BUS industry SAFETY council

Vehicle Technical Operations Committee

Winter Meeting 2019

Louisville, Kentucky

Vehicle Technical Operations Committee

- Welcome
- Thank You For Attending
- Post session survey. Please participate!

This is your forum; we need your feedback for future topics and improvements.

Your forum for safety and compliance.

Thank you to our SME's!

Presented By:

Pat Meisenholder

Product Technical Manager, Michelin

Supporting Panel

Louis Hotard

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Your forum for safety and compliance.

Tire Maintenance Best Practices

- Greenhouse Gas Efficiency Standards
- Tire Rolling Resistance
- Factors that Impact Rolling Resistance
- Fleet Strategies to Address New Requirements
- Open Discussion

Your forum for safety and compliance.

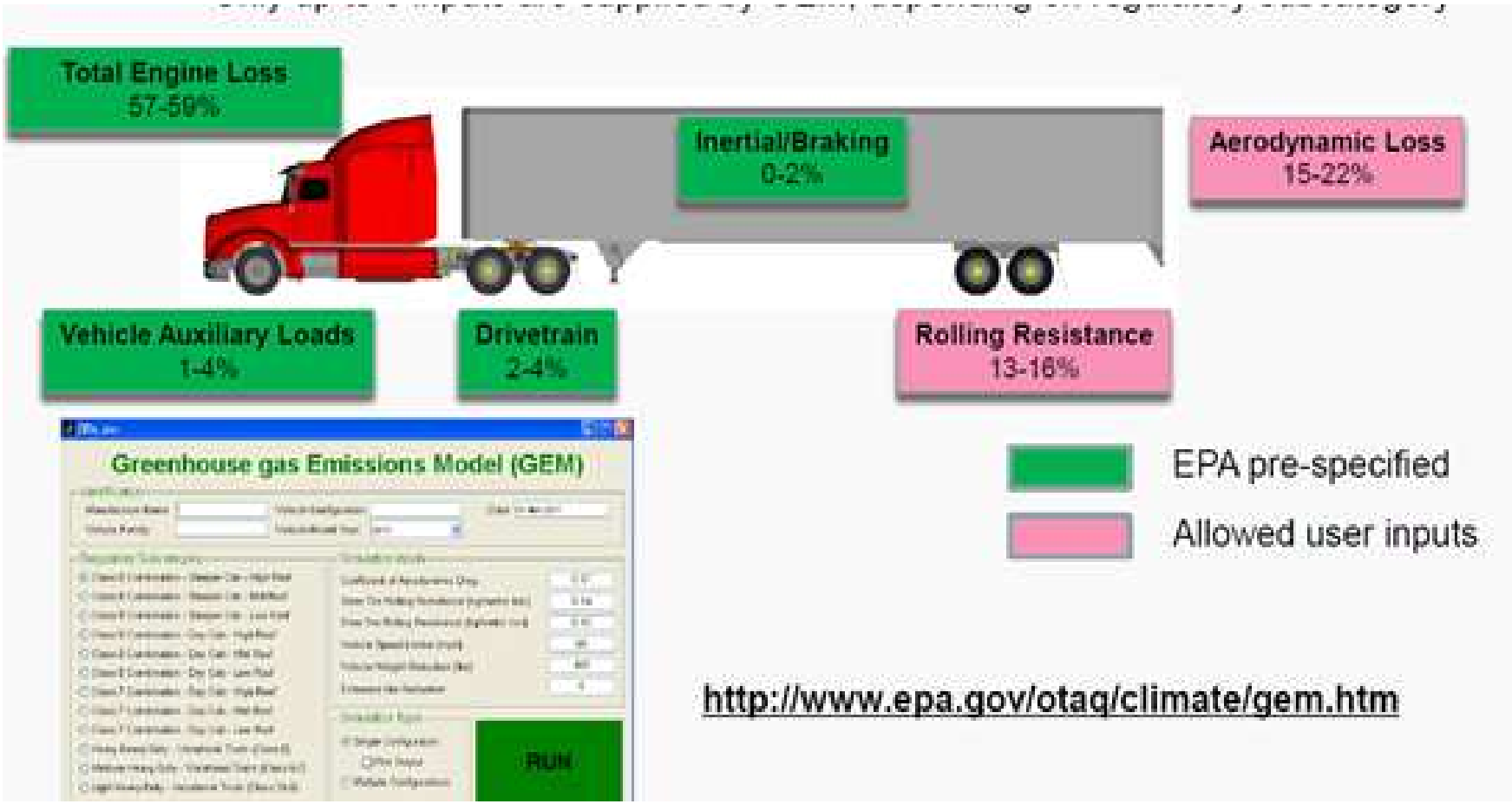
49 CFR Parts 523, 534, 535

- Greenhouse Gas Emissions Standards & Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles
- Phase 1: September 2011 (for MY 2014 – My 2018)
- Phase 2: October 2016 (for MY 2018 – My 2027)
- Greenhouse gas Emission Model (GEM)

