



# Magneto-Rheological Fluid Semiactive Suspension System



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| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                          | Form Approved<br>OMB No. 0704-0188                       |                                 |
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# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## Agenda

- Defining Suspension Types
- Magneto-Rheological Fluid
- Damper Hardware
- Controls & Electrical
- Data & Results
- Summary & Benefits



# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## Active Suspension System

Design Approach: Minimize change of forces caused by the terrain

Hardware: Electrically Controllable Force Actuator  
(replaces spring and shock absorber)

Hull and Suspension Sensors

Controller

Moderate Power Usage



# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## Semiactive Suspension System

Design Approach: Vary damping to minimize hull motion

Hardware: Electrically Controllable Damper  
Hull and Suspension Sensors  
Controller  
Minimal Power Usage



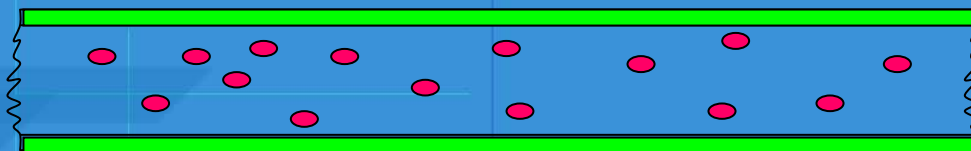
# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

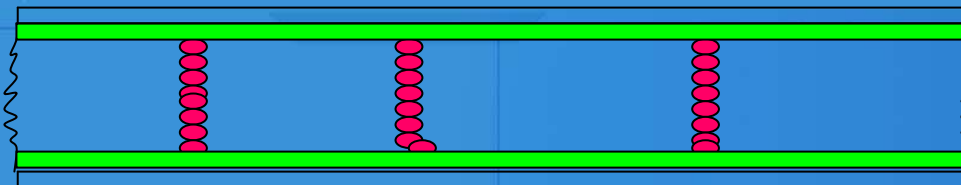
Utilizes Magneto-Rheological (MR) Fluid

- Oil-based fluid containing iron particles
- Fluid's shear stress (viscosity) can be varied by the application of a magnetic field

## Cross Sectional View of MR Fluid



No Field



With Applied Magnetic Field



# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## Damper Hardware

- Stryker Phase II Plus design utilizes heavily modified production dampers (no size penalty)
- Existing Stryker gas spring / height management system is retained and fully operational
- MR Valve is engineered to have exceptional control over a wide range of damper forces
- MR valve demonstrated durability by passing a 1 million cycle military standard endurance test



