EURO NCAP

#FORSAFERVANS

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Frontal Impact

Protocol

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PREFACE

During the test preparation, vehicle manufacturers are encouraged to liaise with the laboratory and to check that they are satisfied with the way cars are set up for testing. Where a manufacturer feels that a particular item should be altered, they should ask the laboratory staff to make any necessary changes. Manufacturers are forbidden from making changes to any parameter that will influence the test, such as dummy positioning, vehicle setting, laboratory environment etc.

It is the responsibility of the test laboratory to ensure that any requested changes satisfy the requirements of Euro NCAP. Where a disagreement exists between the laboratory and manufacturer, the Euro NCAP secretariat should be informed immediately to pass final judgment. Where the laboratory staff suspect that a manufacturer has interfered with any of the set up, the manufacturer's representative should be warned that they are not allowed to do so themselves. They should also be informed that if another incident occurs, they will be asked to leave the test site.

Where there is a recurrence of the problem, the manufacturer’s representative will be told to leave the test site and the Secretary General should be immediately informed. Any such incident may be reported by the Secretary General to the manufacturer and the person concerned may not be allowed to attend further Euro NCAP tests.

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this protocol is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

CONTENTS

SCORING 1

1 MEASURING EQUIPMENT 2

1.1 Reference system 2

1.2 Dummies 2

1.3 Collision partners 2

1.4 Measurements and variables 2

2 TEST CONDITIONS 4

2.1 VUT preparation 4

2.2 Occupant compartment adjustments 4

2.3 Adult dummy positioning 5

3 TEST PROCEDURES 10

3.1 MPDB 10

3.2 Colour band scheme 11

3.3 Injury criteria and limits 12

4 POSTTEST ASSESSMENT & INSPECTION 14

4.1 After test 14

4.2 Post test static measurements 14

4.3 Inspection 15

SCORING

Crash Protection – Frontal Impact	Total points 40
Offset test	**20**
Driver – THOR 50th	10
Front passenger – HIII 50th	10
Compatibility	**20**
Standard Deviation (SD)	15
Occupant Load Criterion	5
MPDB face bottoming out	-5

Definitions used in this protocol can be found in Euro NCAP Technical Bulletin CP 001.

1 MEASURING EQUIPMENT

1.1 Reference system

The sign convention used for configuring the transducers is stated in SAE J211 (2022).

1.2 Dummies

All Anthropometric Test Devices (ATD) shall conform to the specifications detailed in the respective Technical Bulletins below:

Test	ATD
MPDB	THOR 50th percentile - CP 106 Hybrid III 50th percentile - CP 104

1.3 Collision partners

1.3.1 MPDB

The Mobile Progressive Deformable Barrier (MPDB) includes both a barrier face and a trolley. The MPDB shall conform to the specifications of Technical Bulletin CP 101.

1.4 Measurements and variables

1.4.1 Instrumentation general

All instrumentation used in the test shall be (re-)calibrated within at least one year before each test and should be re-calibrated if it reaches its Channel Amplitude Class (CAC) during any test.

The measurement data shall be recorded according to ISO 6487 or SAE J211/1 (2022) at a minimum sample frequency of 20kHz.

1.4.2 VUT instrumentation

Location	Parameter	CAC
B-Pillar - LHS & RHS	Acceleration, A_x	150g
Driver's seatbelt shoulder section	Force, $F_{diagonal}$	16kN
Row 1 passenger's seatbelt shoulder section	Force, $F_{diagonal}$	16kN
Low voltage battery - including secondary batteries	Supply voltage, V_{low}	60V
High voltage battery	Propulsion voltage, V_{high}	1000V

B-pillar accelerometers are to be fitted to a tolerance of ±1 degree and parallel to the X-axis of the vehicle.

Seatbelt loadcells shall weigh <100g and be calibrated in accordance with the procedure in ISO/TS 7242:2014.
Where the fitment of the shoulder belt loadcell significantly influences the natural position of the belt, the loadcell may be supported from above with the use of a weak non-metallic wire or thread. Where loadcells are to be placed on any seatbelts equipped with pretensioners, ensure that the loadcell is placed far enough away from the D-loop to ensure there is no interaction as the pretensioner fires. Where any CRS does not allow the loadcell to be placed a sufficient distance from the D-loop do not attach the loadcell.

