FMCSA
Federal Motor Carrier Safety Administration

Bendix
Bendix Spicer Foundation Brake LLC

Commercial Vehicle Lifecycle Brake Performance:

How It Impacts Roadway Safety

July 31st, 2018

Agenda

Bendix Spicer Foundation Brake LLC

- **Key Safety Decision Points**
  - **Air Disc Brake vs. Drum Brake**
  - **Aftermarket Safety Impacts**
- **Vehicle Brake Performance (Lifecycle)**

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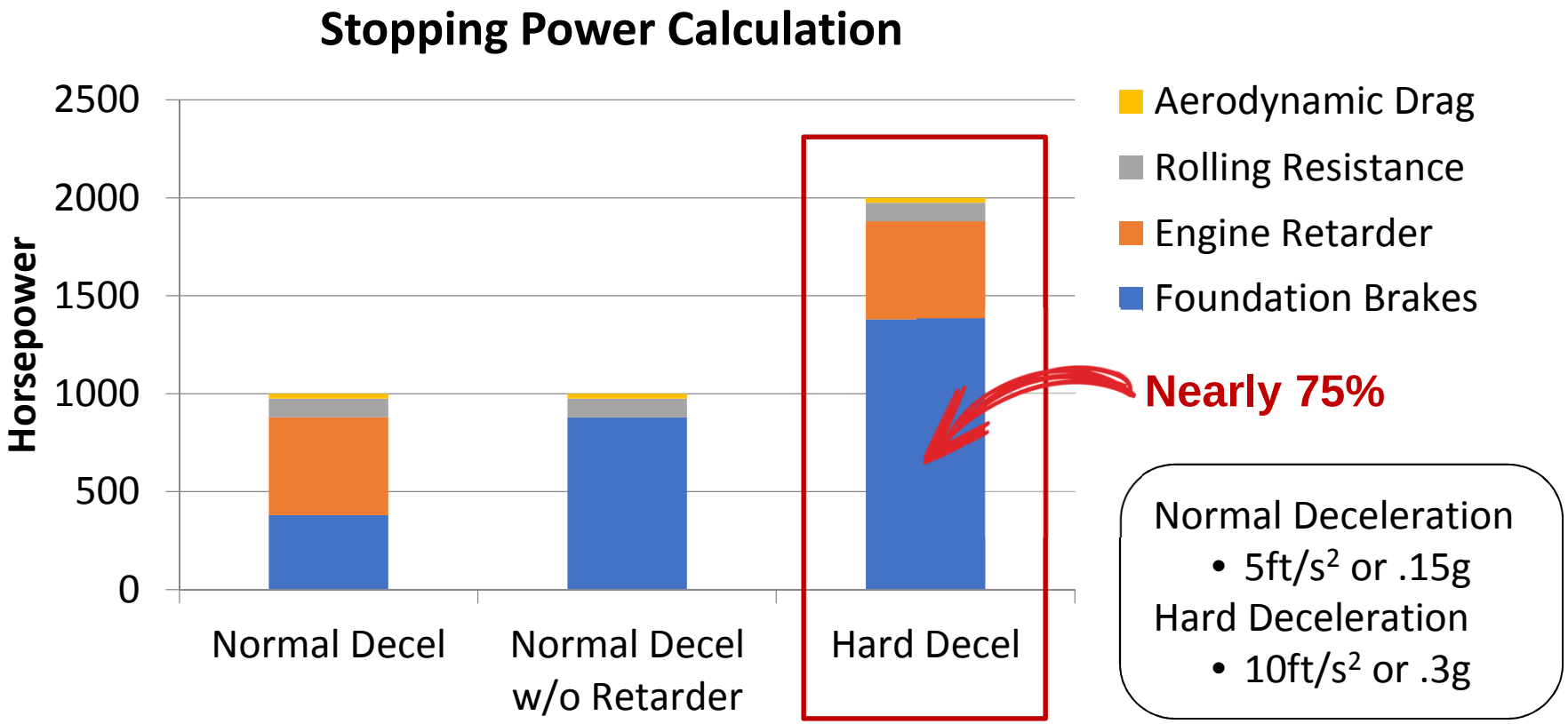
Vehicle Stopping Power

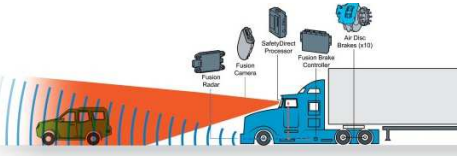
- 80k GCWR stopping from 60-0 mph



(2) Key Decision Points Impacting Safety

Downhill Descents

Collision Mitigation Systems



(1) Brake Specification (New Vehicles)

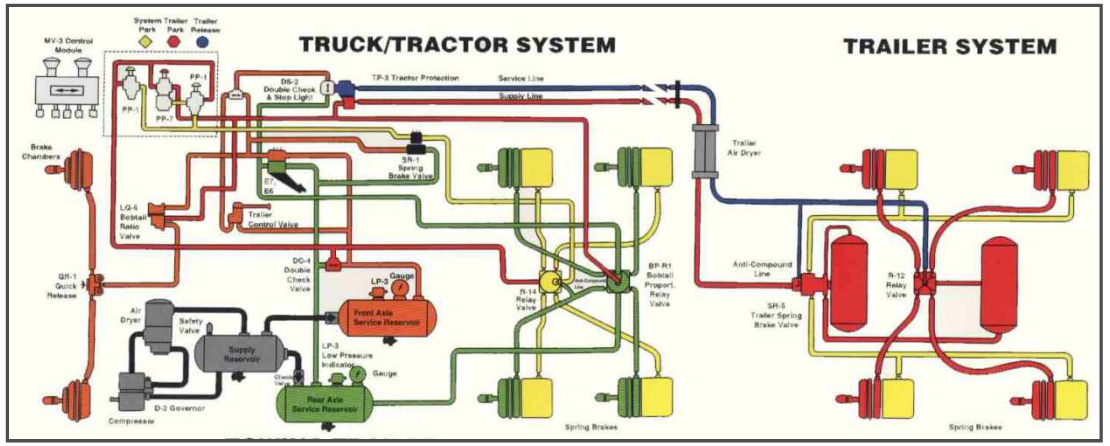
(2) Aftermarket Components (Existing Vehicles)

