

Transmitted by the expert from the United
States of America

Informal document No. GRSP-43-13
(43rd GRSP, 19-23 May 2008
agenda item 5(a))

NHTSA's Initial Evaluation of Child Side Impact Test Procedures

GRSP – 43rd Session
Mary Versailles



Outline

- ★ Background
- ★ Test Conditions
- ★ Test Series
- ★ Future Work

Children Involved in Side Impacts

- ★ Children represent more than 50% of the rear seat occupants in motor vehicle crashes
 - Side impacts account for 27% of crashes involving 0-12 yr old occupants (NASS-CDS 1995, 1996, 1998-2004)
 - 42% involved 0-3 years old
 - 36% involved 4-8 year olds
 - 22% involved 9-12 year olds

Children Involved in Side Impacts

- ★ Side impacts with $\Delta V \geq 30$ kph produced 104 injuries in 28 children ages 1-3 yrs. (unweighted due to paucity of data, NASS-CDS)
 - PDOF of side impact crashes is approx. 30° off lateral
 - Near-side and center occupants suffered more severe injuries (AIS2+) than far-side occupants
 - Direct contact with vehicle interior responsible for 45% (47) of injuries
 - Head - 57% of injuries
 - Torso - 21% of injuries
 - Neck, upper and lower extremities - 6%-9% of injuries

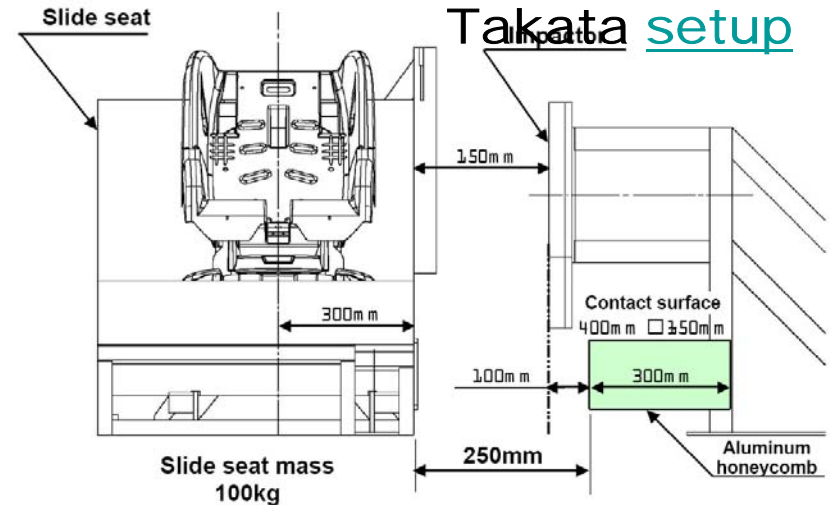
Children Involved in Side Impacts

- ★ For kids 0-8 years old (FARS 1991-2000)
 - 276 fatalities (front passenger or 2nd row seats) per year in side impacts
 - Near side - 170 fatalities/year (43 known CRS use)
 - Far side - 56 fatalities/year (13 known CRS use)
 - Middle - 50 fatalities/year (12 known CRS use)


Test Conditions

Side Impact Sled Variables

- ★ Sliding seat acceleration
- ★ “Door” velocity
- ★ Sled pulse
- ★ Honeycomb stiffness
- ★ “Door” padding stiffness
- ★ Seat cushion foam
- ★ Impact angle
- ★ Locked vs. sliding seat

