2001 SAE Government Industry Meeting

Rollover Crashworthiness Research

National Highway Traffic Safety Administration

Problem Definition

- Average 9,123 rollover involved fatalities (FARS 95-99)
- Average 47,891 incapacitating injuries (NASS GES 92-96)
- 52% of 1999 rollover involved fatalities were ejected, partially or completely (FARS 1999)
- 39,000 to 50,000 annual non-ejected, rollover involved injuries (NASS GES 92-96)
  - 87% of which receive AIS 1 injuries

Rollover Crashworthiness Research

- Ejection Mitigation
  - Dynamic Head Protection Systems
  - Advanced Glazing
  - Door Latch
- Occupant Compartment Integrity
  - FMVSS 216 Roof Crush
- Mitigating Occupant Impacts
  - FMVSS 201 Upper Interior
  - Improved Restraints

Ejection Fatalities

Ejection Status for Occupant Fatalities in Light Passenger Vehicles in 1999 FARS

Event	Fatalities	Percentage
Not ejected	23,113	72%
Completely ejected	7,144	22%
Partially ejected	1,719	5%
Unknown whether ejected	115	-
Total	32,091	100%

NASS indicates twice as many partial ejections – 10%

Rollover Ejection Fatalities

- Average of 419,813 light vehicles involved in rollover crashes, NASS 1995-1999
  - 9,123 NASS annual rollover fatalities (95-99)
    - 10,142 FARS rollover fatalities in 1999
  - 4,772 (of 9,123) NASS fatalities involved complete or partial ejection through glazing (52%, includes all windows and sunroofs)

Ejection Route for Occupants Ejected from Light Passenger Vehicles, Annual Average for 1995-1999 (NASS), Adjusted to 1999 FARS

	Complete Ejection			Partial Ejection		
	Cases	**Estimate**	**%**	**Cases**	**Estimate**	**%**
Windshield	67	2,465	8	94	1,954	11
Front Windows	420	9,684	30	416	11,564	62
Back Windows	75	2,243	7	47	1,641	9
Backlight	103	2,880	9	25	614	3
Roof Window	28	1,116	3	14	993	5
Other Glazing	7	122	0	3	19	0
Unknown Glazing	3	distributed		0	distributed	
Not Glazing	488	13,992	43	69	1,793	10
Unknown Route	336	distributed		58	distributed	
Subtotal-Glazing	703	18,508	57	599	16,784	90
Totals	1,527	32,501	100	726	18,577	100

Rollover and Ejection Mitigation

- Ejection accounts for over half of rollover fatalities
- A 1995 NHTSA matched pair analysis reported that preventing ejection in rollover crashes can sharply reduce the fatality rates
  - Estimating the Injury Reducing Benefits of Ejection Mitigation Glazing by Dr. John Winnicki

Full vehicle Rollover Testing of Side air bags

- Performed 5 FMVSS 208 dolly rollover tests
  - 1997 Ford Explorer
  - Prototype side curtain systems in front outboard positions
    - All tests showed significant potential for mitigating ejections
    - Established baseline kinematics for occupant interaction with side head air bags
    - Prototype systems provided by Simula ASD and TRW

208 Dolly Test

Dynamic Rollover Fixture

- A laboratory test method to reproduce an occupant ejection environment
  - Evaluate ejection countermeasures
    - Particularly to compare effectiveness of advanced glazing and inflatable devices
  - Evaluate potential occupant safety issues
  - Intended as a research tool

