

The 5th ANSA & μ ETA International Conference
(Thessaloniki, Greece, 5th to 7th June 2013)

Introduction of JNCAP and the Comparison with Euro NCAP

Chair of JNCAP, Japan

Professor Sadayuki Ujihashi

What is **NCAP** ?

(New Car Assessment Programme)

1. Information of Vehicles Safety sold in the Market !

2. NCAP is not a rule !

NCAP is normally conducted by a governmental body but not a rule.
Car manufacturers can sell their products even if the products do not meet the NCAP.

3. Where NCAP is conducted !

Country: USA, Japan, Korea, China

Region: Europe, ASEAN, Austrasia, Latin America

What is the purpose of **NCAP** ?

1. To provide consumers the information about the safety level of vehicles sold in the market !
2. To encourage manufacturers to produce safer vehicles !

In order to achieve these purposes what is Japan NCAP doing ?

Introduction of JNCAP

1. Traffic Accident Statistics & Test Items

2. Outline of Test Procedure & Evaluation Method

【Crash Safety】

- 2.1 Full-wrap Frontal Collision Test
- 2.2 Offset Frontal Collision Test
- 2.3 Side Collision Test
- 2.4 Rear Impact Sled Test

【Pedestrian Protection】

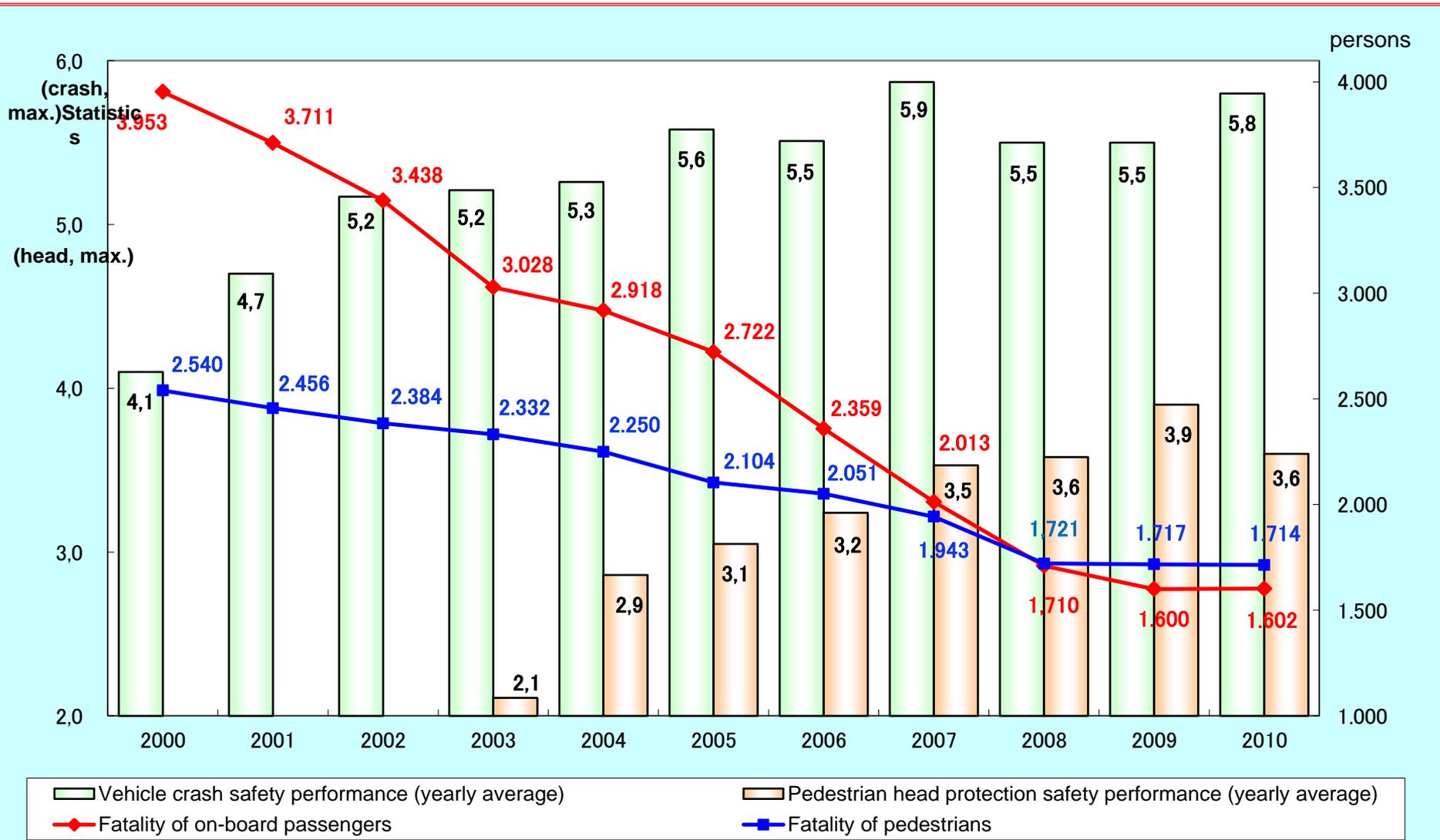
- 2.5 Head Protection Performance Test
- 2.6 Leg Protection Performance Test

【Others】

- 2.7 Passenger Seat Belt Reminder Test
- 2.8 Braking Performance Test
- 2.9 Protection Against Electrical Shock After Collision Test

3. Overall Five-Star Evaluation

1.1 Traffic Accident Statistics



1.2 Test Items & History of JNCAP

Test items

'95

'99

'00

'01

'03

'09

'11

New Car Assessment

I. Crash Safety

Full-wrap Frontal Collision Test

Offset Frontal Collision Test

Side Collision Test

Rear Impact Sled Test

(Neck injury protection for rear-end collision performance test)

II. Pedestrian Protection

Head Protection Performance Test

Leg Protection Performance Test

III. Passenger Seat Belt Reminder Test

IV. Seat Belt Usability Test

V. Braking Performance Test

Child Seat Assessment

Rear Seat Passenger Protection for Frontal Collision Performance Evaluation introduced

New overall evaluation for vehicle safety started

Overall evaluation for crash safety started

Add Side Curtain Airbag evaluation

Occupant Protection Against Electrical Shock After Collision

Evaluation of PSBR

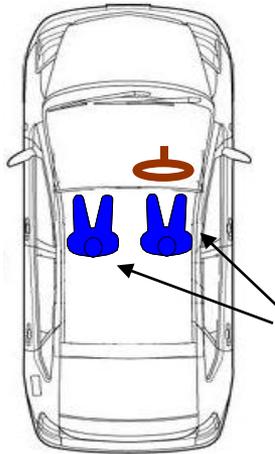
Test seat changed (to ECE test seat)

