FINDING A SAFE TRAVEL CRATE

WHEN BENEVOLENCE GOES WRONG ...

WHO CAN YOU TRUST?

Is My Pet Safe?

Finding A Safe Travel Crate

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Abstract

Pet parents are more aware than ever before of safety issues related to traveling with their pets. Dog owners increasingly look to crates or "dog boxes" to secure their dog in the event of a crash and to also reduce driver distraction. In this paper, I detail the search for a crate meeting my minimal acceptable criteria for safe travel. Coincident with this search, I critique the recent Center for Pet Safety 2015 crate crash test. [1]

1 Introduction

Have you ever been roped into helping out a friend only to find yourself spending far more time on their problem than you ever expected? I can chalk one up thanks to a recent phone call with a college friend. That conversation some how veered from sports to family vacation plans onto traveling with a dog and his utter exasperation of how best to handle a 65lb bundle of energy for hours at a time inside a SUV.

The problem was not so much that my friend was clueless about the subject of traveling with pets. He was aware of recommendations like

- feeding lightly,
- providing fresh water,
- exercise and relief stops,
- comfortable mat or bed,
- a favorite toy.

The hang up was whether his family really needed to confine or restrain their young dog and if so, the best way to do that. They considered a harness but were not sold on its ability to safely restrain a dog in an accident and not become a tangled nuisance during a 12 hour drive.

Like many owners of larger dogs, they also have a crate. Regrettably, my friend did not think their crate was appropriate for the car as it was more like a piece of furniture and might break too easily. He checked for other crates at the local big box store but was not wowed by anything on display. He also

mentioned his wife had looked on Amazon and was overwhelmed by endless choices of crates that all looked more or less the same.

It was at this point I got the question - "Hey, what do you know about this stuff?" Well, nothing like being direct!

I replied honestly - a crate of some kind is the best choice to keep both them and their pet safe in an accident. Their still young dog would also be less of a potential distraction if crated. However, I did not have a specific suggestion off hand as I had no personal experience with any particular style or brand of travel crate.

At this point, I told my friend about my new pet safety website and that his problem would make a really good topic. It would take some time to do the necessary research and analysis but I would help him out.

2 The Search

Before considering the merits of any crates on the market, I thought some time should be spent getting a feel for what is available. I now understand why my friend's wife was so frustrated.

Checking the Petco, Petsmart and Amazon websites brought up many crates, mostly metal wire or plastic and with few distinguishing features. Prior to filtering, Amazon lists 613 "dog crates and kennels" using keywords "travel crate". Walmart had 165, Petco about 80 and Petsmart fewest at around 30.

The majority of the crates are wire frame; the rest are split between hard plastic and various "soft" materials. There are also a surprisingly large number of wood crates for sale. Looking at crates for sale directly from Amazon narrowed the selection to about 100 with a median price around $80.

A cursory look shows little to distinguish crates in each category beyond amenities such as an extra door latch. In the median price range, the soft crates have a bit more variety in appearance due to differences in internal framing.

However, look through the more expensive metal crates and one starts to see some differentiation, such as the shape or door location. Rather than the traditional cubic or rectangular parallelepiped forms, some crates have trapezoidal sides while others may be tapered or use trapezoidal fronts and backs.

2.1 Initial considerations

What makes for safe car travel with a pet? I can argue there are three objectives that need to be satisfied:

1. Distraction to the driver from the pet is reduced.
2. The pet should remain in the rear area of the car at all times.
3. The safety of the pet should be similar to that afforded human occupants.

The first objective is clearly the easiest to satisfy. If preventing or reducing driver distraction were the only objective, a dog harness is a viable solution to

keep Fido from wandering in the vehicle, jumping in the driver's lap or getting into cargo or valuables. A crate of any kind is even more restrictive.

The second objective is a safety issue explained by physics. Sudden braking or turning can launch a dog at high speed into the front of the car (or out of a side window). The dog may hit and injure one or more children or adults while in flight.

Newtonian mechanics tells us a lot about the energy and force in such an event. Per Newton's first law, an unrestrained dog will remain in motion, traveling at the velocity of the car prior to braking. A 65 lb dog traveling close to 35 MPH has a kinetic energy equivalent to a 750 lb weight falling on your foot from a height of 3.5 feet. Ouch!

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It is possible to estimate the actual force conveyed by a dog in flight but that figure is highly dependent upon the parameters of the collision. It is influenced by the time over which the interaction takes place and the composition of items hitting each other. More generally, the damage will also be influenced by the area over which the collision is spread. Figure 1 shows how force varies with both velocity and the time over which the crash takes place.

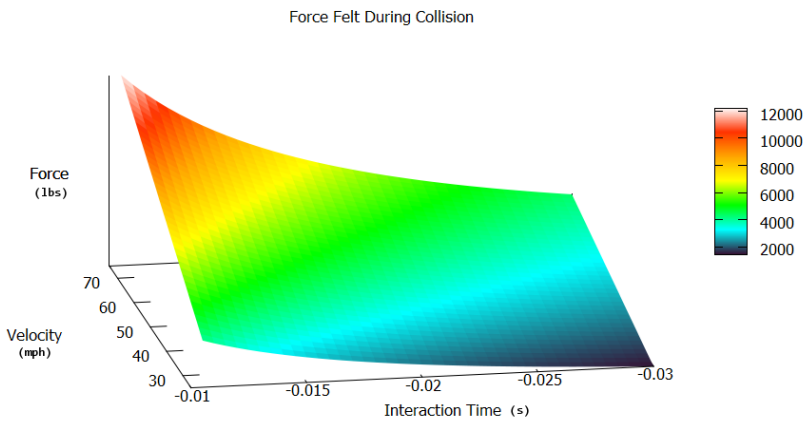

Figure 1: Force felt by a 75 lb dog during collision

Regardless, a dog hitting a human occupant in the head could cause very serious trauma to both. (Small dogs do not get a pass from Newton - the kinetic energy scales linearly with mass and exponentially with velocity. Car speed is far more important, see figure 2)

The third objective overlaps the second but not entirely. Preventing the dog from flying forward into the front of the vehicle will protect the humans but may or may not protect the dog. When the stopping force on the dog is too high, additional trauma can occur. If the crate is too large, the bio mechanics of a body in free space show other non-impact injuries can occur.

