

NHTSA Heavy Vehicle Test Track Research

Frank Barickman

Devin Elsasser

National Highway Traffic Safety Administration



NHTSA Heavy Vehicle Test Track Research

- Stability Control Research
 - Truck-Tractor Stability Control Testing
 - Single Unit Truck Stability Control Testing
- Advanced Technology Research
 - Forward Collision Avoidance Testing

Stability Control Research



NHTSA Test Program

Initial Research

- Evaluate and test the performance of current heavy truck stability control systems
 - Tractor Based Systems
 - Roll Stability Control (RSC)
 - ESC - Yaw Stability Control (YSC) + RSC
 - Trailer Based Systems (no communication with tractor)
 - Roll Stability Control (RSS)
- Understand how these systems perform and their limitations to help estimate potential safety benefits
- Investigate and define test maneuvers that could be used to develop an objective test.

Maneuvers Evaluated

- 150 ft. J-Turn Maneuver
- Single Lane Change and Double Lane Change
- 150 and 200 ft. Constant Radius Maneuver
- High and Low Mu Surface Testing

Initial Results

- Found all levels of ESC/RSC/RSS to be beneficial as compared to the base platform.
- Found tractor based stability systems to be more beneficial than trailer based (i.e. activated sooner and provided interventions to mitigate roll without the trailer based system engaging.)
- Initial decision made to focus on truck tractor stability control and develop a performance test.

Initial Performance Test Focus

RSC – Roll Stability Control for truck tractors

- Develop an “optimized” roll stability performance test that can evaluate roll stability for truck tractors.

NOTE: NHTSA decided this based on preliminary crash statistics that roll stability should be part of any stability control test for truck tractors. Full stability control may be just as important.

RSC Performance Test Development Objectives

- Determine an RSC test maneuver
- Develop a methodology using test maneuver
 - Control trailer (multiple trailers?)
 - Load (CG, Weight, etc.)
 - Driver or Steering controller
 - Outriggers
 - Maneuver speed
- Develop a measure of performance (MOP)
 - Metric (acceleration, roll angle, wheel lift, etc.)