'08

2.1 Full-Wrap Frontal Test (Part 1)

Concrete barrier

55 km/h



Dummy

【Start year】

Introduced from FY1995

【Test speed】

55±1 km/h

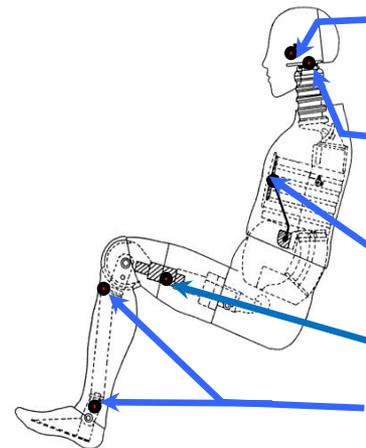
【Offset rate】

100 %

【Placed of dummy】

Driver and Front Passenger
Hybrid III - AM50 dummy

【 Injury value 】



Head Injury Criterion (HIC)

Neck load (tensile, shearing)
Neck moment (extension)

Resultant chest acceleration
Chest displacement

Femur load

Load on Tibia Index

Other injury value : steering wheel displacement
(driver's seat), brake pedal
displacement (driver's seat)



※ "Protection Against Electrical Shock After Collision Test" is also applied to Electric vehicles(EV·HEV). (Introduced from FY2011)

2.1 Full-Wrap Frontal Test (Part 2)

【Driver and Front Passenger】

Body region	Injury value / Injury criteria	Points (a)		Degree of body deformation	Points (b)		Weight (C)		Weighted score ((a)+(b)×(c))
Head	Head injury criterion (HIC36) (650 / 1,000)	0 to 4 points	+	Steering wheel upper displacement (72mm / 88mm)	0 to -1 points	×	0.923		0 to 3.692 points
Neck	Tensile load 0 ms (2.7kN / 3.3kN) 35ms (2.3kN / 2.9kN) 60ms (1.1kN / 1.1kN)	0 to 4 points (the lowest value is chosen)	+	(none)	-	×	0.231	=	0 to 0.924 points
	Shearing load 0 ms (1.9kN / 3.1kN) 25-35ms (1.2kN / 1.5kN) 45ms (1.1kN / 1.1kN)								
	Moment of extension (42Nm / 57Nm)								
Chest	Chest acceleration (373m/s ² / 588m/s ²)	0 to 4 points (the lowest value is chosen)	+	Steering wheel rearward displacement (90mm / 110mm)	0 to -1 points	×	0.923	=	0 to 3.692 points
	Chest displacement (22mm / 50mm)								
Legs	Femur load (lower value of left and right) (7kN / 10kN)	0 to 2 points	+	Brake pedal upper displacement (72mm / 88mm)	0 to -1 points	×	0.923	=	0 to 3.692 points
	Load on Tibia Index (lowest value) (0.4 / 1.3)	0 to 2 points			0 to -1 points				

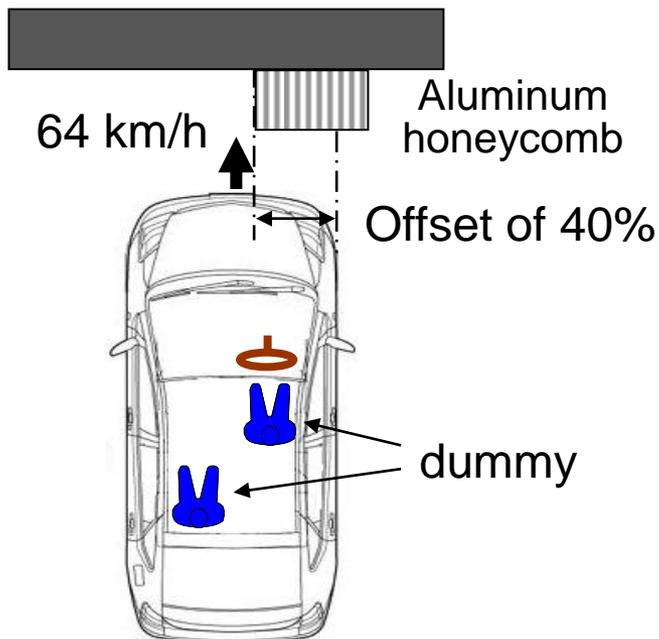
【Rating】

(Driver and Front Passenger)

- Level 1** : less than 6.00 points
- Level 2** : 6.00 to less than 7.50 points
- Level 3** : 7.50 to less than 9.00 points
- Level 4** : 9.00 to less than 10.50 points
- Level 5** : 10.50 points and more

Total 0 to 12 points

2.2 Offset Frontal Test (Part 1)



【Start year】

Introduced from FY 2000

【Test speed】

64±1 km/h

【Offset rate】

40 %

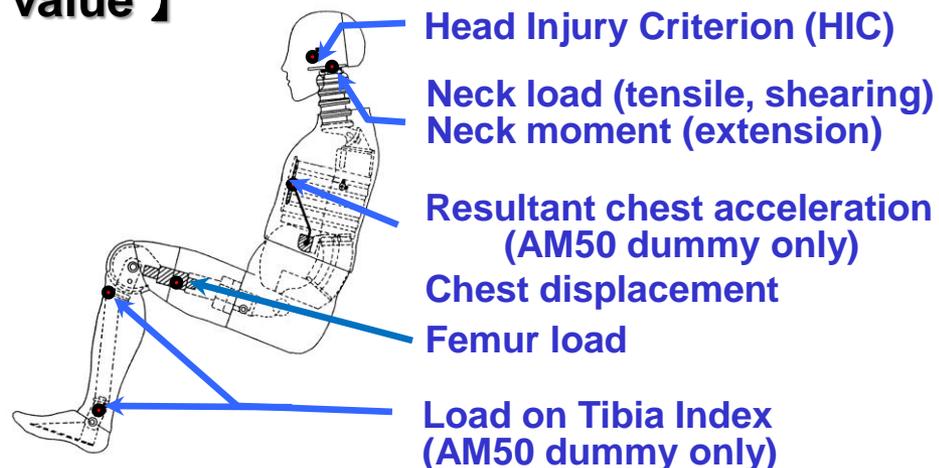
【Placed of dummy】

Driver Hybrid III AM50

Rear Passenger^{※1} Hybrid III AF05^{※1}

※1 AM50 dummy had been placed in the front passenger's seats until FY2008.

【Injury value】



Other injury value : steering wheel displacement (driver), brake pedal displacement (driver's seat), Secondary collision (Rear passenger seat), Riding up of wrap belt from pelvis (Rear passenger seat)



※ "Protection Against Electrical Shock After Collision Test" is also applied to Electric vehicles (EV-HEV). (Introduced from FY2011)

2.2 Offset Frontal Test (Part 2)

【Driver】 Conform to evaluation method of Full-wrap Frontal Test.

【Rear Passenger】

Body region	Injury value / Injury criteria	Points (a)		Modifier	Points (b)		Weight (c)		weighted score $\{(a)+(b)\} \times (c)$
Head	Head Injury Criterion (HIC15)* (500/700)	0 to 4points **	+	Hard contact with car interior	-1 points	×	0.8	=	0 to 3.2 points
Neck	Tensile load (1.70kN/2.62kN) Shearing load* (1.20kN/1.95kN) Moment of extension * (36Nm/49Nm)	0 to 4 points (the lowest value is chosen)		(none)	-	×	0.2	=	0 to 0.8 points
Chest	Chest displacement (23mm/48mm)	0 to 4 points		(none)	-	×	0.8	=	0 to 3.2 points
Abdomen	n/a	4 points ***	+	Pelvis restraint condition	Two pelvis: -4 points One pelvis: -2 points None : 0 points	×	0.8	=	0 to 3.2 points
Legs	Femur load (4.8kN/6.8kN)	0 to 4 points		(none)	-	×	0.4	=	0 to 1.6 points

* : Calculation is done if secondary hard contact exists.

