

NHTSA SS_V

(Strikeable Surrogate Vehicle)

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Acronyms




- CIB: Crash imminent braking, provides automatic braking
- FCW: Forward collision warning, typically visual and auditory
- DBS: Dynamic brake support, automatically provides supplemental braking
- MTRI: Michigan Technical Research Institute
- NCAP: NHTSA's New Car Assessment Program
- RCS: Radar cross section
- SS_V: Strikeable surrogate vehicle
- UHMW: Ultra high molecular weight (plastic)
- UMTRI: University of Michigan Transportation Research Institute
- VRTC: NHTSA's Vehicle Research and Test Center

Why SS_V Development Was Necessary

- Any regulatory evaluation of FCW/CIB/DBS requires a realistic lead vehicle
- FCW tests can be performed with a real lead vehicle because impacts with the test vehicle are not expected
- CIB/DBS tests often produce test-to-lead vehicle collisions, therefore real lead vehicles cannot be used
- All known surrogate vehicles have some undesirable attributes
- Inconsistent CIB/DBS test track performance has been observed at VRTC; the possibility of the surrogate being the cause cannot be overlooked

The surrogate vehicles presently used by NHTSA are research tools, and are not suitable for regulatory use.

Surrogate Vehicle Comparison

Surrogate	Construction	Visual Characteristics				Durability		Radar Characteristics		
		Tail Aspect	3D Tail Aspect?	Rear Tire Gap?	Contrasting features?	Impact Resistance	Max Impact Speed	Reflection Method	Tuned?	Return Signature Fluctuation
NHTSA Foam Car 1 (FC1)	Covered foam frame		No	No	Yes (but better elements are necessary)	Acceptable	>40 mph (>64 km/h)	Internal Foil Panels	No	Considerable
NHTSA Foam Car 2 (FC2)	Covered foam frame		Yes	Yes	Yes	Unknown	>30 mph (>48 km/h)	Internal Foil Panels	No	Considerable
Euro NCAP/ Thatcham/ADAC	Covered inflatable		No	No	Yes	Unknown	31 mph (50 km/h)	Internal Foil Panels + Corner Reflectors	Yes	Unknown

SS_V Concept

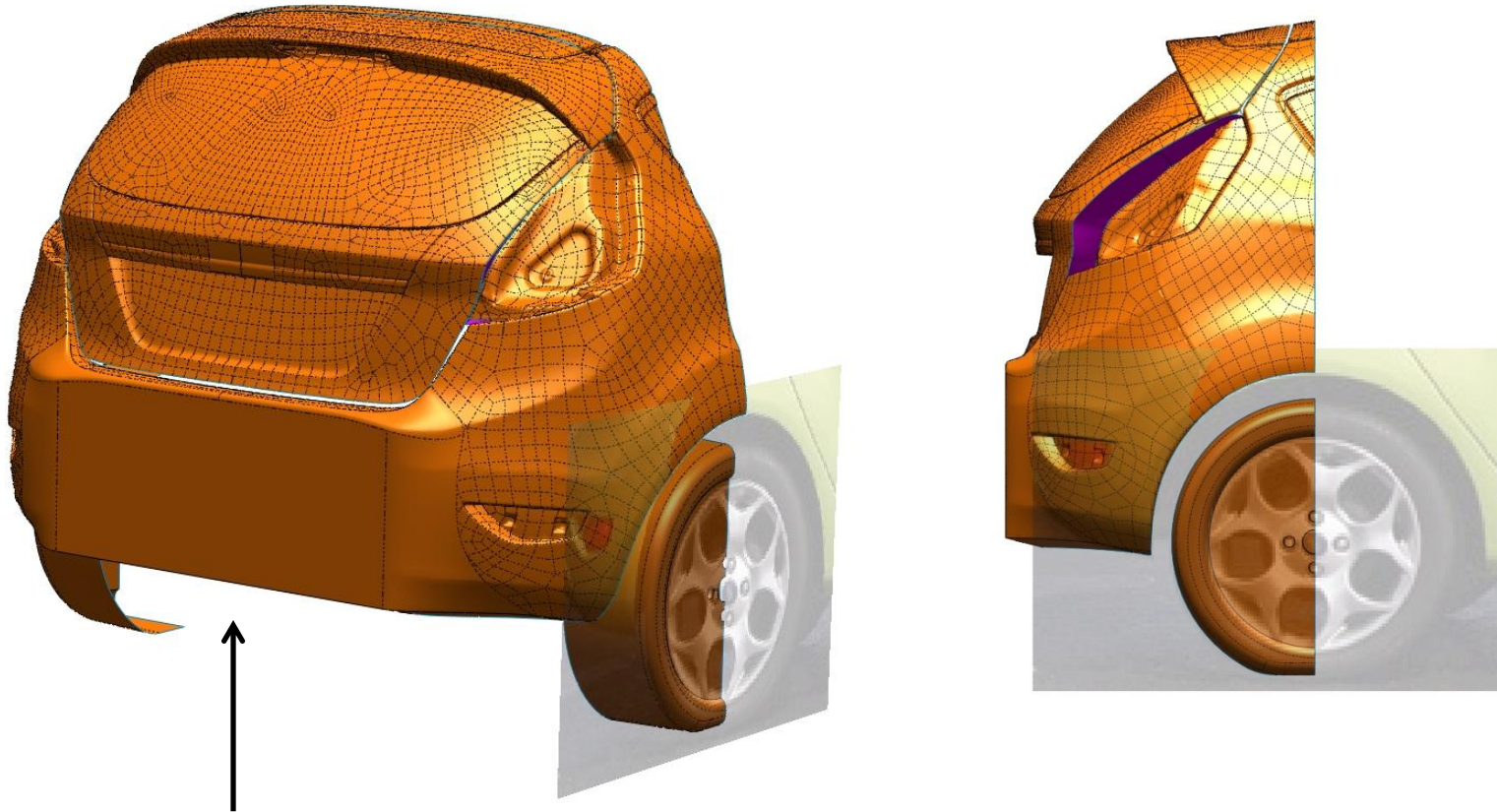
- A new design from the ground up
- Rigid “shell” provides a stable, consistent presence
- Incorporates a slider-and-load frame assembly
 - Helps diffuse impact energy
 - Installed on a trailered guide rail to accurately maintain a known distance to its tow vehicle (until an impact occurs)
- Installed on a road-based monorail to minimize lateral runout
- Can be used to perform common rear end crash scenarios
 - Lead vehicle stopped
 - Slower moving lead vehicle
 - Decelerating lead vehicle

