SEI

Safety Engineering International

HALO™ Rollover Occupant Protection System

Development to Application

Introduction:
SEI Background and Rollover Injuries

Safety Engineering International (SEI) – Designers of HALO™:

- Mr. Friedman and Mr. Grzebieta have been researching crashworthiness for more than 30 years.
- SEI was founded to give fleet owners an alternative to traditional ROPS product.
- SEI studied more than 100 different rollover tests and developed and tested 4 different prototypes of the HALO ROPS.

Advancements in Understanding How Rollover Injuries Occur:

- NHTSA says, “roof crush causes injuries”, May 2009
- IIHS says, “increase in SWR, reduces risk of fatal injury”
- U of W says, “increased risk of spine injury when 3+ inches of roof crush”

HALO™ Description

- The HALO™ is a comprehensive design which consists of an optimized tubular structure mounted on the vehicle roof, similar to a roof rack, in combination with internal B-pillar reinforcements hidden within the OEM (Original Equipment Manufacturer) plastic trim.

- The HALO™ functions by tying all of the underlying vehicle's vertical pillars together and reforming the vehicle's trapezoidal cross-sectional shape while drawing on the internal reinforcement's added vertical support.

- The HALO™ does NOT interfere with any of the OEM internal safety equipment such as side seat and side curtain air bags and seatbelt pre-tensioners.

- The HALO™ product does NOT add the additional hard points to the cabin area like conventional internal roll cages.

- The HALO™ weight ranges 20 to 40 kilograms depending on the size of vehicle. The CG of the vehicle changes only slightly with the installation of the HALO™.

