

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

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October 15, 2008



Report: Comparison of Combination-Unit Truck and Single-Unit Truck Statistics from the LTCCS

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Acronyms

- ◆ **CT** – Combination-Unit Truck
- ◆ **ST** – Single-Unit Truck
- ◆ **CR** – Critical Reason
- ◆ **SV** – Single-Vehicle
- ◆ **MV** – Multi-Vehicle
- ◆ **Trk** – Truck
- ◆ **OV** – Other Vehicle

Purpose & Overview

- ◆ **Review 44 variables:**
 - Crash characteristics
 - Conditions of occurrence
 - Key causal variables
 - Associated factors
 - Fatigue & HOS-related variables
- ◆ **Compare LTCCS CT & ST statistics**
- ◆ **Compare 3 major crash involvement categories:**
 - **Single Vehicle (SV)**
 - **MV Truck Critical Reason**
 - **MV OV Critical Reason (CR)**

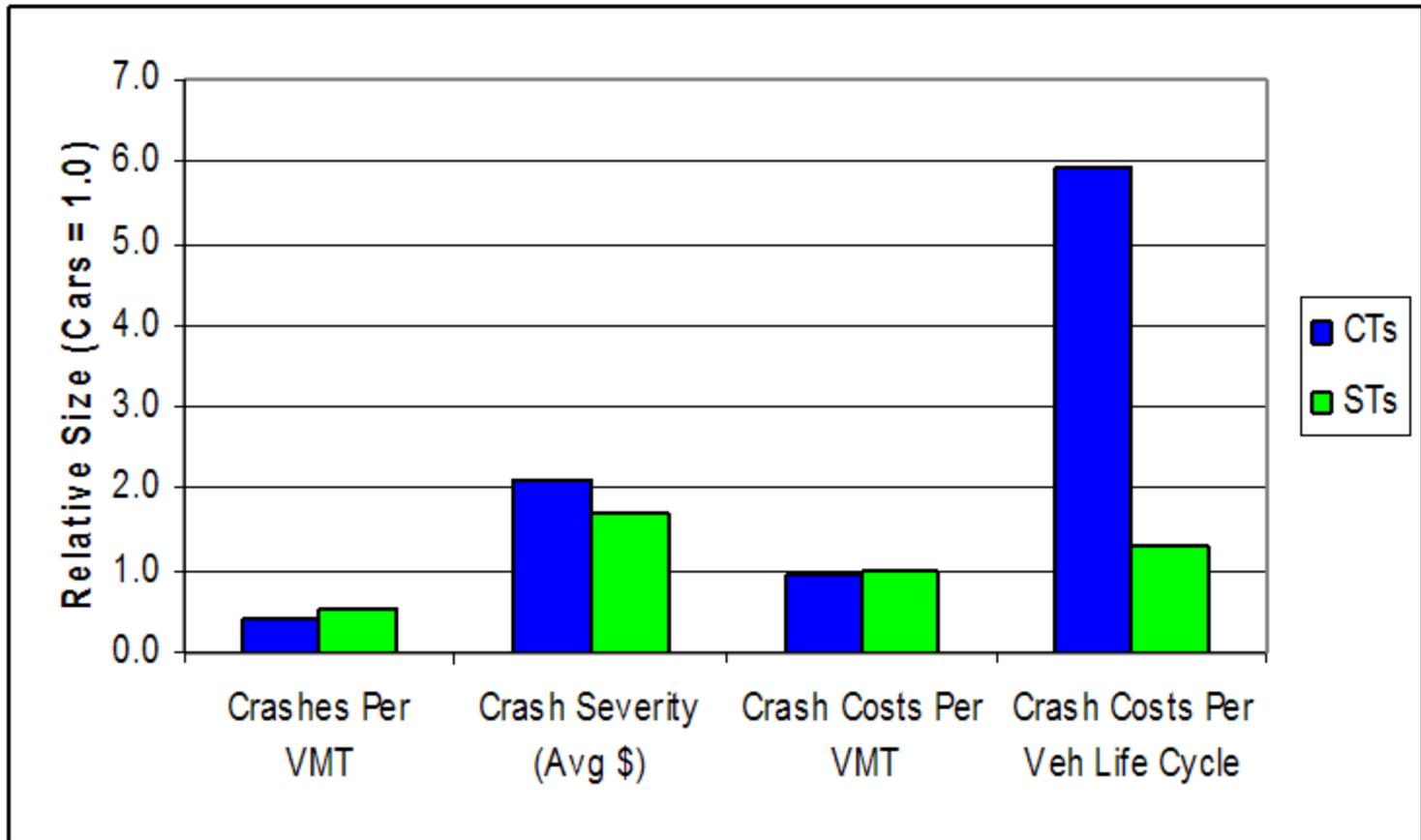


Background: CTs vs. STs

- ◆ CTs and STs have different physical characteristics, operational uses, and exposures.
- ◆ STs: Slightly higher crash *rates* per VMT.
- ◆ CTs: Much greater crash *likelihoods* (per vehicle) because of long-haul exposure.
- ◆ Countermeasures likely to have far greater benefits for CTs than for STs.
- ◆ Federal regulations of interstate transport apply generally to CTs but not STs.