1.4.3 MPDB trolley instrumentation

Location	Parameter	CAC
Trolley C of G	Acceleration, A_x A_y A_z	150g
Trolley C of G, backup sensor	Acceleration, A_x A_y A_z	150g

2 TEST CONDITIONS

2.1 VUT preparation

In advance of test preparation, the OEM shall provide Euro NCAP and the test laboratory with the information detailed in Technical Bulletin CP 002. Prepare the vehicle as a two-seater as defined in Technical Bulletin CP 004 and perform pretest intrusion measurements.

2.2 Occupant compartment adjustments

Position the seats as detailed below. Adjustments not listed will be set to mid positions or the nearest position rearward, lowest or outboard. Adjustments are to be made following the order in each table.

Where specific settings are NOT indicated for either the driver or passenger, the same MDP and setting must be used for all occupants. For seat movement definitions, see CP 001.

2.2.1 50th percentile occupants

Adjustment	Required setting – THOR and Hybrid III
Fore/aft	Mid position between fully forward and 95th otherwise first notch rearwards, measured in lowest position.
Front seat cushion tilt	MDP permissible up to mid, otherwise mid
Front seat height	Lowest position
Front seat torso angle	MDP otherwise 25° torso angle
Front seat lumbar support	Fully retracted
Front seat cushion length	Fully retracted
Front head restraint	**Height:** Mid position **Fore/aft or tilt:** Mid position
Front seat belt anchorage	MDP otherwise mid

2.2.2 Other settings

Other settings	Required setting
Steering wheel	**50th percentile** - mid vertical and horizontal
Arm-rests – front and rear seats	Adjustable arm-rests on the seat back will have them positioned in the 'not in use' position. This position is to avoid interference with view of the pelvis. The arm rest may be fixed to avoid movement during the test. Adjustable arm rests as part of the centre console will have them positioned fully down and fully retracted. The lid of any arm rest/storage compartment shall be closed.
Side window glazing	**Front** – lowered. **Rear** - lowered or removed
Gear change lever	In the neutral position
Parking brake	Disengaged
Pedals	Normal position of rest or MDP for adjustable pedals
Doors	Closed. See Post Crash protocol for ADL requirements.
Roof	Lowered / stowed
Sunroof	Open or removed
Sun visors	Stowed
Rear view mirror	Normal position of use
Front passenger airbag	Enabled – Vehicles equipped with automatic restraint system (e.g. airbag/pretensioner) disabling and default OFF may require specific actions enable the airbag.

2.3 Adult dummy positioning

It is the intention that the dummy is not left to sit directly on the seat for more than 2 hours prior to the test. It is acceptable for the dummy to be left in the vehicle for a longer period, provided that the dummy position is checked no more than one hour prior to test.

Measure the location of the H-point manikin for the 50th percentile occupants using the procedure defined in Addendum 6 of M.R.1.

Once a dummy has been correctly positioned record the measurements defined in the relevant dummy stature Technical Bulletin.

2.3.1 Dummy Placement

If, after dummy positioning, the vehicle is moved or a test run is aborted ensure that the dummy has not moved from the intended pretest position. If there are difficulties with positioning of any dummy, the H-point location shall be the priority followed by the pelvic angle and then the torso angle.

The seat settings shall not be adjusted for dummy positioning unless specifically permitted in the dummy's positioning procedure. If the dummy cannot be positioned within the specified tolerances after three attempts, then it is to be placed as close to the tolerance limits as possible. Record all settings detailed in the table below and those which were not within tolerance.

