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Comparison of Combination-Unit & Single-Unit Trucks in the LTCCS
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Webinar Transcript

Presenters

- Dr. Ralph Craft, Director, Large Truck Crash Causation Study (LTCCS), FMCSA Office of Analysis, Research, and Technology (ART)

Speakers (optional)

- Dr. Ronald R. Knipling, Director, LTCCS, Virginia Tech Transportation Institute
- Kirse Kelly, Webinar Host, FMCSA ART

Description:

Data from the Large Truck Crash Causation Study (LTCCS) were used to compare the crashes involving Combination-Unit Trucks (CTs) to those of Single-Unit Trucks (STs). Forty-four variables relating to crash characteristics, conditions of occurrence, key causal variables, and associated factors, including those relating to driver fatigue and Hours-of-Service, were examined. In this webinar, Dr. Ron Knipling of the Virginia Tech Transportation Institute will discuss how the LTCCS statistics were disaggregated and analyzed. He will provide details about the results which indicate CT and ST crashes were more similar than different, and that crash characteristics had stronger associations with causality than did vehicle type.

COMPARISON OF COMBINATION-UNIT & SINGLE-UNIT TRUCKS IN THE LTCCS

PRESENTATION TITLE SLIDE: COMPARISON OF COMBINATION-UNIT & SINGLE-UNIT TRUCKS IN THE LTCCS

Operator: Christina

Welcome and thank you for standing by for our FMCSA Office of Analysis, Research and Technology conference call. At this time all participants are in a listen-only mode. During the question and answer session please press ***1** on your touch tone phone. Today's conference is being recorded. If you have any objections you may disconnect at this time. And now I'd like to now turn the call over to the web conference coordinator, Kirse Kelly. Ma'am, you may begin.

Kirse Kelly (Webinar Host, FMCSA ART):

Thank you very much Christina, and thanks to all of you who are participating in our webinar on the FMCSA's Large Truck Crash Causation Study Combination-Unit and Single-Unit Truck Crash Statistics. As Christina mentioned, time permitting; all questions will be answered and they'll be answered at the end of the call. You can also submit questions into the **Q&A Box** which is on the lower left side of your screen and you can insert those questions throughout the presentation. Once again, they will be answered at end of the call. At that time, during the question and answer period, of course you'll be able to do questions online and over the phone.

Please note you will be given an opportunity to receive a copy of the presentation at the end of the webinar. That's sometimes people's favorite question, so just letting you know, you will get a copy if you're interested.

Members of the trade or local media participating in today's call are asked to contact our Office of Communications with questions at 202-366-9999; that's once again the Office of Communications, it's 202-366-9999. Now let me go ahead and turn you over to Dr. Ralph Craft of the FMCSA Analysis Division.

Dr. Ralph Craft (Project Manager, FMCSA ART):

Hi, welcome to the webinar today. We are very privileged to have Dr. Ron Knipling from Virginia Tech giving this presentation on Comparing Single-Unit Trucks and Combination-Unit Trucks using the data from the Large Truck Crash Causation Study. I am the director of the Large Truck Crash Causation Study. Ron Knipling worked at the National Highway Traffic Safety Administration and also then came down to the Federal Motor Carrier Safety Administration before he went over to join Virginia Tech. The only thing I want to say about Ron is I didn't work in the same division with Ron, but whenever I was in meetings with Ron here at FMCSA and we were discussing issues, whenever Ron said anything, "I thought, I agree with that guy—he's a sharp guy." So let me turn it over to Ron right now.

Dr. Ronald R. Knipling, (Director, LTCCS, Virginia Tech Transportation Institute):

Thank you very much. Ralph we'll have to talk politics sometime. Thank you everyone for participating. We have 36 slides and we're going to try to cover those in about 36 minutes, so we're going to move along pretty fast here.

SLIDE 2: REPORT: COMPARISON OF COMBINATION-UNIT TRUCK AND SINGLE-UNIT TRUCK STATISTICS FROM THE LTCCS

I first want recognize others involved in the project, my programmer and co-author Joe Bocanegra, of course Ralph, and others who made this possible, including the communications team at FMCSA who put together this webinar.

SLIDE 3: ACRONYMS

Here are some acronyms you're going to see over and over again in this presentation. Of course the two truck types: ***CT***-Combination-Unit Trucks or tractor semi-trailers, primarily; ***ST***-Single - Unit Trucks or straight truck; the ***CR*** is the Critical Reason, which is the critical variable in the LTCCS.

We are going to be talking about single-vehicle crashes, comparing them to multi-vehicle crashes and talking about the truck versus the other vehicle.

SLIDE 4: PURPOSE & OVERVIEW

The purpose of the study was to review some of the basic and fundamental variables in the LTCCS. There were 44 variables in five different categories. We are going to list all 44 of those and briefly talk about each category. We will not have to time to discuss every variable in this presentation. We can do it in questions, if you have questions about variables not covered. The basic purpose was to compare the CT and ST statistics. We did that by, in this last bullet here, by looking primarily at three different crash categories: single-vehicle crashes, which involve the truck of course, multi-vehicle crashes where the truck had the CR or critical reason, and multi-vehicle crashes, where the other vehicle had the critical reason. These are really pretty distinct categories of crashes, of culpability you might say. In the single-vehicle crash you have loss of control of the vehicle due to the driver or perhaps the vehicle; multi-vehicle crash you have driver error primarily by the truck driver but an error in traffic, looked but didn't see, traction or something like that. Then for the other driver, it's typically sort of the same profile of errors, but the other driver is making them. There are three levels of causality and category.

