Crashworthiness Analysis of Canine Automotive Restraint (Size Large)

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Automotive travel for companion animals has increased exponentially in the last several years. The development of new and innovative pet travel products has followed this trend. One segment of the pet travel market, the Canine Automotive Restraint (or Safety Harness) is promoted as a tool by advocates (ASPCA 2010), veterinarians (AVMA 2012) and travel associations (American Automobile Association, PetSpot) to help protect the companion animal and human passengers in case of an automobile accident.

Ample research has been conducted to study automobile restraint effectiveness and traumatic injuries sustained by human occupants in vehicular crashes. We have been unable to locate any studies, to date, on the crashworthiness of companion animal harness-style restraints or injuries sustained by companion animal vehicle occupants. We understand from the human studies that effective restraint is essential to impact survival. We also understand that even the most minor of impacts can cause serious injuries to the occupant when they come in contact with interior vehicle structures.

The focus of this study is to determine the general effectiveness of canine automotive restraints (Size: large) to prevent injury of the companion animal occupant and better understand the potential contribution to secondary injury to the human occupant in an automobile accident. Since standardized testing does not exist for this class of pet product, a test referenced by canine safety harness manufacturers is the Federal Motor Vehicle Safety Standard (FMVSS) 213 (FMVSS 1999) for child restraint systems. Using FMVSS 213 we tested a control group of readily available canine automotive restraints (Size: large).

1.0 Scope
Study the general performance of Canine Automotive Restraints (Size: large) and determine their overall vehicle occupant protection effectiveness using FMVSS 213.

1.1 Purpose
The purpose of this study is:

- To determine the general crashworthiness of “current state” Canine Automotive Restraint harnesses (Size: large)
- Assess the injury potential of the companion animal occupant and assess impact survivability.
- Evaluate the secondary injury potential to other vehicle occupants based on the performance of the canine restraint device.
Test Setup
A third-party independent test laboratory was contracted to perform the restraint tests using conditions outlined in the Federal Motor Vehicle Safety Standard 213.

A specially designed crash test dog was developed to assess the overall performance of the canine automotive restraints. No live dogs or animals were used during these tests. The harness size selection (large) was based on the American Kennel Club’s Most Popular Dog Breed List from 2010, where six of the top ten dog breeds were within the “large” harness category. (AKC 2011) The test dog size and weight were carefully evaluated prior to construction. Using the outer fabric shell of a Melissa and Doug® stuffed Boxer Dog, the test dog had a total distributed weight of 55 lbs. The dog’s internal structure was fabricated of metal and instrumentation was mounted inside the test dog’s chest cavity to gather additional data, and was factored in to the total weight of the dog. Internal padding, factored into the weight of the dog, was used to ensure the proper shape of the test dog and the proper fit of the restraint device. Crash test dogs meeting this specification were used for all four tests.

A total of 12 restraints (different manufacturers) were purchased from online vendor/manufacturer websites and delivered by independent carrier (UPS, USPS, etc.) to the test laboratory. The restraints were received in new, unused condition with intact packaging. The restraints were handled only by laboratory personnel. The control group selection of four harnesses was made based on three different criteria; 1. Perceived material/design strength based on engineer visual assessment. 2. Marketing materials indicating manufacturer testing. 3. Perception of manufacturer brand in the pet travel product marketplace. Although not identified in our study, the control group harnesses are considered quality brands within the pet product industry and are widely marketed as safety devices for companion animal travel.

Following manufacturer documentation, the harness size was confirmed and the crash test dog was determined to be within the “large” size category for all harness models tested. Following manufacturer instructions, the restraint was fitted to the test dog. The test dog was then placed on the test sled bench seat and the harness connection point attached to the manufacturer specified location and adjusted to simulate the position of a real canine traveling in a moving automobile. The connection points of the harnesses varied based on harness design and manufacturer. Each restraint was tested individually.
Test Results

Restraint A:
Connection Point: Type I – Lap Belt

Result Abstract:
This harness showed design integrity and exhibited minimal tearing during the test, although the dog’s head excursion exceeded FMVSS 213 limits. The harness cinched tightly around the dog’s front legs and chest cavity. The cinching/compression injury requires further study to determine the implications to the dog’s musculoskeletal and cardiovascular systems. We assess a high probability for contact injury to the dog based on the head excursion measurement.