Phase 1 GEM Model

- Vehicle simulation tool used by OEMS to demonstrate compliance
- Simulates 3 EPA drive cycles: 55 mph, 65 mph, and transient cycles
- Simple Model- 5 Inputs
    1. Coefficient of Aerodynamic Drag
    2. Steer & Drive Tire Rolling Resistance (kg/metric ton)
    3. Vehicle Speed Limiter (mph)
    4. Vehicle Weight Reduction (lbs)
    5. Extended Idle Reduction

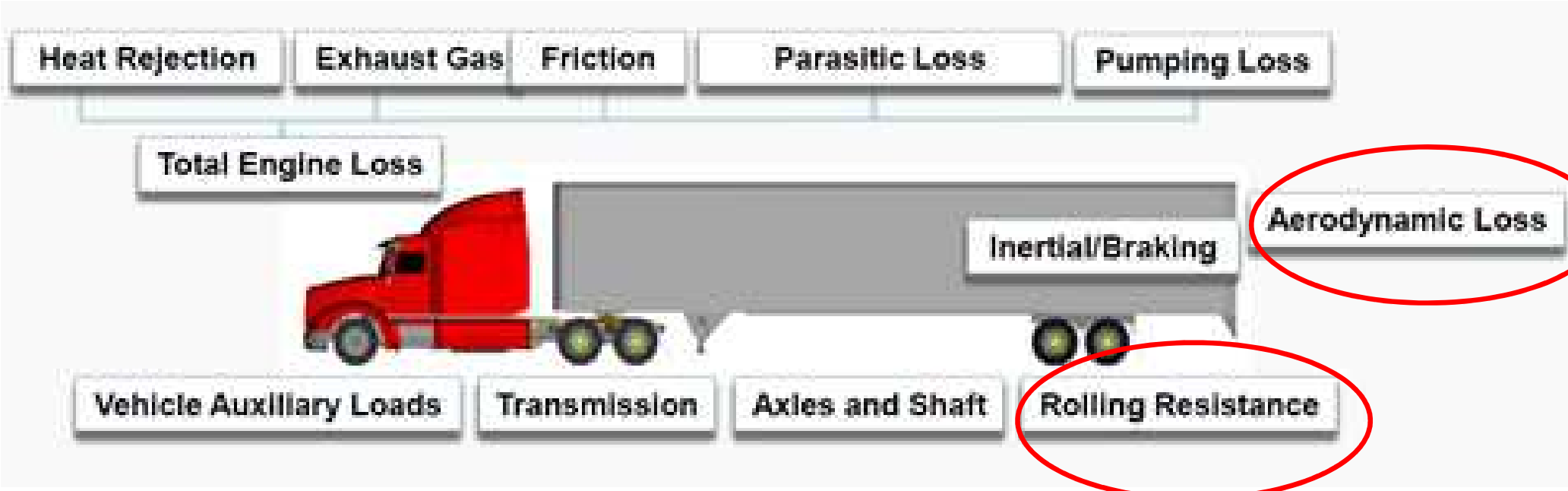
Phase 1 Model



Phase 2 GEM Model

- “All Possible Technologies”
- “EPA Pre-Specified” categories eliminated; OEM must enter all values
- Added Idle Cycle to GEM model
- Expanded to provide additional guidance for light and medium duty vehicles, vocational vehicles. (Trailers and Glider Kits were included but are now pending).

Phase 2 GEM model inputs



GEM Output

- OEMs must measure and certify the CO_2 Standards, measured in grams of CO_2 per ton-mile.
- Two thresholds to meet: MY2021 and MY2027.