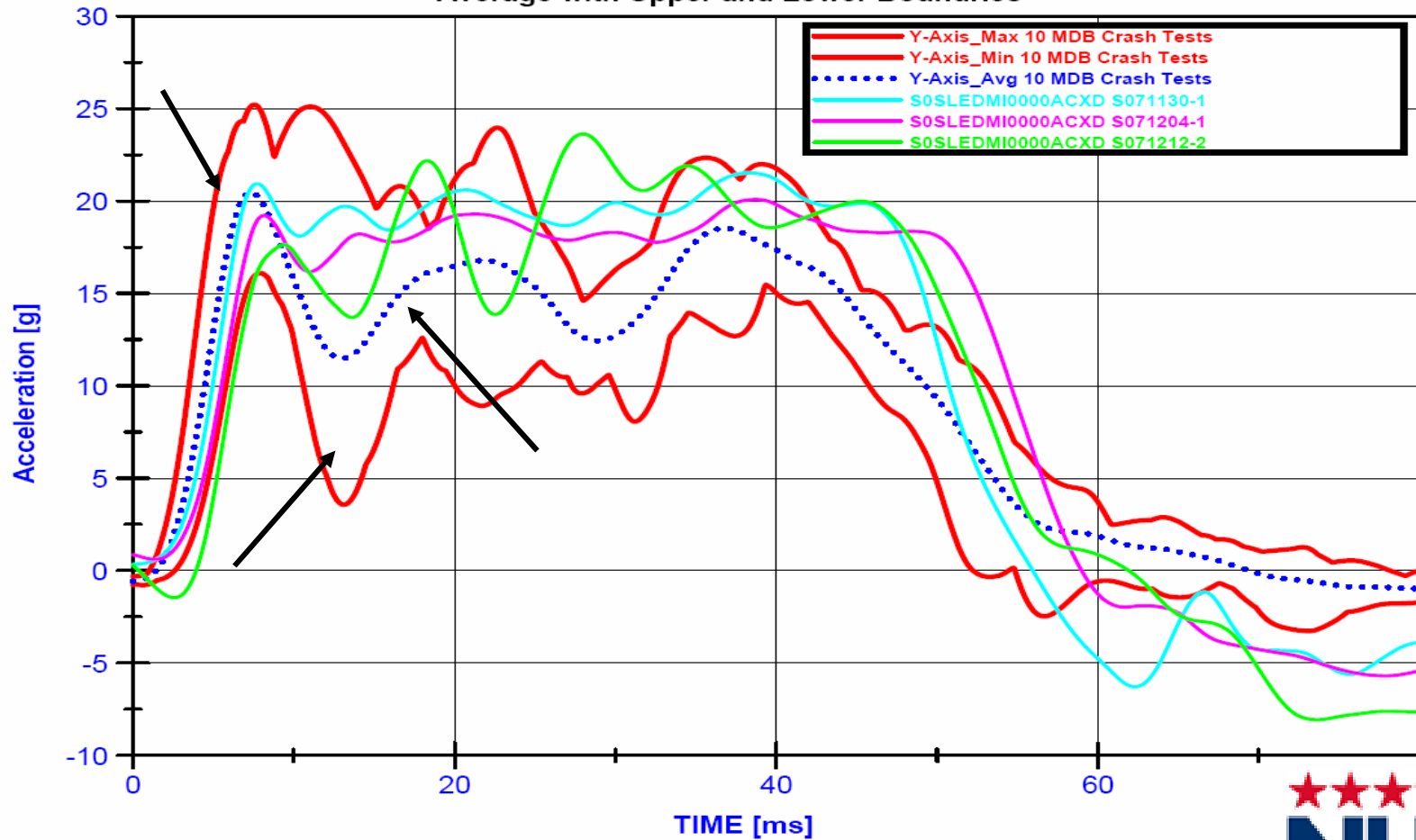


Sled Test Pulse Inputs

- ★ Sliding seat acceleration ~ 20 g's 
 - based on right rear sill accelerometers from 10 FMVSS 214 tests of small vehicles
- ★ Sled (Door) velocity ~ 20 mph
 - based on door accelerometers from 4 FMVSS 214 tests of small vehicles
- ★ Sled pulse – $\frac{1}{2}$ sine
 - shape not critical; reach velocity in 250 mm
- ★ Resultant sled pulse:
 - $\frac{1}{2}$ sine wave with peak of 28 g's and velocity of ~20 mph with a duration of ~50 ms

