Agenda

- Introduction / Background
- Government Truck Safety Initiatives
- Tractor and Trailer Stability Control
- OnGuard Collision Safety / Next generation
- SafetyDirect Information System
- Future Trends
Meritor WABCO

• 50/50% Joint Venture between ArvinMeritor and WABCO Vehicle Control Systems

• Established in 1990

• Focused on providing advanced brake control technology to the North American commercial vehicle industry
World of MERITOR WABCO

- **Romeo**
  - MICHIGAN
  - Test Track

- **Troy**
  - MICHIGAN
  - Corporate
  - Sales
  - Engineering
  - Lab

- **Sault Ste. Marie**
  - MICHIGAN
  - Winter Test

- **Hebron**
  - KENTUCKY
  - Distribution
  - Customer Service
  - Supply Chain

- **Monterrey**
  - MEXICO
  - Sales Office

- **Phoenix**
  - ARIZONA
  - Distribution
Meritor WABCO Product Portfolio

Air and Foundation Systems

Vehicle Control Systems

Complete System Integration

- SmartTrac
- ABS
- OnGuard
- SafetyDirect™
- Diagnostics

- Automatic Traction Control (ATC)
- Driveline Protection Management
- Brake Performance Monitoring (BPM)
- Hill Holder and Work Brake
- Tire Pressure Monitoring (TPM)
- ABS
- Diagnostics
Product Development Vision

Pyramid of Safety

1. SafetyDirect™
   Fleet Performance System
2. OnGuard™
   Collision Safety Systems
3. SmartTrac™
4. Anti-Lock Braking Systems/Automatic Traction Control
5. Stability Control Systems
6. Vehicle Monitoring
7. Collision Safety Systems
8. Foundation Brakes and Controls
9. Complete Brake System Integration
2009 US Large Truck Crash Statistics

- 286,000 large truck police reported crashes
  - 1% had at least one fatality
  - 18% had at least one non-fatal injury
- 2987 fatal crashes
  - 73% combination vehicles
- 51,000 injury crashes
  - 57% combination vehicles
- Alcohol involved in 4.6% of large truck fatal crashes
- Alcohol involved in 50.3% of passenger car fatal crashes
  - >Blood Alcohol Level (BAC) > .01 grams/DL
- Ref: 26,945 passenger car fatal crashes
## 2009 Large Trucks in Crashes by Most Harmful Event for the Large Truck

<table>
<thead>
<tr>
<th>Most Harmful Event</th>
<th>Fatal</th>
<th>Injury</th>
<th>Property Damage Only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Collision with Vehicle in Transport</td>
<td>2228</td>
<td>74.6%</td>
<td>42,000</td>
</tr>
<tr>
<td>Collision with Fixed Object</td>
<td>252</td>
<td>8.4%</td>
<td>4,000</td>
</tr>
<tr>
<td>Collision with Pedestrian</td>
<td>227</td>
<td>7.6%</td>
<td>1,000</td>
</tr>
<tr>
<td>Overturn (Rollover)</td>
<td>129</td>
<td>4.3%</td>
<td>3,000</td>
</tr>
<tr>
<td>Collision with Pedalcycle</td>
<td>54</td>
<td>1.8%</td>
<td>*</td>
</tr>
<tr>
<td>Collision with Parked Motor Vehicle</td>
<td>24</td>
<td>0.8%</td>
<td>*</td>
</tr>
<tr>
<td>Collision with Train</td>
<td>12</td>
<td>0.4%</td>
<td>*</td>
</tr>
<tr>
<td>Collision with Other Object</td>
<td>15</td>
<td>0.5%</td>
<td>*</td>
</tr>
<tr>
<td>Collision with Animal</td>
<td>9</td>
<td>0.3%</td>
<td>*</td>
</tr>
<tr>
<td>Jackknife</td>
<td>0</td>
<td>0%</td>
<td>*</td>
</tr>
<tr>
<td>Explosion / Fire</td>
<td>0</td>
<td>0%</td>
<td>*</td>
</tr>
<tr>
<td>Other</td>
<td>19</td>
<td>0.6%</td>
<td>*</td>
</tr>
<tr>
<td>Unknown</td>
<td>18</td>
<td>0.6%</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,987</td>
<td>100.0%</td>
<td>51,000</td>
</tr>
</tbody>
</table>

*Less than 500 or less than 0.05 percent.

Note: A large truck is defined as a truck with a gross vehicle weight rating (GVWR) greater than 10,000 pounds.

