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Preliminary Plan for Case-Control Crash Risk Study

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PRELIMINARY PLAN FOR CASE-CONTROL CRASH RISK STUDY

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LIST OF ACRONYMS

ATA	American Trucking Association
BMI	Body Mass Index
CDLIS	Commercial Driver License Information System
CMV	Commercial Motor Vehicle
DMV	Department of Motor Vehicles
DOT	U.S. Department of Transportation
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulations
HOS	Hours of Service
GVWR	Gross Vehicle Weight Rating
ICC-MC	Interstate Commerce Commission – Motor Carrier
IRB	Institutional Review Board
LTL	Less-than-Truckload
MAP	Multivariable Apnea Prediction
MCMIS	Motor Carrier Management Information System
NTSB	National Transportation Safety Board
PVT	Psychomotor Vigilance Test
RR	Relative Risk
SAS	Statistical Analysis Software
SST	Statistical Software Tools
TL	Truckload

1. INTRODUCTION

1.1 BACKGROUND AND SCOPE

The primary mission of the Federal Motor Carrier Safety Administration (FMCSA) is to promote the safety of commercial vehicle transportation. This is achieved through a thorough understanding of crash characteristics, precursors, and risk factors, to better identify and evaluate countermeasures. Consistent with the *FMCSA Safety Action Plan 2000-2003*, a case-control study will be performed to identify factors that contribute to increased risks of large truck crashes.

The case-control study will determine critical driving safety factors by estimating the relative crash risks associated with driver characteristics, their physical/medical qualifications, and other driving performance characteristics. The study will also assess crash risks associated with selected vehicle and environmental factors. Rather than look only at data generated from crashes, the study will employ a case-control methodology in which the characteristics and performance correlates of crash-involved drivers (cases) are compared to those of non-crash-involved drivers (controls). Analysis of the data will provide an estimate of the relative risks associated with various driver factors (e.g., sleep disorders, driving habits, etc.). These results could greatly help carriers in selecting drivers who are most likely to achieve excellent safe driving records, as well as identifying countermeasures for controlling significant risk factors in existing drivers.

The case-control crash risk study is one of a portfolio of FMCSA research projects focused on achieving motor carrier safety improvements. Another research project being conducted at FMCSA is the *Large Truck Crash Causation Study*, aimed at determining causes that indicate effective measures that will reduce the risks of future crashes (Craft, 2001). In contrast to that study, the case-control crash risk study will not focus on detailed engineering models of crash causation by crash type, but rather, study the differences between drivers who have accidents and those who do not. Data obtained from this study will complement and help validate the causation models developed in the crash causation project. Conversely, the crash causation project will identify important variables that can be studied further in the case-control study. Such cross-validation is expected to be an important element in discovering and promoting effective crash risk countermeasures for the motor carrier industry.

1.2 STUDY OBJECTIVE

The objective of this case-control crash risk study is to identify and quantify the risks of being involved in a large truck-related accident by sampling a portion of the large truck population. Information on study participants will be collected for crash- and non-crash-related scenarios, and analyzed to obtain odds-ratios that will be used to estimate the driver's relative risk given various driver, vehicle, and trip characteristics.

FMCSA and the Volpe National Transportation Systems Center (Volpe Center) will conduct this study over a three-year period. This study will involve the investigation of driver-related (e.g., health, age, and time spent driving) as well as non-driver-related factors (e.g., weather and road conditions) for crash and non-crash events.

This plan provides the details of a case-control study for determining large truck driver risk factors, including the study approach, sampling and data collection method, major variables to be assessed, and statistical analyses to be conducted. Issues involved in conducting the study are also evaluated.

2. OVERVIEW OF CASE-CONTROL METHOD

A case-control study is designed to collect information in a population with a condition or outcome of interest (*cases*) and compares it with individuals that do not have the condition or outcome (*controls*). The cases and controls are compared with respect to existing or past attributes thought to be relevant to the outcome of interest (in this study, that outcome is a large truck accident). The risk of having a condition with respect to that attribute is then compared to the risk of having that condition without that attribute. This comparison of risks for cases and controls provides an odds-ratio, which is an estimate of the relative risk of having a condition or outcome given the exposure to some trait (e.g., risk of lung cancer due to smoking, risk of heart disease due to high fat intake).

Case-control studies are typically used in epidemiology research. For example, case-control studies have been used to identify the risk of pneumonia in babies that are not nursed, the risk of coronary heart diseases in patients with high fat intake, and the risk of lung cancer based on smoking and smoking cessation [(Cesar, Victora, Barros, Santos, & Flores, 1999), (Tzounou et al., 1993), (Peto, 2000)]. However, the same methodology will also provide valuable insight on the relative risks of vehicular accidents given a driver's background, physical attributes, road, vehicle, and trip characteristics. Previous studies that have used case-control designs for related accident risks include analysis of motorcycle crashes, risks of vehicular crashes due to traveling speed, and the risks of traffic accidents due to cellular phone use [(Haworth, Smith, Brumen, & Pronk, 1997), (Kloeden, McLean, Moore, & Ponte, 1997), (Violanti & Marshall, 1996)].

2.1 ADVANTAGES AND DISADVANTAGES

The advantages of a case-control study are that the study can be of relatively short duration since an analysis can be done on retrospective (or existing) information and it is well suited for rare diseases (or occurrences). The outcome of interest for this study is a large truck-related accident. Given that, a relatively small proportion (approximately 5 percent of the truck-driving population) is expected to be involved in an accident.[1] For example, in a sample of 1,000 drivers, one would expect approximately 50 accidents per year. Over a 3-year period, approximately 150 accidents would be expected in this sample population. Another advantage to using this methodology is that there is typically no risk of danger to subjects and allows analysts to study multiple causes of a disease, or in this case, multiple causes of a crash.

The disadvantage of a case-control study is that most of the information collected relies on recall or records of information on past exposures. To validate the information can be difficult or sometimes impossible. Also, controlling for other plausible clauses (or extraneous variables) may be incomplete (Schlesselman, 1982). Other disadvantages of a case-control study include the inability to study a subject's long-term effects due to the crash over extended periods of time. To analyze if a subject's driving ability is going to be progressively diminished because of a

[1] Five percent was calculated by comparing the number of large trucks involved in traffic crashes in the United States in 1998 (412,000; as reported in NHTSA, "Traffic Safety Facts 1998," DOT Report # DOT HS 808 952) to the number of large trucks registered in the United States in 1998 (7,732,270; as reported by FMCSA Analysis Division in the "Large Truck Crash Facts 1999," April 2001, www.fmcsa.dot.gov).

prior accident, a cohort study (or longitudinal study) is more appropriate. In a cohort study, the researcher has more flexibility in choosing the variables to be recorded. As the study progresses, other variables of interest can be included and monitored. An example of a cohort study is the Framingham heart study. This study began in 1948 and data is still being collected on the original subjects, as well as their offsprings (American Heart Association, 2000). Typically, cohort studies require larger sample sizes because more data on each subject needs to be collected. Since the goal of this study is to assess risk given the existence of some condition, a case-control study is more appropriate.

2.2 ODDS-RATIO

Odds-ratios for the current study provide reasonable approximations for the relative risk of accidents based on variables of interest and can be calculated from data collected in a case-control study. Odds-ratio calculations are based on analysis using a logistic regression that takes into account the joint and individual effects of variables that may have an impact on whether or not a person is a case or control. Further readings on the use of the logistic regression for the analysis of case-control data can be found in Rothman & Greenland and Schlesselman (1998, 1982). A detailed example is also provided in Appendix A.

The odds-ratio calculations can be simplified into a 2x2 table if only one exposure variable is of interest and the assumption is made that there are no other confounding factors for this variable. The following two examples are provided for clarification.

<u>Example 1</u>

Assume that a variable of interest *A* exists, where *A* can be a medical condition, like sleep apnea, or a driving situation, like driving 10 miles over the posted speed limit. To determine whether or not drivers with exposure to *A* have a higher risk of accidents, 100 drivers may be sampled from a population of drivers. The number of drivers who had accidents in the past year (cases) is compared to the number of drivers who did not have an accident in the past year (controls). The number of drivers exposed to *A* in each group is also tabulated and placed in a table (see Table 1).

Table 1. Example matrix of exposure to condition *A* and vehicle accidents

	Risk Factor		
	Exposure to A	*Nonexposure to A*	Total
Case (Accident)	6	5	11
Control (No Accident)	20	69	89
	26	74	100

The result of comparing the odds of getting into an accident *with* exposure *A* with the odds of getting into an accident *without* exposure *A* is the odds-ratio and is calculated as:

$$Odds-Ratio: \frac{Odds(Accident\ with\ A)}{Odds(Accident\ without\ A)} = \frac{\frac{6}{20}}{\frac{5}{69}} \cong 4 \qquad \text{[Eq. 1]}$$

In this example, the results would indicate that drivers who are exposed to *A* are four times more likely to be at risk for an accident.

Example 2

In this example, a study by Kloeden et al. at the Road Accident Research Unit at The University of Adelaide in Australia is reviewed (1997). They studied the risk of an accident due to speeding. The results indicate that a driver is 4.16 times more likely to be at risk for an accident if they are driving 10 kilometers per hour over the posted speed limit (see Table 2).

Table 2. Accidents given traveling speed

	In a 60 km/hr speed limit area		
	70 km/hour	*60 km/hour*	Total
Case (Accident)	20	29	49
Control (No Accident)	34	205	239
	54	234	288

$$Odds-Ratio: \frac{Odds(Accident\ at\ 70\ km/h)}{Odds(Accident\ at\ 60\ km/h)} = \frac{\frac{20}{34}}{\frac{29}{205}} \cong 4.16 \qquad \text{[Eq. 2]}$$

3. STUDY METHODOLOGY

The general approach for this study will include collecting information on cases and controls to identify the relative risks of accidents due to major driver, vehicle, and trip characteristics of commercial drivers of large trucks. The *cases* in this study will be drivers from the defined population who were involved in an accident during the study period. The study period will be defined, retrospectively, as the three years prior to inclusion in the study. The *controls* will also come from the same population, but will be drivers not involved in an accident. Information that will be collected for each driver will include major medical conditions, driver characteristics, and trip characteristics. Retrospective information on trip characteristics for *cases* will come from existing records, such as those available from the driver's motor carrier, police reports, and insurance claims. Existing databases that have motor carrier and driver information (e.g., Motor Carrier Management Information System (MCMIS) and Commercial Driver License Information System (CDLIS)) can also provide crash information. Trip characteristics for *controls* will come from self-reported trip information provided by the drivers and motor carriers. The study will encompass approximately 500-1,000 drivers subject to available resources. All the data will be incorporated into a relational database and analyzed using statistical techniques.

There are six major tasks in conducting this study:

1. Obtain subject population
2. Develop and coordinate agreements
3. Collect data
4. Develop database
5. Analyze data
6. Document findings

3.1 OBTAIN SUBJECT POPULATION

The first step in this study will be to identify the fleets that are willing to work with FMCSA and the Volpe Center and solicit subjects from among their drivers. The subjects for this study will come from a population of licensed commercial drivers that have similar operating characteristics and are employed in one of the selected fleets. To be eligible for the study, they will need a minimum of three years driving experience to establish a substantial retrospective database of moving violations and accidents. All the drivers will need to be located in one geographical area to minimize the traveling required for physicians and researchers. This will also make it easier to conduct on-site research and examinations. A description of the target driver population, sample size, and fleet participation are described in this section.

3.1.1 Target commercial driver population

As part of the research for this study, trucking firms from different organizational structures were interviewed. This included for-hire truckloads (U.S. Xpress, J.B. Hunt), for-hire less-than-truckloads (Roadway Express), dedicated carriers (Lily, J.B. Hunt), and a private carrier (Garelick Farms). From these interviews, many unique company characteristics were identified, both organizationally and operationally. Therefore, other selection criteria will need to be determined, in addition to the eligibility requirements mentioned above. The following is a description of the different types of drivers and explanations for those recommended for the study based on the type of organization, operation, and load.

1. Organization: for-hire, private, or owner-operated

Drivers of for-hire firms: These drivers work for a trucking firm that has multiple customers and the drivers can ship goods to multiple customers and multiple locations. The trucking firms are primarily for-hire of property firms rather than for-hire of passenger firms. That is, they transport goods rather than people.

Drivers of private firms: These drivers work exclusively for one company; ship goods internally for that company, and can have multiple routes for that company.

Owner-operated drivers: These drivers own their trucks and contract out their services and trucks. They may even contract out their services to for-hire firms, but they are not employees of these trucking companies. However, some of the larger firms that contract their services (such as U.S. Xpress and J.B. Hunt) do keep track of the number of owner-operated drivers they have, as well as the number of accidents incurred by these drivers while servicing their company.

In this study, the primary focus will be on drivers of for-hire property firms because these operations typically differ with each load and can encompass many different, and sometimes unfamiliar routes. Identification of accident characteristics due to road/vehicle changes will be achieved with this organization type. As shown in Table 3, the number of crashes for for-hire drivers (which also includes owner-operated drivers) is considerably larger than for private drivers. Given that some owner-operated drivers have service contracts with fleets, it may be possible to obtain a sample of these drivers from the participating fleet. The number of for-hire, owner-operated drivers that are also interstate operators is relatively small (approximately 73,000).[2]

Table 3. Number of crashes by for-hire and private[a]

	Interstate			Intrastate[c]		
	Crashes	**Power units**	**Crash rate[b]**	**Crashes**	**Power units**	**Crash rate**
For-hire	104,037	1,747,027	59.6	1,630	79,350	20.5
Private	28,206	1,367,464	20.6	2,064	127,034	16.2
Total	**132,243**	**3,114,491**	**42.5**	**3,694**	**206,384**	**17.9**

[a]Data collected from SafeStat (www.ai.volpe.dot.gov/SafeStat/SafeStatMain.asp).
[b]The crash rate is defined as the number of state-reported crashes per 1,000 power units.
[c]Information for intrastate accidents is limited to states with complete crash records in SafeStat.

[2] Owner-operators were estimated by selecting carriers in the Census file with number of drivers = 1 and number of power units < 3; this number also excludes private carriers.

2. Operation: long-haul vs. short-haul, interstate vs. intrastate

Long-haul: *Long-haul drivers* (or over-the-road drivers) are distinguished by the radius of operations of the company or individual unit. Long-haul usually means a radius from the terminal area of 300 miles or more. Long-haul operators carry freight over the roads in tractor-trailer units having high-load capacities. They may not always return to their place of domicile every night due to the length of the trip. Many cabs have sleeper berths and some companies use two drivers on very long runs—one drives while the other sleeps in a berth behind the cab. "Sleeper" runs may last for days, or even weeks, usually with the truck stopping only for fuel, food, loading, and unloading. Long-haul drivers tend to utilize the interstate highway system more and have routes consisting of different road types and terrains.

