INTERNATIONAL STANDARD

ISO 13232-8

Second edition
2005-12-15

Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles —

Part 8: Documentation and reports

Motocycles — Méthodes d'essai et d'analyse de l'évaluation par la recherche des dispositifs, montés sur les motocycles, visant à la protection des motocyclistes contre les collisions —

Partie 8: Documentation et rapports

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 13232-8 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.

This second edition cancels and replaces the first version (ISO 13232-8:1996), which has been technically revised.

ISO 13232 consists of the following parts, under the general title *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles*:

— *Part 1: Definitions, symbols and general considerations*

— *Part 2: Definition of impact conditions in relation to accident data*

— *Part 3: Motorcyclist anthropometric impact dummy*

— *Part 4: Variables to be measured, instrumentation and measurement procedures*

— *Part 5: Injury indices and risk/benefit analysis*

— *Part 6: Full-scale impact-test procedures*

— *Part 7: Standardized procedures for performing computer simulations of motorcycle impact tests*

— *Part 8: Documentation and reports*

Introduction

ISO 13232 has been prepared on the basis of existing technology. Its purpose is to define common research methods and a means for making an overall evaluation of the effect that devices which are fitted to motorcycles and intended for the crash protection of riders, have on injuries, when assessed over a range of impact conditions which are based on accident data.

It is intended that all of the methods and recommendations contained in ISO 13232 should be used in all basic feasibility research. However, researchers should also consider variations in the specified conditions (for example, rider size) when evaluating the overall feasibility of any protective device. In addition, researchers may wish to vary or extend elements of the methodology in order to research issues which are of particular interest to them. In all such cases which go beyond the basic research, if reference is to be made to ISO 13232, a clear explanation of how the used procedures differ from the basic methodology should be provided.

ISO 13232 was prepared by ISO/TC 22/SC 22 at the request of the United Nations Economic Commission for Europe Group for Road Vehicle General Safety (UN/ECE/TRANS/SCI/WP29/GRSG), based on original working documents submitted by the International Motorcycle Manufacturers Association (IMMA), and comprising eight interrelated parts.

This revision of ISO 13232 incorporates extensive technical amendments throughout all the parts, resulting from extensive experience with the standard and the development of improved research methods.

In order to apply ISO 13232 properly, it is strongly recommended that all eight parts be used together, particularly if the results are to be published.

Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles —

Part 8: Documentation and reports

1 Scope

This part of ISO 13232 provides a common basis for:

— test and simulation documentation;

— data exchange;

— confirmation of results by other researchers;

— direct comparison of results between different facilities;

— enabling other researchers to reproduce the experiment; and

— the recommended minimum contents of publications which describe tests done according to ISO 13232.

ISO 13232 specifies the minimum requirements for research into the feasibility of protective devices fitted to motorcycles, which are intended to protect the rider in the event of a collision.

ISO 13232 is applicable to impact tests involving:

— two-wheeled motorcycles;

— the specified type of opposing vehicle;

— either a stationary and a moving vehicle or two moving vehicles;

— for any moving vehicle, a steady speed and straight-line motion immediately prior to impact;

— one helmeted dummy in a normal seating position on an upright motorcycle;

— the measurement of the potential for specified types of injury by body region;

— evaluation of the results of paired impact tests (i.e. comparisons between motorcycles fitted and not fitted with the proposed devices).

ISO 13232 does not apply to testing for regulatory or legislative purposes.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13232-1, *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles — Part 1: Definitions, symbols, and general considerations*

ISO 13232-2, *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles — Part 2: Definition of impact conditions in relation to accident data*

ISO 13232-3, *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles — Part 3: Motorcyclist anthropometric impact dummy*

ISO 13232-4, *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles — Part 4: Variables to be measured, instrumentation, and measurement procedures*

ISO 13232-5, *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles — Part 5: Injury indices and risk/benefit analysis*

ISO 13232-6, *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles — Part 6: Full-scale impact test procedures*

ISO 13232-7, *Motorcycles — Test and analysis procedures for research evaluation of rider crash protective devices fitted to motorcycles — Part 7: Standardized procedures for performing computer simulations of motorcycle impact tests*

49 CFR Part 572, subpart E: 1993, Anthropometric test dummies, United States of America Code of Federal Regulations issued by the National Highway Traffic Safety Administration (NHTSA) Washington, D.C.

