MEMO

Date: August 30, 2019
To: City of Walnut Creek
c/o Hall Equities Group / Amy’s Drive Thru
From: Michael Keinath, PE
       Michael Howley
Subject: EVALUATION OF DRIVE-THRU IDLING EMISSIONS

At the request of Hall Equities Group and Amy’s Kitchen Restaurant, Ramboll has prepared this technical memorandum to evaluate the potential emissions from vehicles at a restaurant drive-thru. This evaluation is comprised of two parts: first, the prevalence of automatic stop-start technologies in cars which reduce or eliminate idling emissions, and second, a comparison of idling emissions at a drive-thru compared to start-up emissions at a sit-down restaurant.

Automatic Stop-Start Technology is in Wide Use

The stop-start system used in modern vehicles (cars, trucks, SUVs, etc.) automatically shuts down and restarts the internal combustion engine. This auto shut down reduces the amount of time the engine spends idling, and therefore reduces fuel consumption and emissions, particularly when waiting at traffic lights or stopping frequently in traffic. While this feature is well known in hybrid cars, it is also very common in cars that are non-hybrid electric, including manual transmissions.

Stop-start technology for non-electric vehicles can increase the fuel economy between three and ten percent, potentially up to twelve percent.¹² This technology has several advantages over manually stopping and restarting the engine, including more robust, higher functioning batteries, starters, and crankshafts, and built-in software to monitor engine performance.

¹ https://www.edmunds.com/car-reviews/features/do-stop-start-systems-really-save-fuel.html
As of the issuance of this memo, this technology is already used in many car makes and models, including BMW, Fiat, Ford, General Motors, Honda, Hyundai, Jaguar, Kia, Land Rover, Mazda, SAAB, Suzuki, Toyota, Volkswagen, and Volvo.

It is anticipated that this technology will only become more common as fuel economy and emission regulations continue to be more stringent and that by 2020, it will be difficult to buy a new vehicle that runs while idling. A large fraction of cars on the road today are equipped with automatic stop-start technology. According to data from the California Air Resources Board (ARB), nearly two-thirds of light-duty vehicles in California in 2019 are from 2010 or newer, when start-stop technology was becoming widely available in the US. Coupled with the large and growing share of hybrid and electric vehicles in California, it is likely that already more than half of vehicles in the drive-thru lane emit zero idling emissions, and will only increase over time.

**Idling Emission Rates Are Lower than Low-Temperature Starting Emissions**

Ramboll also estimated the potential emissions from vehicles visiting both a drive-thru restaurant and a sit-down restaurant using most recent version of the ARB's EMission FACtors (EMFAC) model. EMFAC is developed and used by ARB to assess emissions from on-road vehicles. Ramboll limited the evaluation to Reactive Organic Gases (ROG), which is the primary pollutant of concern for health effects from gasoline vehicles.

In the sit-down scenario, the driver turns off the vehicle before entering the restaurant and will start it again after eating. While the engine is switched off after a trip, evaporative hydrocarbon emissions are emitted from the vehicle due to the elevated temperature of the fuel system. In addition, restarting a vehicle produces range of emissions and the magnitude of these emissions is dependent

---

3 https://www.autocar.co.uk/car-news/motoring/bmw-goes-stop-start
4 http://www.italiaspeed.com/2009/cars/fiat/02/500_stop_start_0702.html
11 https://www.mariettatoyota.com/toyota-stop-start-engine-system/
13 https://www.autoblog.com/2011/02/23/volkswagen-технология-автомобиля-
14 https://www.mariettatoyota.com/toyota-stop-start-engine-system/
15 https://www.arb.ca.gov/emfac/2017/
17 https://www2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-modeling-tools
18 Hot Soak Evaporative Hydrocarbon Emissions (HOTSOAK), EMFAC2017 User's Guide, V1.0.1, December 2017
19 Start Exhaust Tailpipe Emissions (STREX), EMFAC2017 User’s Guide, V1.0.1, December 2017
on how long the vehicle has been sitting prior to starting. Ramboll estimated the emissions from a vehicle sitting for 5, 10, 20, 30, 60, and 120 minutes.

In the drive-thru scenario, an operative vehicle emits tailpipe emissions\textsuperscript{26} as a result of burning fuels in the combustion engine. In addition to the tailpipe emissions, an operative vehicle produces evaporative hydrocarbon emissions\textsuperscript{27} due to the elevated temperature of fuel system during the vehicle running time. EMFAC does not separately quantify idling emissions from light duty vehicles, instead including them as part of running emissions. To calculate isolated idling emissions, ARB provides “Speed Correction Factor” (SCF) multipliers to convert running exhaust emission factors in grams/mile to idling exhaust factors in units of grams/idle hour\textsuperscript{28}. Here, Ramboll estimated drive-thru emissions as 5 mile per hour travel, which has an SCF of 2.5. For this evaluation, Ramboll considered two cases: one without any stop-start technology, and one where 50% of the cars are equipped with stop-start technology and therefore produce no idling emissions.

The overall emissions associated with both types of restaurants (sit-down and drive-thru) were estimated assuming a fleet mix of 50% passenger cars (LDA) and 50% split evenly between two types of Light Duty Trucks, LDT1\textsuperscript{29} and LDT2\textsuperscript{30}. It was also assumed that the total drive-thru trip takes 0.05 miles and includes 5 minutes of idling, based on data provided by Amy’s Restaurant. In the 50% stop-start case, only 1.5 minutes of idling were assumed. The results are presented in the table below.

The results indicate that any sit-down scenario will result in greater ROG emissions compared to a drive-thru order, even without accounting for stop-start technology.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Sitting Time (min)</th>
<th>ROG Emission (g/trip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sit-Down Restaurant</td>
<td>5</td>
<td>0.171</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.203</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.267</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0.332</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>0.480</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td>0.537</td>
</tr>
<tr>
<td>Drive-Thru Restaurant (no stop-start)</td>
<td>5</td>
<td>0.124</td>
</tr>
<tr>
<td>Drive-Thru Restaurant (50% stop-start)</td>
<td>2.5</td>
<td>0.113</td>
</tr>
</tbody>
</table>

\textsuperscript{26} Running Exhaust Emissions (RUNEX), EMFAC2017 User’s Guide, V1.0.1, December 2017
\textsuperscript{27} Running Loss Evaporative HC Emissions (RUNLOSS), EMFAC2017 User’s Guide, V1.0.1, December 2017
\textsuperscript{29} Light-Duty Trucks (GVWR <6000 lbs. and ETW <= 3750 lbs)
\textsuperscript{30} Light-Duty Trucks (GVWR <6000 lbs. and ETW 3751-5750 lbs)
Conclusions

Based on the results of this evaluation, idling emissions from a drive-thru restaurant are likely to be minimal, and decreasing over time as stop-start technology and hybrid/electric vehicles make up a greater portion of the vehicle fleet. Even without these low-emission vehicles, drive-thru idling still results in lower emissions than parking and restarting cars at a sit-down restaurant for even a 5-minute shutdown time.