7.0 U.S. Phase

This section of the report presents the results for U.S. Study Phase 2 of the project, as well as combined results for both Study Phases 1 and 2. The U.S. Study Phase 2 of the project, which was completed after the Canada study phase, was designed to assess the effects of the FMT FEEDBACK on fatigue and performance outcomes with an emphasis on night driving. This emphasis was based on interpretations of results from the Canadian study phase, as well from expert assessments of potential FMT utility during nighttime driving relative to daytime driving. Moreover, frequent nighttime driving is more likely to be associated with fatigue based on sleep and circadian biology. However, drivers in the Canada study phase operated single tractor-trailer units with sleeper berths and had only a minority of their drive time at night (approximately 26%). Consequently, we sought to evaluate U.S. drivers who drove frequently at night.

Study Phase 2 relied on volunteer drivers from Con-Way Central Express (Ann Arbor, Michigan, U.S.). They operated tandem tractor-trailer units without sleeper berths, and approximately 90% of their driving was at night. This can be seen in Data Quality Control Table 29 (Appendix C-2), which summarizes the numbers of records in the cleaned analysis sample in which the *AP+ Day Light* sensor indicated nighttime driving (sensor value = 0) or daytime driving (sensor value = 1). Therefore, the data analyses in U.S. Study Phase 2 were restricted to nighttime driving.

Table 17 in the main report reveals differences between the Canadian and U.S. drivers as a function of the time-of-day they tended to drive, their different truck configurations, and other operational differences between their respective companies. The Table displays the Daily Diary data on the mean proportion of days on which certain conditions and activities occurred on average across drivers in the Canada and U.S. study phases, as well as for the NO FEEDBACK and FEEDBACK conditions of each. While "weather problems" occurred in both study phases, the U.S. drivers experienced traffic delays and slow moving traffic much less frequently than did their Canadian counterparts. This is consistent with differences between daytime and nighttime driving. While Canadian drivers frequently napped in their sleeper berths for an average of more than 1.5 hour, U.S. drivers napped less frequently and when they did it is was typically only a few minutes and not in a sleeper berth, since (unlike Canadian drivers) no berth was available. The combination of night

driving, daytime sleep, and limited nap opportunities over the road, resulted in the U.S. study phase drivers obtaining less sleep during workdays than the Canada study phase drivers. This was the case as detailed below in Section 9 below.

7.1 Summary of available data in U.S. Phase

Twelve drivers volunteered for U.S. Study Phase 2 (the limitation on the number of volunteers that could be accommodated were set by the study timeline, resources and target sample size). Using data quality control procedures detailed in section 5 of this report, data from 3 of the 12 drivers had to be excluded from analyses of the *Copilot® measure of PERCLOS*, *SafeTRAC®* and the other *AP+®* recorded outcomes due to technical (equipment) failures that led to insufficient AP+ recordings either during the NO FEEDBACK condition or during the FEEDBACK condition. *SleepWatch®* actigraphy and *Daily Diary* data were available for 10 drivers. *PVT* and post-experimental *Human Factors Questionnaire* data were available for all 12 drivers.

7.1.1 Summary of statistical methods

Data analyses and hypothesis testing were identical to those conducted for Canada Study Phase 1. Driver specific mean and median values were compared between conditions for the following outcome variables: PERCLOS during night hours; SafeTRAC "driver alertness index." Driver specific standard deviation and interquartile ranges were compared between conditions for the following outcome variables: AP+ Lateral distance standard deviation; AP+ Steering wheel movement standard deviation; and AP+ Front wheel movement standard deviation. The median and IQR measures served as non-parametric alternative measures to the mean and standard deviation measures, respectively, for summarizing the within driver and experimental condition distributions. As in Study Phase 1, for each outcome variable recorded by the AP+ system, the following four analyses were performed to assess if there were significant changes from the NO FEEDBACK condition to the FEEDBACK condition.

1. Unweighted analysis of parametric distribution summary statistics
2. Doubly weighted mixed model analysis of parametric distribution summary statistics
3. Unweighted analysis of non-parametric distribution summary statistics
4. Doubly weighted mixed model analysis of non-parametric distribution summaries

Doubly weighted mixed model analyses of variance were used to provide the definitive tests of primary study hypotheses. In these analyses, the statistics used to summarize alertness and performance for each driver within each experimental condition (NO FEEDBACK and FEEDBACK) were made to optimally reflect 'typical' performance by weighting observed values proportionally to their observed record duration time. For example, a record with a duration of 3 seconds was given three times as much weight as a 1 second record by replicating records prior to computing statistics from the within driver and condition specific distributions. These summary statistics included mean, median, standard deviation, and interquartile range values. Then, the statistical efficiency of the inference to the population with regard to differences between the NO FEEDBACK and FEEDBACK conditions was increased by giving greater weight to the above summary statistics that were estimated on the basis of larger cumulative $AP+®$ validated recording times.