Source: FMCSA Large Truck and Bus Crash Facts 2009: Early Release
FMVSS 121 Background

- 1975 introduction covered most air braked vehicles >10,000 lbs
  - Dual air brake circuits
  - Brakes on all axles
  - Stopping distances
    - Service – 293 ft from 60 MPH without significant wheel lock
    - Drove introduction of ABS
  - Emergency
- Static apply and release pneumatic timing
- Inertial dynamometer requirements
  - Fade, recovery and effectiveness
FMVSS 121 Background

- 1978 Paccar & ATA vs NHTSA, 9th Circuit Court rescinded stopping distance requirements
- 1995 amended reinstating stopping distances and requiring ABS on most air braked vehicles above 10,000 lbs
  - Tractors in 1997
  - Trailers, straight trucks and buses in 1998
- 1999 DOT Secretary Rodney Slater announces goal of 50% reduction in truck related fatalities by 2010
- December 2005 Notice of Proposed Rulemaking (NPRM) issued proposing a reduction of 20-30% service and emergency stopping distances for truck tractors
- July 27, 2009 File Rule released
# Large Truck Crash Statistics

Tracking per DOT Secretary Slater’s 1999 Objective

<table>
<thead>
<tr>
<th>Year</th>
<th>Large Trucks Registered</th>
<th>Fatal Crashes</th>
<th>Total Fatalities</th>
<th>Million Vehicle Miles Traveled</th>
<th>Fatalities per 100 Million Miles Traveled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>7,791,426</td>
<td>4560</td>
<td>5380</td>
<td>202,688</td>
<td>2.65</td>
</tr>
<tr>
<td>2007</td>
<td>9,027,624</td>
<td>4204</td>
<td>4822</td>
<td>227,060</td>
<td>2.12</td>
</tr>
<tr>
<td>2008</td>
<td>9,006,738</td>
<td>3733</td>
<td>4229</td>
<td>227,458</td>
<td>1.86</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td>2987</td>
<td>3380</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change 1999/2008</td>
<td>+15.6%</td>
<td>-18.1%</td>
<td>-21.4%</td>
<td>+12.2%</td>
<td>-29.8%</td>
</tr>
</tbody>
</table>
Current Government Initiatives

• Stopping distance regulation
• Potential stability control regulation
  • EEC regulation in 2013
  • Two NHTSA sponsored research projects conducted
• IntelliDrive Communication
• Distracted Driver
• Increased truck size & weights
• Interest in collision safety systems
  • EEC regulation in 2013
  • NHTSA testing and research in progress
FMVSS 121 Final Stopping Distance Rule

- 60 MPH stopping distance for air braked tractors in the loaded to GVWR condition (unbraked control trailer) must be:
  - Tractor with 2 or 3 axles and a GVWR of 70,000 lbs or less must stop within 250 feet (-30%)
  - Tractor with 3 axles and a GVWR of greater than 70,000 lbs must stop within 310 feet (-13%)
  - Tractor with 4 or more axles and a GVWR of 85,000 lbs or less must stop within 250 feet (-30%)
  - Tractor with 4 or more axles and a GVWR greater than 85,000 lbs must stop within 310 feet

- All tractors must stop from 60 MPH in the unloaded condition within 235 feet (-30%)

- Most OEMs require a 10% stopping distance compliance margin
FMVSS 121 Final Stopping Distance Rule

• Implementation Dates
  – August 1, 2011: Standard 3 axle tractors (6X4) with a GVWR less than or equal to 59,600 lbs
  – August 1, 2013: Severe service tractors
    • 3 and 3+ axle tractors with a GVWR greater than 59,600 lbs
  – August 1, 2013: 2 axle tractors
Stability Control

- EEC regulated stability control involving European tractors with a phase-in beginning 2013
- NHTSA regulated stability control for US passenger cars and light trucks with a phase-in beginning 2010
- NHTSA seriously considering a stability control regulation for tractors with an anticipated notice of proposed rulemaking (NPRM) in 2011
  - Potential implementation date 2013
  - Leaning toward a full stability system (roll and yaw functionality)
IntelliDrive involves wireless connectivity between:

- Drivers, vehicles (V2V), infrastructure (V2I) & handheld devices

5.9 GHZ DSRC

Safety Messages

E-payment

Signal Phase and Timing

Probe Data

Instrumented Roadside

Opportunity for Innovation

- Real Time Network Data
- Situation Relevant Information
IntelliDrive Scope

• Safety
  – Increased driver situational awareness
  – Reduced crash frequency - driver warnings, advisories and active control

