenance, or suffers any type of component failure, Executive Officer will determine the demonstration was unable to show compatibility with the engine and application and terminate the application process.

(j) OTHER REQUIREMENTS

(1) Labeling
(A) The applicant must ensure that identical, legible, visible, and durable labels are affixed on both the aftermarket DPF and the engine on which the aftermarket DPF is installed.
(B) All labels must be constructed and affixed so that they resist tampering and remain legible, visible, and durable for the entire time the aftermarket DPF is on the vehicle.
(C) One label shall be welded, riveted, or otherwise permanently attached to the aftermarket DPF and the other affixed to the engine in such a manner that it cannot be easily removed (e.g., bolted).
(D) The applicant and/or installer must ensure that the label is visible after installation.
(E) The required labels must identify:
1. EO number issued by ARB
2. Name, address, and phone number of the applicant
3. Product part number

4. Unique serial number
5. Month and year of manufacture
6. Directional flow arrow
(i) The directional flow arrow shall indicate the direction exhaust is designed to flow through the aftermarket DPF when properly installed.
(ii) The purpose and meaning of the arrow shall be explained in the Installer's Manual (section (j)(7)).
7. Other information such as "birth weight" to help the end user clean their filter.

(F) The label information must be in the following format:
D-XXX-XX (EO number issued by ARB)
Name, Address, and Phone Number of Manufacturer
YYYYYY (Product Part Number)
Unique Product Serial Number
ZZ-ZZ (Month and Year of manufacture, e.g., 06-15)
Other Information



(Directional Flow Arrow)

(2) Installation Requirements
(A) Installers of new aftermarket DPFs must be authorized by the applicant and shall adhere to the following requirements for proper installation. Failure to adhere to these requirements may invalidate a new aftermarket DPF's Executive Order.
(B) The applicant shall provide installation requirements to the installers of its products through its normal means for communicating with installers, including, but not limited to, its Internet website, requests via phone or email for technical assistance from installers, and other documentation distributed to installers, and the Installer's Manual (specified in section (j)(7)).
(C) Installers may not install a new aftermarket DPF on a candidate engine unless all of the following conditions are met:
1. The engine, engine configuration, etc. is specifically listed in the Executive Order for the aftermarket DPF.
2. The engine is beyond the coverage of its OEM emission warranty period. Installers may reference the vehicle owner's manual/warranty booklet or contact the engine manufacturer or its representative to verify the applicable OEM engine emission warranty period.
3. The engine has a legitimate need for replacement of the existing DPF that has been established and documented by the installer on the repair invoice.

If the OEM DPF is present, the installer must make a determination that it is not functioning properly before acting to replace it.

4. The engine shall not be in non-certified configuration.

5. No engine error codes are present that indicate engine problems.

6. The engine and emission control components other than the DPF being replaced are present and in a proper state of maintenance and the engine is operating within manufacturer's specifications.

(i) The applicant must select and define specific assessment criteria (e.g., oil consumption limits, fuel inspection requirements, and visual inspections) which must be used by the installer to determine a proper state of maintenance of the engine and other components (especially for DOC).

(ii) Addition of a datalogger may be proposed to generate data to support assessment of a proper state of maintenance and/or duty cycle behavior.

7. The new aftermarket DPF must be installed in the same location and orientation as the OEM DPF it is designed to replace. The installation may not alter the location, position, or orientation of any OEM sensors upstream and downstream of the DPF.

8. The new aftermarket DPF is installed correctly in accordance with the manufacturer's instructions.

9. The new aftermarket DPF is installed on a one-for-one DPF basis (i.e., a single OEM DPF is replaced with only one new aftermarket DPF).

10. The new aftermarket DPF is installed with all other required emission control components (no consolidation of emission control components, nor addition of extra emission control components).

11. An installation warranty must be offered according to section (l)(2).

12. A warranty card has been filled out according to section (l)(1).

(D) In addition, all installers must document the following:

1. Serial number of the device

2. Device manufacturer and governing Executive Order number

3. Fleet contact information

4. Vehicle identification number or other unique identifier

5. Engine family name, model, horsepower

6. Vehicle type

7. Date of installation

8. Reason for installation of the aftermarket part

9. Party doing the installation

(E) The party performing the installation of the modified part must maintain a record of all documentation used to determine suitability of the engine for the

modified part as described in section (j)(2). All such records must be made available to the Executive Officer within 15 days upon written request.

(F) All installations must strictly adhere to the requirements of the party that holds the certification for the modified part.

(G) The installer must provide a copy of the pre-installation assessment records to the end user and device manufacturer at time of installation of the modified part.

(3) Quality Control Procedures. A new aftermarket DPF applicant shall implement, utilize, and document quality control (QC) procedures to ensure that production new aftermarket DPFs conform to the specifications of the exempted new aftermarket DPFs within acceptable production tolerances.

(A) Requirements for Quality Control Process

1. The QC procedures shall, at a minimum, provide for the monitoring of:

(i) Average per piece precious metal content of coated substrates for each precious metal constituent that is applied.

(ii) Average relative per piece total base metal content that is applied to each substrate.

(iii) Average per piece total washcoat loading applied to each substrate.

(iv) Proper coating of substrates

(v) Proper placement of matting materials around the substrate.

(vi) Leaks after the canning process.

2. No less than one percent of production parts within a production lot shall be evaluated.

3. Parts selected for evaluation shall be randomly distributed over the production lot.

4. The applicant shall submit its quality control procedures for ARB approval, and shall obtain written approval from the ARB prior to implementation of the procedures.

(i) The procedures shall include a production flow chart covering the entire manufacturing process from receipt of raw materials to shipment of the final product. The production flow chart shall identify each quality control check that is performed and at what point in the process it is performed.

(ii) The submitted procedures shall also contain a detailed description of the methods used to measure the properties listed in section (j)(3)(A)(1.), along with all other quality control checks that are performed.

(iii) With concurrence from the applicant, relevant portions of the documentation required in this section may be sent directly to ARB by the manufacturer’s catalyst substrate supplier(s) and any other suppliers involved in the manufacturing process.

(iv) If an applicant or its suppliers fail to adhere to ARB-approved QC procedures, ARB may rescind any exemption granted pursuant to this Evaluation Procedure.

(B) Evaluation Criteria

1. Parts must be free from physical defects which may affect performance or compatibility with the OEM engine including, but not limited to, plugged channels which should be open, open channels which should be plugged, and cracks.

2. Catalyst composition, loading, and coating design (e.g., zone versus straight coating), and formulation must match the approved configuration.

3. Canning must ensure that the core is well-seated and will neither loosen nor allow leaks between the can and the core nor allow holes in the can itself (e.g., due to metal fatigue or poor welding/seals).

(C) Corrective Action

1. If any sample fails to pass all elements of the quality control test, all parts produced from the time the last sample that passed quality control was produced shall be quarantined by the manufacturer.

2. Only quarantined parts that individually pass the manufacturer's quality control test may be released for sale.

3. All other parts must be reprocessed to fall within the evaluation criteria prior to being released for sale.

4. The Executive Officer may require a recall, pursuant to section (j)(5), of any affected parts or lots that have already been released for sale.