2.3.2 50th THOR dummy positioning

Dummy part	Required setting
H-point	Within a square of ±13mm in X and Z of a point 20mm upward and 20mm forwards of the manikin H-point of the 50th percentile using the procedure described in Addendum 6 of M.R.1.
Pelvic angle	Tilt sensor shall read 0°±1° (X) and 33° ±2.5° (Y).
Torso angle	T1 neck tilt sensor 0°±1° (X) and ±1° (Y) with respect to the manufacturers neck T1 design angle. The THOR torso angle might be different to the H-point manikin design angle. The dummy's back shall be in contact with the seat back and the centre line of the dummy shall be lined up with the centre line of the seats. Push the shoulders fully rearward by hand.
Head	Head CoG tilt sensor 0°±1° (X) If there is contact between the head restraint and head that does not result in forwards movement of the CoG, do not adjust head restraint. If the head is pushed forwards by the head restraint, firstly move the head restraint rearwards in X, then in Z if required. If there is still interference and no further adjustment of the head restraint is possible continue with the test.
Upper arms	**Driver** - Adjacent to the torso as far as is possible. **Passenger** - Adjacent to the torso and against the seat back.
Hands	**Driver** - Palms placed against the steering wheel at a position of a quarter to three. The thumbs should be lightly taped to the steering wheel, where applicable, for the test. **Passenger** - Palms in contact with the outside of the legs and the little finger in contact with the seat cushion.

Dummy part	Required setting
Legs	If the knees are in contact with the facia or the gap is less than 30mm, move the dummy and seat rearwards until a gap of 30mm is achieved, or to the nearest notch rearwards. It must be possible to pass a sphere of 30mm diameter between the knee clevis flesh and facia (the tibia flesh shall be ignored). Record the new H-point location within the test details. The femurs shall be in contact with the seat cushion as far as possible. Set the initial distance apart of the outboard metal surfaces of the knee clevis flanges of each dummy to 270mm ± 10mm. When the left foot is placed on a footrest or the right foot is positioned onto the accelerator pedal as described below, the initial distance between the knees may be ignored. The femur and tibia for each leg shall be as close as possible to a vertical plane.
Feet	**Driver** - The right foot shall rest on the undepressed accelerator pedal with the heel on the floor. To keep the upper and lower legs in the same vertical plane, move the upper leg accordingly. If the foot cannot be placed on the pedal then it should be placed as far forwards as possible with the foot perpendicular to the lower tibia, in line with the centre line of the pedal. If a dedicated footrest is present, place the left foot fully on this rest providing a normal seating position can still be achieved. Keep the legs in the same vertical plane. The knee gap requirement of 270mm ± 10mm may be ignored in this case. Where there is no footrest, position the left foot at an equal distance from centre line of seat as the right leg is from centreline. The left foot should be placed as flat as possible on the toe-board parallel to the centreline of the vehicle. Note the knee gap in the test details. **Passenger** - The feet shall be placed with the heel as far forwards as possible with the feet as flat on the floor as possible. Both feet shall be parallel to the centreline of the vehicle.

2.3.3 HIII 50th percentile

Dummy part	Required setting
H-point	Within a square of ±13mm in X and Z of a point 6mm below the manikin H-point of the 50th percentile using the procedure described in Addendum 6 of M.R.1.
Pelvic angle	22.5° ±2.5° from the horizontal.
Torso angle	Dummy's back in contact with the seat back and the dummy centreline aligned with that of the seatback.
Head	The transverse instrumentation platform horizontal to within ±2.5°. Levelling of the head shall be carried out in this order: – Adjust the H-point within the limits – Adjust the pelvic angle within the limits – Adjust the neck bracket the minimum to ensure that the transverse instrumentation platform is level within limits. If there is contact between the head restraint and head that does not result in forwards movement of the CoG, do not adjust head restraint. If the head is pushed forwards by the head restraint, firstly move the head restraint rearwards in X, then in Z if required. If there is still interference and no further adjustment of the head restraint is possible continue with the test.
Upper arms	Adjacent to the torso as far as is possible.
Hands	Palms placed against the steering wheel at a position of a quarter to three. The thumbs should be lightly taped to the steering wheel, where applicable, for the test.
Legs	Femurs shall be in contact with the seat cushion as far as possible. Set the initial distance apart of the outboard metal surfaces of the knee clevis flanges of each dummy to 270mm ± 10mm. When the left foot is placed on a footrest or the right foot is positioned onto the accelerator pedal as described below, the initial distance between the knees may be ignored. The femur and tibia for each leg shall be as close as possible to a vertical plane.
Feet	The right foot shall rest on the undepressed accelerator pedal with the heel on the floor. To keep the upper and lower legs in the same vertical plane, move the upper leg accordingly. If the foot cannot be placed on the pedal then it should be placed as far forwards as possible with the foot perpendicular to the lower tibia, in line with the centre line of the pedal. If a dedicated footrest is present, place the left foot fully on this rest providing a normal seating position can still be achieved. Keep the legs in the same vertical plane. The knee gap requirement of 270mm ± 10mm may be ignored in this case. Where there is no footrest, position the left foot at an equal distance from centre line of seat as the right leg is from centreline. The left foot should be placed as flat as possible on the toe-board parallel to the centreline of the vehicle. Note the knee gap in the test details.