<table>
<thead>
<tr>
<th>Injury Criteria</th>
<th>Test</th>
<th>FMVSS 213 Requirement</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest Injury Criterion</td>
<td>Cumulative Duration</td>
<td>&gt;= 60 g &lt; 3 ms</td>
<td>3 msec clip = 46.4 Duration exceeded 60 g = 0.0</td>
</tr>
<tr>
<td>Restraint System Integrity</td>
<td>Adjustment Position</td>
<td>No change</td>
<td>None</td>
</tr>
<tr>
<td>Restraint Integrity</td>
<td>Restraint Integrity</td>
<td>No complete separation</td>
<td>None</td>
</tr>
<tr>
<td>Occupant Excursion</td>
<td>Torso Retention</td>
<td>Retain within system</td>
<td>Retained</td>
</tr>
<tr>
<td>Head Excursion</td>
<td></td>
<td>&lt;= 81.3 cm (32 in)</td>
<td>&gt;32 in.</td>
</tr>
</tbody>
</table>

Restraint B:
Connection Point: Type II – Lap and Shoulder Belt

Result Abstract:
This harness failed to protect the test dog. The dog’s head excursion exceeded FMVSS 213 limits. The restraint exhibited a multi-point failure leading to complete separation of the harness from the tether allowing the test dog to launch into the front bench fixture. Probable severe/fatal injuries to the companion animal are likely based on test evidence. Additionally, the potential for injury to the human occupant of the vehicle is increased based on the canine restraint failure.

<table>
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<tr>
<td>Chest Injury Criterion</td>
<td>Cumulative Duration</td>
<td>&gt;= 60 g &lt; 3 ms</td>
<td>3 msec clip = 104.6 (1) Duration exceeded 60 g = 12.5 ms</td>
</tr>
<tr>
<td>Restraint System Integrity</td>
<td>Adjustment Position</td>
<td>No change</td>
<td>None</td>
</tr>
<tr>
<td>Restraint Integrity</td>
<td>Restraint Integrity</td>
<td>No complete separation</td>
<td>(2)</td>
</tr>
<tr>
<td>Occupant Excursion</td>
<td>Torso Retention</td>
<td>Retain within system</td>
<td>Not Retained (3)</td>
</tr>
<tr>
<td>Head Excursion</td>
<td></td>
<td>&lt;= 81.3 cm (32 in)</td>
<td>&gt;32 in.</td>
</tr>
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Test Remarks:
1. Chest injuries recorded include canine crash test dummy impact with front bench fixture after the safety harness separation.
2. A complete separation of the safety harness occurred at the point where the harness attaches to the tether that is connected to the vehicles restraint system.
3. The safety harness separated at the attachment point of the tether to the vehicle restraint system. This resulted in the complete separation of the harness system from the vehicle restraint system and allowed the canine to become unrestrained from the harness system.
Restraint C:
Connection Point: Type II – Lap and Shoulder Belt

Result Abstract:
This harness failed to protect the test dog. The dog’s head excursion exceeded FMVSS 213 limits. The restraint’s straps slipped and the chest plate detached from the harness leading to the harness compromising the test dog’s throat/neck area. Probable severe/fatal injuries to the companion animal are likely based on test evidence.

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<tbody>
<tr>
<td>Chest Injury Criterion</td>
<td>Cumulative Duration Over 60 g ≤ 3 ms</td>
<td>3 msec clip = 39.5 Duration exceeded 60 g = 0.0</td>
<td></td>
</tr>
</tbody>
</table>

Restraint System Integrity

<table>
<thead>
<tr>
<th>Adjustment Position</th>
<th>No change</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restraint Integrity</td>
<td>No complete separation</td>
<td>(2)</td>
</tr>
</tbody>
</table>

Occupant Excursion

| Torso Retention | Retain within system | Retained |
| Head Excursion  | ≤ 81.3 cm (32 in)    | >32 in. |

Test Remarks:
1. The safety harness straps slipped at the metal adjustment slides from their original adjusted positions.
2. The harness upper chest strap material separated from the padded chest plate. This resulted in the partial separation of the harness system.