SLIDE 5: BACKGROUND: CTS VS. STS

A little bit of background from data other than the LTCCS. CTs and STs are different in quite a number of ways physically, but really the big difference is operationally, and in terms of their exposure—both quantitative and qualitative—we'll come back to that shortly. If you look at the crash rates, STs are a little higher, but CTs have much greater crash likelihood—that is crashes per vehicle as opposed to crashes per vehicle mile traveled. That makes a very important difference for countermeasures. That is, countermeasures are likely to have far greater benefits for CTs than for STs because they are used for much more driving, so if you buy the same device, it's going to cover five to ten times the exposure for a CT than for an ST. Our study did not involve Federal regulations, but it did involve crashes that might be addressed by those regulations. Federal regulations usually apply to CTs, but most of the time not to STs because they're usually an intrastate commerce.

SLIDE 6: BACKGROUND: CTS & STS COMPARED TO CARS

Here are some of the same concepts, but covered quantitatively here. These are graphs in relationship to cars. 1.0 on this graph is cars, and the two histograms, the blue is CTs and the green is STs. You see they both have crash rates well below cars. In crash severity they both have average crash severities much higher than cars, about twice as high.

Here's an interesting one to me—if you look at crash costs per vehicle mile traveled—this was done in a study I was involved in almost ten years ago—they're almost exactly the same. It costs about the same in terms of the crash costs, regardless of who caused the crash, to drive a truck one mile as to drive a car one mile, and it's about the same for the two types of trucks.

Here's your big difference, the crash cost per vehicle life cycle or you could do vehicle year. Your CT has got roughly six times the crash cost over its life than a car and about five times an ST. That means if you purchase a device and stick it on a CT you're going get five times, five or six times the benefits than you would get from that same device on an ST in general. Of course it depends on the company and the operation, but that is the generality. So you have a completely different cost-benefit picture. That's not further addressed in this study because now we are looking at causation.

SLIDE 7: LTCCS SOUND BITES

A little bit on the LTCCS in general, relevant to this study. There were 963 crashes involving 1,241 trucks. Actually the data we're citing today is all involvement data. It's all truck-level data—that is, it's all based on these 1,241 trucks as opposed to the number of crashes or other vehicles. The LTCCS covered injury crashes only, in fact the top three levels of the injury severity scale. These represent about 11 percent of police-reported crashes, but of course they are the worst 11 percent and the vast majority of the harm coming to crashes. We're going to come back to this injury scale here momentarily, if you're not familiar with that.

Everything is weighted. These are weighted data, weighted to try to make the dataset actually representative. Even though there are 1,000 or more potential variables in the LTCCS, this study just looked at 44 variables.

SLIDE 8: METHODS: CTS VS. STS

For each of these 44 variables we first just did a basic profile difference—descriptive data which you could actually, in almost all of the cases, you could get the same data from GES, but this is the data for all of the trucks and then we disaggregated them for CTs and STs. Then we looked separately at CTs and STs. For each one of those we have a table providing the total percent for that truck type; the total where the truck had the CR, which consists of the following two: single-vehicle crashes and multi-vehicle crashes where the truck had the CR. Then you have multi-vehicle when the other vehicle had the CR. Finally, to get a sense of whether these factors made the truck or car more likely to have the CR and therefore, what you might say, the fault in the crash or the principle claim, even though we don't use that term, we have this row percentage for comparing these two.

Again this color scheme here—red, blue, green—I am going to be using that in a lot of the other slides coming up.

SLIDE 9: EXAMPLE: PRIMARY TABLE FOR LIGHT CONDITION

Here's the first, this is just the variable "light conditions." I sort of picked that one at random as a common crash variable. On our first table we look at the total percentage, and you can just sort of focus on the daylight level here: the total percentage for trucks, CT percentage, the ST percentage. You see a difference right here reflecting the different operations. STs are mainly day use vehicles. Then you've got a ratio between these two percentages, the ratios below one for daylight, but for the dark categories you can see there's quite a few more CT ones than ST ones. We've got a ratio here showing that. That's your basic table. When we had low percentages, we left these ratios here blank.

SLIDE 10: EXAMPLE: CT TABLE FOR LIGHT CONDITION

Here's the table for CTs, and where we had these different categories that I've been talking about. This first column is the same blue column you just saw in the previous table—the total for the CTs. Then you have the total when the truck had the CR, but again, that's a mixture of your single- vehicle crashes and your multi-vehicle crashes. You look at this profile here and then you see the same profile where the other vehicles had the CR. Then you look at the patterns there. There's a lot of noise in these datasets, and you don't always see a perfectly clear pattern, but we did see, not just in this variable, but on others, we did see a trend for the trucks to more likely have the CRs during the day and in heavy traffic and less at night. Look at this 38 percent—of all the multi-vehicle involvement, that's percent where the truck had the CR. This number is a little bit higher, but it shows the that trucks were a little bit more likely to have the CR during the daytime and conversely less likely at night.

SLIDE 11: EXAMPLE: ST TABLE FOR LIGHT CONDITION

It's the same thing for STs—remember their percentages were higher. Going across, even though all of the daylight percentages are higher, it's kind of the same general pattern. You notice that single-vehicle crashes tend to be less during the day; multi-vehicle crashes more during the day. You notice the same thing, where overall, among STs—they got the CR 45 percent of the time in their multi-vehicle involvement, but a little bit higher here for daylight conditions. A little bit of a tendency for more causational side effects on the side of the truck.

