Summary of IHRA Pedestrian Safety WG Activities

Yoshiyuki MIZUNO

On behalf of IHRA Pedestrian Safety WG

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1.Assignment Tasks to PS/WG

- Investigations and analysis on pedestrian accidents for passenger cars in the IHRA member countries
- Propose Harmonized test procedures to expedite improvements of the vehicle construction that reduce fatal or severe pedestrian injuries in a passenger car-pedestrian accidents
- These proposal will be used as the base of future GTR under UN/ECE/WP29/1998 Agreement

2. IHRA Pedestrian Safety WG Members

Y. MIZUNO (Chairman)	Japan	JASIC
J. McLean	Australia	Adelaide Univ.
E. Janssen	EC	TNO
G. Lawrence	EC	TRL
H. Ishikawa	Japan	JARI
M. Tanahashi	Japan/OICA	JAMA
B. Donnelly	U.S.A.	NHTSA
S. Bilkhu	OICA	AAM
O. Ries	OICA	ACEA
F. Brun-Cassan	OICA	ACEA
H. Ishimaru (Secretary)	Japan	JSAE

1997-2000	M. Bartolo	OICA	AAM
1997-2000	A. Sasaki	OICA	JAMA
1997-2002	J. Provensal	OICA	ACEA
1997-2001	R. Saul	U.S.A.	NHTSA

3. IHRA PS/WG Experts Meeting

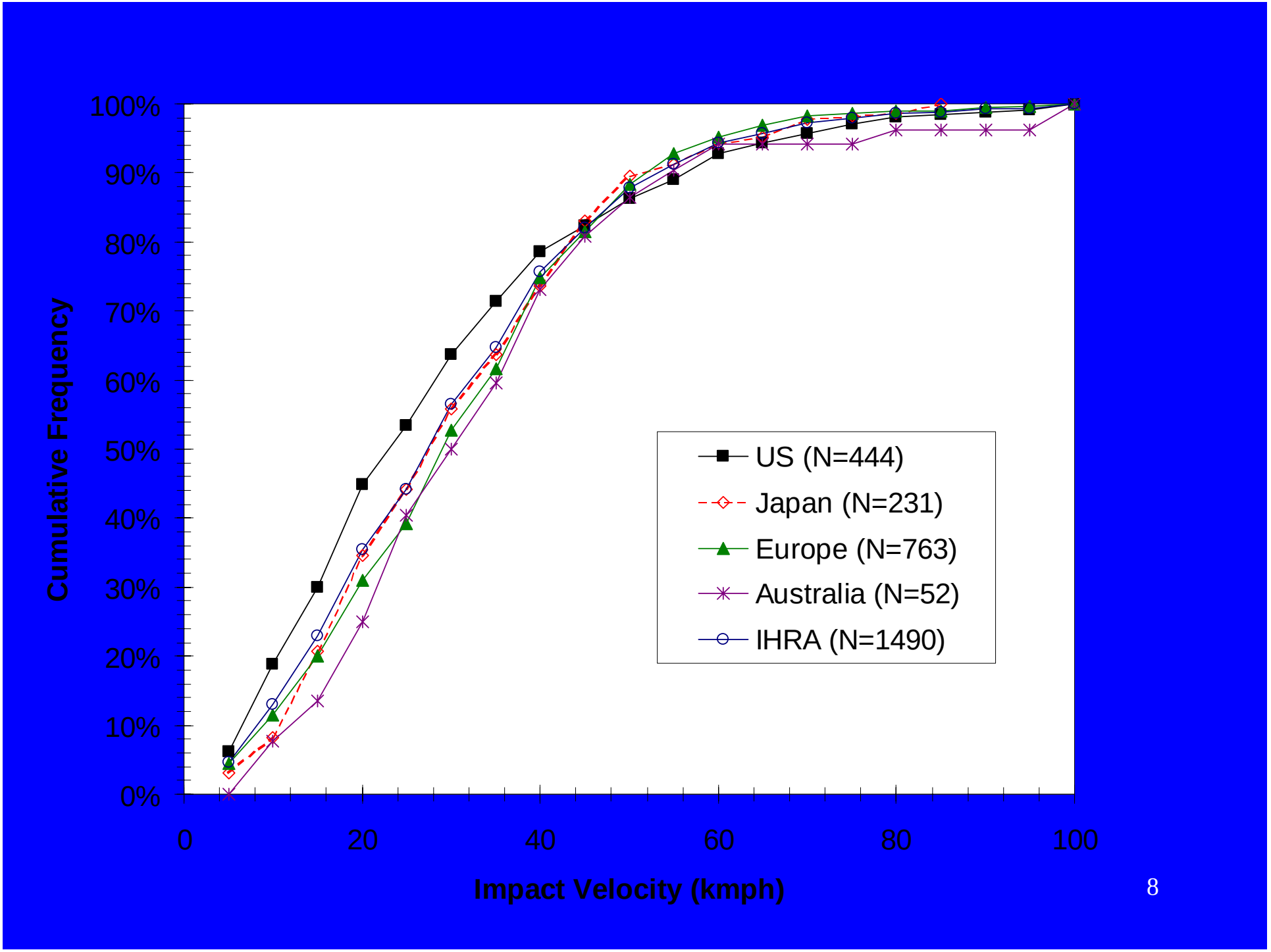
1st PS/WG Experts Meeting	July, 1997	Tokyo,Japan
2nd PS/WG	March, 1998	Washington D.C.,U.S.A
3rd PS/WG	September, 1998	Brussels,EC
4th PS/WG	February 1999	Adelaide,Australia
5th PS/WG	September 1999	Tokyo,Japan
6th PS/WG	March 2000	Washington D.C.,U.S.A.
7thPS/WG	September 2000	Paris ,EC
8th PS/WG	February 2001	Adelaide, Australia
9th PS/WG	May 2001	Gotemba, Japan
10th PS/WG	February 2002	Brussels, EC
11th PS/WG	June 2002	Washington D.C.,U.S.A.