** : Without secondary hard contact, 4 points are given by default.

*** : 4 points are given by default.

Total 0 to 12 points

【Rating】

(Driver and Rear Passenger)

Level 1 : less than 6.00 points

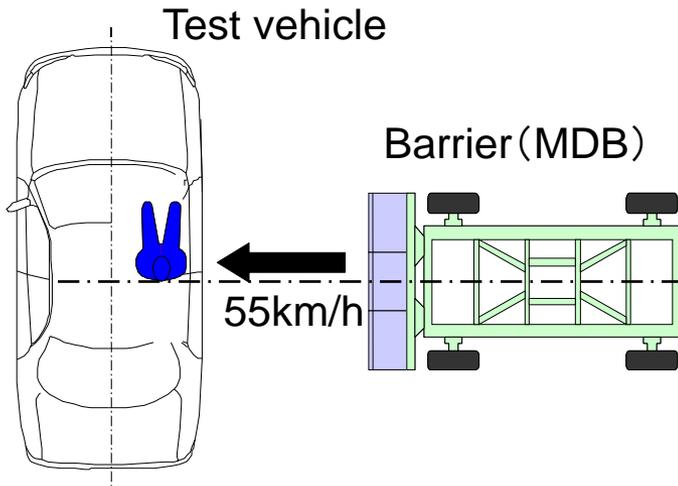
Level 2 : 6.00 to less than 7.50 points

Level 3 : 7.50 to less than 9.00 points

Level 4 : 9.00 to less than 10.50 points

Level 5 : 10.50 points and more

2.3 Side Collision Test (Part 1)



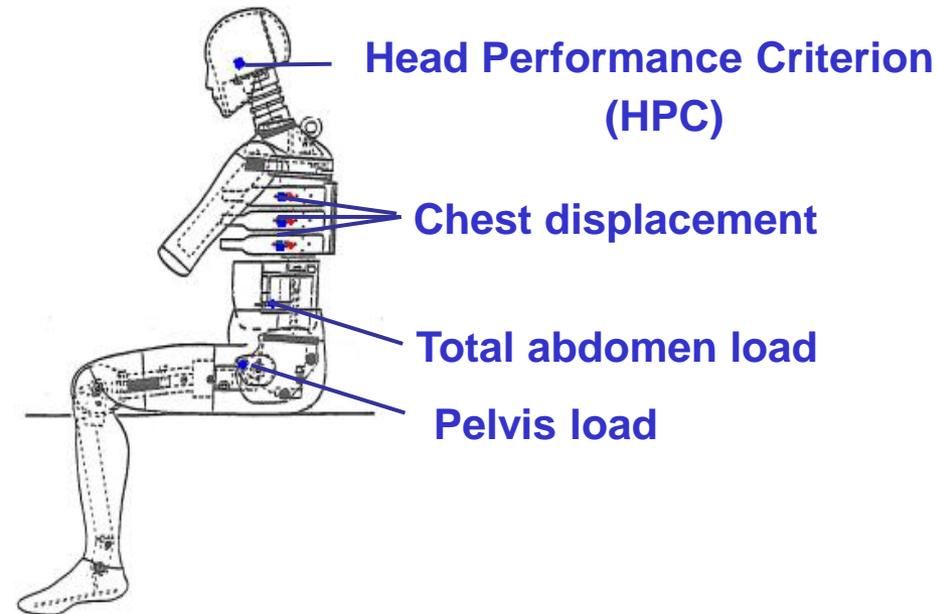
【Start year】 Introduced from FY1999

【Test speed】 55±1 km/h

【Mass of trolley】 950 kg

【Placed of dummy】
Normally on the driver's seat
EURO SID-2 AM50

【Injury value】



※ For the vehicle with side curtain air bags, range of inflating area is also checked. (Introduced from FY2008)

※ "Protection Against Electrical Shock After Collision Test" is also applied to Electric vehicles (EV-HEV). (Introduced from FY2011)

2.3 Side Collision Test (Part 2)

【Driver and Front Passenger】

If the tested vehicle has the same structure for crash safety performance between driver side and passenger side, test is carried out at the driver side, and its test result is diverted to the passenger side.

	Injury value / Injury criteria	Points (a)		Weight (b)		weighted score (a) × (b)
Head	Head Performance Criterion (HP C) (650/1000)	0 to 4points	×	1.0	=	0 to 4 points
Chest	Chest displacement (22mm/42mm)	0 to 4points	×	1.0	=	0 to 4 points
Abdomen	Total abdomen load (1kN / 2.5kN)	0 to 4points	×	0.5		0 to 2 points
Pelvis	Pelvis load (4.8kN/6.8kN)	0 to 4points	×	0.5	=	0 to 2 points

【Rating】

(Driver and
Front Passenger)

- Level 1** : less than 6.00 points
- Level 2** : 6.00 to less than 7.50 points
- Level 3** : 7.50 to less than 9.00 points
- Level 4** : 9.00 to less than 10.50 points
- Level 5** : 10.50 points and more

Total 0 to 12 points

2.4 Rear Impact Sled Test (Part 1)



【Start year】

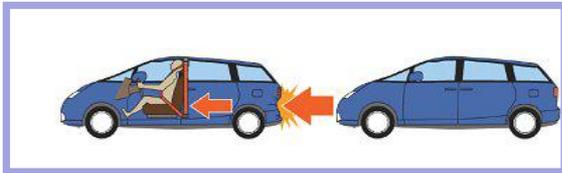
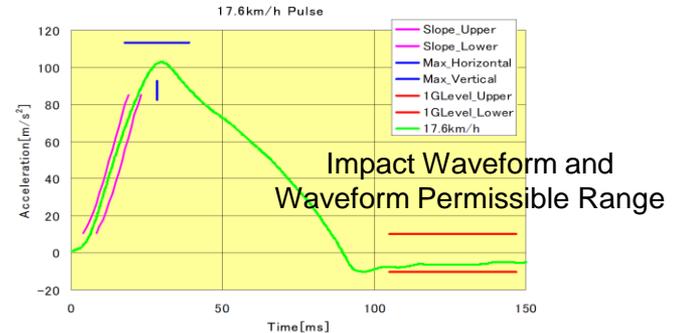
【Test seat】