Short-haul: *Short-haul drivers* (or local drivers) may be assigned short "turnarounds" to deliver a shipment to a nearby city or pick up another loaded trailer, and drive it back to their home base the same day. They usually load or unload the merchandise at the customer's place of business. Short-haul drivers can have multiple deliveries on one day. Short-haul drivers encounter more traffic intersections, signals, and rural routes but are typically back at their place of domicile by the end of their work shift.

In this study, long-haul drivers will be included based on the length and distance covered in their trips. Generally, long-haul drivers have longer driving hours than short-haul drivers and any accidents due to sleep patterns or disorders will be more representative in long-haul drivers.

Interstate carriers: This is a carrier authorized to cross state lines for its operations. Interstate carriers are subject to all the Federal Motor Carrier Safety Regulations (FMCSR) and are required to have a U.S. Department of Transportation (DOT) identification number. This number is used as a census number in the tracking of motor safety compliance issues. A for-hire carrier also needs an Interstate Commerce Commission-Motor Carrier (ICC-MC) number as well.

Intrastate carriers: This is a carrier that is not authorized to cross state lines. They are not required to have a U.S. DOT identification number, but some do have one.

For this study, a representative sample of *interstate* carriers only will be used. Since *intrastate* carriers are not subject to all the regulations of the FMCSR, it will be difficult to identify all DOT-reportable accidents.

3. Load type: truckload vs. less-than-truckload

Truckload (TL): Trucks begin with a full load for one customer. They normally make one stop at an assigned location, but can make additional stops along the way for that same customer.

Less-than-truckload (LTL): Trucks can begin with a full load, but the load consists of multiple shipments to multiple customers. Drivers need to make multiple customer stops for this carrier type. The trucking company consolidates and transports smaller (LTL) shipments of freight by utilizing a network of terminals and relay points.

For this study, a representative sample from only the TL carriers will be used to minimize distinct differences in driver characteristics for the two carrier types. TL drivers tend not to be represented by an organized union (e.g., International Brotherhood of Teamsters) while LTL drivers are typically unionized (Giermanski, 2000). This distinction between union and non-unionized drivers also impacts the pay scale and benefit packages for each group. Interviews with Roadway Express, an LTL firm, also indicate that there are very few accidents among unionized LTL drivers as well. A study conducted by the National Transportation Safety Board (NTSB) also identified that fatally injured TL carrier drivers tested significantly higher for drugs than LTL carriers (1990).

4. Commercial Driver License type: A, B, or C

In all trucking firms interviewed, the minimum license required by carriers was CDL A (U.S. Xpress, J.B. Hunt, Roadway Express, Lily Transportation) with some accepting CDL B (J.B. Hunt, Garelick Farms). The differences among the CDLs are explained below.

Class A: Can drive any combination of vehicles with a Gross Vehicle Weight Rating (GVWR) of 26,000 pounds or more, provided the GVWR of the vehicle(s) being towed is more than 10,000 pounds.
Class B: Can drive any single vehicle with a GVWR of 26,000 pounds or more, or any such vehicle towing a vehicle with a GVWR of 10,000 pounds.
Class C: Can drive any single vehicle less than 26,000 pounds GVWR.

Further, in each class of drivers, different endorsement codes can be obtained:

Code T: Combination vehicles with double or triple trailers.
Code N: Tank vehicles designed to transport any liquid or gaseous materials.
Code P: Vehicles designed to transport 16 passengers or more, including the driver, and any school bus designed to transport 11 passengers or more.
Code H: Vehicles used to transport hazardous materials in placardable amounts (or needs to have a hazardous material placard on the truck).
Code X: Tank vehicles used to transport placardable amounts of hazardous materials.

Statistics are not available for the number of drivers in each class, but since the majority of for-hire firms require a minimum of Class A and B licenses, it is recommended that the drivers in this study encompass this minimum requirement as well. Class C drivers are not allowed to drive tractor trailers since the requirements for this class only allows a single vehicle truck less than 26,000 pounds.

Although most Class A CDL drivers have all endorsements, in this study, drivers that have exclusive N, X, or P codes will not be considered. Codes N and X are for drivers of tankers, which will not be considered due to the historically low risk of being involved in accidents. Code P is predominantly bus drivers and this study is tailored for large truck drivers.

5. Types of trailers

There are many types of trailers that can be used with a tractor. Below is a listing of the more common types:

- Vans or fully enclosed boxes are typically used to ship furniture, appliances, and other household goods.
- Refrigerated trailers are used to ship goods that need refrigeration.
- Flatbeds, drop-decks, and lowboys are open trailers with flat beds used to haul construction equipment or bulky or heavy loads. The primary difference between a standard flatbed, drop-deck, and lowboy is the bed height. Standard flatbeds have a bed height of approximately 60 inches, drop-decks are approximately 38-40 inches and lowboys are approximately 22-24 inches.
- Tankers are vehicles for transporting bulk liquid freight.
- Dump trailers are used to transport and dump material such as gravel, mulch, topsoil, or sand.
- Pups are short semi-trailers, usually between 26-32 feet long, with a single axle.

Data by FMCSA's Analysis Division indicate that the largest number of accidents results from vans and/or enclosed boxes accounting for 43.0 percent of the fatalities, 22.3 percent of the injuries, and 13.1 percent of the property damages.[3] This could be due to a larger number of vans on the road. Interviews with trucking firms indicate that this trailer type was predominant at J.B. Hunt, a TL firm, and the exclusive type used by Roadway Express, an LTL firm. Aside from the FMCSA statistics, there has been no research clearly identifying the significant differences among the trailer types and the types of accidents due to the configuration of each trailer type. However, for analysis purposes, it may be simpler to focus on enclosed containers, or vans.

6. Other differences

Some drivers are also part of a union. A study conducted by Bellman et al., at University of Michigan Trucking Industry Program indicated that the majority of over-the-road drivers did not belong to a union (1998). However, interviews with some of the major carriers indicated that some prefer only unionized drivers (Roadway Express), while others do not (J.B. Hunt, U.S. Xpress). As indicated earlier, the trend toward unionization is prevalent in the LTL firms and toward non-unionization in the TL firms. The smaller firms have a combination of both indicating no preference to union or non-unionized drivers as long as they meet their minimum driving qualifications (e.g., Lily Transportation, Garelick Farms). Given the variety of responses to union or non-union drivers, this will not be a stratification category of this study.

3.1.2 Sample size

To determine the appropriate sample needed for this study, equations for sample-size calculations for case-control studies defined by (Schlesselman, 1982) are used. These calculations are based on the expected relative risk, exposure proportion, and case to control ratio

[3] From "Large Truck Crash Facts 1999" – Analysis Division – FMCSA, April 2001, www.fmcsa.dot.gov.

used. For example, Young et al. indicates that approximately 4 percent of middle-aged male drivers, the predominant population of truck drivers, have sleep apnea (1993). A subsequent study by Young, Blustein, Finn, & Palta determined that the relative risk of being involved in a motor vehicle accident if one has sleep apnea is approximately four (1997). That is, drivers with sleep apnea are four times more likely to have a motor vehicle accident. To support their findings in this case-control study, a minimum sample of 93 cases (accidents) and 372 controls (no accidents) will be needed to identify the same relative risk of 4 with 95 percent confidence if a 1:4 ratio of cases and controls are used.[4] The number of cases would decrease if the ratio of cases to controls were higher (i.e., in a 1:10 ratio, 77 cases would be needed). Likewise, if a smaller relative risk were desired (i.e., greater precision), the number of cases required would increase (i.e., to detect a relative risk of 2, with a 1:4 case-control ratio, 504 cases would be needed). Figure 1 shows how the sample size requirements would change with different levels of precision (or relative risk) and with different case-control ratios. Given that this study will use retrospective information, identifying a relative risk of 4 for the impact of sleep apnea, based on the data from Young et al. (1993), and Young et al. (1997), should be achieved with 1,000 participants if the expected number of accidents in a population of 1,000 is 5 percent per year (or 50 per year for 3 years).

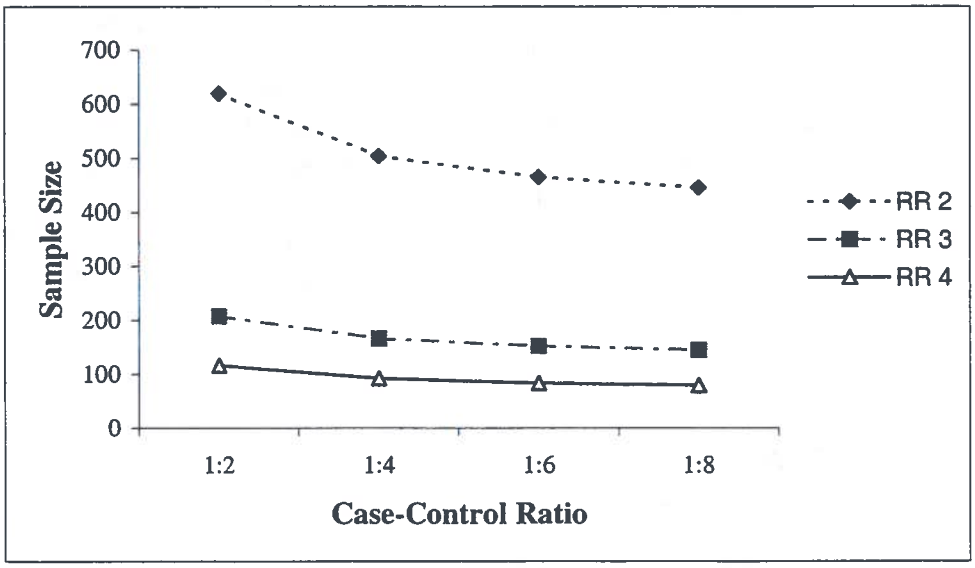

Figure 1. Sample size requirements for a given relative risk (RR)

3.1.3 Fleet participation

Coordination efforts are required with the trucking firms to obtain approval for using their drivers and to obtain records on their drivers. These records will include any moving violations, length with firm, accident records, and insurance claims that may have been filed and police reports on file.

A solicitation will be sent out to all trucking firms that are located in one geographical area. This will allow the team to coordinate meeting with drivers more efficiently. Given that a large

[4] Other calculations will be needed to determine minimum sample size for other medical factors based on the proportion of the population identified with the conditions.

number of trucking firms are located in the southern states, there is a high probability that firms from those states will be selected. Also, since some of the larger firms have drivers stationed all over the country, this study will collect information from truck drivers whose domicile is in the desired geographical location only.

Interviews with various motor carriers indicate that approximately 50–100 drivers can be used from participating organizations for the study. This will vary depending on the size of the fleet. Given that, approximately 10–20 fleets will be needed. The exact number of drivers will depend on the number of fleets participating in the study, as well as the number of drivers the fleets will allow to participate in the study.

3.1.4 Driver selection issues

A bias toward "better" drivers may exist in the selection process due to the likelihood that those drivers who are willing to participate may recognize the importance of the study while those who are not willing to participate may be worried that the study will impact their job security. To minimize this bias, representative fleets from high-risk, medium-risk, and low-risk categories can be proportionately selected. However, motor carriers in each risk group may be difficult to identify since many carriers provide insufficient data for SafeStat, a database with safety statistics on motor carriers (see Table 4). Still, SafeStat can provide some guidance to the types of carriers that are identified in the high-risk category. This will also depend on the number of carriers willing to participate in this study.

Table 4. Number of carriers in accident risk categories

Accident Risk Category	Number of Carriers	% of All Carriers
High Risk (A&B*)	4,231	0.73
Moderate High Risk (C)	3,120	0.53
Medium Risk (D&E)	12,865	2.21
Moderate Low Risk (F&G)	19,826	3.40
Low Risk (unscored)	116,386	19.95
Carriers with insufficient data	427,010	73.19
Total Carriers	583,438	100.00

* Categories listed (A–G and unscored) are SafeStat categories as defined in U.S. DOT-Volpe Center, 2001 (www.ai.volpe.dot.gov/SafeStat/SafeStatMain.asp)

3.2 DEVELOP AND COORDINATE AGREEMENTS

In order to accomplish the objectives of this case-control crash risk study, the Volpe Center and FMCSA will need the commitment and cooperation of a number of parties. This will include a data collection team, the motor carriers, and the truck drivers who are employed for these motor carriers. Other agreements may also be needed with state police, state DOTs, and insurance agencies. This section describes the list of potential partners and stakeholders and their roles in the study.

Participants will need to invest approximately 16-20 hours in this study. Since drivers may be reluctant to spend that amount of time outside of work, monetary incentives will be offered to assure their cooperation and the quality of the data. Carriers will assist in recruiting and supporting participants as well as provide the researchers with some of the required information. It may also be necessary to provide some incentive to the carrier for data acquisition, with the assurances that study cooperation from the individual driver is not compromised by management action or threats. Perhaps these assurances can be secured by making summary data available to the participating motor carrier at specific intervals during the study.

Previous accident data will also need to be obtained on the drivers in the study. If the driver was employed with the motor carrier for the three years prior to this study, the motor carrier may have all the data on the driver. If not, coordination will be needed to obtain police records and/or insurance claims.

3.2.1 Carrier partnership agreement

The partnership agreement with the carrier needs to identify (a) the data items to be collected by the carrier such as previous accident and moving violation records; (b) the items to be collected by the carrier without attribution to driver; and (c) the items to be collected by the researchers from the driver that would and would not be disclosed to the carrier. Consideration may also be given to allow the carrier access to summary data for its fleet sample in comparison with the total for all participating carriers.

3.2.1.1 Information to be provided to carriers

The carriers will be provided with data summaries for their fleet sample over regular time intervals. This information can be compared with the total for all participating carriers. Data for another individual carrier or group of carriers will not be disclosed.

3.2.1.2 Liability protection

Carriers have raised an issue regarding liability exposure in the event of litigation arising from an accident. The information gathered from this study will be protected under research agreements that guarantee anonymity of the participants.

3.2.2 Driver consent agreement

The "informed consent" agreement with the driver will explain the data collection process, in the context of the study objectives, and outline how the driver will be compensated for participation. It will state the researchers' goal of overriding confidentiality of the data records, the possibility of providing that summary, aggregate driver data to the employer, and taking measures for precluding the identification of the driver by name with any associated study data. It will also contain directions for contacting the study team to ask questions, or to withdraw consent for further participation. A copy of a sample informed consent is provided in Appendix B.

3.2.2.1 Compensation

Drivers will be compensated approximately $250 for 1½ days participation in a laboratory study. In the Pack study, compensation was provided in the amount of $350 for the nighttime study and all day testing (2000). Other studies with truck drivers included: $300 for 2-4 weeks driving in the University of Michigan Transportation Research Institute ICC Field Operational Test; $375 for 10 days of driving in a short-haul truck study conducted by Virginia Polytechnic Institute; and $600 for a 2-week long-haul truck study, also conducted at Virginia Polytechnic Institute. Except for the Pack study, these other studies do not involve extra time away from work.