4. Basic Decisions

* Because it was difficult to develop a pedestrian dummy and because many advantages were confirmed in component tests, it was decided that component tests be adopted.
* Based on the results of detail accident data analysis, the following priorities were given in the development of various component tests:
  (1) Adult/child head test (head vs bonnet/windshield)
  (2) Adult leg test (leg vs bumper)
  (3) Adult chest, abdomen, pelvis/femur tests
  Child chest, abdomen, pelvis tests
*Develop test methods on the basis of (a) existing information and expert know-how and (b) the additional studies which will be conducted by volunteers.
*Hold WG meetings about two times a year, each meeting lasting for 3 to 4 days. At the WG meetings, the members will discuss the research results brought by assigned experts and then decide test methods.

5. IHRA Pedestrian Accidents Data-set

Age, Impact velocity, Vehicle / Pedestrian interaction, AIS/ Impact velocity relationship for major injury locations are studied.
Result are shown below


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
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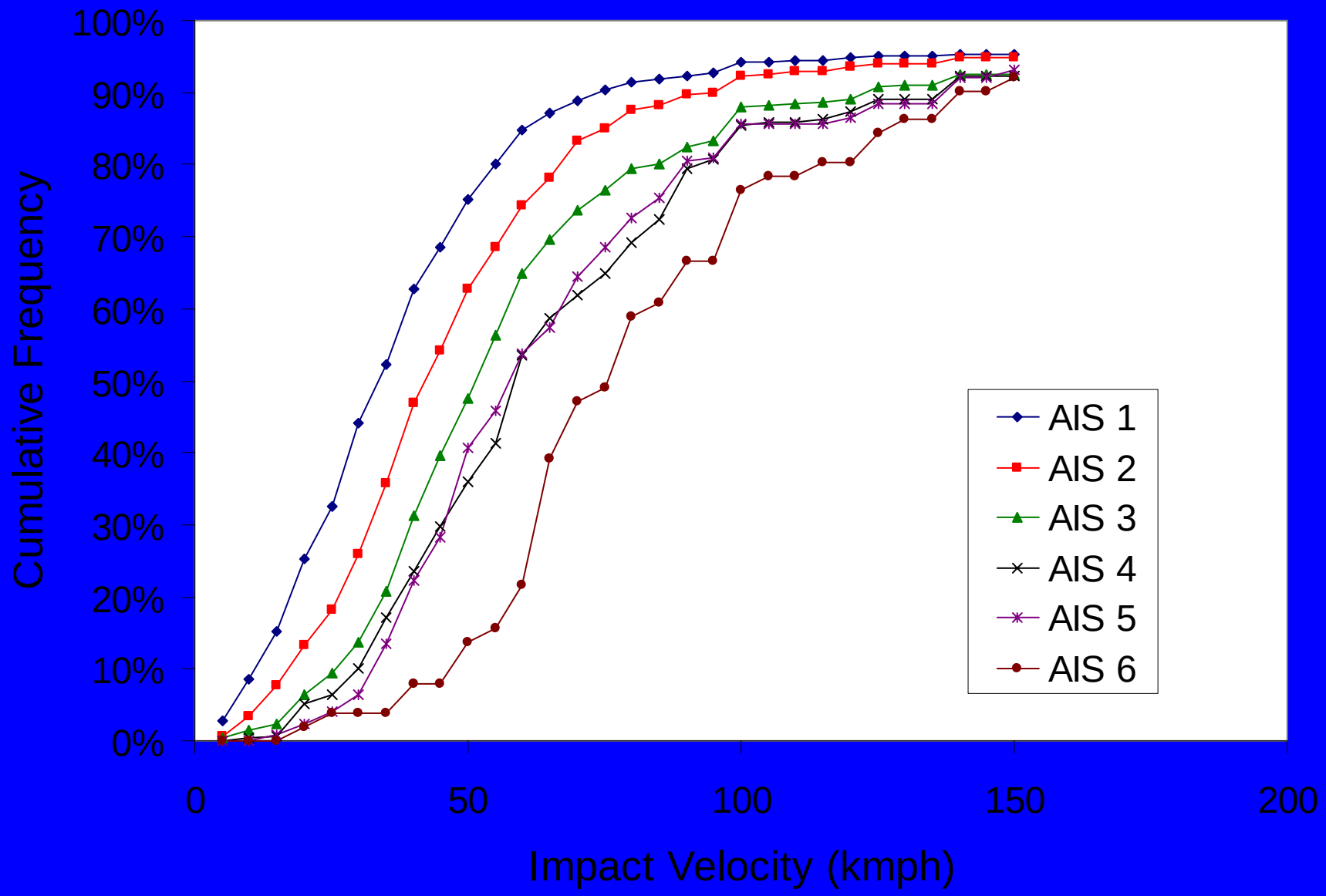
Cumulative Frequency
0
20
40
60
80
100
Impact Velocity (kmph)
US (N=444)
Japan (N=231)
Europe (N=763)
Australia (N=52)
IHRA (N=1490)