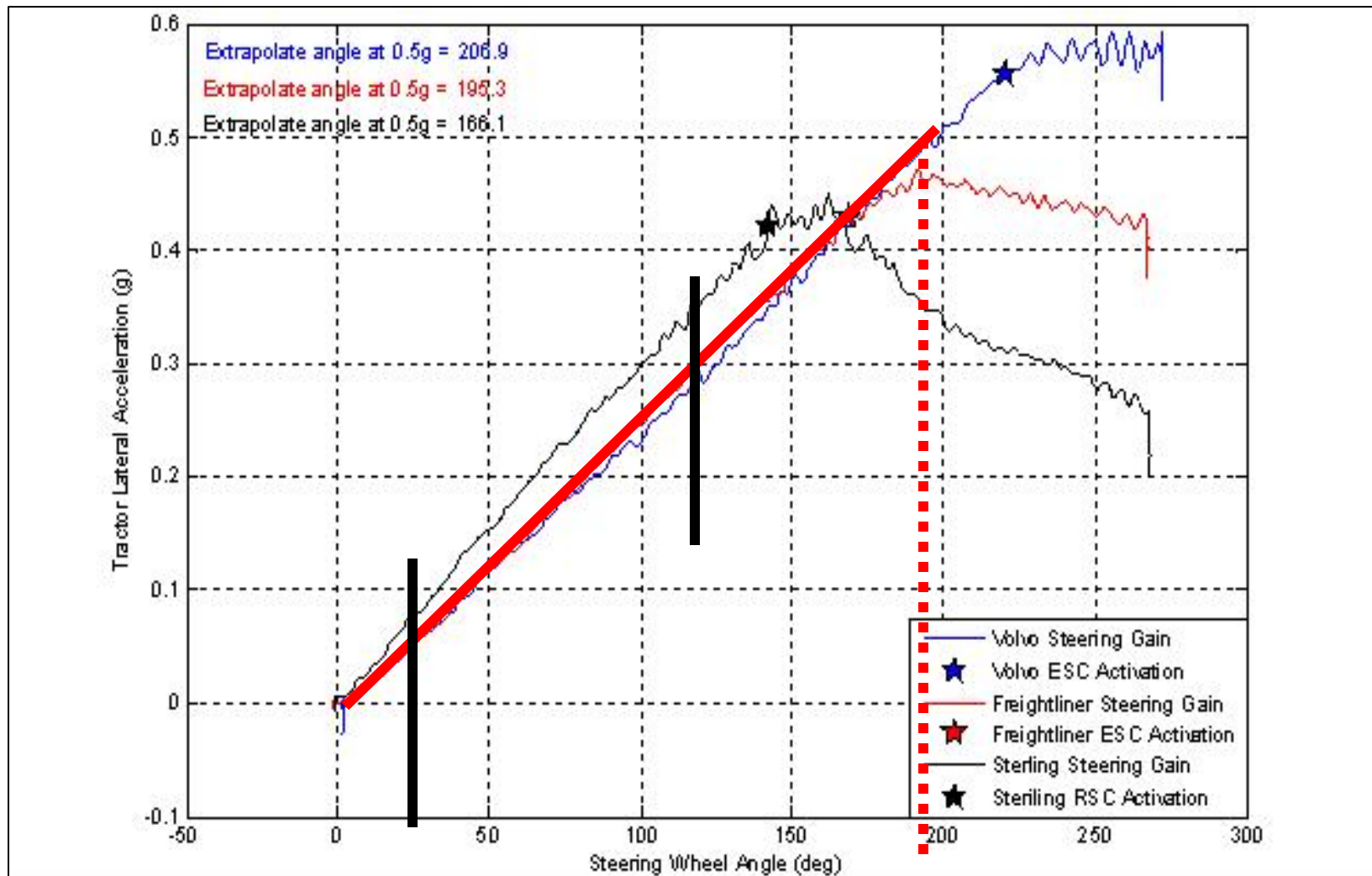
Government and Industry Coordination

- Met with the Truck Manufacturers Association, OEM Truck Manufacturers, and OE Brake Suppliers
- Regular coordination with FMCSA and PHMSA
- Identified potential RSC test maneuvers
 - Ramp Steer Maneuver (RSM)
 - Roll Stability Control Test (RSCT)
 - Decreasing Radius Test (DRT)
 - Slow Increasing Steer Test (SIS)