SLIDE 12: BASIC CRASH CHARACTERISTICS (CHAPTER 3)

Our first category, which happened to be covered in Chapter Three of the report, which was basic crash characteristics. I'm going to be listing all of the variables for each section, but we're not going to have time to discuss them all.

These were the four variables in this category and I promised that I would come back to crash severity. This is what's called the KABCO scale, police-reported crash severity. There are five categories and the LTCCS included fatal, incapacitating and non-incapacitating, which is kind of moderate level injury, but not possible or no injury. It's important to understand that, because it's not all police-reported crashes. It's not even anywhere near half of the police-reported crashes, but it is the most important ones. These are the four variables in this section, but we're just going to talk about a couple of them.

SLIDE 13: THREE CRASH INVOLVEMENT CATEGORIES

The first, you know I've been talking about these crash categories . . . Here's the breakdown for all trucks, for CTs and STs. The color pattern is not the same here.

There were a lot of single-vehicle crashes in the LTCCS. You see there's almost as many, 27 percent, as there were multi-vehicle crashes where the truck had the CR. Multi-vehicle is two or more vehicles in the crash. Forty-four percent of the involvements were multi-vehicle involvements where the truck did not have the CR.

If you look at CTs here, there were actually more single-vehicle involvements than multi-vehicle involvements where the truck had the CR. GES shows a lower percentage of single-vehicle crashes. That's an issue we're not going to have time to address today, but I think it's one worth looking at.

SLIDE 14: CRASH SEVERITY & CR ASSIGNMENT IN MV CRASHES

Here's an interesting one. If you look at crash severity, just the three categories we have—K, A and B—and then you look at multi-vehicle crashes and you say, "Okay, which vehicle had the CR?" there's a very clear trend here. The more severe the crash, the more likely it is that the other vehicle had the CR. Like here in fatal crashes, 77 percent of these involvements the trucks had in fatal crashes, the other vehicle had the CR. Then it goes down from there, 63 percent for A and 54 percent for B. It was the majority in all three cases, but it almost came down to 50:50. In a completely different study when you get down to the most minor police-reported crashes, it is about 50:50 or even a little bit more for trucks, although that was not in the LTCCS.

SLIDE 15: CRASH CONDITIONS OF OCCURRENCE (CHAPTER 4)

The next group is the biggest group, Crash Conditions of Occurrence. That just means the situation in which the crash occurred. If you're familiar with GES and FARS, almost all of these are familiar variables from those. They're descriptive variables. If you are only interested in descriptions, you could just go to GES. The advantage here is you can get some relation to causation.

SLIDE 16: CONDITIONS OF OCCURRENCE HIGHLIGHTS

Here's some sort of sound bites from this section relating to a few of these variables. Most of the crashes were on weekdays, during the day.

Rush hours—there were a lot of rush hour crashes and trucks during the rush hours were more likely to have the CRs than other times of the day. I would say on three or four different variables we saw that dense traffic—the more traffic you have it obviously increases crash risk, but it seems to increase the likelihood that the truck is going to be assigned the CR as well. That's an operational lesson to try to avoid traffic.

CTs had more crashes on divided roads compared to STs as you might expect. I was surprised that the majority of LTCCS crashes occurred in urban areas. Consistent with what we just said, in urban areas trucks are a little bit more likely to have the CR than in rural areas.

Work zones is an interesting one, because it was 13 percent of all the crashes in the LTCCS. That is way above exposure which, in naturalistic driving studies, is less than one percent—so you've got a huge increase in risk for everybody in a work zone, but there was no CR association. It didn't make trucks more or less likely to have the CR; it just was a very large slice of the overall data.

Curves were associated with single-vehicle crashes and especially for CRs. There's one variable here where we did have a kind of an interaction between the type of crash—single-vehicle—and the type of vehicle—CTs—where that combination gave you the highest involvement of curves.

Avoidance maneuvers, only about half of the trucks in the study were voted as having made an avoidance maneuver prior to their impact. It's a little bit more likely to occur for the vehicle that had the CR. In other words, when the vehicle driver made a mistake and realized it and did have time to make an avoidance maneuver where as, the other vehicle probably doesn't. The other driver is probably not even aware of the crash until it happens.

SLIDE 17: KEY CAUSAL VARIABLES (CHAPTER 5)

Chapter five was Key Causal Variables including critical reason, which of course the whole study kind of revolves around that—you have the general category and the specific CRs. We looked at seven major crash types—specific crash types—and looked at them separately in terms of their CR profiles. We're not going to have time to discuss these, except I'm going to just give you an example of how different all these different crash types are.

Even within the rear-end category—in rear-end lead vehicle stopped versus rear-end lead vehicle moving, you've got a difference in the main causes, critical reasons. You have a lot of recognition failures in both, but tailgating or following too closely was only 8 percent of your lead vehicle stopped, but 31 percent of lead vehicle moving. So, these are related, but different crash types. The road departures are completely different of course, than intersection crashes like

SLIDE 18: CR CATEGORIES: ALL TRK-CR INVOLVEMENTS

As far as the CR categories, this is a CT/ST comparison. This is the only slide here I am giving you statistics for all of the truck CR involvements, single and multi-vehicle combined. You've got these categories here; I've given some examples here. These are the overall percents for CTs and STs. For both of them, recognition failures and decision failures are the biggest categories. There is, as far as differences go, there are more similarities than differences, but tend to be CTs are more likely to have these decision errors, like going to fast. I was surprised that STs were more likely to have vehicle failures as the CR—brake failures, and others—especially brake failures—and other types of vehicle failures as the critical reason for the crash.