Sliding Seat Acceleration Pulse

10 MDB Tests Combined
Right Rear Sill Y-axis Acceleration
Average with Upper and Lower Boundaries

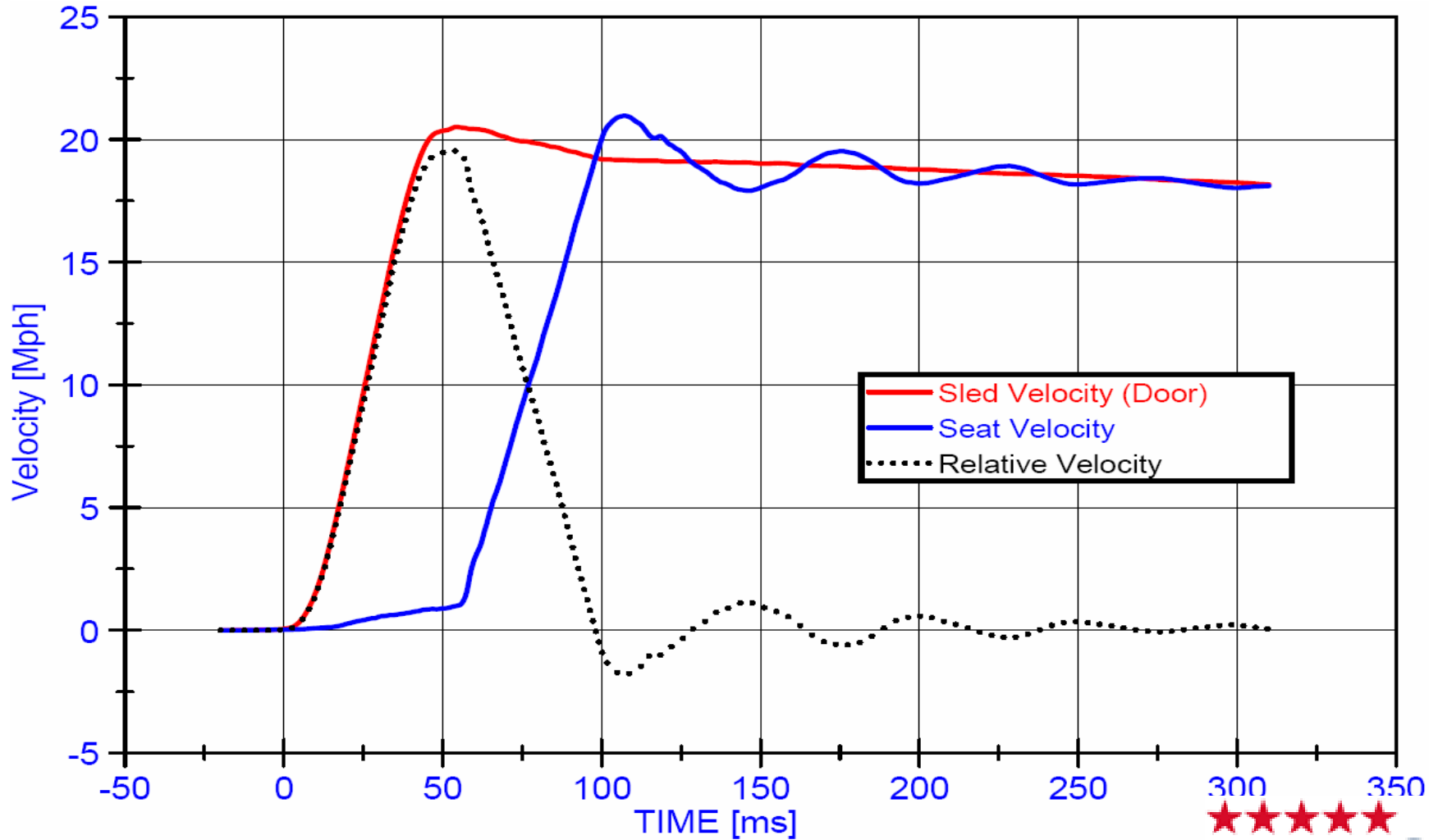


Sled Test Pulse Inputs

- ★ Sliding seat acceleration ~ 20 g's
 - based on right rear sill accelerometers from 10 FMVSS 214 tests of small vehicles
- ★ Sled (Door) velocity ~ 20 mph
 - based on door accelerometers from 4 FMVSS 214 tests of small vehicles
- ★ Sled pulse – $\frac{1}{2}$ sine
 - shape not critical; reach velocity in 250 mm
- ★ Resultant sled pulse:
 - $\frac{1}{2}$ sine wave with peak of 28 g's and velocity of ~20 mph with a duration of ~50 ms








Sled and Sliding Seat Velocity



Sled Test Pulse Inputs

- ★ Sliding seat acceleration ~ 20 g's
 - based on right rear sill accelerometers from 10 FMVSS 214 tests of small vehicles
- ★ Sled (Door) velocity ~ 20 mph
 - based on door accelerometers from 4 FMVSS 214 tests of small vehicles
- ★ Sled pulse – $\frac{1}{2}$ sine
 - shape not critical; reach velocity in 250 mm
- ★ Resultant sled pulse:
 - $\frac{1}{2}$ sine wave with peak of 28 g's and velocity of ~20 mph with a duration of ~50 ms