2.3.4 Seat belt

Adjust the seatbelt D-loop for the relevant occupant as detailed in the tables above, carefully place the seat belt across the dummy and lock as normal. It will be necessary to re-position the hands as described above.

Remove the slack from the lap section of the webbing until it is resting gently around the pelvis of the dummy. Only minimal force shall be applied to the webbing when removing the slack. The route of the lap belt should be as natural as possible.

Place one finger behind the diagonal section of the webbing at the height of the dummy sternum. Pull the webbing away from the chest horizontally forward and allow it to retract in the direction of the D-loop using only the force provided by the retractor mechanism. Repeat this step three times, only.

After following the above steps, the seatbelt should lie in a natural position across the dummy sternum assembly and shoulder clavicle. Where this is not the case, and the D-loop is adjustable, the anchorage shall be adjusted and steps above repeated. For example, an unnatural position would be where the belt is in contact with the neck, neck shield, vehicle seat or above the shoulder rotation adjustment screw (Hybrid III series only).

The upper anchorage should be adjusted by a sufficient amount to ensure a natural belt position, this may require multiple attempts. Where the belt position requires adjustment, pictures must be taken showing the pre and post adjustment position.

Once the belt is positioned the location of the belt should be marked across the dummy chest to ensure that no further adjustments are made. Mark also the belt at the level of the D-loop to be sure that the initial tension is maintained during test preparation.

Where the fitment of the shoulder belt or lap belt loadcell significantly influences the natural position of the belt, the loadcell may be supported from above with the use of a weak non-metallic wire or thread.

3 TEST PROCEDURES

3.1 MPDB

Front Occupants	Head & Neck	Chest & Abdomen	Knee, Femur & Pelvis	Lower leg, Foot & Ankle	Total points
Driver	2.50	2.50	2.50	2.50	**10.00**
Front passenger	2.50	2.50	2.50	2.50	**10.00**

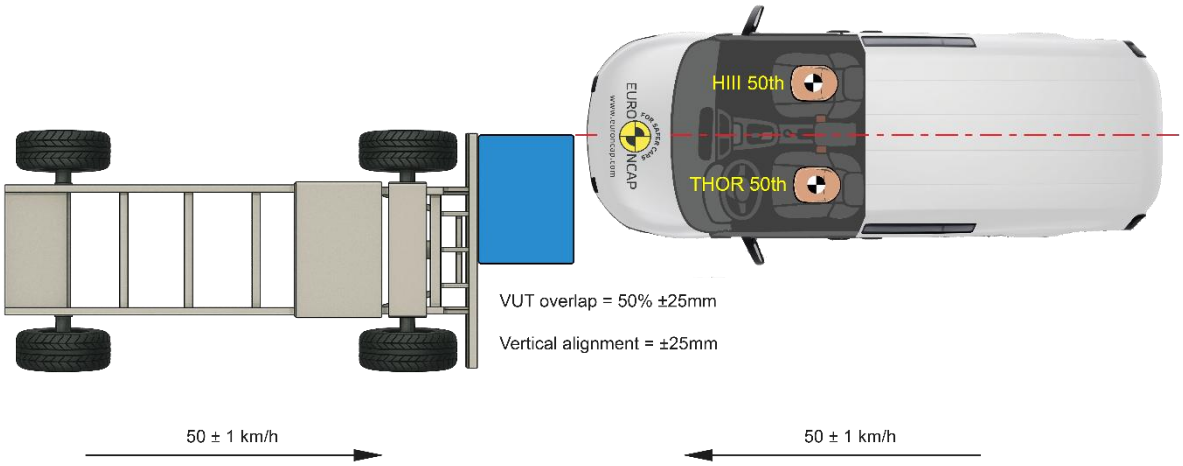

Figure 1 MPDB test

The laboratory shall include on the vehicle or MPDB face a physical means of identifying the overlap between the MPDB face and vehicle at T0.