3 Requirements

3.1 Documentation for full-scale impact tests

All full-scale impact tests which are intended to meet ISO 13232 shall be documented to include the information specified on forms A.1 through A.8 in Annex A.

The extent to which the requirements, recommendations, and procedures of ISO 13232 have or have not been followed shall be documented on form A.7.

A complete set of documentation for a full-scale test shall include the complete information in Annex A, including still photographs and plots, plus copies of the films from the required high speed cameras.

3.2 Documentation for computer simulations

All computer simulations which are intended to meet ISO 13232 shall be documented to include the information specified on forms B.1 through B.8 in Annex B.

The extent to which the requirements, recommendations, and procedures of ISO 13232 have or have not been followed shall be documented on form B.7.

3.3 Documentation for risk/benefit analysis

All risk/benefit analyses which are intended to meet ISO 13232 shall be documented to include the information specified on forms C.1 through C.3 in Annex C.

The extent to which the requirements, recommendations, and procedures of ISO 13232 have or have not been followed shall be documented on form C.3.

3.4 Recommendations regarding publication of results

The test or computer simulation documentation forms described in Annexes A or B, respectively, should be completed prior to publication of results of any test or computer simulation which is intended to meet ISO 13232, and which cites ISO 13232 in the text of the publication.

The risk/benefit analysis documentation forms described in Annex C should be completed prior to publication of results of any risk/benefit analysis which is intended to meet ISO 13232 and which cites ISO 13232 in the text of the publication.

3.4.1 Full-scale test publications

Any publications concerning full-scale tests which are intended to meet ISO 13232, should include the following information, at a minimum.

3.4.1.1 Impact conditions

The publication should include:

a) a description and drawing of the nominal impact configuration, according to the conventions described in ISO 13232-2;

b) photographs (or tracings of photographs) from the high speed camera film for MC top view and MC side view of the frame immediately preceding first MC/OV contact;

c) data for each test measured according to the procedures defined in ISO 13232-4:

   1) MC impact speed,

   2) OV impact speed,

   3) OV contact point,

   4) relative heading angle,

   5) MC roll angle,

   6) change in dummy helmet centroid point and joint locations with respect to the MC relative to the pre-test set up photography.

3.4.1.2 Items not complied with

A list and explanation of all items not complied with, based upon form A.7, should be included in the publication.

3.4.1.3 Vehicle information

The following information should be included in the publication:

— OV make and model;

— MC make and model;

— photographs or scaled drawings of the protective device, in at least two views (from front, side, or top), as fitted, and deployed, if deployable.

3.4.1.4 Impact sequence information

The impact sequence data described in A.8.2 should be included in the publication.

3.4.1.5 Performance data

A listing of values for all of the injury assessment variables, injury potential variables, and injury indices described in ISO 13232-5 and listed in A.8.4 should be included in the publication.

3.4.1.6 Paired comparison information

Only tests which meet the impact condition requirements described in 4.5 of ISO 13232-6 should be published.

Only complete paired comparisons (i.e., results for both the standard MC and the MC with protective device) should be published.

If an out of tolerance test is published, the publication should clearly identify for each such test:

— that the test was out of tolerance;

— the amount by which it was out of tolerance;

— that according to ISO 13232, such test is not considered to be a valid basis for a paired comparison.

The following minimum information should be included in the publication.

3.4.1.6.1 Paired comparisons summary statements

Within each paired comparison:

d) if the injury assessment variables, injury potential variables, and injury indices all show the same kind of effect of the protective device (e.g., all variables show benefits, or all show harm, or all show no effect), then a statement of this should be included in the publication;

e) if the variables are mixed with regard to the effect of the protective device, then a statement of this should be included. In this case, the result should be summarized in the publication by referring to the effect of the protective device on:

   1) the body region of interest (e.g., the head for a head protective device, or leg for a leg protective device),

   2) the head injury potential variables,

   3) the normalized probable injury cost.

3.4.1.6.2 Comparisons across impact configurations summary statements

For each set of paired comparisons (i.e., involving more than one impact configuration), and for a given protective device, the following minimum information should be included in the publication:

— for all of the injury assessment variables, injury potential variables, and injury indices listed in Table 1, summary statements of the following form should be included, depending on the test results (the following is an example);

EXAMPLE "In four out of seven test pairs the neck maximum torsion moment increased, in two out of seven test pairs it remained the same, and in one out of seven test pairs it decreased, when the protective device was fitted."