SS_V Appearance And Construction

- Emulates the rear of a 2011 Ford Fiesta
 - Platform is sold worldwide
 - Hatchback design facilitate a lightweight surrogate
- Carbon fiber construction
 - Stiff (promotes a consistent presence)
 - Lightweight (less mass = less severe impacts)
 - Robust (when properly implemented)
 - Conductive (detected by radar)



Modified Dimensional Scan



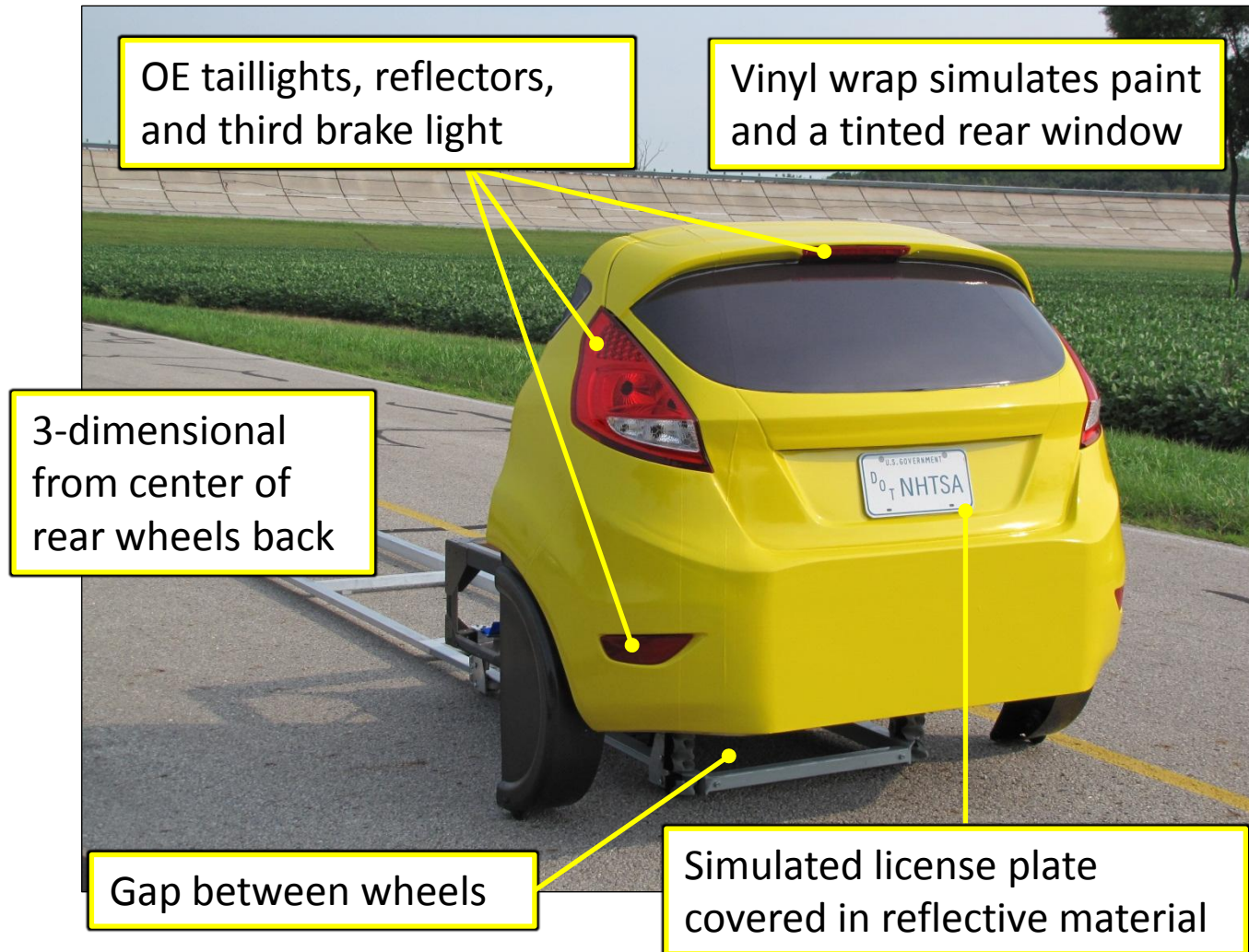
Bumper contour flattened to accommodate impacts with a wide variety of bumper heights