100%
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50%
40%
30%
20%
10%
0%
Cumulative Frequency
0
50
100
150
200
Impact Velocity (kmph)
AIS 1
AIS 2
AIS 3
AIS 4
AIS 5
AIS 6

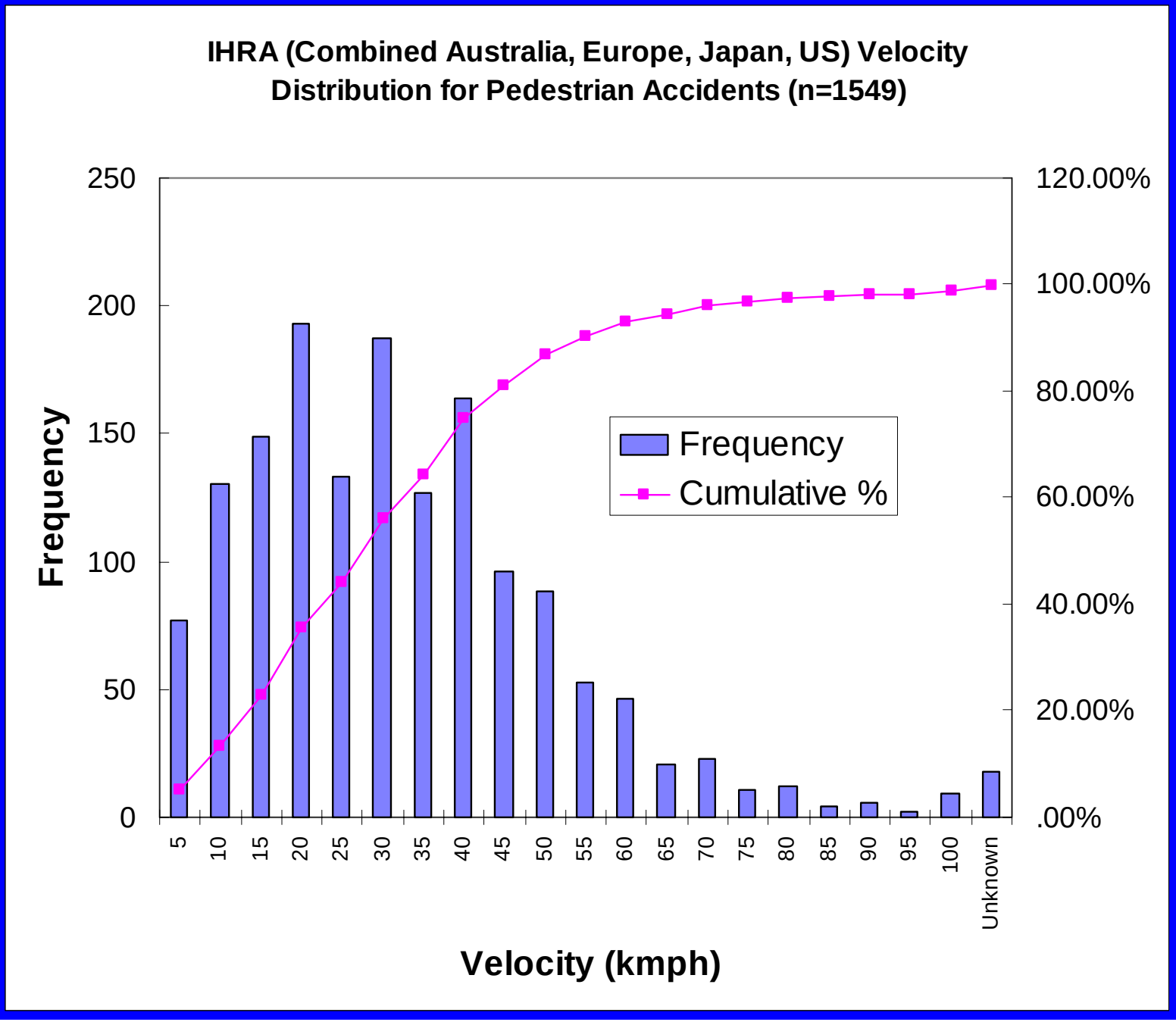

IHRA (Combined Australia, Europe, Japan, US) Velocity Distribution for Pedestrian Accidents (n=1549)
Frequency
250
200
150
100
50
0
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
.00%
Frequency
Cumulative %
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Unknown
Velocity (kmph)