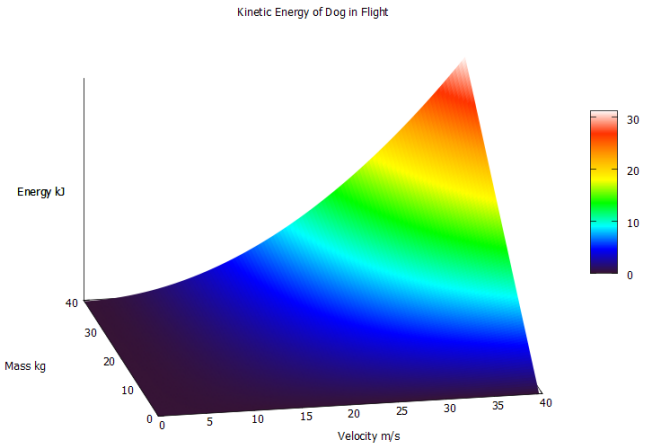

Figure 2: Plot of Kinetic Energy (kJ)

Consideration should also be given to the many types of crash events - frontal, rear, and side impacts all differ as do roll overs. In the case of a crate, it must be able to withstand a roll over or a rear crash as both those events could result in structural damage to the crate from the initial impact. A crate should also avoid causing structural damage to other parts of the car, such as seatbacks.

2.2 Narrowing the choices

Given the hundreds of crates and styles available, I really needed to take a representative sample and go from there. Here are my choices:

Name	Model	Description	Cost
Midwest Life Stages	Double-Door Folding Metal Dog Crate	Traditional folding wire, said to be good for home or car	$90
Good Ideas	KNBK-DES Kennebec Dog Kennel	Traditional hard plastic. What most people envision for car or plane tavel. Can be used in home.	$175
TRIXIE Pet Products	Scratch-Resistant Metallic Crate	The front and back are square but sloped. Mostly solid sides are trapezoidal shaped	$185
ProLine	Condor Dog Crate, Large	Like the TRIXIE features a trapezoidal shape but on all sides. Crash tested	$745
MIM	Safe Variocage SL Single Dog Cage	This is a very unusually shaped metal crate. Crash tested	$837

There is a big step up in price from the Trixie to the ProLine and MIM but I figured why not, there has to be something about the more expensive crates to justify the price.

The TRIXIE, ProLine and MIM Variocage both have "bars" that run in one direction, unlike the lower priced, traditional crates that have cross-crossing metal wires running up/down and front/back.

A big concern I have with all of these crates is deformation in a crash. Deformation is like Goldilocks - too much or too little is not good. When automakers speak of "crumple zones" in a car, they are basically talking about a controlled deformation of the structure of the car. Crumpling absorbs impact energy and **increases** the time over which the impact occurs (the longer the time, the smaller the force from the deceleration). The key word though is *controlled*.

2.2.1 Midwest Life Stages

With the Midwest wire crate, I would be very concerned about significant deformation in any kind of crash, rear in particular. If you have ever put these wire type of crates together, you know even the strongest will bend (and may need to for assembly). Unfortunately, they all will deform unpredictably outwards or inwards, the direction depending upon how much and where forces are applied.

Clearly, bending inward would jeopardize the pet. Another concern is that individual wires may unhook or break their welds and detach from the rest of the frame. This too poses a risk of severe trauma to the pet inside and potentially also to nearby humans.

Similar thoughts apply to the crate door. Will it stay closed in a crash? I would definitely worry the door of a wire crate may open in a crash or potentially worse, be stuck shut afterward. There needs to be a way to get Fido out of the crate at some point, especially if the dog is injured. I am very uneasy that wire crates may lose their structural integrity too easily.

2.2.2 Good Ideas Kennebec

On the other hand, with the Good Ideas crate my concern is the crate will not deform at all. In a rear end crash, it is possible the crate will be impacted by the car body and suffer additional compression forces. These can be relieved in one of two ways - the crate structure breaks or the crate pushes forward into or through a seatback. Without a rear end crash test, it is impossible to predict how the structure of the Good Ideas crate would behave.

However, the Kennebec is a single piece construction so cannot be separated - unlike similar plastic crates joined together from two injection blow mold parts after the fact. Good Ideas touts their process as the same used to make military grade transport containers. All of that may not make the crate any safer for pet transport as the chances of the crate acting as a battering ram against a seatback are probably high.

2.2.3 TRIXIE metallic crate

The TRIXIE crate bears a striking resemblance to the more expensive ProLine model, though rotated by 90 degrees. To get a better handle on this crate, I pulled down a brochure from the manufacturer's website (TRIXIE is a German company.) Based on this information, I have significant concerns about the use of this crate anywhere other than in the home.

MDF can fail spectacularly, splitting with many sharp edges. If a panel were to break inward, it is not hard to envision serious trauma to the pet.

The TRIXIE uses a frame of aluminum with plastic corner connectors. My impression, based on photos and the total weight of the crate, is that the aluminum is probably hollow tubing. Similar vertical bars cover about two-thirds of the face of the front door.

The sides, rear panel and floor are made of MDF covered with an easy to clean metallic plastic finish. MDF is *medium density fiberboard* and is often used in book cases or desks designed for self-assembly at home. MDF is made from fine wood fibers glued and compressed together under pressure. Formaldehyde resins are commonly used to bind together the fibers in MDF and this may be of concern to some pet owners.

My primary concern with the TRIXIE crate is the MDF paneling, less so the plastic corner connectors. MDF is not a particularly strong material and is generally weaker and more flexible than plywood. As noted earlier, though some compressibility can be a good thing, I worry that MDF panels may break, allowing the pet to exit the crate. Breakage from compression on crash impact (i.e., a rear crash) is also a risk.

MDF can fail spectacularly, splitting with many sharp edges. If a panel were to break inward, it is not hard to envision serious trauma to the pet. A pet punching through a panel on impact is at risk of cuts, punctures and abrasions.