# MR Fluid Semiactive Suspension System

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## Controls & Electrical

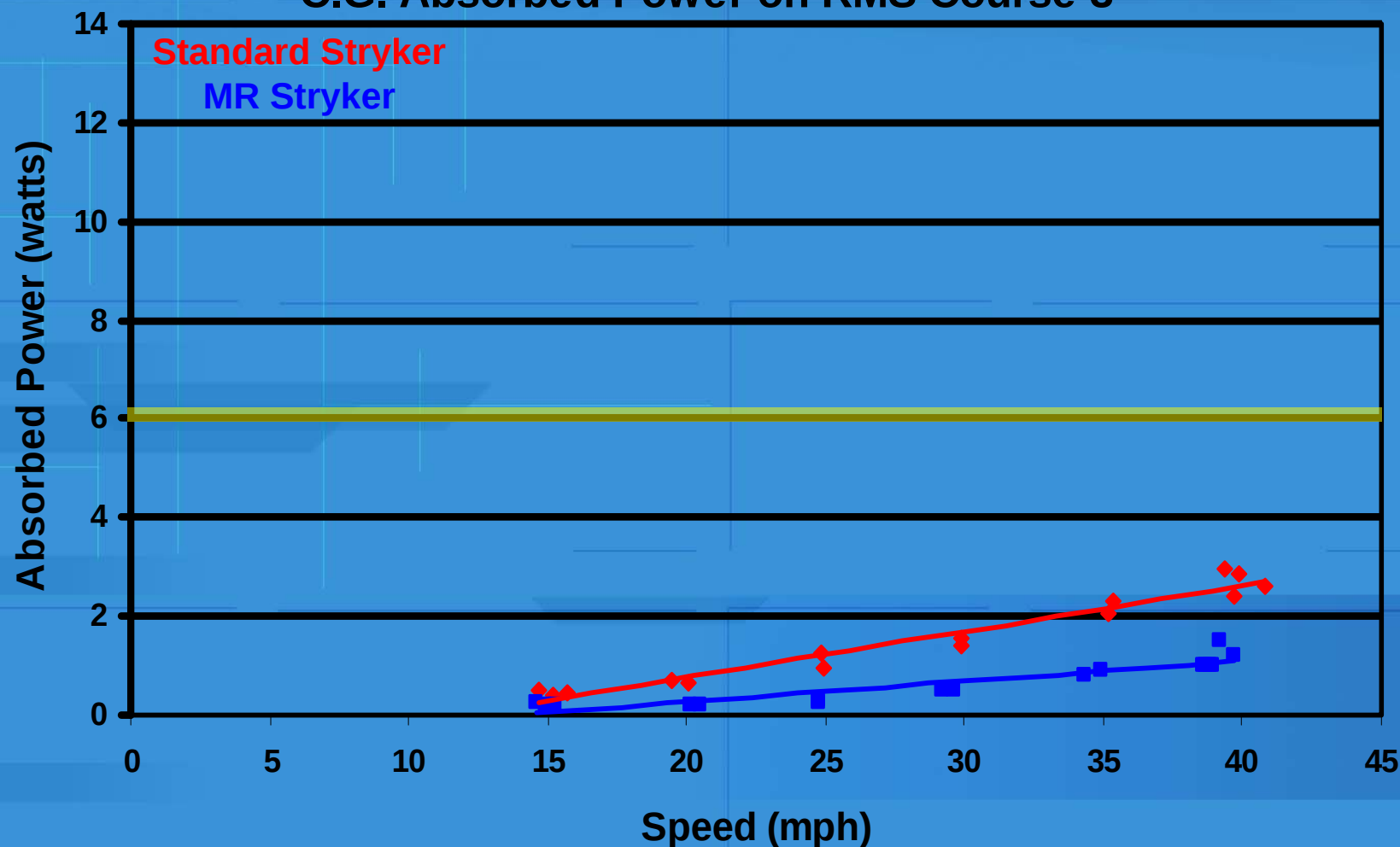
- Compact distributed real-time controllers networked by CAN bus (currently independent of Stryker bus)
- Low power consumption:
  - 80 W at idle, 250 W cross country (est.), 800 W theoretical peak
- Controller update rate:
  - 2000 Hz (0.5 ms)
- Cost effective, reduced sensor suite



# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## C.G. Absorbed Power on RMS Course 3