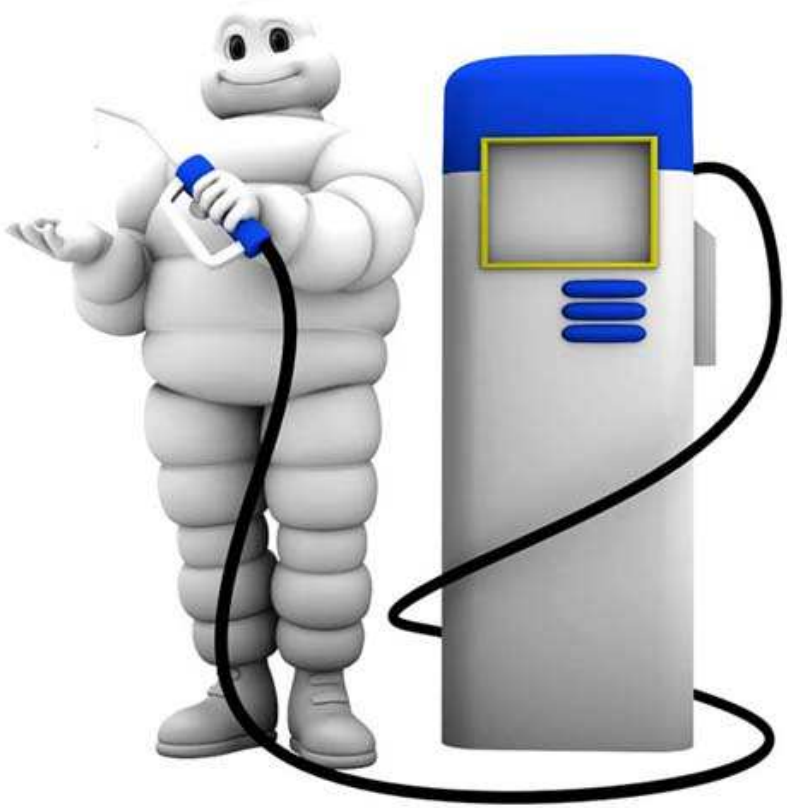
Custom Chassis Category	MY 2021	MY 2027
Coach Bus	210	205
Motor Home	228	226
School Bus	291	271
Other Bus*	300	286
Refuse Truck	313	298
Mixer	319	316
Emergency	324	319

OEM Reporting for vehicle standards

The following is the Greenhouse Gas Exhaust Emission Standards (STD) or Family Emission Limit(s) (FEL) in g/ton-mile as applicable under 17 CCR 95663:

GVWR	CO_2 (in g/ton-mile)		
	STD	Highest Projected FEL	Lowest Projected FEL
GVWR > 33,000	222	220	209

Rolling Resistance Requirements



Rolling Resistance

1. As tires turn, they flex and deform
2. Transform energy into heat.

3. Absorbs the friction when the tires contact the road.

= Rolling Resistance

What is Rolling Resistance?

- The energy dissipated by a Tire, per unit of distance travelled (rolling resistance force F_{RR}) and characterized by a coefficient (C_{RR})
- Expressed in kg/T

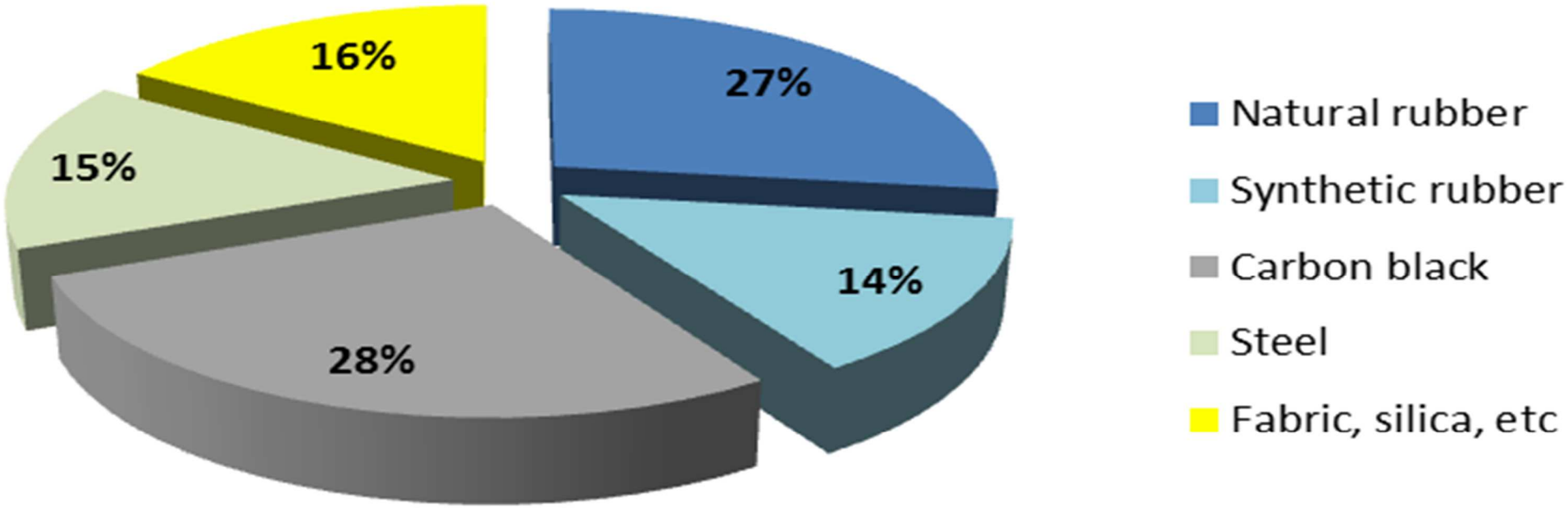
Order of Magnitude:

Passenger Cars:	8 to 12 kg/T
Trucks:	4 to 8 kg/T

Tire Design Impacts Rolling Resistance

1. Rubber Compounding
2. Tire Architecture
3. Tread Pattern

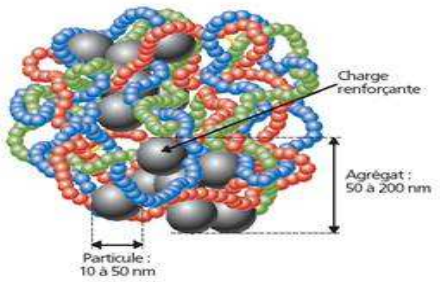
What's in a Bus Tire?



Traditional Rubber Compounding

Carbon Black

- Discovered in 1915
- 30% of compound
- Reinforces rubber compounds to significantly increase wear.



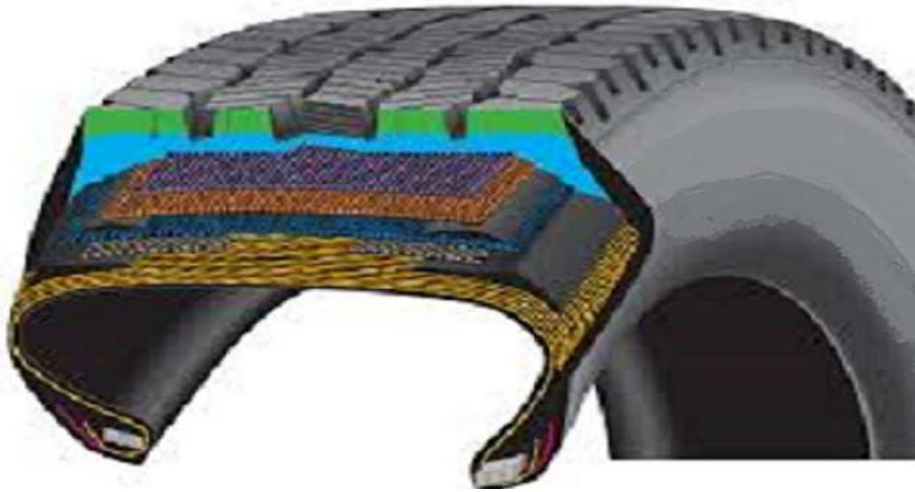
Silica Compounds: 1990s

- Industrialization Breakthrough
  - Improves resistance to tearing
  - Reduces rolling resistance
  - Improves grip on cold & wet surfaces.

"No Compromise"

Dual Compound Technology

- Co-extruded tread designs provide a cooler running base layer to protect casing.
- Tread cap provides high resistance to abrasion and better wear.