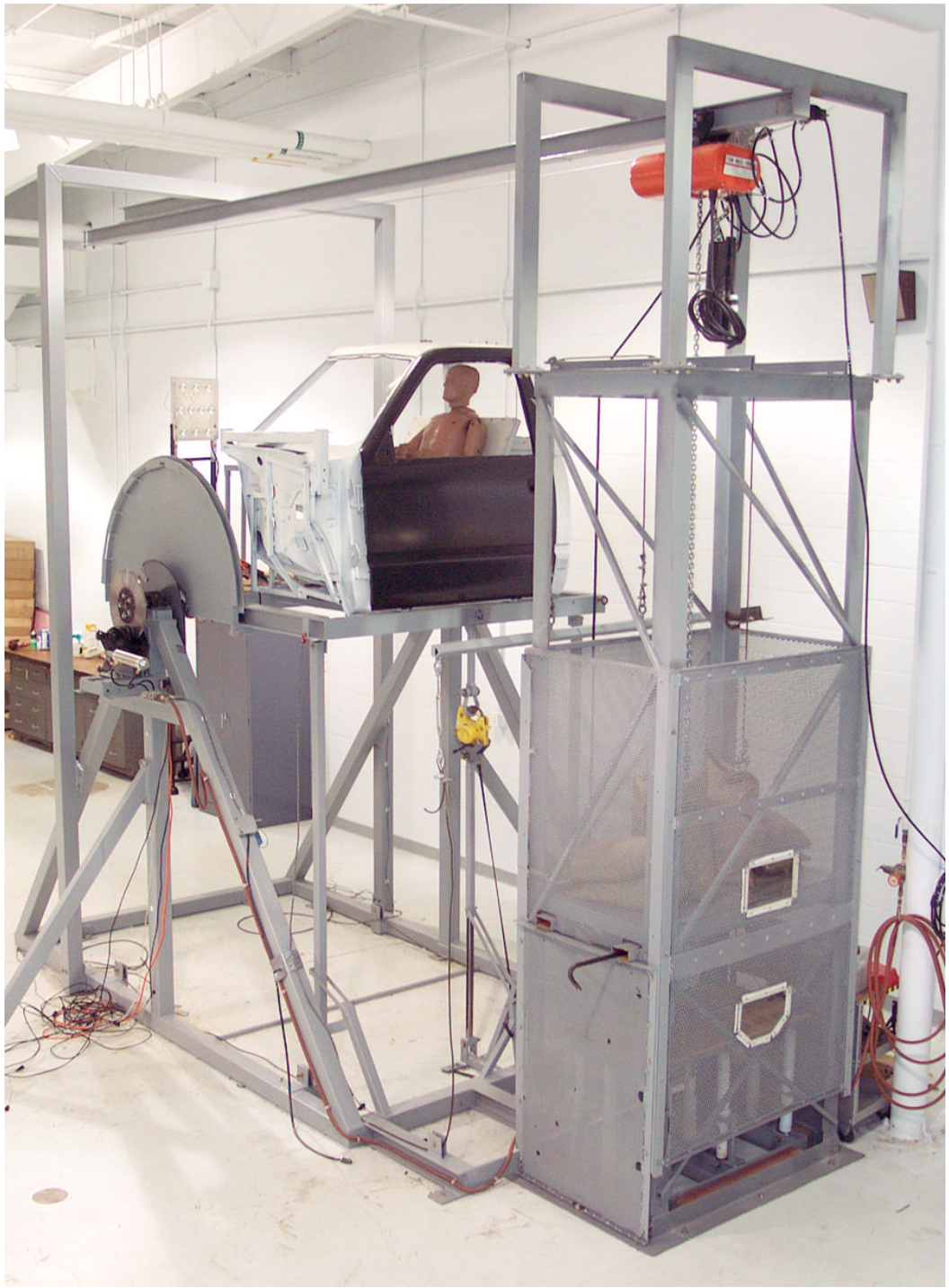
Dynamic Rollover Fixture

Capable of 0.5 to 1.5 revolutions per second

Accelerated controlled by adjustable weight stack

Currently using a C/K 1500 test buck.

Testing using 50^{th} and 5^{th} percentile dummies



Dynamic Rollover Fixture

Current Status

- Preliminary testing of side head air bag systems underway
  - Cooperative research agreements with Simula ASD, and TRW Automotive. Exploring others
- Preliminary testing of side glazing systems
  - Tempered, laminated glass, and polycarbonate side windows
- Restraints testing to resume in Fall / Winter