【Test speed】

Introduced from FY2009

Driver and Front Passenger

ΔV 20.0km/h \pm 1.0km/h

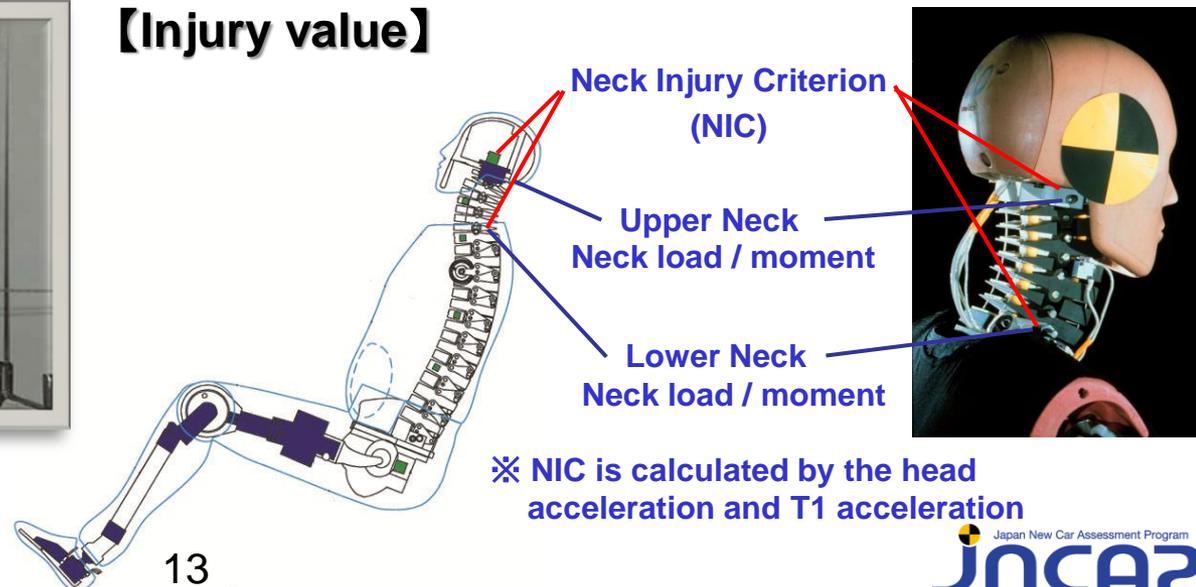
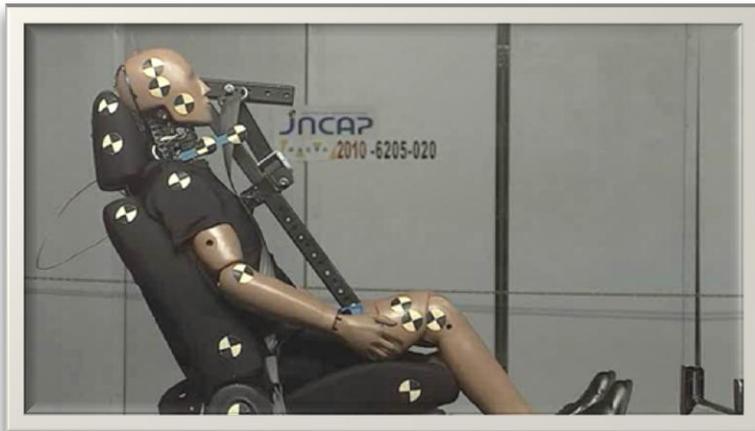


※ a rate of around 32km/h

【 D u m m y 】

BioRID II Dummy
(Equivalent to Hybrid-III AM50)

【Injury value】



2.4 Rear Impact Sled Test (Part 2)

【Driver and Front Passenger】

Injury value / Injury criteria		Points (a)		Weight (b)		weighted score (a) × (b)	
Neck Injury Criterion (NIC) (8 / 30)		0 to 4 points	×	1	=	0 to 4 points	
Neck load / moment	(Upper Neck)	Fx (Shearing load (back of the head)) (340 N / 730 N)	0 to 4 points (the lowest value is chosen)	×	2	=	0 to 8 points
		Fz (Tensile load (upper direction)) (475 N / 1130 N)					
		My (moment of flexion) (12 Nm / 40 Nm)					
		My (moment of extension) (12 Nm / 40 Nm)					
	(Lower Neck)	Fx (Shearing load (back of the head)) (340 N / 730 N)					
		Fz (Tensile load (upper direction)) (247 N / 1480 N)					
		My (moment of flexion) (12 Nm / 40 Nm)					
		My (moment of extension) (12 Nm / 40 Nm)					

【Rating】

(From FY 2012)

- Level 1** : less than 6.00 points
- Level 2** : 6.00 to less than 7.50 points
- Level 3** : 7.50 to less than 9.00 points
- Level 4** : 9.00 to less than 10.50 points
- Level 5** : 10.50 points and more

Total 0 to 12 points

2.5 Head Protection Performance Test (Part 1)

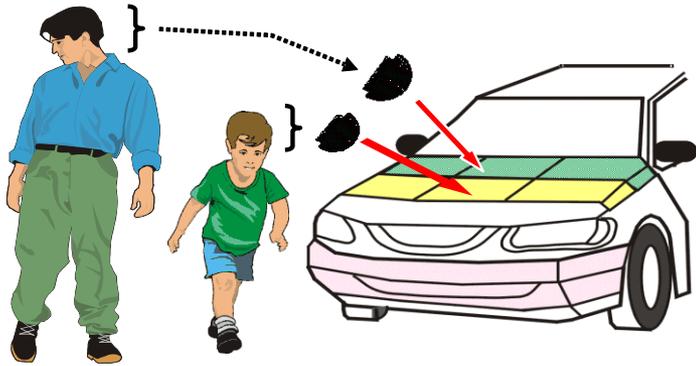
【Start year】

Introduced from FY2003

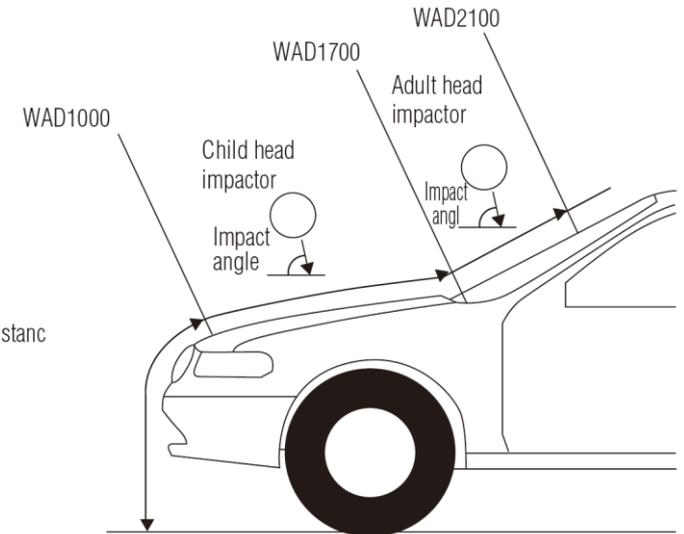
【Test speed】

35.0±0.7km/h

※ The collision speed received by the pedestrian against the car is equivalent to 44km/h.