(D) Documentation Requirements

1. Within 15 days of written request by ARB, applicant shall report for each aftermarket DPF design the following information for each production lot produced within the quarter:

(i) The average per piece precious metal content of the coated substrates, reported in absolute grams per cubic foot, for each precious metal constituent contained on the catalyst (e.g. platinum, palladium), along with the minimum acceptable loading specification.

(ii) The average per piece total base metal content of the coated substrate, reported in relative grams per cubic foot, along with the minimum acceptable base metal loading specification.

(iii) The average per piece total washcoat loading of the coated substrates reported on either a weight basis (e.g., grams per part or grams per unit volume) or a total surface area basis (e.g., square meters per part, square meters per unit volume, or square meters per unit weight of coated part) along with the minimum acceptable loading specification.

(iv) Results of the manufacturer's QC inspection findings for the substrate, applied mattings, and the integrity of the can and welding, including minimum acceptable specifications for each inspection.

2. Reports shall be sent to the Chief, In-Use Programs Branch, ECARS Division, 9480 Telstar Avenue, Suite 4, El Monte, California 91731.

3. With concurrence from the applicant, relevant portions of the documentation required in this section may be sent directly to ARB by the manufacturer's catalyst substrate supplier(s) and any other suppliers involved in the manufacturing process. Applicants may omit confidential information from submitted written procedures provided the confidential details are provided to ARB staff upon request.

(4) Audit Testing

(A) The Executive Officer may, with respect to any new aftermarket DPF sold, leased, offered for sale, intended for sale, or manufactured for sale in California, require an applicant to send up to five new aftermarket DPFs per applicant per year for audit testing including, but not limited to, new aftermarket DPFs that are in the possession of authorized dealers but not yet installed on applicable engines.

(B) New aftermarket DPFs selected for audit testing must be delivered at the manufacturer's expense to ARB at the Haagen-Smit Laboratory, 9528 Telstar Avenue, El Monte, California or another location as specified by the Executive Officer.

(C) The Executive Officer may also, with respect to any modified part DPF being sold, leased, offered for sale or lease, intended for sale or lease, or manufactured for sale in California which is subject to an audit require the manufacturer, to produce records regarding sales/leases, swapping, quality assurance, and warranty claims which are complete and current as of the date of ARB's written request. These documents must be provided within 10 days of such a request.

(D) If one or more of the tested DPF meets any of the failure criteria listed below, the Executive Officer may revoke the Executive Order, request further analysis and data from the applicant, additional information or data, or require, at the applicant's expense, additional aftermarket DPF (from the same aftermarket DPF model as the failed DPF) to be procured and sent for testing. Such additional testing shall be limited to no more than five new aftermarket DPFs from the same Executive Order as the failed DPF.

1. Fails to meet the applicable certification emission standards in an applicable test engine.

2. Fails to conform to its original aftermarket exemption.

3. Negatively impacts engine durability and functionality.
4. Causes damage to the engine or vehicle.
5. Is not compatible with the OEM system (e.g., triggers engine fault codes/MIL, alters ECU behavior)
6. Poses a safety risk. In evaluating whether a new aftermarket DPF represents a safety risk the Executive Officer will consider all relevant information, including information submitted by the applicant regarding potential safety and catastrophic failure issues associated with use of the new aftermarket DPF including potential failure modes including uncontrolled regeneration, improper maintenance, unfavorable operating conditions, use of inappropriate fuel, high exhaust temperatures, substrate failure, and sensor failures.
7. Causes secondary emissions.

(5) Recall

(A) Recall Provisions. If the Executive Officer determines after a review of an applicant's or installer's warranty report (pursuant to section (l)), an enforcement case, audit testing, quality control, or any other information, that a new aftermarket DPF has the potential to experience catastrophic failure or other safety related failure, has valid warranty claims in excess of four percent as defined in section (l), or has caused engine issues or other parts to fail on the engine, or a substantial number of units experience a failure of an operational feature, parts have failed QC, or the manufacturer or installer has not resolved warranty claims within the 30 day timeframe, the Executive Officer may require a recall.

(B) In the event of a recall the Executive Officer shall provide notification to the applicant or installer that includes a description of the nature of the failure or warrantable condition, the factual basis for the determination, and shall designate a date at least 60 days from the date of receipt of such notification by which the applicant shall submit a recall plan for review and approval to address the failures or warrantable condition.

(C) Each recall plan must be approved by the Executive Officer in writing.

(D) No further sales, leases, or installations of the aftermarket DPF shall take place after the applicant receives the recall notification from the Executive Officer.

(E) Recall Plan. At a minimum, a manufacturer's or installer's recall plan shall contain the following information unless otherwise specified in the notification:

1. A description of each exempted new aftermarket DPF subject to the recall including the number of units to be recalled, the emission control group(s) affected, and any information required to identify the recalled units.

2. A description of the type and nature of the failure, issue, or warrantable condition and the specific modifications, design changes, alterations, repairs, adjustments, or other changes to be made to correct the failures or warrantable condition with a description of the technical studies, data, or other information which support the applicant's decision regarding specific corrections to be made.

3. A description of the method by which the applicant or installer will determine the most current names and addresses of the end users and the applicant's methods and schedule for notifying the end users and service facilities.

4. A description of the procedure to be followed by the end users to correct the failures or warrantable condition. This shall include the date on or after which the end user can have the failures or warrantable condition remedied, the time necessary to perform the remedy, and the designation of facilities at which the remedy can be performed, as well as how the applicant or installer will ensure the remedy addressed the issue or problem.

5. The plan may specify the maximum incentives, if any, the applicant or installer will offer to induce vehicle or equipment owners to present their aftermarket DPFs for repair, as evidence that the applicant has made a good faith effort to repair or replace all the aftermarket DPFs in the plan. The plan shall include a schedule for implementing actions to be taken, including identified increments of progress towards implementation and deadlines for completing each such increment.

6. A copy of the letter of notification to be sent to the end users.

7. A description of the system by which the applicant or installer will assure that an adequate supply of parts will be available to perform any repairs under the recall plan, including the date by which an adequate supply of parts will be available to initiate the repair or replacement campaign, and the method to be used to assure that the supply remains both adequate and responsive to end user demand.

8. A copy of all necessary instructions to be sent to those persons who perform the replacement or repair.

9. A description of the impact the proposed replacement or repairs will have on the vehicle, equipment, or engine including: exhaust backpressure, exhaust temperature, durability, regeneration, maintenance, fuel economy, drivability, performance, safety, warranty, and a summary of the data and technical studies used to support such determinations.

(F) Reporting Requirements. Unless otherwise specified by the Executive Officer, the applicant or installer shall report on the progress of a recall campaign by submitting subsequent reports on a monthly basis, at a minimum, until the

recall process is complete. Such reports shall be submitted no later than 25 days after the close of each month to: Chief, In-Use Programs Branch, ECARS Division, 9480 Telstar Avenue, Suite 4, El Monte, California 91731.

(G) The Executive Officer may revoke the Executive Order of an aftermarket DPF if the applicant fails to adhere to the requirements of this section.

(6) Owner's Manual. The applicant must provide a copy of the new aftermarket DPF's owner's manual to the Executive Officer for review and approval and, if approved by the Executive Officer, to the end user, which must clearly specify at least the following information:

(A) A Table of Contents located at the beginning of the owner's manual identifying the location of subsections (B) through (M) identified below.