3.2.2.2 Protection from adverse actions

The "informed consent" agreement must explain protection, agreed on by the carriers, against employer repercussions, including, but not limited to, adverse actions (e.g. dismissal) based solely on participation and findings (or surmising of findings).

3.2.3 Agreement with physician

If the physician conducting the study and physical exam identifies a medical condition that a driver should be aware of, the physician will notify the driver immediately of the condition and provide any supplemental handouts to identify how a driver should be treated for that specific condition. Whether or not a driver chooses to correct the situation and/or inform their employer will be at the discretion of the driver.

3.2.4 Insurance groups

Insurance companies that work with truck drivers (e.g., Liberty Mutual, Fireman's Fund, and Travelers) may also have a role in providing accident information. Many insurance claims provide detailed information on an accident that may not be documented in police reports or within the motor carriers.

3.2.5 State organizations

The study will need to coordinate with state police and/or state DOTs (depending on who maintains the police accident records).

3.2.6 Union alliance

Union-represented drivers may present additional limitations and/or opportunities for data collection. LTL drivers with larger firms (Roadway Express, Yellow Freight, etc.) are more likely to be unionized. Full truckload carriers tend not to be unionized. If, as discussed earlier, the study focuses on full truckload drivers, union issues will probably not be a concern. If it is expected that a large proportion of the participants will be involved in a union, it would be helpful to solicit the union's approval for the study to convince member drivers of the merits of the study and provide further assurance of confidentiality protection. To achieve this sort of collaboration, the study team can solicit the union to reinforce the methodologies and techniques used for the research.

3.2.7 Involvement of other organizations

There may be a need to coordinate with other groups that have not yet been interviewed. Various insurance agencies, academic institutions, and research foundations have conducted driver safety research. These organizations may have an interest in collaborating with the Volpe/FMSCA study team for a mutual benefit and cost sharing. Other groups may include the American Trucking Association (ATA) and its membership state associations, who promote carrier interests to industry and government.

3.3 COLLECT DATA

Data for each driver will be collected as soon as the motor carriers and targeted drivers have been selected and participation has been coordinated. Information on many variables of interest will be gathered from these selected drivers including biographical, driving, and medical data. Descriptions of the variables of interest, as well as the process used to collect the data are presented in this section.

3.3.1 Variable list

The major focus of this study will be on driver characteristics and how to obtain relative risks of accidents given these characteristics. A baseline control will need to be established to ensure that there is no confounding of other elements. Therefore, information will be collected on the roadway, vehicle characteristics, and atmospheric conditions. A description of these variables and the most feasible method to obtain the information is presented.

The variables are divided into the following categories:

1. Biographical data (Table 5)
2. Driver characteristics (Table 6)
3. Vehicle characteristics (Table 7)
4. Medical data (Table 8)
5. Crash and control variables (Table 9)

Table 5. Required biographical data

	Biographical Variables	Data Acquisition Method
1	Age	Initial survey
2	Sex (male or female)	Initial survey
3	Number of traffic violations in past 5 years	Department of Motor Vehicles (DMV), state, or fleet records
4	Educational attainment level	Initial survey
5	Marital status	Initial survey
6	Children	Initial survey
7	State of domicile	Initial survey
8	English comprehension	Written assessment
9	Job satisfaction	Assessment with stress screening tool
10	Credit rating	Credit agency

Table 6. Required driver characteristic data

	Driver Characteristic Variables	Data Acquisition Method
1	Number of years of CMV driving experience	Initial survey
2	Type of driver training received (entry level, formal, on-the-job, family, or friend)	Initial survey
3	State classified licenses, Non-CDL	Initial survey
4	Type of CDL endorsement	Initial survey
5	Union or non-union	Initial survey
6	Own, lease, or company-supplied truck	Initial survey
7	If own, own tractor, trailer, or both	Initial survey
8	Drive alone, with team, with others (pet, children?)	Initial survey
9	Sleeper berth in cab? Yes/No	Initial survey
10	Number of miles driven per year	Fleet records
11	Average driving speed	Initial survey
12	Miles driven per day	Initial survey
13	Driver unloads vs. lumper	Initial survey
14	Regularity of schedules	Initial survey
15	Time of day normally driven	Fleet records
16	Months and years with current company	Fleet records
17	Majority of driving: days, nights, or equal part of both	Fleet records

Table 7. Required vehicle characteristics data

	Vehicle Characteristics Variables	Data Acquisition Method
1	Type of trailer (flatbed, tanker, enclosed van (single, double, or triple)	Initial survey/control trip survey
2	Age of vehicle	Initial survey/control trip survey
3	Miles on vehicle	Initial survey/control trip survey
6	Type and number of in-vehicle devices in vehicle (cell phones, CB radio, CD player, GPS device, etc.)	Initial survey/control trip survey
7	Ability to see cars in right blind spot, with help of mirrors	Driver information
8	Ability to see cars in left blind spots, with help of mirrors	Driver information
9	Ability to see behind driver's vehicle	Driver information
10	Cargo type/hazmat	Fleet records
11	Fleet maintenance program or driver responsibility	Fleet records
12	Type of recorder (HOS (hours of service) Logs, Time Card, GPS)	Fleet records

Table 8. Required medical data

	Medical Variables	Data Acquisition Method
1	Weight	Exam during clinical study
2	Height	Exam during clinical study
3	Visual impairments - 20/40 with corrected lenses	Exam during clinical study/ Cert. of Physical Exam 391.43
4	Visual impairments - problems with binocular vision	Exam during clinical study/ Cert. of Physical Exam 391.43
5	Visual impairments – color blindness	Exam during clinical study/ Cert. of Physical Exam 391.43
6	Hearing	Exam during clinical study/ Cert. of Physical Exam 391.43
7	Blood pressure (cholesterol level)	Exam during clinical study
8	Heart rate	Exam during clinical study
9	Snoring	Exam during clinical study
10	Coronary heart disease (yes/no)	Self-reported driver survey
11	Hypertension (yes/no)	Self-reported driver survey
12	Diabetes (yes/no)	Exam during clinical study/ Cert. of Physical Exam 391.43
13	Sleep apnea (yes/no)	Exam during clinical study
14	Risk of sleep apnea	Exam during clinical study
15	Awareness of sleep apnea (yes/no) (If yes, is driver treating it? yes/no)	Self-reported driver survey
16	Sleeping patterns – narcolepsy (yes/no)	Self-reported driver survey
17	Sleeping patterns – number of hours of sleep/night	Self-reported driver survey
18	Sleeping patterns - driver's assessment of frequency of napping during the day	Self-reported driver survey
19	Sleeping patterns - driver's assessment of frequency of falling asleep at the wheel	Self-reported driver survey
20	Caffeine usage	Self-reported driver survey/urinalysis
21	Alcohol usage (not necessarily while driving)	Self-reported driver survey/urinalysis
22	Prescription/over the counter (legal) drug use	Self-reported driver survey
23	Smoking (yes/no), if smoke, amount of smoking in a week.	Self-reported driver survey
24	Reaction time based on response time to stimuli, frequency of lapses, and slowing of responses over period of testing.	Psychomotor Vigilance Test (PVT) during clinical study
25	Body-mass index (BMI)	Calculation
26	Alertness measures (Stanford Sleepiness Scale)	Clinical study
27	Alertness measures (Multiple Sleep Latency Test)	Clinical study
28	Other cognitive performance tasks	PC simulation test
29	Other driving performance measures	Low-cost PC-based simulator

Table 9. Required crash (and control) data

	Crash and Trip Variables	Data Acquisition Method
1	Type of crash/near miss	Police report (if available)/fleet records
2	Event prior to crash (e.g., another accident ahead; blinding light, etc.)	Police report (if available)/fleet records
3	Severity of accident	Police report (if available)/fleet records
4	Number of vehicles involved	Police report (if available)/fleet records
5	Number of pedestrians involved	Police report (if available)/fleet records
6	Condition of the road (wet, dry)	Police report (if available)/self-report trip survey
7	Ambient light condition (day, night)	Police report (if available)/fleet records
8	Roadway illumination (yes/no)	Police report (if available)/fleet records
9	Type of crash/near miss	Police report (if available)/fleet records
10	Prior experience on road where crash/trip occurred	Fleet records/self-report trip survey
11	Roadway alignment (curved road, straight)	Police report/self-report trip survey
12	Roadway class (divided, undivided; if undivided, # of access points)	Police report/self-report trip survey
13	Number of lanes on roadway	Police report/self-report trip survey
14	Time of accident (or trip)	Police report/self-report trip survey
15	Date of accident (or trip)	Police report/self-report trip survey
16	Day of week of accident (or trip)	Police report (if available)/fleet records
17	Posted speed limit on roadway	Police report (if available)/fleet records
18	Number of consecutive driving hours for the trip period (if crash, number of hours prior to crash) [1]	Fleet records
19	Record of driving and duty time for the 7 days prior to the day of crash (record of driving and duty time for the 7 days prior to a trip) [1]	Fleet records
20	Number of hours off-duty prior to the current duty cycle[1]	Fleet records
21	Months and years driving vehicle	Fleet records
22	Months and years driving type of vehicle	Fleet records/self-report trip survey

[1]Variables from Paul Jovanis' *Hour of Service and Crash Risk Study*, 2001.

The medical conditions identified in Table 8 are based on previous research that suggested an increase in accident risk due to the condition. For example, studies have shown that those with sleeping disorders (untreated sleep apnea and narcolepsy) are more likely to be at risk for vehicular accidents (Aldrich, 1989; Broughton, 1976; George, Nickerson, Hanly, Millar, & Kryger, 1987; Young et al., 1997). However, if a driver is being treated for sleep apnea, their risk of being involved in an accident is greatly reduced (Cassel et al., 1996; George, 2001). Therefore, variables on their awareness of the condition, as well as their treatment of the condition, are included.

The driver's sleeping patterns can also be an accident risk. For example, Haworth, Vulcan, Schulze, & Foddy, and NTSB have identified a relationship between truck accidents and driver fatigue as well as between accidents and alcohol and drug use (1997, 1990). Arnold et al., and McCartt, Rohr Baugh, Hammer, & Fuller, have also studied drivers who fall asleep behind the wheel due to fatigue and found an increased risk for vehicle accidents among this group (1997, 2000). Data from SafeStat indicates that among the interstate, for-hire drivers, the largest cause of accidents due to driver-conditions are fatigue and falling asleep at the wheel. Additional SafeStat data is included in Appendix D.

McCartt et al. also identified accident risks associated with hypertension, and diabetes (2000). A higher accident risk for drivers with diabetes is also supported by the findings of Dionne, Desjardins, Laberge-Nadeau, & Maag (1995). These studies would support FMCSA Section 391 that indicates that drivers are not allowed to operate a motor vehicle if they have been identified as insulin-dependent diabetics. However, Mathiesen & Borch-Johnsen showed that the risks of accidents and permanent disability are not increased in persons with diabetes (1997). The case-control study will collect additional information to investigate the divergent findings.

Other variables of interest include colorblindness where studies have indicated that anywhere between 8-10 percent of males has some degree of colorblindness (Rigden, 1999). Color blindness and other visual defects (e.g., visual acuity, field of vision) are typically tested for commercial drivers under Section 391 of the FMCSR. The medical exams conducted for Section 391 should be available from the participating fleet.

Although more variables could have been included, this study is targeting the major causes of crashes based on the existing literature. Further, some variables will not be used (e.g., tire treads, type of illumination) due to the difficulty of obtaining the information in a cost-effective and timely manner for both the cases and controls in the study. Other variables were deemed infeasible due to the limited number of data points that may be available for that variable during the study period.

3.3.2 Data collection process

The data variables will be collected at various points throughout the study. Once drivers agree to participate in this study, steps such as those outlined below can be taken to collect the required information.

Step 1. Drivers agree to participate in study.

Step 2. Drivers sign consent forms and fill out (at home):

- Biographical questionnaire
- Take-home medical questionnaire similar to the Sleep Score Questionnaire used by Pack (2000). An example is provided in Appendix C.

Step 3. Researcher gathers previous driving records (i.e., accidents and moving violations) from one or more of the following sources, depending on availability and quality of information:

- The driver's motor carrier firm
- Insurance company records
- National Highway Traffic Safety Administration-held state data (available for 17 states)
- State records available from state departments or DMVs

- CDLIS: A nationwide linkage of state driver license systems; it allows quick access to license status and violation history for any CDL driver in North America. CDLIS is used during roadside inspections to identify drivers with revoked, suspended, or bogus licenses (Inspector On-Line Services, 2001).
- MCMIS: The national data warehouse of safety performance information on over 350,000 interstate motor carriers, MCMIS is the authoritative source of safety information used to drive National Motor Carrier Safety programs and to feed other information systems (Inspector On-Line Services, 2001).

Step 4. Researcher schedules the participants for a clinical study that will require an overnight stay. Approximately 20 drivers every week will participate in the clinical study. Therefore, if there are 1,000 participants, this will take approximately 50 weeks or one year. During the clinical study, information will be collected from drivers in the following time sequence:

(Day 1) 8:30 p.m.: Drivers arrive and receive a briefing by researcher; a packet of information is distributed.
8:40 p.m.: Two-page trip questionnaire is filled out.
8:55 p.m.: One-page (8-item questionnaire) Epworth Sleepiness Scale is filled out [to assess the degree of self-reported sleepiness).
9:00 – 9:15 p.m.: Break.
9:15 – 10:00 p.m.: Drivers undergoes a physical that includes BMI assessment, neck circumference, weight, blood pressure. The information will be used for the multivariable apnea prediction (MAP) discussed in the Data Analysis section.
10:00 p.m.: Driver is prepared for sleep. Brain activity, heart rate, oxygen level, and breathing will be monitored.

(Day 2) 8:00 –9:00 a.m.: Drivers awake. Conduct urinalysis.
9:00 – 9:30 a.m.: Continental breakfast.
9:30 a.m. – Noon: Each driver will need
10 minutes for the PVT,
~30 minutes for Divided Attention Driving Task (DADT),
~ 30 minutes for other performance measures using a low-cost PC-based simulator.
Noon – 1:00 p.m.: Lunch.
1:00 p.m.: Debriefing and payment.

The Epworth sleepiness scale, sleep tests, and questionnaire on sleepiness used in this study will be similar to the scales and tests used by Pack (2000).

A subcontractor may be needed to help facilitate the data collection process. If this is deemed necessary, a solicitation will go out for a data collection group.

3.4 DEVELOP DATABASE

The information collected will be placed into a relational database designed at the Volpe Center. The exact attributes for each variable in the study will need to be determined before the data structure is designed.

The relational database to be designed will have several components:

Persons file: This database will include all biographical and socioeconomic information on each driver. This information should be collected at the beginning of the study.

Medical file: This database will include all pertinent medical data on the driver; including data reported per Section 391 and collected from the sleep clinic.