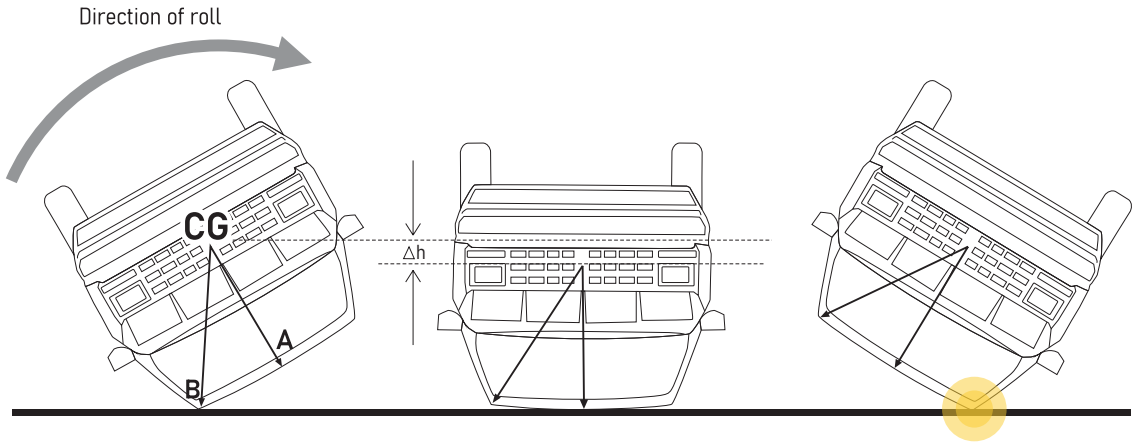
The HALO™

Geometric Effect on Vehicles

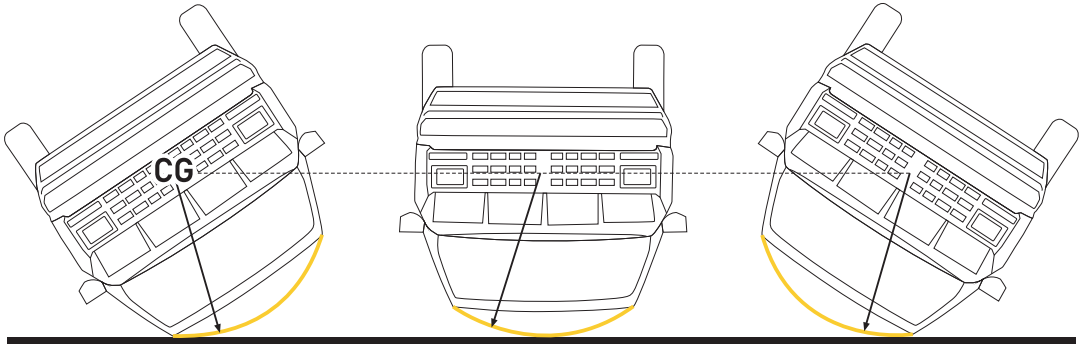
Adding an external roll hoop changes the rolling geometry of the vehicle.

- Top row: Vehicle's CG drops during rollover and then rises again;

- Bottom row: Hoop maintains vehicle's CG at constant height, thus reducing roof load on the trailing side.



Without HALO, the CG drops to the Minor Radius and crushes the trailing side corner.



With HALO, the CG maintains the Major Radius and prevents crushing on the trailing side.