Figure 31a. Number of pedestrian injuries related to contact location and body region for Australia, Europe, Japan and the USA (All Age Groups, AIS 2-6)

Contact \ Body Region		Head	Face	Neck	Chest	Abdomen	Pelvis	Arms	Legs					Unknown
									Overall	Femur	Knee	Lower Leg	Foot	
Part of the Vehicle	Front Bumper	24	2		3	5	2	6	50	58	71	458	30	1
	Top surface of bonnet/wing	224	16	2	139	46	44	86	23	3	1	1	2	1
	Leading edge of bonnet/wing	15	2	3	42	79	83	35	58	40	5	28	1	1
	Windscreen glass	347	57	12	30	5	12	23	2			1	1	1
	Windscreen frame/A pillars	180	30	4	40	11	19	35	8	1				2
	Front Panel	5	1		9	14	8	6	9	14	11	35	3	
	Others	42	7		37	11	12	14	17	7	5	37	18	
	Sub-Total	837	115	21	300	171	180	205	167	123	93	560	55	6
	Indirect Contact Injury	13		18	2	1	7	1		3		1	2	
	Road Surface Contact	176	25	2	22	2	9	44	6	4	3	5	15	2
	Unknown	28	4	3	20	14	16	24	2	7	9	32	3	8
	Total	1054	144	44	344	188	212	274	175	137	105	598	75	16

Figure 31b. Number of pedestrian injuries related to contact location and body region for Australia, Europe, Japan and the USA (Ages < 16, AIS 2-6)

Contact Location \ Body Region		Head	Face	Neck	Chest	Abdomen	Pelvis	Arms	Legs					Unknown
									Overall	Femur	Knee	Lower Leg	Foot	
Part of the Vehicle	Front Bumper	5			1	3		3	27	19	5	45	1	1
	Top surface of bonnet/wing	78	9	1	12	6	2	15	1	1				
	Leading edge of bonnet/wing	11	1	2	3	11	5	8	3	11	1	6		1
	Windscreen glass	40	2	1	1			2						1
	Windscreen frame/A pillars	13	1		3	1	1	4	4					
	Front Panel	5			1		1	1		5	1	1		
	Others	9			4	1		2	4	4		13	5	
	Sub-Total	161	13	4	25	22	9	35	39	40	7	65	6	3
	Indirect Contact Injury	1		1		1		1						
	Road Surface Contact	48	8	1	1	1	1	16	6				1	
	Unknown	6			1	2		5		3		4		1
	Total	216	21	6	27	26	10	57	45	43	7	69	7	4

Figure 31c. Number of pedestrian injuries related to contact location and body region for Australia, Europe, Japan and the USA (Ages > 15, AIS 2-6)

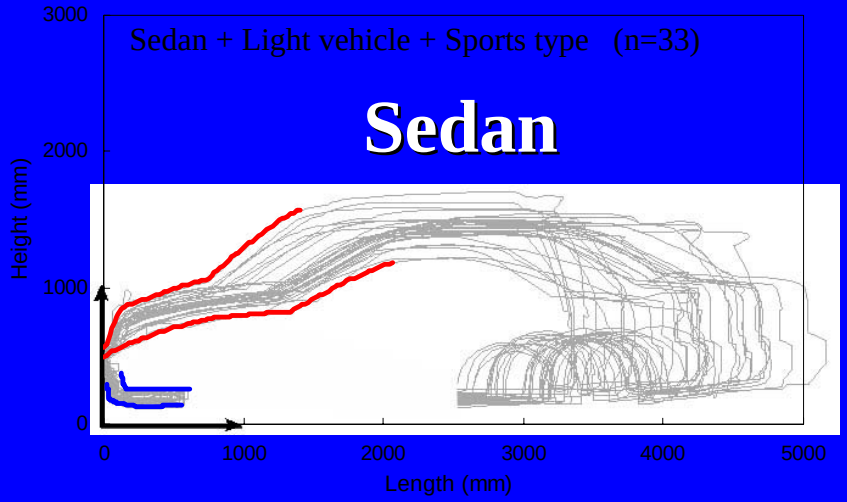
Contact Location \ Body Region		Head	Face	Neck	Chest	Abdomen	Pelvis	Arms	Legs					Unknown
									Overall	Femur	Knee	Lower Leg	Foot	
Part of the Vehicle	Front Bumper	19	2		2	2	2	3	23	39	66	413	29	
	Top surface of bonnet/wing	146	7	1	127	40	42	71	22	2	1	1	2	1
	Leading edge of bonnet/wing	4	1	1	39	68	78	27	55	29	4	22	1	
	Windscreen glass	307	55	11	29	5	12	21	2			1	1	
	Windscreen frame/A pillars	167	29	4	37	10	18	31	4	1				2
	Front Panel		1		8	14	7	5	9	9	10	34	3	
	Others	33	7		33	10	12	12	13	3	5	24	13	
	Sub-Total	676	102	17	275	149	171	170	128	83	86	495	49	3
	Indirect Contact Injury	12		17	2		7			3		1	2	
	Road Surface Contact	128	17	1	21	1	8	28	0	4	3	5	14	2
	Unknown	22	4	3	19	12	16	19	2	4	9	28	3	7
	Total	838	123	38	317	162	202	217	130	94	98	529	68	12

