Justification for Combination Test

National Highway Traffic Safety
February 2004
Case Study of Combination Forces (Longitudinal Compression and Lateral Tension) causing Door Openings
Illustration of Door Openings caused by Longitudinal Compression and Lateral Tension Forces in Side Impacts

- Involves all near side door openings in side impacts

Side impacts cause the near side door to shift into the B-pillar creating longitudinal compression between the latch and striker. The compression then translates to causing the door end to move outwards from the vehicle placing the latch and striker in tension laterally.
NASS Case Study – Near Side Door Opening in Side Impact

- Case Vehicle - 1997 Chevy Cavalier
- NASS Case ID: 656500511
- Delta-V: 35 km/h
- Crash Summary
  - The vehicle experienced a near side impact, in the left side, at a two way intersection
  - Left front door opened during collision due to structural damage to the latch/striker and hinge.
Door end moves rearward of pillar

Evidence of rearward displacement of the door

Latch is torn from door in direction showing lateral tension with striker

Striker slightly bent downward from longitudinal compression with latch and door end
NASS Case Study – Near Side Door Opening in Side Impact

- Case Vehicle - 1997 Ford Explorer
- NASS Case ID: 626400241
- Delta-V: Unknown

Crash Summary
- Case vehicle was heading west bound entering an intersection when another vehicle heading north impacted its left side.
- Left front door opened during collision due to structural damage to the latch/striker.
Latch is crushed inwards showing longitudinal compression

Door end bowed outwards from vehicle showing evidence of lateral tension

Separation between the door and pillar shows rearward displacement of the door

Latch is crushed inwards showing longitudinal compression

Latch and striker in good condition showing possible bypass failure
Illustration of Door Openings caused by Longitudinal Compression and Lateral Tension Forces in Frontal Impacts

Involves all near side door door openings in full, oblique and offset frontal impacts

These frontal impacts cause the front fenders to crush into the door moving it into the pillar. The door then bows outwards causing the latch system to be in compression longitudinally and in tension laterally.
NASS Case Study – Frontal Offset Impact with Near Side Door Opening

- 1998 Chevy S-10 Blazer
- NASS Case ID: 129000735
- Delta-V: 37 km/h
- Crash Summary
  - The vehicle left the roadway, striking a telephone pole with its front end. The vehicle rotated around the pole bounced off and contacted an 8' chain link fence with it's right side. This caused a large amount of scraping and crush down the vehicle's right side.
  - Right door came open during collision
Door end moves rearward of pillar

Striker is compressed longitudinally into door end far enough to break the latch and tear the sheet metal.
Illustration of Door Openings caused by Longitudinal Compression and Lateral Tension Forces in Rear Impacts

- Involves all near side door openings in full, oblique and offset rear impacts

These rear impacts cause the rear fenders to crush into the door moving it into the pillar. The door then bows outwards causing the latch system to be in compression longitudinally and in tension laterally.
Photos of Combination Test

Striker attachment to loading device
Directions of Forces in Combination Test

Pre-test Conditions

Load Device

Latch

Latch on Test Device Moves to Mate with the Striker

Sliding Rod

Striker

Load Device

16,000 N

6,650 N
Agency Research Findings

- Door openings occur due to simultaneous forces acting between the latch and striker depending upon the direction of impact in a crash.
- Combination test accounts for longitudinal compression and lateral tension forces.
Relation to Realworld Crashes
TARGET POPULATION OF COMBINATION TEST
1995-2002 NASS and FARS Door Ejection Fatalities and MAIS 3+ Injuries based on Door Openings and Failure Modes

- Fatalities: 395 Complete, 40 Partial
- MAIS 3+: 357 Complete, 9 Partial

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Fatal</th>
<th>MAIS 3+</th>
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<tbody>
<tr>
<td>Combination Test</td>
<td>435</td>
<td>366</td>
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MTSA Logo
Range of Loads for Combination Test

- 17,000 N – Minimum average force experienced by vehicles that did not have door openings in NASS
- 19,000 – Maximum average force experienced by vehicles that had door openings in NASS
- On average doors that open in crashes experience an additional 2,000 N force
Effectiveness Estimates for Combination Test

<table>
<thead>
<tr>
<th>Test Load</th>
<th>Reduction in Door Open Rate</th>
<th>Fleet Failure Rate</th>
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<tbody>
<tr>
<td>@15,000 N*</td>
<td>0.089</td>
<td>39%</td>
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<tr>
<td>@17,000 N</td>
<td>0.133</td>
<td>43%</td>
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<tr>
<td>@19,000 N</td>
<td>0.242</td>
<td>67%</td>
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* 15,000 N selected for sensitivity evaluation
**Benefit Estimates for Combination Test**

<table>
<thead>
<tr>
<th></th>
<th>@15,000 N</th>
<th>@17,000 N</th>
<th>@19,000 N</th>
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</thead>
<tbody>
<tr>
<td><strong>Fatalities Prevented</strong></td>
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<tr>
<td>Complete</td>
<td>25</td>
<td>37</td>
<td>68</td>
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<tr>
<td>Partial</td>
<td>3</td>
<td>4</td>
<td>7</td>
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<tr>
<td><strong>Total</strong></td>
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<tr>
<td><strong>MAIS 3+ Injuries Prevented</strong></td>
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<tr>
<td>Complete</td>
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<td>26</td>
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<tr>
<td>Partial</td>
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<tr>
<td><strong>Total</strong></td>
<td>17</td>
<td>27</td>
<td>48</td>
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Cost Estimates

The maximum upgrade cost per door for combination test = $0.21