【Test area】



【Headform Impactor】

Adult (Diameter : 165mm, Mass : 4.5kg)

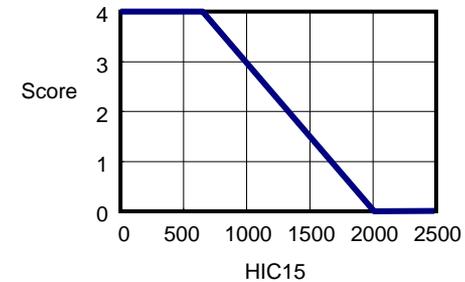
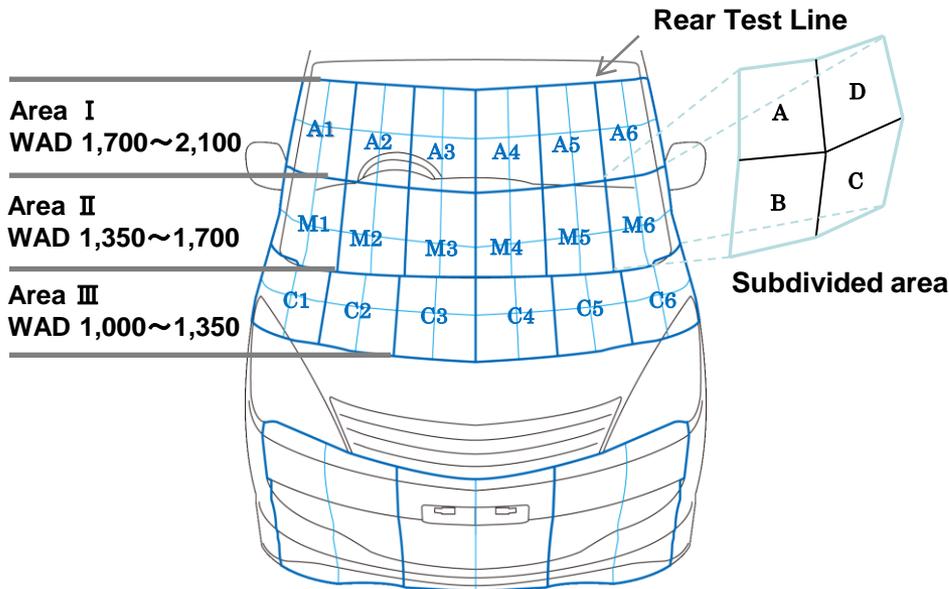
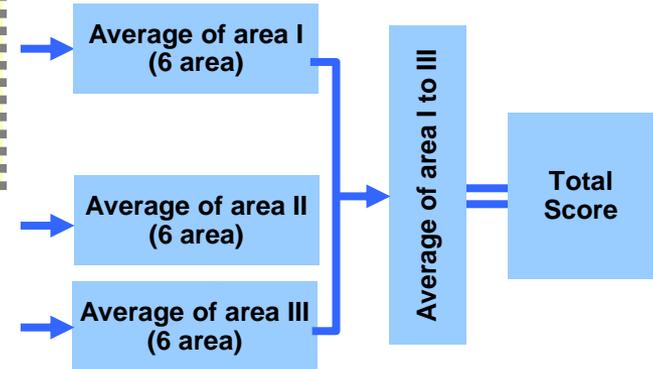
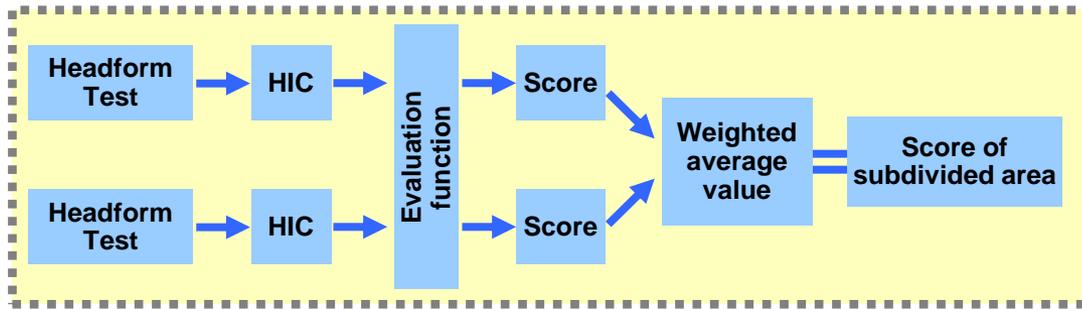
Child (Diameter : 165mm, Mass : 3.5kg)



【Injury value】

Head Injury Criterion (HIC)

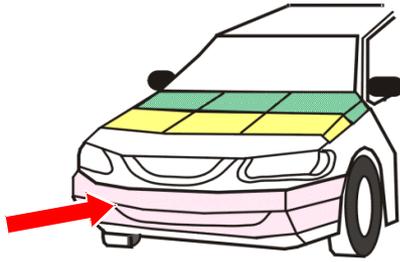
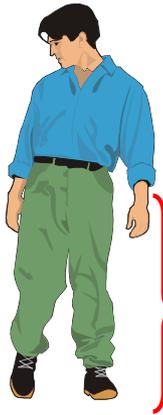
2.5 Head Protection Performance Test (Part 2)



- 【Rating】**
- Level 1** : less than 2.09 points
 - Level 2** : 2.09 to less than 2.50 points
 - Level 3** : 2.50 to less than 2.92 points
 - Level 4** : 2.92 to less than 3.33 points
 - Level 5** : 3.33 points and more

	Injury value	Injury criteria	Points (a)
Head	Head Injury Criterion (HIC15)	(650 / 2,000)	0 ~ 4 Points

2.6 Leg Protection Performance Test (Part 1)



【Start year】

Introduced from FY2011

【Except vehicle】

“Bumper lower height (BLH)”
is 425 mm or more vehicles.

Also vehicles 425mm and more of BLH
may be tested if “Pushing Down Mode”
is not occurred in these vehicles.

【Test speed】

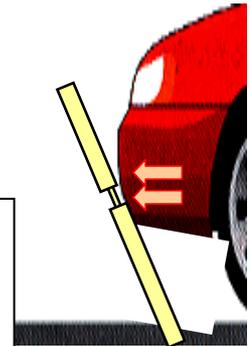
40km/h \pm 0.7km/h

※ Acceleration of impact speed
(to 44km/h) will be considered
after the safety regulation is
implemented.

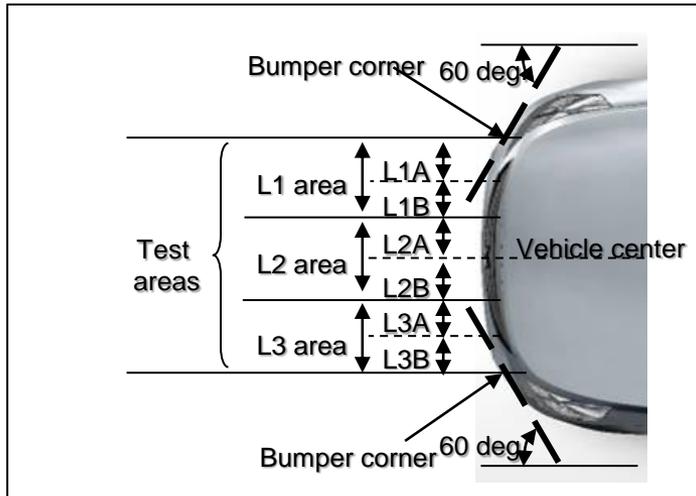


【Definition of Pushing Down Mode】

- ① After collision, upper part of leg impactor is not declined forward direction at the very early stage (within 20ms)
- ② Before reaching to max values for every measured values (bending moment of Tibia, elongation of MCL & ACL), upper part of leg from impactor is declined to forward direction.