Stop-Go Traffic

Automated Driving

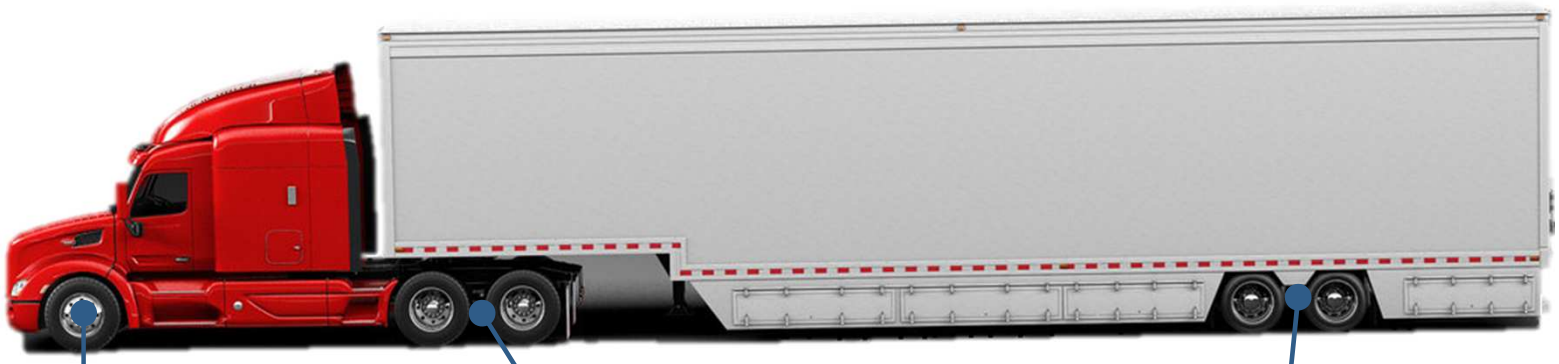
1) Vehicle Specification Impact on Safety

- **Date of Manufacture: All Vehicles meet FMVSS-121**
  - Meet Reduced Stopping Distance (RSD) – Tractor units since 2013 (Ph-2)
    - 250 feet (at 60mph)
- **Vehicles brake specifications vary**
  - Tractor / Truck
  - Trailer
- **Brake Performance (varies)**
- **Driver Familiarity (varies) (not married to vehicle)**



- **Again …. All meets current regulation requirements ….. At Manufacture**

Brake System Choices

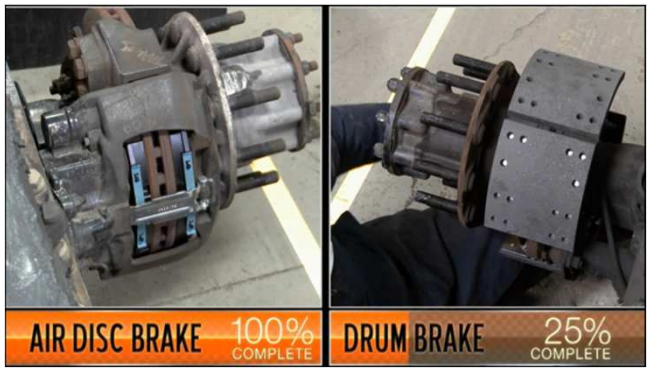


	Front Steer Axle Brakes	Rear Drive Axle Brakes	Trailer Brakes
(A)[1]	RSD Drum Brakes Delete Credit	RSD Drum Brakes Delete Credit	Either Combination: Drum Brakes OR Air Disc Brakes (X) (Y)
(B)[1]	Air Disc Brakes	RSD Drum Brakes Delete Credit	
(C)[1,2]	Air Disc Brakes	Air Disc Brakes	

(1) - Brake Combination(s) meets FMVSS-121 Requirements

(2) - Standard Spec. on (4 of 6) Major Truck OEMs

Air Disc Brakes (Lower Total Cost of Ownership)



- **1.5x Longer Pad Life**
  - Fleet opportunity to eliminate a friction change
- **Lower Maintenance Cost**
  - 1/4th Friction change time of Drum

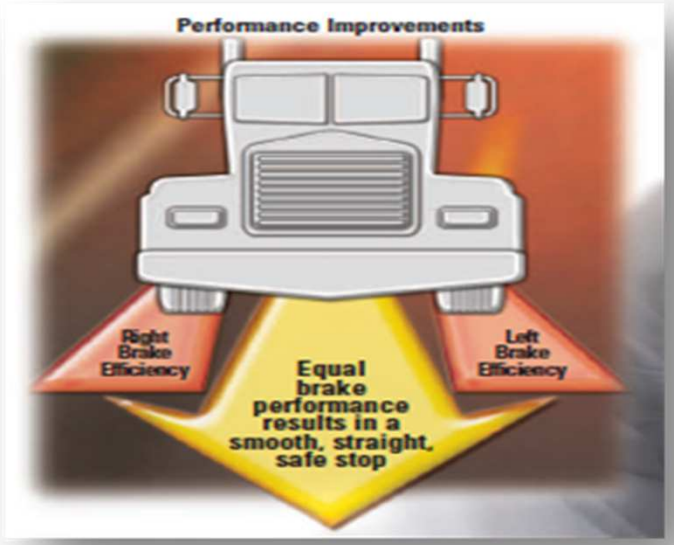
- **Eliminates Rust Jacking**

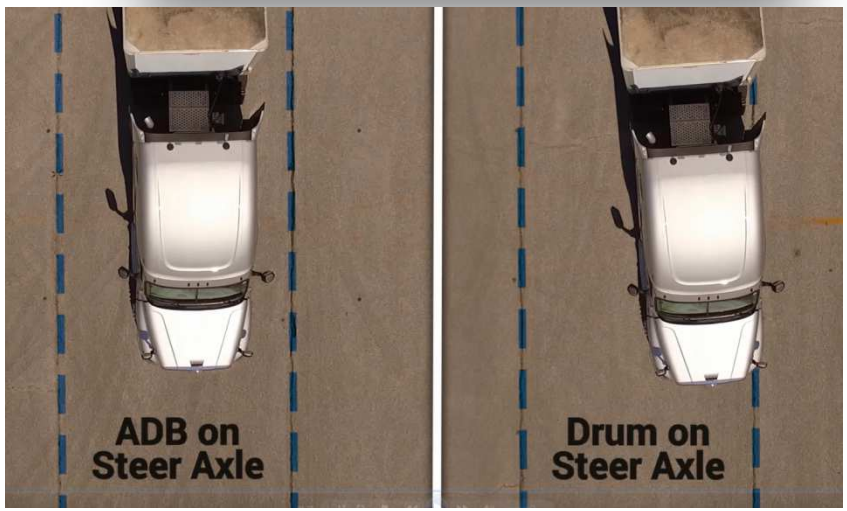
Payback that overcomes Delete Credits!!