— if zero precedes "out of" in the summary statement (e.g., "in zero out of seven test pairs"), then the phrase containing the zero may be omitted;

— a statement referring to the need to evaluate protective devices across the population of impact configurations.

3.4.2 Risk/benefit analyses publications

Any publications concerning risk/benefit analysis which are intended to meet ISO 13232 should include the information in form C.2, and a list and explanation of all items not complied with, based upon form C.3, at a minimum.

Table 1 — List of injury assessment variables, injury potential variables, and injury indices for inclusion in publications of paired comparisons

Injury assessment variable, injury potential variable, injury index	Time window
Head maximum GAMBIT;	Entire
HIC;	Entire
Head PAIS;	Entire
Neck NII;	Entire
Neck PAIS;	Entire
Chest PAIS;	Entire
Abdomen PAIS;	Entire
Number of femur fractures;	Entire
Number of knee dislocations;	Entire
Number of tibia fractures;	Entire
Maximum vertical difference in helmet trajectory (protective device minus baseline);	Primary
Percentage change in helmet resultant velocity (protective device compared to baseline);	At first helmet/OV contact
Partial permanent incapacity index;	Entire
Probability of fatality;	Entire
Risk of life threatening brain injury, from HIC;	Entire
Total normalized injury cost.	Entire

Annex A
(normative)

Forms for full-scale impact test documentation

The forms which are required to be completed for documentation of each full-scale impact test are given below.

Form A.1 is the document cover page. A.2 contains the motorcycle information. A.3 contains the protective device information. A.4 contains the opposing vehicle information. A.5 contains information on the dummy and instrumentation. A.6 contains impact condition information. A.7 contains a compiled checklist of procedures. A.8 contains the resulting test data.

A.1 Documentation for motorcycle/opposing vehicle full-scale impact test

According to ISO 13232

Test number:_____

Motorcycle/protective device:_____

Impact configuration code:_____

Test number to which this test is being compared:_____

Test facility:_____

NOTE Complete all information on the following pages. For items requiring yes/no responses, indicate "no" if the response is unknown or negative. Wherever a negative response (i.e., "no") is given, attach an explanation.

A.2 Motorcycle information (ISO 13232-6, 5.2.2)

Manufacturer:		
Model:		
Year:		
Engine displacement: cc		
Optional accessories, as tested:		
Colour, as tested:		
Frame serial number:		
Weight (empty, no dummy, with test equipment and protective device, if fitted):	Front:	kg
	Rear:	kg
	Total:	kg
		Yes No
Pre-test photographs (without dummy) are attached (side, front views)		☐ ☐
At the time of the test, the motorcycle was in sound condition with no structural damage or alteration except those related to the fitment of the protective device, if present:		Yes No ☐ ☐

A.3 Protective device information (if fitted)

Device description:	
	Yes No
Photographs or scale drawings in two views are attached:	☐ ☐

A.4 Opposing vehicle information (ISO 13232-6, 4.1)

Manufacturer:
Model:
Year:
Colour, as tested:
Vehicle identification number:

Test weight (with test equipment per ISO 13232-6, 5.2.1):		Left front:	kg
		Right front:	kg
		Left rear:	kg
		Right rear:	kg
		Total:	kg
Measured overall length:	cm	Reference OV curb mass:	kg
Measured overall width:	cm	Reference OV curb mass:	kg
Measured overall height:	cm		

	Yes	No
Pre-test photographs attached (side, front views):	☐	☐

A.5 Dummy and instrumentation information (ISO 13232-3, ISO 13232-4, ISO 13232-6)

A.5.1 Dummy mechanical

	Yes	No
The test dummy meets the requirements of ISO 13232-3:	☐	☐

Notes:
Number of full-scale impact tests since calibration of (ISO 13232-6, 4.3.1):
head:
neck:
thorax:
knee, L:
knee, R:
Total dummy mass, including sensors, DAS, and permanently mounted cables.