2.6 Leg Protection Performance Test (Part 2)



【Test areas】

- 6 divisions between bumper corners
- Every area shall be tested

If damage point is included for test.
However, test will be done inside of the edge of bumper beam, lower rail, cross beam.

【Leg from Imactor】

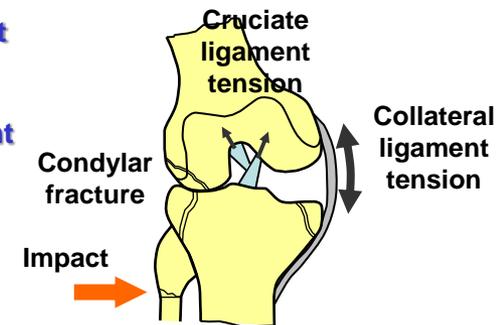
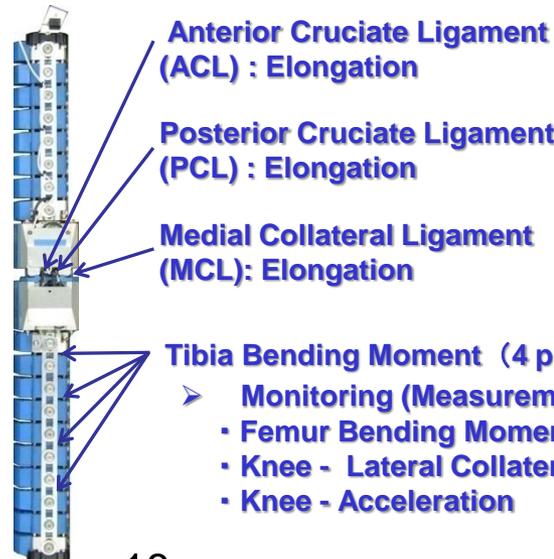
FLEX-PLI

※ Rigid legfrom imactor and upper legfrom imactor are not used.

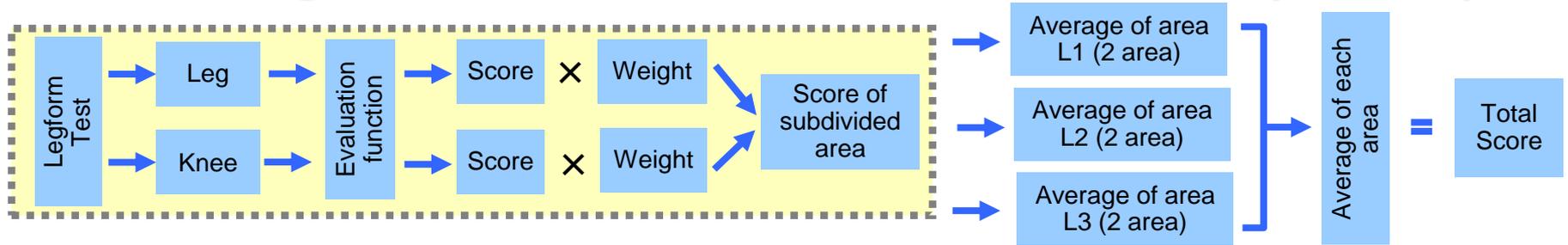


【Injury value】

(Reference : Damage mechanism of knee)



2.6 Leg Protection Performance Test (Part 3)



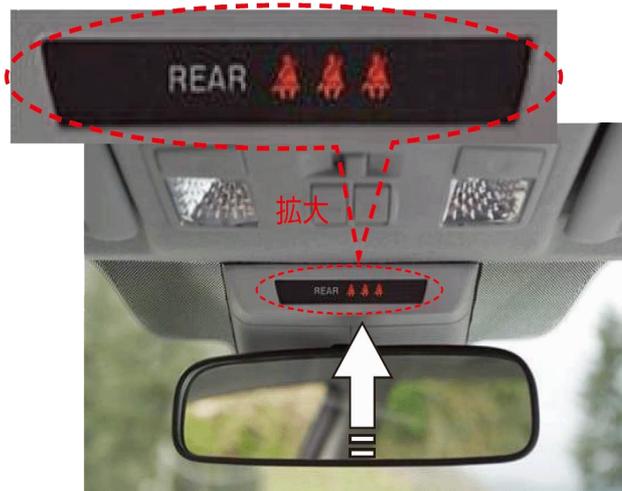
Impactor region		Injury criteria	Score (a)		Weight (c)		weighted score (a) × (b)
Leg	Tibia 1	Bending moment (224Nm / 380Nm)	0 to 4 points (the lowest value is chosen)	×	<u>0.73</u>	=	<u>2.92</u>
	Tibia 2						
	Tibia 3						
	Tibia 4						
Knee	MCL (Medial collateral ligament)	Elongation (16.4mm / 22.0mm)	0 to 4 points (the lowest value is chosen)	×	<u>0.27</u>	=	<u>1.08</u>
	ACL (Anterior cruciate ligament)	Elongation (- / 13mm)					
	PCL (Posterior cruciate ligament)	Elongation (- / 13mm)					

【Rating】

- Level 1** : less than 2.00 points
- Level 2** : 2.00 to less than 2.67 points
- Level 3** : 2.67 to less than 3.33 points
- Level 4** : 3.33 points and more

Total 0 to 4 points

2.7 Passenger Seat Belt Reminder Test (Part 1)



【Start year】

Introduced from FY2009

※ Only presence of the equipment is published until FY 2010.

【Tested seats】

“Front passenger’s seat” and “Rear passenger’s seat”

【Evaluation item】

- ◆ Reminding type (Display · Audible)
- ◆ Start of reminding
- ◆ Reminding duration
- ◆ Reminder confirmable position
- ◆ Equipment condition of “change of status reminder”

【The Main Requirements in the Front Passenger’s Seat】

Reminding type”	“Reminder display” or “Audible reminder”
Start of reminding	Within 60 seconds, within 500m or at the rate of 25km/h or slower after running
Reminding duration	30 seconds or longer
Reminder confirmable position	“Driver’s seat” or “Front passenger’s seat”

【 The Main Requirements in the Rear Seat】

Reminding type	“Reminder display” or “Audible reminder”
Start of reminding	As provided by the vehicle manufacturer
Reminding duration	30 seconds or longer
Reminder confirmable position	“Driver’s seat” or “Rear passenger’s seat”

【Common Requirements】

“change of status reminder”

2.7 Passenger Seat Belt Reminder Test (Part 2)

Scoring (total 100 points) by the improvement ratio of seat belt wearing rate by visible / audible warning from each seat position

[Front Passenger Seat SBR]

	Indicator location	Requirement	Point
Visual signal	Center console part	In the case the SBR at one of the following indicator locations is able to be confirmed from the driver or front passenger(s).	10
	Room mirror part		
	Inside meter		
	Glove box area		

	Requirement	Point
Audible signal	In the case the signal sound is able to be confirmed from both the driver and front passenger(s).	40

- When there are plural seats (bench seat, etc.), the point of each seat position is calculated first and the mean of the abovementioned points become the total score of the front passenger seat.