SLIDE 19: TOP 6 CRS: SV CRASHES

Now we're looking separately at the different crash categories. There were about 40 of these CRs. Our report has them all, but now I'm just giving you the top six for all trucks, CTs and STs. These are again, single-vehicle crashes. ***Speed*** is the dominant cause of single-vehicle crashes. There are more than twice as many as any other category, particularly for CTs. Then tied for second, you have ***asleep at the wheel*** and ***inattention***. Then going down you get a number of causes that are down in the middle/single digits. The ones that happen to be highest are ***cargo shifts***, ***heart attacks/impairments***, ***overcompensation***.

This one here was surprising to me that the asleep at the wheel percentage as a CR was actually higher for STs than CTs given that these are short-haul vehicles versus long-haul and we'll talk about that more later. I think what it says to me is that—and we'll reinforce that later—it's not schedule that drives these asleep at the wheel crashes, it's things like the driver's susceptibility and sleep hygiene and things like that. It's not apparent from this data, but that's my interpretation of it.

SLIDE 20: TOP 6 CRS: MV CRASHES

Multi-vehicle crashes, and again, we have about 40 of these CRs, but this is the top six and they're more different than they are the same. The two top categories are both types of recognition failures. ***Inadequate surveillance***: look but didn't see; and this is high for trucks because you have so many visibility-related crashes. For example, lane change, where the driver looks, but whether it's a blind spot or just not looking well enough, we have a lot of these crashes. Then other forms of ***inattention***, and I grouped some different specific types of distractions (like) daydreaming. ***Speed*** is apparent on this, of course. Then you have these things like ***illegal maneuvers***, ***following too closely*** and ***brake failure*** and things like that. I mentioned CT/ST difference on brake failure. This is in multi-vehicle crashes, you see quite a bit higher, where as speed was higher for STs—speed was higher. turn across path in their patterns of causation.

SLIDE 21: TOP 8 OV CRS (COMPARED TO TRUCKS)

Now let's look at the other vehicle in a multi-vehicle crash. This time I've given you the top eight. I have aggregated the trucks, so this column here is the total for CTs and STs, whereas here, this is when the other driver makes the error. You have ***inattention*** as the leading one for both. ***Inadequate surveillance*** is the common error for all drivers, but more so for truck drivers than car drivers probably because of the visibility around the truck.

Here's an interesting one, ***asleep at the wheel***. There was a very strong, much higher involvement of the other driver asleep at the wheel—9 percent of their multi-vehicle involvement versus one percent for the truck driver. This is also true for ***heart attacks and other physical impairments***; three times more likely that the other driver had this impairment. There's a lot of concern about truck driver health and wellness, and rightfully so, but in the crashes it's the other drivers that have more of these episodes.

SLIDE 22: HOW SIMILAR ARE CR PROFILES?

How similar are these CR profiles among these different types? We used several statistical methods to compare them. The one that I think people are most comfortable with is called the Pearson r correlation coefficient. It's not necessarily mathematically the best, but I think it makes the point best. If you take that list of 40 CRs and just run a correlation between them for CTs and STs, the correlation is about 0.74 for single-vehicle crashes, 0.76 for multi-vehicle, which means that they're—one would be a perfect correlation, so it means that they're very similar. Not exactly similar given that you have sampling error and everything else, it's very high. Even the other vehicles, if you compare the other vehicles to trucks, they're quite similar in the mistakes they make causing multi-vehicle crashes. But if you look at single-vehicle crashes versus multi-vehicle crashes for the trucks, they're—zero would be a no relation; one is a perfect correlation. You see it's a lot closer to zero than it is to one. They're not… They're a little bit alike—they've got overlap—but they're also much more different than the other characteristics. The conclusion there is different vehicles are more similar to each other in crash causation in different crash categories. An implication of that is if you're combining all the truck CR crashes together, as I did myself here a few slides ago, if you are mixing these two types you really are mixing apples and oranges there because these two types—they're more, are really more different than they're alike.

SLIDE 23: EXAMPLE: PRE-CRASH MOVEMENT "NEGOTIATING A CURVE"

If you're doing statistical comparisons, and I just happened to chose here one, negotiating the curve as a pre-crash movement. Here's the basic statistics, that for all crashes it's 19 percent; for all truck CRs it's 28; single-vehicle it's 46, and these are the multi-vehicle crashes.

If you're calculating relative risk—this is like relative risk of CR assignment to the truck. You use this number and compare it to this number and you come up with one sense of relative risk, which is 3-fold, but if you just limit it to multi-vehicle crashes, it's a lot less. There may be some tendency for trucks to be more likely to make the critical error in curves than cars, but it's mainly because it's associated with single-vehicle crashes.

SLIDE 24: VARIOUS ASSOCIATED FACTORS (CHAPTER 6)

We have another set of the associated factors. These are kind of a hodge-podge of variables. The first two of these had some, I think very interesting data.