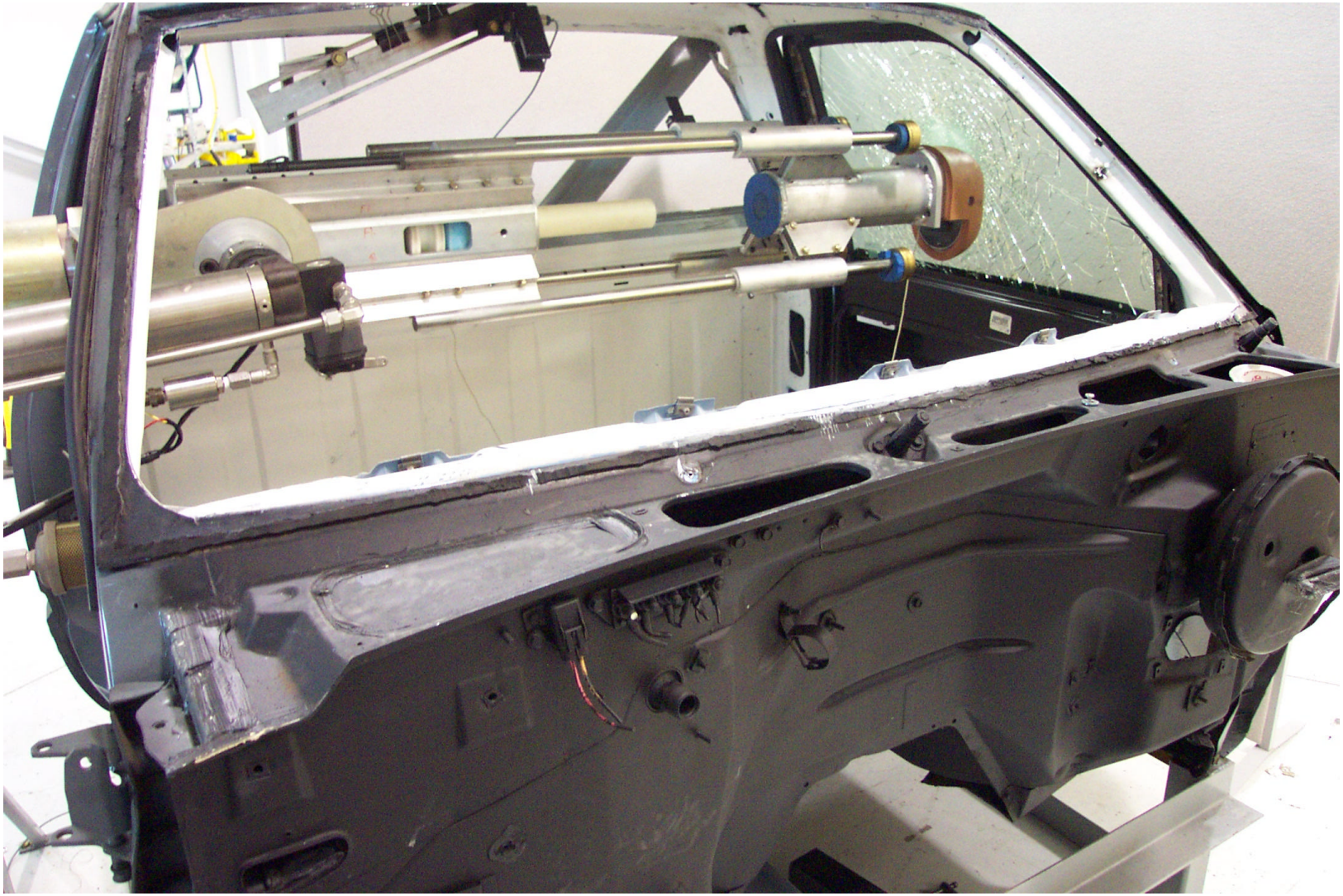
Glazing Research

- Started in late 1980's
- Focused on ejection mitigation
  - Developed retention impact test
  - Lateral sled tests
  - FMVSS 201 impact testing
- Evaluated a wide range of glazing materials
- Status reports published in 1995 and 1999