A method may be employed to prevent secondary impacts between the vehicle and trolley. This may be an emergency braking system on the vehicle and trolley or another method. There must be no braking at T0. Braking must NOT begin until 100ms after the vehicle velocity has reached zero or 100ms after T0 where the vehicle continues to move forward.

Measure the speed of both the test vehicle and the trolley as near as possible to the point of impact. Record the actual test speeds in the test report.

If the impact alignment cannot be established, film analysis will be used to try to assess the alignment. Both the horizontal and vertical alignments shall be noted in the test report along with the impact angle of both the test vehicle and the trolley as near as possible to the point of impact.

3.2 Colour band scheme

Adult	Criterion		Green	Yellow	Orange	Brown	Red
Body region	**Limit value points**		< HPL 100%	80%	40%	20%	≥ LPL 0%
Head & Neck	HIC_{15}	-					
	A_{res}-3ms	g					
	$F_{X,shear}$	kN					
	$F_{Z,tension}$	kN					
	$M_{Yextension}$	Nm					
Chest & Abdomen	$D_{chest\ compression}$	mm					
	$V_{viscous\ criterion}$	m/s					
	$D_{abdomen\ compression}$	mm					
Knee, femur and pelvis	$F_{acetabulum}$	kN					
	F_{femur}	kN					
	D_{knee}	mm					
Lower Leg, Foot & Ankle	I_{tibia}	-					
	F_{tibia}	kN					

3.2.1 Prediction by OEM

The vehicle manufacturer may provide the Euro NCAP Secretariat with colour predictions detailing the protection offered by the vehicle based on CAE or in-house test data, which may then be used in the vehicle rating. Predictions must be provided to the Euro NCAP Secretariat before any test preparation begins. In order for ANY predicted data to be used in the rating, all of the following requirements must be met:

Prediction is provided for MPDB.

Prediction is provided for all dummies and applicable dummy assessment criteria detailed in Section 3.2 & 3.3.

Prediction is provided based on dummy performance without modifiers applied.

The predicted level of protection offered by the vehicle is verified by Euro NCAP with the use of the full scale tests. The difference between the predicted data and that recorded in the official test must be within 25% of the colour band width for each assessment criterion (LPL-HPL)/3.

When a measured dummy parameter performs better or worse than predicted, but within the tolerance, the predicted result is used in the rating. When a measured dummy parameter performs better or worse than predicted and is outside the tolerance, the measured value shall be used in the rating. After the results comparison has been made, any modifiers identified will then be applied to the relevant body regions and test scores.

An example of the prediction and scoring method is detailed in Technical Bulletin CP 006.

Where the OEM provides no predicted data or the data provided does not meet the requirements detailed above in this section, the vehicle rating shall be based on the measured results obtained in the official test.

3.3 Injury criteria and limits

Where multiple criteria exist for an individual body region, the lowest scoring parameter is used to determine the performance of that region. Capping limits will not be applied to sled and virtual test assessments.

3.3.1 Head & neck

Criterion		HIII 50th		THOR 50th	
		HPL - LPL	Capping	HPL - LPL	Capping
HIC_{15}	-	500 - 700	700	500 - 700	700
A_{res}-3ms	g	72 - 80	80	72 - 80	80
$F_{X,shear}$	kN	1.9 - 3.1	3.10	1.9 - 3.1	3.1
$F_{Z,tension}$	kN	2.7 - 3.3	3.30	2.7 - 3.3	3.3
$M_{Yextension}$	Nm	42 - 57	57	42 - 57	57

A hard contact is assumed if the peak resultant head acceleration exceeds 80g or if there is other evidence of hard contact. Only where the peak resultant head acceleration A_{res} exceeds 80g or there is a hard contact, will the limits for HIC_{15} and A_{res}-3ms be applied.

3.3.2 Chest & abdomen

Criterion		HIII 50th		THOR 50th	
		HPL - LPL	Capping	HPL - LPL	Capping
$D_{chest\ compression}$	mm	20 – 42[2]	42	35 - 60[1]	60
$V_{viscous\ criterion}$	m/s	0.5 - 1.0	1.0	-	-
$D_{abdomen\ compression}$	mm	-	-	88	-

Biomechanical limits applicable to LPL only - 45 year old[1], 65 year old[2]

The THOR chest assessment is based on the maximum compression of all four ribs, R_{max}.