SLIDE 25: BELT NON-USE & UNFAMILIARITY WITH ROADWAY: RELATION TO CRASH CATEGORIES

If you compare our three main types here, this is non-belt use—belt non-use—and road unfamiliarity by the driver; you have your single-vehicle crashes, multi-vehicle [crashes] where the truck driver had the critical error, the CR, and the multi-vehicle [crashes] where the other driver had it. You see here a very clear pattern related to the causality of the crash of non-belt use by the truck driver. Then you have the same thing for road unfamiliarity, the numbers, the levels are different, but the pattern is the same. What's interesting to me is these both relate to the driver but in a different way. Non-belt use has to do with the driver traits: driver personality, conscientiousness or lack of conscientiousness, unwillingness to follow rules, risk taking. That has—you're dealing with driver traits there. Where as here, unfamiliarity with road is a temporary state, but both of them are strongly associated with pattern of involvement in crashes.

SLIDE 26: OVERALL INCIDENCE IN TRUCKS: VARIOUS OTHER ASSOCIATED FACTORS

Some overall variables—here's the rest of them just spread out here. These are just the overall levels. For each of these associated factors, the definitions are somewhat different. You barely, strictly speaking, you can't really compare them to each other because they have different definitions—some are more inclusive than others—but you get a sense here of how they're coded.

SLIDE 27: DIFFERENT ASSOCIATED FACTORS HAVE DIFFERENT RELATIONS TO CRASH CATEGORIES

For three of these, I've chosen three that have sort of different patterns in relationship to our crash types—you can see some patterns here:

Traffic—that means that the presence of other traffic had some role in the crash. For single-vehicle crashes it's six percent, but of course it's much higher for multi [vehicle crashes] as and, we've seen in other places, there was a tendency for the truck to be more likely to have the CR when there's traffic than for the other vehicle to have the CR. That's one pattern.

Vehicle problems and this is with the truck, as I understand it, this could be anything as little as a brake out of adjustment or any vehicle factor noted. It didn't have to be the cause of the crash, of course. Here you see a pattern more like we saw for the other two previous ones, where the highest level is single-vehicle, next is for multi [vehicle] where the truck has the CR and much lower multi where the other vehicle has the CR. My personal opinion is that this has more to do with the quality of the carrier and the driver than it does with these vehicle factors, actually playing a principle causal role, but this data does not allow you to make that inference one way or the other; that's just my opinion.

Weather basically had no effect on causal pattern. It seemed to have the same influence whether it was single [vehicle], multi-vehicle, truck and other vehicle having the CR, were all the same. So that kind of implies to me, weather raises the risk for everything, but no one in particular.

SLIDE 28: FATIGUE-RELATED ASSOCIATED FACTORS (CHAPTER 7)

Fatigue variables—fatigue-related associated factors and these are mostly schedule-related ones.

SLIDE 29: FATIGUE-RELATED HIGHLIGHTS

Here are some highlights there. For most truck drivers, but especially CT drivers, their sleep schedule is driven by their work schedule, as it is for most working people, but more so for CT drivers and ST drivers. Driver fatigue as an associated factor was higher for CT drivers than for ST drivers. This doesn't mean it was the CR. This is the CR percentages down here and they were almost exactly the same for your ST drivers as your CT drivers. There's a little bit of a difference there of how you define fatigue as to how it affected the driver types. If you look at schedule-related variables, and right now we're talking about the effect of these schedule variables on overall crash involvement: does your driving schedule, how many hours you've driven or worked, does it affect your overall pattern of involvement in crashes? The first observation is that most crashes occur not in the 11th hour driving or the 14th hour working. Most crashes occur early in or middle hours of work. That really almost certainly just has to do with exposure. Every driver drives the first hour, but very few drivers actually drives the 10th hour, which was the legal maximum here in this study. Further, there was little relation between these work and driving hours and the overall crash involvement or these categories. We did see patterns for these other variables, but we did not see them for work- and schedule-related ones.

SLIDE 30: WATCH YOUR SAMPLING FRAME! ASLEEP-AT-THE-WHEEL AS CR FOR DIFFERENT CRASH CATEGORIES

Going back to ***asleep at the wheel*** as the CR, it's so easy to get confused on these kinds of statistics because, depending on your sampling frame—that is what group of crashes you're talking about. You should always keep that clear in your mind or in anything you say or write, because it's so different for the different categories.

Look at all the crashes, all the crash involvements the numbers were four percent and four percent. If you look at all CR involvements that percent is seven. Single-vehicle involvements were actually higher for the STs, but overall higher. Multi-vehicle involvements were all together 13 times less—a little over one percent for your CTs and well under one percent for your STs. In this case, you've got a 40-fold difference between these two ***asleep at the wheel*** for your single-vehicle risks multi-vehicle crashes. Now that gets back to the apples and oranges things.

Here's an interesting one also. This is now the other driver multi-vehicle crashes. It happened to be much higher for the CTs than the STs. I interpret that as the fact that CTs are the ones out on the big highways and doing the long-haul driving and that means they're exposed to four-wheelers doing long-haul driving and falling asleep at the wheel where as STs are not so exposed.

SLIDE 31: THE AVERAGE LTCCS CRASH INVOLVEMENT OCCURRED UNDER "BENIGN" SLEEP AND SCHEDULE CONDITIONS

Getting back to these schedule variables, the average LTCCS crash occurred under what I call benign sleep and schedule conditions. The driver, according to the investigations, had 7.5 hours sleep; it had only been 6.3 hours on average since their last sleep; it was midday; after 3.8 hours of driving when the legal maximum was 10; after 4.4 hours of work or slightly different hours since their last break; and 4.5 hours of work. These are all midday or even early in the schedule as averages.

