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NHTSA's ESC Research Program: 2005 Activities and a Look to the Future

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Garrick J. Forkenbrock
W. Riley Garrott
NHTSA VRTC

Presentation Overview

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- 2005 Testing
- Maneuver Reduction
- ESC Evaluation Metrics
- Repeatability Evaluation
- Future Research
- Concluding Remarks

2005 Testing

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- **ESC Effectiveness**
  - Participated in a collaborative data collection with 11 vehicle manufacturers
  - 62 vehicles, 128 configurations evaluated
- **Sine with Dwell Repeatability**
  - Collaborative testing effort with the Alliance of Automobile Manufacturers
  - Two vehicles presently being evaluated at five proving grounds

Maneuver Reduction

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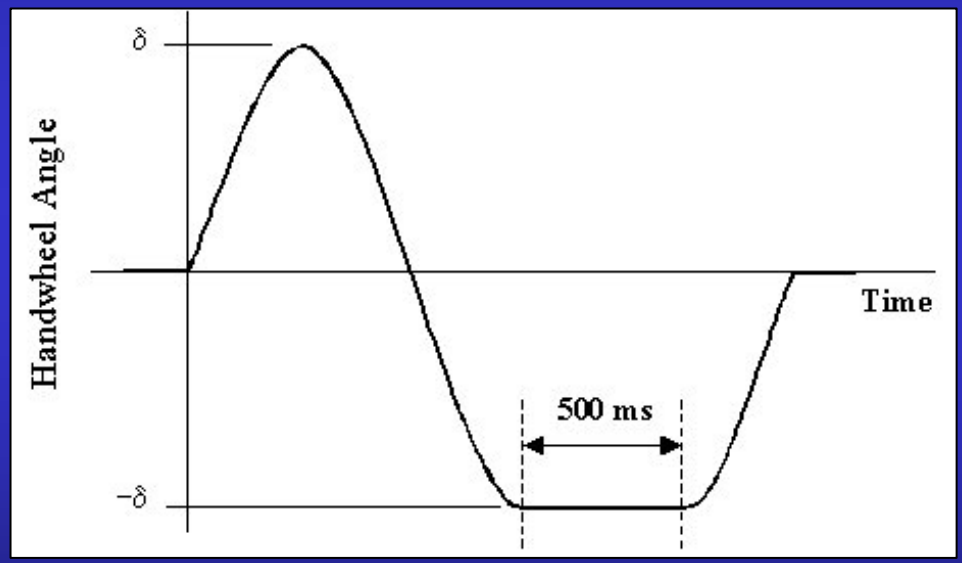
- **Phase 1 (2004)**
  - **12 maneuvers, 21 steering combinations used**
  - **Four top candidates identified**
- **Phases 2a and 2b (2005)**
  - **Four Phase 1 maneuvers used for 24 vehicles**
  - **0.7 Hz Sine with Dwell selected as preferred ESC effectiveness maneuver**

0.7 Hz Sine with Dwell

- **Requires use of a steering machine**
- **Based on a single cycle sinusoidal steering input**
- **Frequency is 0.7 Hz**
- **500 ms pause after 3rd quarter cycle**
- **Performed at 50 mph** (drop throttle only)
- **Severity increased via steering angle increments**



ESC Evaluation Metrics

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- **Many methods for evaluating lateral stability and responsiveness considered**
- **Lateral stability:**
  - **Vehicle must not spinout (oversteer mitigation)**
  - **Requires yaw rate to decay in a reasonable manner**
- **Responsiveness:**
  - **Complements lateral stability**
  - **Reflects NHTSA opinion that it is important for a vehicle retain reasonable avoidance capability**

Repeatability Evaluation

- **The outcome of a test used to evaluate minimum performance should not depend on where the test was performed**
- **Tests being performed at five locations**
  - **Ohio** *(VRTC)*
  - **Michigan**
  - **South Carolina** *(VRTC)*
  - **Arizona**
  - **California**

Documentation/Presentation

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- **Documentation**
  - **ESV Paper 05-0221** *(Phase 1 research)*
  - **DOT HS 809 875** *(human driver steering capability)*
  - **Technical report summarizing 2005 ESC research in approval circulation**
- **Presentations**
  - **2005 ESV**
  - **2005 SAE Government / Industry**
  - **ESC docket 19951**