Accident (Case) file: Although it is highly unlikely, a driver might be involved in more than one accident. If this occurs, separate records will be collected on each accident including any related trip information. This information will be used for the cases.

Trip (Control) file: This file will contain information that will be used for non-accident trips.

3.5 ANALYZE DATA

The analysis will reflect answers to several research questions including what driver characteristics contribute to truck-driving accidents, and what is the relative risk of a truck driver being involved in an accident if they had one of those driver characteristics (i.e., sleep apnea, diabetes, are older, are overweight, etc). The Volpe Center will develop a set of hypotheses to address these risk factors.

3.5.1 Preliminary analysis

The Pack study provides a valuable source of information for the case-control study. Pack's study explored sleep characteristics of truck drivers and his methodology provides the basis for the overnight portion of the case-control study. Variables of interest collected by Pack include age, type of commercial driver, driving schedule, use of alcohol and drugs, sleep measures (e.g., collar size, BMI, snoring, self-reported sleepiness), and measures of cognitive load (driving errors, decrement in tracking performance over time). His study assessed the cognitive load in a simulated driving test by determining how driver performance is impacted if the driver was at a high- or low-risk for sleep apnea.

Assuming that data from Pack's study is available, the researchers at the Volpe Center would like to investigate the characteristics of crash-involved drivers to non-crash-involved drivers and supplement these findings with the analysis already conducted by Pack. Although Pack did not identify the number of driving accidents by participants in his study, he did give drivers questionnaires that assessed the type of schedule and operations the commercial driver had (e.g., type of vehicle, amount of driving, and normal work time of day) in addition to determining a driver's reaction time. Variables included in this study will be compared to the variables retrieved for the subjects used in Pack's study.

3.5.2 Multivariable apnea prediction

In this study, MAP, based on Pack, will also be calculated to assess likelihood of having sleep apnea (age, gender, BMI) (2000). Pack's equation is defined as:

$$MAP=e^x(1-e^x) \qquad [Eq. 3]$$

where $x=-8.160+(1.299*\text{Index 1})+(0.163*\text{BMI}) - (0.028*\text{Index 1 BMI})+ (0.032*\text{Age}) + (1.278*\text{Male})$

Index 1 = the computed mean of the responses to questions about sleeping. These questions correspond to those shown in Appendix C.

BMI=Body Mass Index to be assessed at the overnight study.

Male=1 if subject is a male or 0 if subject is a female.

3.5.3 Analysis techniques

The analysis of the data will be conducted in several ways. Estimation of odds-ratios will be calculated to determine the relative risks of accidents given specific driver characteristics. Other statistical techniques will also be used to support the estimation of the odds-ratio as well as validate the findings. This will include the use of logistic regression techniques as exemplified in Appendix A, as well as descriptive statistics (mean, standard deviation, etc.), and cross tabulations.

3.6. DOCUMENT FINDINGS

The final step in the process will be to document all the information collected and analyzed. An interim report will be provided to FMCSA and will include the preliminary analysis conducted with Pack's data. The final draft will include all the data analysis from the information collected by the drivers and motor carriers. This draft will go to FMCSA Research and Technology for review. Other organizations will review the document once the report is finalized.

4. SCHEDULE

The following schedule is proposed for the tasks need to accomplish this plan:

Task	Start Date	End Date
1. Submit final study plan	10/01/01	11/30/01
2. Conduct preliminary data analysis with Pack data	01/15/02	05/31/02
3. Prepare and submit interim report based on Pack analysis	06/01/02	07/31/02
4. Prepare documentation for and receive approval from a subject use review group	11/01/01	04/15/02
5. Prepare a statement of work and submit solicitation for independent data collectors and support organizations	12/17/01	02/28/02
6. Award contract for independent data collector and other support organizations	03/01/02	04/30/02
7. Prepare a statement of work and submit solicitation for potential carriers for study	02/28/02	04/30/02
8. Volpe Center selects carriers for study	06/01/02	07/31/02
9. Prepare and coordinate carrier partnership agreements	02/01/01	08/30/02
10. Select driver volunteers	07/01/02	09/30/02
11. Recruit and coordinate agreements with drivers	08/01/02	10/15/02
12. Prepare initial surveys	03/01/02	10/15/02
13. Distribute initial surveys to drivers	08/15/02	10/30/02
14. Get prior driving records from carrier	08/01/02	11/15/02
15. Prepare data requirements/forms for medical study	10/01/01	11/15/02
16. Conduct laboratory data collection	12/01/02	12/15/03
17. Develop attribute list for database	06/01/02	07/31/02
18. Develop database	08/01/02	11/15/02
19. Input study data into database	11/15/02	01/15/04
20. Conduct preliminary data analysis	03/01/03	06/01/03
21. Submit preliminary analysis report	06/01/03	08/30/03
22. Conduct data analysis	08/30/03	04/15/04
23. Submit draft final report	10/01/03	07/15/04
24. Prepare final report	05/01/03	09/30/04

5. COSTS

The following are the identified cost elements for this study:

1. Clinical study facility. (space rental for approximately 50 weeks; 2 days/week). This facility will need to be accessible to the researchers day and night and be large enough to accommodate 10–20 beds for 10–20 drivers every night (10 drivers on one night and 10 drivers on the next night, or 20 drivers in one evening, depending on available space). A medical facility is preferred, but not required. However, the facility needs to be able to accommodate the use of medical equipment.
2. Simulator cost. To assess the driver's reaction time, attention on the road, and overall driving performance, a low-cost, PC-based simulator will be used. Some comparable tools include those developed by WayPoint Research Inc. and Systems Technology, Inc. These and similar tools will be investigated for cost, and applicability to this study.
3. Other equipment. It is highly probable that the rented facility will not be equipped with the type of medical equipment needed. Therefore, sleep monitoring equipment and beds will be needed.
4. Physician's time (approximately ½ hour with each driver). It is expected that a physician (or medical professional) is not needed the entire time that a driver is participating in the sleep study. But the physician will need to spend approximately ½ an hour with each driver's information and, if any medical follow-ups are needed, the driver will be referred to his own attending physician. A researcher working with the physician will be at the sleep clinic at all times while the drivers are there.
5. Driver's incentive. It is expected that approximately 1,000 drivers will be compensated for their time in the study. This will include a monetary incentive, as well as meals during the clinical study.
6. Fleet's incentive (for approximately 10-20 carriers). Although it has not been discussed in any detail, an incentive may need to be provided to the fleet to encourage their participation in this study. It may not necessarily be a monetary amount, but the time invested by the fleets (i.e., to obtain records for the researchers and assist in the identification of drivers) may need to be compensated.
7. Travel. Depending on how the study is set up, the medical physician and research team may need to travel to various locations to set up the sleep study and to get and coordinate information from the carriers and drivers.
8. Surveys (design, printing, and bulk mailing). There will be a cost in the design and printing of the surveys and questionnaires administered in this study. Further, some of the surveys (e.g., the initial biographical data) may be designed as mail-backs. If that is the case, there will be a cost for bulk mailing.
9. Subject use review group fee. An Institutional Review Board will need to review the study methodology and approve the use of subjects in the manner that will be considered.
10. Legal fees (for agreements). The agreements and consent forms may need to be reviewed by attorneys to ensure that all issues regarding liabilities are covered.

11. Computer programming fees. For the database development.

12. Data collector/test administrator. This person will be responsible for collaborating the data and administering the test procedures during the clinical portion of the study.

13. Data input. Given the amount of data expected from this study, a data entry person may be hired to input all the data.

14. Researchers' fees. For the coordination of the fleet and driver participation, design and development of the surveys and tests, coordination of the sleep clinic studies, validation of the database design, data analysis, and documentation.

6. SUMMARY

The case-control methodology is designed to collect information on drivers who are and are not involved in accidents. This database of information will form the basis for analyzing the relative risk of being involved in a large truck accident. It is anticipated that this study will be conducted over a two-year period. The first phase of the study will involve the coordination of efforts with the organizations and individuals involved. This will include the insurance companies, police and state departments, medical professionals, motor carriers, and participating drivers. The second phase will include the collection of data from self-reported surveys, previous driving records, and information from an overnight study. The data will be analyzed using various statistical techniques and presented in an FMCSA document. The results of this study will help provide a better understanding of truck crashes and enable corrective actions to be developed that will reduce the number of commercial motor-related fatalities.

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APPENDIX A. LOGISTIC REGRESSION AND ODDS-RATIOS

A.1 INTRODUCTION

The purpose of this analysis is to demonstrate how information from a case-control study would be analyzed. It is important to understand that the case-control methodology defines how the data is to be *collected* and the logistic regression shows how the data is to be *analyzed.*

This is an example of how logistic regressions are used to obtain odds-ratios. The 1999 GES database was used for the analysis. This relational database is separated into three parts consisting of a persons file, vehicle file, and accident file. The analysis was conducted on the persons file only and within the persons file, only motorist information (drivers and passengers) was used. Non-motorists and unknowns were excluded.

A.2 PURPOSE OF ANALYSIS

A logistic regression looks at a conditional probability or the likelihood of obtaining a binary response (yes/no situations such as accident/no accident, alcohol/no alcohol). The logistic regression for this analysis was set up to look at the risk of being involved in a severe injury given that an accident occurred (the GES database contains accident information only; there is no non-accident information).

In this case, the response variable is:

1 if the motorist had a severe injury (incapacitating or fatal injury as defined by INJ_SEV = 3,4),

0 otherwise (includes non-injuries and other types of non-incapacitating and non-fatal injuries).

In other words, what is the probability of having a severe injury in a motor vehicle accident?

If all significant variables are not included, the estimated parameters may overinflate the risk of getting into a severe injury accident if the effect of that parameter will vary based on an ignored variable. If that parameter is not impacted by other variables, the calculations for the odds-ratio could be simplified using a 2x2 matrix.

This is exemplified in the following two models.

MODEL 1

If only the effect of seatbelt usage and drowsy driver was used in the model, the logistic regression estimate (using SAS (Statistical Analysis Software)) is:

$$\text{Pr(Severe Injury)} = -2.82 - 1.15\ \textit{Seatbelt} + 1.68\ \textit{Drowsy} \qquad \text{[Eq. A1]}$$

where

Seatbelt equals 1 if a seatbelt was used, 0 otherwise.

Drowsy equals 1 if the person was identified by a police officer as drowsy, fatigued, or asleep, 0 otherwise.

Each parameter (seatbelt and drowsy) was identified as being statistically significant at the 95 percent confidence level. The important thing to note is the sign (+ or -) of the coefficients. For example, seatbelt has a coefficient of –1.15. This means that people who have their seatbelt on are less likely to get into a severe injury in an accident. On the other hand, drowsy drivers are more likely to get into a severe injury accident.

The odds-ratio for these parameters based on this equation is as follows:

Seatbelt	0.32	(95 percent CL: 0.31, 0.32)
Drowsy	5.36	(95 percent CL: 5.24, 5.48)

These numbers are derived from the "anti-log" of the logistic regression model above. That is, since the coefficient of Seatbelt (–1.15) is the logs odds-ratio of seatbelt, or

$$ln[\text{odds-ratio}] = -1.15 \qquad \text{[Eq. A2]}$$

then the anti-log, or

$$e^{-1.15} \text{ (or } e^{\ln[\text{odds-ratio}]}\text{)} = 0.32. \qquad \text{[Eq. A3]}$$

Since this odds-ratio is under 1, this indicates that seatbelts help reduce your risk of a severe injury in an accident. On the other hand, if you are a drowsy driver, your odds of getting into a severe accident are 5.36 to 1.

MODEL 2

If more explanatory variables are included in the model (age, alcohol usage, female drivers), the logistic regression model now looks like this:

$$\text{Pr(Severe Injury)} = -3.01 - 1.11\ \textit{Seatbelt} + 1.49\ \textit{Drowsy} + 1.30\ \textit{Alcohol} + 0.24\ \textit{Female Driver} + 0.38\ \textit{Older} \qquad \text{[Eq. A4]}$$

where

Seatbelt equals 1 if a seatbelt was used, 0 otherwise,
Drowsy equals 1 if the person was identified by a police officer as drowsy, fatigued, or asleep, 0 otherwise,
Alcohol equals 1 if alcohol was involved, 0 otherwise,
Female Driver equals 1 if the person was the driver of the vehicle and a female, 0 otherwise, and
Older equals 1 if the person was 65 years old or older, 0 otherwise.

All variables were significant at the 95 percent confidence level.

The odds-ratio for these parameters based on this equation is:

Seatbelt	0.33	(95% CL: 0.33, 0.33)
Drowsy	4.44	(95% CL: 4.34, 4.55)
Alcohol	3.68	(95% CL: 3.64, 3.72)
Female Driver	1.28	(95% CL: 1.27, 1.29)
Older	1.47	(95% CL: 1.45, 1.48)

Consistent with the first model, seatbelt usage reduces your risk of a severe injury, and drowsy drivers have an increase risk of a severe injury. However, now that other variables are included in the model, the odds-ratio of drowsy driver is not as great as in the first model. In Model 1, the odds of having a severe injury if you were a drowsy driver was 5.4 to 1. With the inclusion of alcohol, older drivers, and female drivers, the odds are now 4.4 to 1.

DISCUSSION

The two models designed in this paper used the 1999 GES *persons* file only. Other parameters could have been estimated from the *vehicle* file and *accident* file and may be done in a later paper. However, the purpose of these analyses was to show how information from a case-control study could be analyzed. These two models show us the importance of including all potential predictor variables. It is better to include more variables and filter out the ones that are not significant by looking at either the t-statistic or the chi-square. If a predictor variable is not significant, this will normally be identified in the output generated by many statistical packages (including SAS, SST (Statistical Software Tools), STATA).

When significant variables are overlooked, information can be lost and the impact of parameters can be over or under estimated. This was exemplified in the two models. Model 1 assumed that only seatbelt usage and drowsy drivers impact the severity of injury in an accident. Model 2 showed that this was not a correct assumption since the coefficient for drowsy driver was impacted by other variables.

Seatbelt usage showed a consistent result in both models. This suggests that seatbelts will result in a less severe injury regardless of other factors. If there are no other confounding variables, a single 2x2 table could have been used to show the odds-ratio calculations. To demonstrate this, the cross tabulation of seatbelt and severe injury from the 1999 GES database is provided in the following table:

Table A1. Matrix of seatbelt use and severe vehicle accidents

	Risk Factor	
	Seatbelt	No Seatbelt
Case (Severe Injury)	234,400	161,475
Control (Non-Severe Injury)	12,220,000	2,652,479

The odds-ratio can be calculated as:

$$Odds-Ratio: \frac{Odds(SevereInjury\ with\ SeatbeltUse)}{Odds(SevereInjury\ without\ SeatbeltUse)} = \frac{\frac{234400}{12220000}}{\frac{161475}{2652479}} = 0.32 \qquad \text{[Eq. A5]}$$

As one can see, this odds-ratio estimate is comparable to the estimate derived in Model 1 and Model 2. This indicates that seatbelt is, indeed, a variable that is not confounded by other parameters. That is, if you wear your seatbelt, you are more likely to have a less severe accident.