SLIDE 32: CRASH INVOLVEMENTS BY HOUR-OF-DRIVING

Here I've taken this same data for one particular variable, ***hour-of-driving***, for CTs and STs, and the legal maximum was ten. You can see that the vast majority of these crashes are happening first, second, third, fourth, fifth hour of driving and it goes way down from there. There were some, of course, where you had what was not illegal driving, but it's not a high percent of the crashes—crash involvements.

SLIDE 33: FEW DISCERNIBLE SCHEDULE EFFECTS ON OVERALL CRASH CAUSATION; AVERAGE CT VALUES (USING MID-POINTS)

If you compare these different categories, this is CT data, you compare these same single-vehicle, multi-vehicle, truck CR and multi-other vehicle CR. We're not going to go through these individually, but they were almost the same. Here's one that was a little different: the single-vehicle crashes tend to, drivers tend have little bit lower levels of sleep. Most of the others they're all about the same. There is really no pattern there. If fatigue, hours of working and these schedule factors for driving overall involvement and type of involvement, like the other variables did, then you would expect to see some differences and we did not see those.

SLIDE 34: CUMULATIVE INVOLVEMENTS BY HOURS-OF-DRIVING FOR THREE CRASH CATEGORIES (CTS + STS)

Here I've done this for the same variable. I've done it a different way where I am plotting the cumulative curves for these same three crash types. If these schedule variables . . . The single-vehicle crashes have 13 times the fatigue, asleep at the wheel at least than the multi-vehicle ones. If these schedule variables were affecting overall crash causation, I would expect to see some differences between these three lines. I would expect to see the single-vehicle line start low and then come high, as these hours of driving are creating fatigue that is a big factor in single-vehicle crashes. I would expect to see some separation and that's not the case, so I interpret that being these schedule factors do not drive crash causation.

SLIDE 35: SUMMARY & CONCLUSIONS

That's it. We looked at 44 variables. There are numerous specific findings: some of them all kind of go together in a harmonious way, some of them are specific; some differences between CTs and STs, but many more similarities. Really, the most revealing difference is were between the different crash types, the different crash categories and also the specific crash types that we didn't have time to talk about.

The moral of the story here is that crash causation is very much crash category specific.

SLIDE 36: *THANKS FOR PARTICIPATING!* RON KNIPLING – RKNIPLING@VTTI.VT.EDU

That's it. Thank you for getting through this with me.

[44:34]

QUESTIONS AND ANSWERS

Kirse Kelly: This is Kirse again. We are now open for questions. If you want to ask a question, you can submit questions in the **Q&A Box** which is on the left side of your screen, or if you want to ask questions over the phone, you just press ***1** and state your name to the recorded message. When your line is open Christina, our phone operator, will announce you by name. So please state your name clearly for proper pronunciation. The questions are going to be answered in the order that they are received. Also, once again, please note you are going to be given an opportunity to receive a copy of this presentation at the end of the webinar. If you need to leave, you can come back to this website later and download the presentation. It will be available at the end of the webinar.

Kara Kockelman: ***You mention "cars"; do you mean "LDVs"?***

Ron Knipling: In the LTCCS, other vehicle was any other vehicle. The one graph where I had a histogram where 1.0 was cars, those were passenger cars.

Guest: ***Does ST include buses and coaches?***

Ron Knipling: No. This is straight trucks—10,000 pounds minimum, non-articulated truck.

Harold McClellan: ***Was this study done before the change to 11 hours driving?***

Ron Knipling: Yes, that change was early 2004 and this data collection ended in 2003, so it was the old hours of service.

Marlene Mirochna: ***Was what shift the driver was on—days, swing or night—a factor in any of these crash causations?***

Ron Knipling: We did not look at shift per se. Actually, one thing we did look at that maybe answers that question a little bit and I meant to mention this along the way—as far as time of day, we mostly just looked at the crash types that I have shown here, but we did one other comparison. And that is, we looked at the CR of asleep at the wheel and we related that to time of day. And this was really quite interesting. I meant to mention this earlier. Sixty-two percent of all of the ***asleep at the wheel*** crashes occurred between just a two hour period, between 4:00 A.M. and 6:00 A.M. Of all the other crashes, it was five percent of the crashes. So you have no schedule variables, where at least as far as overall involvements were very weak, but as far as asleep at the wheel goes, time of day was a major factor. We did not look specifically at shifts and we did not look at the schedule variables in terms of—we did not do a complete analysis of those in the sense of looking at all the different sleep things like the driver fatigue variables by schedule or CR by schedule. There may be some relationships there that exist as far as fatigue crashes—probably are, but we did not. This was not primarily a sleep study, so we did not look at that.

Tom Anderson*:** ***How was determination made on the asleep causation?

Ron Knipling: I'm going to let Ralph comment on that in a second because he can say more. I will say this, the reason why I like the CR variable—you know, you can criticize it as being—people say it's interpreted as the sole cause and it's easy to fall into that, but the reason I like it is you've got a full array of choices and the investigator chooses among those choices. I think the bias in those selections is very minimal. Whereas the associated factor variables, in general, it's easy to say, oh well, he was probably fatigued or some other associated factor, he was probably emotional. And I think it would be easy to overcoat those whereas the critical event ones the investigators are choosing from a list based on certain criteria. Ralph, you probably want to say more about that.