CG = Center of Gravity CG-A = Minor Radius CG-B = Major Radius

Dynamic Rollover Testing

Jordan Rollover System (JRS) – 1993 Production Jeep Video

Click image to see video

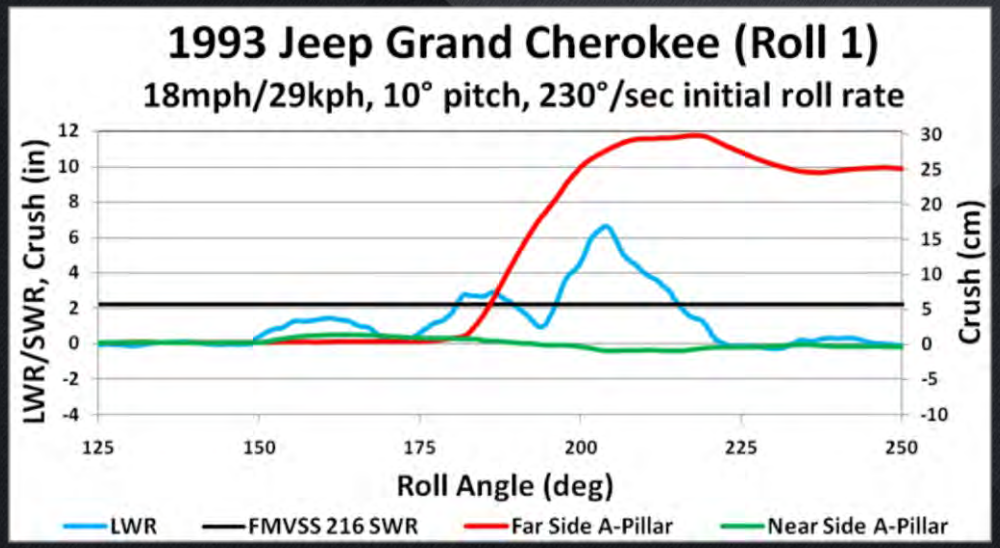
Testing a ROP Retrofit

Rollover Testing of Final Design Configuration

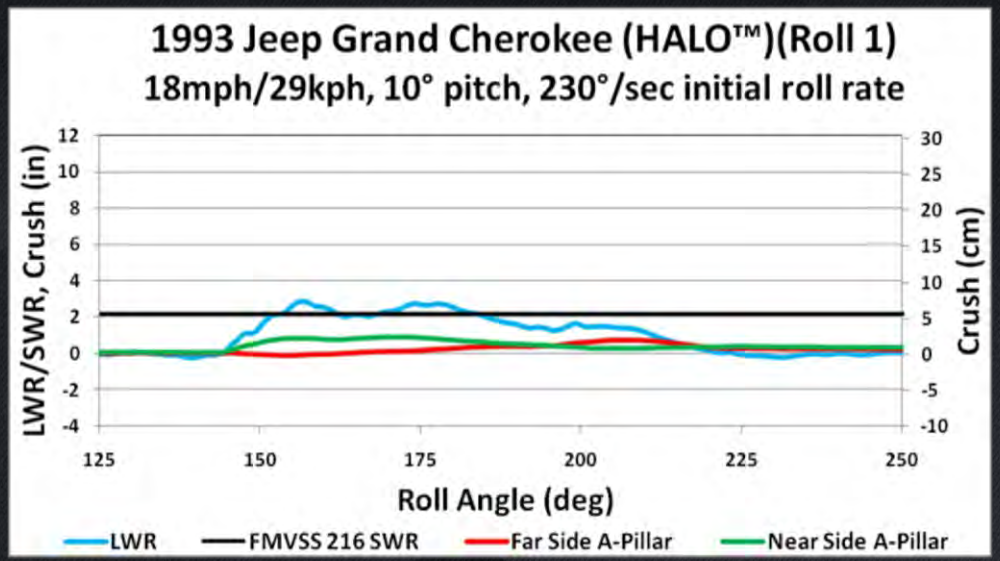
Click image to see video

Dynamic Rollover Testing

Road loading comparison – 1993 Jeep with and without HALO



- Road loading – 1993 Production Jeep: The blue line shows the forces measured on the roadbed. The jagged line shows multiple significant impacts.