[Rear Seat SBR]

	Indicator location	Requirement	Point
Visual signal	Center console part	In the case the SBR at one of the following indicator locations is able to be confirmed from both the driver and rear seat passenger(s).	25
	Room mirror part		
		In the case of either driver or rear seat passengers(s).	12.5
	Inside meter	In the case the SBR at the following indicator location is able to be confirmed from the driver.	12.5
	Frontal seats seat back	In the case the SBR at one of the following indicator locations is able to be confirmed from rear seat passenger(s).	12.5
	Ceiling center		

	Requirement	Point
Audible signal	In the case the signal sound is able to be confirmed from both the driver and rear seat passenger(s).	25

- When there are plural seats, the point of each seat position is calculated first and the mean of the abovementioned points become the total score of the rear seat.
- * When calculating the total score, point is not counted twice or more when plural visual signals are confirmed from the same seat position.

[Rating]

- Level 1:** less than 45.0 points
- Level 2:** 45.0 to less than 60.0 points
- Level 3:** 60.0 to less than 75.0 points
- Level 4:** 75.0 to less than 90.0 points
- Level 5:** 90.0 points and more

2.8 Braking Performance Test

◇ Dry condition ◇



【Start year】

Introduced from FY1995

【Test speed】

100 km/h

【Test condition】

➤ Road surface temperature

Dry: 35.0 ± 10.0 °C

Wet: 27.0 ± 5.0 °C

➤ Friction co-efficient

Dry: around 1.0

Wet: around 0.80

◇ Wet condition ◇

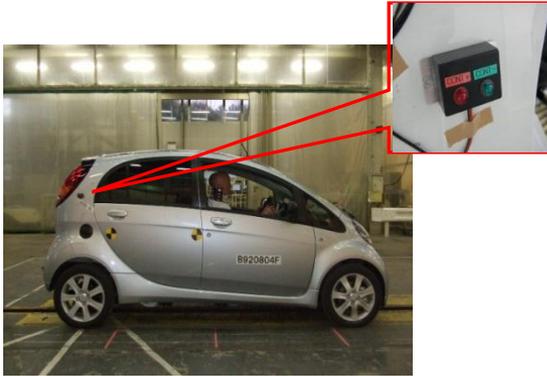


【Evaluation item】

Stopping distance

Deviation from lane (3.5m)

2.9 Protection Against Electrical Shock After Collision Test (Part 1)



【Start year】

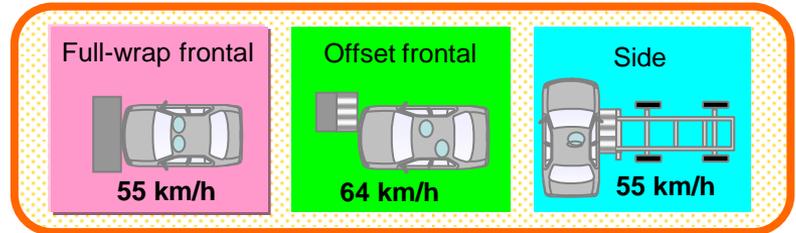
Introduced from FY2011

【Test vehicle】

Electric vehicles (EV·HEV)

※ Excluding vehicles with an electric motor of a working voltage of less than AC30 or DV60)

【Test items】



【Evaluation items】

- Protection against electrical shock
- Electrolyte spillage
- Rechargeable energy storage system (RESS) retention

【Check items】

- The operation situation of the high voltage automatic cut-off (when the device is installed)

Protection against electrical shock

【Basic】

Human body protection
 Protection against direct contact (IPXXB)
 +
 Protection against indirect contact

【Option】 (when the vehicle manufacturer and importer requests)

Method of measure isolation resistance

Method of measure residual energy

Method of measure residual voltage

※ The performance may be confirmed by the combination of above methods

2.9 Protection Against Electrical Shock After Collision Test (Part 2)

Items	Standard evaluation
Performance of protection against electrical shock*	① protection against direct contact + protection against indirect contact <ul style="list-style-type: none"> Protection of the power train (excluding the coupling system for charging the RESS) shall be as prescribed protection IPXXB against direct contact with live parts. Resistance value between an accessible exposed conductive parts and an electrical chassis shall be less than 0.1 Ω in the state that carried away electric currents more than 0.2A.
	② Isolation Resistance Measurement <ul style="list-style-type: none"> An AC circuit and an AC circuit shall be more than operating voltage 500 Ω/V in circuit to include. When requirements of protection class IPXXB and the voltage of the AC part is less than 30V, operating voltage shall be more than 100 Ω/V. DC circuits shall be e more than operating voltage 100 Ω/V.
	③ Measure residual voltage <ul style="list-style-type: none"> The residual voltage of the high voltage part to be able to put 60 seconds after five seconds shall be less than AC30V or less than 60V after collision.
	④ Measure residual Energy <ul style="list-style-type: none"> The energy of the high voltage part pro-power to be able to put 60 seconds after five seconds shall be less than 2.0J after collision.
Performance of RESS electrolyte spillage	<ul style="list-style-type: none"> There is not the electrolyte leak in the compartment. When there is an electrolyte leak to the compartment outside, quantity of leak after the progress shall be lower than 7% of quantity of total electrolyte for collision . The battery for opening-style drive shall be less than 7% following or 5L of the quantity of total electrolyte
Performance of fixation of RESS	<ul style="list-style-type: none"> RESS in the vehicle shall be fixed to the appointed position. RESS out of the vehicle shall not penetrate it in a vehicle.

※The confirmation range of electric shock protection performance requirements “inside of vehicle” until FY2013 and “inside or outside of vehicle” after FY2013, perform it by a combination of method for measurement ①~④, and confirm the electric shock protection performance of the high voltage part pro-all power.

3. Overall Five-Star Evaluation

New overall evaluation for vehicle safety : total score : 208 points

(Star rating)

Less than 110.0 points	★
110.0 ~ Less than 130.0 points	★★
130.0 ~ Less than 150.0 points	★★★
150.0 ~ Less than 170.0 points	★★★★
170.0 points and more	★★★★★

Additional requirement for acquiring ★★★★★ (5★)

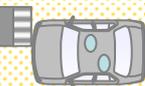
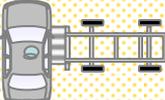
In order to get 5★, test levels of each crash safety test and pedestrian head protection test must be Level 4 or more (score of rear impact sled test must be light green or green), and pedestrian leg protection test must be Level 3 or more.

※ From FY2012, Level 4 or more is necessary for rear impact sled test.

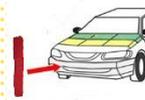
Occupants protection performance
(0 to 100 points)

Pedestrian protection performance
(0 to 100 points)

Crash Safety

	Point	Weight	Weighted score
Full-wrap frontal 	D and FP 0 to 12 points	× 1.250	= 0 to 30 points
Offset frontal 	D and RP 0 to 12 points	× 1.250	= 0 to 30 points
Side impact 	D and FP 0 to 12 points <u>No SCA: Deduct 3.5 points from the score of test results on each seat</u>	× 1.042	= 0 to 25 points
Rear impact sled test 	D and FP 0 to 12 points <u>In addition, speed conversion factor (0.9) is applied in FY 2011.</u>	× 0.625	= 0 to 15 points

Pedestrian protection

	Point	Weight	Weighted score
Head protection 	Average of each area 0 to 4 points	× 18.75	= 0 to 75 points
Leg protection 	Average of each area 0 to 4 points	× 6.25 × ^{※1} (0.95)	= 0 to 25 points

※1 Speed conversion factor (0.95) is applied until the testing speed is reviewed.