Plastic corner connectors are a potential point of failure that makes the entire frame suspect. The TRIXIE is put together much like tents used for camping, tailgating and sometimes car shelters. A not uncommon complaint is of tents collapsing after the connectors shatter under stress and strain. If this happened to a crate, the loss of structural integrity could result in parts of the crate flying throughout the vehicle, putting pets and humans at risk of injury. Worse yet, the pet inside is no longer contained by the crate.

The potential for failure of the plastic frame connectors, the MDF panels or both, in my opinion, make this crate an unsafe choice for use in a car. Though the industrial look may not be everyone's cup of tea, for use in the home it is probably OK.

2.2.4 ProLine Condor

Moving up the price ladder, next in my list is the ProLine Condor crate. Like the TRIXE, the bars and frame are aluminum. However, the ProLine connectors are fiberglass, rather than plastic, and are bolted to the aluminum framing. The front (door) has vertical bars, the rear is a hard panel with a small gap of vertical bars at the top for ventilation.

ProLine states they use vertical rather than horizontal bars to prevent the

dog from causing chewing damage. I've watched my dog chew a hard bone in multiple directions so I don't think this is a big selling point. The composition of the solid side and rear panels is not clear from the marketing literature but like the TRIXIE, they too are silver.

ProLine also mentions their detail in craftsmanship and how their crates require little, if any, maintenance. Without examining the crate by hand, it is impossible to assess the build quality. However, for a $700 product, it should be well built! As to maintenance, again not a big issue as I don't think most crates require it.

ProLine's website (www.safetycrate.com) has a configurator to help the owner pick the correct crate size for their dog and car from the eight available models. I find it disconcerting ProLine refers to the crate as a "dog box" but perhaps that is just a cultural difference, ProLine is a Swiss product.

My initial take is similar to the TRIXIE - I have concerns about the side and rear panels, and slightly less so for the fiberglass connectors. In addition, the rear panel has a support bar mounted on the interior running horizontally. This strikes me as a poor design. In a crash, the dog may first hit a narrow, sharp edge and transmit the impact force across a small area, rather than the much larger area of the full panel. (ProLine sells an accessory "Crash Bag" for $90. It is a foam pad that attaches to the rear panel to provide additional impact protection.)

ProLine states this crate has been independently crash tested by the German firm TÜV-SÜD and awarded a "certification".

2.2.5 MIM Safe Variocage

At the highest price point is the MIM Safe Variocage. The Variocage will not win any beauty awards. It is a starkly utilitarian design that looks more like something one would find in a factory than the back of a car. Even so, we all should agree that our primary mission is to find the safest crate, not the best looking.

The standard Variocage, available in four base sizes, is further adjustable to better accommodate any sized dog. The Variocage also is available as a segregated double wide for multidog families. MIM has two additional models to meet unique needs - one designed for compact cars, the other for very small dogs or cats.

The Variocage is sloped front and back. The sides are mostly normal to the base, slightly tapered near the top. Unlike the other barred crates, the Variocage uses vertical bars on the front (door) and horizontal bars on the two long sides. The rear is a mixed metal panel, solid on the lower third and up the sides while grilled in the central two thirds.

A nearly flush horizontal reinforcement midway down the front door appears not to protrude significantly into the interior. The door can be locked with a key and there is a small storage area to tuck a training lead. The marketing material notes that the door is mounted on hydraulic hinges to make for a smoother open and close.

MIM took this dire circumstance into consideration by providing an additional "escape hatch" through which the pet can be extracted.

The horizontal bars comprising the sides of the Variocage are unique and a closer look reveals they are two pieces, one fitting inside the end of the other. In their product description, MIM notes that in a rear end collision the Variocage is designed to partially crumple. The telescoping nature of these horizontal side bars are a key element of that safety feature.

The most outstanding design feature of the Variocage is the ability to absorb crash energy by crumpling in a predefined, controlled manner. In a rear crash, MIM has eliminated one of the most significant risks - a crate acting as a battering ram that can break a seatback and injure the occupant. The pet is also better protected from potential trauma as the Variocage won't shatter, nor are metal parts likely to protrude into the interior of the crate.

Without multiple situational crash tests of each crate, it is not possible to quantify the likelihood the door remains closed in an accident nor whether the door can be opened afterward. If the door is mangled in the collision, it may be slow or very difficult to open, potentially putting humans and pets at additional risk of injury.

MIM took this dire circumstance into consideration by providing an additional "escape hatch" through which the pet can be extracted. The rear metal panel of the Variocrate is hinged so it can be folded down after loosening two retention knobs on the top of the crate. Only a handful of crates offer a second door and, other than the Variocage, they are all basic wire structures.

MIM, like ProLine, also states their crate was independently crash tested. Unlike ProLine, MIM provides PDF copies of the test procedures and results on their website.

3 Crash Test Reports

3.1 Paid By The Manufacturer

Much of the above analysis is based on product literature and visual appearance. Augmenting that with actual crash testing data would give me more confidence in my final determination.

Both the ProLine and the MIM Variocage have undergone some type of crash testing by a third party at the request of the manufacturer. I utilized the manufacturer and testing company websites to better understand the methodologies used and the test results.

3.1.1 TÜV-SÜD

ProLine commissioned TÜV-SÜD to perform their crash testing. TÜV-SÜD is a German technical services firm founded in 1866. One of their major lines of work is product testing. From their website:

> "We provide testing to international standards and directives that are endorsed by leading quality and safety marks. For example, the US Nationally Recognized Testing Laboratory (NRTL) Mark, and

the European Communitys CE Marking and GS Mark. We also issue TÜV-SÜD product certification marks based on standards set according to internationally recognized benchmarks."

Unfortunately, there is too little detail provided about the test to make any kind of informed judgment.

The ProLine crate received a TÜV-SÜD product certification mark, Certification nr. B 13 01 29106 011 on February 18th, 2013. Unfortunately, there is no mention of what standard was tested against. ProLine does, however, provide a list of components of the test. Some are only tangentially related to safety - labeling, user manuals, general information. Others just appear to be check box items: screws, connection points, rivets, corrosion protection, safety instructions.

The crash test setup is described as using a 55 kg reference weight placed inside a crate that is mounted on a sled. The test described attempts to emulate a frontal collision at a speed of 50 km/h. To pass, the dummy weight must not break through the back panel of the crate. ProLine claims all of their crates passed.