Lightweight Carbon Fiber Shell

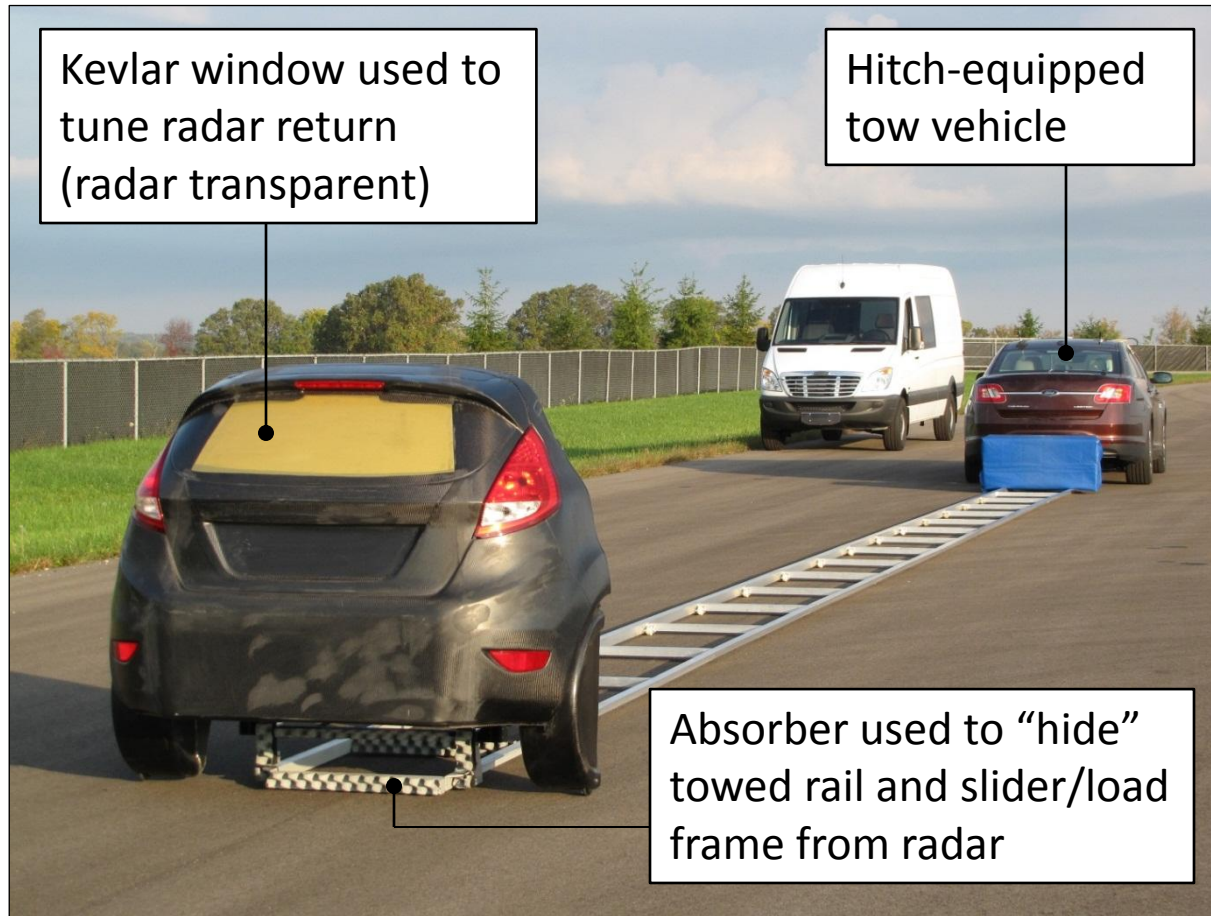


Prototype. Rear window later replaced with Kevlar to improve radar return characteristics.