- **Improves CSA scores**
  - Out-of-Service as result of Brakes out of Adjustment

Brake Performance Differences (Brake Steer)

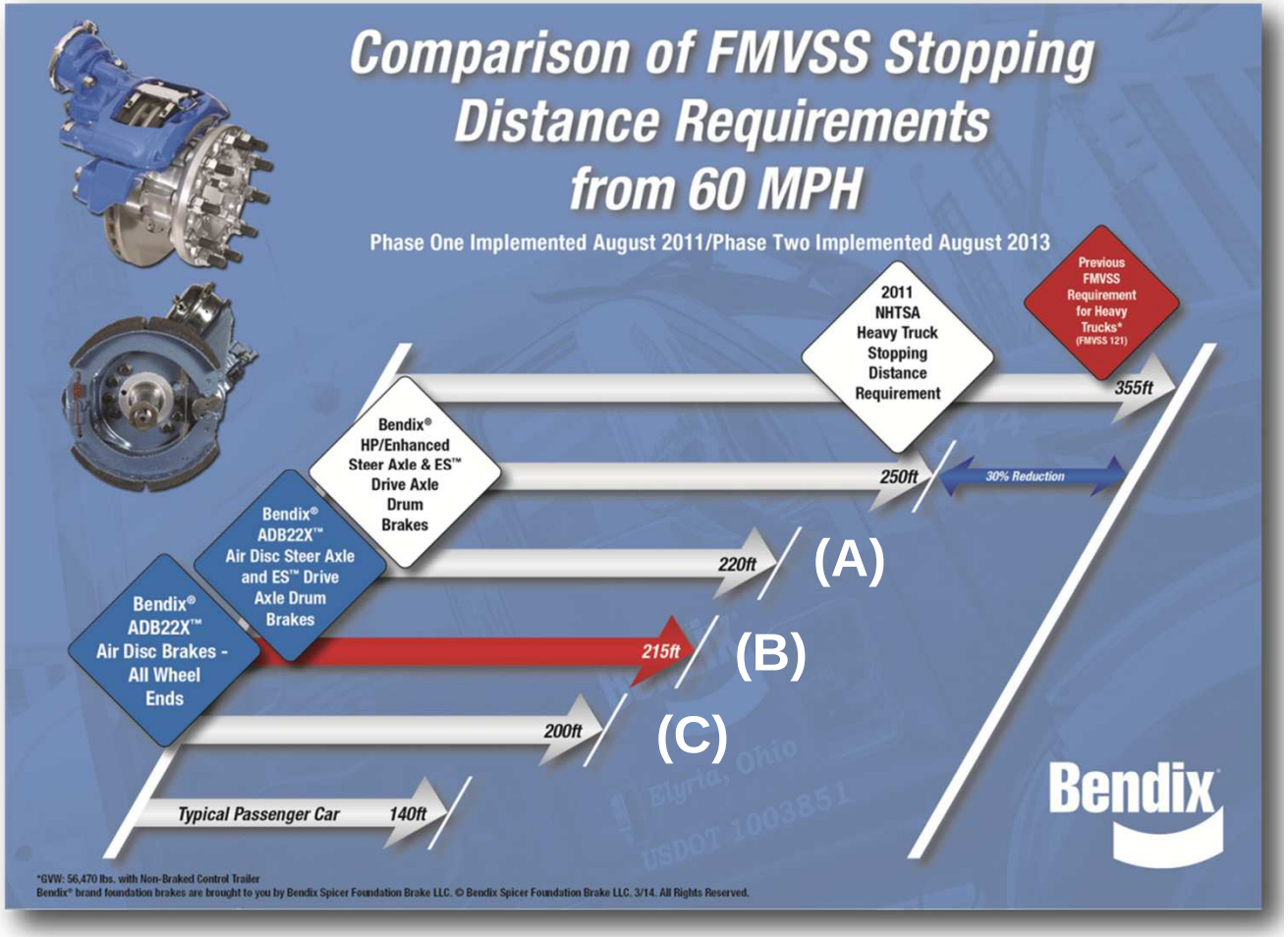
- **Brake Steer**
  - Torque imbalance across the axle
- **Torque imbalances produce:**
  - Steer at steer axle
  - Yaw (pull) at the drive axles
- **Air Disc Brakes virtually eliminate brake steer conditions**
- **Providing Smoother / Straighter / <u>Safer Stops</u>**



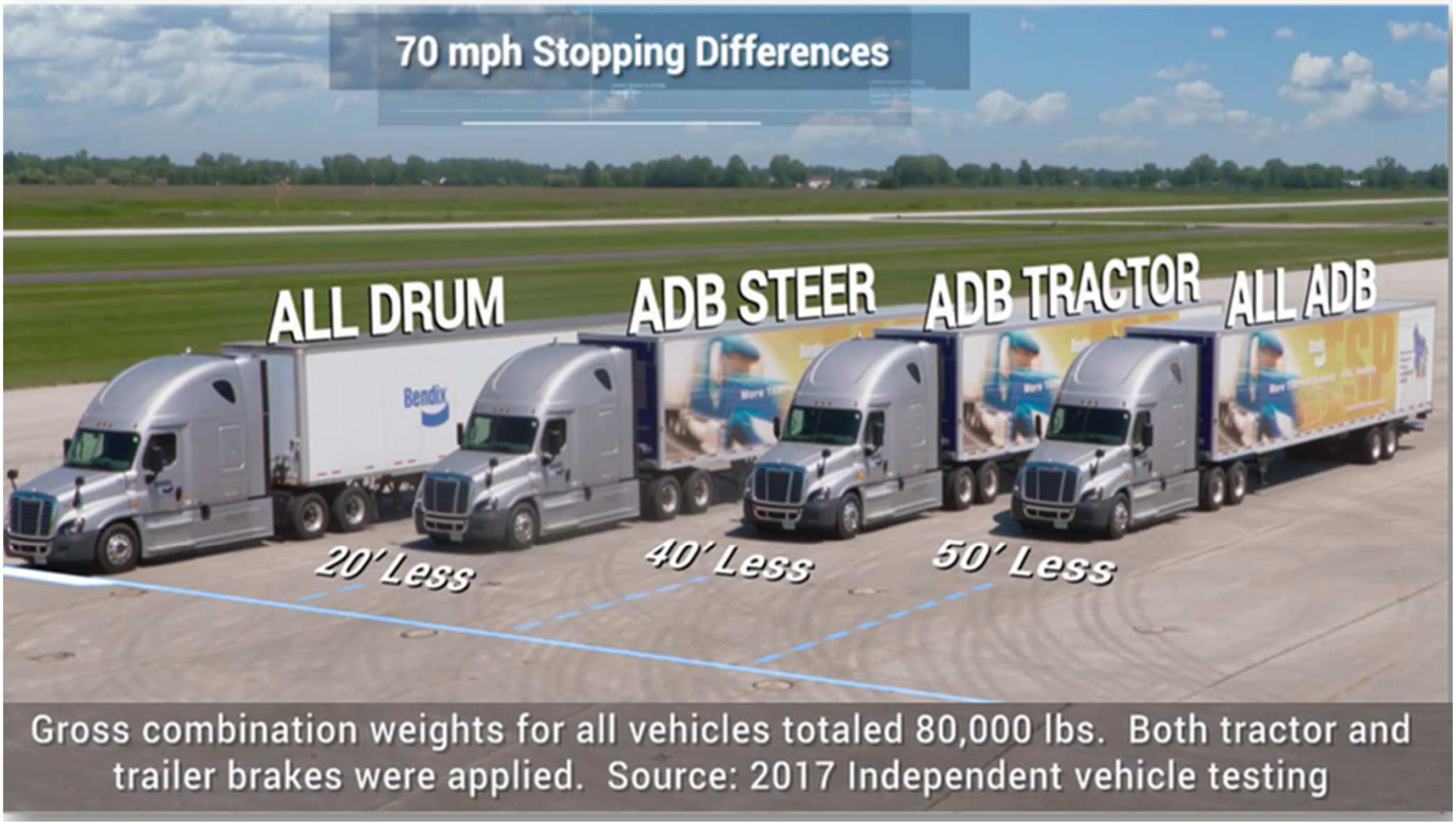


Brake Performance Differences (Stopping Distance)