Unfortunately, there is too little detail provided about the test to make any kind of informed judgment. Is the crate bolted down? Tied down? Was there a seatback in front? Did the rear panel break but the weight was contained? What kind of damage might be inflicted upon a real dog?

ProLine also describes a "rough road" test that seems primarily designed to test that the crate door stays closed and the provided Velcro anchors remain attached. The test is done at a speed of 25 km/h. This test is purely for marketing literature in my opinion.

Without more information about the frontal crash test, it is hard to feel confident in ProLine's assessment of the results. ProLine did not test for a rear collision and that too is disappointing.

3.1.2 SP Structural and Solid Mechanics

MIM provides multiple PDFs on their website with copies of their crash testing results, one each for the standard and double size crate. Conducted by Swedish testing firm SP Structural and Solid Mechanics, the reports are 21 pages long and include descriptive results, photos and sensor output.

Multiple tests were performed to simulate frontal, rear and roll over impacts. The tests were done in February, 2012 following the "SPCT-method". SPCT is an acronym for "Safe Pet Crate Test," the methodology developed by SP Structural and Solid Mechanics in an effort to establish a uniform European testing standard for dog crates.

The SP website contains a 12 page PDF describing the entire SPCT methodology. The primary basis is ECE R17 (United Nations regulation no. 17), a standard used to test safety restraints and seat strength in auto crashes. SP has extended portions of that framework to test pet crates under the conditions of front and rear end collisions as well as roll-overs. ECE R44 (standard for restraining devices for child occupants) is also utilized in the SPCT basis.

The SPCT test methodology is, and I may be understating, robust. For instance, to more accurately reflect what happens in a real frontal impact, the sled is decelerated at up to 28Gs after it reaches a speed of 50 km/h. In addition to assessing the condition of the crate and seatback, the rear collision test monitors a standard human crash test dummy placed in the rear seat. SPCT also evaluates the potential for injury to the pet, both from the crash impact and any stray pieces of the crate.

In addition to assessing the condition of the crate and seatback, the rear collision test monitors a standard human crash test dummy placed in the rear seat. SPCT also evaluates the potential for injury to the pet, both from the crash impact and any stray pieces of the crate.

Both the front and rear collision tests use the rear chassis of an actual car (Volvo V70N) with a 60/40 rear seat. Multiple accelerometers and high speed cameras gather data and imaging of the crash. The test crate is positioned behind the seatback as is consistent with standard cargo loading and manufacturer recommendations.

The end result states that the dummy dog, the crate, the seatback and the human dummy all survived the crash tests. The dummy dog stayed inside the Variocage, both doors were closed and still functional, and no sharp edges were found. In the frontal test, one of the two retaining straps (front) that anchor the crate broke free. All measured values were found to be well below the maximums allowed by the ECE basis for acceleration of occupants and penetration and damage to the seatback.

Initially, I considered stopping at this point. However, I thought I owed it to TRIXIE and Good Ideas to check the internet for any independent testing that included their products. Though I did not locate any, I did find a recent test conducted by the "Center for Pet Safety" that included both the MIM Variocage and the ProLine (Milan, not Condor model). As CPS states they are not hired by manufacturers to provide evaluations, I felt a review of their test results for the ProLine and MIM crates would be in order and worthwhile.

3.2 Center for Pet Safety 2015 Study

Center for Pet Safety ("CPS") is a 501(c)(3) non-profit research and advocacy organization dedicated to companion animal and consumer safety. Their website mission statement indicates a focus on pet travel safety. The founder, CEO and primary author at CPS is Lindsey Wolko. Ms. Wolko was previously involved with pet advocacy since 2004 at "Canine Commuter."

In 2011, CPS reports on their website they conducted preliminary crate testing with a 55 lb. crash test dog using the ECE-R17 Test Standard for "Seats, their anchorages and any head restraints". CPS states "The engineered, weighted and instrumented CPS Crash Test Dog was destroyed in this test," yet that is not at all clear. A video is posted of an unrestrained wire crate containing a test dog that slides into the front of the crate. Simultaneously, the crate itself impacts into a rear seat. Beyond that one video, it is difficult to determine anything else about the CPS trial as no written report or additional data is available on the CPS website.

In 2015, CPS conducted a series of simulated crash tests on a sample of crates costing less than $1,000. According to the CPS website, the purpose of the testing is to:

- Independently evaluate the current-state travel crate products that claim "testing", "crash testing" or "crash protection" and cost less than $1,000.00 (US).
- Examine the safety, structural integrity and crash worthiness of "value" crates.
- Examine connection options to help educate pet owners.
- Collect performance data necessary to support a formal test protocol and ratings guidelines for pet travel crates.
- Determine top performing crate brand(s).

A PDF of the 2015 report is available on the CPS website free of charge. In it, prior to briefly describing the test methodology, is this claim:

> " Crates that are not structurally sound, have insufficient connection strength and/or are reliant on the seatback for additional support during a sudden stop or accident place the pet and human vehicle occupants at risk. [1] "

I checked the referenced material - *"In-Depth Evaluation of Real-World Car Collisions: Fatal and Severe Injuries in Children Are Predominantly Caused by Restraint Errors and Unstrapped Cargo,"* a report from 2011 published in the journal ***Traffic Injury Prevention***. The publisher, Taylor and Francis, states that submitted manuscripts are single blind peer reviewed. The article has, per the journal website, been cited twice and it is also listed in the PubMed database.

The authors studied 15 high-impact car crashes involving 27 children. Injuries were found to be due to unstrapped luggage in 4 of 15 and "technical error" in 1 of 15.

I am unclear how the referenced study supports the CPS *a priori* claim that a reliance upon a seatback for additional support is risky. Nor is it clear how that statement is supported by their prior 2011 initial testing. In the one test video made public, the crate is not positioned against the seatback.

3.2.1 Methodology and ECE R-17

CPS says their testing methodology follows ECE R-17 and the data collected was from a front-impact. The following statement, within the methodology description, confuses me:

> Because crates are generally considered cargo, Center for Pet Safety acknowledges the increased risk of seatback failure should a front impact accident occur and cargo (weight of the crate plus the dog) exceeding 40 lb strikes the seatback.