Restraint D:
Connection Point: Type II – Lap and Shoulder Belt

Result Abstract:
This harness failed to protect the test dog. The dog’s head excursion exceeded FMVSS 213 limits. The restraint exhibited complete separation of the harness from the tether allowing the test dog to launch as a projectile. Probable severe/fatal injuries to the companion animal are likely based on test evidence. Additionally, the potential for injury to the human occupant of the vehicle is increased based on the canine restraint failure.

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</thead>
<tbody>
<tr>
<td>Chest Injury Criterion</td>
<td>Cumulative Duration Over 60 g ≤ 3 ms</td>
<td>3 msec clip = 20.5 Duration exceeded 60 g = 0.0</td>
<td></td>
</tr>
</tbody>
</table>

Restraint System Integrity

<table>
<thead>
<tr>
<th>Adjustment Position</th>
<th>No change</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restraint Integrity</td>
<td>No complete separation</td>
<td>(1)</td>
</tr>
</tbody>
</table>

Occupant Excursion

| Torso Retention | Retain within system | Not Retained (2) |
| Head Excursion  | ≤ 81.3 cm (32 in)    | >32 in. |

Test Remarks:
1. A complete separation of the safety harness occurred at the point where the harness attaches to the metal tether that is connected to the vehicles restraint system.
2. The harness separated at the metal attachment point of the tether to the vehicle restraint system. This resulted in the complete separation of the harness system from the vehicle restraint system and allowed the canine to become unrestrained from the harness system.
Additional Performance Evaluation

The Center for Pet Safety performed a follow-up evaluation of the same Size: Large canine automotive restraint models using quasi-static test methods. The goal was to compare the static test results to the dynamic test results and confirm the initial findings.

Test Setup

A third-party independent test laboratory was contracted to perform quasi-static testing.

A canine mannequin was designed to a similar size/weight as the crash test dog. The mannequin was constructed with a dense, firm foam outer shell and wrapped in black fiberglass impregnated industrial tape. A canine mannequin meeting this specification was used for all four tests. No live dogs or animals were used during these tests.

A safety harness was fitted to the canine mannequin and secured to a t-slot floor via a high strength belt used to simulate a vehicle’s seat belt. A load cell was placed in-line of the hydraulic cylinder and the canine mannequin’s load attachment point. A preload of 150 lbf was placed on the cylinder; a pretest check was performed to validate that all attachment points were secure and that load angles were within tolerance. All adjustment mechanisms were marked with witness paint prior to the test.

Quasi-Static Test Result Abstract:

Restraint A. Restraint performed similarly to the dynamic test. The harness cinched tightly around the dog’s front legs and chest cavity. The cinching/compression injury requires further study to determine the implications to the dog’s musculoskeletal and cardiovascular systems.

Restraint B. Restraint performed similarly to the dynamic test; exhibiting material failure at the attachment point.

Restraint C. Restraint performed similarly to the dynamic test. This test exhibited a metal attachment failure.

Restraint D. Restraint design had been modified by the manufacturer since the time of the dynamic test. This restraint exhibited an improved load capacity, however the connection point failed at the harness attachment point.

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1 Canine Automotive Restraint B. The restraint was constructed using different fabric material for the chest plate. All other components of the restraint were identical to the initial restraint tested.

2 Canine Automotive Restraint D. The restraint couplings (buckles) and connection point design were different from the restraint used in the initial sampling due to manufacturer re-design. The product packaging, model number, and photography were identical to the initial restraint tested.
Conclusion
The overall crashworthiness of canine automotive restraints (Size: large) is poor. There is warranted concern that these restraint devices do not adequately protect the companion animal from injury during an accident. Due to canine restraint failure the potential of secondary collision injury to the human occupant of the vehicle is possible.

References


About the Center for Pet Safety
The Center for Pet Safety (CPS) is a registered 501(c)3 non-profit research and advocacy organization dedicated to companion animal and consumer safety. Our mission is to have an enduring, positive impact on the survivability, health, safety and well-being of companion animals and the consumer through scientific research and product testing.

CPS is an independent safety science entity leading a unique mission for companion animals and their owners. Through the scientific study of pet products, we establish criteria to ensure acceptable product performance.

• CPS does not use live animals in our testing.
• CPS is not affiliated with the pet product industry.
• CPS does not endorse products.