- Higher speeds generate longer stopping distances
- Not linear !!!
- Kinetic Energy = 1/2•mass•velocity^2
- Energy dissipated as heat

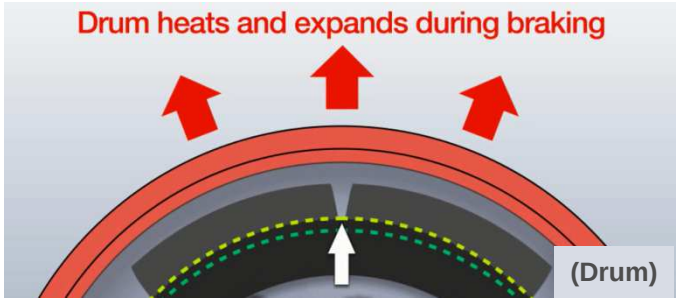


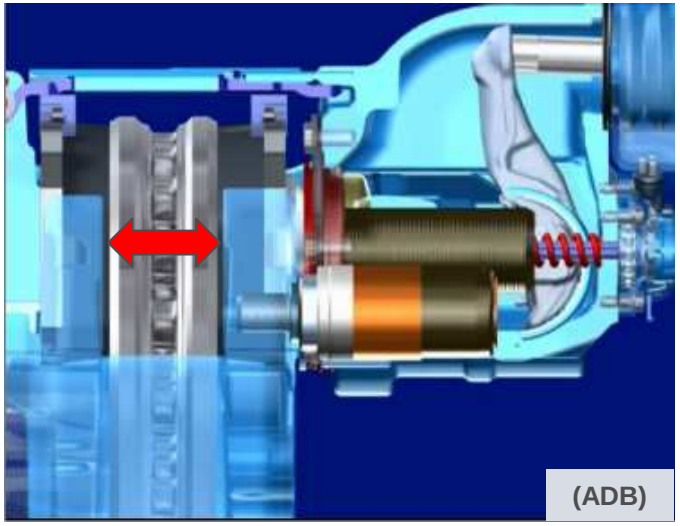
What combination is behind you ???”



Brake Performance Differences (Brake Fade)

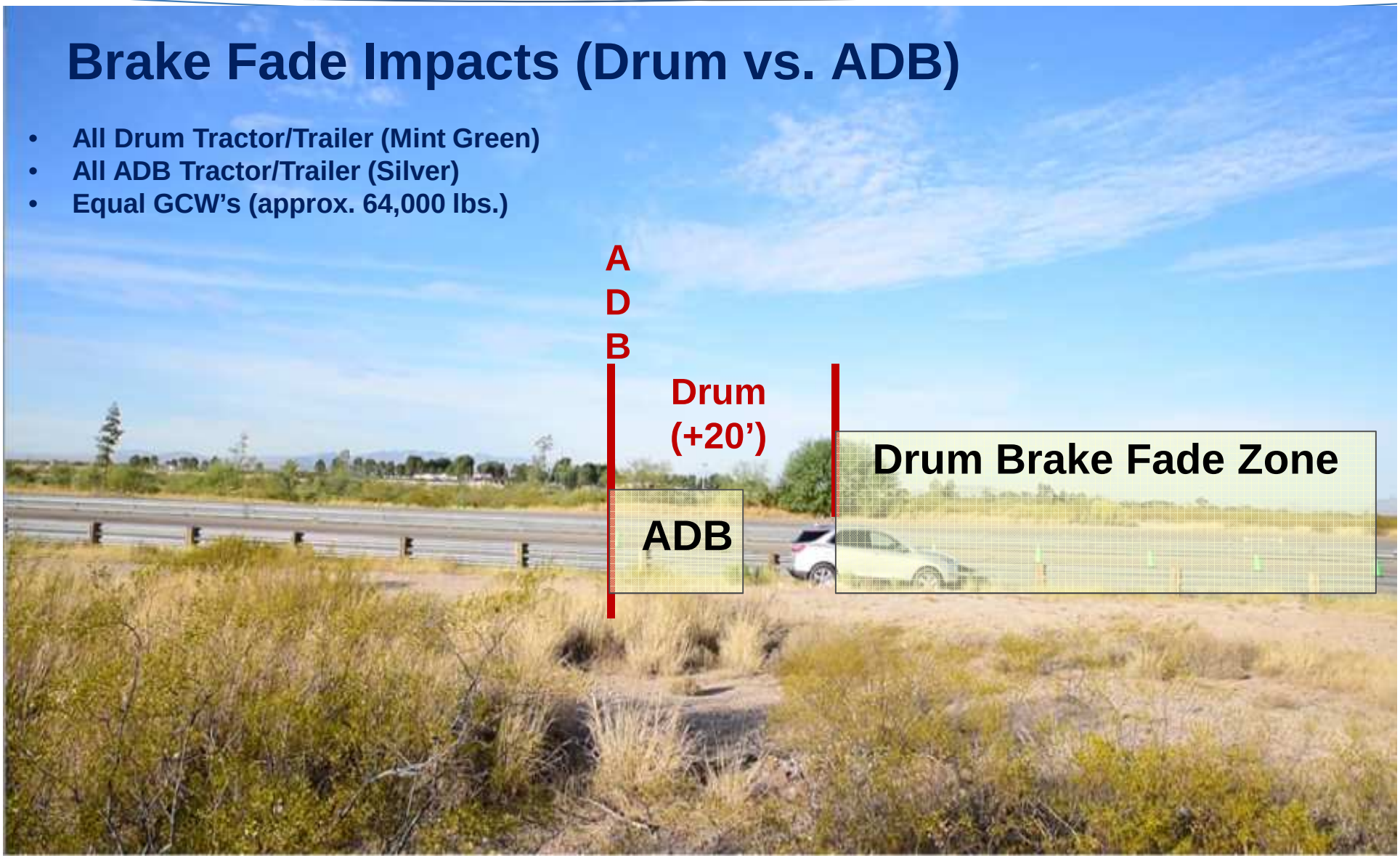
- **Multiple and/or Harder brake stops generate more heat**
- **Heat dissipates into brake system mass**
  - Drum: Friction, Brake Shoes, Drum, etc.
  - ADB: Friction, Pads, Rotor, etc.
- **Brake System Designs differ:**
  - Drums expand away from friction
    - Produces **Longer** stopping distances
    - Inconsistent brake performance (to driver)
  - ADB rotors expand towards friction
    - (Maintains **Consistent** stopping distances)