Background:

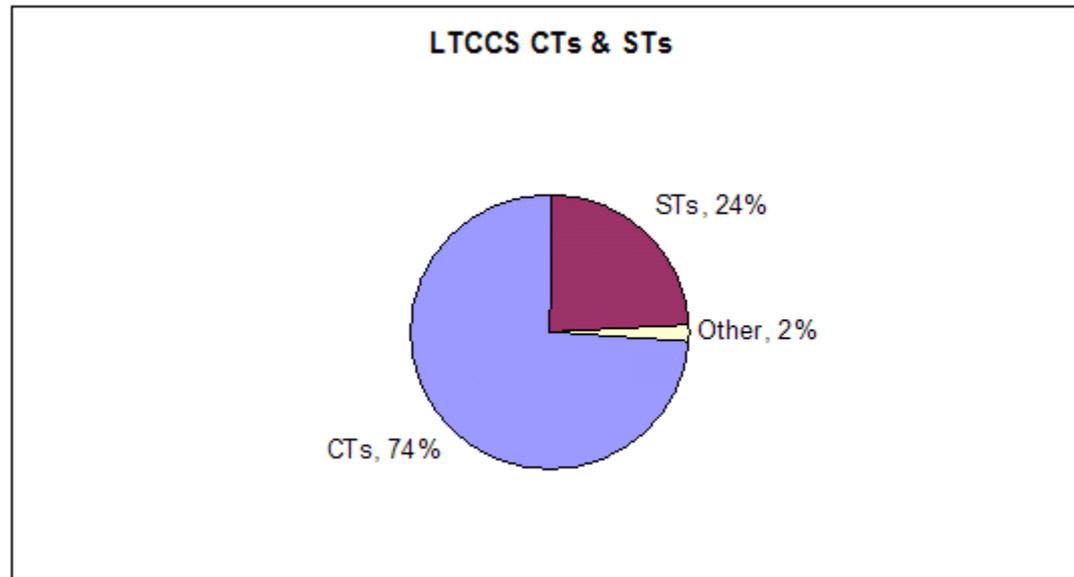
CTs & STs Compared to Cars



Source: Wang, J.S., Knipling, R.R., & Blincoe, L.J. The dimensions of motor vehicle crash risk. *J. of Trans & Stats.* Vol. 2, No. 1, Pp. 19-43, May 1999.

LTCCS Sound Bites

- ◆ Data collection in 2001-2003.
- ◆ 963 crashes involving 1,241 trucks & 837 other vehicles.
- ◆ Injury crashes (K, A, B) only, representing worst ~11% of police-reported large truck crashes.
- ◆ Crashes & vehicle involvements weighted to be nationally representative (*ala* GES).
- ◆ ~ 1,000 potential variables describing crash, driver(s), vehicle(s), environment, and carrier(s).



Methods: CTs vs. STs

- ◆ Compare & contrast CTs & STs in 44 variables
- ◆ Compare attribute profiles within variables
 - All trucks
 - CTs
 - STs
- ◆ For each truck type, compare attribute profiles for different crash/CR categories:
 - Total%
 - Trk CR %
 - SV %
 - MV Trk CR %
 - MV OV CR %
 - + Row Trk CR% for above two.

Example:

Primary Table for Light Condition

Light Condition	Total	CT	ST	CT/ST
Daylight	74%	69%	87%	0.8
Dark	10%	12%	4%	2.9
Dark, but Lighted	13%	15%	6%	2.5
Dawn	2%	2%	3%	0.7
Dusk	1%	2%	0%	---
Total	100%	100%	100%	---

Example:

CT Table for Light Condition

Light Condition	Total	Tot Trk CR	SV	MV Trk CR	MV OV CR	%MV Trk CR
Daylight	69%	73%	69%	77%	66%	42%
Dark	12%	13%	16%	9%	10%	37%
Dark, but Lighted	15%	12%	12%	13%	18%	31%
Dawn	2%	1%	2%	1%	3%	---
Dusk	2%	1%	1%	0%	3%	---
Total	100%	100%	100%	100%	100%	38%

Example:

ST Table for Light Condition

Light Condition	Total	Tot Trk CR	SV	MV Trk CR	MV OV CR	%MV Trk CR
Daylight	87%	89%	77%	95%	84%	48%
Dark	4%	3%	4%	2%	6%	---
Dark, but Lighted	6%	4%	6%	2%	9%	---
Dawn	6%	5%	12%	1%	1%	---
Dusk	0%	0%	0%	0%	0%	---
Total	100%	100%	100%	100%	100%	45%