At first it is not clear why CPS feels the need to "acknowledge" risks of any kind in a crash test. If the premise of a test and the methodology used

to perform it are legitimate and repeatable, the results should stand on their own. If analysis shows that either the premise or methodology are flawed, that assessment should be stated plainly and results invalidated when appropriate. Here, CPS seems to be saying that a certain outcome may occur and they are sorry in advance.

Two excerpts from the actual ECE R-17 document that relate to seatback testing are included as an appendix to this post.

CPS provides a diagram and description of their test sled, which is carpeted to emulate a car interior. Earlier, CPS stated the seatback mounted on the sled is a "rigid metal fixture" they developed in house to simulate a seatback.

The simulated seatback is a potential deviation from ECE R-17. CPS does not provide any quantitative information about the materials used and assembly of the seatback. Nor does CPS provide any baseline comparison of how their simulated seatback responds in comparison to a standard automobile seatback. This is really surprising as there is no way to ascertain if the simulated seatback is more rigid, less rigid or, more generally, rigid in the same areas as an actual seatback. As a point of comparison, the Swedish firm SP utilized the actual rear end of a Volvo automobile, seats included.

However, CPS has clearly deviated from ECE R-17 in the positioning of the test crates on the sled. Annex 9 of the specification says the test weight should be placed 200 mm (7.8 in) behind the seatback and the distance may be reduced if there is not sufficient room.

The CPS sled diagram shows the cargo area to be 78" long and the tie down anchors spaced 33" apart. The anchors appear to be placed equidistant from each end of the cargo area, leaving approximately 16.5" clear area to the front and rear (I assume the anchors are 1" wide). Another way to calculate this is to take the dimension, if available, of the test crate. The first model tested was a ProLine Milan. CPS does not say if they used the medium or large variant. The large model is 36.8" long. Assuming the crate is centered as in the CPS sled diagram, this leaves a gap from the simulated seatback of just over 20."

I think we can toss the notion that CPS is trying to faithfully duplicate ECE R-17; they are not. The problem with that is it raises some credibility issues. Regrettably, a typical consumer may not notice these discrepancies. But in carrying out research, it is wrong to claim "I have tested 'A'" when in fact you have tested some undocumented variation of 'A'.

I do wish there was better documentation from TÜV-SÜD, SP Mechanical provides a long document outlining their methodology, *specifically noting those elements taken from ECE R-17 and 44*. Like CPS, they use a heavier weight (45 kg) and position the crate "per manufacture instructions"; unlike CPS they do not claim those to be ECE R-17 basis compliant.

Finally, the last paragraph in the CPS methodology gives the reader additional instructions:

> . . . it is important to focus on the structural integrity of the crate and the connectors provided by, or specified by, the manufacturer. Connections should not break or detach from the crate in a crash

> simulation. Additionally, the crate should not rely on the seatback for additional support in a front impact crash, nor should the product shift excessively or release completely from the anchorage.

Again, this is not part of ECE-R17. Nor is the state of the connectors or any reliance of the crate upon a seatback for additional support set out in the initial purpose of the CPS testing. Though CPS did say they "want to examine connection options to help educate pet owners," the above instructions effectively voice a predetermined judgment rather than provide education.

There is a very after the fact feel to this. If the state of the connectors is extremely important, shouldn't that been part of the test scope, along with the reasons? Perhaps CPS feels it is obvious why they should, but one thing I learned doing lab experiments is never to assume anything obvious to me is also so to my partner or the intended audience of my results.

The extra CPS requirement that a crate not rely on a seatback for additional support is at first confusing but then explained subsequently. CPS runs two tests on each crate. Test 1 is

Let's start with the CPS test sled cargo dimensions. 78" is longer than the entire interior of many vehicles.

> designed to reflect a "real-world" test where the crate for the large dog would necessitate folding the rear seats down to accommodate the larger containment system. The crate was placed centrally in the simulated cargo area and attached to the anchor points per manufacturer instructions without contacting the simulated seat.

Those placement instructions confirms that firm adherence to the ECE-R17 basis is out the window.

3.2.2 Is the test "real-world"

More puzzling to me at least is what is "real-world" about anchoring the crate in the center of the cargo area?

Let's start with the CPS test sled cargo dimensions. 78" is longer than the entire interior of many vehicles. As CPS has been supported by Subaru, let's consider a 2013 Outback hatchback. With the second row of seats up, the area between the wheel wells is 43" wide by 40" long. The ProLine Milan L is 37" long by 21.5" wide. Centering the crate would leave just under 11" free on each side to store any additional cargo *and only 3" behind the seatback.* I think I am safe saying that the vast majority of owners with any additional cargo would position the crate to be flush with one of the wheel wells. That would leave 21.5" of *usable* space on the other side.

The rear seats in an Outback do not fold flat which doesn't really help, though does extend the available length to 66" (and eliminates those pesky back seat drivers). However, other SUV's do have seats that fold flat, extending the cargo area length another 20" or so. That may sound like it makes centering viable but it really does not as the interior width available remains on the order of 12". That is just not very much to work with.

As additional points of reference, a Chevrolet Suburban has 64" length to the back of row two and 100" to the back of the first row; the GM Escalade has

a maximum cargo area length of 94". The CPS 78" sled length seems outside the available cargo length of all but the largest SUV. So in a "real-world," the crate will *always* be positioned closer to a seatback than in the CPS testing.

Bottom line, I find it very presumptuous that CPS assumes "real-world" dog owners do not also travel with children, friends or other cargo that precludes the extension of the cargo area by flipping down seats.

This can be considered from another angle as well. In most instances when loading a truck, cargo is tied down forward unless this could change the center of gravity enough to adversely affect vehicle stability. See for example fmcsa.dog.gov. The same applies to cars. Both the Automobile Association (AA) and Consumer Reports recommend loading items front to back.

> Make sure the heaviest items are put as far forward in the cargo area as possible, and keep them on the floor. Source: *Consumer Reports*

3.2.3 Cargo straps/tie downs

CPS also focuses on cargo tie downs, particularly if they remain intact throughout their crash test. I think it is good they bring attention to the issue of cargo straps.