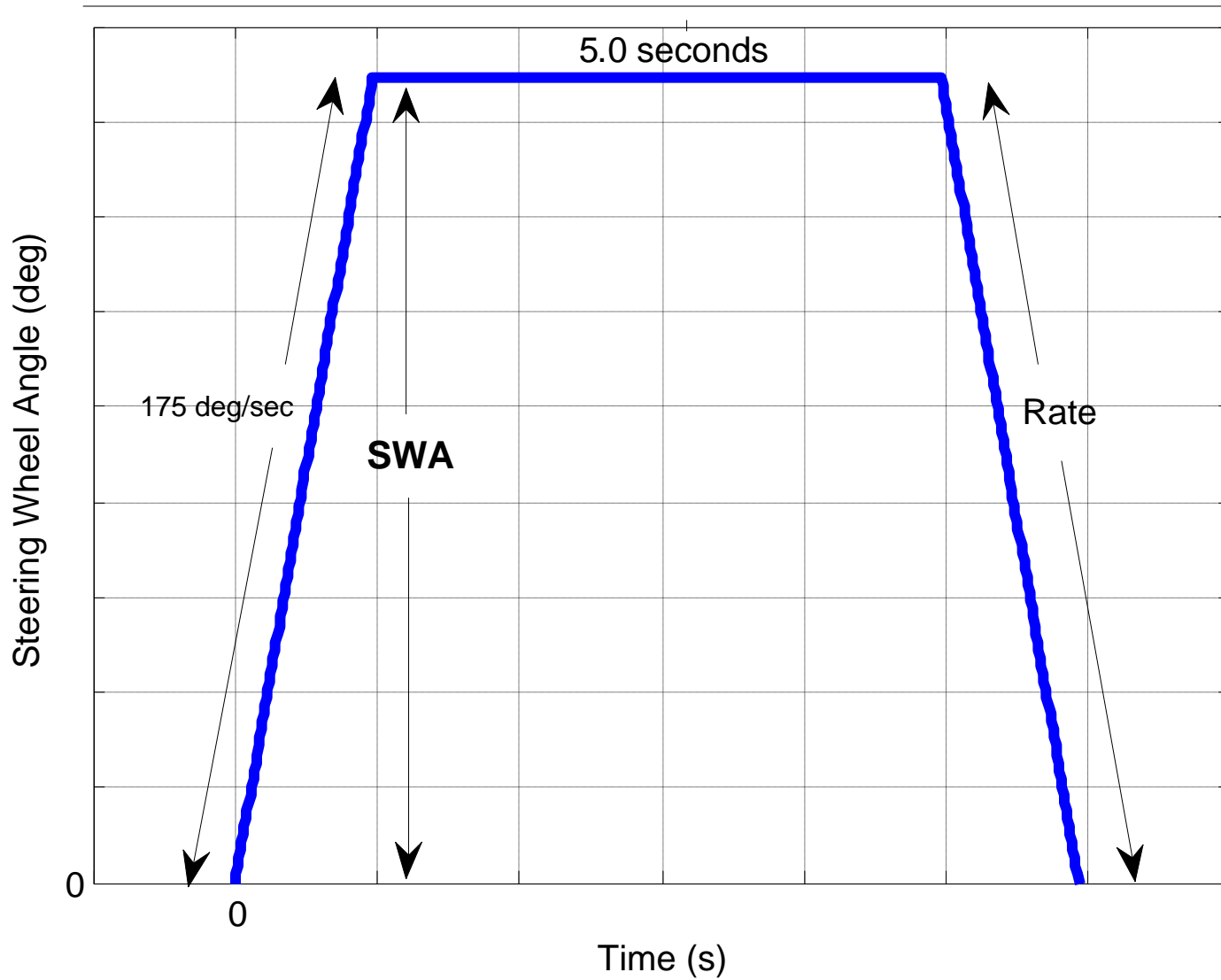
Research Maneuver Decision

- Slow Increasing Steer Maneuver
 - Platform characterization
 - Average steering wheel angle (SWA) at projected 0.5G lateral acceleration
- Ramp Steer Maneuver
 - Tweaked maneuver using ideas from the previously identified maneuvers
 - Use SWA for steering magnitude (from SIS test)
 - Test drop throttle – clutch in
 - Trailer is unbraked