- Road loading – 1993 Jeep with HALO™: The blue line here is now flattened out, showing minimal forces and a smooth roll.

Testing of Prototype 4: Final HALO™

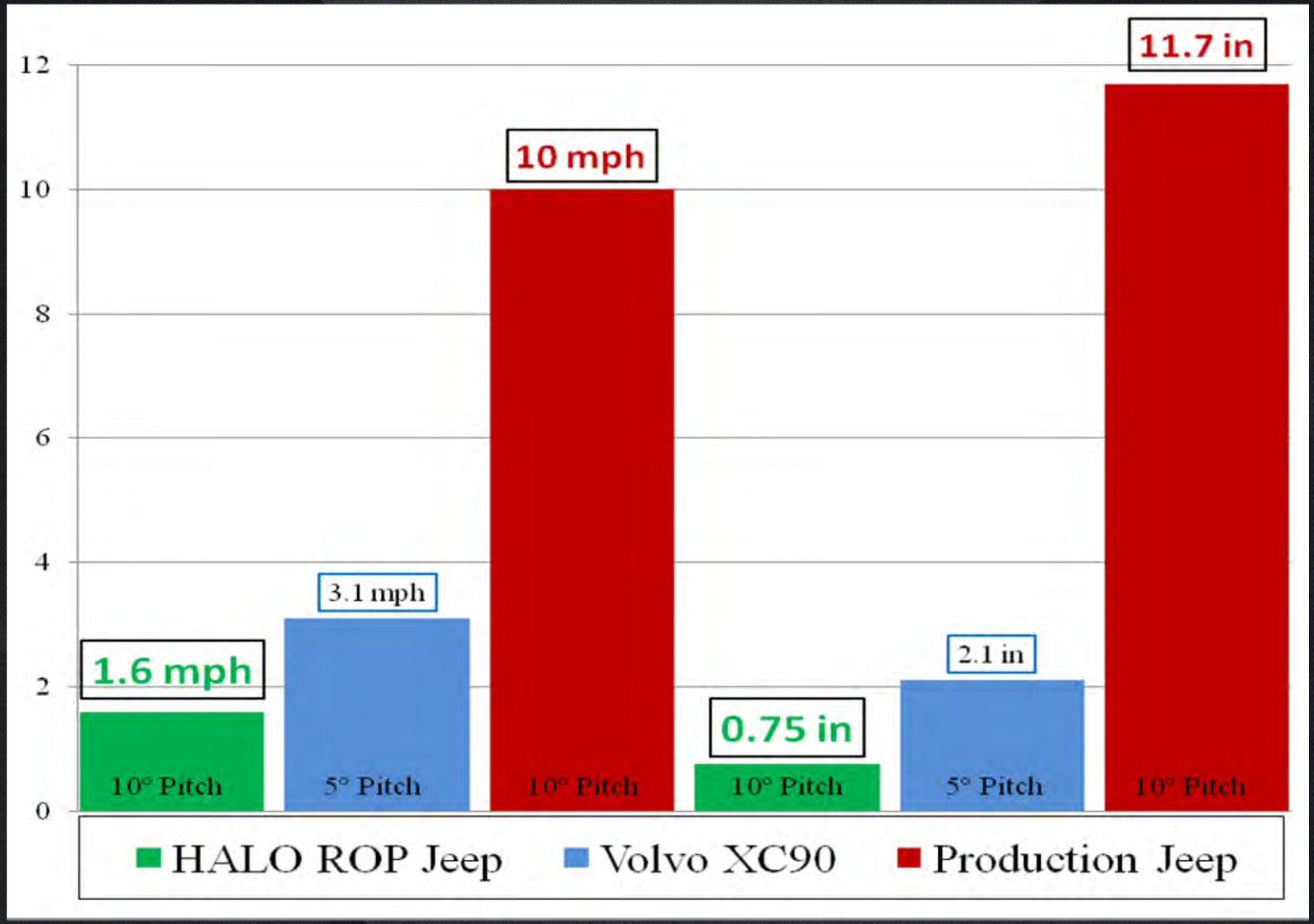
Prototype 4 ROLL 1	Peak Roof Crush (in)	Peak Roof Crush (mm)	End of Test Roof Crush (in)	End of Test Roof Crush (mm)	Peak Roof Crush Velocity (mph)	Peak Roof Crush Velocity (kph)
A-Pillar	-0.8	-19.4	-0.2	-4.6	1.0	1.6
B-Pillar	-0.2	-5.6	0.2	4.7	0.7	1.2
Roof Header	-0.8	-21.4	-0.3	-7.9	1.5	1.3
Near Side A-Pillar	-0.9	-23.2	-0.3	-7.5	1.6	2.6