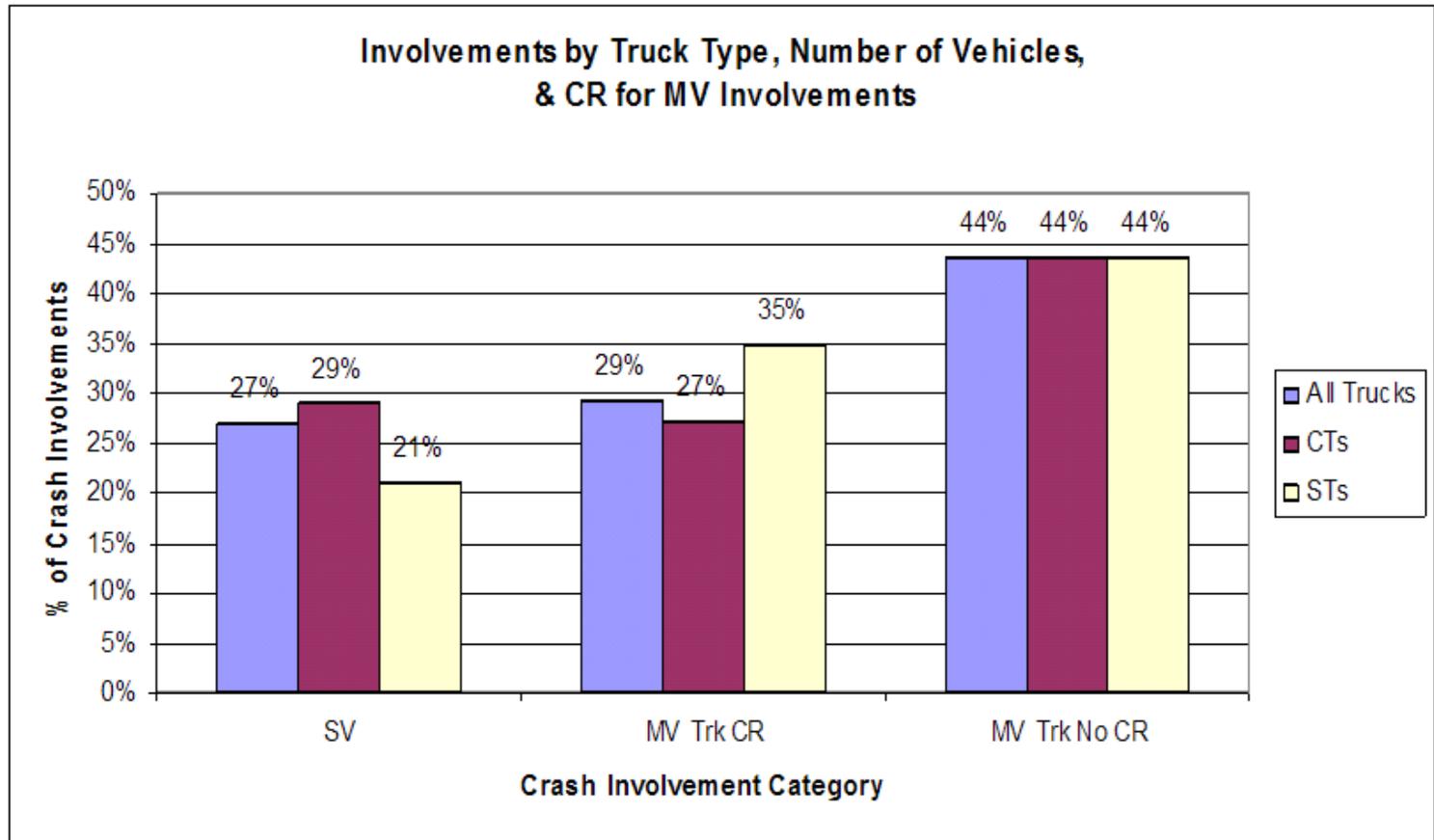
Basic Crash Characteristics

(Chapter 3)

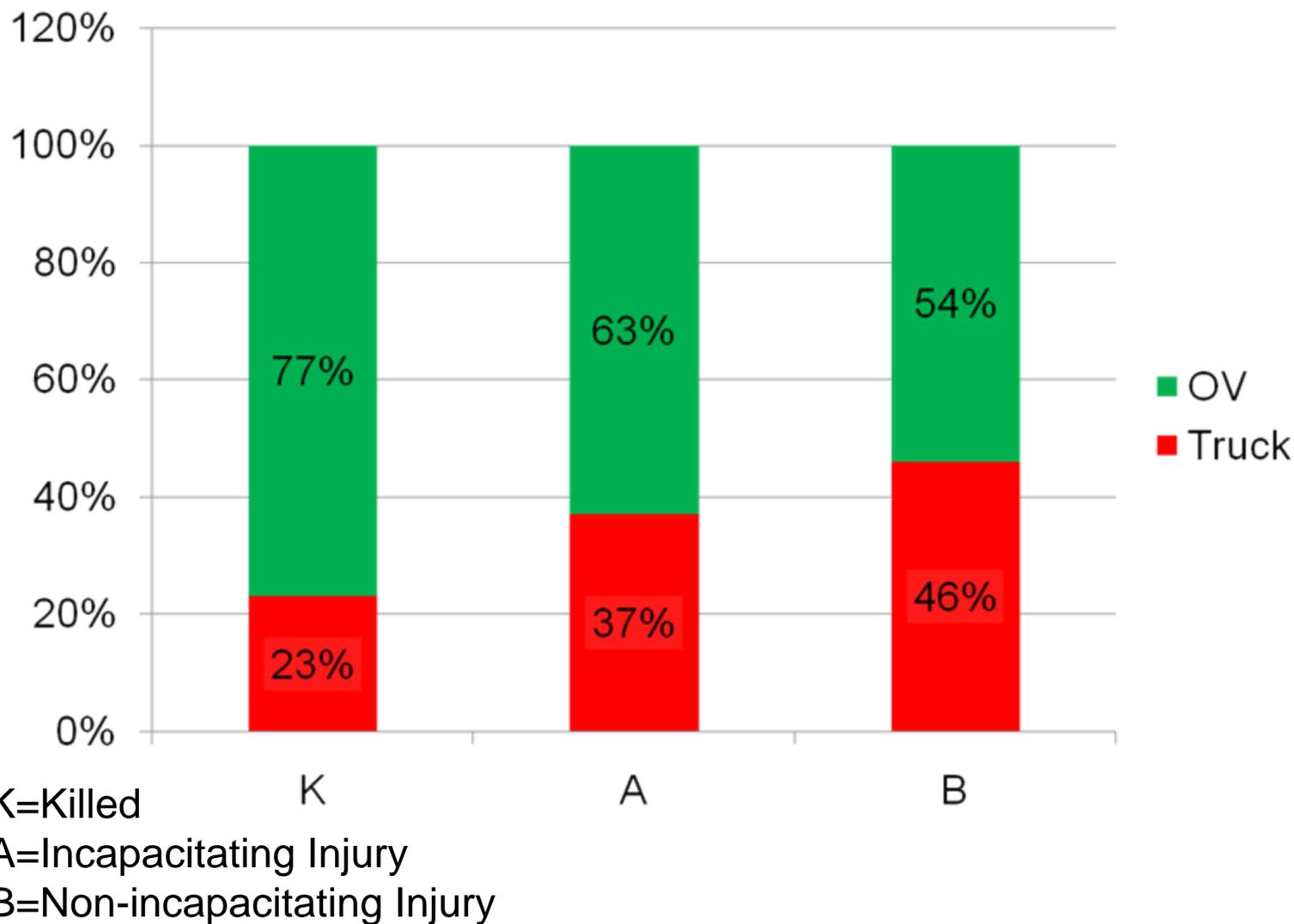
- ◆ **Number of Vehicles Involved**
- ◆ **Crash Severity**
 - **K – Fatal**
 - **A – Incapacitating**
 - **B – Non-Incapacitating**
 - **C – Possible**
 - **O – No injury (PDO)**
- ◆ **Crash Types**
- ◆ **Driver Age**



