JOHNSON MATTHEY INC.
456 DEVON PARK DRIVE WAYNE PA 19087 USA
T +1 610 341 8300 **F** +1 610 341 8258 www.jmcatalysts.com

Johnson Matthey
Catalysts

April 5, 2016

VIA ELECTRONIC FILING
Clerk of the Board
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Johnson Matthey Inc. Public Comments
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

Dear Clerk of the Board:

Johnson Matthey Inc. (JM) is a global sustainable technology company that, among other things, is a world leading catalyst manufacturer for mobile and stationary exhaust emission control systems. Since the adoption of U.S. EPA heavy-duty emission regulations in 2007, JM has been a leading supplier in emission control technologies to all of the on- and off-road Original Engine Manufacturers (OEMs). JM has been a participant in California Air Resources Board's (Board) Truck & Bus Regulation since its adoption in 2008 providing emission control systems to pre-2007 heavy-duty trucks operating in California. JM appreciates the opportunity to provide comments in the above-referenced docket in response to aspects of the proposal posted on March 1, 2016 (hereinafter referred to as the "Proposal") for approving aftermarket diesel particulate filters (DPFs) for 2007-2009 on-road heavy-duty diesel engine program ("Program").

ECG Classification

The Proposal offers to group an Emission Control Group (ECG) by OEM, as specified in the Procedure.[1] The Procedure requires an aftermarket DPF manufacturer (AMM) to select a "worst case" engine within a single OEM for laboratory testing and field demonstrations of compatibility.[2] Staff explained that it "selected these seven ECGs to ensure that appropriate, compatible aftermarket DPFs are installed, without creating onerous, cost-prohibitive testing requirements."[3] JM certainly understands

[1] Staff Report at p. 7.
[2] *Id.*
[3] *Id.*

the aim of the Proposal. However, in our vast experience developing many of the original MY2007-2009 emission control systems, including DPF washcoat formulations, and working with our OEM partners for the better part of a decade, JM believes that limiting ECG by OEM only does not strike the appropriate balance between "[p]roved[ing] flexibility in the marketplace for end users seeking to purchase a replacement for their out-of-OEM-warranty DPFs" and "[e]nsur[ing] that the aftermarket part does not reduce the effectiveness of any required pollution control device nor cause the vehicle emissions to exceed the applicable standards."[4] As Staff pointed out at the April 7, 2015 workshop (and JM agreed), if an OEM certified a DPF with a different part number, it did so because the DPF operates and interacts with engine system differently. JM, as a first-fit DPF washcoat supplier for many of the 2007-2009 vehicles, can confirm that there are significant differences in washcoat formulation, production and performance across DPF part numbers.[5] With Staff's decision to limit the ECG by single OEM only, the Proposal now ignores this critical point and, as a result, significantly increases the chances that an AMM could introduce incompatible aftermarket (AM) DPFs into the market.

There are significant differences between pre-2007 and MY2007-2009 heavy-duty trucks that alter the manner in which DPFs operate on these trucks. The DPFs designed for pre-2007 trucks (i.e., retrofit market) rely primarily on passive regeneration systems and involve a great deal of pre-assessment work to ensure that a particular customer's duty cycle will allow the retrofit DPF to operate effectively. In contrast, MY2007-2009 DPFs almost exclusively rely on active regeneration strategies due, in part, because the OEMs have limited ability to effectively evaluate an individual customer's duty cycle.[6] As a result, the OEMs had to ensure that DPFs would work in all possible scenarios over a wide range of applications (thus, leading to the OEMs' reliance on active regeneration strategies).[7] Given this dynamic, AMMs cannot simply engineer around "worst case" scenario engines or approximate "general" engine conditions to design a "one size fits all" AM DPF that would apply across all of the engine families within a single OEM. Instead, it will take much more detailed specific calibration to each engine for an AM DPF to be truly compatible. For example, coating formulation changes have significant impact on backpressure calibration and inherent backpressure is controlled, in large part, by the type of washcoat that is applied and how the washcoat is applied to the substrate.[8] Therefore, an AMM simply trying to reverse engineer and approximate first-fit DPF metal loadings will not reliably ensure compatibility.

Additionally, with post-2007 DPFs, OEMs, among other things, are looking to minimize the frequency of active regeneration events so as to control emissions and preserve fuel economy.[9] OEM control schemes closely monitor DPF sensors to determine if the backpressure is triggering a threshold limit.[10] An AM DPF's trigger can be biased if it is inherently more or less restrictive than the OEM part. OEMs use regeneration timers to make sure they clean at least every so often, which means the

[4] *See id*. at p. 4.
[5] Lorentzou, S., Pagkoura, C., Konstandopoulos, A., and Boettcher, J., "Advanced Catalyst Coatings for Diesel Particulate Filters," SAE Technical Paper 2008-01-0483, 2008, doi:10.4271/2008-01-0483.
[6] W. Addy Majewski, *Diesel Filter Systems* (DieselNet.com; Revision 2015.03a) https://www.dieselnet.com/tech/dpf_sys.php, at §1.
[7] Majewski at §2.1.
[8] Koltsakis, G., Dardiotis, C., Samaras, Z., Maunula, T. et al., "Optimization Methodologies for DPF Substrate-catalyst Combinations," SAE Technical Paper 2009-01-0291, 2009, doi:10.4271/2009-01-0291.
[9] Majewski at §2.3.
[10] *Id*. at §4.2.