Realistic Design Elements



Installed On A Towed Rail



Not shown with simulated paint (vinyl wrap) or UHMW skid plates on towed rail

Rear Views

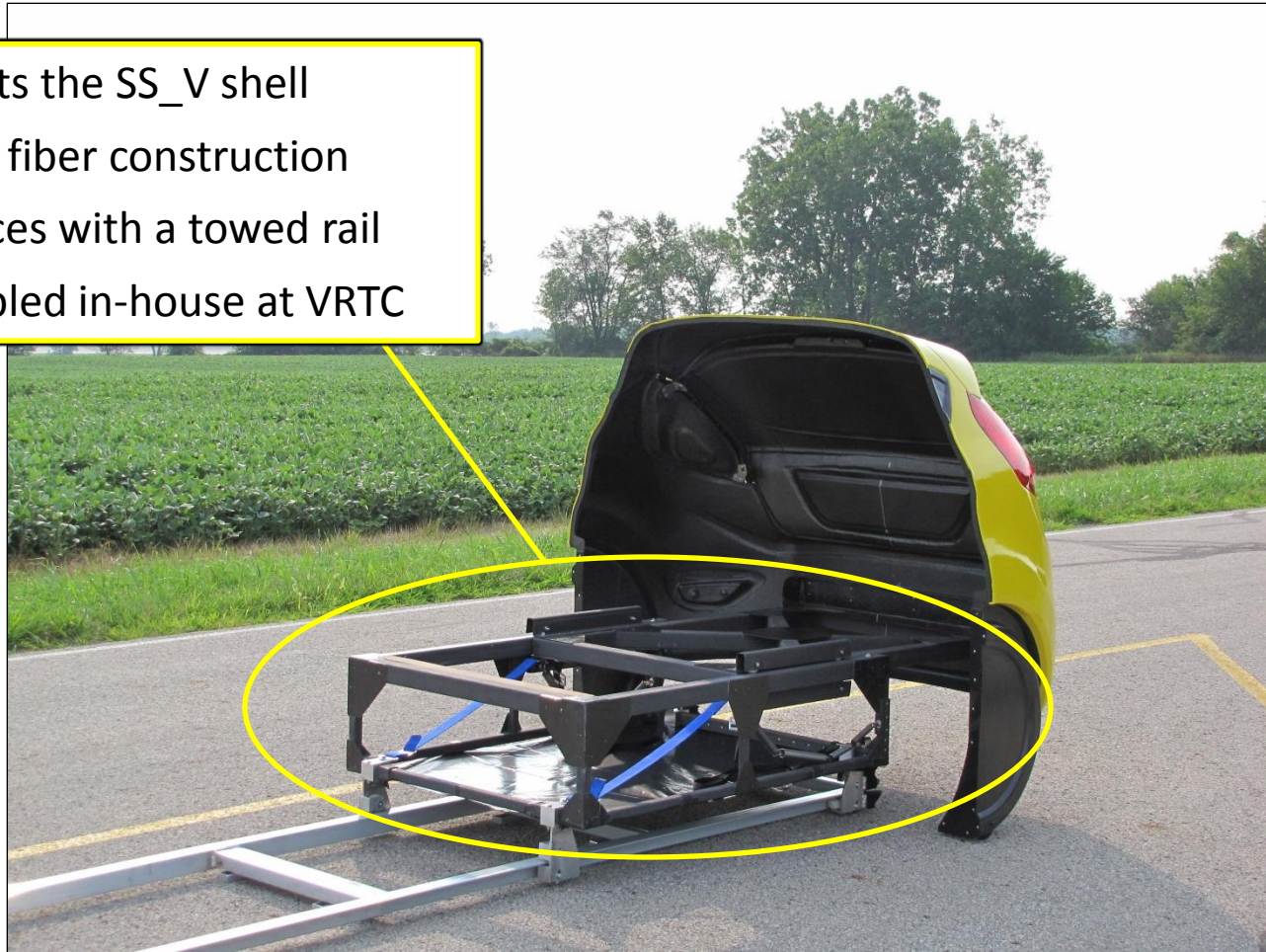


Bulkhead and internal gusset increase rigidity

Not shown with simulated paint (vinyl wrap)

Slider / Load Frame

- Supports the SS_V shell
- Carbon fiber construction
- Interfaces with a towed rail
- Assembled in-house at VRTC



Not shown with bulkhead or internal gusset

Stationary Lead Vehicle Test

(158th WP.29-13 - 16 November 2012, agenda item 6)

(test vehicle: 20 mph)



Slower Moving Lead Vehicle Test

(test vehicle: 25 mph; lead vehicle: 10 mph)



Striking Vehicle Protection Concept

- Protects against initial impact
- Foam material
- License plate-based dimensions
 - European width
 - US height
- Positioned in center of vehicle, at license plate attachment location
- Alternatively, protective foam may be moved to the SS_V
 - Testing presently underway



Radar Characteristics

- Measured by UMTRI/MTRI using Ka and W-bands
 - Evaluated how 24 and 77 GHz radar-based systems “see” the SS_V
 - Scans performed at different elevations, aspects, and azimuths
- Preliminary results
 - The flat “strikeable area” of the SS_V bumper contributes to a strong radar return when approached directly from the rear
 - The SS_V exhibits automobile-like radar scattering characteristics at the tail-aspect for both band radars
 - The SS_V resemblance to real cars degrades with viewing angles further away from the tail
- Key finding: The SS_V is suitable for evaluating radar-based FCW/CIB/DBS

Durability

- Design intent is to withstand 30 mph relative impact speeds
 - 25 mph relative impacts have been performed successfully
 - Repeated 15 mph stationary impacts are reliable