Three Crash Involvement Categories



Crash Severity & CR Assignment in MV Crashes



Crash Conditions of Occurrence

(Chapter 4)

- ◆ Day-of-Week
- ◆ Hour-of-Day
- ◆ Light Condition
- ◆ Roadway Surface Condition
- ◆ Relation to Junction
- ◆ Interchange
- ◆ Right-of-Way
- ◆ Route Signing
- ◆ Trafficway Functional Class
- ◆ Trafficway Flow
- ◆ Flow Restriction
- ◆ Construction Zone
- ◆ Posted Speed Limit
- ◆ Roadway Alignment
- ◆ Roadway Profile
- ◆ Pre-Crash Movement
- ◆ Pre-Impact Stability
- ◆ Attempted Avoidance Maneuver.

Conditions of Occurrence Highlights

- ◆ **Most crashes on weekdays, during the day**
- ◆ **Rush hours: many crashes & trks more CRs**
- ◆ **More CT crashes on divided roads**
- ◆ **Urban 53% > Rural 47%**
Urban → More Trk CRs
- ◆ **Work zones: 13% but no CR association**
- ◆ **Curves associated with SV crash involvements, especially for CTs**
- ◆ **~1/2 of trucks made avoidance maneuver; more likely when CR assigned to truck.**

Key Causal Variables (Chapter 5)

- ◆ **Critical Event Category**
- ◆ **Critical Reason (CR) Category**
- ◆ **Specific CR**
- ◆ **Top CRs for 7 Crash Types:**
 - **Road departures**
 - **Rear-end, lead vehicle stopped, striking vehicle**
 - **Recognition failures – 31%, tailgating – 8%**
 - **Rear-end, lead vehicle moving, striking vehicle**
 - **Recognition failures – 20%, tailgating – 31%**
 - **Sideswipe, encroaching vehicle**
 - **Opposite direction (e.g., head-on), encroaching vehicle**
 - **Turn across or into path, turning vehicle**
 - **Straight crossing paths, striking or struck.**

CR Categories: All Trk-CR Involvements

Category	Examples	CT	ST
Driver Physical Failure	<ul style="list-style-type: none"> o Sleep-at-the-wheel o Heart attack o Other physical impairment 	12%	12%
Recognition Failure	<ul style="list-style-type: none"> o Inattention o Distraction (internal or external) o Looked but did not see 	28%	31%
Decision Error	<ul style="list-style-type: none"> o Too fast for conditions o Following too closely o Misjudgment or false assumption 	41%	30%
Performance Error	<ul style="list-style-type: none"> o Overcompensation o Poorly executed maneuver 	6%	3%
Unknown Driver Error/Other	o Truck driver errors not classifiable	4%	3%
Vehicle Failure	<ul style="list-style-type: none"> o Brake failure (full or partial) o Tire failure o Cargo shift 	9%	15%
Environment: Highway or Weather	<ul style="list-style-type: none"> o Road signs/signals missing o Road design o Weather and/or slick roads 	1%	6%
Total:		100%	100%

Top 6 CRs: SV Crashes

Critical Reasons (some aggregated)	Tot Trk%	CT%	ST%
Too fast for conditions or curve/turn	30%	32%	23%
Sleep; that is, actually asleep	13%	12%	18%
Inattention (e.g., distraction, daydreaming)	13%	11%	17%
Cargo shifted	7%	8%	1%
Heart attack or other physical impairment	6%	7%	2%
Overcompensation	4%	5%	1%

Top 6 CRs: MV Crashes

Critical Reasons (some aggregated)	Tot Trk%	CT%	ST%
Inadequate surveillance (looked but did not see)	20%	18%	22%
Inattention (e.g., distraction, daydreaming)	20%	22%	14%
Too fast for conditions or curve/turn	14%	17%	7%
Illegal maneuver	8%	10%	6%
Following too closely	8%	9%	5%
Degraded braking or brakes failed	4%	3%	8%

Top 8 OV CRs (Compared to Trucks)

Critical Reasons (some aggregated)	MV OV CR	MV Trk CR
Inattention (e.g., distraction, daydreaming)	20%	19%
Inadequate surveillance (looked but did not see)	10%	19%
Driver error, type unknown	10%	4%
Too fast for conditions or curve/turn	10%	13%
Asleep-at-the-Wheel	9%	1%
Response execution error (e.g., overcompensation)	9%	3%
Illegal maneuver	7%	8%
Heart attack or other physical impairment	6%	2%

How Similar Are CR Profiles?



- ◆ Several statistical methods were used to compare various profiles.
- ◆ The Pearson r correlation coefficient is the most familiar.
- ◆ CTs vs. STs in SV crashes: $r = +0.74$
- ◆ CTs vs. STs in MV crashes: $r = +0.76$
- ◆ Trks vs. OVs in MV crashes: $r = +0.66$
- ◆ SV vs. Trk-CR MV crashes: $r = +0.18$
- ◆ Conclusion: In regard to causation, different vehicles are more similar than different crash categories.
- ◆ Implication: Analyses that combine all truck-CR crashes (SV + MV) are mixing “apples and oranges.”