6. Study on Passenger Car Front Shape

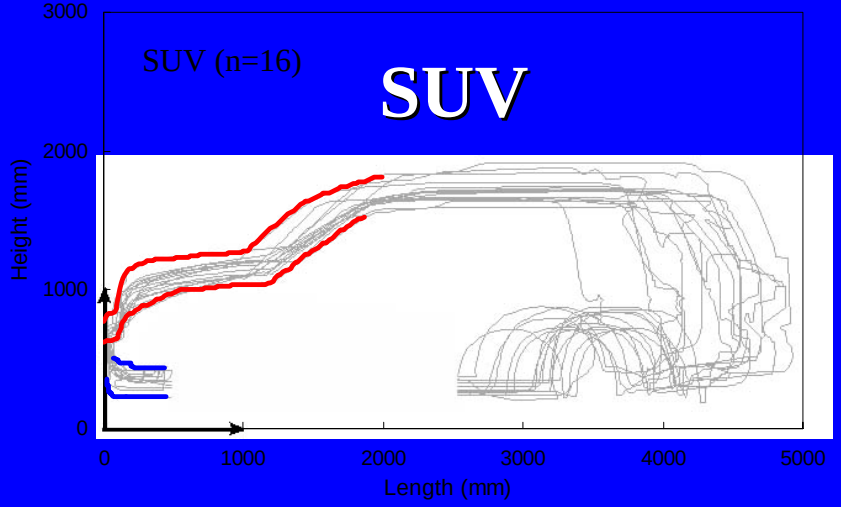
US, European and Japanese passenger car front shapes are collected from OICA members

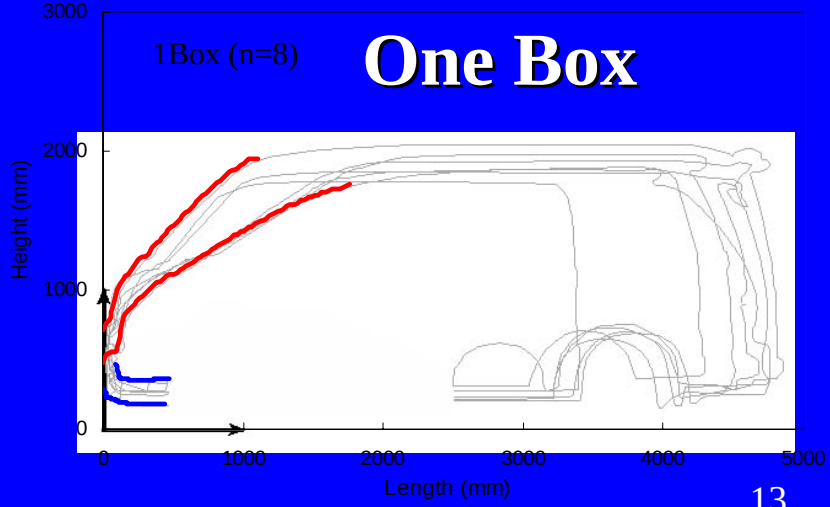
Front Shape of Sedans, SUVs, One Boxes will be shown in this Chapter

Study on Car Front Shape



- Car front shapes in IHRA member countries
- Corridors for computer simulation





7. Test Procedures

7-1 Adult/Child Head Test Procedures for Bonnet and Windshield

*** Adopt component tests.**

*** Scope**

The collisions of the adult's and the child's heads with the bonnet and windshield of a passenger car.

*** Impactors**

Select the head of a 6-year-old as impactor model, since child-car accidents peak with 6-year-olds.

Use a AM50 percentile head for adults.

Development of hemispherical impactors underway on the basis of:

Child 3.5 kg 165 mm diameter

Adult 4.5 kg 165 mm diameter

Follow up with examination into impactor specification details and calibration/certification test methods.

*** Categorization of applicable vehicles**

Domestic information of member countries supported by OICA members collected on three categories of passenger cars (sedans, SUVs, one-boxes).