I had conversations with a number of pet and non-pet owners, as well as a new car sales and service manager with 25+ years experience. My question to all of them was: Do you tie down your dog crate? Do you tie down cargo in your car? Do your customers use cargo straps?

Unfortunately, the answer was a resounding no. Most people rarely secure the crate (or other cargo) in their car. Those that qualified their answer pointed to basing their decision on the likelihood the crate/cargo would shift a lot during turning or breaking. Another frequent qualification was 'it really depends how far I have to go.' Also mentioned: 'it depends if I can find the tie downs.'

Crates and cargo should always be tied down to prevent shifting during transit. A moving crate is not only distracting, it is a danger to the dog inside. In some cases, shifting over time might even loosen the locking mechanism on the door.

However, I do have an issue with the CPS statement "Connections should not break or detach from the crate in a crash simulation." Perhaps that is true in a very idealized world or a classroom discussion of the proverbial spherical cow. But reality, which CPS says they want their test to reflect, is not that kind. Consider the myriad variables:

However, in a crash, tension on the Subaru tie down hooks will approach 1,700 lb, far exceeding their MBL. A severe failure of the hooks is near certain, thus freeing the crate.

- the condition and age of the strap,
- is it tied to the crate correctly,
- is it attached properly to the car,
- is the ring or hook in-auto attachment point strong enough?

The last point may ultimately outweigh those of possible operator error. It is widely known that the quality of cars can vary between model lines and even more between make. Manufacturer expectations of customer use may also dictate the type and strength of anchor points used in a particular model car or SUV.

I don't think any pet owner is wise to rely upon tie down hooks or rings. Why? Again, take the Subaru Outback. The 2015 owners manual on page 6-18 warns:

> The convenient tie-down hooks are designed only for securing light cargo. Never try to secure cargo that exceeds the capacity of the hooks. The maximum load capacity is 110 lb (50 kg) per hook.

Working Load Limits (WLL) are often quoted as 1/3 of the minimum breaking load (MBL) (ref: Wikipedia). For the Subaru, this translates to a MBL of 330 lb.

With the CPS study as a guide, CPS envisions the crate to be tied down with stays at 45 degree angles in both the vertical and horizontal direction on all sides, if possible. For our Subaru, that translates to 110 lb of tension in the front and rear directions with 220 lb directed downward. This is more than sufficient to prevent sliding and is in excess of the recommended 80% of load (our dog and crate) expected in normal hard breaking (ref: fmcsa.dot.gov).

Figure 3: Anchor on CPS test sled (Subaru press kit)

Figure 4: D-ring and anchor on CPS test sled (Subaru press kit)

However, in a crash, tension on the Subaru tie down hooks will approach 1,700 lb, far exceeding their MBL. A severe failure of the hooks is near certain, thus freeing the crate.

Reliance upon either the tie downs straps or the anchors to which they attach should be avoided. Every car and truck presents a different situation and finding the data necessary to make a calculation like the above may be difficult for the owner. Tie downs should only be used to keep the crate stationary under normal driving conditions; that they may, in some cases, significantly restrain the crate during a crash is a benefit but without a guaranty.

In fact, it is highly unlikely that many consumer trucks or cars are equipped with anchors similar to those pictured.

I read in the CPS carrier FAQ that they recommend pet owners use "strength rated" straps to anchor a crate. They also provided a link to Gunner Kennels (one of the crate manufacturers they tested) who sell straps rated at 2,500 lb. Again, I remind owners they should not reply upon straps or anchors *unless they are able to verify all parts of the anchor/strap/crate system are able to withstand crash forces.* A strap rated at 2,500 lb does no good if the hook is only rated at 100 lb.

Yet, the anchors used on the CPS test sled (figures 3 and 4) are anything but "real world" as found in a typical Subaru. In fact, it is highly unlikely that many consumer trucks or cars are equipped with anchors similar to those pictured. See figure 5 for examples of consumer d-rings and anchors.

Figure 5: Consumer d-rings and anchors (Miskulin, Subaru press kit)

3.2.4 CPS Advisory

Before moving forward to the ProLine Milan and MIM Variocage tests, I need to point out that **CPS is well aware of the limitation of anchor points** and has a special "Cargo Area Connection Advisory" that reads, in part:

> At Center for Pet Safety we routinely receive questions from pet owners about how to anchor a pet in the cargo area with a harness. While many harness brands recommend this as a viable option, at CPS we have serious concerns about the structural integrity of the cargo area platform and the connections therein.
>
> Cargo area anchors are not necessarily weight-rated to the requirements needed to properly anchor your pet. Additionally, the cargo area platform is not necessarily as solid as you think it may be.
>
> Before choosing to anchor your pet in the cargo area, we recommend that you reach out to your vehicles manufacturer and confirm the connection strength in the cargo area - to ensure it will hold up.

The reality is that in a crash, most crates will break free and if CPS positioning guidelines are followed, become dangerous projectiles with room to fly.

I fully agree, but am completely shocked and perplexed why CPS, in their 2015 crate study, is so focused on crates remaining fully tied down when CPS realizes this is probably not a "real world" objective that can be reliably and easily met. The reality is that in a crash, most crates will break free and if CPS positioning guidelines are followed, become dangerous projectiles with room to fly.

3.3 CPS 2015 Study Test Results

3.3.1 ProLine Milan

So lets look at what CPS found out in their testing of the ProLine Milan and MIM Variocage crates.

CPS tested a ProLine Milan model - there is no mention of sizing (S, M or L). The ProLine Condor I had selected is in the same product line as the Milan but is slightly taller and not quite as long.

Test run #1, where the crate is tied down about two feet behind the simulated seatback, is about as extreme a result as you can expect to see - it is akin to putting the crate in the back of an empty SUV with both the 2nd and 3rd row seating turned down. The back of the ProLine was destroyed and the test dog emerged partially out of the back. The door required significant force to open.

The more realistic second test run stows the crate directly behind the seatback. In this case, the back of the crate did not completely break but the damage was still severe. The front door was slightly mangled, became stuck and would not open without the use of a crow bar.

My concerns about the ProLine crate were confirmed. The panels, per CPS are wood, probably made of one of the many available composites (like MDF). There is no assurance that in an actual crash the rear panel would behave more

like run #2 than run #1. Likewise, impact from other cargo into the side panels could result in complete failure and put the pet inside at substantial risk of injury.