Ralph Craft: Sure, I am interpreting the question to mean how did you know that somebody was asleep or fatigued? There is no scientific way to measure fatigue. There's some—I know that Ron's been involved in naturalistic driver studies where you can, where there's a camera in the truck or other vehicle focusing on the driver so you can see the driver sort of nod off or watch their eyes blink or watch their attention wander, but there is no—we didn't have those kind of cameras obviously involved in this study. Fatigue was determined on the basis of the researcher talking to people at the scene, talking to witnesses, talking to drivers, reading police reports, autopsy reports, hospital reports, putting everything together. In some cases we tried to get our researchers and police officers who inspected the trucks and the truck driver to the scene as quickly soon as possible. And in some cases drivers would admit that they had fallen asleep or were fatigued. In other cases, witnesses were used. We had one case where a truck driver's records all completely checked out, but he fell asleep between every interview at the scene of the crash, so he was coded as being fatigued at the time of the crash. It is a subjective judgment on whether somebody was fatigued or asleep based on the judgment of the researcher and the people who backed up the researcher and reviewed the data that was coded based on whatever information could be gathered at the scene of the crash and before from the companies involved and even from relatives and friends. In cases where drivers died, relatives and friends of the drivers were interviewed.

Kirse Kelly: Christina do we have any questions on the phone line?

Christina: At this time we have no questions.

Julia Trobaugh: Do you have a theory as to why most crashes are occurring during the early hours of driving as later hours would seem more likely?

Ron Knipling: Well, my theory is that it's the—two things. I think it's traffic, exposure to traffic that it drives crash involvement much more than any other factor, so I think if you basically look at when the traffic is heaviest, that's when you are going to see the most crashes, regardless of schedule or even time of day, even though time of day has a very strong effect on CT crashes, that's just one, that's really small percentage of crashes. I think it's traffic and also it's just exposure. Again, every truck driver who works drives the first hour, but then some of them stop after the first hour and some of them stop after the second hour and so forth down the line. It's a relatively small percentage of drivers in any given work day that are driving maximum hours, so there's just not that much exposure. All the debate about 10 versus 11 hours, we're really just talking you know maybe just five percent. I don't know the exact percentage there, we don't have exposure numbers in the LTCCS, but it's something like five percent of the crashes in driving are occurring during that particular hour.

Tom Anderson: Was crash avoidance technology noted in the study?

Ron Knipling: We did not look at it. I'm pretty sure it was noted, but I'm also pretty sure it was such a small percentage of vehicles that it was miniscule in the data. Right, Ralph?

Ralph Craft: Yes, that's right. At the time the study was done, 2001–2003, there was very little equipment that was installed on trucks. It's not a factor, really at all.

Kara Kockelman**:* ***There's a question here. How do you feel about the risks of longer combination vehicles? Are a superior drivers and driving conditions? What makes their crash rate and crash severities lower? Are their rates dramatically lower, in your opinion?

Ron Knipling: We did not look at them in this study. I know that there were some. So Ralph can tell you about that.

Ralph Craft: We had no triple-trailers in the study. No crashes was there a triple-trailer combination and very, very few long double combinations, so we really can't comment on whether they're safer or not based on the study.

Ron Knipling: Right. And I'll just say that separate data that I have looked at, I think they are driven by superior drivers as you suggest. That is probably the principle reason why they have such a good crash rate picture. Of course, there's the whole idea—remember the slide that said every vehicle type has about the same crash cost per mile and that's $0.10 cents? And that's through combination trucks, single-unit trucks, cars, light trucks, vans. Motorcycles are the only one that's way out of line there. If these other vehicle types, they all have the same crash cost per mile, if the LCVs fall into that same pattern, then for the freight movement, it's safer to move freight with a larger vehicle. I think that's the principle of safety, but that's not from this study.

Mark Schauerte: What prompted you to study the difference in terms of crash results for these two types of CMVs?

Ron Knipling: This was put out for proposals and this is was one that we wrote. It was really the rationale that I gave early; the two slides giving the background information from the other study: you've got a very different crash picture in terms of crash problem size. Similar in some respects, but very different in the big one, which is the per vehicle likelihood of crashes and crash costs which drives just about every countermeasure, and is applied on a per vehicle or per driver basis, so there's a huge difference. The study did not address regulations, but if you're doing cost-benefit analysis on some device or regulation that affects one of these crash types, you really should do it with the vehicle types that are addressed by the regulation. If there were a big difference between CTs and STs, then you could overestimate or underestimate your effectiveness by using aggregated statistics when you should disaggregate them and, at a federal level, use CT statistics.

Ralph Craft: I want to comment on that a little. As Ron said, this is one of the studies of the LTCCS data that we funded. We funded this one because of exactly what Ron just said, that combination-unit vehicles have a great deal—there's a much higher lifetime cost per vehicle to a combination-unit vehicle truck. This could have great implications for our safety regulation because we could emphasize more combination-unit trucks than single-unit trucks because they will have a higher lifetime crash cost in terms of lives lost, injuries and property damage. So the main reason we funded this study was that Ron is an expert in this area—the difference between single-unit trucks and combination-unit trucks—and we wanted him to get a look at the data and find out anything that he could about these differences.

Kirse Kelly: Christina is there any questions on the phone lines?