passive regeneration behavior is important to make sure the upper end of the timing interval is still within a safe particulate matter (PM) loading level on the DPF such that an inappropriate or "runaway" regeneration event is not triggered.[11] The engine controls will routinely make assumptions on how much ash is being stored on the DPF.[12] So, if the AM DPF is not able to store ash in a manner consistent with the OEM part, then the contribution of the ash build-up to the DPF's backpressure profile is altered and the engine controls may not initiate the active regeneration at the appropriate time. Such a condition can lead to burned-through DPFs if there is more PM than expected, or it could lead the engine controls to initiate regeneration events more often than necessary leading to decreased fuel economy and increased greenhouse gas emissions.[13] So, the engine ECU is expecting certain behavior from the DPF and if an AM DPF is not completely compatible, it could cause poor performance or even lead to DPF failure.[14]

Similarly, the DPF's ability to oxidize and store soot is also programmed into the engine ECU.[15] This allows the ECU to track how much accumulated soot and ash are contributing to the backpressure of the DPF and ultimately allows the ECU to determine when to initiate a regeneration event. The DPF's ash level in the ECU is determined by comparing the backpressure across the DPF to a programmed reference value after a regeneration event has removed all the soot. However, if the soot does not oxidize at the same rate on the AM DPF because the catalyzed coating on the aftermarket DPF is different than the OEM part, then the AM DPF may not clean completely before the ECU terminates the regeneration event.[16] The ECU could then incorrectly assume that the AM DPF is loaded with inert ash when it actually could still be loaded with soot. Such a result could bias the ECU's soot estimate to be lower than the actual soot level which could lead to a burned-through DPF if the ECU delays the next regeneration beyond the DPF's safe soot threshold.[17] It should also be noted that copying the physical characteristics of the OEM's bare substrate to the aftermarket part is not enough to duplicate the backpressure response when it is loaded with soot and ash. If the physical characteristics of the AM DPF's coated substrate (e.g., porosity, wall thickness, and channel dimensions) are different than the OEM part, then the soot storage between regeneration events may provide a different backpressure response to the ECU, thereby introducing another opportunity to bias the ECU's soot estimate on the DPF. Also, the interaction of the applied washcoat can modify the effective porosity and channel dimensions of the substrate and similarly alter the backpressure response of the DPF.

JM also would like to highlight an important consideration related to the competitive landscape. The OEMs' first-fit DPF business is an extremely competitive environment. Suppliers, like JM, must show "best in class" technology with a strong emphasis on reducing costs wherever possible. Competitive forces dictate that first-fit suppliers, in this case, drive technology innovation to the fewest DPF variants as possible to effectively operate across an OEM's engine families. Typically, we have found that, for MY2007-2009, some OEMs have between 5-10 different and distinct DPF part numbers. In contrast, the Proposal creates a program where an AMM, with relatively limited supporting data and no

[11] *Id*.
[12] *Id*.
[13] *Id*. at §2.3.
[14] *Id*. at §4.2.
[15] *Id*.
[16] *Id*.
[17] *Id*.

interaction with the OEM, can certify one aftermarket DPF to operate across an OEM's entire suite of engine families. Given the competitive landscape, it is reasonable to assume that the first-fit technology competition process would have produced a "one size fits all" DPF if it was truly compatible, and sufficiently reliable and robust to apply across all of an OEM's applications.

For the reasons outlined above, JM believes that Staff's original April 7, 2015 draft proposal to limit the definition of an ECG by single OEM *and* by OEM DPF part number is a more suitable approach. However, we understand that such a program could result in over 40 ECGs to cover the entire complement of 2007-2009 engines. We understand that AMMs are concerned that this outcome would be too costly for them to participate in the Program. In response to this argument, JM would like to emphasize that it costs first-fit suppliers tens of millions of dollars and requires significant resources to properly support our OEM partners to certify each and every engine family and individual configuration. So, we fully appreciate the costs involved with developing and commercializing compatible and reliable emission control technologies, but recognize that this is the nature of business. Nevertheless, as a compromise, JM believes that there could be merit in having Staff investigate limiting ECGs by OEM *and* OEM engine size. While such a program would continue to ignore the different tunings and calibrations that led the OEM to certify more than one configuration for each engine size (and, in several instances, utilize different DPF washcoats), it would still better reflect some of the major differences spanning across an OEM's suite of engine families. Under this paradigm, JM understands that an AMM would have to certify between 20-25 different ECGs to cover the entire complement of 2007-2009 heavy-duty engines. In our view, an ECG classification limited by OEM and engine size would produce a more equitable outcome for all interested stakeholders and allow the Board to implement a robust program that better mitigates the risk of incompatible aftermarket DPFs coming to market.