3.3.3 Knee, femur & pelvis

Criterion		HIII 50th HPL - LPL	THOR 50th HPL - LPL
$F_{acetabulum}$	kN	-	3.3 - 4.1
F_{femur}	kN	3.8 - 9.1	3.8 - 9.1
D_{knee}	mm	6 - 15	6 - 15

3.3.4 Lower leg, foot & ankle

Criterion		HIII 50th HPL - LPL	THOR 50th HPL - LPL
I_{tibia}	-	0.4 - 1.3	0.4 - 1.3
F_{tibia}	kN	2.0 - 8.0	2.0 - 8.0

3.3.5 Compatibility

The compatibility score is calculated as defined in technical bulletin CP 005. Where a vehicle starts with the full points available and score is deducted based on the compatibility score.

4 POSTTEST ASSESSMENT & INSPECTION

4.1 After test

Immediately after the test, check that none of the doors and boot lids have opened or partially opened during the test. Where this is the case photographic evidence shall be obtained and provided in the test report.

Refer to the Euro NCAP Post Crash protocol for further details of all post-test assessments and provide all required information in a Post crash report.

4.1.1 Dummy removal

Before dummy removal, refer to the Post Crash protocol for seat belt buckle unlatching.

Before dummy removal, measure the distance between all foot pedals and a fixed point in the footwell, e.g. seat runner, seat mounting bolt. If access cannot be gained remove the dummies taking care not to disturb any pedals and then record the measurement. This measurement should be re-checked before the pedals are measured with the 3D measuring system. If the pedal has moved re-position the pedal using the measurement taken previously.

Do not move the driver or passenger seats, try to remove the dummies. If the dummies cannot be removed with the seats in their original positions, recline the seat back and try again. Note any entrapment of the dummies. If the dummies can still not be removed, try to slide the seats rearwards on their runners. If the dummies can still not be moved, the seats may be cut out of the car.

Record the method used to remove the dummies.

4.2 Post test static measurements

Measure and record the post test vehicle intrusion defined in Technical Bulletin CP 004. Perform the post test barrier face scan as defined in CP 007.

4.3 Inspection

After the test, Euro NCAP will perform a vehicle inspection where scoring modifiers can be applied.

4.3.1 Occupant Modifiers

The modifier penalties mentioned in the table below are defined as a percentage of the maximum body region score for each dummy, in each loadcase and are applied to that body region. Further details regarding the modifiers and how they are applied to the rating can be found in Technical Bulletin CP 007.

Adult Occupants	Modifiers	Criterion	Modifier score
Head & neck	Head bottoming out	Inspection	-20%
	Unstable airbag contact	Inspection	-20%
	Hazardous airbag deployment	Inspection	-20%
	DAMAGE (THOR-50)	0.42 ≤ DAMAGE < 0.47 ≥ 0.47	-20% -40%
	Incorrect airbag deployment	Inspection	-20%
Chest	Steering wheel contact	Inspection	-20%
	Shoulder belt load	50th Percentile ≥ 6.00kN	-40%
	Incorrect airbag deployment	Inspection	-20%
Knee, femur and pelvis	Submarining	Inspection	-100%
	Knee load – Variable	≥ 3.8kN or 6.0mm Inspection	-20%
	Knee load – Concentrated	Inspection	-20%
	Incorrect airbag deployment	Inspection	-20%
Lower leg, foot and ankle	Pedal displacement	Rearward ≥ 100mm Rearward ≥ 200mm Vertical 72mm	-50% -100% -20%
	Pedal blocking	50mm	-20%

4.3.2 Test Modifiers

The modifier penalties mentioned in the table below are defined as a percentage of the maximum MPDB test score.

Test penalties	Modifiers	Criteria	modifier score
A-pillar	Rearward displacement	100mm	-2.5%
Steering column displacement	Rearward Vertical Lateral	90mm 72mm 90mm	-1.25%
Bodyshell integrity		Inspection	-1.25%
Footwell rupture		Inspection	-1.25%
Door opening	Per door	Inspection	-2.5%
Door detachment	Structural detachment	Inspection	-50%
Restraint failure		Inspection	-50%