Example: Pre-Crash Movement “Negotiating a Curve”

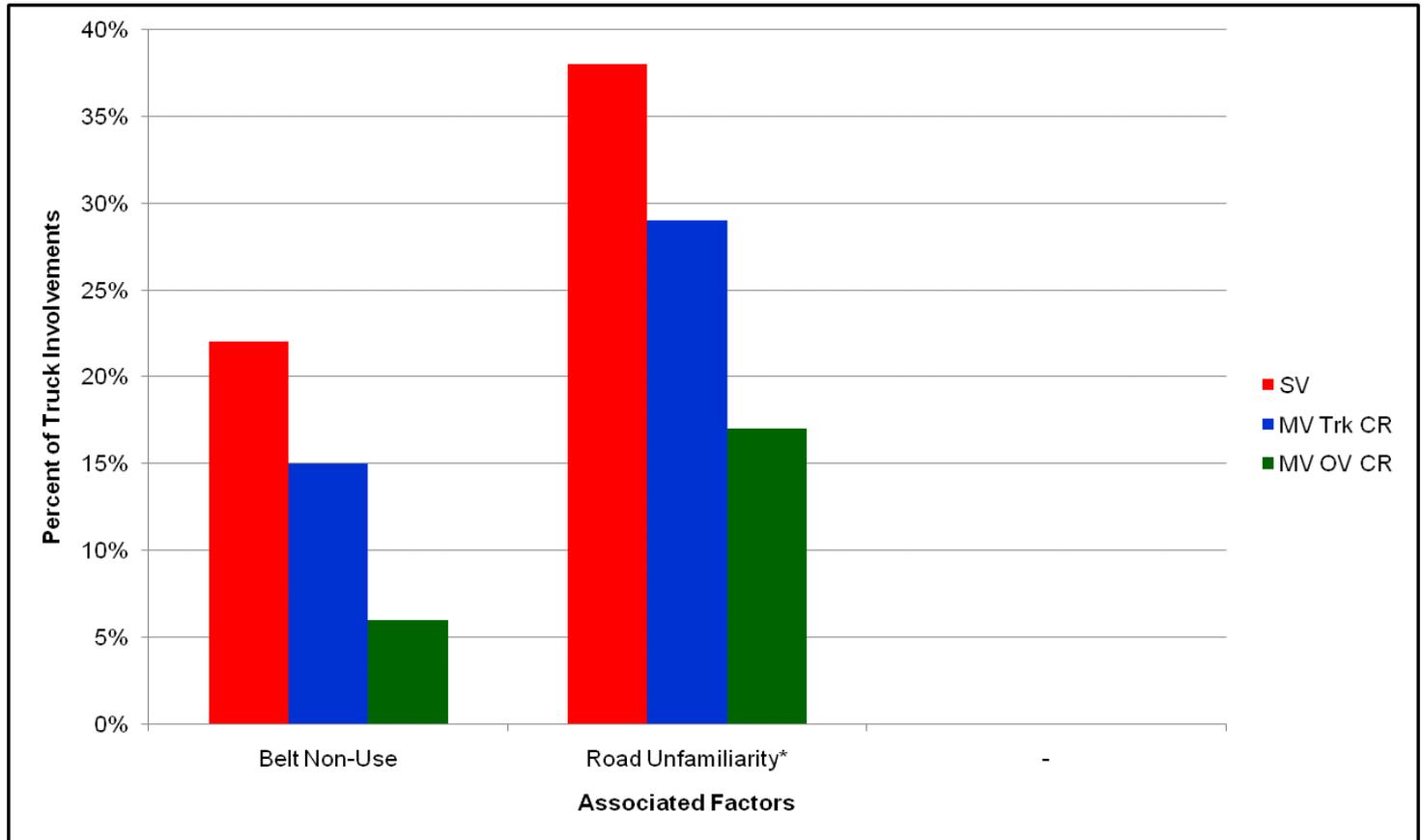


- ◆ Incidence for various LTCCS crash involvement categories:
 - All: 19%
 - All Trk CR: 28%
 - SV: 46%
 - MV Trk CR: 12%
 - MV OV CR: 9%
- ◆ “Relative risk” calculation method #1:
 $All\ Trk\ CR / MV\ OV\ CR = 28\% / 9\% = 3.1$
- ◆ “Relative risk” calculation method #2:
 $MV\ Trk\ CR / MV\ OV\ CR = 12\% / 9\% = 1.3$

Various Associated Factors (Chapter 6)