Christina: At this time, ma'am, there are no questions.

Guest: Regarding more accidents that are happening in the early hours, what percentage of the trips are greater than one, greater than two or greater than ten hours long?

Ron Knipling: We did not have that data because in the crash dataset every trip ends with a crash, so you don't have non-crash trips. Other people have done those studies and some cases they have claimed/seen the effects of schedule on crashes versus non-crashes. There are quite a few methodological issues in those, but it wouldn't be right for me to pontificate on that. We don't have that.

Peter DePuccio: Was age considered a factor in this study?

Ron Knipling: We looked at age, not only in general, driver age, but also we looked at it, we did look at in relationship to several other variables. I could've included a little bit on that. One interesting thing was there weren't a lot of older drivers. Since I'm 61, I'll say that older driver here is 61 or older. They were the best drivers as far as their profile of CRs or non-CRs. They were least likely to have the CR and that was almost across the board in terms of different categories, including, I'm pretty sure, physical ailments and asleep at the wheel. There weren't a lot of them in the study, but they were the best category.

Chuck Fortin: For crashes where vehicle failure was involved, what do you think contributes to the vehicle failure?

Ron Knipling: For CTs, there were quite a few cargo securement problems. For STs, it was mostly brakes—although brakes were on both. Then you had some other things as well, tires—I'm looking for this in their report, just a second here. Actually this particular information, you would find if you have some of the main reports that FMCSA's put out about the study, particular CRs are listed. Okay, you've got—cargo shifts were a lot higher for CTs than STs; suspension failures were more of the STs—two percent of the ST critical reasons, but none of the CTs; brakes were more common, were almost three percent of the STs, but only half that of CTs. Tires were about one percent of STs, but about a half for CTs.

IMMI: ***Of the crashes in question, what amount would have benefited from technologies like forward-collision warning systems and blind spot detections?***

Ron Knipling: We did not calculate those specific percentages. I would say it was—my opinion is that it's a lot of them. Your rear-end crashes would be highly addressed by forward collision warning systems. Your lane change merge crashes—we didn't talk about that, but lane change merge crashes are the crash type where trucks are most over-involved compared to other vehicles—you have your side object detection systems, and they're very applicable. Road departures, you have lane departure warning systems for more your drift-off road scenarios. You have your rollover systems that detect excessive speed on curves and that was patterned there. So if Ralph would give me a little bit more money, I'll give you complete rundown based on the CRs, but I think that they're highly applicable to many of these truck crash types.

IMMI: ***Does the estimated crash cost per mile of $0 .10 relate to this study only? How was the figure established?***

Ron Knipling: It was not from the current study it was a study that I was involved in. I did provide the citation on the slide. I've got that PDF if somebody wants to e-mail me, I'll send it to you. It was a study called of *Dimensions Motor Vehicle Crash Risks*. Just to clarify that was the costs, the economic costs—economic loss, including loss of wages, lost income, medical for everybody involved in all of the crashes that those vehicles were involved in. I wouldn't say that they are causing that loss, just that they were involved in it. When you calculate that for each vehicle type, the way it came out was that the four main vehicle types, cars, light trucks/vans, tractor-trailers and single-unit trucks were all almost exactly the same. Motorcycles were five times higher. If you looked at crash cost per vehicle life cycle, the other thing that needs to be said is tractor-trailers—the CTs were way above everything else. That's why with all of these metrics, you need to know what you're denominator is.

Harold McClellan: ***Was overweight (it's not clear if this means a person being overweight or a truck being overweight), considered into the vehicle causation?***

Ron Knipling: We did not look at it. There were vehicle inspections. I don't really know anything about the vehicle being overweight. I could talk a little bit about people being overweight, but I don't think that's the question.

Kirse Kelly: Are there any other questions on the phone line at this time, Christina?

Christina: If you would like to ask a question please press *1. No, we do not have any cued up at this time.

Kirse Kelly: Okay, thanks. Okay we will go ahead and move on though, since we do not have any other questions here.

[1:07]

Kirse Kelly: We just want to thank you very much for participating in today's webinar. We'd like to ask you to just fill out our evaluation and let us know your comments about this webinar and suggestions, any suggestions for future webinars. To insert suggestions, you would just type comments in the space at the bottom of the pod on the left side and click on the arrow. The comments provided here can be viewed by all the participants in the meeting room. So if you want to be anonymous you need to click on **Everyone** and chose **FMCSA Host** and that's the one you will write to.

You can also download a PDF version of the presentation at this time. Just highlight the document in the "Download presentation" pod and click **Save to My Computer.**

Once again, members of the trade or a local media who are participating in today's call should contact our Office of Communications, and that's 202-366-9999.

Once again, thanks a lot, thank you for participating in our webinar. We have confirmed webinars for October and we will be sending out invitations. Please continue to check the FMCSA ART website to register for future webinars. If you are not yet on our mailing list, you can send a request to Kirse.Kelly@dot.gov. You can also see up here the Large Truck Crash Causation Study Website. If you want to get more information on the study you can go there and check that out. And you can e-mail Dr. Knipling or Dr. Craft with any questions you have.

Thank you very much, Ron, and thanks again for participating. Christina can you switch back to presenter only and close the lines?

Christina: Yes. All parties may disconnect at this time and I'll place you back in post conference, one moment.

Kirse Kelly: Thank you.

Christina: You're welcome.

[1:10]