APPENDIX B. SAMPLE INFORMED CONSENT FORM

CASE-CONTROL CRASH RISK STUDY

I, ________________________, agree to participate in the Volpe National Transportation Systems Center (Volpe Center) study of motor carrier driver crash risk factors.

I have been informed that the Volpe Center, in collaboration with the U.S. DOT Federal Motor Carrier Safety Administration (FMCSA), is conducting a study to identify conditions that may impact driving safety. The purpose of the study is to determine, over a wide variety of drivers and travel demands, why accidents may occur on some trips and not on others.

The Volpe Center will conduct studies on each participant that will include an overnight stay at a laboratory facility and a physical examination. Information to be collected will include previous trip and driver information.

I understand that as a participant, I freely agree to take part in the study, understanding that it involves: (1) completing an initial survey; (2) completing a questionnaire on selected trips; and (3) taking part in a single comprehensive, overnight physical exam.

I understand that my participation is entirely voluntary and that I may refuse to answer any questions if I choose, or may withdraw my consent to participate at any time without penalty. In general, the information I provide will be treated with complete confidentiality and without disclosure outside the study team. My name will not be retained in the experimental database, released to anyone not on the study team, or appear in any reports or papers written about the project. Summary results that are not individually traceable, may be available to the participating carriers or statewide trade organizations on a fleet-wide or geographic basis.

I will be paid $250 for participating in this study, payable after completion of the study.

I understand that I may ask any questions I have about the study at this time. If I have further questions about this study I may contact:

Linda Boyle, Ph.D., DOT Volpe Center
Accident Prevention Division, DTS-73
55 Broadway, Cambridge, MA 02142
Phone: (617) 494-3604

________________________	________________________
Participant's signature & date	Interviewer's signature & date

1 copy for participant, 1 copy for interviewer

APPENDIX C. TAKE-HOME QUESTIONNAIRE[5]

On average, how many days/nights during the last month have you had, or been told to do the following WHILE ASLEEP OR TRYING TO SLEEP (check one per row)

	(0) Never	(1) Rarely (less than once a week)	(2) Sometimes (1-2 times per week)	(3) Frequently (3-4 times per week)	(4) Always (5-7 times per week)	(888) Do not know
1.Wheeze or whistle from your chest						
2.Chest pain while in bed						
3.Needed to wake up from sleep to use toilet 2 or more times						
4.Lying awake during your sleep time feeling worried, depressed, or sad						
5.Lying awake during your sleep time with thoughts racing through your mind						

Over the last month, how frequently have you experienced DISTURBED SLEEP because of the following (check one per row)

	(0) Never	(1) Rarely (less than once a week)	(2) Sometimes (1-2 times per week)	(3) Frequently (3-4 times per week)	(4) Always (5-7 times per week)	(888) Do not know
6. Pain or physical discomfort						
7. Noise						
8. Heartburn during sleep time						
9. Indigestion during sleep time						

10. In what position do you normally sleep?

1) My back
2) My side
3) My stomach
4) My back and side
5) My stomach and side
6) My stomach and back
7) All positions
8) Sitting up
888) Don't know

[5] Adapted from Pack, 2000.

11. If you snore, over the LAST MONTH, has your snoring usually been (check one)
1) Only slightly louder than heavy breathing
2) About as loud as mumbling or talking
3) Louder than talking
4) Extremely loud-can be heard through a closed door
5) I haven't snored in the last month
888) Don't know

For the following, please circle the number that best describes your feelings:

12. How would you rate the overall quality of your life?

1	2	3	4	5	6
Perfect health					Miserable

13. Are you hopeful that your quality of life will improve soon?

1	2	3	4	5	6
Things will totally improve					Things will never improve

14. During the past month, how would you rate your level of energy?

1	2	3	4	5	6
Fresh as a daisy					Tired to death

SMOKING HISTORY

15. Have you ever smoked cigarettes? (NO means less than 20 packs in a lifetime, or less than one cigarette a day over a year) 1) YES 2) NO

If NO, skip to 21, if YES, continue:

16. How old were you when you first started regular cigarette smoking? Age in years __________

17. On average, over the entire time you smoked, how many cigarettes did you smoke per day?
Cigarettes per day ______________

18. Over the last month, have you smoked at least one cigarette per day? 1) YES ___ 2) NO ____

19. If YES to question 18, approximate number of cigarettes per day ______________

20. If NO to question 18, How old were you when you stopped smoking? Age in years __________

USE OF ALCOHOL

21. Current Use: During the past month, how many drinks per week have you had?

Wine _________ Beer ______________ Spirits __________ Total _______________

22. During the past month, on how many days per week have you had at least one drink?

Please circle one of the following numbers: 0 1 2 3 4 5 6 7

APPENDIX D. SAFESTAT DATA

Table D1. Distribution of crashes by trafficway type for interstate and intrastate carriers, further differentiated by for-hire vs. private operations

	Interstate				Intrastate			
	For-hire		Private		For-hire		Private	
Type of Trafficway	Number	%	Number	%	Number	%	Number	%
Undivided	28,958	27.8	11,814	41.7	874	53.6	1,221	59.0
Divided[1]	48,339	46.4	9,078	32.1	487	29.9	511	24.7
Other and unknown[2]	26,775	25.7	7,412	26.2	269	16.5	337	16.3
Total	**104,072**	**100.0**	**28,304**	**100.0**	**1,630**	**100.0**	**2,069**	**100.0**

Notes

[1] Divided highway with median strip, with or without traffic barrier.

[2] Includes one-way trafficways, and other and unknown trafficways.

Table D2. Distribution of crashes by road surface condition for interstate and intrastate carriers, further differentiated by for-hire vs. private operation

	Interstate				Intrastate			
	For-hire		Private		For-hire		Private	
Road Surface Condition	Number	%	Number	%	Number	%	Number	%
Dry	68,758	66.1	19,789	69.9	1,264	77.5	1,563	75.5
Slippery[1]	19,258	18.5	4,942	17.5	246	15.1	332	16.0
Other and unknown	16,056	15.4	3,573	12.6	120	7.4	174	8.4
Total	**104,072**	**100.0**	**28,304**	**100.0**	**1,630**	**100.0**	**2,069**	**100.0**

Notes

[1] Includes: wet; ice; snow or slush; and sand, mud, dirt, or oil.

Table D3. Distribution of crashes by weather condition for interstate and intrastate carriers, further differentiated by for-hire vs. private operation

	Interstate				Intrastate			
	For-hire		Private		For-hire		Private	
Weather Condition	Number	%	Number	%	Number	%	Number	%
Clear	69,470	66.8	19,942	70.5	1,215	74.5	1,566	75.7
Adverse[1]	21,005	20.2	4,753	16.8	226	13.9	298	14.4
Other and unknown	13,597	13.1	3,609	12.8	189	11.6	205	9.9
Total	**104,072**	**100.0**	**28,304**	**100.0**	**1,630**	**100.0**	**2,069**	**100.0**

Notes

[1] Includes: rain; sleet, hail; snow; fog; severe crosswinds; and blowing sand, soil, dirt, or snow.

Table D4. Distribution of crashes by light condition for interstate and intrastate carriers, further differentiated by for-hire vs. private operation

	Interstate				Intrastate			
	For-hire		Private		For-hire		Private	
Light Condition	Number	%	Number	%	Number	%	Number	%
Clear	62,319	59.9	20,555	72.6	1,306	80.1	1,690	81.7
Adverse[1]	31,862	30.6	5,261	18.6	268	16.4	279	13.5
Other and unknown	9,891	9.5	2,488	8.8	56	3.4	100	4.8
Total	**104,072**	**100.0**	**28,304**	**100.0**	**1,630**	**100.0**	**2,069**	**100.0**

Notes

[1] Includes: dark, not lighted; dark, lighted; dawn; and dusk.

Table D5. Distribution of crashes by driver condition for interstate and intrastate carriers, further differentiated by for-hire vs. private operation

	Interstate				Intrastate			
	For-hire		Private		For-hire		Private	
Driver Condition	Number	%	Number	%	Number	%	Number	%
Appeared normal	81,210	78.0	22,151	78.3	1,136	69.7	1,482	71.6
Had been drinking	541	0.5	137	0.5	5	0.3	10	0.5
Illegal drug use	164	0.2	42	0.1	6	0.4	3	0.1
Sick	257	0.2	47	0.2	3	0.2	1	0.0
Fatigue	801	0.8	104	0.4	4	0.2	4	0.2
Asleep	869	0.8	181	0.6	4	0.2	5	0.2
Medication	113	0.1	28	0.1	4	0.2	0	0.0
Other and unknown	20,117	19.3	5,614	19.8	468	28.7	564	27.3
Total	**104,072**	**100.0**	**28,304**	**100.0**	**1,630**	**100.0**	**2,069**	**100.0**

Table D6. Frequency of occurrence of specific driver violations. Distribution for different carrier categories (1998-2001)

		Interstate Carriers		Intrastate Carriers	
Violation Codes	Violation Description	For-hire	Private	For-hire	Private
39111B4, 39111B6	Driving without corrective lenses	2,262	923	33	60
39141, 39141A	No medical certificate	86,092	77,720	2,720	4,764
39143E, 39143F, 39143G	Improper medical exam form/certificate	13,378	7,464	285	695
39145, 39145B, 39145B1	Expired medical exam/certificate	29,695	19,561	955	1,245
3953A1, 3953A2, 3953B	Hours of service violations	148,605	10,923	261	102

Table D7. Frequency of occurrence of crashes for driver found with specific driver violations. Distribution for different carrier categories (1998-2001)

Violation Codes	Violation Description	Interstate Carriers		Intrastate Carriers	
		For-hire	Private	For-hire	Private
39111B4, 39111B6	Driving without corrective lenses	249	47	2	1
39141, 39141A	No medical certificate	7,240	2,596	151	149
39143E, 39143F, 39143G	Improper medical exam form/certificate	1,319	436	21	22
39145, 39145B, 39145B1	Expired medical exam/certificate	3,260	1,247	71	49
3953A1, 3953A2, 3953B	Hours of service violations	16,026	838	28	6

APPENDIX E. MEETING WITH U.S. XPRESS AND U.S. DOT – VOLPE CENTER

Date: March 20, 2001 – March 21, 2001

Location: U.S. Xpress, Chattanooga, Tennessee

Attendees: Russ Moore, Vice President of Operations and Safety (U.S. Xpress)
Wally White, Director of Safety (U.S. Xpress)
Marty Fletcher, Director of Technology (U.S. Xpress)
(Volpe Center – Accident Prevention Division)
Linda Boyle, Neil Meltzer, Bruce Wilson, and Jonathan Koopmann

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Objective of Meeting

The primary purpose of this meeting was to inform and discuss with U.S. Xpress [USX] the issues pertaining to the Case-Control Crash Risk Study. As a secondary objective, the Volpe Center wanted to share information on the Volvo/U.S. Xpress VORAD pilot tests as well as discuss drowsy drivers research issues.[6] The slides presented at this meeting are attached.

The meeting started off with a presentation of the Case-Control Crash Risk Study by Linda Boyle. An overview of the study's goals and objectives were presented followed by the issues involved in the study. After this was complete, a discussion of the issues began. This memorandum begins with a general overview of U.S. Xpress followed by a discussion of the issues involved with the Case-Control Crash Risk Study.

Overview of U.S. Xpress

U.S. Xpress is headquartered in Chattanooga, Tennessee, and has six service centers throughout the nation. It employs approximately 6,500 drivers, of which 1,000 are employed as a team (husband/wife, father/son, partners, etc.). Turnover rates are typical for the industry (approximately 115%). There are approximately 4,300 U.S. Xpress owned trucks and 700 owner operated vehicles. They are considered a truckload carrier (rather than a less-than-truckload carrier) which means the trucks have one complete load on departure. They ship for many major companies including Federal Express and Lowe's Hardware Stores.

Discussion of Case-Control Study Issues

<u>Subject Population</u> - Need to identify the driver participants for the study.

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[6] The meeting held with U.S. Xpress was used to accomplish two goals. One was to identify the feasibility and willingness of the firm to participate in the Case-Control Study and the other was related to the Eaton-VORAD project and Drowsy Driver project (separate studies being conducted at the Volpe Center). Therefore, information on the other study is recorded in these meeting minutes as well.

Type of trucking firm - Should it be state, regional, or national?

[RM] USX is in the process of taking the business and breaking it into smaller business units; therefore, there will be a regional, customer-based, and over-the-road unit. This should be transparent to customers. Each business unit will have separate general managers and each unit will need to measure accidents, file claims, and assign costs and accountability.

[LB and RM] If a collaborative agreement was to be established with USX and FMCSA (Federal Motor Carrier Safety Administration) for this study, all data will still be available at a corporate level.

Type of drivers - Union or non-union?

[RM] USX has all non-union drivers, typical for truckload carriers.

Type of drivers - Minimum licensing criteria?

[RM] All USX drivers must have a Class A CDL, HazMat endorsement.
[RM] Turnover – 115% turnover. Has been 80-90% in past. They train many drivers (approximately 100-150 drivers per week). However, not all drivers succeed after training. The company is currently transitioning from six weeks with driver-trainer to more training time for the trainers themselves. Drivers need six months experience before being considered an "experienced driver."

Representative sample

[LB] One fleet? Multiple fleets?
[LB] Length of time with employer could be factor.
[RM] Would like study to be multiple fleets. Speeds, experience, training, miles, region (weather!) varies with fleet. Different trucking firms have different training methods as well. For example, J.B. Hunt dropped training and employs only experienced drivers.

Sample size

[LB] We are considering 500 to 1,000 participants – Does that seem like a reasonable request from a fleet?

(The following is a summary of the discussion of the related projects USX are involved in. This was provided to give us an indication of the number of participants in each project.)

[MF] USX is active in other government and university sponsored projects. For example, currently, the IVI project is their largest project with 50 control units in revenue generating service. There exist problems with DAS (data acquisition system), and USX is working on resolving these issues. Eventually, 100 tractors will participate in study. There are other projects with Tennessee Oak Ridge National Lab (working with Tykey Truett or ORNL) - six units with rollover detection. USX also looks at real-time load shifting with three tractors, six trailers. With University of Tennessee, investigating transmitting devices near dangerous curves. They also provide accident and maintenance data to Battelle. Will do lightweight component testing with Volvo. Also will be involved in a drag coefficient study with Georgia Tech.

Length of study - 2 or 3 years?

[LB and RM] These time periods are fine, but don't expect same driver for this time frame. In a case-control study, the sample population can be set up as an open cohort where drivers can come "in and out" of a study.

<u>Data Requirements</u> - Need to identify all potential crash causal factors.

[LB] We have identified variables to include in this study. However, we want to include variables that industry has identified as potential crash risk factors. These variables are separated into major categories.