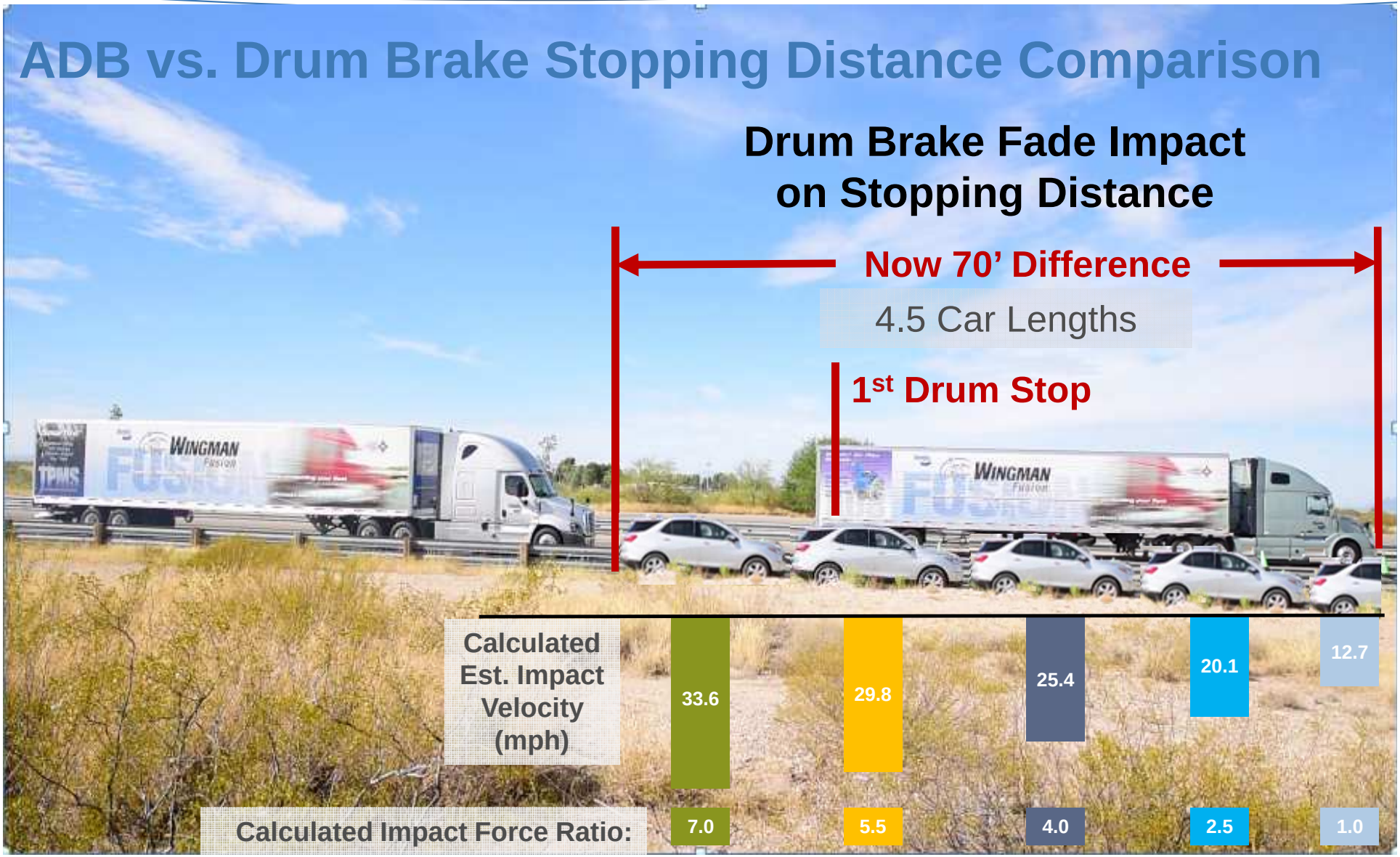


Brake Fade Impacts (Drum vs. ADB)

- All Drum Tractor/Trailer (Mint Green)
- All ADB Tractor/Trailer (Silver)
- Equal GCW's (approx. 64,000 lbs.)



ADB vs. Drum Brake Stopping Distance Comparison



2) Aftermarket Components Impact on Safety

- **Typical considerations made when replacing friction:**
  - What Geometry / FMSI?
  - Inventory availability
  - 6x4 Pricing
    - Non-RSD ($300)
    - RSD ($400)

6x4 Configuration.: $100 Difference

- **Brake Performance (increased variation)**
  - Brake performance will vary / Wider scope of friction choices
  - Non-RSD Friction: RSD stopping distance **(Non-Compliant)**
  - RSD Friction: **(Compliant)** additionally more fade resistant
- **Driver Familiarity**
  - Are they married to vehicle?
- **What performance requirements does the AM follow?**

2) Aftermarket Components Impact on Safety

- **AM Perceptions:**
  - Non-RSD AM replacement shoes are acceptable replacements
    - Regardless if they are RSD manufactured tractors
  - RSD ONLY applies to OEM manufactures
  - DO NOT understand FMCSA 393.40(b)(2)
    - **FMCSA 393.40(b)(2)**
      - Air brake systems. Buses, trucks and truck-tractors equipped with air brake systems and manufactured on or after March 1, 1975, and trailers manufactured on or after January 1, 1975, must, at a minimum, have a service brake system that meets the requirements of FMVSS No. 121 in effect on the date of manufacture.
  - Identification? / Enforcement?
- **Pre-Trade-In / Post Trade-In:**
  - 50% Min. Lining Requirement: Fleet replaces w/ low cost friction
  - Traded-As-Is: Dealer may replace with low cost friction

2) Aftermarket Components Impact on Safety

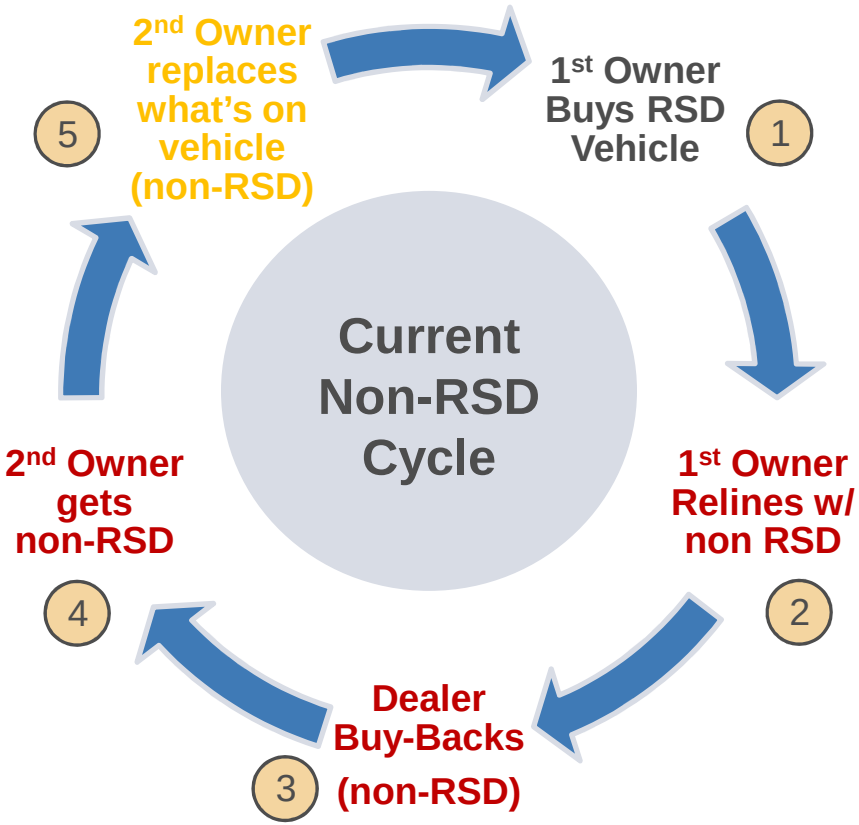
Impacts to non-RSD choices

- Longer Stopping Distances
- Non-Compliance to FMCSA
- Accident Liability

Brake Performance Diminishes:

- As soon as 1st Owner replaces friction
- Continued Cycle for vehicle life
- 2nd, 3rd, etc. Owners unaware

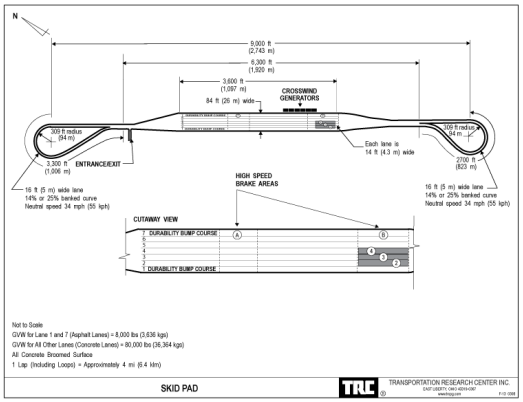
Vehicle Life-Cycle of Degrading Brake Performance



OEM RSD vs. Typical AM Non-RSD Performance

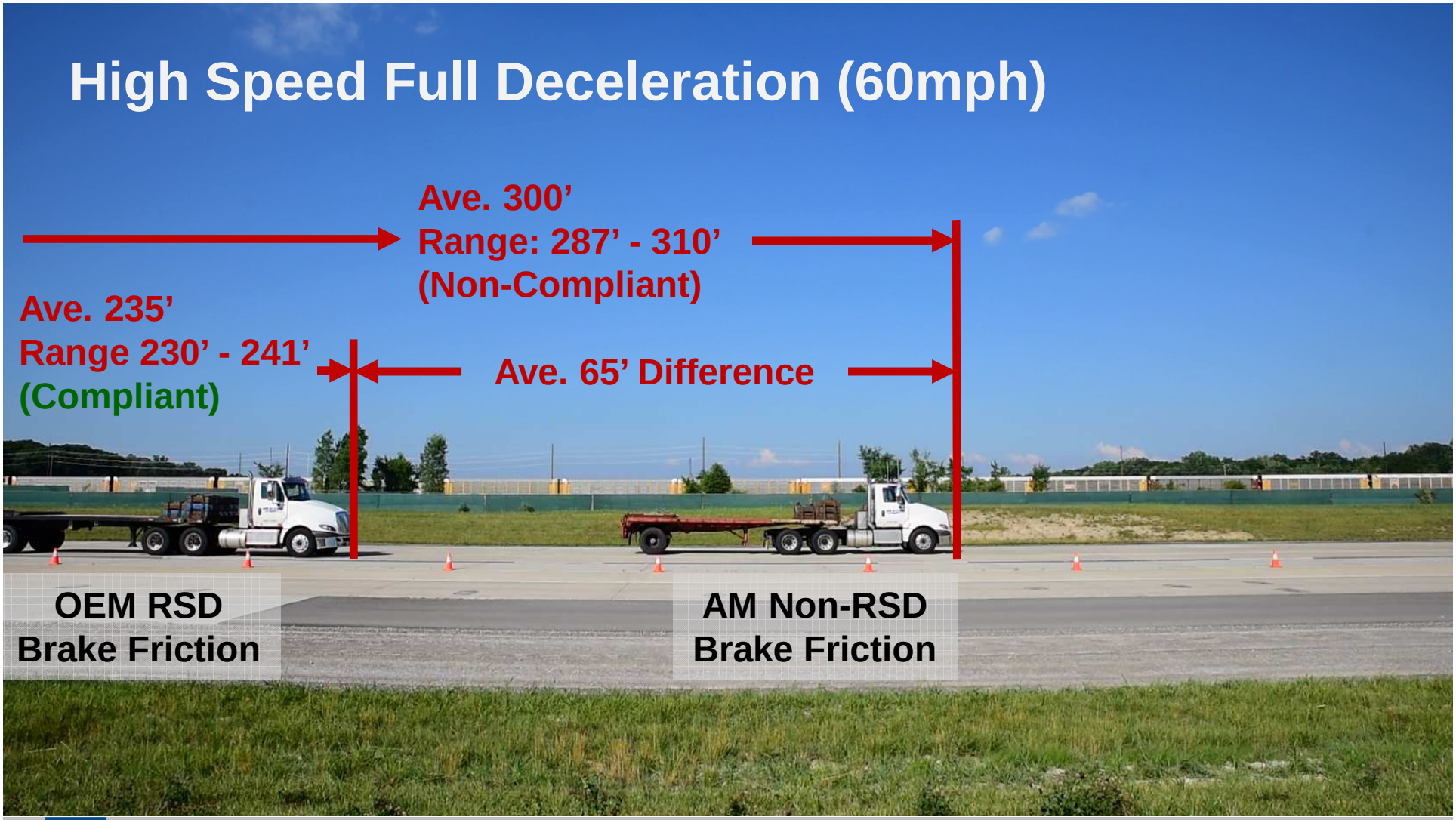
- **Conducted FMVSS-121 Stopping Distance Test**
- **Configurations:**

Configuration	Front Axle	Drive Axles	GCW
OEM Friction (5.5”)	13,440 lbs.	39,620 lbs.	47,504 lbs.
AM Non-RSD Friction (5.5”)	13,340 lbs.	39,820 lbs.	47,502 lbs.