(B) A statement alerting the end user of their responsibility for maintaining the candidate engine such that it continues to meet the pre-installation assessment conditions identified in section (j)(2)) and the OEM engine maintenance requirements.

(C) Warranty statement including the warranty period.

(D) Installation procedure and maintenance requirements for the aftermarket DPF.

(E) Notification that the Executive Order for a new aftermarket DPF is only valid if the aftermarket DPF is installed in accordance with applicant installation procedures and maintenance requirements.

(F) An objective criteria for ash removal (pressure drop across the filter, maximum clean filter weight, pre-installation filter weight comparison, etc.) for determination if a filter is "cleaned" pursuant to section (j)(9)(B).

(G) Fuel requirements, including sulfur limits, if any.

(H) Requirements for lubrication oil quality and maximum lubrication oil consumption rate.

(I) The following statements must be included verbatim in the owner's manual:

YOUR RIGHT TO MAINTENANCE INFORMATION

The Air Resources Board requires that (Applicant's name) provide detailed maintenance information for the new aftermarket DPF upon delivery to the end user pursuant to the Title 13, California Code of Regulations, Section 2222(k), at no additional cost to the owner. If you do not already have this information, contact (Applicant's chosen contact) at 1-800-xxx-xxxx.

THE IMPORTANCE OF ENGINE MAINTENANCE

Proper engine maintenance is critical for the proper functioning of your new aftermarket DPF. Failure to document proper engine maintenance, including oil

consumption records, may be grounds for denial of a warranty claim for a failed new aftermarket DPF.

THE IMPORTANCE OF PROPERLY MAINTAINING AN AFTERMARKET DPF
Proper maintenance is critical for the new aftermarket DPF to function as intended. Failure to document maintenance, including cleaning and/or ash removal of the system, replacement of consumables, and replacement of broken/failed parts, may be grounds for denial of a warranty claim for a failed new aftermarket DPF.

(J) Contact information for replacement components and cleaning agents.
(K) Contact information to assist an end user to determine proper ways to dispose of waste generated by the new aftermarket DPF (e.g., ash accumulated in filter-based systems). At a minimum, the owner's manual should indicate that disposal must be in accordance with all applicable Federal, State and local laws governing waste disposal.
(L) Parts list. An identification of the new aftermarket DPF and all associated parts by description, quantity and part number.
(M) Notification of potential safety concerns associated with the operation of the aftermarket DPF.
(N) Other Informational Material Requirements. The applicant is responsible for developing informational materials to ensure end users can safely operate and maintain their new aftermarket DPF. The informational materials must include, at a minimum: a review of the installation assessment results, the effects of engine maintenance on the part's performance, identification of all warning and/or fault alarms and appropriate end-user responses, and cleaning and maintenance information for the aftermarket DPF. If the applicant allows the end user to perform routine maintenance of the aftermarket DPF, this training information must include the maintenance procedures described in section (j)(9). The applicant is responsible for ensuring that this training is presented to the end user before the vehicle, equipment, or engine is put back into service following the installation of the aftermarket DPF and must be available to the end user on an on-going basis (e.g., online training materials). The Applicant may include such information in the owner's manual or other separate documents.

(7) Installation Instructions/manual. The applicant must provide a copy of the installation instructions that the applicant intends to provide to installers. The installation manual must include sufficient information to enable the installer to properly install the aftermarket DPF such that the installation is free from defects in workmanship, materials, or operation which could cause any of the components of

the aftermarket DPF to fail and allow the installer to warrant the installation pursuant to section (l)(2). In addition, the installation instruction must explain the purpose and meaning of the directional arrow from section (j)(1), if applicable.

(8) Technical service bulletins, installation criteria, other service-related information, or any other documentation that affects the proper operation and maintenance of the new aftermarket DPF provided to end users or installers must be submitted concurrently to ARB. Technical service bulletins shall not contradict any information supplied or approved as part of the aftermarket DPF exemption.

(9) Maintenance Requirements. The applicant must provide information regarding maintenance of the new aftermarket DPF as follows:

(A) The applicant must identify all normal maintenance requirements for the aftermarket DPF.

1. The applicant must specify the recommended intervals for cleaning and/or replacing components.

2. Any components to be replaced within the warranty period must be included within the original aftermarket DPF package or provided free of charge to the customer at the appropriate maintenance intervals.

3. In addition, the applicant must specify procedures for proper handling of spent components and/or materials cleaned from the aftermarket DPF. If any such materials are hazardous, the applicant must identify them as such in the owner's manual.

(B) The applicant must provide detailed maintenance information for the new aftermarket DPF to the owner upon delivery of the new aftermarket DPF. This information must not conflict with or contradict OEM engine applicant’s instructions for proper engine maintenance. If the applicant allows the owner to perform the maintenance procedures, the information provided must be sufficient to enable the owner to properly conduct the routine maintenance on the aftermarket DPF. The required information includes, but is not limited to:

1. Specific routine maintenance and cleaning procedures and timeframes.

2. All performance criteria used to determine a proper state of maintenance, such as the pressure drop across a fully-cleaned aftermarket diesel particulate filter. The information provided must be detailed and specific enough to allow determination of whether a filter has been properly cleaned, and should not recommend, and must exclude practices which may result in damage to the aftermarket DPF.

3. Any prohibitions or specific maintenance practices which may result in damage to the aftermarket DPF.

4. Directions consistent with OEM engine applicant's directions for proper handling of ECU, error codes, and engine maintenance.

(10) Aftermarket DPF Component Swapping Practices

(A) Applicants may authorize that an ARB exempted aftermarket DPF component be moved from the original installation and transferred to another vehicle, provided the following provisions are met:

1. Applicants must first receive ARB's written approval for the conditions and terms for this swapping policy.

2. End-user must first receive written authorization from the applicant (aftermarket DPF exemption holder) allowing the practice of DPF swapping. .

3. An aftermarket DPF may only be swapped to appropriate engines in proper working condition.

4. The swapping must be within the same common ownership fleet as defined in Section (b) of the Procedure.

5. The swapped aftermarket DPF must be the same size and model, and incorporate the same flange type or muffler design as the original aftermarket DPF. The swapped aftermarket DPF must be covered under the same Executive Order as the original aftermarket DPF. The swapped aftermarket DPF must have been originally purchased by the common ownership fleet as a new DPF and must not have been acquired as a used part.

6. The swapped aftermarket DPF must fit directly in place of the original aftermarket DPF in the correct filter orientation without modification of the existing installation.

7. The end user and installer must verify that the vehicle meets the conditions and terms of the original aftermarket DPF exemption (EO).

8. Any vehicle involved in swapping must stay in a certified configuration. No vehicle should ever be operated without an approved DPF (either the original OEM part, OEM replacement part, or approved aftermarket modified part).

9. The aftermarket DPF must be installed by the procedure described in the corresponding aftermarket DPF installation manual or other manual designated for swapping procedures.

10. The aftermarket DPF must be properly maintained as specified in ARB approved aftermarket DPF installation, maintenance or operation manuals.