Medical data - Physical examination
(e.g., weight, vision, sleeping disorders, diabetes)

[WW] All new drivers need DOT physicals per Section 391 (U.S. DOT requirement). Other drivers need physicals every two years. Some drivers need re-certification more frequently. For example, those who have a known medical problem but have been approved to drive need to have physical more frequently. This data would only be shared with the driver's consent. If this information is needed for the study, agreements will need to be established beforehand.

Medical data – Initial survey
(e.g., caffeine usage, sleeping patterns)

[RM] – As discussed earlier, a bigger group makes it tougher to collect this data. It is more manageable for the trucking firm to allow 50 driver participants instead of 500.

Crash data

[LB] Crash data will come from several sources: Police report (reported data on incident), GIS/GPS (roadway information, time of day), Post accident surveys (driver's assessment of incident, driving conditions)

[WW] GPS unit in data logger will identify location within 100 yards or so. USX records location data for all incidents. Most trucking firms record who, what, where, when, why, how. QUALCOMM records location every 55 minutes. "911" (emergency) macro transmits truck's present location. Most large firms have QUALCOMM in trucks. Safety/claims people battle. Safety people want all data while claims people don't want potentially incriminatory data. USX have concerns that claimants' attorneys will use technology-producing data against them.

[LB] – The study will need non-crash data, too; i.e., control data.
[USX] concerned that data recorder data could be used against them. Drivers will be opposed to all this extra data taken about them. For example, drivers have disconnected Eaton VORAD units. For every satellite communication (every time drivers push a button on the QUALCOMM), there's a cost.

[MF] – It is difficult coordinating different technology devices that give early feedback before accidents. Would like to be in proactive mode, not reactive mode. Currently in a reactive mode. Note: one of the rollover units is tied to a shaker seat.

[USX] Wally White currently measures many accident factors. Drivers with less than six months at USX have more accidents. "Key crashes" – potentially serious accidents that may not be DOT-recordable, but still want to monitor cases. Drivers need to report crashes, staff available 24 hours a day.

[RM] We look at behavior, not outcome. For example, one of their drivers nicked a pergola in Seattle. (The pergola was a wrought iron structure built at the beginning of the 1900s to shelter people in downtown Seattle waiting for streetcars.) This accident resulted in $750,000 worth of damage, but it was a minor driving error. On the other hand, minor damage resulting from a major driving error is treated more seriously, as these types of errors could be more costly.

Driving characteristics - Initial survey information
(vehicle driven, years driving, years with company, time of day)

[USX] Team status (father/son, husband/wife) is a variable. They have 25% female drivers (this is a high percentage of females). There is a large demographic mixture with teams driving trucks. Recently USX hired a 74-year old trainee. Some trucks have passengers, pets, and even children. They do not like pets. QUALCOMM is a distraction, and so are CB radios, warning devices, and even passengers.

Driver has to interact with many devices in their vehicles (e.g., cell phone, pager, VORAD, smart dashboard, autoshift). Trucks are getting PCs too. They have many concerns about overloading drivers with information. Type/quantity of in-vehicle drivers should be a variable. Are acquiring truck with night vision, want it to be event activated – it only operates when it sees something that driver needs to see.

Driving characteristics - GIS/GPS
(roadway information, time of day)

[LB] Data recorder information will be needed for drivers not involved in a crash, as well as for those involved in a crash.

Demographic variables - Initial survey information
(age, children, marital status)

[WW] Recently had an immigrant driver whose limited English contributed to an incident. (He had received a ticket.)
[LB] English fluency and comprehension of drivers should probably be a factor, but how to measure?
[WW] There are different types of drivers (i.e., employees, independent contractors, drivers employed by independent contractors). Owner-operated drivers are typically at a lower risk for accidents since they tend to take better care of their own vehicle. Independent contractors tend to get riskier "flawed" drivers, since independent contractors have trouble attracting the same caliber of drivers that USX gets.

Other data requirements?

[WW] Truck maintenance may be something that we should add as a variable; and perhaps this is actually a multitude of variables. Tire tread thickness is measured after an accident. In "loss of control" type accidents, we need to consider many potential causes. Traction control should be a variable because this makes a big difference in a truck's ability to maintain traction. Drivers do daily walks around their vehicle to assess the vehicle condition. Every 30,000 miles, trucks are serviced (preventive maintenance) at their trucking service center. Teams can cover 30,000 miles in two months; solo drivers can cover 30,000 miles in three months.
[WW] What kind of accidents are we considering? Can't look at every backing accident in detail. They have a 1-800 number that receives 20 calls/week (1-800-2advice).

Agreements - Need to identify parties, relationships, and concerns

Types of agreements that will be needed?

[USX] Can't guarantee drivers immunity from things they tell us. They have "blindspots" – some data comes in without them seeing it. For example – EAP (Employee Assistance Programs) substance abuse – they can't access this data. However, agreements will be needed to ensure that litigation issues that might arise will be taken into account.
[WW] – We may need agreement with equipment manufacturers, this requires consideration. Certainly insurance company should be aware of this.

Organizations that should be involved?

[LB] We understand that there are many organizations that will probably need to be coordinated with (Fleets, American Trucking Association, Regional Trucking Associations, Trucking Insurance Brokers, Unions).
[WW] TCA (Truckload Carriers Association), CVSA (Commercial Vehicle Safety Alliance)
[MF] – Jim Britell (NHTSA) has lots of contracts with IVI participants; we can talk to him about this.

[MF] – What happens if we find product defect during study, how should this be handled? Should there be an agreement on this? For example, they have had a disabled VORAD's monitoring data. They understand that DAS data is not available to external parties. Similar agreement may be needed for case-control study (i.e., data exists, but cannot be used for incriminatory purposes).

Participation - Need to identify willingness to participate

[USX] Motor carriers will likely participate on limited scale: 25-40 drivers, but not much more. 10 fleets with 50 drivers might work. 500 drivers from same firm is overwhelming for fleet. Our effort cannot impact fleets too much, or fleets will not participate. Jim Britell knows industry, so knows what will work. Truck needs to keep moving.
Proposed study is much trickier than Eaton VORAD FOT, as we will need a lot more personal information about drivers.
[WW] – Discouraging us from studying low-level (knocking dumpster over) accidents, or we'd be overwhelmed with data. Focus on 50% reduction in fatalities.

Open discussion

[USX] Would be interested in feedback we obtain from other firms.

Eaton VORAD study and Drowsy Driver studies

At this time, Bruce Wilson presented his findings on the Eaton VORAD pilot testing and discussed new research areas in Drowsy Drivers.

Videos of the Eaton VORAD pilot tests were observed (approximately 15 minutes)

Volvo/U.S. Xpress Eaton VORAD Pilot Testing: Preliminary Results

[RM] indicated that the Eaton VORAD system needs to alert at 4 seconds (at a minimum) or 420 feet to stop (approximately 9 ft/s^2). The current alert does not provide enough time when the lead vehicle is stationary. The current alert algorithm has been enhanced to reflect various suggestions from USX.

[USX] not surprised at the results. For the target resolution, a motorcycle has a small cross section.

[USX] asked many questions about the software and hardware that was used to collect the data.
[BW] noted that the data was obtained from the DAS box, not from the Eaton VORAD unit.
[USX] recommended that DOT, if possible, collect data directly from the Eaton VORAD unit, as this would provide an unprocessed version of the original data.

Most information that the Volpe Center provided in the briefing is fairly consistent with what USX has observed. USX defines a false alert as spurious electronic signals only. An alert issued for, say, a signpost, is not false; it is considered a nuisance.

USX indicated that drivers are annoyed at nuisance alerts or variations in the size of the envelope of opportunity.

Envelope of opportunity (required reaction time and braking level): some drivers indicate that the alerts assist them; others report that the alerts do not.

Regarding the side sensor: USX measured a 12-17 degree side sensor cone. Aberdeen testing was closer to 0 degrees; that testing was essentially static. They mentioned that the sensor is a Doppler radar, which requires relative motion for detection (we measured using a slow moving car, motorcycle). Finally, USX would like a second side sensor (mounted further forward), as they believe that the sole sensor has too narrow of a FOV (field of view), and does not cover the entire blind spot.

[USX] has an onsite person to align the front CWS antenna and to check its range.

[USX] said that the peak deceleration of a truck is 9-13 ft/s^2.

[MF] found side sensor information surprising (everything else seems as expected).

Drowsy Driver Research

Topics discussed by BW included:
- Experience with drowsy driver technology
- Driver reaction to monitoring devices
- Driver schedules/flexibility

Experience with Drowsy Driver Technology

SafeTRAC Drowsy Driver/Lane Departure warning

[BW] Has U.S. Xpress used any devices?
[MF] Three Iteris devices so far: Iteris will soon supply USX with 15 devices to do an FOT. The sensors will be on board in 30 days, in conjunction with Freightliner. They have also acquired a shaker seat, which they plan to test.

[BW] Is U.S. Xpress pursuing devices?

[MF] Couple of different alert scenarios (SafeTrac) – gives display and audibles only. Not really sure what form the new 15 will be and not sure what to expect from it. From a drivers' perspective a drowsy sensor is a useful device. However, so little testing done; not enough to comment on now.

[USX] is trying to move to "cockpit scenario" with a truck PC. The device would prioritize information and present information to the driver accordingly. USX is enthusiastic about voice warnings, rather than pulse (or other) alerts.

They are installing an event-activated night vision device. System integration (not overloading the driver with information) and tamper-proof devices are both necessary.

<u>Driver Reaction to Monitoring Devices</u>

Using Eaton VORAD monitoring cards? Reaction?

[USX] does not use the monitoring cards, as they know who is driving at a given time. Drivers do not like being monitored, but (Russ Moore) says that drivers acknowledge that it is part of their job, similar to "How's my driving" stickers on the truck. Many times USX representatives stated that they would like real-time feedback regarding driver behavior. With this feedback, they could advise the driver to alter his/her behavior.

IR device (PERCLOS)

[BW] Would employer impose requirement to use IR device?
[USX] Probably. The consensus seems to be that while drivers do not like being monitored; they would accept it if it improved safety.

Driver Schedules and Flexibility
Typical schedule
For U.S. Xpress?
For Other firms?

[USX] No such thing as typical. Their schedule is varied. There are many different entities within USX with different schedules; some with dedicated runs; some with a load from NJ to SF and they have a specified number of days to deliver.

Flexibility within schedules
Can drivers stop to rest?
[USX] Yes!

Are rest areas generally available?
[USX] Not a lot of places large truck drivers can pull over; availability of safe rest areas is a big issue. Big impression on the driver is that if you are too tired, pull over. However, by 8 or 9 p.m., the rest areas are full and drivers may not find a place to stop.

PROGRAMS TO ADDRESS DROWSY DRIVER ISSUE

[USX] Operations: 2 days with two types of program - training (on what to do) and moral issues (showing video tapes of what will happen if you don't rest properly). USX broadcasts a daily "Safety Minute" regarding safety issues.

Recognition of the drowsy driver as it happens (as he/she begins to doze off) is the key! Compliance is a big issue and needs to be impressed. Driver background is typically blue collar. Their values dictate that as long as you work hard, you are a good person. This is an interesting point. A driver's value system provides him/her with a desire to keep working, even when tired.

[WW] mentioned that the regulations do not accommodate human needs. He said imagine if you quit work at 5:00 and someone tells you that you now have eight hours off. Chances are that you would like to relax, maybe exercise, eat, shower, etc. and at 11:00 rest. However, if you had to adhere to the eight hour rule, you would need to wake up at 1:00 a.m. and go to work.

[WW] Need to get the proper rest, but there are other factors that may prevent you from resting immediately when your time is done for the day (e.g., dinner, TV, shower, etc.).

[WW] Giving the driver the authorization to say no when they know it is time to stop.

[WW] Measure your waking hours instead of your sleeping hours; they might be more willing to buy into it.

[RM/WW] There have to be standards; therefore regulations need to be there. Intrastate trucks are involved in just as many accidents, but they have fewer regulations.

Day 2

USX took us on a tour of their service center in Tunnel Hill, Georgia, and provided Volpe with examples of USX accident data, as well as their accident reporting methods.

APPENDIX F. MEETING WITH GARELICK AND U.S. DOT – VOLPE CENTER

Date: May 4, 2001

Time: 8:00 a.m. to 10:00 a.m.

Location: Garelick, Franklin, Massachusetts

Attendees: Lawrence M. Cuomo (Regional Senior Director, Risk Management), Linda Boyle (Volpe Center), and Neil Meltzer (Volpe Center)

Objective of Meeting

The primary purpose of this meeting was to inform and discuss with Garelick Farms, Inc. the issues pertaining to the Case-Control Crash Risk Study. Linda Boyle and Neil Meltzer handed out information about the study that included the list of variables being considered and issues to be discussed.

Overview of Garelick

Garelick Farms, Inc. is located in Franklin, Massachusetts and is a subsidiary of Suiza, GTL, LLC, a national public company. They are a dairy company and their trucks are used only for transporting dairy products from their processing plants. Although Suiza, their parent company, operates across the Northeast, Garelick truck drivers operate in the New England region only. The milk used for Garelick Farms comes from farms in New York State and is also used for dairy products from 14 processing plants in the Northeast. The products from these plants are also marketed under the labels of Tuscan Farms (primarily New Jersey), and Lehigh Valley Dairies (primarily Pennsylvania). Garelick's as well as all Suiza's trucking operations are exclusively for their own product distribution. Our research indicated that approximately 200 of their drivers are located in the Massachusetts area. They have had no fatalities in the past year.

Discussion of Case-Control Study Issues

Subject Population

Type of trucking firm – state, regional, or national

Although Garelick's truck drivers work primarily in the New England region, U.S. DOT could work with the parent company, Suiza, to get drivers across the country. In the Northeast region (includes New England and mid-Atlantic states), there are 1,200 large truck drivers.

Type of drivers

Depending on location, some of the drivers are represented by unions, primarily the Teamsters.

Garelick drivers are required to have a Class B CDL, although some do have Class A. They are all qualified to drive tractor-trailers; but some drive straight trucks and some drive tractor-trailers.

Drivers have to go through a road test and have a background check. They do not have a requirement for any minimum number of years as a CDL. However, they do a thorough check that includes looking into prior accident records.

Driver routes and schedules

Driver routes are all assigned for round trip completion within one daily shift, usually a maximum of 10 hours. Deliveries and pickups can vary.

Representative sample

A proportion of their trucks are leased, but all drivers are their own employees. Drivers are limited to within a one-day return schedule (i.e., there are no overnight schedules). Most graduated driver school, some on-the-job training, some promotion from clerical positions.

Accidents – Garelick primarily tracks DOT-reportable, but do account for fender-benders as well, since they can be very costly. There is a monthly committee review with drivers and management of all accidents, primarily to investigate whether or not an accident could have been prevented. If an accident could have been prevented, a corrective action plan is determined. There are also driver incentive programs for accident reductions.