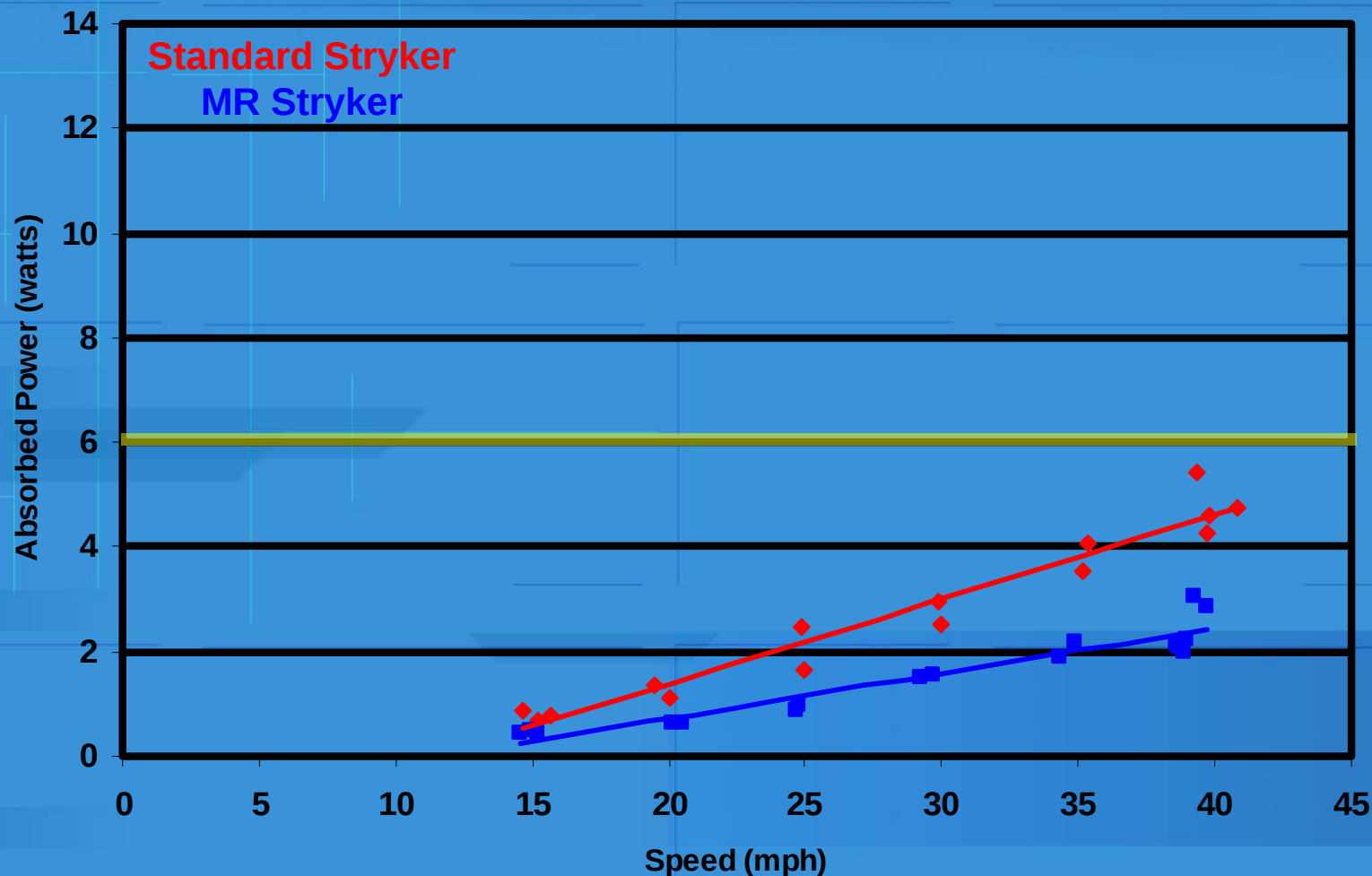




# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## Driver Absorbed Power on RMS Course 3