Example of SIS



Ramp Steer Maneuver

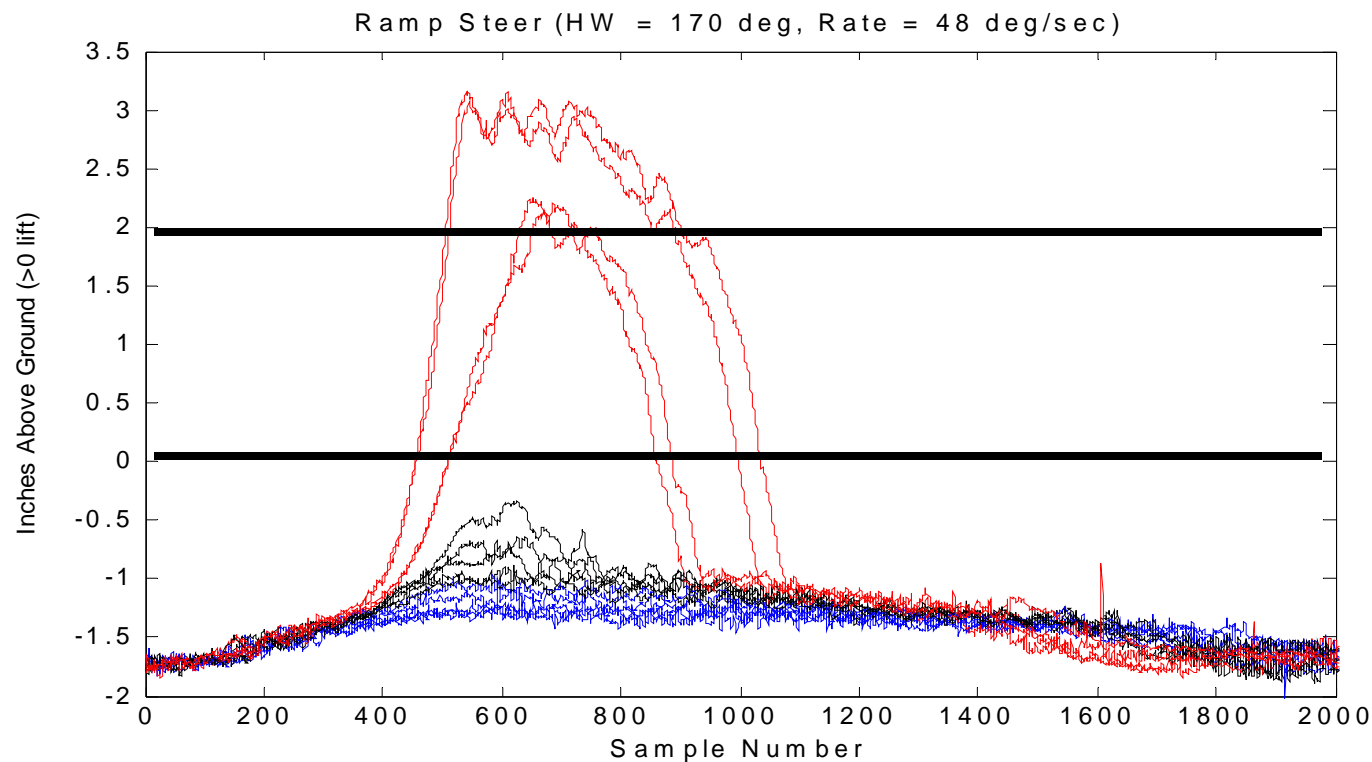


Potential Measures of Performance

- Wheel Lift
- Tractor Lateral Acceleration Ratio (LAR)
- Trailer Lateral Acceleration Ratio (TrILAR)
- Trailer Roll Angle Ratio (RAR)

Wheel Lift

Considered to be any tractor or trailer wheel lift that occurs during a test that greater then 2.0 inches.