Future Research
Understeer Mitigation

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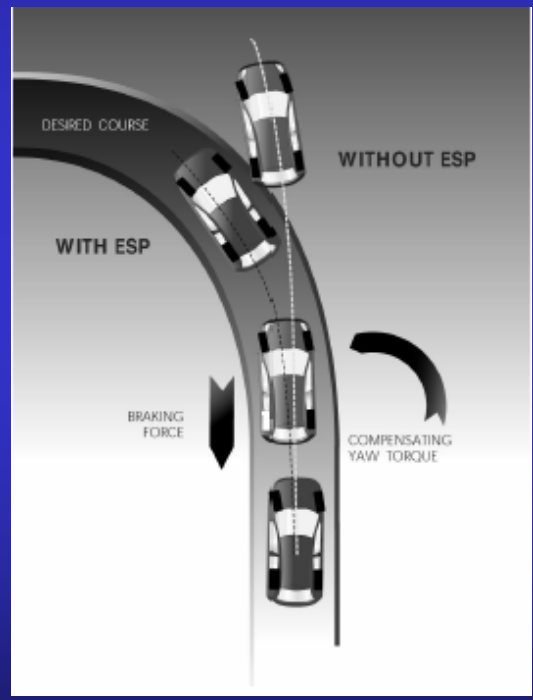
Research Objectives

- Determine common understeer events
- Identify a test maneuver(s) capable of quantifying understeer mitigation effectiveness
- Assess low friction test feasibility



Future Research
Understeer Mitigation

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- **Anticipated maneuvers**
  - **J-Turn**
  - **Closing Radius Turn**
  - **Slowly Increasing Steer**
- **Small, diverse test fleet**
  - **Sports car**
  - **Two SUVs**
  - **Two sedans**
  - **15-passenger van**
- **One load configuration** *(Nominal load)*

- **Testing to begin winter 2005**
- **Winter proving grounds tests may be performed**
  - **Ice testing**
  - **Snow testing**
  - **Results could be compared to those produced on the TRC wet Jennite pad**

Future Research
Understeer Mitigation – Testing Concerns

- ESC benefits on low friction surfaces have been documented, but are based on crash data and subjective test track evaluations
- Results from tests performed on low friction surfaces are prone to high test variability
- NHTSA would like to objectively quantify the effects of understeer mitigation so that minimum performance criteria can be developed
- NHTSA would greatly appreciate suggestions on how to resolve this problem!

Future Research
Roll Stability Control (RSC)

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- **Research Objectives**
  - Gain an increased awareness of RSC functionality and effectiveness
  - Determine metrics capable of identifying whether a vehicle is equipped with RSC
  - Assess whether improved dynamic rollover resistance is achieved at the expense of lateral stability and/or responsiveness
- **Results will be documented in a technical report**

Future Research
Roll Stability Control (RSC)

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- **Maneuvers to evaluate rollover, lateral stability, and responsiveness**
  - **NHTSA Fishhook**
  - **0.7 Hz Sine with Dwell**
- **Four SUVs**
- **Four load configurations** *(presented on next slide)*
- **Testing to begin early spring of ’06 at VRTC**

Future Research
Anticipated RSC Load Configurations

- **Nominal Load**
  - Instrumentation, driver, and outriggers
- **Multi-Passenger Load**
  - Three 175 lb water dummies
- **Rear Trunk Load**
  - Vehicle weight at GVWR, rear GAWR
- **Roof Load**
  - SSF lowered by 0.1

Future Research
Brake Assist (BA)

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- **Research Objectives**
  - **Reveal and document BA thresholds**
  - **Compare thresholds to existing human factors based brake data**
- **Test Variables**
  - **Rate of pedal apply**
  - **Force of apply**
  - **Pedal displacement**
  - **Other vehicle factors** *(i.e., adaptive algorithms)*

Future Research
Brake Assist (BA)

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- Anticipated maneuvers to include:
  - Straight line braking
  - Brake in-a-curve
- Small fleet of diverse test vehicles
- All steering and braking will be automated via a programmable controller
- Testing to begin late spring of ’06 at VRTC
- Results will be documented in a technical report

Concluding Remarks

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- **NHTSA has identified the 0.7 Hz Sine with Dwell as a good maneuver for evaluating the lateral stability and responsiveness of ESC-equipped vehicles**
- **Future testing will include the evaluation of understeer mitigation, RSC, and BA**
- **Any suggestions on how to best evaluate these technologies would be appreciated!**

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Questions?