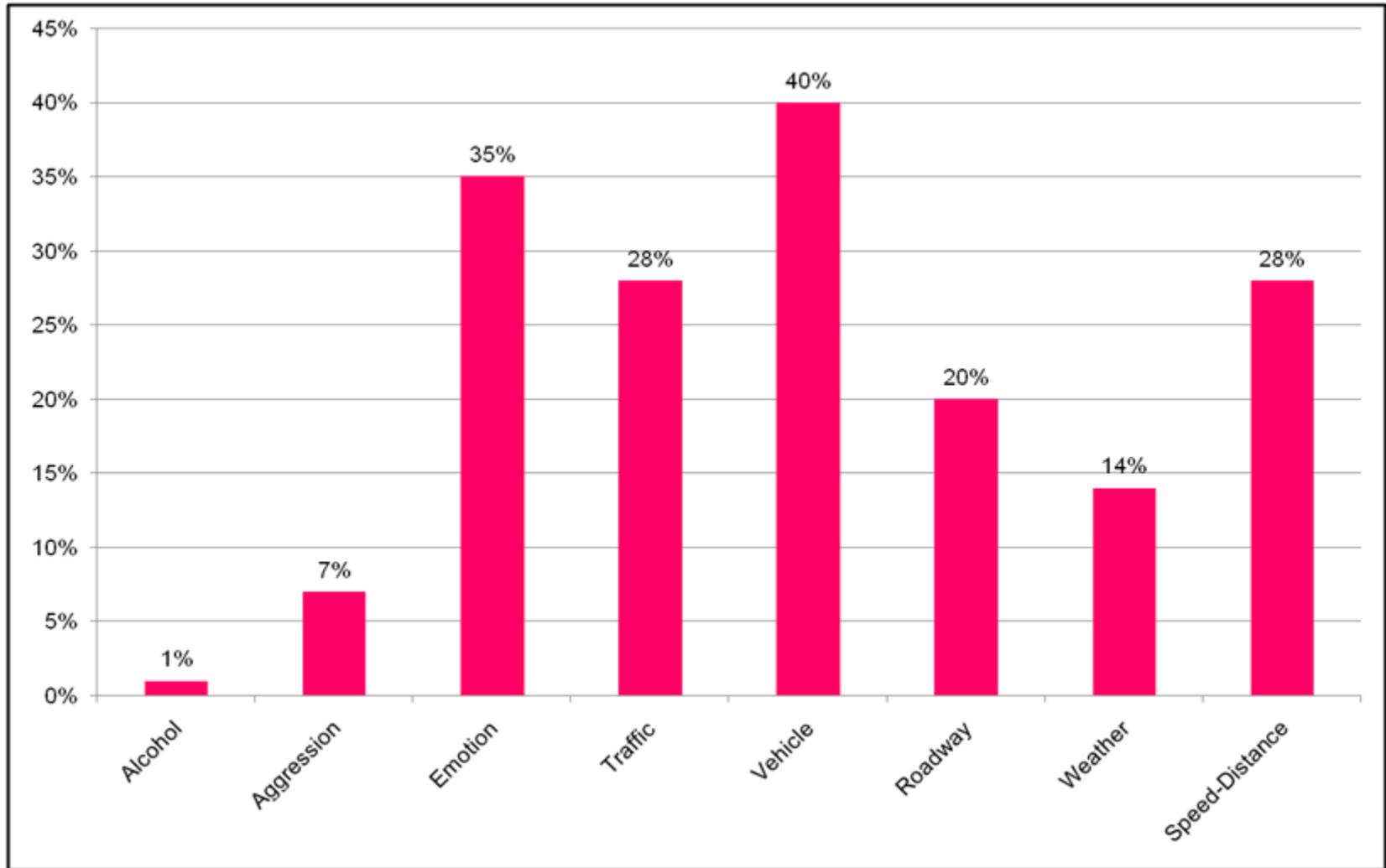
- ◆ Police-Reported Driver Safety belt Use
- ◆ Driver Roadway Familiarity
- ◆ Alcohol involvement
- ◆ Aggression factors
- ◆ Emotion/experience factors
- ◆ Traffic factors
- ◆ Vehicle factors
- ◆ Roadway factors
- ◆ Weather factors
- ◆ Speed/Distance Factors.

Belt Non-Use & Unfamiliarity With Roadway: Relation to Crash Categories

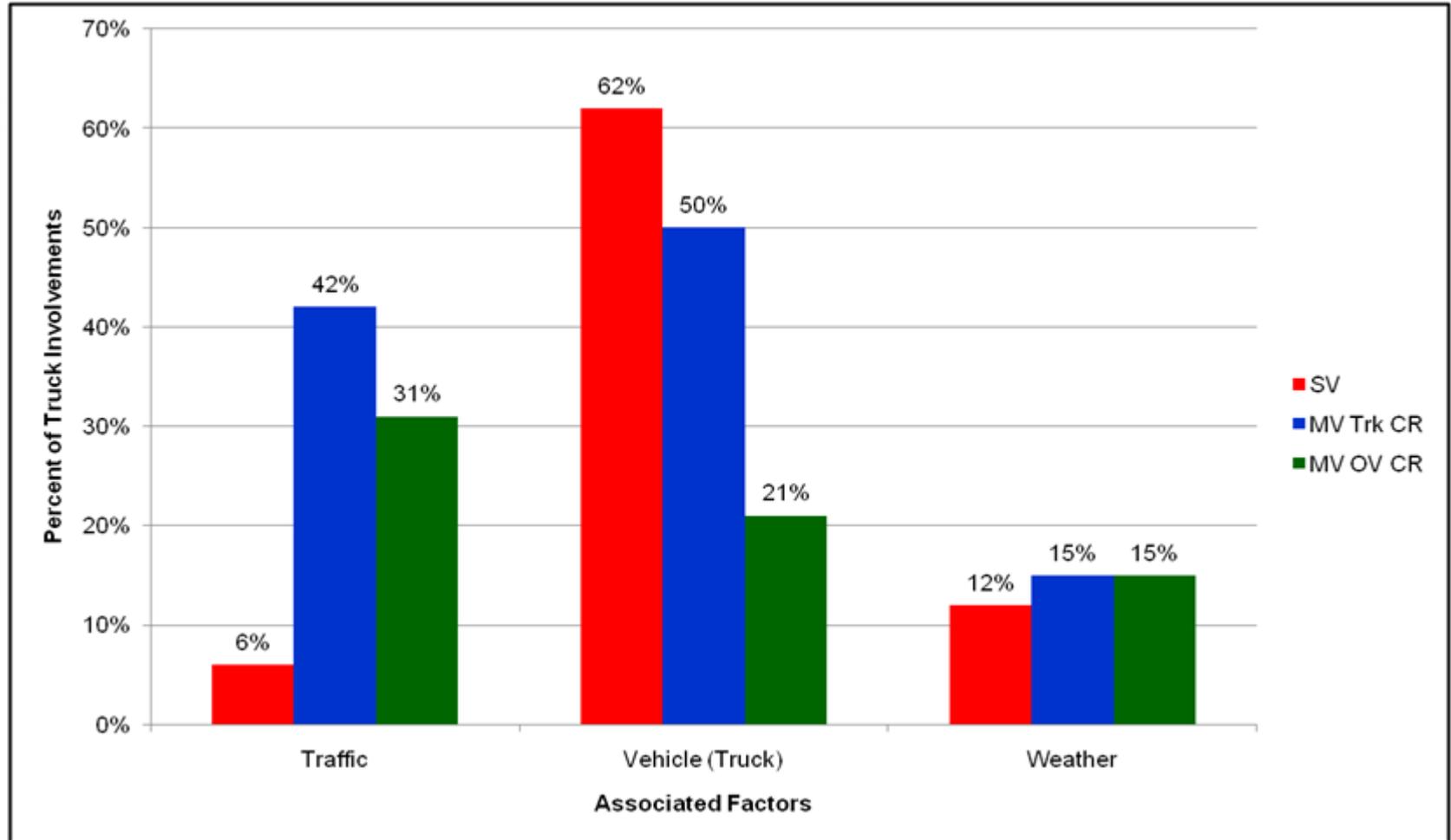


* Rarely or never drove road before.