***Impact speed**

Propose feasible test methods assuming a pedestrian-passenger car impact speed within a 30-50 km/h range.

***Impact zones of adult/child impactors**

From the accident data of IHRA member countries, the impact zone is set at WAD 900-1,700 mm for the child impactor and WAD 1,400-2,400 mm for the adult impactor; the adult/child overlap area is 1,400-1,700 mm. While discussion is underway for adoption of the overlap test method, JARI's study indicates there is no big difference in the life saving rate between overlap and boundary test methods.

***Computer simulation**

Using their respective mathematical models for the analysis of pedestrian-passenger car collisions, NHTSA (U.S.), JARI (Japan) and RARU (Australia) conducted computer simulations on the basis of vehicle shape and other agreed basic parameters. Parameters are pedestrian size (2), walking position (3), vehicle shape (3X3), vehicle stiffness (2), vehicle crash speed (3), braking (1) and others.

But the simulation results diverged widely among the three institutes' analysis. The basic specifications were therefore modified, and the second simulation is now underway.

7-2 Leg Test Procedures

*Discussion on this subject was started recently.

*Efforts are being made to collect existing information and expert know-how regarding the following matters:

Detailed accident information

Biomechanical data (injury mechanism and its tolerance)

Information on leg impactors and pedestrian dummies concerning their shortcomings and necessary improvements

Evaluation of component/full tests

On the basis of the above information collected, the research tasks, work assignments and time schedule will be finalized.

*Impact speed

Assume a pedestrian-passenger car impact speed between 30 and 50 km/h in conformity with the head component test.

*All tasks will be completed by the end of 2005.

Computer Simulation

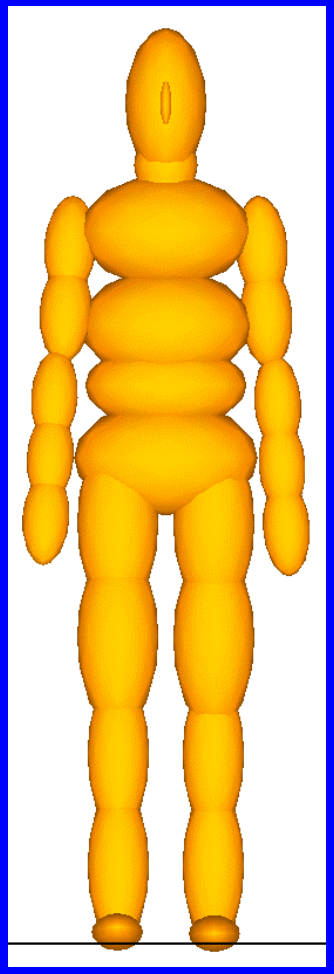
- Head Impact Speed / Vehicle Impact Speed
- Head Impact Angle
- Head Effective Mass / Head Mass
- WAD / Pedestrian Height