CRS Tested

U.S. Models	Graco SafeSeat Step 2 Toddler		
	Evenflo Triumph Advance DLX		
	Safety 1st All-in-One Convertible		
European Models	Maxi-Cosi Priori (SIP)		
	Graco Logico M (SIP) (does not meet FMVSS 213)		Doesn't have LATCH

Test Series

CRS SI Sled Test Series

★ Series #1:

- Sliding seat
- Q3s dummy
- 0° and 10° impact angles

★ Series #2:

- Locked seat
- Q3s dummy
- 0° and 10° impact angles

Series # 1: Sliding Seat, 0° vs. 10° Impact Angle

- ★ Q3s dummy
- ★ Original sliding seat fixture
- ★ 0° and 10° impact angles
 - 10° based on FMVSS 214 crash data
 - Performed repeat tests with 5 CRS models at 0°
- ★ Door padding - 2” foam thickness
 - Takata’s foam (stiffer)
 - Ethafoam type (softer) – 0° tests only
 - no apparent differences observed between Takata and Ethafoam in 0° series

Safety 1st All-in-One, 0° vs. 10° Impact

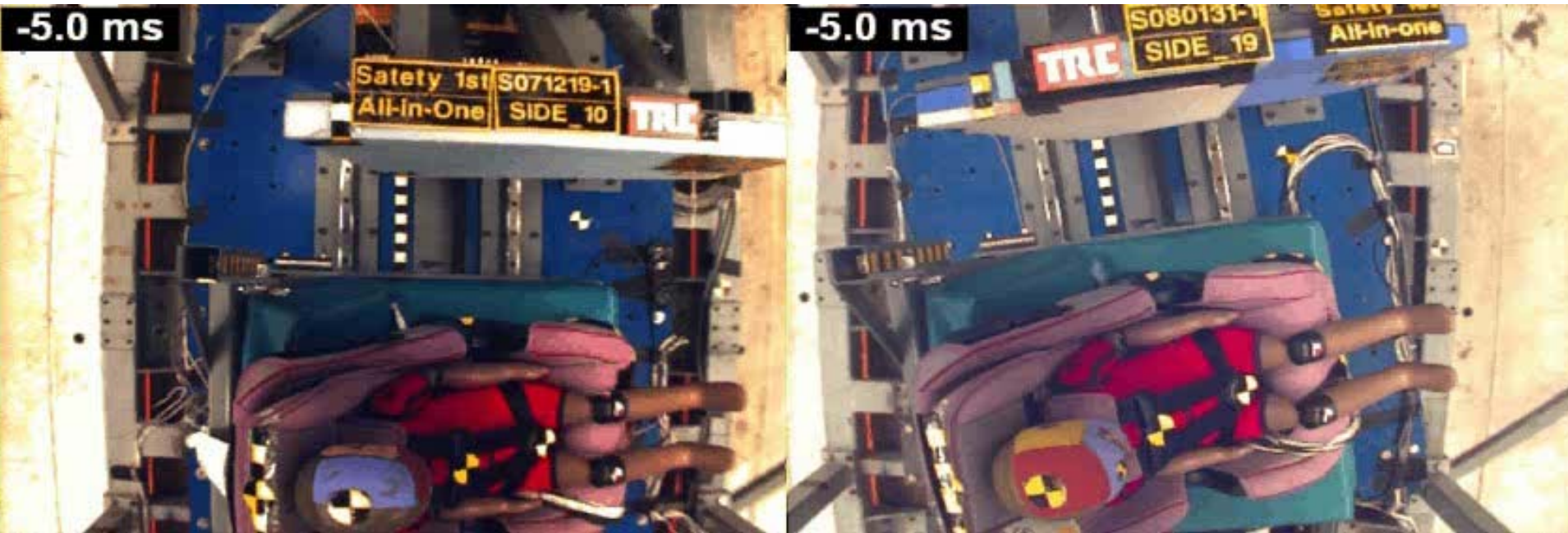


0° impact



10° impact

Safety 1st All-in-One, 0° vs. 10° Impact



0° impact

10° impact

Sliding Seat, 0° vs 10° Impact Angle Summary

- ★ Takata sled exhibited good repeatability
- ★ Able to distinguish between car seat models using injury levels
 - No significant differences between European (2 models) and U.S. seats (3 models) tested
- ★ Two “door” foams used did not appear to affect results
- ★ Minimal differences observed between 0° and 10° impact angles for 5 CRS models tested
 - Significantly higher neck tensions during 10° test for 2 CRS