• Mobility
  – Traffic, transit, parking, performance management
  – E-payment of tolls, vehicle inspection

• Environment
  – Reduced emissions, fuel savings
Truck Size & Weights

• Pilot programs running in Maine and Vermont
  – Increases the Maine / Vermont interstate highway weight limit to 97,000 lbs. for six axle trucks
  – Obama administration voiced support to make the pilot programs permanent

• Safe & Efficient Transportation Act (SETA)
  – Introduced in House (H.R. 1799) and Senate (S. 3705)
  – Allow all states option to set interstate weight limits up to 97,000 lbs. for trucks equipped with six axles

• Coalition for Transportation Productivity - John Runyan
  – www.transportationproductivity.org
Antilock Braking System (ABS)

• Helps prevent high levels of wheel slip (wheel lock) during braking
  – Overbraking based on existing physical conditions
  – Typically occurs on slippery road surfaces, light vehicle loads, worn tires
  – Wheel lock adversely effects lateral control of vehicle (jacknife), ability to steer and stopping distances

• Components: Electronic Control Unit (ECU), modulator valves, wheel speed sensors, wiring harness
Typical Tractor ABS (4S/4M)

One ECU

Four Wheel Speed Sensors

Four ABS Modulator Valves

COLOR KEY
- Primary
- Secondary
- Park & Emergency
- Blended Air
- Supply
- Electrical Wire
Automatic Traction Control (ATC)

• Helps prevent high levels of wheel spin during periods of driver demanded acceleration
  – Typically occurs on slippery road surfaces, light vehicle loads, worn drive axle tires
  – Spinning drive axle wheels adversely effect lateral control of vehicle and can lead to jacknife as well as potential axle carrier damage

• Components: ABS plus drive axle solenoid valve, software enhancement
Tractor ABS + Traction Control (ATC)
SmartTrac™
Stability Control Systems
ABS Based Stability Control

• Stability control functionality integrated within the pneumatic ABS platform

• FMVSS 121 requires commercial vehicles above 10,000 lbs and trailers to be equipped with ABS

• Three pneumatic Stability Control Systems commercially available from Meritor WABCO
  – Roll Stability Control (RSC) - tractor/straight truck based, addresses roll phenomenon
  – Electronic Stability Control (ESC) – tractor/straight truck based, addresses roll and directional instabilities (oversteer, understeer)
  – Roll Stability Support (RSS) – trailer based, addresses roll phenomenon
Stability Control Functionalities

- **Monitor**
  - Constantly measure key variables affecting vehicle stability

- **Compute**
  - Estimate key stability thresholds necessary for safe driving

- **React**
  - Automatically intervenes if computed stability thresholds are exceeded
  - Deceleration to reduce rollover tendency
  - Counteractive brake forces to regain directional stability

- **Train**
  - Driver learning through system warnings and interventions
    - Stability thresholds hard to determine
    - Management involvement assessing driving characteristics
Roll Stability Control (RSC)

- Tractor based stability control system that primarily addresses and attempts to reduce untripped rollover risk
  - Integrated in ABS platform. Lateral accelerometer directly mounted to ABS ECU printed circuit board
- Roll threshold calculated based on vehicle mass
- If threshold is exceeded, RSC automatically intervenes and attempts to rapidly decelerate the vehicle
  - Reduced velocity equates to reduced rollover risk
  - Message on SAE 1939 datalink de-throttles engine and applies retarder
  - Solenoid valves activate drive and trailer axle foundation brakes
- Components: ABS plus lateral accelerometer, two solenoid valves, software enhancement
Tractor ABS + Roll Stability Control (RSC)
Electronic Stability Control (ESC)

- Tractor based stability control system that addresses and attempts to reduce risk of untripped rollovers and directional instabilities (understeer / oversteer)
  - Integrated in ABS platform
  - Separate ESC module containing yaw rate sensor and lateral accelerometer
  - Turn angle sensor (determination of driver’s directional intention)

- Roll functionality identical to RSC except for the addition of steer axle braking

- Activation of foundation brakes to generate counteractive force to combat yaw
Tractor ABS + Electronic Stability Control (ESC)
Trailer Stability Control
Roll Stability Support (RSS)

• Supports both spring and air ride suspensions
• Primarily addresses roll instability
  • No interaction with tractor
• Installation similar to current ABS
• SAE diagnostics using ToolBox PC software or blinkcodes
• On-board data recording for effective fleet management
• Advance warning of impending instability
• Critical event notification with popular telematic devices
Problem: Rear-End Collisions

- All drivers experience periods of distraction, inattentiveness & incorrect perception
  - FMCSA study indicated over 80% of safety critical events involved some degree of driver distraction
  - Increases reaction time
  - Higher propensity for rear end accidents

- Safety & Economic Impact
  - Injuries
  - Equipment / Cargo / Infrastructure Damage
  - Lost productivity
Basis of Product Strategy

Of the accidents caused by delay in recognition, 90% could be prevented if the driver is able to recognize the situation approximately 1 second earlier.