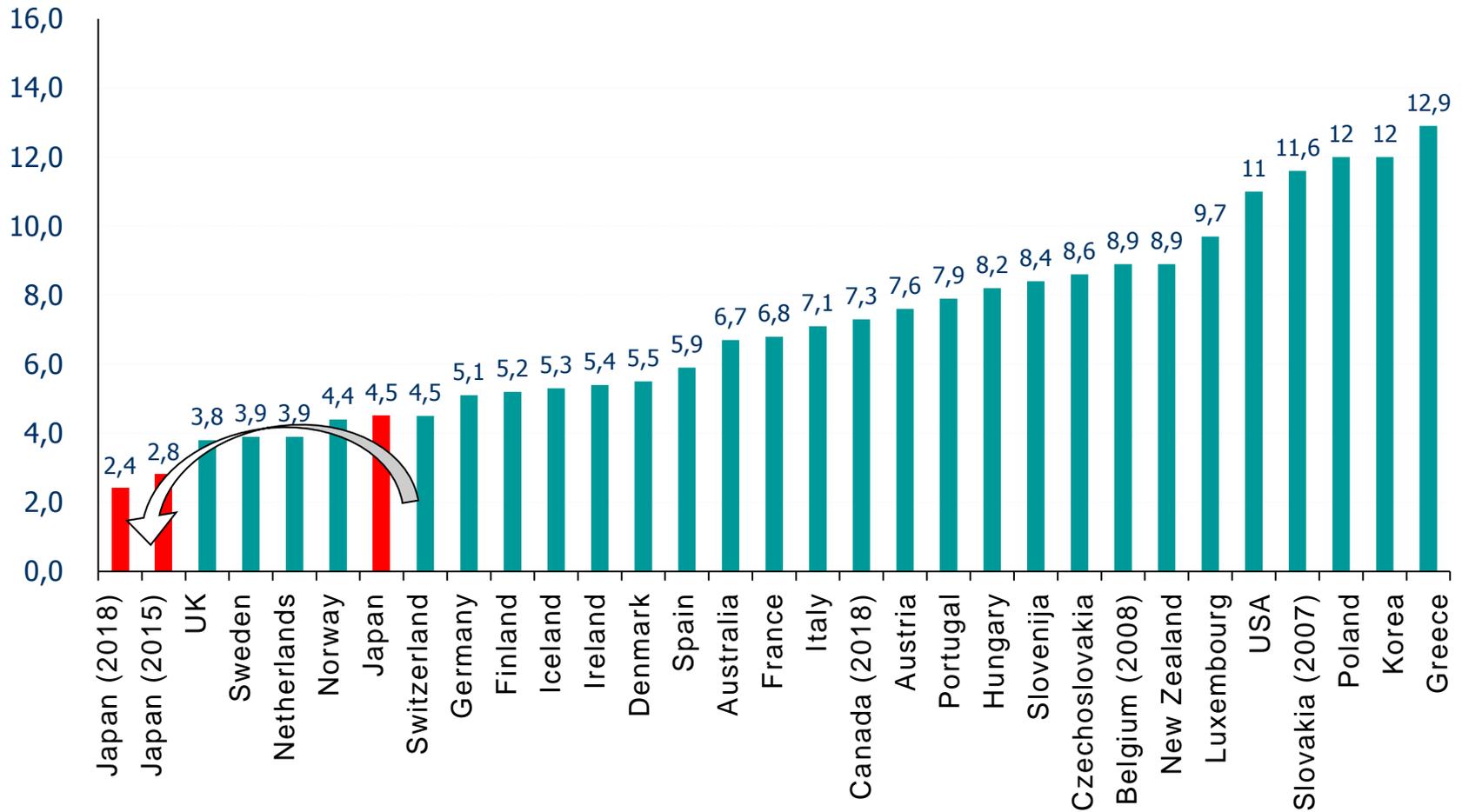
Passenger Seat Belt Reminder
(0 to 8 points)

Point	0 to 100 points
Weight	× 0.08
Weighted score	= 0 to 8 points



Statistics of Traffic Accident in the World

Thousand



Number of Deaths every 100 Thousands Population

Euro NCAP in Comparison with JNCAP

Euro NCAP vs JNCAP

- Offset Frontal Impact < DB, 64km/h, Child > **JNCAP: AF05**
- Side Impact < MDB, 50km/h, Child > **JNCAP: 55km/h, Driver only**
- Rear Impact < Seat, Trapezium Pulse > **JNCAP: Triangle Pulse**
- Pole Impact < 29km/h > **JNCAP: not available**
- Pedestrian Protection < Head & Leg > **JNCAP: available**
- ESC < availability > **JNCAP: not available**
- Seat Belt Reminder < all seats > **JNCAP: available**
- Speed Limiter < availability > **JNCAP: not available**
- **Braking Performance Test in JNCAP**
- Overall Rating
JNCAP: Rating Weight for Pedestrian Protection is the same as Passenger Protection

Implementation Plan of Euro NCAP and JNCAP

	2011	2012	2013	2014	2015	2016	onward
Euro NCAP	ESC(ECE R13)			ESC(availability)			
				AEB(car)		AEB(pedestrian)	
				LDW/LKA			
			ISA				
			ESC(availability)		ESC(performance inclusive)		
	JNCAP				AEB(car)		AEB(pedestrian)
						others	

Further Activities of JNCAP

Collaboration & Harmonization with other NCAPs

- US NCAP
- CNCAP
- KNCAP
- Austrasia NCAP
- Euro NCAP
- ASEAN NCAP
- Latin NCAP
- GNCAP



GNCAP2012 Meeting (Japan)

Conclusions

1. Passive Safety

Passive safety such as Frontal, Side, Rear Impacts etc. are well established and the differences between Euro NCAP & JNCAP are becoming small but the details are still different.

2. Active Safety

Active safety is a very important issue which Euro & JNCAP are very keen to introduce continuously. However aspects of active safety range widely and have been discussed in Euro & JNCAP individually.

So far ESC, AEB LDW etc. are nominated to be introduced as active safety factors of priority.

3. JNCAP Priority

In JNCAP pedestrian safety is considered as much more important because the number of victims of pedestrian is taking over the number of passenger victims in the past few years.



GNCAP2013 Meeting (30th May, Korea)

Global NCAP 2013 held in Seoul

Discussed Important Issues

1. New Vehicles Concept

- Small Vehicle
- Electric Vehicle
- Hybrid Vehicle

2. Aging Society

- Car Design & Market Trend is changing

3. Overall Rating

- 5 Star Rating is getting more common

New Implementation Schedule of Euro NCAP

2013 Pedestrian (Head), Speed Limit Information

2014 Pedestrian (Lower Leg), AEB against Car, LDW, LKA

2015 Full Wrap Frontal Impact, Side Impact, Pole Crash, Upper Leg

2016 AEB against Pedestrian