

COMMENTS OF
TULA TECHNOLOGY, INC.
ON CALIFORNIA AIR RESOURCES BOARD PROPOSED
Heavy-Duty Engine and Vehicle Omnibus Regulation and Associated Amendments
(hdomnibus2020)

August 20, 2020

Tula Technology provides the following comments in support of the recent rulemaking by the California Air Resources Board on the Heavy-Duty Engine and Vehicle Omnibus Regulation (HD Omnibus rulemaking), with comment period ending August 25th, 2020. Tula appreciates the opportunity to provide feedback on this rulemaking, with our comments focused on the scope of Tula's capability and knowledge base, as it relates to the regulation and the readiness of solutions, to meet the proposed HD Omnibus requirements.

Tula Technology supports the reduced oxides of nitrogen (NO_x) levels established in the proposed HD Omnibus rulemaking. Tula also supports the proposed Low Load Cycle (LLC) as a key operational cycle to assure a close parallel to real world operation, in conjunction with the legacy heavy duty Federal Test Procedure (HD FTP) and ramped mode cycles (RMC). We are concerned that the implementation timeframe of the 2024 model year may be somewhat aggressive, though we do maintain with justification that the integration of Tula's key technology diesel Dynamic Skip Fire (dDSF™) can be realized in an original equipment manufacturers (OEM) normal development cycle timeframe. Tula is not able to comment on OEMs' ability to meet all internal and external requirements for saleable product for 2024MY, as we believe this level of detail can only be accurately assessed by the OEMs due to the highly integrated nature of a complete development cycle, including emissions durability testing.

Tula's dDSF technology deploys patented digital signal processing algorithms into each manufacturer's unique powertrain control structure to reduce NO_x emissions while simultaneously improving fuel efficiency in diesel engines. Tula's software pairs with available valvetrain deactivation systems to enable complete deactivation of all valves in each cylinder, and in all cylinders of the engine, on an event-by-event basis.

For application to diesel engines, the control system minimizes excess air from the combustion process, effectively lowering the air to fuel ratio into the aftertreatment (AT) system. This results in increased AT temperatures in the challenging low to moderate engine load regions such as found on the LLC test cycle, ultimately reducing tailpipe NO_x emissions. Simultaneously, there is reduced pumping work and reduced need for burning diesel fuel to overcome exhaust throttle loads, or in the exhaust system, via post injection or burner. This results in also achieving a substantial reduction in carbon dioxide (CO₂) emissions. The dDSF control system in HD diesel applications includes dynamically scheduling the challenging idle region, while respecting constraints for noise, vibration and harshness relative to factors such as, durability, driver's comfort and fatigue avoidance. There is ongoing work to ensure noise, vibration and harshness can be controlled adequately across the wide range of applications and duty cycles in the commercial vehicle landscape.

dDSF offers a cost-effective and durable solution with the flexibility to integrate other viable technologies, typically realizing both technologies' gains. Tula's proven control algorithms that underpin dDSF are already in production in over 700,000 gasoline powered vehicles in North America. The flexibility of the software-based system also recognizes when hardware durability might be exceeding thresholds, at which point an internal diagnosis algorithm protects engine hardware if switching times are exceeded or even a single event is missed, avoiding expensive repairs. Tula recognizes the ramp-in of durability requirements in the HD Omnibus rulemaking and agrees that the ramp is desirable in allowing hardware durability to progress over time, though we prefer not to comment on the amount required, as this is best left to hardware suppliers and OEMs with the needed expertise.

In conclusion, Tula supports the HD Omnibus rulemaking set forth, beginning with the 2024 model year. With our core focus on efficiency and emissions improvements, we exist to assist the world's OEMs with technology to meet regulations and customer requirements. Engineering development has shown the efficacy of the dDSF solution to provide the simultaneous reduction in NO_x emissions, which is proposed in the HD Omnibus rulemaking, and reduction in CO₂ in accordance with existing greenhouse gas (GHG) legislation, while conserving fuel for the given outcome. While we consider the implementation timeline for the regulation to be somewhat aggressive, we know that the Tier 1 supplier support network is committed to ensure the success of this critical regulation. Tula is prepared to support all industry players to implement dDSF technology for use in meeting the regulations set forth.

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