- Provide information earlier
- React boldly, promptly & automatically
Collision Safety Systems

- Uses forward-looking 77 Ghz radar sensor technology to monitor distance to target vehicle

- Integrates collision safety system control with ABS and stability control.
## OnGuard
Forward Radar Continuously Monitors
Integrated with Foundation Brakes for Active Braking

<table>
<thead>
<tr>
<th>Collision Warning</th>
<th>Adaptive Cruise w / Active Braking</th>
<th>Collision Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Audible &amp; visual warnings provides detection of developing rear end collisions</td>
<td>• Provides adaptive cruise for both decel and automatic resume</td>
<td>• “Always on” emergency activation</td>
</tr>
<tr>
<td></td>
<td>• Maintains 3.6 second following distance</td>
<td>• Calculates to determine impending collision</td>
</tr>
<tr>
<td></td>
<td>• Provides sequential deceleration activation:</td>
<td>• Initial Haptic warning</td>
</tr>
<tr>
<td></td>
<td>• Torque reduction</td>
<td>• 0.35 g decel (1/2 full brake apply)</td>
</tr>
<tr>
<td></td>
<td>• Retarder control</td>
<td>• Functions at speeds &gt; 15mph</td>
</tr>
<tr>
<td></td>
<td>• Foundation braking</td>
<td>• Automatically disengages if driver takes appropriate action</td>
</tr>
<tr>
<td></td>
<td>• Max decel 0.25g (1/3 full brake apply)</td>
<td></td>
</tr>
</tbody>
</table>
CMS Intervention Sequence

**System Reactions**

- **Warning Tone and Lamp**
- **Engine Torque Limitation**
- **Brake Activation**

**Potential rear end collision detected**

- **Object tracked**
- **Collision warning: Visual and Audible**
- **Collision warning: Haptic (short brake pulse)**
- **Avoidance maneuver not possible**
- **Automatic braking for collision prevention or mitigation**
- **Crash prevented or mitigated**

**Time Sequence**

- **t₀**
- **t₁**
- **t₂**
- **t₃**
- **t₄**
Lane Prediction / Target Detection

- Integrated yaw rate gyro sensor adjusts radar beams when in a curve to look only in appropriate travel lane, not adjacent lanes.

- In real traffic world radar sees many objects which are interpreted in a target map. Magenta box indicates appropriately selected lead vehicle. Everything else is either road side clutter or non threatening vehicles.
• SafetyDirect a web based reporting tool
  – uses onboard data logger to capture and report driving behavior, vehicle characteristics and critical events
  – Data communicated from various control systems to datalogger via SAE 1939
  – Data is automatically saved and transferred to a website

• SafetyDirect can be installed with any of the available combinations of Meritor WABCO’s ABS, ATC, SmartTrac, OnGuard and Iteris’ LDW

• Safety managers will access the data to proactively manage fleet drivers and vehicles
Comprehensive High Level Reports – Detailed Metrics

- SafetyDirect saves *every* safety event happening in vehicle
- Each event tracked by vehicle, driver, with date / timestamp and location
- Events deemed to be severe are augmented by a complete event history of data 10 seconds before and after for detailed event reconstruction
  - Video also possible
- SafetyDirect can also send real-time immediate event notifications for severe events and vehicle condition
What is required for SafetyDirect™
Fleet Performance System

1. Vehicle equipped with any combination of
   - LDW
   - SmartTrac
   - OnGuard

2. Data Logger or LDW

3. Telematic Provider
   - Qualcomm
   - PeopleNet
   - Or Manual Download
System Data Flow

Features
- Automated reporting
- Driver specific metrics

OnGuard™
SmartTrac™
LDW
ABS

OTA provider

Automated data transfer using existing providers

Fleet operations

OnGuard™

SmartTrac™

LDW
ABS

OTA provider

Fleet operations

OnGuard™

SmartTrac™

LDW
ABS

OTA provider

Fleet operations
SafetyDirect Events

The following safety events are stored by SafetyDirect:

<table>
<thead>
<tr>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive Braking</td>
<td>Breaking with more than 0.4g deceleration</td>
</tr>
<tr>
<td>Excessive Curve Speed</td>
<td>Turning with more than 0.4g side acceleration</td>
</tr>
<tr>
<td>Lane Departure Warning</td>
<td>Crossing a lane marking w/o using turn signal</td>
</tr>
<tr>
<td>Excessive Lane Departure</td>
<td>Passing 6” further beyond the warning limit</td>
</tr>
<tr>
<td>Lane Change Without Turn Signal</td>
<td>Crossing line fully into next lane</td>
</tr>
<tr>
<td>Loss of Video Tracking</td>
<td>Loss of video from damage or tampering</td>
</tr>
<tr>
<td>LDW System Disabled</td>
<td>Driver disables system with disable switch</td>
</tr>
<tr>
<td>Distance Alert</td>
<td>Audible warning for following too close</td>
</tr>
<tr>
<td>Forward Collision Warning</td>
<td>Audible and visual warning for pending collision</td>
</tr>
<tr>
<td>Haptic Warning</td>
<td>Physical brake pulse to warn of pending collision</td>
</tr>
<tr>
<td>Collision Mitigation Braking</td>
<td>Automated braking to mitigate a collision</td>
</tr>
<tr>
<td>ATC</td>
<td>Automatic Traction Control event</td>
</tr>
<tr>
<td>ESC</td>
<td>Electronic Stability Control event</td>
</tr>
<tr>
<td>RSC</td>
<td>Roll Stability Control event</td>
</tr>
<tr>
<td>ABS</td>
<td>Antilock Brake System event</td>
</tr>
</tbody>
</table>
http://www.SafetyDirectPortal.com

Simply Login....

SafetyDirect™
Fleet Performance System by Meritor Wabco
# Driver Comparison

## Division Report

**Division:**
(All divisions)

**Date Range:**
07/13/2010 - 08/12/2010

**No. Drivers:** 2

**No. Vehicles:** 2

### Division Average: Miles Between Events

<table>
<thead>
<tr>
<th>Miles</th>
<th>Excessive Braking</th>
<th>Excessive Curve Speed</th>
<th>Lane Departure Warning</th>
<th>Excessive Lane Departure</th>
<th>Loss of Video Tracking</th>
<th>Lane Change w/o Turn Signal</th>
<th>Distance Alert</th>
<th>Forward Collision Warning</th>
<th>Haptic Warning</th>
<th>Collision Mitigation Braking</th>
<th>ATC</th>
<th>ESC</th>
<th>RSC</th>
<th>ABS</th>
<th>Average Following Distance</th>
<th>Average Fuel Consumption</th>
<th>Average ACC Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTALS</strong></td>
<td>5,005</td>
<td>250</td>
<td>33</td>
<td>37</td>
<td>88</td>
<td>5,005</td>
<td>5,005</td>
<td>61</td>
<td>25</td>
<td>52</td>
<td>53</td>
<td>89</td>
<td>38</td>
<td>5,005</td>
<td>69</td>
<td>2.7s</td>
<td>87.0</td>
</tr>
<tr>
<td><strong>High Performer Threshold</strong></td>
<td>1000</td>
<td>100</td>
<td>25</td>
<td>50</td>
<td>25</td>
<td>1000</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>Low Performer Threshold</strong></td>
<td>100</td>
<td>100</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>100</td>
<td>30</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

### Driver Breakdown

| VHCLID=1042698 | 4,116             | 217                   | 98                     | 34                       | 76                     | 50                          | 4,116         | 412                         | 206           | 2.7s                         | 15.5           | 29%           |
| VHCLID=Meritor  | 889               | 889                   | 08                     | 52                       | 296                    | 889                         | 889           | 04                          | 09            | 09                            | 16             | 07             | 889            | 17             | 2.7s                       | 15.5                   | 29%                  |
Severe Event

For severe event, pre/post data is stored and displayed.
Future Trends

• Continued development of vehicle control systems that make commercial vehicles safer to drive

• Penetration rate of stability control, collision safety and lane departure systems expected to increase
  – Industry knowledge and acceptance growing
  – Fleets finding systems cost effective
  – Potential legislation for mandate and tax incentive

• Higher volumes will drive system integration

• Higher fleet usage of brake system information

• System maintenance and skillful drivers keys to achieving anticipated safety benefits
Thank –you!