Prototype 4 ROLL 2	Peak Roof Crush (in)	Peak Roof Crush (mm)	End of Test Roof Crush (in)	End of Test Roof Crush (mm)	Peak Roof Crush Velocity (mph)	Peak Roof Crush Velocity (kph)
A-Pillar	-2.1	-52.1	-1.1	-27.0	2.0	3.2
B-Pillar	0.0	-0.5	0.5	11.5	0.7	1.2
Roof Header	-1.8	-46.6	-0.8	-19.8	1.5	2.4
Near Side A-Pillar	-1.4	-35.2	-0.5	-12.6	1.3	2.2

Prototype 4 ROLL 3	Peak Roof Crush (in)	Peak Roof Crush (mm)	End of Test Roof Crush (in)	End of Test Roof Crush (mm)	Peak Roof Crush Velocity (mph)	Peak Roof Crush Velocity (kph)
A-Pillar	-1.8	-45.0	-0.4	-10.7	2.4	3.9
B-Pillar	-0.7	-17.6	0.1	3.4	1.1	1.8
Roof Header	-1.8	-46.6	-0.5	-11.6	1.6	2.6
Near Side A-Pillar	-1.4	-36.2	-0.2	-6.3	1.8	2.9

Testing Results Comparison

HALO ROPS Jeep vs. Volvo XC90 vs. Production Jeep



Dolly Rollover Testing

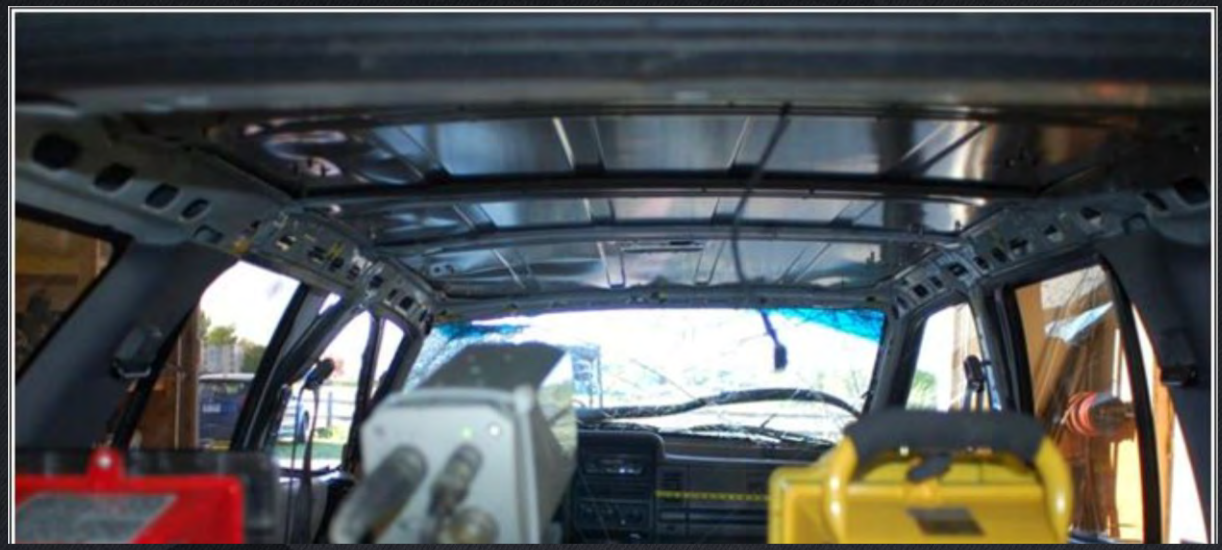
Prototype 4 HALO™ – 3 roll dolly rollover test

Click image to see video

Dolly Rollover Testing

Dolly Rollover Testing Results

Prototype 4 HALO™ after a 3 roll dolly rollover test



Real World Rollover Results

- HALO™ protects TransCanada employees when they rollover in their Mitsubishi Triton Dual cab vehicle.

- Both occupants were uninjured, the windows did not break preventing ejection, and there was no bending at the B-Pillar keeping the occupant survival space in tact.

Real World Rollover Results

- HALO™ protects occupants when they rollover in their Toyota Hilux vehicle.

Advantages of HALO ROP System

- Protects front seat occupants by distributing loading across all structural components.
- Limits crush and crush speed to maintain Occupant Survival Space and restraint function.
- Deployment of seat and window curtain airbags.
- Light weight design has little effect on the CG or payload capacity.

Government Agency Vehicles

- U. S. Border Patrol had more than 33,000 vehicles in 2008
- Seven on-duty agents were killed in rollover crashes in 18 months
- Agent Pena only person to survive a rollover – Remains Quadriplegic

Military Fleet Vehicles

- U.S. Military Branches use 12 and 15 Passenger Vehicles for Troops
- Fourteen Marines in rollover crash – 2 Killed – 12 Injured
- Van Roof tented and match-boxed

Retrofit: 12-15 Passenger Vans

- HALO™ roll hoops mounted to roof
- Interior reinforcement Pillars added to existing structure

Examples of Poor ROP Systems

Internal Roll Bar and Cage Configurations

- Deficiencies in Rollovers:

  - Prohibits deployment of side window curtain airbags.
  - Decreased seat and restraints functionality.
  - Addition of steel structures increases head strike injury potential.
  - Decreased occupant compartment and cargo space functionality roof load on the trailing side.
  - Doesn't prevent A-Pillar collapse.

Examples of Poor ROP Systems

External Cage Configurations

- Deficiencies in Rollovers:
  - Not tested on test rig.
  - Doesn't prevent A-Pillar collapse.
  - Requires cutting of the side pannel for installation.

SEI presentation of: HALO™ Rollover Occupant Protection System

Development to Application

THANK YOU