Architecture- Contributions to Rolling Resistance

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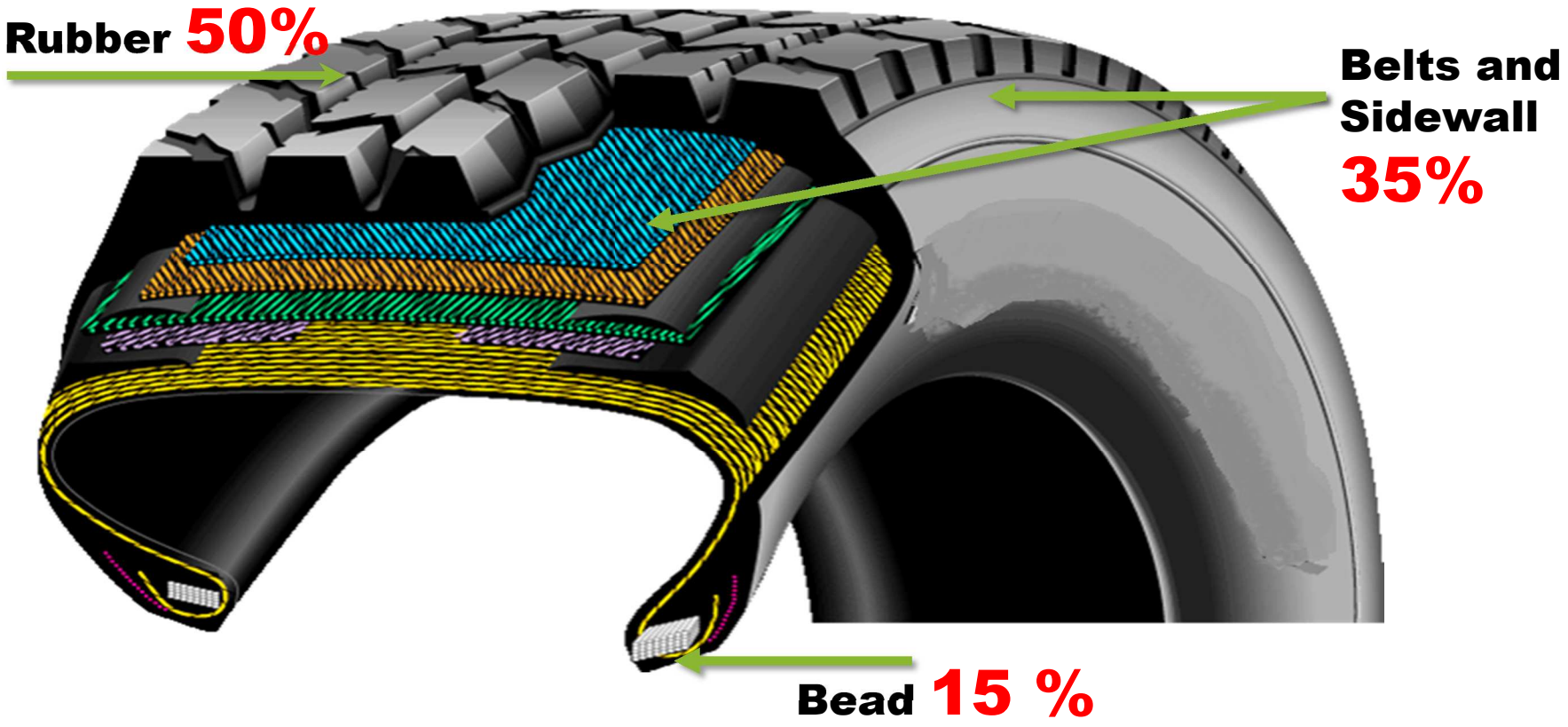

Tread Pattern

External Factors that Impact Rolling Resistance

1. Tire Pressure
2. Tread Wear
3. Rolling Time
4. Ambient Temperatures
5. Road Surfaces
6. Speed

Tire Pressure

1. An underinflated tire is over-deflecting and has a higher rolling resistance.
2. 8 psi underinflation increases rolling resistance by 12 %
3. 15 psi underinflation increases rolling resistance by 30%

External Factors that Impact Rolling Resistance

1. Tire Pressure
2. Tread Wear
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Tread Wear

1. As tire wears, rolling resistance improves.
2. Expect 30 – 40% improvement from when the tire is new to fully worn (2/32”).
3. Anticipate a drop in fuel economy when tires are replaced.

External Factors that Impact Rolling Resistance

1. Tire Pressure
2. Tread Wear
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Rolling Time

- For motor coach tires, approximately 60 – 90 minutes of use to “warm up”.
- A cold tire is 30% less efficient than a warm tire
- Cool down= 3 hours.

Rolling Time: Thermal Equilibrium

- The heat generated within the tire is equal to the heat being dissipated.
- Normally considered to be “ambient + 60 degrees F”, about 10 – 15 % higher than cold pressure.
- Maximum is **194 degrees F**
- Operation above **230 degrees F** impacts rubber properties.

External Factors that Impact Rolling Resistance

1. Tire Pressure
2. Tread Wear
3. Rolling Time
4. Ambient Temperatures
5. Road Surfaces
6. Speed

Ambient Temperatures

1. Tires operate more effectively when it is warm outside.
2. Optimal range- 60°F and 95°F
3. Rolling resistance improves 6% as temperature increases in 20 °F increments.