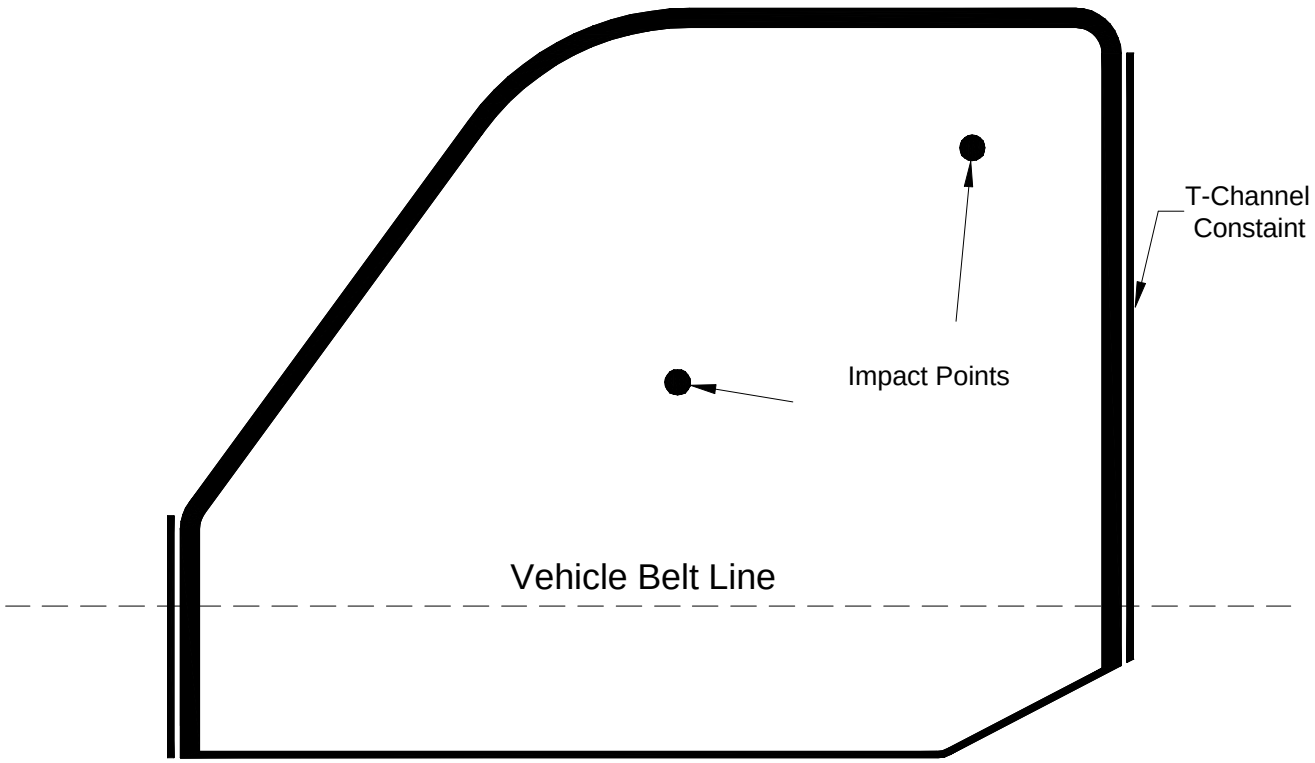
Occupant Retention Testing

- Used 18 kg guided impactor to simulate load of an occupants head and neck
- Struck the window center and upper corner adjacent to the dummy’s head
- Evaluating maximum displacement and penetration of window glazing
- Impact speed 20 - 24 kmph

Retention Test Device



Impact Locations



Results

- All of the tested materials could retain an impactor at 24 kmph
- The containment extent could be controlled based on the type and severity of modifications to the window / door system
- The center impacts were a more severe retention test than the corner impacts