11. Prior to installation of the aftermarket DPF, the exhaust system must be inspected for the presence of lubricating oil, fuel, and other engine related fluids.

(B) Additional Requirements for Applicant's Swapping Practices:

1. Applicants must provide detailed written instructions to the end-users in the owner's manual, installation manual, or other manual regarding how to swap

and install spare filter and provide explicit instructions on the type of information which must be maintained for swapped systems and vehicles. Applicants may not include any prohibitions or limitations to the required warranty, nor can the instructions direct the end-users of the aftermarket DPFs to conduct any activity which violates the terms of the governing Executive Order series or any other applicable regulation.

2. Applicants must honor the original product warranty and warranty period for this swapping practice.

3. Applicants must maintain accurate records of the vehicles and systems subject to the swapping policy. For every swapped aftermarket DPF, these records must include: DPF unique serial number, part number, complete contact information for the end-user/fleet, engine serial number of each engine, vehicle type of each vehicle, engine family name for each vehicle, horsepower of each vehicle, vehicle mileage or hours at time of each swap (must include mileage/hours of donor vehicle and candidate vehicle), and dates of removal or installation. The dates of DPF service/cleaning and what service was provided as well as the state of the filter (determination that the DPF was cleaned and in proper working condition) must also be kept. Information must be complete and accurate enough to allow the fleet, applicant, and ARB to trace the history of a swapped DPF over its regulated lifetime. Applicants must ensure each approved fleet understands what information must be kept and is capable of complying with these requirements. Applicants must provide these records to ARB within 30 days of receiving a written request from ARB.

(11) Noise Level Control. New aftermarket DPFs are not exempted from compliance with any applicable state or federal noise level requirements.

(12) Fuel Additives and Alternative Diesel Fuels. A new aftermarket DPF must not include the use of fuel additives or alternative diesel fuels as part of its emissions control strategy. The use of fuel additives or alternative diesel fuels with a new aftermarket DPF is strictly forbidden.

(13) Fuel and Oil Requirements. The applicant must specify the fuel and lubricating oil requirements necessary for proper functioning of the new aftermarket DPF. The applicant must also specify any consequences that will be caused by failure to comply with these requirements, as well as methods for reversing any negative consequences. The applicant shall remind end-users that use of unqualified fuels and lubricating oils may be grounds for disallowing a warranty claim.

(14) No person or entity shall install, sell, offer for sale or advertise a used aftermarket DPF.

(15) Sales and Installation. No person or entity shall install, sell, offer for sale or advertise, any device, apparatus, or mechanism as a new aftermarket DPF that does not meet the terms and conditions of the new aftermarket DPF's Executive Order.

(16) Exemption of a new aftermarket DPF by the Air Resources Board does not exempt an applicant from complying with all other applicable legal requirements.

(k) SAFETY

(1) Installation and Operation.

(A) The applicant and any installers must ensure that the installation of a new aftermarket DPF does not relocate the OEM exhaust system over either any occupied space (e.g., driver or passenger compartments) or result in any noncompliance with any applicable safety standards, including the Federal Motor Carrier Safety Administration, *Parts and Accessories Necessary for Safe Operation*, Subpart G Section 393.83 *Exhaust Systems*[45].

(2) Design of Aftermarket DPF. The applicant must give consideration to safety and catastrophic failure in the design of the new aftermarket DPF.

(A) The applicant must provide an analysis of all potential safety and catastrophic failure issues associated with the use of the new aftermarket DPF including an analysis of all potential failure modes. This analysis must include, but is not limited to, the effects of: uncontrolled regeneration, improper maintenance, unfavorable operating conditions, use of inappropriate fuel, high exhaust temperatures, substrate failure, and sensor failures. For any potential safety or catastrophic failure issues identified, the applicant must provide a detailed description of the safety risk mitigation strategies that it employs.

(B) The Executive Officer may require additional safety testing and design modifications to the new aftermarket DPF both before and after exempting the new aftermarket DPF which may include destructive testing. In making these determinations, the Executive Officer may consider all relevant information including, but not limited to, the safety and catastrophic failure analysis provided by the applicant, system design, properties of the materials used by the aftermarket DPF, field experience, and warranty report data. The Executive

[45] Federal Motor Carrier Safety Administration (FMCSA). *Parts and Accessories Necessary for Safe Operation*, Subpart G Section 393.83 *Exhaust Systems*. Washington DC; (December 7, 1988)

Officer will require that safety testing be conducted by an independent test facility that has appropriate safety testing experience.

(C) If the Executive Officer determines that an applicant has not made a satisfactory demonstration of the safety of its new aftermarket DPF, the Executive Officer may deny the applicant's request for an aftermarket DPF exemption or revoke an existing exemption.

(l) WARRANTY

(1) Product Warranty

(A) The applicant of the new aftermarket DPF must warrant to all owners, for ownership within the warranty period and lessees, for lease contracts within the warranty period, that its new aftermarket DPF is free from defects in design, materials, workmanship or operation which cause the new aftermarket DPF to fail to conform with the requirements of this Procedure provided the operation of and conditions of use conform with the operation and conditions specified in the Executive Order.

(B) The minimum warranty period for a new aftermarket DPF is 2 years from the date of installation. The warranty must cover the full repair or replacement cost, including diagnosis, parts, and labor and any damage to the engine proximately caused by the aftermarket DPF.

(C) The warranty must also cover the full repair or replacement cost of returning the engine to the condition the engine was in prior to the failure, including parts and labor, for damage caused by the new aftermarket DPF. Repair or replacement of any warranted part, including the engine, must be performed at no charge to the vehicle owner. This includes only those relevant diagnostic expenses in the case in which a warranty claim is valid. The applicant may, at its option, instead pay the fair market value of the engine prior to the time the failure occurred.

(D) The applicant must resolve all warranty claims within 30 days of notification (as notified through either the applicant directly or authorized installer) of an issue with an aftermarket DPF or modified system. The applicant must provide an appropriate replacement part(s) within 5 business days of determining the part(s) is malfunctioning or failed. Failure of the vehicle or engine owner to ensure scheduled maintenance or to keep maintenance records for the vehicle, engine, or new aftermarket DPF may, but shall not per se, be grounds for disallowing a warranty claim.

(E) Within 15 days of denying a claim (which may be in addition to the 30 day warranty resolution period), the applicant must provide "Grounds for Denial" in the form of a dated letter or document to the owner of any new aftermarket DPF for which a claim was denied. This document must identify the reason(s) for the denied claim, the date of the claim, the unique serial number of the unit, the part

number, the nature of any damage to the engine, and the contact information of the new aftermarket DPF owner. This authority may be delegated to an installer if the installer also provides a copy of the Grounds for Denial to the applicant at the same time that the "Grounds for Denial" letter is sent to the owner of the new aftermarket DPF. Grounds for Denial must be provided to ARB within 15 days of written request.

(F) Warranty Card

The applicant shall provide a warranty card with each new aftermarket DPF intended for California sale or use. The warranty card shall include:

1. The general terms and conditions of the new aftermarket DPF warranty;
2. A statement that the new aftermarket DPF has been designed and manufactured to meet the warranty requirements;
3. A place for the customer's signature in acknowledgement of receipt of the new aftermarket DPF warranty;
4. The new aftermarket DPF part number;
5. The new aftermarket DPF unique serial number
6. The vehicle year, make, model, VIN, and odometer reading on which the new aftermarket DPF was installed;
7. The date of installation;
8. The name of the installation shop or facility; and
9. Acknowledgement that the installer followed the applicant's requirements for assessing the vehicle for compatibility prior to installation of the new aftermarket DPF.

