ESC and Handling
NHTSA's Program Plan for 2004

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Presentation Overview

- Project Motivation
- ESC Installation Rates
- Background
- Current Objectives
- Test Vehicles
- Maneuvers
- Load Configurations
- Schedule

Motivation
Recent NHTSA Handling Research

- Dynamic rollover resistance testing mandated by the TREAD Act
- High on-road rollover resistance may be achieved by compromising “good handling”
  - Low-grip tires
  - Degraded responsiveness
- Providing a handling rating to the consumer will contribute improved to rollover resistance / handling tradeoff awareness

Motivation
Relation of Handling and ESC

- The handling rating development process offers an opportunity for the evaluation of ESC
  - Tests performed with ESC active and disabled
  - Many maneuvers
- Opportunity to assess how ESC could influence handling ratings

Motivation
Recent ESC Research

- Recent ESC studies show and/or predict ESC can offer significant safety benefits
- Understanding these benefits are of great interest to NHTSA
- Many results presented at 2003 SAE Government/ Industry by Dr. Steinmeier (Continental Teves)
  - DaimlerChrsyler
  - Toyota
  - Swedish National Road Administration
  - European Accident Causation Survey
  - DEKRA

Motivation
Recent ESC Research - Summary

- Multiple studies provide similar results:
  - Significant reduction in single vehicle and head-on crashes
  - Crash severity involving vehicles equipped with ESC is believed be lower than that of other vehicles not so equipped
  - If accident causation was “loss of vehicle control”, the benefits of ESC are expected to be especially apparent
- Reductions in side-impacts, rollover crashes, and average injury severity

ESC Installation Rates

- 29 vehicle makes offer ESC for MY2004 for vehicles sold in the US
- ESC available on 124 2004 models
  - Standard on 75 models
  - Availability is increasing
- 9% of all vehicles manufactured in the US are equipped with ESC

Data provided by the ESC Coalition

Background
Recent NHTSA Handling Research

- Some handling tests were performed during Phase VI rollover testing
  - Slowly Increasing Steer (SAE J266)
  - Step Steer (ISO 7401)
  - Dropped Throttle In-A-Turn (ISO 9816)
- Analysis underway
- VRTC presently observing other research
  - Alliance is working on handling metric that combines the subjective impressions of professional drivers with objective maneuvers
  - Delphi is performing ESC work as part of a cooperative effort with NHTSA

Background
NHTSA ESC Research

- Work first started in 2000
  - 2000 Lexus LX470
  - 1999 Mercedes ML320
- Only a limited number of tests were performed
  - Responding to TREAD Act responsibilities required direct ESC research be suspended
  - Tests performed limited to those used for measuring rollover resistance
- Preliminary results have been presented
  - SAE Government/Industry Meeting (May 15, 2001)

Current Objectives
Handling Test Development

- Develop a handling-based “rating” metric
  - Will ultimately be used for consumer awareness
  - Rating convention must be easily understood
- Use a small but diverse fleet of vehicles
- Use a large set of maneuvers

Current Objectives
ESC Research

- Familiarization
  - Direct experience with ESC functionality necessary
  - Promotes understanding
  - May uncover important system behavior
- Evaluate ESC effectiveness on the test track
  - Perform concurrently with Handling Test Development research
- Decide what makes for a “good” ESC system
- Program is a learning experience!
  - Follow-ups are anticipated

Test Vehicles
2004 Volvo XC90

- ESC = “DSTC”
- Roll Control (“RSC”)
- Baseline weight = 4,804 lbs
- Nominal Load SSF = 1.225
- First SUV to offer RSC; offered as standard equipment
- Limited tests already performed
  - No two-wheel lift regardless of whether ESC was enabled or disabled
  - “Aggressive” ESC algorithm

Test Vehicles
2003 Toyota 4Runner 4x4

- ESC = “VSC”
- Baseline weight = 4,409 lbs
- Nominal Load SSF = 1.165
- Limited tests already performed
  - No two-wheel lift regardless of whether ESC was enabled or disabled
  - “Aggressive” ESC algorithm

Test Vehicles
2004 GMC Savana 3500

- ESC = “Stabilitrak”
- Baseline weight = 6,771 lbs
- Nominal SSF = 1.100
- First 15-passenger van to offer ESC (standard equipment)
- Limited tests performed during Fall 2003
  - Rollover resistance tests
  - Reports presently being reviewed
  - “Aggressive” ESC algorithm

Test Vehicles
2003 Toyota Camry

- ESC = “VSC”
- Baseline weight ≈ 3500 lbs
- Nominal Load SSF = TBD
- High volume passenger car

