

# NCAP BRAKING

## CONSUMER BRAKING INFORMATION

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SAE GOVERNMENT/INDUSTRY MEETING

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# INTRODUCTION

- Concerns about developing brake system rating focus on variability of:
  - Vehicle
  - Test driver
  - Test surface

# PROGRAM SUMMARY

- 1998 – 1999 Initial testing at Aberdeen Test Center
- 1999 – 2000 Round-robin testing at Aberdeen, MGA, TRC
- 2002 Additional research on pedal force, pavement friction, statistics

# 1998 ABERDEEN TEST PROGRAM

- OBJECTIVES
  - Test a variety of light vehicles
  - Limit test conditions to reduce variability
  - Use only ABS-equipped vehicles
  - Perform statistical analyses of stopping distance results

# VEHICLES TESTED

- 10 ABS-EQUIPPED VEHICLES
  - 5 Passenger cars (including control vehicle)
  - 2 Minivans
  - 1 Sport Utility Vehicle
  - 1 Full-Size Van
  - 1 Full-size Pickup (Rear wheel only ABS)

# VEHICLE TEST CONDITIONS

- Straight line stops
- Dry Asphalt
- Wet Asphalt
- Test Speed - 100 km/h (62 mph)
- Loaded and unloaded conditions
- 10 stops per test condition

# TEST RESULTS

- Pedal forces higher than target (112 lbs) by 3X
- Higher pedal forces did not affect stopping distance results
- Rate of pedal application seems most important
- On Control Vehicle
  - Shortest stop: 139 ft with 237 lbs pedal force
  - Longest stop: 150 ft with 309 lbs pedal force

# STATISTICAL ANALYSIS METHOD

- Average of 10 braking stops
- Standard Deviation
- 95th percentile: 95% of the time vehicle would stop within this distance. Also measures stopping performance consistency.



# TEST SURFACE PFC

- Dry Asphalt PFC: 0.89 - 0.95
- Wet Asphalt PFC: 0.85 - 0.88
- Variability low, magnitude high
- PFC measured with skid trailer using:
  - ASTM Method E1337-90
  - ASTM E1136 Standard Reference Test Tire

# VARIABILITY OF PFC

## PEAK FRICTION COEFFICIENT



# 1999 ROUND-ROBIN TEST PROGRAM

- Further evaluate the effects of surface variability
- 4 vehicles tested at 3 different test sites, and again at first site
- Surface friction measured at each site during testing
- Analyzed and compared vehicle stopping distance performance at each test site

# 1999 ROUND-ROBIN TESTING Results Summary

- PFCs are different at each test track.
  - Some wet surfaces have friction as high as some dry surfaces
  - TRC had “ideal” PFCs, Aberdeen and MGA had rougher pavements due to weathering and little use
- Brake application rate is important - 100 lbs in 0.2 seconds is achievable.

# NON-ABS VEHICLES

Problems with testing non-ABS vehicles:

- Stopping distance is dependent on driver skill
- Driver brake pedal modulation results in larger deviations between test runs
- These stopping distance values may be less useful to consumers if they can't obtain similar real-world performance

# DRAFT TEST PROTOCOL

- ABS-equipped vehicles only
- Test Surface
  - Dry PFC 0.90 - 0.95
  - Wet PFC 0.80 - 0.85 (water depth  $\leq$  3 mm)
- Loading: Lightly-loaded weight with 180 kg
- Pedal Force - 500 Newtons in 0.25 sec.
- Number of stops - 10 per vehicle
- Surface Temperature:
  - Dry: 25°C - 45°C (77°F - 113°F)
  - Wet: 22°C - 32°C (72°F - 90°F)
- Data: Average and/or 95<sup>th</sup> percentile

# U.S./JAPAN TEST CONDITIONS COMPARISON

## U.S. NCAP Research

- Test speed: 100 km/h
- Lane width: 3.7 m
- IBT:  $\geq 65^{\circ}\text{C}$   $\leq 100^{\circ}\text{C}$
- Transmission: In gear
- Pedal force: 500 N in 0.25 sec.
  
- Number of stops: 10
- 180 kg load

## Japan NCAP

- Test speed: 100 km/h
- Lane width: 3.5 m
- IBT:  $\geq 65^{\circ}\text{C}$   $\leq 100^{\circ}\text{C}$
- Transmission: In neutral
- Pedal force: 500 N in 0.25 sec. for ABS
- Number of stops: 5
- 110 kg load

# ROAD SURFACE CONDITIONS COMPARISON

## U.S. NCAP Research

- Dry PFC 0.90-0.95
- Wet PFC 0.80-0.85
- Water depth:  
 $\leq 3$  mm
- PFC measured using ASTM 1337-90 with SRTT  
ASTM 1136-93
- Specify surface temperature

## Japan NCAP

- Surface specified as a flat, clean, asphalt-paved road
  - dry road surface, temperature of 25 - 45 C
  - wet road surface, temperature of 22 - 32 C



# Test Site Issues

- NHTSA's VRTC East Liberty, Ohio track – winter testing issues
- NHTSA's San Angelo, Texas UTQG facility is speed limited, dedicated to tire testing
- NHTSA is now identifying potential test sites. No contract action as of this time.
  - Contract testing of NCAP vehicles
  - Available to vehicle manufacturers

# Request for Comments

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- RFC Notice published July 17, 2001. Closing date October 15, 2001.
- Public Meeting was cancelled
- View all materials at:
  - <http://dms.dot.gov>
  - Docket No. 6583

# Summary of Comments

- PFC – Specified range would result in 5% to 6% variation in stopping distance.
  - Better to have a target PFC
  - 1 recommendation to correct stopping distance for PFC
  - 1 recommendation for 0.5 wet PFC
  - Generally, all recommend one test site

# Summary of Comments

- Wet PFC
  - Close to dry PFC, will not produce much longer stopping distances
  - NHTSA believes that the lower the PFC, the greater the variability
  - Some suggestions to review skid numbers in addition to PFC

# Summary of Comments

- Brake pedal application criteria
  - Some recommend 500 N be attained in 0.15 second instead of 0.25
  - Trigger stop using  $>0$  pedal force instead of stop lamp switch
  - Some recommend 500 N steady-state pedal force instead of 670 N

# Summary of Comments

- Vehicle loading
  - Some recommend GVWR tests in addition to LLVW
- Non-ABS vehicles
  - Some recommend testing them as well, driver best-effort
  - Stopping distance and stability important to convey to consumers

# Summary of Comments

- Reporting results
  - Many recommend average instead of 95<sup>th</sup> percentile
  - One recommends shortest stop
  - Most recommend bar graph (JNCAP), no support for star ratings
  - Recommendation to perform research in this area

# Summary of Comments

- Recommendation that safety benefits (crash avoidance, likelihood of injury/fatality) be related to stopping distance



# Additional Testing - 2002

- Investigate pedal force application criteria (ramp-up and steady-state) to finalize
- Additional statistical review of stopping distance data
- Continue pavement friction testing and evaluating variability

# Future Testing

- Identify test site to conduct NCAP Braking program
- Investigate methods of wetting test surface
- Finalize wet and dry PFC values
- Run pilot test program

# NHTSA and JNCAP

- Visit the NHTSA website at [www.nhtsa.dot.gov](http://www.nhtsa.dot.gov)
  - Two test reports available here as well at from Docket
- JNCAP Results at [www.osa.go.jp](http://www.osa.go.jp)