The warranty card shall be supplied and filled out in triplicate; the original for the customer, one copy for the installer to keep, and one copy to be sent back to the applicant. The copy to be returned to the applicant shall have pre-paid postage and be of sufficient size to allow for mailing without the use of a separate envelope.

(G) The applicant must ensure each aftermarket DPF sold to the ultimate purchaser includes a copy of the governing Executive Order, and owner's manual.

(H) Warranty Reporting

1. The applicant must review warranty claim records for new aftermarket DPFs covered under each Executive Order on a production year basis for a period of five years following the production year and shall submit a warranty report to the Executive Officer annually by April 1 of each calendar year for each aftermarket DPF with a unique Executive Order.
2. Products covered by several Executive Orders must not be combined into a single report.

3. Parts with different part numbers determined by the Executive Officer as constituting one part category or grouping during the exemption process must be reported as such.
4. The warranty report must include all warranty claims, even those that were denied, and must delineate claims that resulted in warranty service (i.e., valid claims) from those that were denied. Any claim relating to a new aftermarket DPF that was brought by an owner of a new aftermarket DPF to an installer or to the applicant within the warranty period must be reported as a claim. Prescreening of invalid claims must not occur. Invalid claims may be identified as denied claims in the warranty report and an appropriate reason for the denial must be included (e.g., outside the warranty period, no problem with device, etc.).
5. If at any time the cumulative number of valid claims exceeds four percent of total sales, the applicant must submit a written report to ARB within 15 days after making that determination. For less than 25 cumulative valid claims the applicant need not issue a supplemental report in addition to the annual report. The applicant shall include in the report a description of the type(s) of failure, the probable cause of the failures, and data or an engineering evaluation of the impact of the failures on vehicle or engine emissions, and any potential safety concerns.
6. The warranty report (annual and those triggered by exceedances of the 4 percent or 25 unit trigger) must, at a minimum, include the following information:

(i) The applicant's corporate name, sales for the given calendar year and cumulative sales, and leases for the given calendar year and cumulative leases of an aftermarket DPF.

(ii) An annual summary of warranty claims for the given calendar year. The summary must include:

a. A description of the nature of the claims (including denied warranty claims) and of the warranty replacements or repairs. The manufacturer must categorize warranty claims for each new aftermarket DPF covered by a unique Executive Order by the part(s), part group(s) or component(s) replaced or repaired. All information must be correlated to a valid and unique aftermarket DPF serial number.

b. Each part number, part description (common name of the part) or part grouping (in cases identified by the Executive Order due to a parts change request) for which there was a valid claim. Denied claims which were for parts or part grouping under warranty must be reported.

c. The total number of claims (absolute and as a percentage of cumulative sales) for a part or part grouping.
d. Valid claims involving engine components not part of the new aftermarket DPF (by OEM part number and common name description) which suffered damage caused by the new aftermarket DPF (including thermal events).
e. Denied claims for engine parts not part of the new aftermarket DPF which suffered damage caused by the new aftermarket DPF (including thermal events).
f. The reason for the failure, repair, or replacement.
g. The engine family, engine model, and horsepower associated with each claim.
h. The vehicle application associated with each claim.
i. The fleet contact information corresponding to each claim.
j. The installer for each claim.
k. Date of claim(s).
l. Mileage at time of claim(s) and mileage at time of installation.
m. The time from report of issue to resolution of the claim (in days).
n. If a claim was deemed valid, “good faith”, or denied.
o. If a claim was denied the applicant must clearly state the reason(s).

7. A current list of installers for the aftermarket DPF.
8. An aftermarket DPF warranty report that does not contain all required information, or contains inaccurate information, will not be considered complete.
9. The Executive Officer may suspend the review of all other applications sent by an applicant if that applicant fails to submit warranty reports.

(l) Product Warranty Statement.
The applicant must include a copy of the warranty statement in the owner’s manual of each new aftermarket DPF sold. A copy of the owner’s manual, installation manual, warranty card and governing Executive Order must be provided to each owner at the time of sale of the aftermarket DPF. The applicant may include in the owner’s manual descriptions of circumstances that could result in the denial of a warranty claim, but those descriptions shall not limit warranty coverage in any way.

YOUR WARRANTY RIGHTS AND OBLIGATIONS

(Applicant’s name) warrants that its new aftermarket DPF is free from defects in design, materials, workmanship, or operation which cause the new aftermarket DPF to fail to conform to all the requirements of Title 13, California Code of

Regulations, Section 2222(k) for the period of time listed below, provided there has been no abuse, neglect, or improper maintenance of the new aftermarket DPF or engine, as specified in the new aftermarket DPF's owner's manual. Where a warrantable condition exists, this warranty covers engine damage directly caused by the aftermarket DPF subject to the same exclusions for abuse, neglect or improper maintenance. Please review your owner's manual for other warranty information. Your new aftermarket DPF may include a core part (e.g., particulate filter in an appropriate housing), as well as flanges, brackets, gaskets, additional sensors and other system related assemblies. Where a warrantable condition exists, (Applicant's name) will repair or replace your part at no cost to you including diagnosis, parts, and labor.

WARRANTY COVERAGE:

The warranty period is 2 years from the date of installation. If any part of your new aftermarket DPF is defective in design, materials, workmanship, or operation thus causing the new aftermarket DPF to fail to conform to the governing Executive Order or requirements in title 13, CCR 2222(k) within the warranty period specified above, including posing a safety risk or generating secondary emissions, (Applicant's name) will repair or replace the new aftermarket DPF at no cost to you, including diagnosis, parts, and labor.

In addition, (Applicant's name) will replace or repair engine components to the condition they were in prior to the failure, including parts and labor, for damage to the engine proximately caused by the new aftermarket DPF. This also includes those relevant diagnostic expenses in the case in which a warranty claim is valid. (Applicant's name) may, at its option, instead pay the fair market value of the engine depending on the nature of the damage prior to the time the failure occurs.

OWNER'S WARRANTY RESPONSIBILITY

As the (vehicle, engine,) owner, you are responsible for performing the required maintenance described in your owner's manual. (Applicant's name) recommends that you retain all maintenance records and receipts for maintenance expenses for your vehicle, engine, and new aftermarket DPF. If you do not keep your receipts or fail to perform all scheduled maintenance, (Applicant's name) may have grounds to deny warranty coverage. You are responsible for making your engine and new aftermarket DPF available to (Applicant's name) as soon as a problem is detected. You must ensure that you make the engine available for review and assessment by the applicant or its authorized representative so it can process the warranty claim. The warranty

repair or replacement should be completed in a reasonable amount of time, not to exceed 30 days. If a warranty claim is denied, (Applicant's name) must provide a written reason why the claim was denied. You should retain this written statement for your records should a warranty dispute arise. Failure to retain the written statement may, but shall not per se, be grounds for disallowing a warranty claim.