Test Vehicles
2002 Chevrolet Corvette

- ESC = “Active Handling”
- Baseline weight = 3,361 lbs
- Nominal SSF = 1.749
- ESC has two user-defined settings:
  - Standard
  - “Competition”
- Near-term “Competition” testing not anticipated
- Limited testing performed during Fall 2002
  - Analysis of results underway

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Test Maneuvers

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Maneuver Group 1
Performed With A Steering Machine

Maneuver	Throttle Application	Brake Application	Surface	Entrance Speed
Slowly Increasing Steer	Applied as Needed	None	Dry to Wet Asphalt Transition at Max Ay	50 mph
Slowly Increasing Steer	Applied as Needed	None	Dry Asphalt	50 mph
Road Edge Recovery	Released Before Steering Begins	None	Wet Asphalt	35 – 50 mph
Road Edge Recovery (SS=6.5)	Released Before Steering Begins	None	Dry Asphalt	35 – 50 mph (or to TWL)
Road Edge Recovery (SS=5.5)	Released Before Steering Begins	None	Dry Asphalt	45 and 50 mph (or to TWL)
J-Turn (w/RER Steering Angles & Rates)	Released Before Steering Begins	None	Wet Asphalt	35 – 60 mph
J-Turn (w/RER Steering Angles & Rates)	Released Before Steering Begins	None	Dry Asphalt	35 – 60 mph

Maneuver Group 2
Performed With Four Human Drivers

Maneuver	Throttle Application	Brake Application	Surface	Entrance Speed
Constant Radius Turn, 300 ft radius	Slowly Increasing	None	Wet Asphalt	Max Attainable
Constant Radius Turn, 300 ft radius	Slowly Increasing	None	Dry Asphalt	Max Attainable
Closing Radius Turn	Constant	None	Dry to Wet Asphalt Transition	Max Attainable (up to 60 mph)
Closing Radius Turn	Constant	None	Dry Asphalt	Max Attainable (up to 60 mph)
Split-Mu Single Lane Change	Released at Entrance Gate	None	Wet Asphalt to Wet Epoxy Transition	Max Attainable (up to 50 mph)
Split-Mu Single Lane Change	Released at Entrance Gate	Constant 125 lbf at Entrance Gate	Wet Asphalt to Wet Epoxy Transition	Max Attainable (up to 50 mph)
ISO 3888 Part 2 Double Lane Change (Modified)	Released at Entrance Gate	None	Wet Asphalt	Max Attainable
ISO 3888 Part 2 Double Lane Change (Modified)	Released at Entrance Gate	None	Dry Asphalt	Max Attainable

Maneuver Group 3
Performed With A Steering Machine

Maneuver	Throttle Application	Brake Application	Surface	Entrance Speed
Frequency Response Tests	Constant	None	Dry Asphalt	TBD (75 kph?)
Single Cycle Sinusoids (see Alliance matrix)	Released Before Steering Begins	None	Dry Asphalt	TBD (80 kph?)
Pulse Steer (constant rate)	Released Before Steering Begins	None	Dry Asphalt	TBD (80 - 120 kph?)
Pulse Steer (constant width)	Released Before Steering Begins	None	Dry Asphalt	TBD (80 - 120 kph?)
Road Edge Recovery w/yaw rate feedback	Released Before Steering Begins	None	Dry Asphalt	35 – 50 mph
Dropped Throttle In-A-Turn	Released After Steady-State Ay	None	Dry Asphalt	50 mph
Step Steer w/Different Handwheel Angles	Released Before Steering Begins	None	Dry Asphalt	50 mph (100 kph?)

Blue = Presently being evaluated by the Alliance of Automobile Manufacturers

Green = Recommended by Volvo

Orange = Used by NHTSA in the past, data needs to be reviewed before committing to the maneuver

Black = Recommended by Delphi

Load Configuration

- Nominal Load
  - Driver
  - Full Fuel
  - Instrumentation
  - Outriggers *(not used for the Corvette)*
- One Additional Configuration
  - Rear GAWR? *(most likely candidate)*
  - Vehicle GVWR?
  - Use of water dummies?

Meeting With Industry

- Industry has extensive experience with light vehicle handling
  - Use of body slip angle sensors
  - Have developed valuable analysis techniques
- Alliance of Automobile Manufacturers presently developing an objective handling metric
- Delphi currently working with NHTSA to evaluate various active safety systems
- Industry insight promises to be a valuable asset to NHTSA
- Input from all sources welcome and encouraged!
  - Private testing organizations / companies
  - Public

Schedule

Vehicle Preparation

- 4 of 5 vehicles presently instrumented

Maneuver Group 1

- Presently underway

Maneuver Group 2

- Late May → July

Maneuver Group 3

- July → September

Reports

- 15-passenger van rollover / lateral stability report (Spring ’04)
- ESC results (Late ‘04)
- Handling (Early ’05)

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Discussion

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