Testing Protocol

In JM's view, the Proposal has not adequately established a framework which will ensure AM part compatibility (especially across all of the engine families for which the AMMs will most likely be seeking certification) and appropriate durability. It is not clear how the Procedure assesses various engines within the ECG to identify the "worst case" engine choice within a single OEM for testing as well as field demonstrations of compatibility. Seemingly, worst case is a subjective term that lies with the discretion of the AMM applicant,[18] who is not incentivized to select a challenging application. It does require other engines be field trialed with an AM part, but it is not clear that they must be from different applications or span across different engine families. Similarly, in the Procedure Sec. (d)(7)3.2.4, applicants are required to identify the "worst case" application within the ECG from the perspective of the effects of the AM DPF on the engine, including, among other things, ECU behavior and active regeneration. As described above, many AMMs will not likely have experience working with the OEMs on the original 2007-2009 systems, so we are unsure how many of the AMMs could provide credible information on how the AM DPFs will impact ECU behavior. AMMs must also address "AECD and infrequent regeneration events," which JM understands is not publicly available and would require EPA, CARB or the OEMs to disclose this information to the applicant prior to the application submission. JM agrees that the considerations described in (d)(7)3.2.4 are important to

[18] Evaluation Procedure at p. B-28.

proving the compatibility of an AM DPF to an engine's control and AECD strategy; however, these are best remediated by having robust field testing requirements in the evaluation procedure. As described in the preceding section of our comments, implementing application-specific ECG definitions would naturally build such safe-guards into the procedure.

Additionally, the Proposal removes the OEM part from the aging sequence and emissions test. The deterioration factor of the AM part at the end of its useful life (at 2 years) should be similar to the similarly-aged OEM part to provide further proof that it is compatible with the control system over time. However, with no requirement for an AMM to do any analysis on the aged OEM part, it will not be possible to compare the deterioration factor of the AM part to the OEM part. Also, the Proposal does not require the AMM to use the OEM's engine control regeneration strategy in the regeneration emissions measurement portion of the testing protocol, instead the Proposal allows applicants to recommend regeneration methods for measuring emissions during DPF regeneration events. Yet, the Procedure notes that "[a]s these modified parts are not part of the original system, it is essential to evaluate their ability to function with the engine and ECU to properly regenerate."[19] By not requiring the use of the OEM's engine control strategy, it will be extremely difficult to determine whether the AM part is compatible with the temperature ramp rates and ensure that any hydro-carbon slip is similar to that of OEM's in real-world applications. Finally, in JM's view, it is critical for the AMM to test the AM DPF on each OEM engine family for which it is seeking certification to ensure compatibility with the different engine control strategies which vary across an OEM's suite of engine families. The Proposal incorrectly does not include this requirement.

Negative Long-Term Consequences That Could Stem from Incompatible Aftermarket DPFs

If the Proposal is adopted without modification, the resulting regulatory regime could allow incompatible and less-durable AM DPFs to come to market, which could precipitate a multitude of negative, longer-term consequences. First, as described above, incompatible AM DPFs could cause upstream, engine-related malfunction, which will lead to significant truck downtime.

Second, as we have explained above, incompatible AM DPFs could easily lead to the Board not realizing the PM and greenhouse gas emission reductions that it anticipates (and has modeled) from the 2007-2009 heavy-duty truck fleet. Additionally, in more extreme cases, real public safety concerns could result if the AM DPF causes the significant build-up of ash and soot.

Third, incompatible AM DPFs could lead to more frequent than necessary DPF replacements, engine failures, engine damage, truck downtime, and reduced fuel efficiency. All of these outcomes perpetuate an unfortunate rhetoric that emission control systems do not work properly, which unfairly tarnishes those in the industry, like JM, that have (i) worked extremely hard to build a positive image of U.S. EPA 2007 and 2010 systems; and (ii) invested tens of millions of dollars to ensure that emission controls significantly reduce criteria pollutant and greenhouse gas emissions all while not coming at an unreasonable cost, not damaging engines, not leading to truck downtime, and not undermining fuel efficiency. Moreover, a distrust of the emission control industry also undermines the Board's credibility to uphold existing emission regulations, and to implement new regulations in the future that will be

[19] Appendix D at p. D-16.

necessary to meet the state's aggressive and vitally important criteria pollutant and greenhouse gas objectives.

JM commends Staff for all of the hard work and resources invested in designing a proposal that develops a heavy-duty AM DPF market while ensuring that Californians realize anticipated emission benefits at the lowest possible cost. JM sincerely appreciates the opportunity to provide comment and for continued collaboration with Staff throughout this process.

Respectfully submitted,
JOHNSON MATTHEY INC.

David A. Cetola
Director of Regulatory Affairs
(610) 341-8371
David.Cetola@jmusa.com

/s/ Mark Schmale
Mark Schmale, P.E.
Technical Program Manager
(484) 320-2258
Mark.Schmale@jmusa.com

cc (via email): Annette Hebert, ARB
Sharon Lemieux, ARB
Shawn Daley, ARB
Yong Yu, ARB