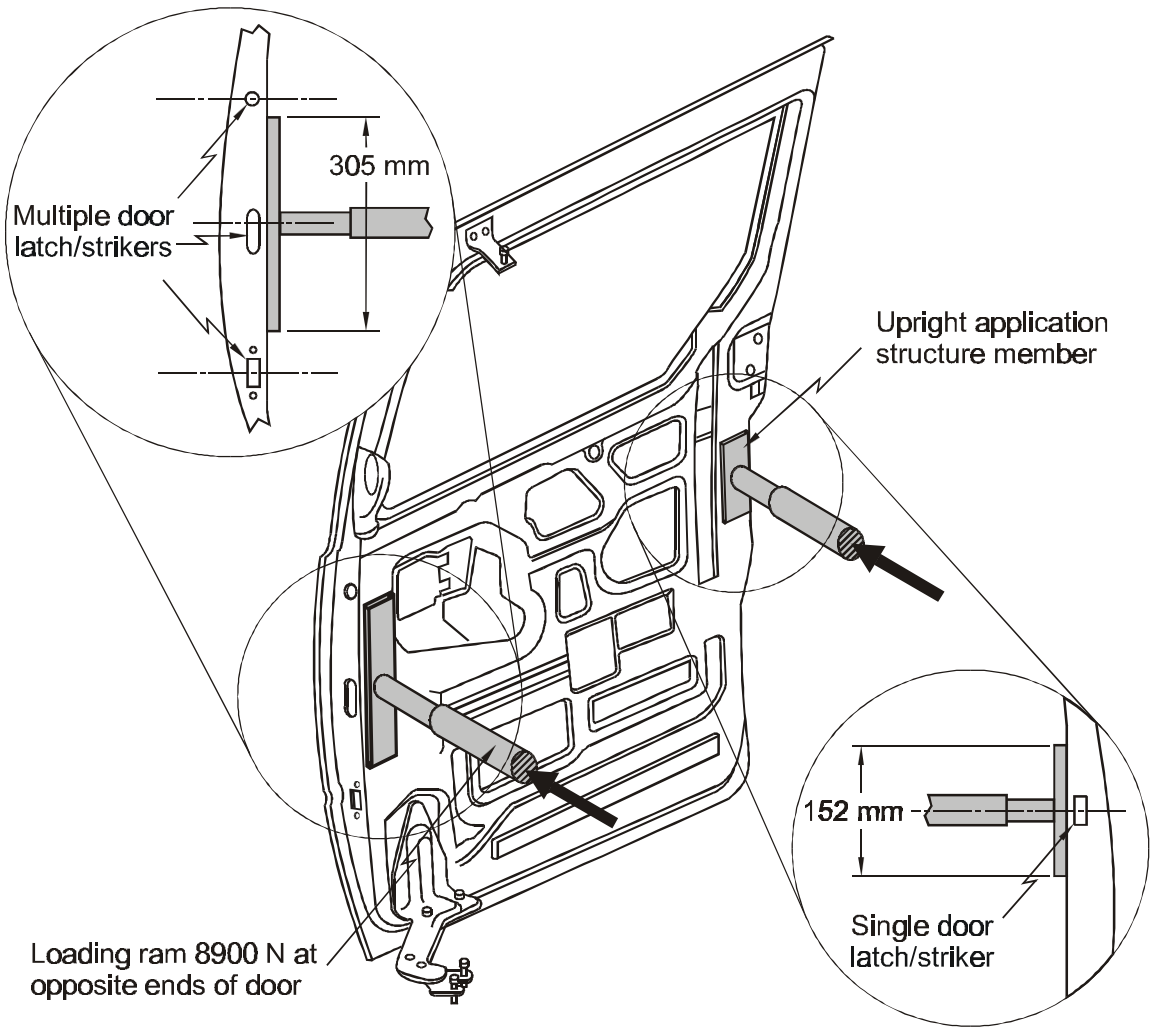
Glazing Research Status

- Report to Congress to be released soon
- Final status report to follow this summer
  - Provides supporting data for the Report to Congress
- Research underway to test retention impactor on side head airbags
- The glazing ejection research is being merged with the side air bag work into a general ejection mitigation research program
  - Evaluation of motorcoach windows, laceration, entrapment, and harmonization issues will continue as required

Door Latch Research

- Develop test methods for sliding doors
  - Baseline tests conducted with Transport Canada
  - Evaluation criteria
- Investigate alternative test methods for FMVSS 206
  - Full door Lateral
  - Full door longitudinal
  - Bypass

Sliding Door Test
Transport Canada



Sliding Door Test

Door Latch Research Status

- Preliminary sliding door test developed
  - Need to formalize the test method and measurements
- Full door longitudinal, lateral and bypass test methods developed and evaluated
  - Some test procedures need to be clarified
  - Complexity of correlating benefits of component test method

Roof Crush Research

- Evaluation of testing alternatives for FMVSS 216
- Status report completed and available from http://www-nrd.nhtsa.dot.gov/vrtc/cw/roofcrsh.pdf
- Primary objective was to determine similarities and differences in quasi-static and dynamic roof crush testing

Roof Crush Status

- Preference for a static test due to repeatability of test procedures
  - Some correlation possible between static and dynamic test results
- Complexity of correlating benefits of test methods
  - Analysis of post crash head room and occupant injury is underway