Overall Incidence in Trucks: Various Other Associated Factors



Different Associated Factors Have Different Relations to Crash Categories



Fatigue-Related Associated Factors (Chapter 7)

- ◆ Sleep Related to Work Schedule
- ◆ Driver Fatigue
- ◆ Hours of Last Sleep
- ◆ Hours Since Last Sleep
- ◆ Hours Driving Since Last 8-Hour Break
- ◆ Hours On-Duty Since Last 8-Hour Break
- ◆ Hours Worked on Day of Crash.

Fatigue-Related Highlights

- ◆ **Sleep Related to Work Schedule:**
 - **CT drivers: 89%**
 - **ST drivers: 74%**
- ◆ **Driver Fatigue (Associated Factor):**
 - **CT drivers: 15%**
 - **ST drivers: 9%**
- ◆ **Asleep-at-the-wheel CR (in all involvements):**
 - **CTs: 3.8%**
 - **STs: 3.9%**
- ◆ **Schedule-related variables:**
 - **Most crashes in early or middle hours of schedule**
 - **Little relation between work/driving hours and crash causation category.**

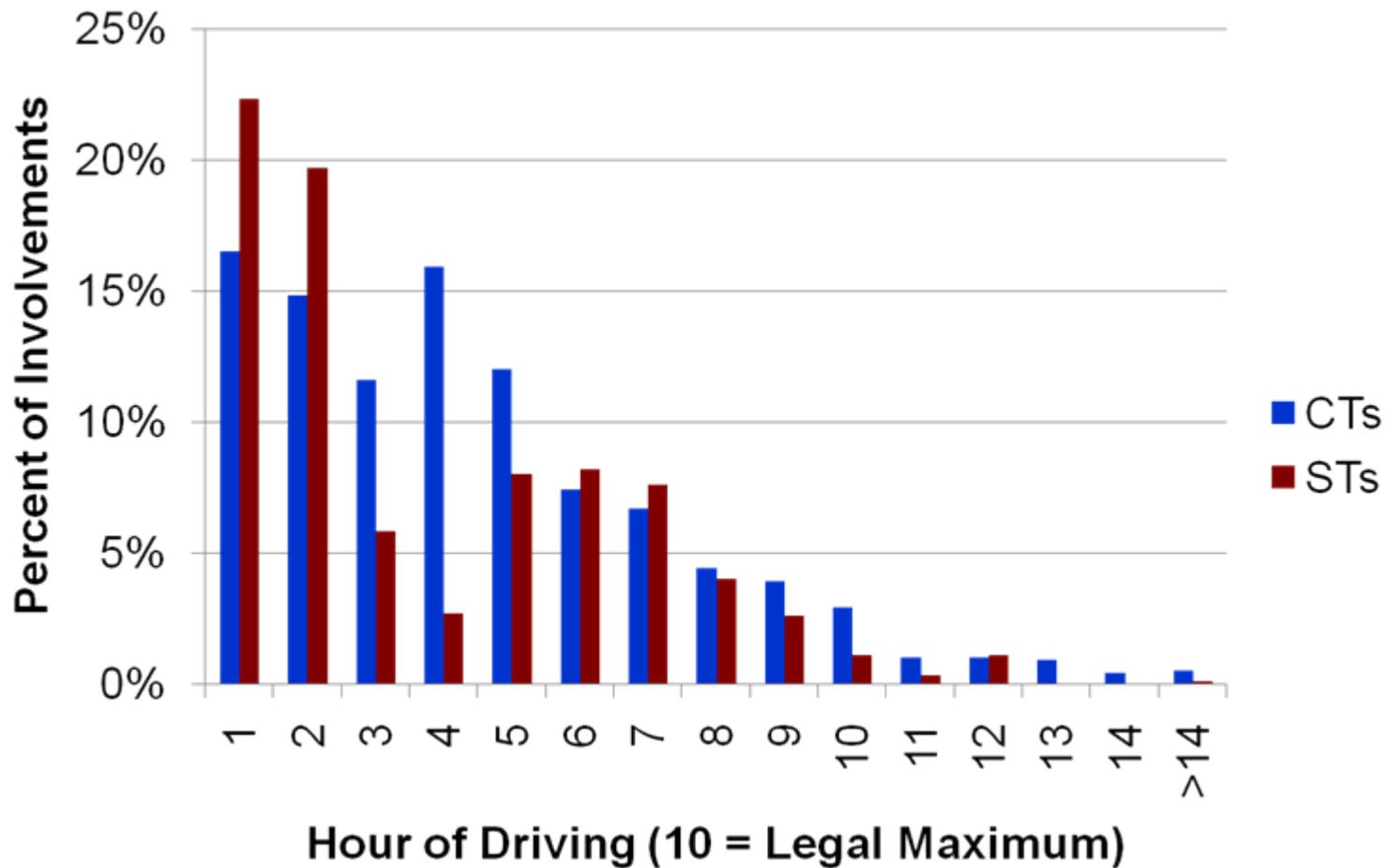
Watch Your Sampling Frame! Asleep-at-the-Wheel as CR for Different Crash Categories

Crash Category	CT %	ST %
All Involvements	4%	4%
All Trk CR Involvements	7%	7%
SV Involvements	12%	18%
MV Truck CR Involvements	1.4%	0.4%
MV OV CR (<i>Other Driver</i>)	11%	1%