External Factors that Impact Rolling Resistance

1. Tire Pressure
2. Tread Wear
3. Rolling Time
4. Ambient Temperatures
5. Road Surfaces
6. Speed

Road Surfaces

1. Types of roads impact rolling resistance
   - Sand, Dirt, Asphalt, Concrete
2. Road surfaces have different levels of roughness (macro to smooth)
3. A rough road surface may increase rolling resistance over a smooth surface by 30%.

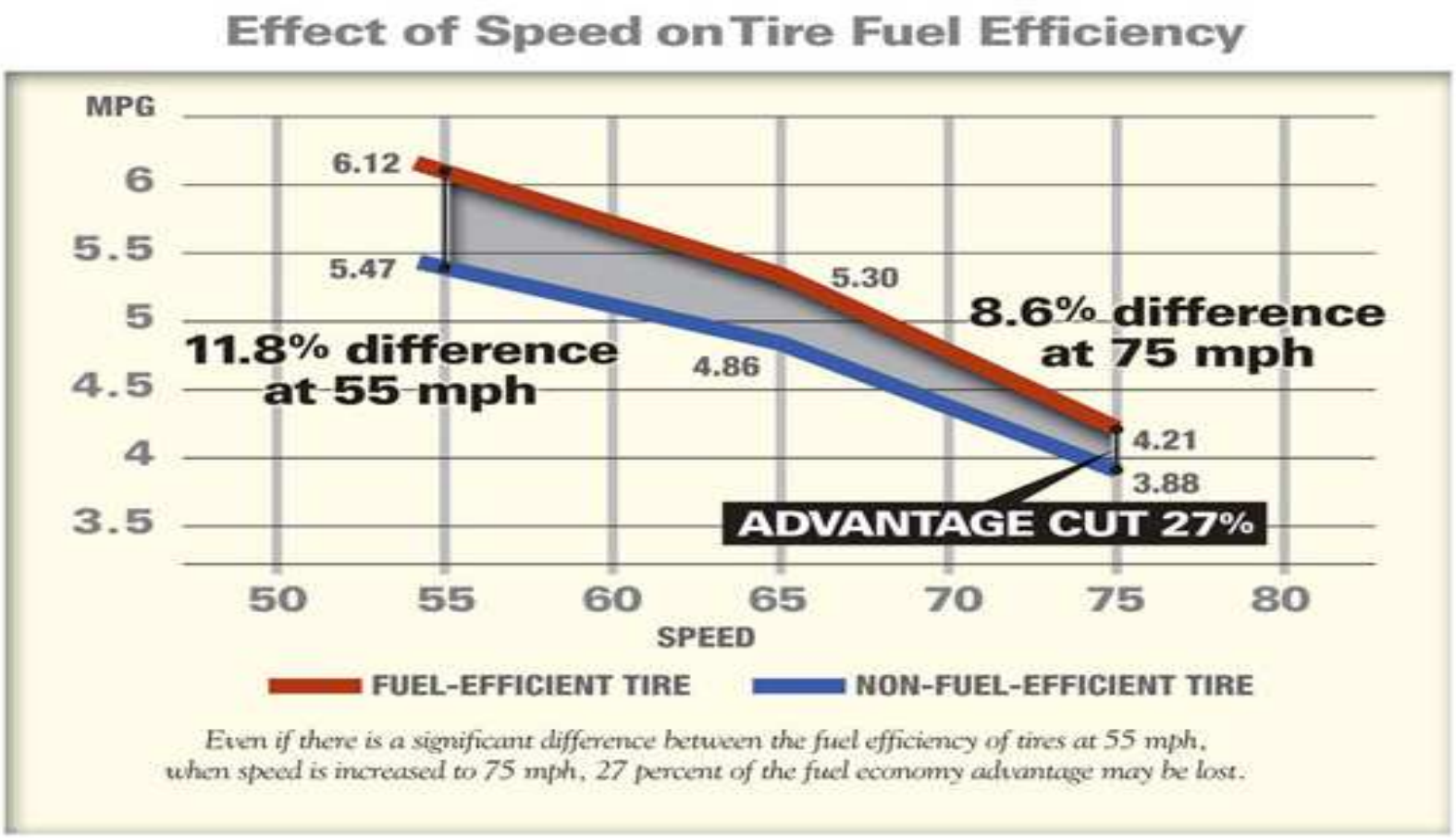
External Factors that Impact Rolling Resistance