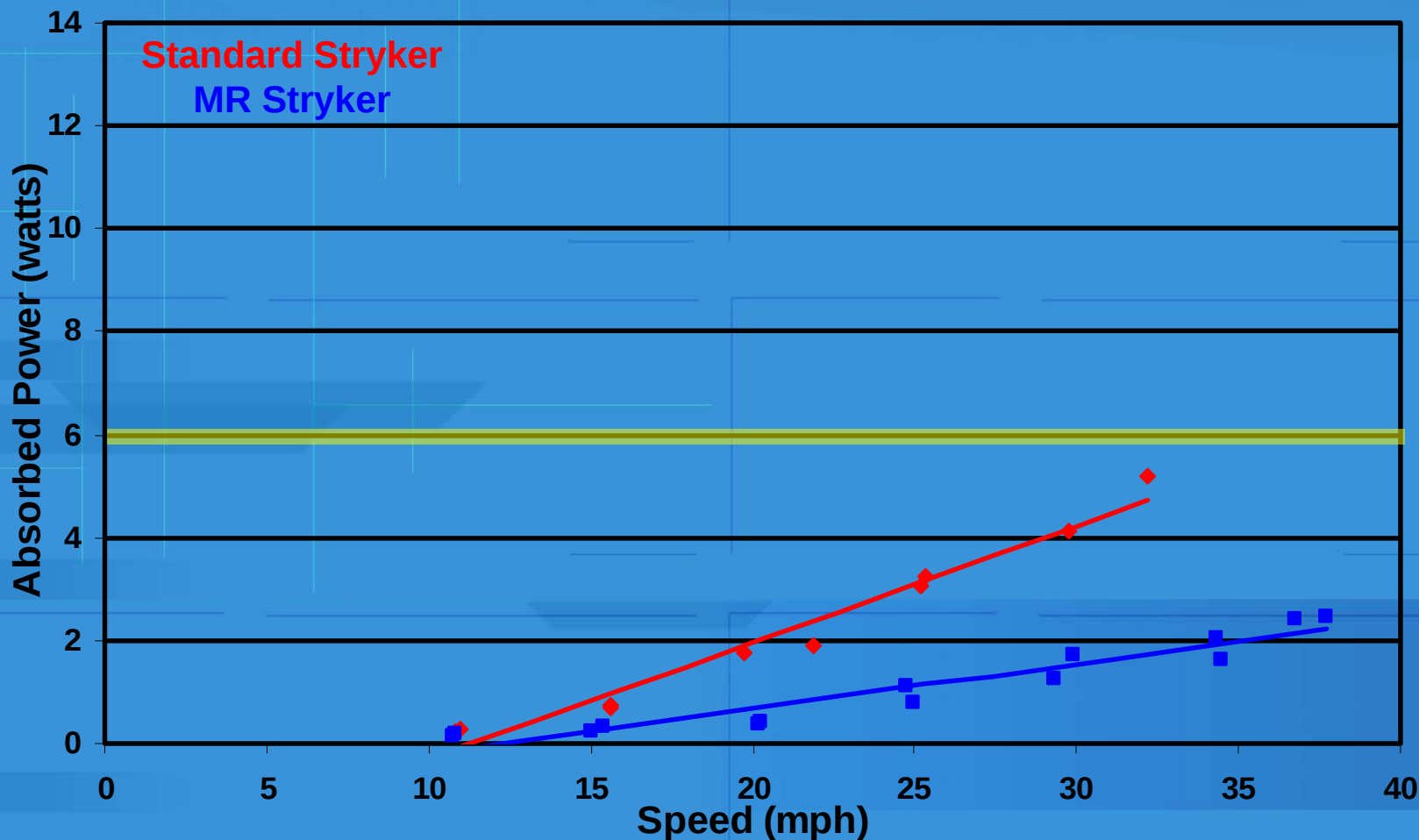




# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## C.G. Absorbed Power on RMS Course 4