Computer Simulation

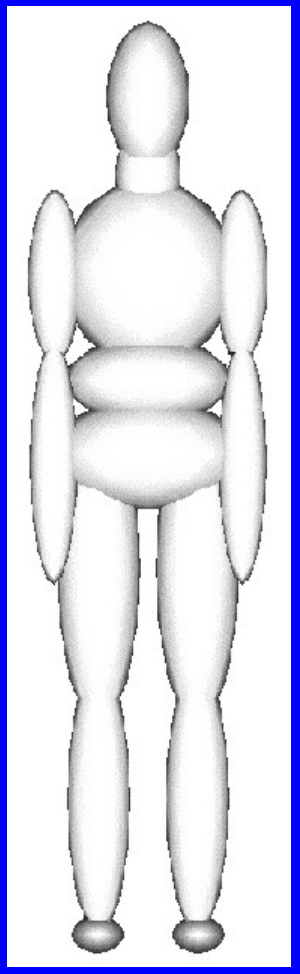
Pedestrian Models

NHTSA

JARI



RARU



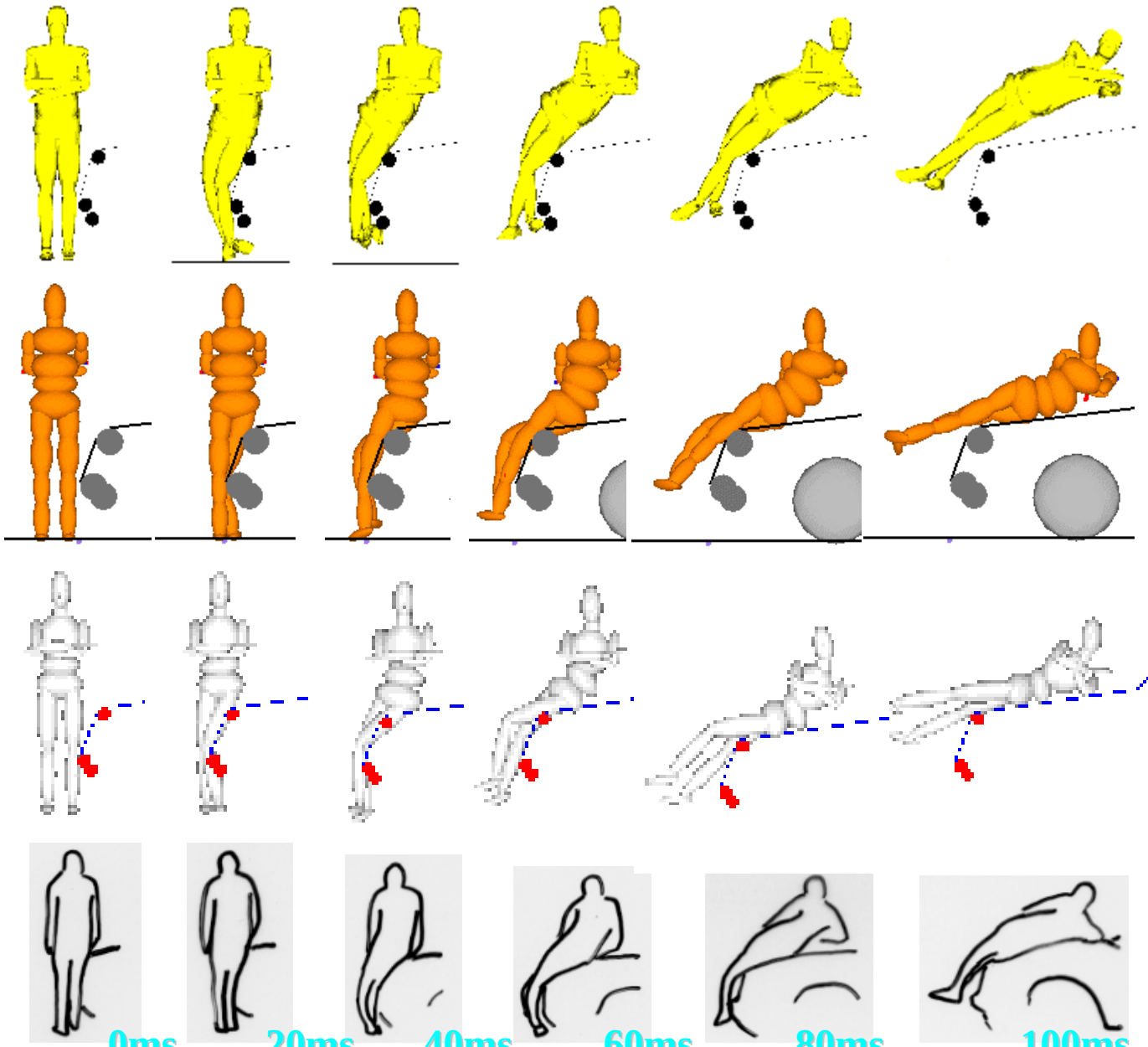
Validation - Car A - 40km/h (Kinematics 0-100ms)