1. Tire Pressure
2. Tread Wear
3. Rolling Time
4. Ambient Temperatures
5. Road Surfaces
6. Speed

Speed

1. Tires impact rolling resistance up to 55 mph.
2. As speed increases, tires become less of a factor.

Speed

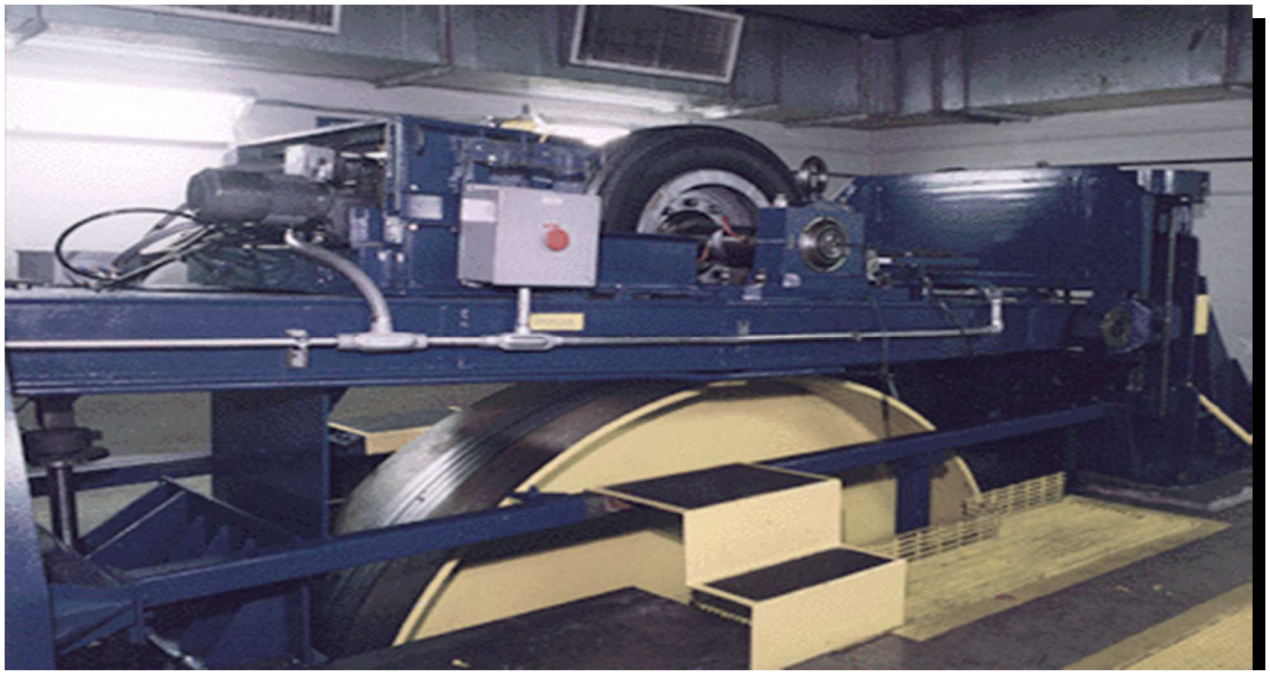

Effect of Speed on Tire Fuel Efficiency
MPG
6
5.5
5
4.5
4
3.5
6.12
5.47
5.30
4.86
4.21
3.88
11.8% difference at 55 mph
8.6% difference at 75 mph
ADVANTAGE CUT 27%
50
55
60
65
70
75
80
SPEED
FUEL-EFFICIENT TIRE
NON-FUEL-EFFICIENT TIRE
Even if there is a significant difference between the fuel efficiency of tires at 55 mph, when speed is increased to 75 mph, 27 percent of the fuel economy advantage may be lost.