A.5.2 Dummy frangible component conformity of production test data (ISO 13232-3)

Component	Manufacturer	Lot number	Initial and subsequent COP data attached	
			Yes	No
Abdominal insert:				
Frangible femurs: L				
R				
Frangible knee shear pins: L varus valgus				
L torsion				
R varus valgus				
R torsion				
Frangible knee compliance elements: L varus valgus				
L torsion				
R varus valgus				
R torsion				
Frangible tibias: L				
R				
All frangible components were new and not previously used:				

A.5.3 Sensor, data acquisition and post processing systems verification (ISO 13232-6)

	Yes	No
The verification test described in 4.3.3 and 5.3.1 was done and the time history plots are attached:	☐	☐

A.5.4 Joint tensions (ISO 13232-6)

	Yes	No
All joint tensions were set according to Annex A	☐	☐

A.5.5 Helmet (ISO 13232-6)

Manufacturer:	Serial number:	Lot number:	
Model:	Size: ☐ S (56 cm);	☐ M (58 cm)	
		Yes	No
Meets all requirements of 4.3.7:		☐	☐
The helmet was installed on the dummy according to Annex D:		☐	☐
Dimension A of the helmet alignment tool was not modified:		☐	☐
If modified, the new dimension was:			mm

A.5.6 Instrumentation (ISO 13232-4)

A.5.6.1 Electronic variables recorded (4.1)

Time histories for the following recorded variables are attached in A.8.3 in the following sequence:

Required electronic variables recorded:	Recorder channel	Full-scale recording and plotting range	Plot page sequence	Plot attached to A.8.3			
				Primary		Secondary	
				Yes	No	Yes	No
First MC/OV contact occurrence[a]							
Head:							
a_1		± 400 *g*	1				
a_2		± 400 *g*	1				
a_3		± 400 *g*	1				
a_4		± 400 *g*	2				
a_5		± 400 *g*	2				
a_6		± 400 *g*	2				
a_7		± 400 *g*	3				

Required electronic variables recorded:	Recorder channel	Full-scale recording and plotting range	Plot page sequence	Plot attached to A.8.3			
				Primary		Secondary	
				Yes	No	Yes	No
a_8		± 400 *g*	3				
a_9		± 400 *g*	3				
Chest:							
l_{uL}		± 60 mm	6				
l_{uR}		± 60 mm	6				
l_{lL}		± 60 mm	6				
l_{lR}		± 60 mm	6				
Upper neck:							
$F_{x,n}$		± 15 kN	4				
$F_{y,n}$		± 15 kN	4				
$F_{z,n}$		± 30 kN	4				
$M_{x,n}$		± 700 N • m	5				
$M_{y,n}$		± 1000 N • m	5				
$M_{z,n}$		± 700 N • m	5				
Upper femurs (required for leg protective device research):							
$F_{z,uF,L}$		± 12 kN	7				
$M_{x,uF,L}$		± 600 N • m	7				
$M_{y,uF,L}$		± 600 N • m	7				
$F_{z,uF,R}$		± 12 kN	8				
$M_{x,uF,R}$		± 600 N • m	8				
$M_{y,uF,R}$		± 600 N • m	8				
Upper tibias (required for leg protective device research):							
$M_{x,uT,L}$		± 400 N • m	9				
$M_{y,uT,L}$		± 400 N • m	9				

Required electronic variables recorded:	Recorder channel	Full-scale recording and plotting range	Plot page sequence	Plot attached to A.8.3			
				Primary		Secondary	
				Yes	No	Yes	No
$M_{x,uT,R}$		± 400 N • m	9				
$M_{y,uT,R}$		± 400 N • m	9				

Permissible electronic variables recorded:	Recorder channel	Full-scale recording and plotting range	Plot page sequence	Plot attached to A.8.3			
				Primary		Secondary	
				Yes	No	Yes	No
Lumbar spine:							
$F_{x,l}$		± 5 kN	10				
$F_{y,l}$		± 5 kN	10				
$F_{z,l}$		± 10 kN	10				
$M_{x,l}$		± 500 N • m	11				
$M_{y,l}$		± 500 N • m	11				
$M_{z,l}$		± 250 N • m	11				
Upper femurs:							
$M_{z,uF,L}$		± 400 N • m	7				
$M_{z,uF,R}$		± 400 N • m	8				
Lower femurs:							
$F_{z,lF,L}$		± 12 kN	12				
$M_{x,lF,L}$		± 500 N • m	12				
$M_{y,lF,L}$		± 500 N • m	12				
$M_{z,lF,L}$		± 300 N • m	12				
$F_{z,lF,R}$		± 12 kN	13				
$M_{x,lF,R}$		± 500 N • m	13				
$M_{y,lF,R}$		± 500 N • m	13				
$M_{z,lF,R}$		± 300 N • m	13				
Upper tibias:							