Being able to extract the pet from the crate in an emergency is of very high importance and the ProLine failed here as well. In my opinion this, combined with the wood paneling issue, disqualifies the ProLine from further consideration as a safe travel crate.

3.3.2 MIM Variocage

The MIM Variocage was also subjected to two test runs. In run #1, the tie down straps failed and the crate crushed an average of 10" on impact. Though there was also minor deformation of the top and sides, the front door remained locked and was easily opened. The test dog remained inside the crate.

Recall from my initial description of the Variocage: the controlled deformation of the crate during a collision is a design feature that operates on the same principle as "crumple zones" in automobiles. When the crate deforms, it absorbs some of the energy of the crash and extends the time over which the interaction takes place, further reducing the forces on the crate. Based upon the CPS description, the Variocage functioned exactly as expected.

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For run #2, placing the Variocage behind the simulated seat resulted in nearly identical results, the only difference being just one strap failed. The crate maintained structural integrity, the dog was contained in the crate and the front door was easy to open.

Again, CPS does not state the exact model or size of the crate as tested (recall the Variocage is also adjustable within base sizing). This complicates my analysis. If the crate crumpled 10" on impact, is that a lot? A little? CPS gives no indication that the test dog was left in a compromised position, so I can only assume there was sufficient room after impact. For reference, MIM lists the length of their Variocage Original SL as 760-1030 mm (30" - 40.5"). So a 10" crush is between 25% and 33% of the crate length. Without doubt, owners **must** take this into account when sizing this crate to their pet and car.

3.3.3 Other crates

CPS also tested two plastic body crates. One, the Gunner G1, was only tested in the run #1 scenario. This provides limited information as the crate remained anchored. Though the door remained intact and opened easily, that outcome is based largely on the crate's connection to the test sled. Looking at the results of the other crates, I still have concerns about the front door on the Gunner.

. . . the Gunner crate cannot be fully evaluated until the door is subjected to realistic crash forces. I would like to see, at a minimum, this crate placed behind the seatback and tested without the benefit of tie downs.

The other plastic crate, the Roto Mold "Ruff Tough Kennel" displayed mixed results. In both runs, the structural integrity of the crate was maintained. What is very troubling about the Roto Mold crate is that the door failed in both runs, dramatically so in the second when it completely detached from the crate, allowing the test dog to fly out. Even in the first run, the door partially shattered and, though contained, the test dog was at risk from sharp protruding

edges. Based on the CPS images as well as my own web search, it appears that this door is plastic, a really poor design choice.

The Gunner uses a door that is made of metal parts and the connection points with the plastic body are fully recessed, unlike the Roto Mold. My strong opinion is that the Gunner crate cannot be fully evaluated until the door is subjected to realistic crash forces. I would like to see, at a minimum, this crate placed behind the seatback and tested without the benefit of tie downs.

Revisiting my short list, the Good Ideas Kennebec crate has a similar, if not stronger, body as the Roto Mold. Structurally, at least in a front crash, I expect it will perform well. The marketing materials indicate it has a "secure, hi-tension spring door" that by visual inspection is a metal grill with four recessed connection points. Though I do not worry that this door will shatter like the plastic Roto Mold, I have concerns the connection points may not be sufficiently recessed, nor the gauge of the wire sufficiently large, to withstand a crash impact. Like the Gunner, I can't feel totally comfortable without a test demonstrating the door acts appropriately during and after a crash.

CPS also tested a traditional wire framed crate. It was completely mangled as was expected.

3.3.4 What happened to . . . ?

In the introductory sections of the test report, CPS repeatedly states their concerns about crates hitting, and possibly penetrating, car seatbacks. Yet, in none of the individual test results is any mention made of the type and severity of damage to the seatback. Further, if the risk of impact with the seatback is to the passenger on the other side, it would be appropriate to position a human test dummy with standard monitors to assess any potential injuries.

I really feel CPS has done a significant disservice to pet owners by not recommending the Variocage.

4 Conclusions

4.1 Highly Recommended

MIM Variocage

The only crate that I can recommend unconditionally to my friends is the MIM Variocage. There is no doubt in my mind that it is the safest crate for both the dog inside as well as the other passengers in the car. While the testing commissioned by MIM was thorough and included rear crash and drop tests, it was really the flawed CPS testing that made me most confident about the Variocage. Even in those tests, it did everything it was expected to do flawlessly. I really feel CPS has done a significant disservice to pet owners by not recommending the Variocage.

As is often the case, the best performing may come with the highest price tag and there is no exception for the MIM Variocage. It is the most expensive crate I considered and, to the best of my knowledge, also the most expensive in

the marketplace. But unlike other expensive crates, the Variocage delivers with certainty.

If there is a downside to the Variocage, it is the same as exists with a modern car. Crumple zones collapse in a significant crash, resulting in significant repair bills. In the case of the Variocage, that almost certainly means replacement with a new crate. I urged my friends to check with their insurance carrier if they purchase a Variocage to be certain the damaged crate would be covered under their policy.

4.2 In A Pinch

Good Ideas Kennebec

If I were pressed to recommend a less costly alternative, I might give a very conditional nod to the Good Ideas Kennebec. My prime worry is the ability of the crate door to stay closed in a significant collision and still be functional afterward. Unfortunately, only crash testing can remove that qualification.

Further, until hard plastic style crates are subjected to rear end testing, be very cautious not to place this crate behind an occupied seat to avoid any chance it becomes a battering ram in a rear collision. Though the Gunner crate tested by CPS is similar, it is much more costly, was not tested in a rear-end collision and has the same question marks about its door.

Ultimately, it is up to the pet parents to decide if the cost savings and usage constraints are worth the potential trade offs in safety to both the pet and human occupants.

4.3 Additional Padding

Much of the analysis of crates done here, by CPS and other testing companies has focused solely on the crate - whether or not it survives and any collateral damage it may cause to human occupants. The addition of foam or similar padding to the rear panel of a crate should reduce the force felt by the pet on impact by extending the time over which the collision takes place. This may or may not amount to a significant improvement but it is one worth further examination.