The average LTCCS crash involvement occurred under “benign” sleep and schedule conditions

- ◆ 7.4 hours of last sleep
- ◆ 6.3 hours since last sleep
- ◆ 3.8 hours of driving (Max = 10)
- ◆ 4.4 hours since last 8-hour break (Max = 15)
- ◆ 4.5 hours worked (Max = 15)

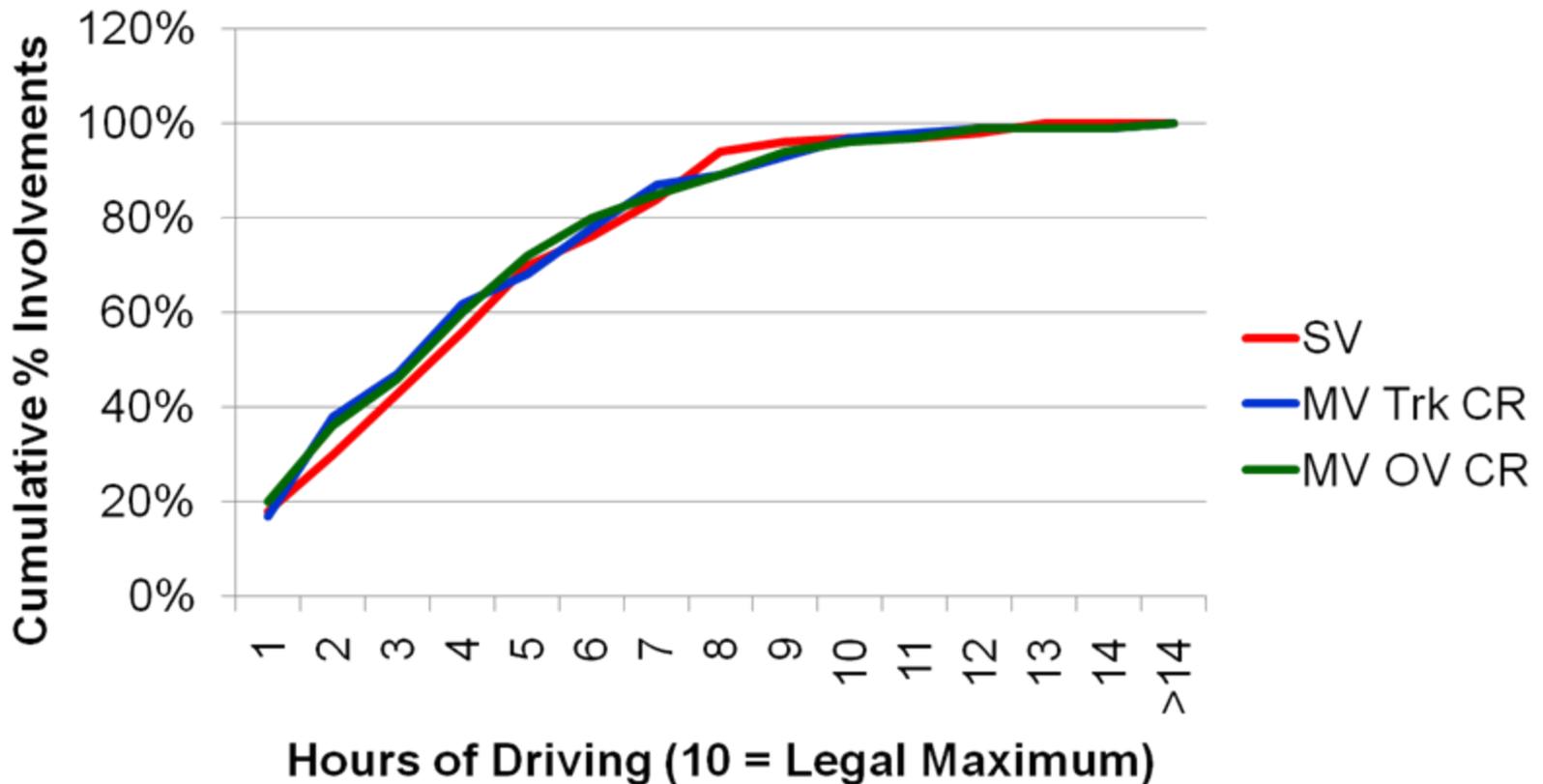
Crash Involvements by Hour-of-Driving



Few Discernible Schedule Effects on Overall Crash Causation; Average CT Values (Using Mid-Points)

Schedule-Related Variable	SV	MV Trk CR	MV OV CR
Hours of Last Sleep (0-12)	6.8	7.7	7.4
Hours Since Last Sleep (0-18)	5.9	6.2	6.5
Hours Driving Since 8-Hr Break (0-10)	3.7	3.6	3.6
Hours Driving Since 8-Hr Break (0-11)	3.7	3.8	3.6
Hours Driving Since 8-Hr Break (0-14)	4.0	3.9	3.8
Hours On-Duty Since 8-Hr Break (0-14)	4.7	4.1	4.5
Hours Worked on Day of Crash (0-14)	4.4	4.6	4.6

Cumulative Involvements by Hours-of-Driving for Three Crash Categories (CTs + STs)



Summary & Conclusions

- ◆ **Examined 44 LTCCS variables in 5 groups:**
 - **Basic Characteristics**
 - **Conditions of Occurrence**
 - **Key Causal Variables**
 - **Associated Factors**
 - **Fatigue-Related Factors**
- ◆ **Numerous specific findings**
- ◆ **Some CT-ST differences but many more similarities**
- ◆ **Most revealing findings related to 3 crash categories examined:**
 - **SV**
 - **MV Trk CR**
 - **MV OV CR**
- ◆ ***Crash causation is crash category specific!***

Thanks for participating!

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Thanks