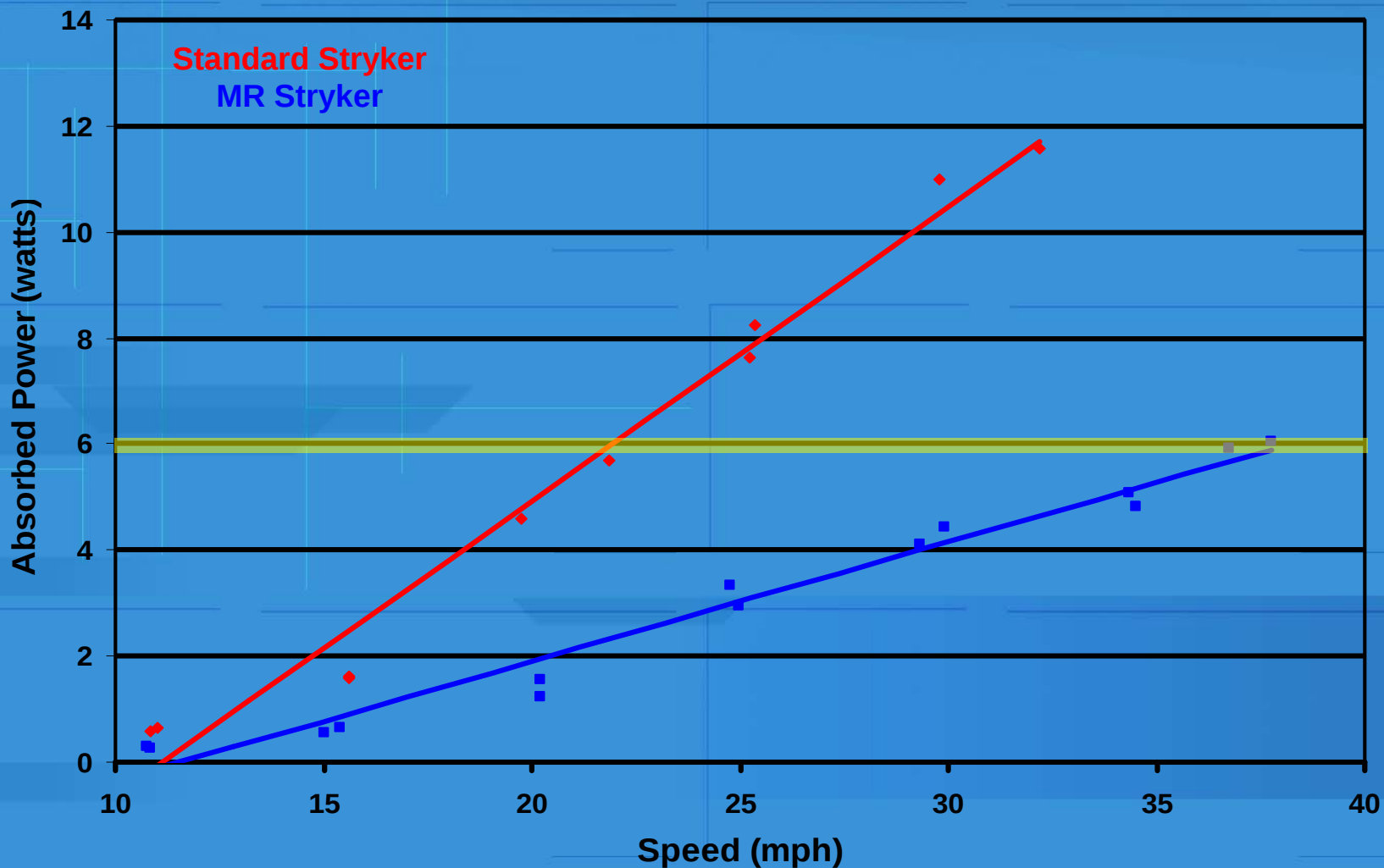




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SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## Driver Absorbed Power on RMS Course 4