Earlier I mentioned that ProLine sells a “Crash Bag” for about $90. It is a very high price for a foam pad inside a good liner. So while I was not impressed by their crate, I do see merit to their Crash Bag. If testing confirms the benefits, I would like to see other crate manufacturers offer something similar for their products, though hopefully at a better price. Optional of course, as clearly it provides a tempting target for a distracted pup!

5 A Short Note on CPS

My comments to this point about CPS have been negative and based upon my review of their 2015 crate study as it applied to two of the crates in my own short

list. Some of the flaws in the CPS study have already been pointed out and many reflect a general lack of transparency. With no backup and details, the CPS crate test might receive a failing grade were it a college lab assignment. The onus is on CPS, as a new player in crash testing, to provide sufficient authoritative detail to promote confidence in their procedures and methods. This is all the more important since CPS is pushing the crash testing of products that have had limited, if any, public testing prior to their efforts.

At the least, references must be available to backup critical issues with the testing methodology. As an example, where are the testing results to indicate the CPS simulated seatback does behave like a typical auto seatback? Another is that when published standards are the basis for a test, deviation from that standard must be noted.

I also think CPS needs to take a step back and be sure to apply a common sense review of all current and future testing methodology. Sometimes it is easy to get so caught up in the small details that we can miss that the whole picture is off center. CPS also should be sure to present consistent recommendations throughout all their materials and boldly note when and where deviations are acceptable.

CPS must realize that their statements are not perceived as just an opinion but are now viewed as authoritative.

In fact, I think CPS has performed a *disservice* to pet owners with their 2015 crate test. They have disqualified one product and recommended another based upon a standard that, by their own admission, is flawed. Would the typical pet owner quickly reading the crate test report know that CPS implores pet owners not to rely upon anchoring systems for safe crate travel? Instead, the report makes clear pet owners should place great emphasis on a crate remaining attached to the test sled. CPS also deviated from the methodology they stated would be used (ECE R17) without making clear they were doing so.

I also believe CPS errs in issuing a recommendation of any kind without also having rear crash test performance data. Will CPS reverse their recommendation of the Gunner as "safe" if it fails subsequent rear testing? What of the pet owners who purchase based on that previous recommendation? CPS *must realize* that their statements are not perceived as just an opinion but are now viewed as *authoritative.*

Even so, I do applaud the effort that CPS is making to try to bring independent testing to the pet industry. For CPS to really make inroads, they must be extremely credible, to a flaw. Unlike Consumer Reports, who have a long testing track record and a large budget, CPS is new and run on good will and a shoe string. Hopefully these are just growing pains and CPS can gain additional funding and adjust their procedures to give pet owners confidence that manufacturers are really and truthfully being held accountable.

If CPS fails to make these types of adjustments, pet owners who rely on their recommendations could be led astray and influenced to purchase a product that may be less safe, perhaps even dangerous, for both their pet and themselves. That would be a tragedy for all involved and is one of the primary reasons I started ismypetsafe.com:

Unfortunately, pets are not immune from an internet full of unsafe

products, dubious claims and well intentioned but ill informed advice. Products and procedures are often panned by those who go on little more than gut feelings or a poor and incomplete understanding of the product/procedure, including the testing behind it. This can lead to a spiral of hearsay causing owners to reject otherwise safe products or procedures that are a good fit for their pet.

I do hope that CPS will take these criticisms into consideration.

6 ANNEX

6.1 ECE R-17

The following is a portion of the actual ECE-R17 document.

5.15. Special requirements regarding the protection of occupants from displaced luggage

5.15.1. Seat-backs

Seat-backs and/or head restraints located such that they constitute the forward boundary of the luggage compartment, all seats being in place and in the normal position of use as indicated by the manufacturer, shall have sufficient strength to protect the occupants from displaced luggage in a frontal impact. This requirement is deemed to be met if, during and after the test described in annex 9, the seat-backs remain in position and the locking mechanisms remain in place. However, the deformation of the seat-backs and their fastenings during the test is permitted, provided that the forward contour of the parts of the tested seat-back and/or head restraints, that are harder than 50 Shore A, does not move forward of a transverse vertical plane which passes through:

(a) a point of 150 mm forward of the R point of the seat in question, for the parts of the head restraint;

(b) a point of 100 mm forward of the R point of the seat in question, for parts of the seat-back;

excluding the rebound phases of the test blocks.

All measurements shall be taken in the longitudinal median plane of the corresponding seat or seating position for each seating position constituting the forward boundary of the luggage compartment.

During the test described in annex 9, the test blocks shall remain behind the seat-back(s) in question.

Annex-9

2. Test preparation

2.1. Test of seat-backs (see figure 1)

2.1.1. General requirements

2.1.1.1. At the option of the car manufacturer, parts whose hardness is lower than 50 Shore A can be removed from the tested seat and head restraint for the tests.

2.1.1.2. Two type 1 test blocks shall be placed on the floor of the luggage compartment. In order to determine the location of the test blocks in the longitudinal direction, they shall first be positioned such that their front side contacts that part of the vehicle which constitutes the forward boundary of the luggage compartment and that their lower side rests on the floor of the luggage compartment.

They shall then be moved backwards and parallel to the longitudinal median plane of the vehicle until their geometrical center has traversed a horizontal distance of 200 mm. If the dimensions of the luggage compartment do not allow

a distance of 200 mm and if the rear seats are horizontally adjustable, these seats shall be moved forward to the limit of the adjustment range intended for normal occupant use, or to the position resulting in a distance of 200 mm, whichever is less. In other cases, the test blocks shall be placed as far as possible behind the rear seats.

6.2 Some calculations

6.2.1 Kinetic energy of a dog in free flight

A 30kg dog has kinetic energy of 3,375 joules when traveling at 15 m/s (or roughly 65 lb going 33 MPH). Put another way, this is the same amount of energy imparted by 345 kg (760 lb) falling on your foot from a height of 1 m (3.3 feet).

6.2.2 Force in a crash

Force in crash: A combined 34 kg (75 lb) crate plus dog at 15 m/s (33.5 MPH) will result in a force of 7650 N (1720 lb), assuming the deceleration is over a distance of 0.5 m (about 20").