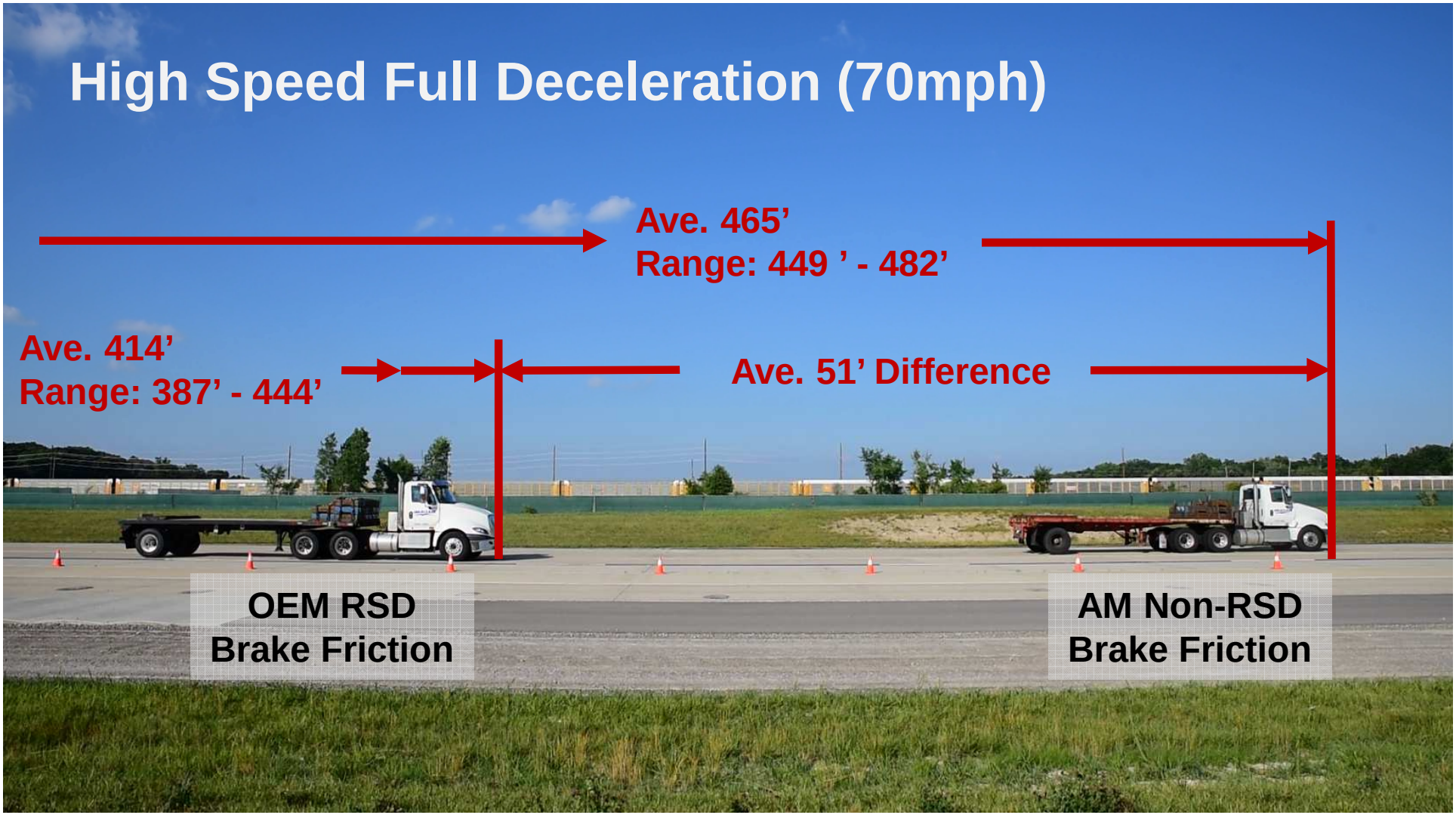


- **Transportation Research Center (TRC) in Ohio**
  - **4-Mile Skid Pad**
  - **8 Minute Cycle Times**

OEM RSD vs. Typical AM Non-RSD Performance



OEM RSD vs. Typical AM Non-RSD Performance



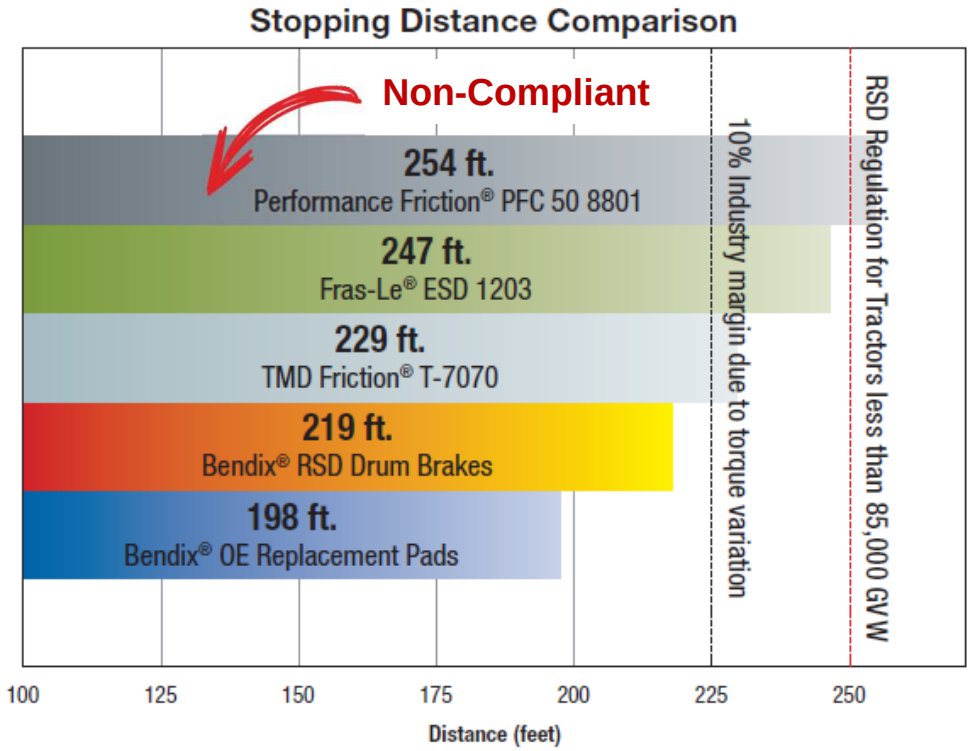
Similar Safety Impact in AM (even with ADB)

- **Industry Perceptions about Air Disc Brakes:**
  - Stop Shorter
  - Eliminate Brake Fade
  - Eliminate Brake Steer
  - Require Less Maintenance
- **ONLY if replaced with “Like-for-Like” in the AM**
  - Due to rigorous testing
- **ADB Aftermarket at risk of following current AM drum friction practices**
  - Pressure to reduce ADB AM costs
  - AM Components in most cases DO NOT follow same test protocol

Similar Safety Impact in AM (even with ADB)

AM Pad Stopping Distance:

- Genuine OEM Replacement Pads maintain the original OE performance
- Other AM Pad choices can increase stopping distance by **over 50 feet**.
- Industry perception is …
  ADB stops shorter !!!!