Sample size - length of study

There is also a low turnover rate in this company. Therefore, a fairly consistent sample will be used over the 2–3 year study period if Suiza participated in the study. Reasons for the low turnover rate include family-friendly work environment that attracts and retains stable drivers (most have family living in the local area). They are also not over-the-road drivers. Therefore, their work schedule is less stressful. They have a comprehensive benefits package as well as sign-up bonuses.

<u>Data Requirements</u>

Driver longevity and training

At Garelick, a driver with less than 6-month experience is not necessarily less safe. New hires are <u>not</u> given the more difficult route and all drivers get on-the-job training with a more experienced driver at their side. Suiza has found it difficult to get good drivers with CDL. Therefore, they have provided incentives to employees who are willing to go through the CDL training.

GPS equipment

Their vehicles are not equipped with GPS. Therefore, if we need to track drivers by location, we would have to provide the GPS unit.

Tracking information

If the drivers need to travel over 100 miles, they are required to record everything on an HOS logbook. If they are traveling less than 100 miles, they are still required to record their schedules on a trip sheet.

Each driver usually has a delivery sheet that has predetermined routes and these routes are all pre-timed. Therefore, the company knows where their drivers are at all times.

In-vehicle equipment

The drivers all have CB radios, but cellular phones are highly discouraged.

Vehicle maintenance

The company contracts the maintenance work to Ryder. They conduct all the preventive maintenance services and any vehicle repairs that need to be done.

Insurance sources

Travelers and CNA are the insurance companies used by Garelick.

Medical data

Linda and Neil explained what type of medical data the DOT would like to obtain and the need to keep drivers in a sleep clinic to monitor sleeping patterns. However, as discussed earlier, their drivers do not do any over-the-road operations.

Agreements

Type of agreements needed

L. Cuomo stressed the importance of dealing with unions; e.g. Teamsters. If we can strike up an agreement with the international teamsters union, locals will follow.

Action items:

L. Cuomo will discuss ideas with Corporate and propose areas and extent of willingness to participate. Volpe will follow up this meeting by contacting L. Cuomo in June for the outcome of his meeting.

Type of drivers - Minimum licensing criteria?

[BE] The minimum licensing criteria is different for each dedicated carrier. Before drivers can start work, they should have at a minimum two years verifiable experience. However, trying to do a background check on drivers can be very difficult. Usually, 90% of the driver's previous employers do not respond when contacted.

Representative sample

[Lily] There are many types of truck drivers. Again, depending on the contract, some drivers start off with a Truckload, but make six to seven stops. Other drivers are less-than-truckload.

[BE] Is DOT only looking at DOT reportable accidents? At Lily Transportation, less than 10% were DOT reportable in the year 2001.

[LB & NM] Not necessarily. Accidents that are considered severe and costly for the company should also be considered as well.

Sample size

[LB] We are considering 500 to 1,000 participants

[BE] If you want that many participants, you will definitely need multiple fleet participation unless you are only focusing on larger firms.

Length of study

[LB] We are expecting to collect data over a two to three year period. Given the high turnover rates in most trucking firms, we don't expect the same driver to be associated with the firm from the beginning of the study. In a case-control study, the sample population can be set up as an open cohort where drivers can come "in and out" of a study.

[Lily] We are not sure if you will have much luck following drivers from firm to firm. It is difficult enough, for Lily, to just verify previous employments of truckers.

Data Requirements - Need to identify all potential crash causal factors.

[LB] We have identified variables to include in this study (handout given to Lily Transportation). However, we want to also include variables that industry has identified as potential crash risk factors.

Medical data

[BE] Although there is a Section 391 requirement, it does not really provide a detailed enough physical. There are many things that will not be identified in the Section 391 requirement, like sleep apnea. Many of the questions are "yes/no" and based on the trucker's word.

Crash data

[LB] Crash data will come from several sources: Police report (reported data on incident), GIS/GPS (roadway information, time of day), and post-accident surveys (driver's assessment of incident, driving conditions).

Driving characteristics

[LB] Data recorder information will be needed for drivers not involved in a crash, as well as for those involved in a crash.

[Lily] Only some drivers have some GPS tracking system – it depends on the contract. The same is true for cellular phones, only some accounts require the drivers to carry one. However, Lily typically knows where their drivers are at a specific time.

Demographic variables - Initial survey information
(age, children, marital status)

[LB] U.S. Xpress has indicated that they have seen a problem with drivers who do not speak English well. Does Lily Transportation see a similar situation, in terms of accidents, and understanding rules and regulations?

[BE] It is a problem; approximately 50% of Lily's drivers are not fluent in English.

Other data requirements?

[BE] What about roads? The government allows larger and heavier trucks, but many roads (especially in older cities in NY and MA) are not built for these larger and heavier trucks.

[BR] Should also look at (1) how many stops the driver has to make per day, and (2) how they are paid (i.e., hourly, mileage, percentage, or combination). We have seen some abuse on drivers, especially by the grocery stores, where drivers who are paid by the miles, have to wait all day before they can unload their shipment. These drivers are not getting paid while they wait.

[LB] Do all drivers get paid for meals and gas?

[BE] It depends on the contract and if they have to stay overnight somewhere. Lily typically pays for fuel, and it is up to the drivers to examine the trucks for tire wear and damage.

[BE & BR] We have also seen a number of accidents due to backing and tight corners.

Agreements - Need to identify parties, relationships, and concerns

Types of agreements that will be needed?

[Lily] Not sure exactly what agreements are needed at this time, but if DOT has a list of agreements and/or contracts written up at a later date, Lily will be more than happy to look them over and provide feedback.

What organizations should be involved?

[LB] There are many organizations that will need to be coordinated with (Fleets, American Trucking Association, Regional Trucking Associations, Trucking Insurance Brokers, Unions). Can you think of other organizations?

[Lily] It will be very difficult obtaining information from the unions. Two insurance firms that deal a lot with the trucking industry are Liberty Mutual and Fireman's Fund. You may want to talk to them. Other organizations to consider are state Police and state DOTs.

Participation - Need to identify willingness to participate

[BE] Most trucking firms, if they know it is a study to help improve safety and decrease accidents in some way will most likely be willing to participate.

[BE] Truck drivers, on the other hand, will be more difficult to convince – even with an incentive. Those that are willing to participate may be the "better" drivers while the "lower" end drivers may not be willing to undergo physicals, or have someone delve too much into their past.

Other items

[BE and BR] Asked if we have considered private firms. For example, grocery chains usually have a trucking division.

[LB and NM] We will be trying to make visits to them as well.

APPENDIX H. MEETING WITH J.B. HUNT AND U.S. DOT – VOLPE CENTER

Date: June 20, 2001

Time: 9:00 a.m. to 4:00 p.m.

Location: Lowell, Arkansas

Attendees: J.B. Hunt Transport, Inc.
Greer Woodruff, Vice President Corporate Safety
Clark Woods, Director of Casualty Claims
David Whiteside, Director of Safety Administrative Services
Mark Whitehead, Director of Claims
Craig Harper, Chief Operations Officer

U.S. DOT – Volpe Center
Linda Boyle, Accident Prevention Division
Neil Meltzer, Accident Prevention Division
Jonathan Koopmann, Accident Prevention Division

Objective of Meeting

The primary purpose of this meeting was to inform and discuss with J.B. Hunt the issues pertaining to the Case-Control Crash Risk Study and obtain information on the feasibility of the methodology. Neil Meltzer began by providing J.B. Hunt an overview of the Volpe Center and how the Center works with other agencies within the U.S. DOT. Linda Boyle then gave a presentation of the Case-Control Crash Risk Study. (Copies of the presentation were handed out at the meeting.) This presentation included an overview of the study's goals and objectives and the issues involved in the study. Afterward, a discussion of the issues began.

Overview of J.B. Hunt

J.B. Hunt Transport, Inc. is headquartered in Lowell, Arkansas, and has 18 major terminal cites for their truckload operation. They have dedicated fleets, over-the-road truck and intermodal services. They have approximately 6,000 long-haul drivers (over-the-road), 1,500 intermodal local drivers (short-haul that drive from rail locations within 200-300 miles), 3,000 dedicated freight drivers (that includes over-the-road and short-haul), and 215 owner-operated drivers.

The Truck Driving Population at J.B. Hunt

The average driver age is 43 (and ranges from 23-76). Their drivers are non-unionized and are mostly Class A drivers. In the future, they will have some Class B drivers for local deliveries (approximately 15-20 drivers). Most drivers have Hazardous-Material endorsement and one year experience (the typical requirement for hiring) but there are a few drivers with only 6 months experience (they are then given additional training).

Turnover rates at J.B. Hunt dropped from 90% to 45% after pay increases were initiated in 1997. Turnover rate is increasing now due to soft freight business, and decreased miles for drivers. The driver records are typically kept for three years after drivers leave the firm.

VEHICLE

Most vehicles have GPS units in the vehicle. Trucks are speed limited to 62 mph.

J.B. Hunts have both cabover trucks and conventional trucks. Some truck drivers indicated that they like the cabover trucks better.

The vehicles are not assigned to any one driver. J.B. Hunt uses a "slip seat" system where drivers need to return the vehicle if they are going on vacation or if the driver will be unavailable for any length of time. This enables the vehicle to be used as often as possible.

J.B. Hunt's carriers are mostly self-insured (i.e., J.B. Hunt underwritten), with some AIG (supplemental insurance).

CRASH INFORMATION

Accident rates are approximately 33% higher for drivers with less than 6 months driving experience. Therefore, it is more desirable to hire drivers with more experience. There is an ongoing training program for all drivers.

Of the 10 fatalities thus far this year, 9 were not J.B. Hunt's fault.

After a crash, initial data collection includes:

- Basic roadway information
- Basic driver information
- Classifying vehicle maneuver – accident type

Studies done at J.B. Hunt indicate that the primary reason for a crash is following distance (or headway) related. J.B. Hunt's safety people promote space management with 7-second following distances between automobiles and trucks.

Key crash types include: (mainly speed- and fatigue-related)

- Rear ends
- Lane changes
- Rollovers
    - Rollovers at night are generally on straight roads and occur due to fatigue
    - Rollovers during daylight are usually on curved roads and are speed-related

J.B. Hunt also identifies backing incidents as accidents. Many accidents are due to compounding factors.

Rear-end collisions are 3% of the accidents but 15% of accident costs. Approximately 40-60% of accidents have a PAR (Police Accident Report) and 99.9% of DOT-reportable accidents have a PAR.

OTHER EQUIPMENT

Eaton-VORAD system. J.B. Hunt tested 100 VORAD EVT-300 units over 8,000,000 miles and found the units actually had detrimental safety effects.

Cellular phones. Greer Woodruff conducted a random sample of 107 drivers and found 54% had cell phones. However, using cell phones is highly discouraged.

QUALCOMM. J.B. Hunt would like to limit the use of QUALCOMM devices to only when the vehicle is stopped. However, drivers say they need the device to read the directions off the system (particularly at night) because it has a backlight feature.

Seatbelts. Seatbelt usage thought to be approximately 85%. J.B. Hunt is considering a brighter color for their seatbelts (like bright orange or bright yellow) so they can be more identifiable.

Mirrors. J.B. Hunt's cabover trucks have 5 mirrors; conventional trucks have 6 mirrors – too many mirrors may cause driver overload.

J.B. Hunt's Recommendations for Study

Greer Woodruff recommended that a combination of private and for-hire firms should be used for the study to get a representative trucking sample.

He also wanted to know if we would capture information on the truck manufacturers. Some trucks may be more crashworthy than others. (*Note. An Internet search showed that there are several large truck manufacturers including Volvo, Freightliner, International, Kenworth, GMC, Mack, Ford, Isuzu, and Peterbilt.*)

Greer Woodruff also asked if there would be any mechanisms to capture the other side of the story for an accident (i.e., in many large truck accidents, there is a high probability that the other driver is at fault). Linda Boyle indicated that the study will probably not capture information on the other driver unless that driver was also a truck driver and also part of this study. The only other way to capture this information is through a police report, if one was filed.

Linda Boyle indicated that once the fleets agree to participate, a notice would go out to the truck drivers in the fleets for study volunteers. Only those drivers that want to participate would be chosen. That is, no drivers will be forced into the study. There was concern that if it is voluntary, only drivers with a "better than average" record would be willing to participate. Therefore, a suggestion was made to obtain the records of the participating fleets to compare the overall fleet's accident records with the records of the participants to see if it was representative.

Linda Boyle also indicated that some information could be collected from police reports if it is available. Mark Whitehead (Director of Claims) also indicated that data could be mined from claims information too.

Recommendations of other people to talk to:

- AIG insurance
- Great West insurance: underwrites for small and medium sized firms and keeps very good crash data
- State DOTs: for driver information, road alignment
- OOIDA: Owner-Operated Independent Drivers Association; it may be beneficial to get information on owner-operated drivers and this group has valuable information on this group of drivers.
- Trailer manufacturers – for information on run-under accidents
- Aftermarket producers of safety equipment; e.g. mirrors and 3M products like vehicle reflectors

J.B. Hunt's Concerns about Participation

1. Concern regarding cases that might fall under litigation; J.B. Hunt needs to protect the driver and the firm, if you collect information on drivers, lawyers will want to get it.

2. Concerns about access to vehicle information from GPS units.

3. If we have participants undergo a sleep study, when will any health issues be disclosed to driver and trucking firm. For example, there may be a liability issue if DOT knew the driver has sleep apnea or diabetes and the drivers are allowed to continue with the study (could accident be due to condition?). Should the drivers be told immediately about the results of the initial physical and sleep study? J.B. Hunt does not fire drivers if they have sleep apnea as long as they treat it. As a matter of fact, they do have drivers who have sleep apnea. J.B. Hunt typically will pay for the first tests drivers need on sleep apnea. However, any subsequent follow-ups are usually paid for by the driver themselves.

4. May need to consider protecting firm from EEOC (Equal Employment Opportunity Commission).

5. FMCSA section 193 exemptions – how do these exemptions relate to accidents?

TOUR OF FACILITY

The Volpe Center personnel were provided a tour of the facility in the afternoon. The tour included where truck drivers rest, where trucks are repaired and maintained, and where training sessions occur. Because J.B. Hunt uses a "slip-seat" system, the vehicles are stripped of any person belongings. If the driver wants a radio or CD-player, they need to provide it since the cabs do not have this equipment. The Volpe Center personnel were also allowed inside their cabs (both the conventional and the cabover).

APPENDIX I. MEETING WITH ROADWAY EXPRESS AND U.S. DOT- VOLPE CENTER

Date: June 29, 2001

Time: 8:30 a.m. to 12:00 p.m.