If you have questions regarding your warranty rights and responsibilities, you should contact (Insert chosen applicant's contact) at 1-800-xxx-xxxx or the California Air Resources Board at 9528 Telstar Avenue, El Monte, California 91731, or (800) 363-7664, or electronic mail: helpline@arb.ca.gov.

(2) Installation Warranty

(A) An installer must warrant that the installation of a new aftermarket DPF is free from defects in workmanship or materials which would cause the new aftermarket DPF to fail to conform to the applicable requirements in this Procedure.

(B) The installation warranty for the aftermarket DPF must be for a period of 2 years from the date of installation.

(C) The extent of the warranty coverage provided by installer is the same as the warranty provided by the new aftermarket DPF applicant as specified in section (l)(1) above, and the same exclusions apply. The installer must resolve all installation-related claims within 30 days of notification.

(D) Applicant must ensure the installer has the ability to maintain appropriate information on each installation and activity and be able to provide this information to the applicant and ARB within 15 days of written request.

(E) Applicant must ensure the installer has the ability to properly track and report new aftermarket DPFs (e.g., address the variable warranty periods). Applicant must ensure it receives the installer's notification of compliance of systems which exceed the warranty rate (4 percent triggers) prior to the annual reporting requirement and whenever it is triggered.

(F) The installer must provide information on each installation and service event to the applicant per its requirements. This includes, but is not limited to, information about each installation required for tracking and warranty purposes and compliance within 30 days for providing this information to the aftermarket DPF applicant.

(G) An installer must ensure that the engine ECU(s) is not directly or indirectly altered or changed from its certified configuration by the installation of the aftermarket DPF.

(H) The installer must be able to provide appropriate technical support in the event of an installation related warranty claim. This shall include being familiar with the operation and installation of the aftermarket DPF and having the technical skills, abilities and instruments to assess issues with the part and OEM engine such that it can accurately determine the nature of the problem and provide appropriate direction to the aftermarket DPF owner or correct the problem.

(I) Within 15 days of denying a claim (which may be in addition to the 30 day warranty resolution period), the installer must provide “Grounds for Denial” in the form of a dated letter or document to the owner of any new aftermarket DPF for which an installation claim was denied. This document must identify the reason(s) for the denied claim, the date of the claim, the serial number of the unit, the part number affected (if appropriate) or engine damage incurred, and the contact information of the aftermarket DPF owner.

(J) The installer is responsible for providing a copy of the Grounds for Denial letter to the new aftermarket DPF applicant. This copy should be sent to the new aftermarket DPF applicant at the same time as it is sent to the owner of the aftermarket DPF. The Grounds for Denial letter must be provided to ARB within 15 days of written request.

(K) Installation Warranty Report

1. The installer must submit identical warranty reports to both the Executive Officer of ARB and to the new aftermarket DPF applicant annually by March 1 of each calendar year for each new aftermarket DPF with a unique Executive Order.
2. New aftermarket DPFs covered by several Executive Orders or from different applicants must not be combined in a single report.
3. The installation warranty report must include all installation warranty claims, even those that were denied, and must delineate all installation warranty claims that resulted in warranty service (i.e., valid claims) from those that did not result in warranty service. Any issue relating to the installation of a new aftermarket DPF that is brought by an owner of a new aftermarket DPF to an installer within the installation warranty period must be reported as a claim. Prescreening must not occur.
4. Installers are also required to monitor installation warranty claims on an ongoing basis and report to ARB and the new aftermarket DPF applicant within 30 days when the rate of installation warranty claims exceeds 4 percent of the total installations of the new aftermarket DPFs by the installer.
5. The installer must comply with warranty requirements applicable to the aftermarket DPF applicants.

6. The installation warranty report must include the same information as in the product warranty report specified in section (l)(1)(H)6 of this Procedure but relative to installation claims.

7. The installer must provide complete and accurate information to the new aftermarket DPF applicant and ARB to ensure compliance with these warranty requirements.

8. An installation warranty report that does not contain all required information, or contains inaccurate information, will not be considered complete.

(L) Installation Warranty Statement. The installer must furnish the owner with a copy of the following statement.

YOUR WARRANTY RIGHTS AND OBLIGATIONS

(Installer's name) warrants to all owners, for ownership within the warranty period and lessees, for lease contracts within the warranty period, that the installation of the new aftermarket DPF is consistent with the installation instructions provided by its applicant, and is free from defects in, workmanship or materials which cause the new aftermarket DPF to fail to conform to the governing Executive Order or the requirements of Title 13, California Code of Regulations, Section 2222(k). The warranty period and the extent of the warranty coverage provided by installer must be the same as the warranty provided by the new aftermarket part applicant and the same exclusions must apply.

OWNER'S WARRANTY RESPONSIBILITY

As the vehicle or engine owner, you are responsible for presenting your vehicle, engine and new aftermarket DPF to (installer's name) as soon as a problem with the installation is detected.

If you have questions regarding your warranty rights and responsibilities, you should contact (Insert chosen installer's contact) at 1-800-xxx-xxxx or the California Air Resources Board at 9528 Telstar Avenue, El Monte, California 91731, or (800) 363-7664, or electronic mail: helpline@arb.ca.gov.

(m) COMPLIANCE

(1) The Executive Officer may modify or revoke an existing Executive Order for any violation of the conditions governing Executive Order or this Procedure, including but not limited to:

(A) Any changes in the design or production of a new aftermarket DPF that have not been approved by ARB.

(B) Failure to submit warranty reports or any other requested information (e.g., recall plan, proof of pursuit of sales, quality control).

(C) Failure to demonstrate compliance with the requirements or provisions of the Executive Order or this Procedure (e.g., audit testing requirements).

(D) Errors, omissions, inaccurate information, or fraudulent submittals.

(E) Failure to comply with recordkeeping requirements in this Procedure.

(2) No person shall represent a device as being an ARB exempted new aftermarket DPF unless it has received an exemption for the new aftermarket DPF pursuant to this Procedure.

(3) No party shall install, sell, offer for sale or advertise, a used DPF.

(4) ARB has the right of entry to any facility owned, operated, used, leased or rented by an applicant or installer in order to inspect or verify compliance with the provisions of this Procedure.

(5) Compliance with the provisions of this evaluation Procedure does not exempt new aftermarket DPFs from compliance with other applicable federal and state statutes and regulations such as noise requirements, safety codes, and other safety regulations, nor will the Air Resources Board test for or determine compliance with such other statutes or regulations.

(n) PENALTIES

The Executive Officer may assess penalties to the extent permissible under Part 5, Division 26 of the Health and Safety Code for violations of this Procedure.

(o) REFERENCES

1. *Motor Vehicle Pollution Control Devices,* Title 13, CCR, §1900(b) (October 8, 2015)

2. American Society for Testing and Materials (ASTM), *Standard Specification for Diesel Fuel Oils*, ASTM D975-81, ASTM International, West Conshohocken, PA (May 1982)

3. *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1334-84, January 18, 2001

4. *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1335-90, September 5, 1997

5. *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1327-90, September 5, 1997.