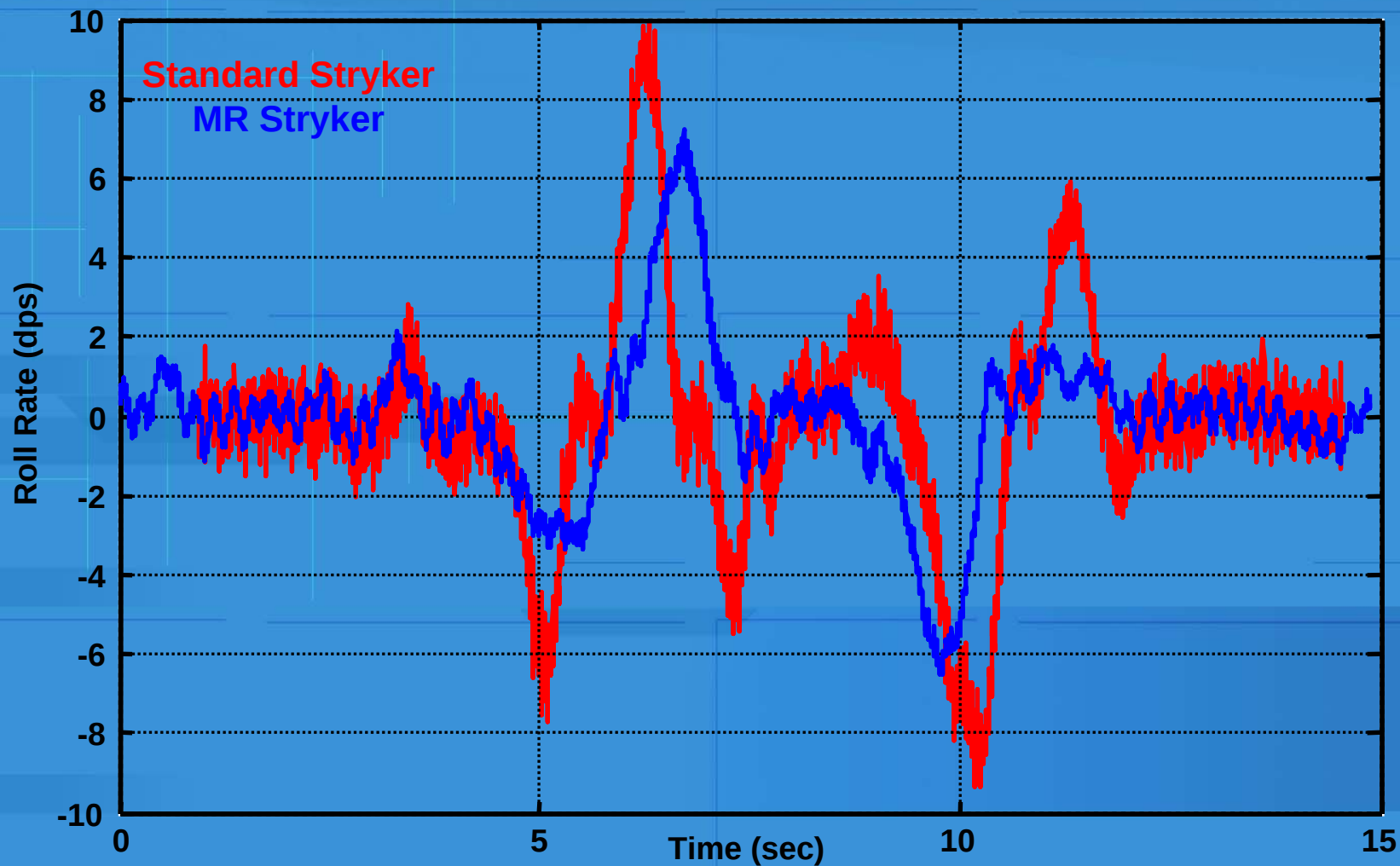




# MR Fluid Semiactive Suspension System

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Roll rate vs. Time for 35 mph Double Lane Change





# MR Fluid Semiactive Suspension System

SUPERIOR TECHNOLOGY FOR A SUPERIOR ARMY

## Summary of Benefits

- Significant reductions in driver absorbed power and vehicle body motions compared to the standard vehicle
- Very low power consumption and favorable failure modes compared to fully active suspension systems
- Minimal System Configuration Changes
  - Wiring harnesses and Control boxes
  - Additional weight (~200lbs)
- Scalable to nearly any sized vehicle