CRS SI Sled Test Series

★ Series #1:

- Sliding seat
- Q3s dummy
- 0° and 10° impact angles

★ Series #2:

- Locked seat
- Q3s dummy
- 0° and 10° impact angles

Series # 2: Sliding vs. Locked Seat

- ★ Q3s Dummy
- ★ Locked seat fixture
 - initial position dependent on width of CRS tested (approximately 2” from edge of CRS to padded wall)
- ★ 0° and 10° Impact angles

Sliding vs. Locked Seat



Evenflo Triumph



Graco SafeSeat

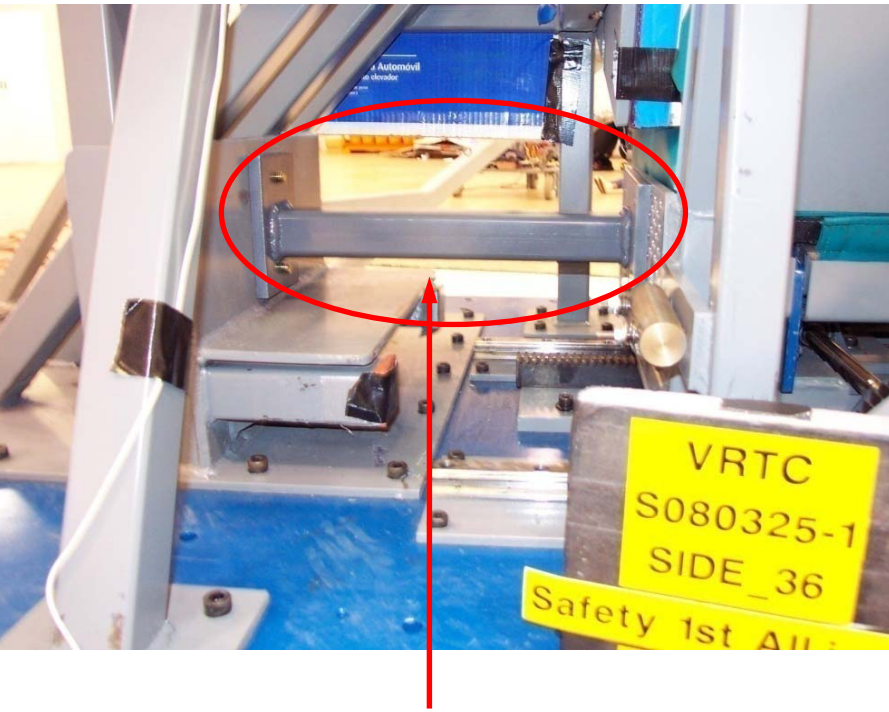


Maxi Cosi Priori



Safety 1st All-in-One

Method to Lock Seat



Rigid bar with removable shims



Sliding vs. Locked Seat 10° impact

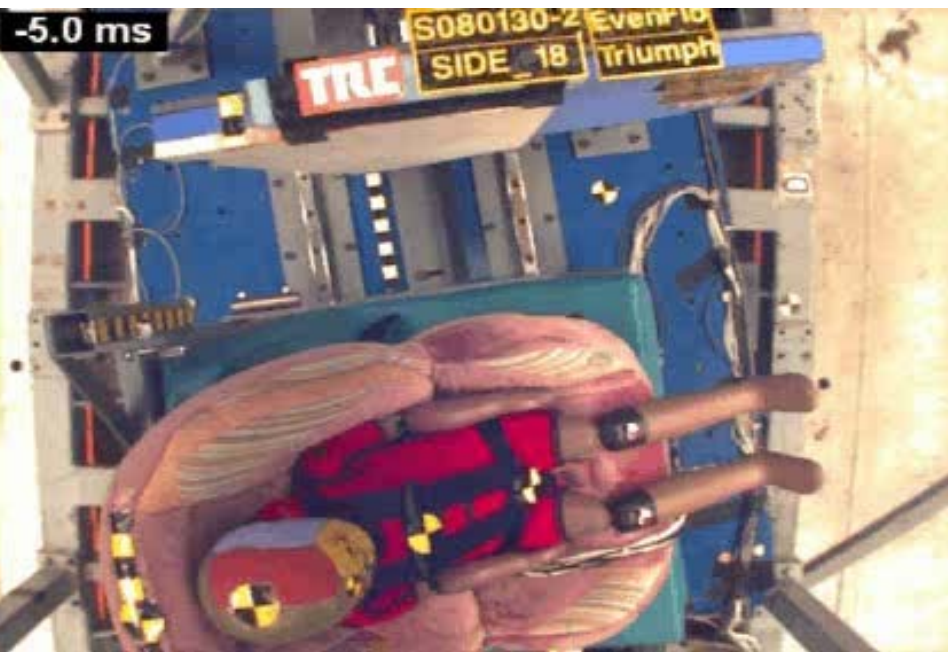


Sliding seat

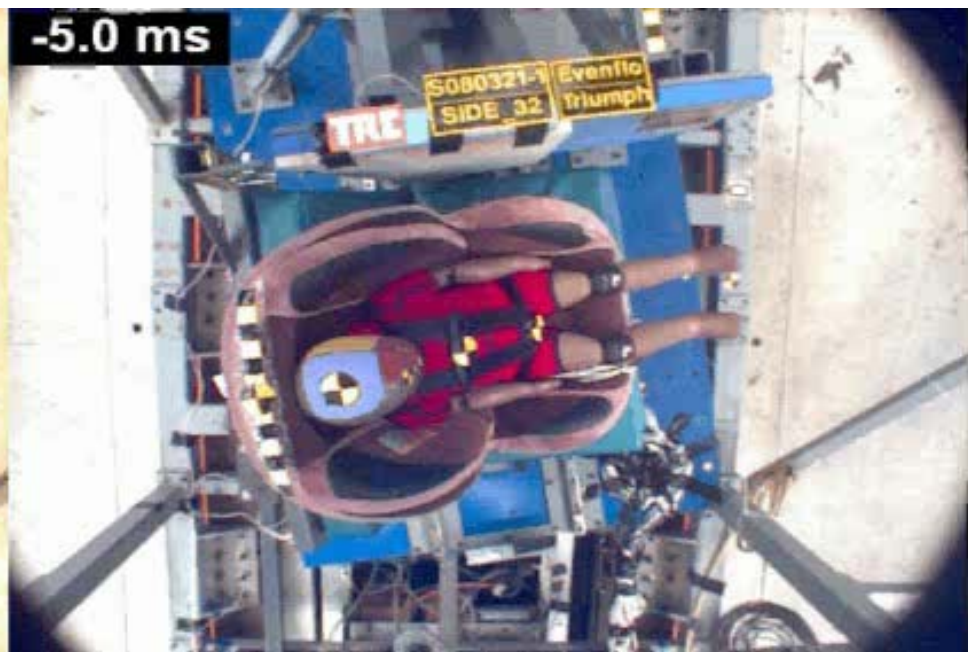


Locked seat

Sliding vs. Locked Seat 10° impact



Sliding seat



Locked seat

Sliding vs. Locked Seat Summary

- ★ Sliding Seat Configuration
 - better real-world simulation
 - sliding seat configuration repeatable
- ★ Locked Seat Configuration
 - simpler to fabricate
 - have not conducted repeatability tests
 - generally resulted in higher injury values
 - reducing velocity could compensate for difference in values
- ★ Unknown if both sled configurations will produce same outcome/countermeasures
 - Mixed outcomes of observed trends

Future Work

NHTSA's Future CRS Side Impact Research

- ★ Continue test procedure development and evaluation
 - Wall padding stiffness
 - Buck angle
 - Seat cushion stiffness
 - CRS fleet performance
 - Other CRS types and child size dummies
- ★ Continue Q3s development and evaluation
- ★ Continue development of viable IARV's

For additional inquiries, contact

Allison E. Louden

allison.louden@dot.gov

(937) 666-4511

Lisa K. Sullivan

lisa.sullivan@dot.gov

(937) 666-4511



Thank You