Permissible electronic variables recorded:	Recorder channel	Full-scale recording and plotting range	Plot page sequence	Plot attached to A.8.3			
				Primary		Secondary	
				Yes	No	Yes	No
$M_{z,uT,L}$		± 200 N • m	14				
$M_{z,uT,R}$		± 200 N • m	14				
Lower tibias:							
$F_{z,lT,L}$		± 40 kN	15				
$M_{x,lT,L}$		± 400 N • m	15				
$M_{y,lT,L}$		± 400 N • m	15				
$F_{z,lT,R}$		± 40 kN	16				
$M_{x,lT,R}$		± 400 N • m	16				
$M_{y,lT,R}$		± 400 N • m	16				
Other data plots							

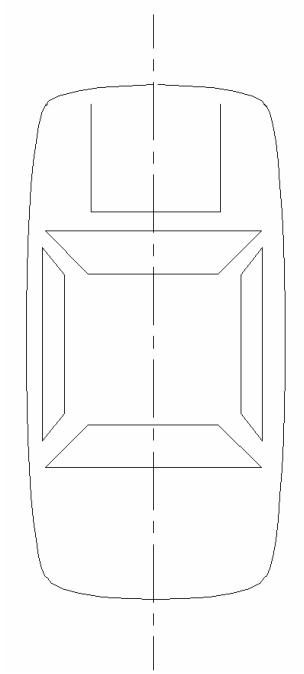
[a] Label the first MC/OV contact signal on all plots on which it appears.

A.5.6.2 Data acquisition external cable usage (according to 4.5 and 4.5.1 of ISO 13232-4)

	Yes	No
There were no external cables attached to the dummy except detachable cables, as described in 4.5.1. Only detachable cables, meeting the requirements of 4.5, were used (recommended):		
Non-detachable cables were used (not recommended):		
a) If used, each non-detachable cable had a mass of less than or equal to 1/3 kg:		
b) If used, each non-detachable cable had a length of greater than or equal to 12 m:		
c) If used, the total mass of the non-detachable cables was less than or equal to 4 kg:		
d) If used, the non-detachable cables were arranged so that each was unrestrained:		
e) If used, the non-detachable cables were not attached to the MC, the dummy, or any other cable, except at the cable extremities:		
f) If used, the non-detachable cables were attached to the rear portion of the pelvis:		

A.6 Impact condition information (ISO 13232-2, ISO 13232-4, ISO 13232-6)

A.6.1 Nominal test condition (according to ISO 13232-2)



Code:_____ _____ _____ - _____ /_____

OVCP MCCP RHA OVS MCS

m/s m/s

Indicate with an arrow approximately 2 cm long, which represents the MC, the intended orientation and position of the MC centre line at first MC/OV contact.

Indicate with a dot the intended contact point on the OV, and on the MC centre line (front end, mid-point, or rear end).

A.6.2 Motorcycle (with or without dummy, as specified) (ISO 13232-6)

	Yes No
Requirements described in 5.2.2 were met:	☐ ☐
Hand grip outboard end height at centre (before dummy is placed on the MC) (C.1) L:_____cm; R:_____cm	
	Yes No
Handlebars are adjusted to the same position for all tests within a paired comparison:	☐ ☐
Ride height, centre of headlamp (5.3.5)	cm
Ride height, centre of taillamp (5.3.5)	cm
Overall length (5.2.2)	cm
Type of foot rest (C.2.2):	

A.6.3 Dummy (positioned on MC) (ISO 13232-6)