6. Federal Motor Carrier Safety Administration (FMCSA). *Parts and Accessories Necessary for Safe Operation*, Subpart G Section 393.83 *Exhaust Systems*. Washington DC; (December 7, 1988)

7. *Maintenance,* CFR, Title 40, Part 86, Subpart A, §86.004-25, as it existed on February 13, 2016

8. ASTM, *Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Motor Fuels and Oils by Ultraviolet Fluorescence,* ASTM D5453-93, West Conshohocken, PA (September 15, 1993)

9. ASTM, *Standard Test Method for Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels and Aviation Turbine Fuels by Supercritical Fluid Chromatography*, ASTM D5186-03(2009), West Conshohocken, PA (April 15, 2009)

10. Ibid

11. ASTM, *Standard Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection*, ASTM D4629-96, West Conshohocken, PA (April 10, 1996)

12. ASTM, *Standard Test Method for Ignition Quality of Diesel Fuels by the Cetane Method*, ASTM D613-84, West Conshohocken, PA (January 3, 1984)

13. ASTM, *Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)*, ASTM D287-82, Philadelphia, PA (August 27,1982)

14. ASTM, *Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter*, ASTM D4052-96(2002), West Conshohocken, PA (May 2002)

15. ASTM. *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)*, ASTM D445-83, Philadelphia, PA; (October 28, 1983)

16. ASTM, *Standard Test Method for Flash Point by Pensky-Martens Closed Tester*, ASTM D93-80, Philadelphia, PA (August 29, 1980)

17. ASTM, *Standard Test Method for Distillation of Petroleum Products*, ASTM D86-96, West Conshohocken, PA (April 10, 1996)

18. *Motor Vehicle Diesel Fuel; Nonroad, Locomotive, and Marine Diesel Fuel; and ECA Marine Fuel*, Title 40, CFR, Part 80, Subpart I, as it existed on February 12, 2016.

19. *Ibid*

20. *Ibid*

21. *Ibid*

22. *Exhaust Test Procedures for Heavy-Duty Engines,* CFR, Title 40, Part 86, Subpart N, as it existed on February 12, 2016.

23. *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1334-84, January 18, 2001

24. *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1335-90, September 5, 1997

25. *Emission Regulations for New Otto-Cycle and Diesel Heavy-Duty Engines; Gaseous and Particulate Exhaust Test Procedures,* CFR, Title 40, Part 86, Subpart N, §86.1327-90, September 5, 1997.

26. U.S. EPA, 2006a. *Heavy-Duty Highway Guidance for Infrequent Regeneration of Diesel Particulate Filters,* Compliance and Innovative Strategies Division (CISD) CISD-06-17, August 7, 2006

27. U.S. EPA, 2006b. *Alternative Heavy-Duty Highway Guidance for Infrequent Regeneration of Diesel Particulate Filters,* CISD-06-22, November 6, 2006)

28. *Compliance with Emission Standards,* CFR, Title 40, Part 86, Subpart A, §86.004-28(i), as it existed on February 13, 2016

29. *Exhaust Test Procedures for Heavy-Duty Engines,* CFR, Title 40, Part 86, Subpart N (As it existed on February 12, 2016).

30. Ibid

31. Ibid

32. ibid

33. Ibid

34. Ibid

35. ARB, Standard Operating Procedure (SOP) No. MLD 104: “Standard Operating Procedure for the Determination of Aldehyde and Ketone Compounds in Automotive Source Samples by High Performance Liquid Chromatography,” April 1, 2006.

36. ARB, SOP No. MLD 102/103: “Procedure for the Determination of C_2 to C_{12} Hydrocarbons in Automotive Exhaust Samples by Gas Chromatography,” March 15, 2007.

37. ARB, SOP No. MLD 148: “Procedure for the Analysis of C_3 to C_{12} Hydrocarbons in Automotive Exhaust by Gas Chromatography/Mass Spectrometry with Pre-Concentration System,” March 2009.

38. *Methods for Unregulated and Special Pollutants,* CFR, Title 40, Part 1065, Subpart L, as it existed on February 12, 2016

39. Ibid

40. Ibid

41. *Equipment Specifications,* CFR, Title 40, Part 1065, Subpart B (as it existed on February 12, 2016)

42. *Exhaust Test Procedures for Heavy-Duty Engines,* CFR, Title 40, Part 86, Subpart N, as they existed on February 12, 2016

43. Ibid

44. Ibid

45. Federal Motor Carrier Safety Administration (FMCSA). *Parts and Accessories Necessary for Safe Operation*, Subpart G Section 393.83 *Exhaust Systems*. Washington, DC; (December 7, 1988)

APPENDIX 1

Emission Control Groups (ECGs)

ARB assessed the Original Equipment Manufacturer (OEM) engine and aftertreatment configurations for 2007-2009 model years to identify 7 major emission control groups based on OEM engine manufacturer, OEM market share, and aftertreatment configuration.

The 7 ECGs are identified in the following table:

Table 1: 7 ECGs Concept[1]

ECG#	Representative OEM Manufacturer or Emission Control Configuration	Testing Requirements
1	Cummins	Full testing required[2]
2	Detroit Diesel Corporation	Full testing required[2]
3	International/Navistar	Full testing required[2]
4	Volvo/Mack	Full testing required[2]
5	Caterpillar	Full testing required[2]
6	Uncatalyzed DPF + Burner	Full testing required[3]
7	General Motors/Isuzu/Mitsubishi	See note[4]

[1] Hino is excluded from this evaluation procedure because its unique aftertreatment design is out of the scope of this aftermarket DPF evaluation procedure;
[2] Full testing requirements include laboratory aging, field demonstration and emission testing;
[3] Only one minimum 500 hours field demonstration;
[4] Applicants which only want ECG#7 must conduct full testing. Applicants that successfully complete all requirements for ECG#1, 2, 3, or 4, must only conduct field demonstrations for ECG#7.

APPENDIX 2

DPF Aging Protocol Multi-point Temperature Measurement Requirements

1. Exhaust temperatures must be recorded at suitable multiple locations in a DPF to reflect the thermal exposure.

2. ARB suggests applicants use the method as follows:

2.1 13 point temperature measurement

Figure 1 describes the temperature sensor locations in a DPF. Applicants shall use 13 temperature sensors to measure multi-point temperature.

2.2 Temperature sensors' requirements

2.2.1 Temperature sensors' specifications

Applicants shall use 0.032" K-type thermocouples as temperature sensors.

2.2.1 Depth of thermocouples inside of a DPF

Applicants shall insert thermocouples one inch deep from DPF outlet face.

2.3 Data measuring, recording and reporting frequency

The temperatures shall be measured at a minimum rate of once every second (1 Hz).Recording and reporting shall follow the Procedure's requirements for DPF degreening or aging periods.