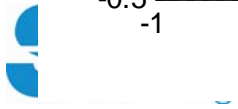
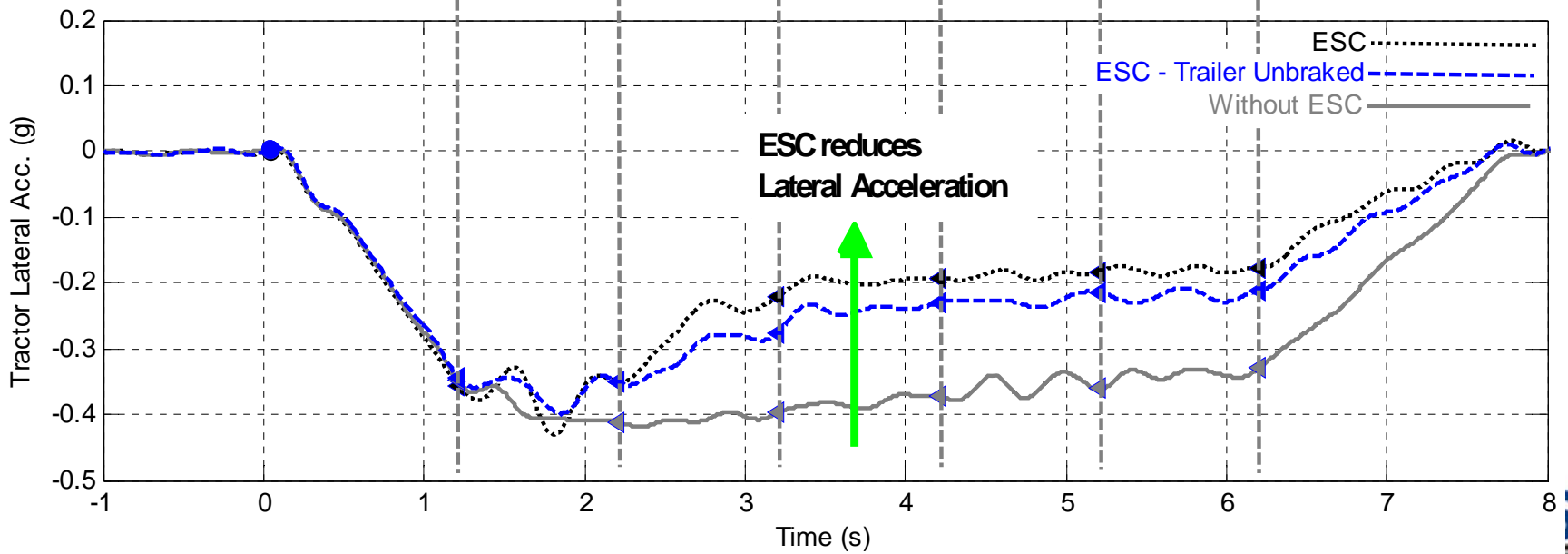
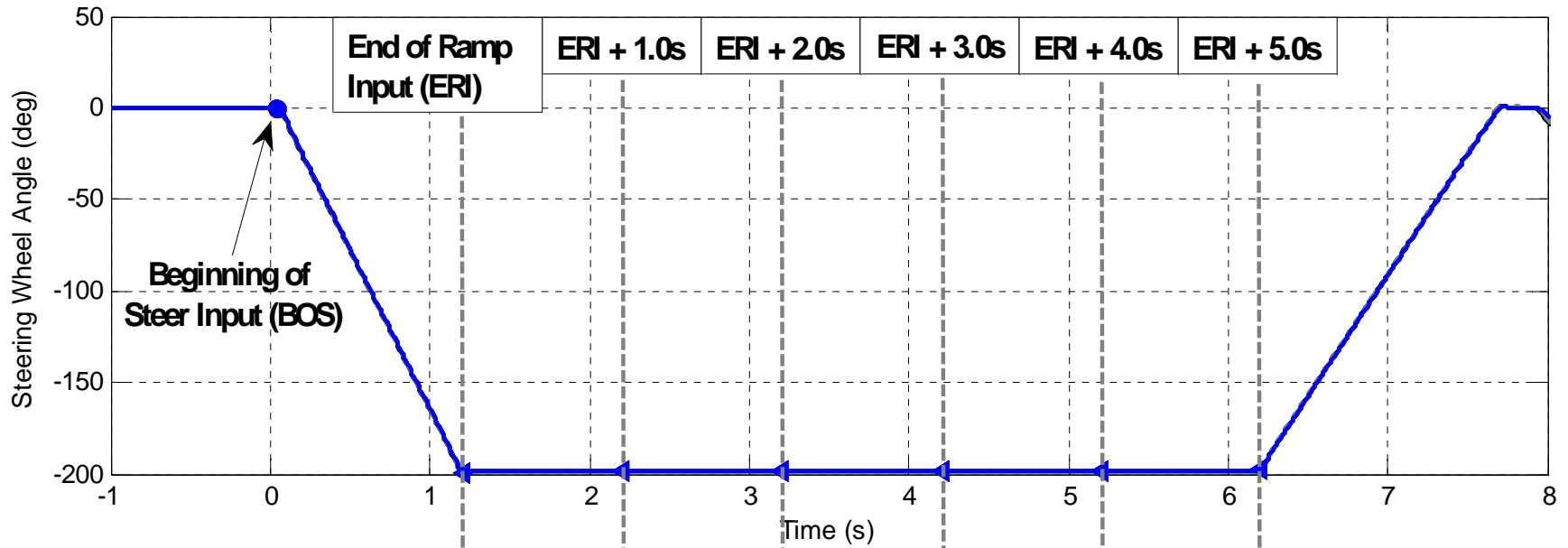
Tractor Lateral Acceleration Ratio (LAR)