Which procedure was used to position the boots: C.2.2.1, C.2.2.2, or C.2.2.3?			
			Yes ☐ No ☐
Did any part of the right boot lie below the brake pedal?			☐ ☐
If yes, the distance from the forward edge of the right boot to the forward edge of the right foot rest:			cm
			Yes ☐ No ☐
Did any part of the left boot lie below the gear shift pedal?			☐ ☐
If yes, the distance from the forward edge of the left boot to the forward edge of the left foot rest:			cm
Distance between knee centre line indices (C.2.3):			cm
K point location (from rear axle, MC centre line, ground) (C.2.4)	x_k	y_k	z_k
L:	cm	cm	cm
R:	cm	cm	cm
S point location (from rear axle, MC centre line, ground) (C.2.4)	x_s	y_s	z_s
L:	cm	cm	cm
R:	cm	cm	cm
Upper torso pitch angle (forward of vertical): (C.2.4.2) _____deg			
			Yes ☐ No ☐
Upper torso pitch angle set at standard value: (C.2.4)			☐ ☐
If "no", then the reason was because there was an obstruction between the dummy _____ and the _____.			
Pre-test MC roll angle with dummy (C.2.4.3) _____.			
			Yes ☐ No ☐
Helmet alignment tool upper edge was horizontal: (D.3)			☐ ☐
If "no", then the helmet alignment tool upper edge deviation from the horizontal			deg
Lower serrated neck joint setting _____deg flexion ☐ extension ☐			
Center serrated neck joint setting _____deg extension			

A.6.4 Opposing vehicle (ISO 13232-6)

Ride height (5.2.1)	Measured values	Reference values
Front, lowest point of bonnet at forward end of bonnet centre line:	cm	cm
Right, highest point of front door:	cm	cm
Left, highest point of front door:	cm	cm
Rear, lowest point of boot lid at rearward end of boot lid centre line:	cm	cm

A.6.5 Pre-test measurements (ISO 13232-4, ISO 13232-8)

	Yes	No
Camera specification page attached (see ISO 13232-8, A.6.5.1):	☐	☐
Target location page attached (see ISO 13232-8, A.6.5.2):	☐	☐
Photograph of the MC with the dummy in the proper position is attached (ISO 13232-4, 4.7):	☐	☐

Perpendicular distances from targets to camera lens (ISO 13232-4, 5.1):	MC side view camera	MC top view camera	OV side view camera
Ground target 1			———
Ground target 2			———
MC main frame front target			———
MC main frame rear target			———
OV side reference target	———	———	
Helmet centroid			———

Distance between photo-optic or electro-mechanical contact switches, if used (ISO 13232-4, 5.1):	
OV: cm	MC: cm

A.6.5.1 Camera set up information (ISO 13232-4, 4.6 and 4.7)

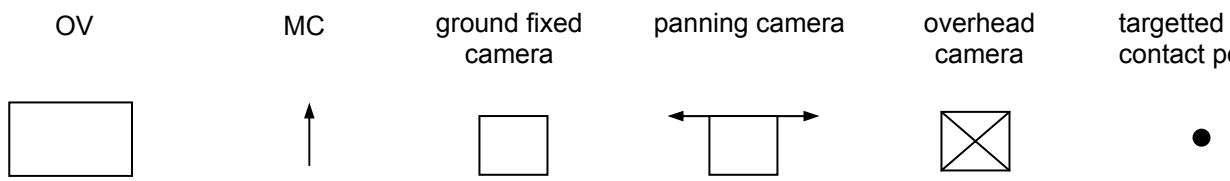
Instructions:

1) Sketch the top view of the test layout and camera positions in the box at the right, using the defined symbols and including the targetted OV contact point.

2) Sketch the + x axis to be in the direction of initial motion of either the MC or the OV, along the track or rail, and beginning at the targetted OV contact point as defined in ISO 13232-2, Figure 1, as expected at first MC/OV contact, projected to ground level.

3) Sketch the + y axis to be 90° clockwise from the + x axis. Consider the + z axis to be into the ground.

(Not to scale)



Camera number	Field of view	Nominal frame rate f/s	Film width mm	Lens focal length mm	Camera location x m	Camera location y m	Camera location z m	Film analysis interval frames	Field of view width[a] m
1	MC side, narrow (required)								
2	MC top, narrow (required)								
3	MC rear (or front) (required)								
4	OV side (required, if OV speed is from film)								
5	MC side (required)	still							
6									
7									
8									
9									
•									
•									

[a] At first MC/OV contact

A.6.5.2 Ground target location information (ISO 13232-4, 4.3.4)

Instructions:

1) Sketch the top view of the test layout and ground target positions in the box at the right, using the defined symbols and including the targetted OV contact point.

2) Sketch the + x axis to be in the direction of initial motion of either the MC or the OV, along the track or rail, and beginning at the targetted OV contact point as defined in ISO 13232-2, Figure 1, as expected at first MC/OV contact, projected to ground level.

3) Sketch the + y axis to be 90° clockwise from the + x axis. Consider the + z axis to be into the ground.