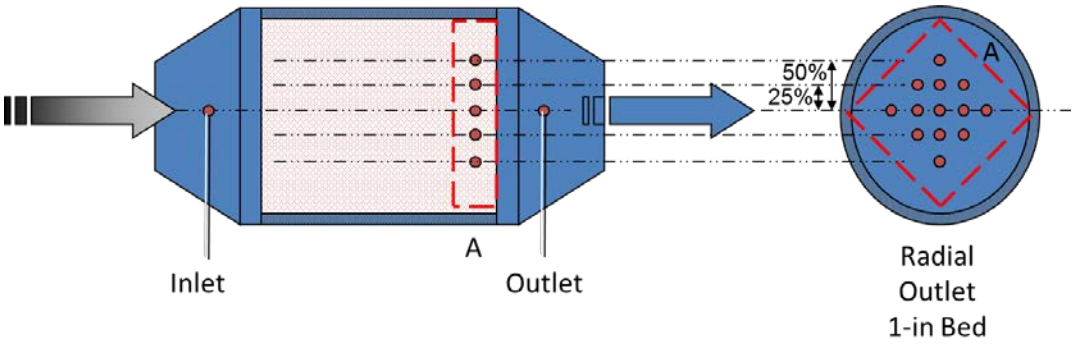


Figure 1 Temperature sensors location for DPF aging

3. An applicant may select different sensor locations and/or use additional sensors than those specified in ARB's suggested method, based on best engineering judgement. Such applicant's proposed test method must be approved by ARB.

References:

1. Eakle, S.T. and Bartley G.J., *The DAAAC Protocol™ for Diesel Aftertreatment System Accelerated Aging*. Proceedings of the Emissions 2014 Conference, 2014. (https://gamcinc.com/cfiles/emissions-2014-files/) (Last accessed February 12, 2016)

APPENDIX 3

Method to Determine Effective Active Regeneration Aging Time

Applicants must calculate the effective aging time according to the principles described here.

1. Recording multiple temperature points inside of a DPF

Applicants shall follow the instructions in APPENDIX 2 to measure and record temperature inside of the DPF.

2. Reference temperature and actual temperature

The reference temperature is the targeted DPF bed temperature and set default value as 700 Celsius. The actual temperature is the highest temperature among the 13 locations specified in APPENDIX 2.

3. Equation

Aging time is a function of aging temperature as defined by the Arrhenius equation.

3.1 Applicants shall apply the following equation to calculate the equivalent aging time corresponding to a reference temperature.

$$\frac{t_2}{t_1} = \exp\left[-\frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)\right]$$

Where

R is the universal gas constant (8.315 $Jmol^{-1}K^{-1}$)

E_a is the activation energy; use the value of 150 $KJmol^{-1}$ for traditional PGM catalyst. For other types of catalyst, applicants must contact ARB.

T_2 = reference temperature (DPF peak bed temperature, set default value as 973), in *K.*

T_1 = the highest temperature among the 13 locations specified in APPENDIX 2), in *K*.

t_2 = the time, set default value as 10 seconds, corresponding to the reference temperature

t_1 = the equivalent aging time, in seconds, needed to produce, by exposing the DPF at the temperature T_1, the same amount of aging as if the DPF was exposed at the temperature T_2 during the time t_2.

3.2 The total equivalent aging time shall be calculated in accordance with the following equation:

$AT = \sum_{i=1}^{n} t_1^i$ / 3600

Where

AT = total equivalent aging time, in hours,

t_1^i = the equivalent aging time, in seconds, during each second of the active regeneration period.

i = bin number, where 1 is number for the bin with the earliest time and *n* the value for the bin with the last time (in seconds) for active regeneration.

4. Minimum 100 hours effective active regeneration aging time.

Applicants must perform the minimum 100 hours effective active regeneration aging time.

References:

1. US EPA *Bench Aging Time (BAT) Calculator,* March 24, 2010 (http://www.epa.gov/oms/regs/ld-hwy/durability/bench-aging-calculator-spreadsheet-03-24-10.xls) (Last accessed January 15, 2016)
2. Bartley, G.J. *Improved Aging Precision Using RT-BAT™ and MTM™*. Proceedings of the Emissions 2014 Conference, 2014. (https://gamcinc.com/cfiles/emissions-2014-files/) (Last accessed February 12, 2016)

APPENDIX 4

"Drain and Weigh" Method for Engine Oil Consumption during Laboratory Aging

1. Applicant shall develop an accurate method for determining engine oil consumption during the laboratory aging period. The method must be based on sound principles of science and engineering, and includes but is not limited to gravimetric methods[1] (i.e. "drain and weigh", market-ready oil measurement systems[2-3]), volumetric methods[1], or methods with radioactive/non-radioactive tracers[1].

2. The "drain and weigh" method is described:

2.1 Principle

The "drain and weigh" is a conventional gravimetric method, which involves weighing the oil both before and after a certain engine operating interval (hours to days) to quantify the oil consumed.

2.2 Equipment and Instruments

A constant volume oil sump system (conforms to ASTM standard D7156-13[4], which is hereby incorporated by reference herein)

An external reservoir and pump (maintains the oil level in engine)

A balance (accuracy within 1 gram)

Oil drain pan

Necessary supplies during the oil drain (e.g., rags)

2.3 Procedure

Step 1: Fill the engine with new oil by the oil pump. Check the oil level and make sure both the engine and external sump are full.

Step 2: Start the engine and operate the engine over desired laboratory aging cycles for minimum 1 hour.

Step 3: Once cycle is complete, allow oil temperature to stabilize at a steady-state engine condition before shutting the engine down.

Step 4: Weigh a clean and empty oil pan, and any clean supplies for the oil drain process.

Step 5: Drain oil by the external oil pump for 10 minutes, then an additional 10 minutes after shutting the pump off.

Step 6: Weigh and record the drained oil (in oil pan and any supplies). The difference between clean oil pan and drained oil pan plus the difference between clean supplies and dirty supplies is the total oil removed from the engine.

Step 7: Carefully return the oil to the engine.

Step 8: Weigh the empty oil pan and any supplies used for oil drain/return process. The difference between clean oil pan/supplies and dirty oil pan/supplies is the residual oil that was not returned to the engine.

Step 9: Subtract the amount of residual oil on the dirty oil pan and supplies from the amount of total oil removed from engine. The difference is the oil returned to engine.

Step 10: Operate the engine under the desired laboratory aging cycles for a certain interval (e.g., 24 hours).

Step 11: Repeat Step 3-6.

Step 12: Subtract the amount of oil removed from the engine in Step 11 from the amount of oil returned to the engine in Step 9. The difference is the total oil consumption during such certain engine operation interval. Divide the total oil consumption (in grams) by the time (in hours) accumulated in Step 10, the result is the oil consumption rate (in grams/hour).

3. Applicants may use AVL 406 Oil Consumption Meter[2] or Cummins Smart Oil Consumption Measuring System[3] or similar to track the oil consumption.

References:

1. Froelund, K., and Jääskeläinen, H. *Measurement of Lubricating Oil Consumption*. Dieselnet, November 2009. (https://www.dieselnet.com/tech/lube_cons_measure.php) (Last accessed February 12, 2016)
2. AVL List GmbH Hans-List-Platz, *AVL Oil Consumption Meter*, January 28, 2009 https://www.avl.com/-/avl-oil-consumption-meter. (Last accessed February 12, 2016)
3. Weng, W. and Richardson, D. *Cummins Smart Oil Consumption Measuring System*. SAE Technical Paper 2000-01-0927, 2000 World Congress, March 6-9, 2000.
4. ASTM D7156-13: *Standard Test Method for Evaluation of Diesel Engine Oils in the T-11 Exhaust Gas Recirculation Diesel Engine,* West Conshohocken, PA. (May 1, 2013)