 - Additional durability tests are presently underway
- Other factors:
 - UHMW skids on towed rail have a long service life
 - Most service or repairs can be performed in a basic machine shop
 - If necessary, more extreme shell repairs can be performed by repeating the mold and autoclave process

Estimated Costs (USD)

Description	Approximate Cost (\$)	
	One-Time Cost	Reproductions
Shell	\$32k ¹	\$12k
Slider and Load Frame	\$7k	\$7k
Towed Rail Assembly	\$7k	Not necessary
Road-Based Monorail, Installed	\$15k	Not necessary
Total	\$61k	\$19k

¹Cost includes molding process (including a 3D vehicle scan, model optimization, and CNC plug work).

Summary

- Inherent realism promotes good real-world performance
 - Reduced potential for gaming
- Design addresses known shortcomings of other surrogate vehicles
 - Balances RCS realism with universal strikeability
 - RCS tuning and robustness evaluations presently underway
 - Industry feedback welcome
- Apparatus may be used at many test sites, for light and heavy vehicles
- Accurate conduct of the decelerating lead vehicle scenario possible should the agency wish to expand it's test efforts
- Schematics and dimensional scan information to be publicly available
- Reasonable cost

Docket/Contact Information

- Docket No. NHTSA-2012-0057
 - Available at www.Regulations.gov
 - Includes this presentation
 - SS_V construction details (provided as they become available)
 - SS_V radar return characteristics report (when available)
 - CIB / DBS draft test procedures
 - Responses to NHTSA's request for comments (RFC) on a research report summarizing the agency's light vehicle CIB / DBS research efforts
- Technical Contact at VRTC:
 - Garrick Forkenbrock (garrick.forkenbrock@dot.gov)

Thank you for your attention!