4) For the table below, the origin for the ground targets is as noted as in 2, above, at ground level.

(Not to scale)

OV MC targetted OV contact point targets

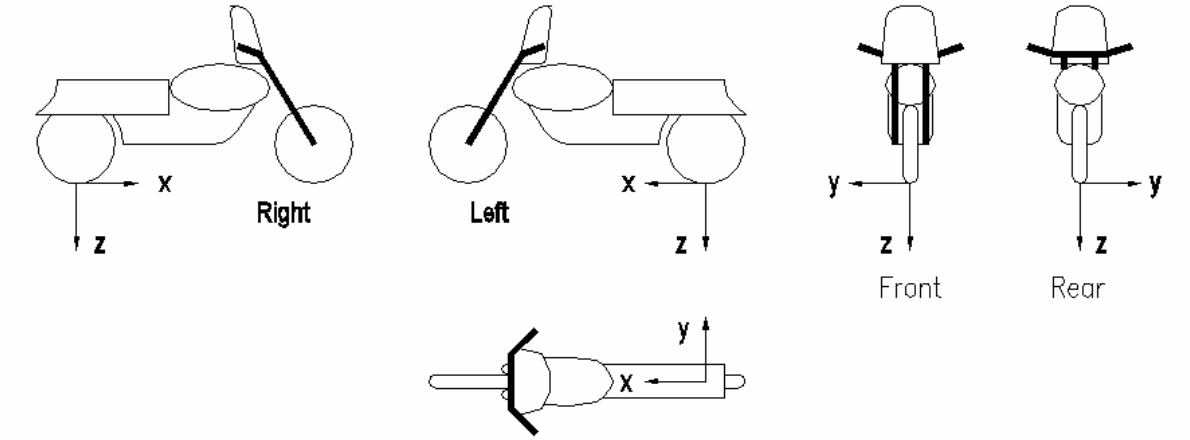
Target	Description	Target location x m	y m	z m
A				
B				
C				
D				
E				
F				
G				
H				
I				
J				
K				
L				
M				

Target	Description	Target location x m	y m	z m
N				
O				
P				
Q				
R				
S				
T				
U				
V				
W				
X				
Y				
Z				

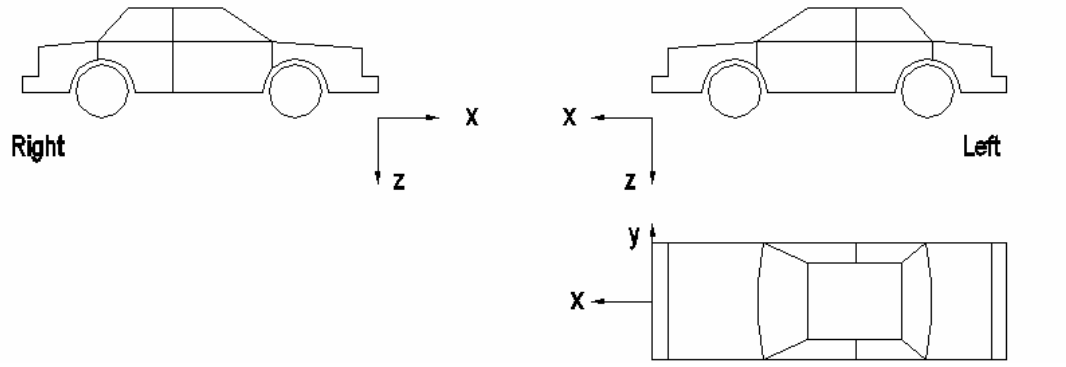
Test number _____

A.6.5.3 MC and OV target information (ISO 13232-4, 4.3.2 and 4.3.3)

Mark and number the MC and OV targets on the drawings provided. Complete the respective tables.



Target	Description	Target location		
		x, m	y, m	z, m
MC-1				
MC-2				
MC-3				
MC-4				
.				



Target	Description	Target location		
		x, m	y, m	z, m
OV-1				
OV-2				
OV-3				
OV-4				
.				
.				
.				