Location: North Reading, Massachusetts

Attendees: <u>Roadway Express</u>
Gerald Brewster, Manager Corporate Safety
Steve Powers, District 21 Safety Manager
Robert Duffy, Terminal Manager

<u>U.S. DOT – Volpe Center</u>
Linda Boyle, Accident Prevention Division
Jonathan Koopmann, Accident Prevention Division
Bruce Wilson, Accident Prevention Division

Objective of Meeting

The primary purpose of this meeting was to inform and discuss with Roadway Express the issues pertaining to a study being proposed by Federal Motor Carrier Safety Administration (FMCSA) and the Volpe Center to understand the relative risks of crash. The study, titled "Case-Control Crash Risk Study" will look at trips that involve accidents (cases) and trips that do not involve accidents (controls). The feasibility of the methodology involved in this study were discussed at this meeting.

The meeting began with a brief overview of the Volpe Center and how the center works with other agencies within the U.S. DOT. This was then followed by a tour of Roadway Express' facilities. Linda Boyle then gave a presentation of the Case-Control Crash Risk Study. (Copies of the presentation were handed out at the meeting). This presentation included an overview of the study's goals and objectives and the issues involved in the study. Afterward, a discussion of the issues began. The meeting closed with Gerald Brewster briefing the Volpe Center on accident information gathered by Roadway Express that may also be of interest to the study.

Overview of Roadway Express

Roadway Express is a less-than-truckload (LTL) motor carrier that provides transportation services in national and international markets. They have been in existence for 70 years and are headquartered in Akron, Ohio. They have approximately 28,000 total employees: 21,000 union drivers and dockworkers, and 7,000 managerial and office employees. Of the 21,000 union members, approximately 12,000 are drivers (including 8,000 line drivers [Long-haul] and 4,000 pickup and delivery drivers [Short-haul]). The long-haul operation encompasses approximately

460 to 512 million miles per year and the short-haul operation encompasses approximately 120 million miles per year.

Facility Tour and Roadway Express operations

In an LTL operation, trucks are loaded with multiple shipments to multiple customers. Each customer shipment is less than a truckload. However, trucks can and are typically loaded full with multiple shipments.

The tour consisted of observing Roadway Express' loading and unloading docks as well as their dispatching room. At 4 p.m. the night before, shipments come in from all across the country. They are unloaded on one side of the docking area and loaded to their final destinations on the other side of the docking area. The process is usually completed by 10 a.m. where drivers take the shipments to their final destinations. There are approximately 75 doors (or docking bays). Trucks back the vans up to the doors where they are loaded and unloaded.

Roadway's primary method for moving freight is a "slip seat" relay system. Using a network of 45 relay stations supported by state-of-the-art information systems, freight flows steadily through the system as drivers exchange vehicles to return to their domicile. This system provides Roadway with operational flexibility. This also allows employees not to be away from home for long periods, which means a better quality of life.

Long-Haul operations work in two ways:

1. "Bid system" where drivers choose location (flexibility), or
2. Drivers subject to call for a load. Most drivers fall into this category and these drivers would probably be better candidates our study.

Trailers used are vans (i.e., they are not flatbeds, tankers, or other types of trailers). The long-haul trailers are 48 feet long, or 28 feet long for doubles and triple trailers.

QUALCOMM onboard satellite communications are used to increase reliability and efficiency.

Driver population

Unionized drivers. All drivers are unionized. They find that the drivers are better, less likely to leave (lower turnaround rate; current turnover rate is 30%), and insurance and benefits are taken care of by the union. Therefore, they can give drivers better pay.

Licensing requirements. Most drivers have CDL A, and most drivers are HAZMAT certified. The minimum age requirement for drivers is 23 years with a minimum of two years experience. The two years minimum experience requirement went into effect only 4-5 years ago.

Shifts. They have scheduled shifts for the drivers. They start anywhere between 5 a.m. to 2 p.m.

Fitness. Before beginning work, drivers have KIP training that consists of stretching exercises to get the drivers ready for the day. These exercises consists of 13 stretches to warm-up the drivers.

Driver records. Roadway Express maintains driver records for five years.

Re-certification. Drivers have re-certification training every three years.

Hours of service. Drivers are limited in hours of service. All the shipment routes are tested. Their tests indicate that 500 to 550-mile runs are achievable in 10 hours, and drivers are allowed a 2-hour break when not responsible for equipment. They also allow drivers extra rest time when requested. Many safety issues built in process to avoid fatigued drivers on highway.

Owner-Operated. They have no owner-operated drivers in their system.

Linda Boyle indicated that although they have both long-haul and short-haul drivers, the study would probably include only long-haul drivers since they have more varied routes and more varied schedules.

Data requirements

Medical data. There is a strong interest in collecting information on driver characteristics as part of this study. Linda Boyle indicated that part of the study would entail the drivers participating in a sleep clinic during their non-working hours. For example, drivers could come in on a Friday night and leave Saturday morning after a physical was done.

Roadway Express has their own physicians to conduct the required Section 391 physical on drivers. They currently have five drivers who have medical waivers, but they normally discourage hiring someone with a waiver.

GPS data. Linda Boyle indicated that to identify where drivers were during the study, a GPS unit may be used to identify the types of road they are on and the type of road condition they are encountering on the trip. This will help establish the trips of the "controls" (drivers who did not have an accident on a trip). Roadway Express uses the slip-seat operation and therefore, the drivers do not have assigned tractors. However, if Roadway Express was a participant in this study, they could assign drivers to a particular tractor for the duration of the study.

Bob Duffy indicated that as of next month, the Boston terminal would start using satellites on their short-haul trucks as well as long-haul trucks to more effectively track loads.

DRIVER'S EQUIPMENT

GPS and QUALCOMM units are installed on all long-haul trucks. The QUALCOMM unit is placed in the back of the truck to ensure that they are not being used while driving.

Short-haul drivers also have two-way Nextel phones for communications with the central dispatch office.

Long-haul drivers permitted to bring their own CB and radio but it is not provided in the trucks.

Short-haul drivers are not allowed to have any additional devices in their vehicle.

ROADWAY EXPRESS ACCIDENT DATA

Years with company. Gerald Brewster conducted a study of 1999 accidents and compiled the following data:

- New drivers (0-5 years with firm) 16% of accidents
- 5-10 years 36% of accidents
- 10 + years 46% of accidents
- Drivers with 15+ years had 37% of accidents of group within 10+ years group.

English fluency. Linda Boyle asked if they had seen any problems with English comprehension in their drivers. Gerald Brewster indicated that language barriers were not a problem in incidents. Drivers need to understand language and road signs; it is a DOT requirement.

Fatalities. Roadway Express has had 7 fatalities last year, mostly not their fault.

Roadway configuration. Two-lane drivers have fewer accidents. This could be due to more stimuli (e.g., varying terrains, signs, houses, trees, etc.) to keep driver alert.

Roadway Express has had 33 run-off-road accidents in 2000 and a total of 4,500 incidents. There were 298 DOT-reportable accidents last year.

Last year, Roadway Express had:

- 4,500 accidents and incidents combined
- 298 DOT-reportable
- 652 backing
- 201 rear end
- 130 failure to maintain control
- 93 jackknife
- 31 lane change
- 14 distraction by any cause
- 35 failure to yield in any traffic condition; most likely due to inattention

The largest cause of accidents (with 629 accidents) is failure to maintain clearance while moving forward.

Roadway Express has had only 6 accidents due to drowsy drivers. They attribute this to the limits in hour of service they enforce as well as the availability of rest (2 hour breaks) when needed. There are also many safety issues built into the process to avoid fatigued drivers on the highway. Roadway Express operates similar to a "pony express" system where drivers change at specified locations. Drivers are not pushed to the extreme to make more money.

When a driver is in an accident deemed serious, the driver is taken out of service until the end of the investigation - the driver is then disciplined if at fault.

Seasonal changes. Roadway Express has not seen, in their data, any strong month-by-month trends in accidents.

AGREEMENTS

Since all of their drivers are unionized, DOT may need to coordinate some participatory issues with the union (International Brotherhood of Teamsters). Steve Powers indicated that union contracts indicate that drivers need to be compensated for their time. Therefore, DOT may need to pay them for off-duty time, overtime, and 1.5 times on weekends. However, Gerald Brewster pointed out that participation in this study is on a voluntary basis, so firm would not need to pay them.

PARTICIPATION

Linda Boyle asked if this study were underway, would a company like Roadway Express be willing to participate? She also indicated that there would definitely be a monetary incentive to participate: approximately $500–$600 dollars. Roadway Express indicated that amount might not be sufficient incentive for drivers. Robert Duffy says driver can typically earn $500 for two Saturdays. Therefore, for $500, what amount of work would the drivers have to put into this study? Linda Boyle explained that there would probably be an initial survey to collect biographical data and assess their current driving habits. The drivers, during the course of the study, will also undergo a sleep study that would involve an overnight stay at a sleep clinic. If an accident occurs, an assessment of what happens may also be needed. The study also calls for information on those who do not have accidents, so periodically, drivers who did not have accidents will be surveyed for information. The study will last approximately two to three years, so drivers may be asked for information anytime during that period.

ROADWAY EXPRESS' STUDY CONCERNS

The best drivers. If DOT gets 50 drivers from each trucking organization, they may only get the 50 best drivers, the ones who understand the importance of this information. Lousy drivers won't want extra scrutiny. Gerald Brewster indicated that DOT would probably need a blend of drivers, ideal and not-so-professional.

Highest risk drivers. The highest risk drivers will not be found in companies like U.S. Xpress, J.B. Hunt, or Roadway Express, but rather in the independent drivers (Gypsies) who work through brokers. They are the ones who don't always have the newer or well-maintained trucks and who really push themselves to get the miles and the load delivered as quickly as possible to get the next shipment. Linda Boyle wanted to know if they had any suggestions on how to get a hold of these people and their likelihood to participate in this type of study. She suggested the possibility of using newsletters in ATA or State Trucking Associations. Steve Powers said that these types of drivers might still not read information in these newsletters. DOT may have better luck talking to freight brokers. These brokers operate in various ways; some assign loads to whoever shows up; others have the same drivers picking up loads all the time.

OTHER ITEMS

Roadway Express, like J.B. Hunt, uses the "Smith system" for professional driver safety training. The general trend seen in accidents is the driver's lack of the "big picture." To get the big picture (i.e., what's around the truck), drivers are told to have an 8-second following distance and keep eyes 15 seconds ahead.

APPENDIX J. MEETING WITH LIBERTY MUTUAL AND U.S. DOT – VOLPE CENTER

Date: May 21, 2001

Time: 12:30 p.m. to 4:30 p.m.

Location: Hopkinton, Massachusetts

Attendees: Tom Leamon, Ph.D. (Vice President, Liberty Mutual)
Patrick Dempsey, Ph.D. (Researcher, Liberty Mutual)
Gary Sorock, Ph.D. (Senior Research Associate Epidemiology, Liberty Mutual)
David Money, CDT (Technical Director Transportation Training, Liberty Mutual)
Mary Lesch, Ph.D. (Cognitive Psychology, Liberty Mutual)
Simon Matz, M.S. (Biostatistics, Liberty Mutual)
Krystyna Gielo-Perczak, Ph.D.
(Aeronautics and Mechanical Engineering, Liberty Mutual)
Linda Boyle (Volpe Center)
Neil Meltzer (Volpe Center)

Objective of Meeting

The primary purpose of this meeting was to inform and discuss with Liberty Mutual the issues pertaining to the Case-Control Crash Risk Study and obtain information on the feasibility of the methodology. The experiences of Liberty Mutual researchers in conducting similar studies were shared. The meeting ended with a tour of the lab facilities and truck training grounds.

Overview of Liberty Mutual Group

Tom Leamon provided an overview of the Liberty Mutual Group, Research Center for Safety and Health. They have three primary research areas: Safety Research, Disability Research, and Home Safety. They have collaborative efforts nationally and internationally (including work with Harvard School of Public Health and research centers in China) and have conducted a great deal of research in occupational injuries and transportation safety as well as published in many refereed journals.

Discussion of Case-Control Study Issues

Linda Boyle presented an overview of the study plan being evaluated with FMCSA (Federal Motor Carrier Safety Administration) and the issues that need to be addressed. These issues included the subject population, data requirements, methodology, agreements, and driver participation.

Subject Population

Patrick Dempsey (Liberty Mutual) indicated that Liberty Mutual has used truck drivers in previous studies and has indicated that it was helpful to contact the drivers every three months to ensure that they were still available as participants. Depending on the study, drivers were not necessarily Liberty Mutual insured (i.e., they could have been insured by other agencies) and their CDL was either A or B (not C).

Data Requirements

Simon Matz and Gary Sorock were concerned about the number of variables in our study. Gary Sorock has conducted many epidemiology studies and has used approximately 10-15 variables compared to the Volpe list of 80 variables. Simon Matz also indicated that DOT should try to tailor the study to more defined focuses. That is, instead of targeting all potential crash causal factors, target just the *major* factors.

Regarding medical data, the study may also want to collect data on sleeping behavior prior to an accident. For example, questions on the driver's sleeping pattern in the day prior, the week prior, etc., may need to be assessed. Linda Boyle indicated that they were considering this.

Simon Matz indicated that DOT might want to obtain an accident reconstruction expert. Although police reports will be used, these reports do not normally have information on exposures, average miles driven, and size of the truck.

Patrick Dempsey indicated that whenever they use truck drivers or any subjects, they have a pilot test on a small subset. Linda Boyle indicated that they were planning on doing this for the DOT study as well. She also indicated that they would collect retrospective information as well as crash data as the study progresses over the two-year period. Simon indicated that it would be a very good idea to use some of the retrospective information to help eliminate variables that may not really be pertinent.

A discussion on identifying risky behavior in subjects ensued. This information may be highly correlated with the number of accidents a driver is likely to be involved in.

David Money indicated the DOT might also want to collect video data, such as can be obtained using a commercially available product like DriveCam (which is available for approximately $795 according to their website). This product provides video and audio information regarding near encounters and actual crashes.

Agreements

Experiments such as these typically need an "informed consent" that drivers will need to sign in order to participate. These "informed consents" include information on the study, statements on voluntary participation, purpose of study, expected duration of study, etc.

Liberty Mutual related studies

Simon Matz is working on a study on severe vehicular injuries and the likelihood of these injuries using 100 cases from 1986-1989. Since 54% of age information was missing, this variable could not be used. However, other pertinent information was obtained including the impact of alcohol, drugs, fatigue, and weather/road conditions.

David Money indicated that they were also conducting studies on alternate back-up devices and alternatives to mirrors, like using a camera to view the back of a truck. It has been a very effective way of seeing things directly behind your vehicle. Studies have also been conducted on the proper way to get on and off a truck, accidents in construction zones, and the use of in-vehicle devices.

Other items

David Money indicated that Liberty Mutual is the fifth largest insurer of truck drivers. After the discussion sessions, Linda Boyle and Neil Meltzer were taken on a tour of the research labs and then to the training track where large truck trainers are trained. Linda Boyle and Neil Meltzer were also given the opportunity to drive a large truck (Volvo cab).