ADVANCED RESTRAINT SYSTEM (ARS)

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CRASH AVOIDANCE METRICS PARTNERSHIP (CAMP) ARS

- 4 year Cooperative research program
- Demonstrate restraint systems that can take advantage of pre-crash information
  - Estimate target population and predict benefits
  - Develop objective tests
  - Develop prototype systems
PROJECT OBJECTIVES

- Develop and validate minimum performance requirements and objective test procedures for advanced restraint systems
- Identify and fabricate the most promising prototype candidate advanced restraint systems to support test method development
- Support NHTSA’s preliminary estimates of predicted benefits from prototype advanced restraint systems
PROJECT DELIVERABLES

- Minimum performance specifications for candidate advanced restraint safety systems
- Relative occupant performance based on current ATD technology
- Test procedures for evaluating the performance of candidate restraint systems
- Methodology for estimating preliminary system benefits
- Testing and Draft report due in December 2010
Subtask 2.7 - Develop Preliminary Functional Requirements for Pre-Crash and Restraint Components and/or Systems Based on Performance Metrics

Precrash sensors:

The system shall be capable of detection and identification of the following vehicle and object groupings:

1. All light vehicles, medium/heavy duty semi-trucks, and trailers
2. Utility poles, trees
3. Concrete pillars, walls, bridge supports
4. Guard rails
5. Sign posts
Preliminary Functional Requirements – Pre-crash Sensors

The system shall determine:
- Location of front impact on the subject vehicle (left, center, right)
- Approach angle of the subject vehicle with respect to the target vehicle or object (±5 degrees)
- Closing velocity (±2mph)
- Notification of impending impact with time-to-collision prediction (±5ms)
NHTSA used the NCAC Taurus model and ARSC used a current production mid-size vehicle for study. Computer aided engineering (CAE) to determine worst case crash modes including the following:

<table>
<thead>
<tr>
<th>Crash Mode No.</th>
<th>Description of Crash Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>30 deg. Left angle oblique wall impact (35 mph)</td>
</tr>
<tr>
<td>2.</td>
<td>Center pole impact (40 mph)</td>
</tr>
<tr>
<td>3.</td>
<td>Center pole impact (35 mph)</td>
</tr>
<tr>
<td>4.</td>
<td>50% overlap 15 deg. Principle Direction of Force (PDOF), rigid barrier (35 mph)</td>
</tr>
<tr>
<td>5.</td>
<td>40% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph</td>
</tr>
<tr>
<td>6.</td>
<td>50% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph</td>
</tr>
<tr>
<td>7.</td>
<td>65% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph</td>
</tr>
<tr>
<td>8.</td>
<td>80% overlap, 15 deg. PDOF, car-to-car both cars @ 35 mph</td>
</tr>
<tr>
<td>9.</td>
<td>50% overlap, 15 deg. PDOF, Moving Deformable Barrier (MDB)-to-car (35 mph)</td>
</tr>
<tr>
<td>10.</td>
<td>80% overlap, 15 deg. PDOF, MDB-to-car (35 mph)</td>
</tr>
</tbody>
</table>
## Restraint Supplier Proposed ARS System

<table>
<thead>
<tr>
<th>Element</th>
<th>Driver Side</th>
<th>Passenger Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seat</td>
<td>Mechanical seat ramp-pre-crash (reversible)</td>
<td>Mechanical seat ramp-pre-crash (reversible)</td>
</tr>
<tr>
<td>Steering Column</td>
<td>Single load level collapsible (same as baseline)</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Seat Belt</td>
<td>Three point with motorized seat belt (reversible); dual retractor PT (pyro) and lap PT seat belt; variable load limiting EA seat belt (two level switchable variable load limiting).</td>
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</tr>
<tr>
<td>Frontal Airbag</td>
<td>Dual stage programmable venting module airbag (airbag pressure tailorable by varying deployment time of inflator assembly vent)</td>
<td>Dual stage programmable venting module airbag (airbag pressure tailorable by varying deployment time of inflator assembly vent)</td>
</tr>
<tr>
<td>Knee Airbag</td>
<td>Extended coverage driver knee airbag</td>
<td>Extended coverage driver knee airbag</td>
</tr>
<tr>
<td>Floor Carpet Airbag</td>
<td>Carpet pad (crushable foam; not provided by Takata)</td>
<td>Carpet pad (crushable foam; not provided by Takata)</td>
</tr>
<tr>
<td>Side Curtain Airbag</td>
<td>Modified side curtain airbag deployed in offset crash (with extended A-pillar coverage of additional A-pillar airbag)</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
TASK 8 – TESTING PLAN

- Up to 12 full-scale crash tests
- Up to 49 sled tests
- Vehicle-to-Object will be evaluated using CAE & 2 full scale tests
- Vehicle-to-Vehicle will be evaluated using CAE, sled tests & full vehicle tests
- Completed by August 2010
Joint effort between NHTSA/Volpe/ARSC
- Include multiple body regions
- High and low speed categories
- 3 occupant sizes
- 2 crash types
  - Vehicle to vehicle
  - Vehicle to object
- Draft report December 2010
NHTSA’S ARS
FRONTAL CRASH PROTECTION

- Rollover restraints research has been underway for several years
  - ESV 2007 (07-0279)
  - ESV 2009 (09-0483)
- Examine the performance of selected ARS in frontal sled tests
TEST CONDITIONS

- 35 mph NCAP pulse for a mid-size car
- 2 dummies side-by-side
  - Hybrid III 50th percentile male
  - THOR 50th percentile male
- Head, neck, chest, pelvis instrumentation
- Head, knee excursion through video analysis
- Use of vehicle seats on sled buck
- Test matrix - TBD
RESTRAINTS USED

- Non-Integrated Three-Point Seat
  - Standard fleet representative three-point restraint attaching to a B-pillar frame element of the vehicle.
RESTRAINTS USED

- Retractor Pretensioner
  - uses a pyrotechnic discharge to remove the slack from a seat belt when triggered by a sensor. A force around 1500 Newtons is experienced at the shoulder belt when the retractor is fired.

- Buckle Pretensioner
  - pyrotechnic device incorporated in the buckle and is fired to remove the slack near the pelvic region. A force around 500 Newtons is observed at the lap belt when the buckle is fired.
RESTRAINTS USED (CONT.)

- Motorized Retractor
  - Electric pre-pretensioner, is a reusable device designed to remove slack from the seat belt system. The force rating is generally much lower than the pyrotechnic devices (~140 N). The reusability of the device allows implementation much earlier when the possibility of a crash is sensed, but the crash is not yet imminent.
RESTRAINTS USED (CONT.)

- Four-Point Seat Belt
  - Belts across both shoulders and buckles at the center of the lap.

Two pyrotechnic pretensioners are utilized on each side of the restraint’s lower retractors. This is a prototype device being evaluated by suppliers and OEMs for improved restraint performance in both frontal and side crash protection.
TESTING SCHEDULE

- Testing Summer / Fall 2010
- Results to be presented at SAE Gov/Industry meeting or ESV