3508 Far West Blvd., Suite 210
Austin, TX 78731

MEMORANDUM

TO: Alison Eyth, EPA

FROM: Allison DenBleyker, ERG

DATE: August 14, 2019

SUBJECT: New Method to Project Age Distributions

This documentation describes a new method to adapt base year age distributions for use in future years. The goal is to ensure that the economic recession "dip" in light-duty vehicle sales is reflected for the same model years at a more advanced age in the future. For the 2016v1 platform, the plan is to adjust the age distributions only from the light-duty source types Passenger Car, Passenger Truck, and Light Commercial Truck, from the base year 2016 to future years 2020, 2023, and 2028.

The new method is different from the existing "Age Distribution Projection Tool for MOVES2014" (available online at https://www.epa.gov/sites/production/files/2016-06/age-distribution-projection-tool-moves2014.xlsm). Key features of that tool involved (1) shifting the entire base year age distribution by the desired number of years and (2) predicting new model year sales using estimated national growth rates.

By contrast, the new method does not attempt to predict any future growth, and only shifts the economic recession "dip" downstream while dampening the recession's magnitude/effect with increasing calendar year. No other features of the age distribution change, except minor shifts due to re-normalizing the distributions.

Adjustment Methodology

Figure 1 shows an example calendar year 2016 age distribution for passenger cars for a single county. The recession dip spans the age IDs 5, 6, and 7, which corresponds to the model years 2011, 2010, and 2009 in the calendar year 2016. Adjusting the 2016 age distribution for future year 2020 requires shifting the recession by 4 years, so that the relatively low fractions of vehicle model years 2011, 2010, and 2009 show up as the age IDs 9, 10, and 11 in 2020.

Three separate equations applied in order will be used to implement this adjustment. First, Equation 1 gap fills the recession vehicle model years (MDYs) the base year using linear interpolation between the fractions for MDYs 2008 and 2012. Second, Equation 2 shows the

downstream shifting and dampening of the base year recession dip. Third and finally, Equation 3 shows the normalization required so that all age fractions sum to one (1) over the 31 age IDs.

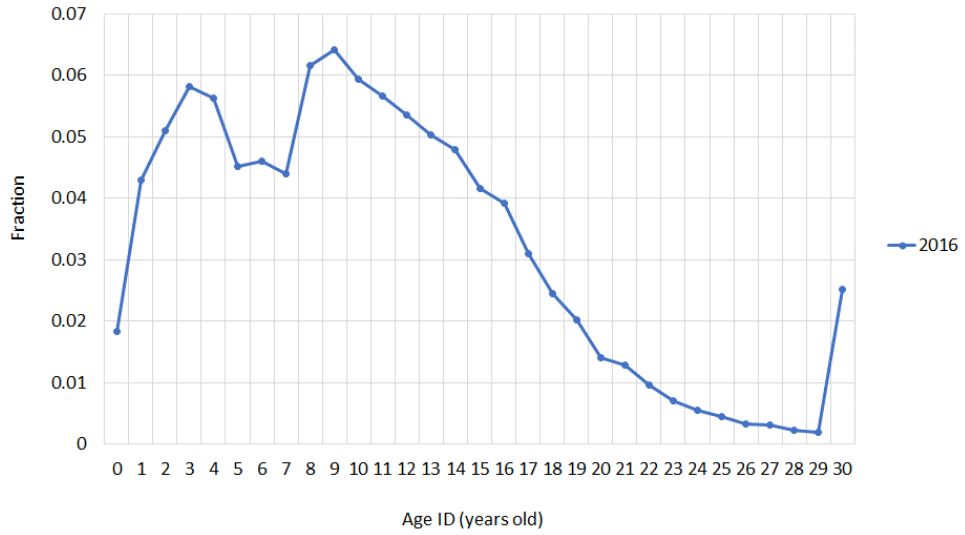

Figure 1. Example Base Year 2016 Age Distribution for Passenger Cars

Equation 1 below fills in the age fractions for recession model years in the base year using linear interpolation.

$$LFraction_{i,BY} = \frac{(i-2012)}{(2008-2012)} \times (Fraction_{2008} - Fraction_{2012}) + Fraction_{2012} \qquad \text{Eqn. 1}$$

Where: ***LFraction*$_{i,BY}$** = the linearly interpolated fraction of vehicles in model year ***i*** in the calendar base year ***BY***.

i = the set of vehicle model years (2009, 2010, 2011).

***Fraction*$_{2008}$** = the existing fraction of vehicles that are model year 2008.

***Fraction*$_{2012}$** = the existing fraction of vehicles that are model year 2012.

Equation 2 calculates what the recession dip would look like in the future year based on the reduction of the linearly interpolated data point to the actual recession data point age fraction in the base year. The future year recession is also dampened by a "Scrappage Ratio" that reflects the ratio of MOVES default national population for recession vehicle model year ***i*** (e.g., 2009) in the future year (e.g., 2028) relative to the base year (e.g., 2016). The scrappage ratios relevant to the 2016v1 modeling platform are shown in Table 1.

$$NFraction_{i,FY} = Fraction_{i,FY} \times \left[1 + \frac{(Fraction_{i,BY} - LFraction_{i,BY})}{LFraction_{i,BY}} \times ScrappageRatio\right] \quad \text{Eqn. 2}$$

Where: ***NFraction$_{i,FY}$*** = the new fraction of vehicles for the recession model years ***i*** in the calendar future year ***FY***.

Fraction$_{i,FY}$ = the existing fraction of vehicles for the recession model years ***i*** in The calendar future year ***FY***.

i = the set of vehicle model years (2009, 2010, 2011).

Fraction$_{i,BY}$ = the existing fraction of vehicles for model year ***i*** in the base year ***BY***.