NHTSA

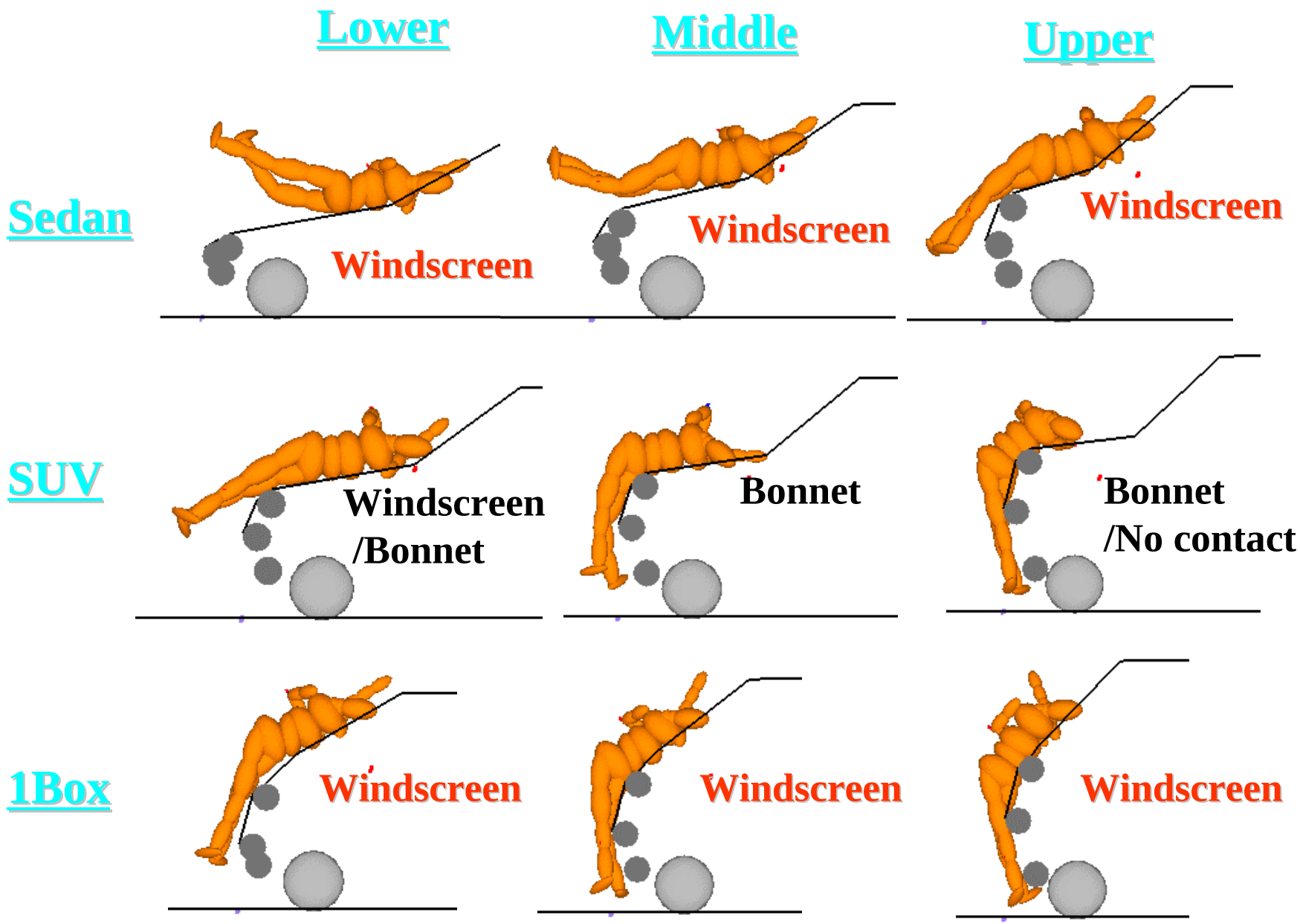
JARI

RARU

PMHS



Head Contact Locations with Car Front Shape



Computer Simulation Results

Head Impact Speed/Impact Speed

	Bonnet	Windscreen
Sedan	(0.81±0.17)	(1.06±0.13)
SUV	(0.71±0.21)	(0.96±0.07)
One-Box	no contact	(0.68±0.21)

Head Impact Angle (with horizontal)

	Bonnet	Windscreen
Sedan	(60.6±14.4)	(43.5±7.9)
SUV	(77.9±19.3)	(68.5±7.5)
One-Box	no contact	(45.1±9.5)

Head Effective Mass/Actual Mass

	Bonnet	Windscreen
Sedan	(1.01±0.13)	((0.79±0.23)
SUV	(0.99±0.35)	(0.84±0.20)
One-Box	no contact	(0.76±0.30)

Adult: 4.5 kg

8. Future Tasks (New Terms of Reference)

8-1 Pedestrian Head Impact Test Methods (Adult, Child)[by mid of 2003]

- **The main portions of the test methods are scheduled to be decided by June 2001 excluded impact conditions. The remaining details need to be finalized in the following months.**
- **Specifically,**

- **Test will be performed to evaluate the biofidelity, durability, reproducibility, inertia moment, etc. of the new head-form impactors**
- **Through actual testing, the details of certification test procedures will be verified.**
- **Conduct technical feasibility study and reflect such result to the test procedures.**

- **Computer simulation and validation [by mid of 2003]**

- **Obtain improved PMHS data and additional accident data, and improve model/validation, for example, sensitivity study (car stiffness, stance, statue, etc) , simulation other statues (small, large child ; small, large adult)**

8-2 Adult Leg Test Method [by mid of 2005]

- WG will be considered not only subsystem test method but also other test method [by end of 2003]
- Biomechanical data will be collected and analyzed concerning the pedestrian injury mechanism, human tolerance, etc. in the speed range of 30-50 Km/h. [by end of 2002]
- From such biomechanical data, measurement items and levels will be determined for the test procedure. [by end of 2002]
- Judgement will be made on the existence of an impactor satisfying the specified measurement items and levels [by mid of 2003]
- If an appropriate impactor does not exist, an existing one will be improved or a new one will be developed.
- In this case, a volunteer country(s) will be selected and the schedule for such impactor improvement or development will be set [by mid of 2003]
- In the development of a new test method, the portions of the existing component test which are adaptable or not adaptable to the new test method will be identified, and the development effort will be focused on the unacceptable portions.
- Conduct technical feasibility study and reflect such result to the test procedures [by mid of 2005]

8-3 Establishment of Test Methods for Other Important Body Regions [?]

- The previous priority ranking will be checked, and about one or two body regions will be selected and establish work plan [by mid of 2003]
- Volunteer countries, their work assignments, deadlines, etc. will be decided and the development work will be initiated

8-4 Computer simulation [by mid of 2005]

- Study how far we can use computer simulation study for test procedure, also check the limitation of computer simulation study.