MEMORANDUM

To: Professors David Bunch, Trudy Cameron, and Walter McManus

From: SRA International

Date: September 9, 2011

Subject: Review of Consumer Choice Model

You have agreed to serve as an expert peer reviewer of the consumer choice model developed by the Oak Ridge National Laboratory (ORNL) through the support of EPA-OTAQ. This memorandum sets out the parameters of your review and expectations for the work product you will deliver at the conclusion of your review.

Background on the Consumer Choice Model

The specification by OTAQ to ORNL for consumer choice model development was:

> "ORNL shall develop a Nested Multinomial Logit (NMNL) or other appropriate model capable of estimating the consumer surplus impacts and the sales mix effects of greenhouse gas (GHG) emission standards. The model will use output from the EPA's Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA), including changes in retail price equivalents, changes in fuel economy, and changes in emissions, to estimate these impacts. …The model will accept approximately 60 vehicle types, with the flexibility to function with fewer or more vehicle types, and will use a 15 year planning horizon, matching the OMEGA parameters. It will be calibrated to baseline sales projection data provided by the EPA and will include a buy/no-buy option to simulate the possibility that consumers will choose to keep their old vehicle or to buy a used vehicle."

Most consumer choice models use discrete-choice methods to estimate consumers' vehicle purchases and are, by far, the most common methodology used to mathematically model lightduty passenger vehicle demand, based on both consumer and vehicle characteristics. Baltas and Doyle (2000) succinctly summarize the methodology of discrete choice models, also referred to as random utility (RU) models. "In RU models, preferences for such discrete alternatives are determined by the realization of latent indices of attractiveness, called product utilities. Utility maximization is the objective of the decision process and leads to observed choice in the sense that the consumer chooses the alternative for which the utility is maximal. Individual preferences depend on characteristics of the alternatives and the tastes of the consumer….The analyst cannot observe all the factors affecting preferences and the latter are treated as random variables."[1]

[1] Baltas, G. and P. Doyle, 2001. "Random utility models in marketing research: a survey", *Journal of Business*

Since the early applications of random utility models in the 1970s[2], formulations of RU models have proliferated. Baltas and Doyle (2000) identified 14 different methods which they grouped into three fundamentally different approaches depending on the nature of the random utility:

- Unobserved product heterogeneity;
- Taste Variation (consumer heterogeneity);
- Choice Set Heterogeneity.

Nearly all applications of random utility models to automobile choice fall into the first two groups because the availability of different types of automobiles is rarely a significant issue. Randomness in the simple multinomial logit model derives primarily from unobserved attributes. Its error term may also include unobserved variations in taste but the representation of these variations is limited and simplistic. The same applies to Nested Multinomial Logit Models (NMNL), though their ability to represent randomness in unobserved attributes and tastes is much more complex. In these models, heterogeneity in consumers' preferences is commonly represented by explicit functional relationships between product attributes and consumer characteristics. Mixed Logit models allow variations in consumers' preferences to be represented by random coefficients, whose distributions can be inferred either from survey or market shares data.

Materials to Be Reviewed

We will provide you the model contained in a computer program and described in the report documenting the model. The report details the structure, key modeling assumptions, and data inputs utilized in developing this modeling approach to vehicle consumer choice. No independent data analysis will be required for this review.

Focus of Your Review

EPA is seeking your expert opinion on the data, concepts, and methodologies upon which the model relies, whether or not the model will execute the analysis correctly, and the suitability of the model for analyzing the effects of regulatory programs on consumer vehicle choices. Toward this end, we ask that you review and comment on the following items:

(1) in general, the overall approach to the specified modeling purpose and the particular methodology chosen to achieve that purpose;
(2) the appropriateness of the model parameters and other inputs;
(3) the types of information that can be inputs to the model;
(4) the types of information that the model produces;
(5) the accuracy and appropriateness of the model's conceptual algorithms and equations;

Research, vol. 51, pp. 115-125.

[2] . McFadden, D., 1973. "Conditional logit analysis of qualitative choice behavior", pp. 105-142 in P. Zarembka, ed., *Frontiers in Econometrics*, Academic Press, New York.

(6) the congruence between the conceptual methodologies and the program execution;
(7) clarity, completeness and accuracy of the calculations made by the model;
(8) assessment of the accuracy of the model results and appropriateness of conclusions to be drawn from the model; and
(9) any caveats about the use of the model for regulatory analysis.

In your comments, you should distinguish between recommendations for clearly defined improvements that can be readily made based on data or literature reasonably available to EPA, and improvements that are more exploratory or dependent on information not readily available to EPA. Any comment should be sufficiently clear and detailed to allow a thorough understanding by EPA or other parties familiar with the model. EPA requests that you not release the peer review materials or your comments to anyone else until the Agency makes its report and supporting documentation public.