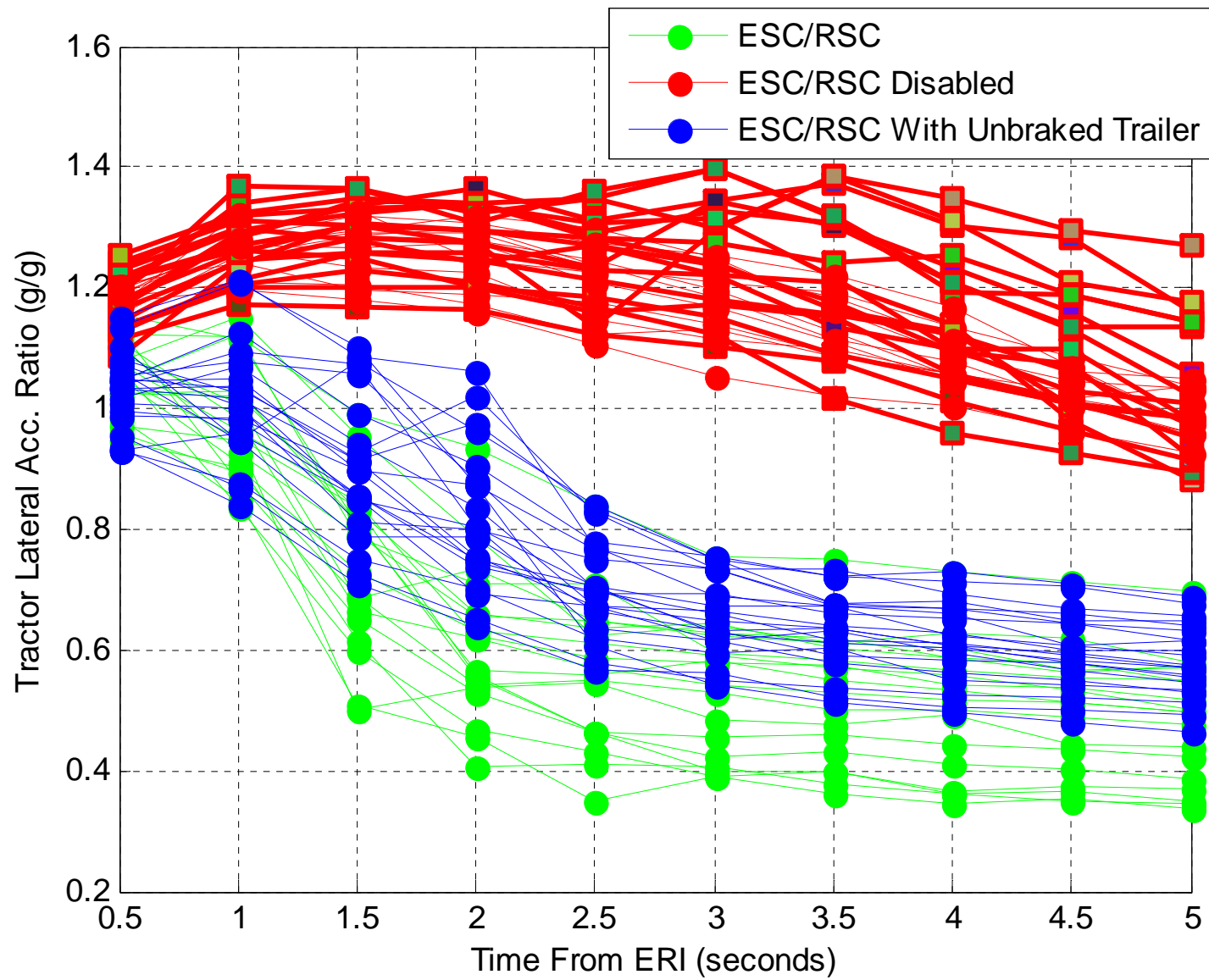
$$\text{LAR} = \frac{A_{y_{Tractor}}(ERI + 1.0, +2.0 \dots + 5.0 \text{sec})}{A_{y_{Tractor}}(ERI)}$$

Where:

$A_{y_{tractor}}$ = Lateral Acceleration of the tractor

ERI = End of Ramp Input





Single Unit Truck and Bus Stability Control Test Track Testing



SUT and Bus Stability Control

Covers a wide range of vehicle applications.

Class 3: 10,001 – 14,000 lbs.

Class 4: 14,001 – 16,000 lbs.









Class 5: 16,001 – 19,500 lbs.

Class 6: 19,501 – 26,000 lbs.

Class 7: 26,000 – 33,000 lbs.

