Report."¹⁵ These conclusions were largely based on the Baltimore instrumented vehicle survey data. Subsequent analysis has found the larger three-city instrumented vehicle results to be consistent with the Baltimore-only results. The three-city analysis showed that nearly 13 percent of vehicle operation, on a time-wrighted basis, occurs at combinations of speed and acceleration that fall outside the matrix of speeds and accelerations found on the LA4 driving cycle. The maximum observed in-use speed was 95.5 mph, compared to the LA4 maximum speed of 56.7 mph, and slightly more than seven percent of inuse vehicle operation time was spent at speeds greater than 60 mph. Average speed from the three-city in-use data was 25.9 mph compared to 19.6 mph over the LA4.

Specific power is also useful when analyzing aggressive driving behavior.¹⁶ Measures of power also indicated that in-use driving behavior was more aggressive than reflected in the LA4. Specific power in the three-city sample ranged up to 723 mph²/sec and averaged 47.0 mph²/sec. The LA4 has maximum power of 192 mph²/sec and an average of 38.6 mph²/sec.

The Agency analyzed the in-use survey data to determine how the above

findings on speeds, accelerations, and power measures were affected by other factors, including vehicle type (car/ truck), transmission type, vehicle performance level, time of day, and day of the week. The first three vehiclerelated factors are reflected in today's proposal. The discussion of the analysis and findings are in the Support Document to the Proposed Regulations for Revisions to the Federal Test Procedure: Detailed Discussion and Analysis and the Technical Reports.

The Agency also examined start driving behavior as represented by the instrumented vehicle survey data. The Agency determined that the start driving (operation following the initial idle and before coolant temperature exceeded 140° F) in the survey data generally did not exceed 240 seconds. Further analysis showed that the speeds of start driving did not change substantially following soaks of different durations, but they did differ from those found in hot stabilized driving. The results for inuse initial idle time and start driving are different than the representation of these elements in the FTP. The LA4 cycle has atypical high speeds over the first four minutes of a vehicle trip. On the other hand, the LA4 has substantially less aggressive accelerations than the first 80 seconds

or so of typical in-use start driving, while it is substantially over-aggressive when compared to the succeeding 160 seconds. For initial idles, the FTP presumes 20-second durations for both cold and hot starts, whereas the in-use averages from EPA's data were 28 seconds for cold starts and only 12 seconds for hot starts.

The previous discussion of in-use speeds and accelerations presents a snapshot of driving behavior. Although the acceleration measure, which looks at the change in speed from one second to the next, partially characterizes the transient nature of driving, other measures expand the time interval to examine the rapid fluctuations in speed, or microtransients. One measure, referred to as jerk, is equal to the change in acceleration. A related measure is the second-to-second change in specific power. Conceptually, this measure captures the change in the power requirement imposed by the driving behavior.

The Agency used the three-parameter instrumented vehicle data from Baltimore, Spokane, and Atlanta,¹⁷ to calculate these microtransient measures for in-use driving behavior and compared the results to the LA4's representation. The measures of jerk and change in power are shown in Table 2.

TABLE 2.—MEASURES OF MICROTRANSIENT DRIVING FROM INSTRUMENTED VEHICLE DATA/SEC

Source	Jerk		Change in power	
	Mean of the absolute values (mph/sec)	Standard deviation (mph/sec)	Mean of the absolute values (mph ² /sec)	Standard deviation (mph ² /sec)
In-use driving LA4	0.47 0.36	0.89 0.63	20.48 14.96	34.36 22.96

For both jerk and change in power, the mean of the absolute values were used in order to look at both the positive and negative values (the mean of the signed values of jerk is always equal to zero). The in-use means were higher than those for the LA4, indicating larger inuse changes in acceleration and power, as well as reflecting, in part, the LA4's acceleration rate cutoff of 3.3 mph/sec and the maximum speed of 57 mph. The standard deviations of jerk and change in power are probably a better measure of microtransient behavior. Again, inuse data show larger values for both measures. The greater variation around the mean demonstrated by the in-use data suggests that the LA4 does not adequately represent the microtransient nature of in-use driving behavior.

B. Soak Behavior

The survey data were also analyzed to determine the frequencies at which soaks of different durations occurred inuse. The Agency found that soaks of less than 10 minutes and greater than 8 hours occur with the highest frequencies in use. However, EPA also found that a significant portion of in-use soaks are of intermediate duration. For example, nearly 40 percent of all soaks in the Baltimore survey data were between 10 minutes and 2 hours. Given that the current FTP employs only two soaks (the 10-minute hot soak and the 12- to 36-hour cold soak) to represent the range of soaks in-use, EPA was concerned that the current FTP might not adequately control for emissions following these intermediate-duration soaks.

C. Air Conditioning

A number of variables affect the range of A/C usage, particularly temperature, sun load, and humidity, all of which

¹⁵ U.S. Environmental Protection Agency, Federal Test Procedure Review Project: Preliminary Technical Report, EPA 420–R–93–007, Office of Air and Radiation, May 1993.

¹⁶The power needed from an engine to move a vehicle is proportional to both the vehicle speed

and the acceleration rate. Neither variable, by itself, is a good measure of the load placed on the engine. The joint distribution of speed and acceleration is probably the best measure, but it must be examined in three dimensions, which is difficult to visualize and comprehend. The concept of specific power

provides a two-dimensional measure which is roughly equal to 2*speed*acceleration and has the units of mph²/sec.

 $^{^{17}}$ See the Technical Reports for a full description and analysis of this data.