LFraction$_{i,BY}$ = the linearly interpolated fraction of vehicles from Equation 1.

ScrappageRatio = the ratio of MOVES national source type population in the future year ***FY*** to the base year ***BY*** for model year ***i***. See Table 1 for values.

Table 1. Scrappage Ratios (referenced in Equation 2) for the 2016v1 Platform

Ratio of MOVES National Population in 3 Future Years Relative to the Base Year 2016

MOVES Source Type	2020	2023	2028
Vehicle Model Year 2009			
Passenger Car	0.890	0.660	0.186
Passenger Truck	0.753	0.554	0.261
Light Commercial Truck	0.753	0.554	0.261
Vehicle Model Year 2010			
Passenger Car	0.908	0.757	0.237
Passenger Truck	0.783	0.592	0.296
Light Commercial Truck	0.783	0.592	0.296
Vehicle Model Year 2011			
Passenger Car	0.925	0.817	0.302
Passenger Truck	0.814	0.632	0.336
Light Commercial Truck	0.814	0.632	0.336

Equation 3 re-normalizes the distribution of fractions by age after previous equations have been applied so that the fractions sum to one (1).

$$NFraction_{ST,a} = \frac{Fraction_{ST,a}}{\sum Fraction_{ST,a}} \qquad \text{Eqn. 3}$$

Where: ***NFraction$_{ST,a}$*** = the normalized age fraction for source type ***ST*** and age ID ***a***.
ST = the MOVES source type. For the 2016v1 platform, we will only adjust the light-duty source type IDs 21, 31, and 32.
a = the age ID in number of years old (values are 0 to 30, inclusive).
Fraction$_{ST,a}$ = the intermediate age fraction for source type ***ST*** and age ID ***a*** after Equations 1 and 2 were applied.

Figure 2 shows the cumulative effects of Equations 1- 3 applied to the base year 2016 age distribution for passenger cars from Figure 1 for future years 2020, 2023, and 2028. Figure 3 shows the same analysis years and same example county, for passenger trucks. Note that the recession dip shifts downstream with advancing future year, and the relative impact shrinks in the future such that it is barely detectible by 2028.

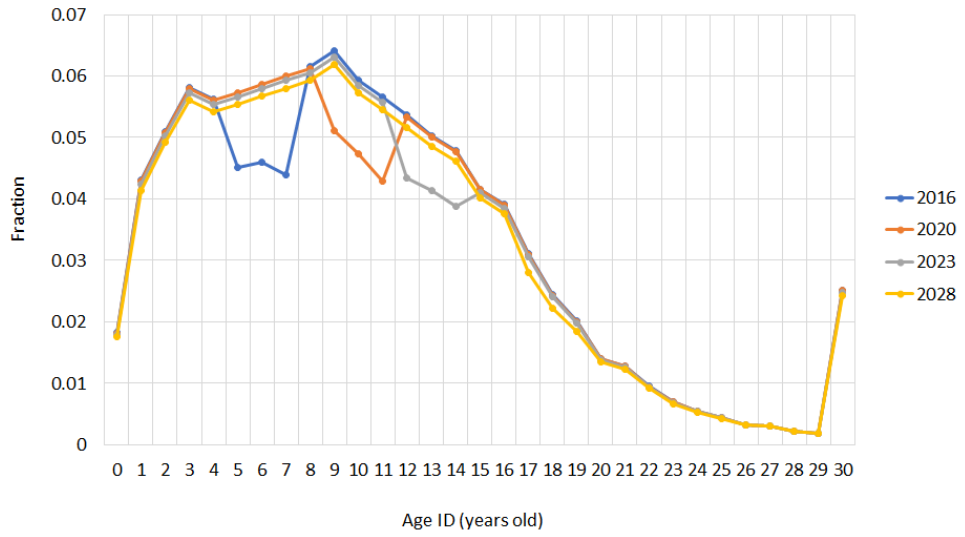

Figure 2. Example Base and Future Year Age Distributions for Passenger Cars

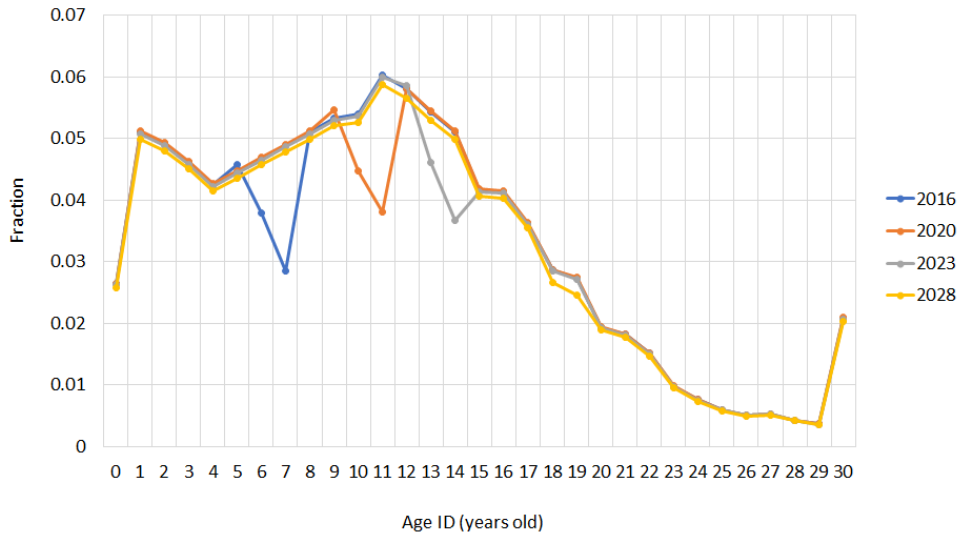

Figure 3. Example Base and Future Year Age Distributions for Passenger Cars