Class 8: 33,001 and over

TRAA VEHICLE IDENTIFICATION GUIDE[®]

CLASS 1 • LIGHT-DUTY • (6,000 lbs. or less GVW - 4 tires)* 	Information Needed To Correctly Dispatch Towing and Recovery Units: <ul style="list-style-type: none">• Year, Make and Model of Vehicle to be Towed or Recovered• DOT Classification (Class 1 – 8 based on GVW)• Location of Vehicle• Type of Tow (imposed, accident, recovery motorist assist, etc.)• Additional Vehicle Information<ul style="list-style-type: none">- 2 wheel drive, 4 wheel drive, all wheel drive- damage to vehicle, tire condition- vehicle loaded or empty- cargo contents- does the vehicle have a trailer- are the keys with the vehicle <p><i>Note:</i> Any vehicle may carry hazardous materials. Advise if placarded.</p> <p><i>Note:</i> The Gross Vehicle Weight Rating (GVWR) of the vehicle to be towed or recovered can be found on the identification label on the vehicle's driver's side doorframe. The number of pounds listed on the label can then be compared with the DOT Classification Vehicle Type Chart for the correct DOT class.</p>
CLASS 2 • LIGHT-DUTY • (6,001 - 10,000 lbs. GVW - 4 tires)* 	
CLASS 3 • MEDIUM-DUTY • (10,001 - 14,000 lbs. GVW - 6 tires or more)* 	
CLASS 4 • MEDIUM-DUTY • (14,001 - 16,000 lbs. GVW - 6 tires or more)* 	
CLASS 5 • MEDIUM-DUTY • (16,001 - 19,500 lbs. GVW - 6 tires or more)* 	
CLASS 6 • MEDIUM-DUTY • (19,501 - 26,000 lbs. GVW - 6 tires or more)* 	
CLASS 7 • HEAVY-DUTY • (26,001 - 33,000 lbs. GVW - 6 tires or more)* 	
CLASS 8 • HEAVY-DUTY • (33,001 lbs. and over GVW - 10 tires or more)* 	

Classes 1 and 2 include passenger vehicles, light trucks, minivans, full-size pickups, sport utility vehicles and full-size vans.

Classes 3 through 6 include a wide range of mid-size vehicles, delivery trucks, utility vehicles, motorhomes, panel trucks, ambulances, small dump trucks, limousine trucks, flatbed and stake trucks, refrigerated and box trucks, small and medium school and transit buses.

Classes 7 and 8 include a wide range of heavy vehicles, large delivery trucks, motor coaches, refuse trucks, cement mixers, all tractor trailer combinations including double trailers.

Reprinted © 1997 National Vehicle Identification Code - CVIC

Objectives of SUT and Bus Track Testing

- Understand the base stability characteristics
- Test a variety of platforms ranging from Class 3 – Class 8 SUTs (including a motorcoach)
- Evaluate SUTs using previously developed test maneuvers
 - ⌘ SIS, Ramp Steer, Sine with Dwell, Half Sine, Fish hook
 - ⌘ Base platform in some cases since ESC is not available.

Advanced Technology Research



Forward Collision Warning

- Forward collision warning systems and other technologies are becoming available for both LV and HV platforms.
- NHTSA announced Crash Avoidance NCAP for LV in July 2008
 - NHTSA-2006-26555 (July 2008)

Objectives

- Evaluate the performance of a state-of-the-industry HV FCW system.
- Examine the applicability of objective test procedures developed for light vehicle NCAP.
 - Do the procedures work for the HV platform?
 - What changes need to be made in the method?
- Gather objective data to help understand and define the performance of FCW technology for heavy vehicles.

Objective Tests to be performed

- Subject Vehicle (SV) Encounters a Stopped Principle Other Vehicle (POV)
- Subject Vehicle (SV) Encounters a Decelerating Principle Other Vehicle (POV)
- Subject Vehicle (SV) Encounters a Slower Principle Other Vehicle (POV)

Frequent Truck Pre-Crash Scenarios

LV objective tests correlate well with frequent HV pre-crash scenarios (top 3).

Conflict	Annual # Trucks in Crashes	Relative Frequency
SV encounters Stopped POV	25,444	46%
SV encounters Decelerating POV	12,709	23%
SV encounters a Slower POV	6,942	14%

Volvo IVI FOT Evaluation Report (2007)

Questions?