Phase 2 Tire Rolling Resistance Requirements

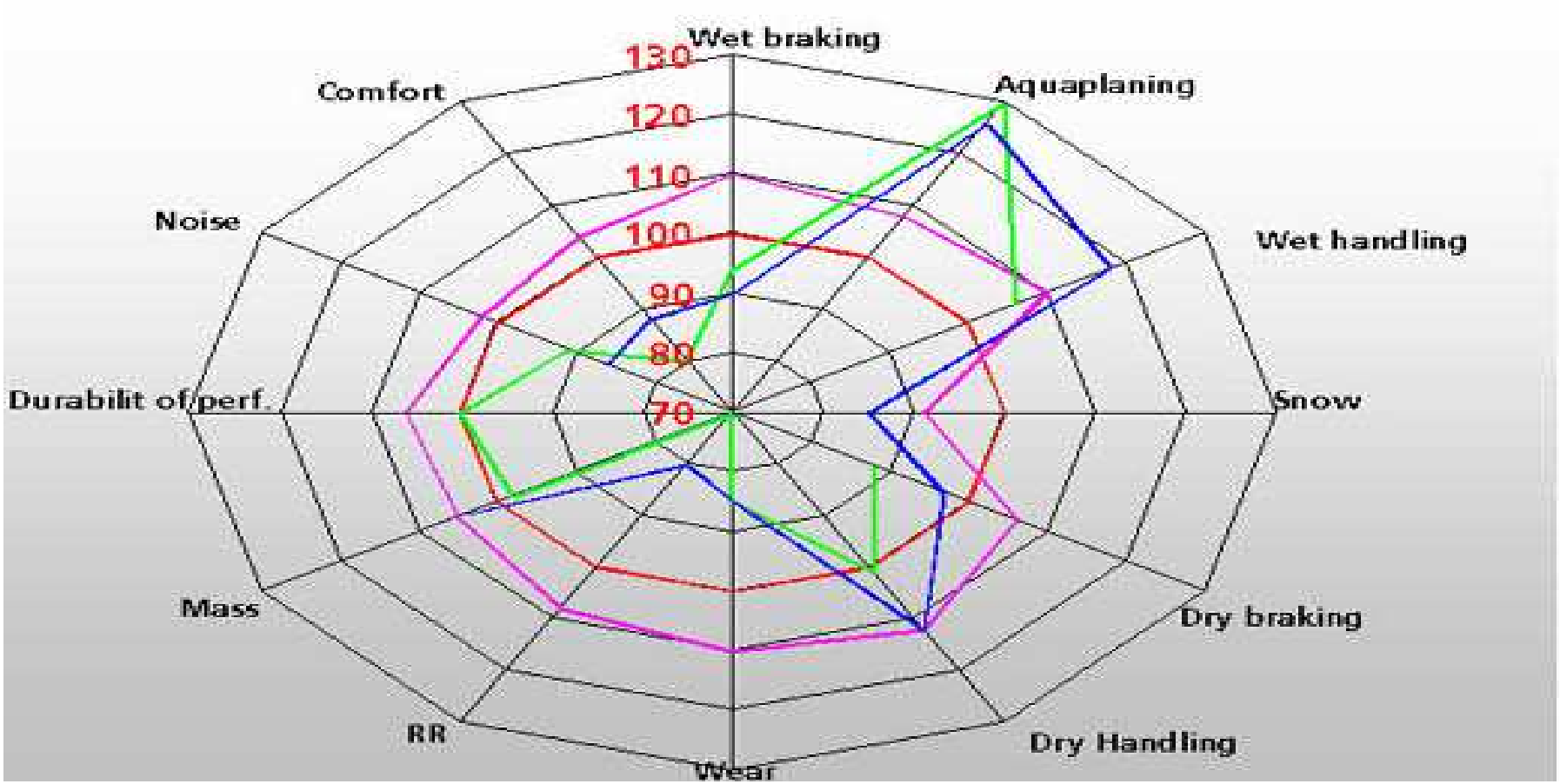
CO_2 Emissions Standards for Certain Vocational Vehicles 1037.105(h) Alternative Compliance With Use Through 2026			
Vehicle	**MY 2021 - 2026**	**MY 2027**	ATIS or TPMS
Regional Coach buses, Motorhomes	6.7 kg/t	≤ 6.0 kg/t	Y
Urban Emergency	8.7 kg/t	≤ 8.4 kg/t	
Urban Concrete mixers, Mixed use	7.6 kg/t	≤ 7.1 kg/t	

Rolling Resistance Testing

- SD = +/- 0.3kg/T is the 3 sigma value for the average Crr value reported.
- ISO 28580 with 2.0 m drum report reference
- Self Reporting



Tire Replacement - Balance



Tire Replacement Strategy

1. CRR values are Confidential
    - Consult Tire Manufacturers/Websites

2. Tire manufacturers have different strategies to reach required Rolling Resistance Targets
    - Tire casing optimization, tread compounds, original tread depths, etc

Total Cost of Ownership

Fleet Evaluation of Your Facts

- Tire Wear Analysis-
  - ❑ Seasonal Pull Points?
  - ❑ Evaluation of Pull Point
- Tire Selection-
  - ❑ Drive Tires versus All Position Tires
  - ❑ Retread versus New Tires
- Downtime Analysis
- Fuel Consumption Analysis

In Summary

- Greenhouse gas Emission Standards extend to MY2027
- OEM Tire manufacturers are prepared to meet the challenges
- Contact your tire supplier for questions and advice.

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