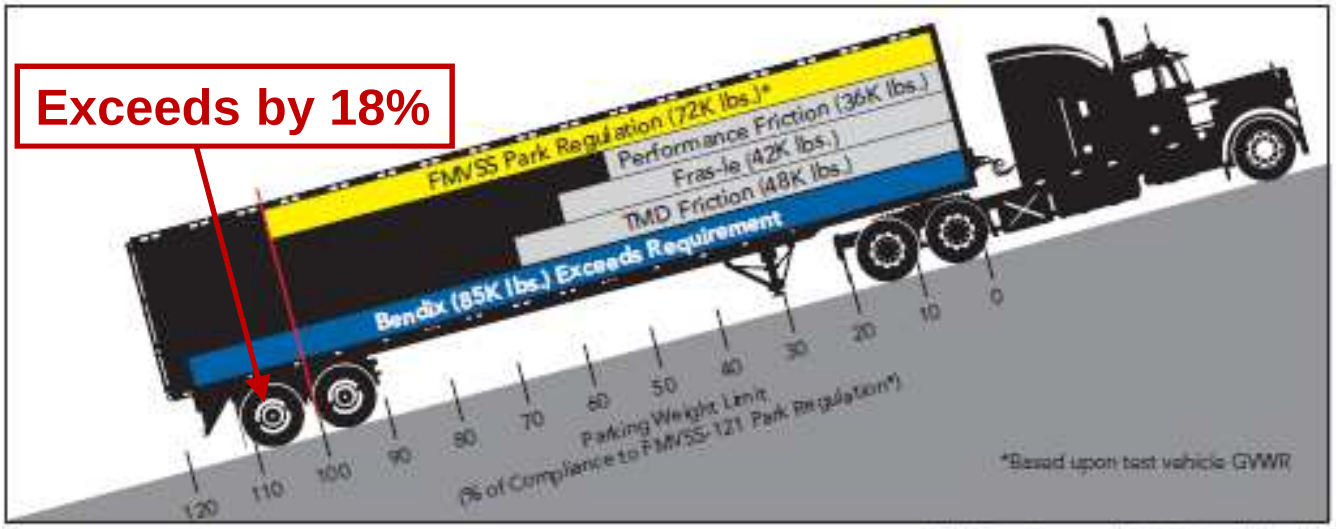


Source: 2015 Bendix testing. Stopping distances are simulated based on FMVSS-121 Hot Stop and Recovery Dynamometer Simulation.

Similar Safety Impact in AM (even with ADB)

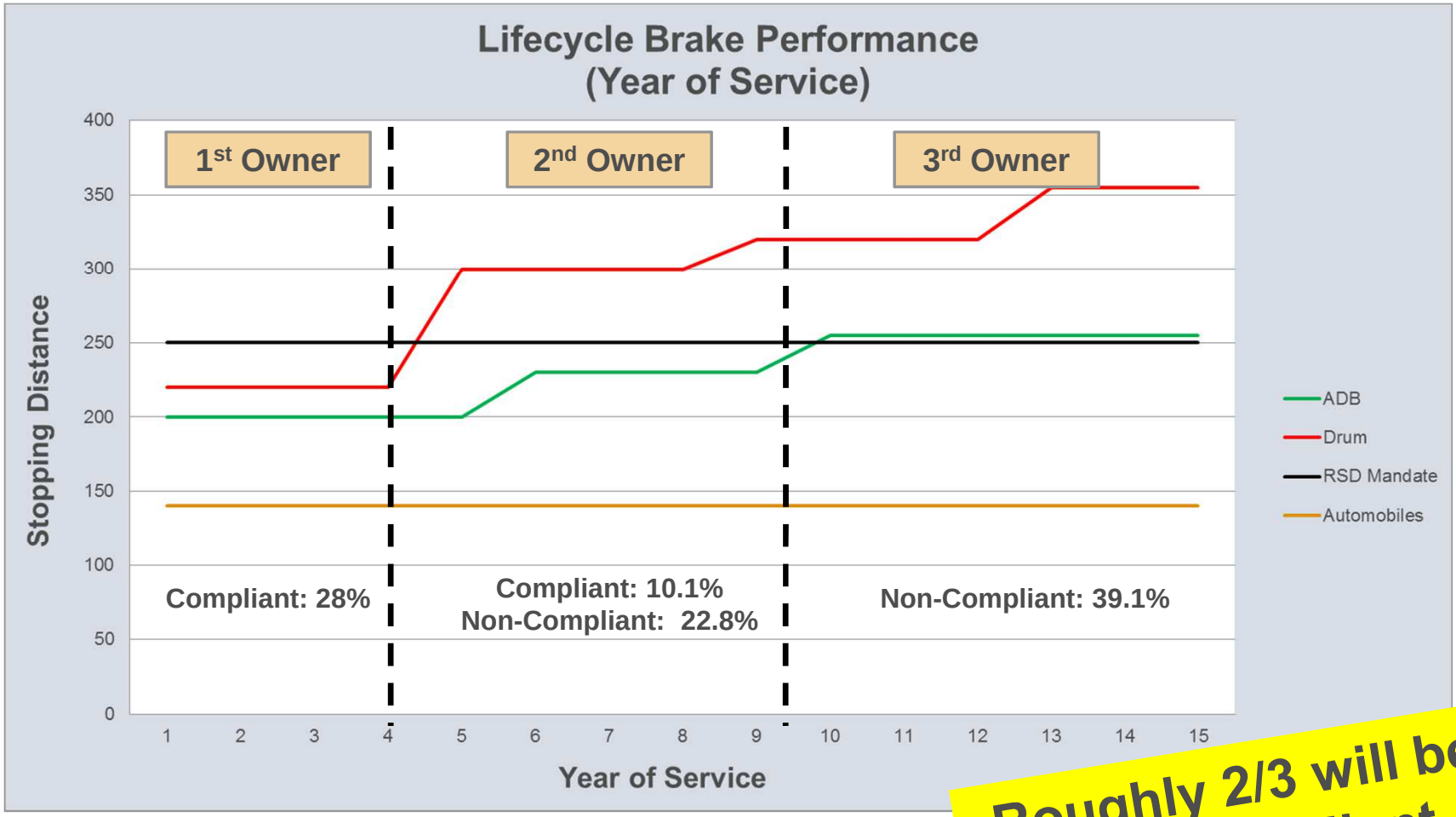
AM Pad Park Capability:

- Genuine OEM replacement pads: Exceed the FMVSS-121 park requirement
- Typical AM replacement pads: May demonstrate a reduced park-hold capability
- Risk: Roll-Away



Bendix pads versus typical aftermarket pads.
Source: 2015 Bendix testing.

Diminished Vehicle Brake Performance Trend (Lifecycle)



Roughly 2/3 will be Non-Compliant

Summary

- **(2) Key Decision Points that define vehicle brake safety**
  - **Vehicle Specifications**
    - Brake Steer vs. Non-Brake Steer effect
    - Stopping Distance Delta (Cold): 20-25 feet
    - Brake Fade Impact to Stopping Distance (Hot): (add'l 50 feet)
    - While Compliant / Maybe be up to 70 feet different / Less Consistent (affecting CMS)
  - **Friction Replacement in the AM (not replacing "Like-for-Like)":**
    - Stopping Distances increase: (by up to 80 feet) / **Saved $100**
    - Increased Brake Fade / Inconsistent Stopping Distances
    - Reduced Park-Hold / Risk of Roll-Aways
- **Lifecycle Brake Performance trending across the Industry**
  - Stopping Distances could vary anywhere from 200' to 355'
  - Incrementally increase with speed and heat

Bendix Spicer Foundation Brake LLC

Thank you !!

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