Test number _____

A.6.6 Measured impact conditions (ISO 13232-4 and ISO 13232-6)

		Absolute tolerance requirement met		Relative tolerance requirement met with respect to test number: _____ (ISO 13232-6, 4.5.4)	
		Yes	No	Yes	No
Relative heading angle (ISO 13232-4, 5.3.2):	deg				
OV impact speed (ISO 13232-4, 5.3.1): measurement was electronic ☐ or film analysis ☐	m/s				
MC impact speed (ISO 13232-4. 5.3.1): measurement was electronic ☐ or film analysis ☐	m/s				
MC roll angle (ISO 13232-4, 5.3.3):	deg				
OV contact point from reference point (centre line of OV leading edge) (ISO 13232-4, 5.3.4):	cm				

Dummy target positions (ISO 13232-4, 5.3.5):	Pre-test image			Pre-impact image			Tolerance met (± 3 cm) (pre-test to MC/OV pre-impact)	
	x	y	z	x	y	z	Yes	No
Helmet centroid	cm	cm	cm	cm	cm	cm		
Shoulder	cm	cm	cm	cm	cm	cm		
Hip	cm	cm	cm	cm	cm	cm		
Knee	cm	cm	cm	cm	cm	cm		
Ankle	cm	cm	cm	cm	cm	cm		

Photographs are attached for:	Yes	No
Pre-test image:		
MC side view frame		
MC top view		
Pre-impact image:		
MC side view		
MC top view		
Frame preceding first MC/OV contact:		
MC side view		
MC top view		
MC front or rear view		

Test number _____

A.6.7 Ambient conditions (ISO 13232-6)

The requirements for the following conditions were met:	Yes	No
The temperature in all dummy preparation areas was between 13° C and 30° C (4.5.5):		
If "no," was the soaking procedure required (4.5.5)?		
If "yes," was the soaking procedure used (5.7)?		
Wind velocity (4.5.5):		
Test surface gradient (4.5.5):		

Enter the time and temperature of each dummy preparation area, measured while the dummy was in the area, beginning at least three hours before the planned time of impact.

Time		Air temperature in area, °C:					
Start	End	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6

Actual impact time:

Each time the dummy was moved to a new area, record the start and end times. Each new area should be recorded on a separate line.

Area	Description
1	
2	
3	
4	
5	
6	

Test number _____

A.7 Checklist for full-scale impact test procedures

NOTE This checklist lists all requirement subclause titles, with pertinent procedure subclauses listed below the specific requirements. Each required procedure subclause must be complied with, in addition to the requirement. Procedure subclauses are indicated with an asterisk (*).

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
Part 3 Motorcyclist anthropometric impact dummy (all referenced figures and tables are in ISO 13232-3)						
4.1 Basis dummy	√					
4.2 Motorcyclist dummy head skins (see Figure A.1)	√					
4.3.1 Neck shroud (see Figure A.2)	√					
4.3.2 Lower neck mount (see Figure A.3)	√					
4.3.3 Motorcyclist neck (see Figures A.4 and A.5)	√					
* 6.8 Motorcyclist neck dynamic axial torsion test (see Figure A.30)	√					
4.3.4 Replacement nodding blocks (see Figure A.6)	√					
4.4.1 Replacement thoracic spine		√				
4.4.2 Modified chest skin	√					
4.5.1 Modified straight lumbar spine (see Figures A.7 - A.10)	√					
4.5.2 Motorcyclist dummy abdominal insert (see Table 1 and Figure A.11)	√					
* 6.7 Frangible abdomen test (see Figure A.29)	√					
4.5.3 Sit/stand pelvis	√					
4.6 Modified elbow bushing (see Figure A.12)	√					
4.7 Motorcyclist dummy hands	√					
4.8.1 Frangible femur bone and mounting hardware (see Table 2 and Figures A.13 and A.14)	√					
* 6.1 Frangible bone static bending deflection test (see Table 6)	√					
* 6.2 Frangible bone static torsional deflection test	√					
* 6.3 Frangible bone dynamic bending fracture test (see Figures A.20 -A.26)	√					
* 6.4 Frangible bone dynamic torsional fracture test	√					
* 6.5 Frangible femur bone static axial load fracture test (see Figure A.27)	√					
4.8.2 Femur load cell simulator, if load cell not used (see Figure A.15)	√					
4.9 Motorcyclist dummy frangible knee assembly (see Table 3 and Figure A.16)	√					
* 6.6 Frangible knee static strength and deflection test (see Figure A.28)	√					
4.10 Leg retaining cables	√					
4.11.1 Frangible tibia bone and mounting hardware (see Table 4 and Figures A.17 and A.18)	√					

a "Req" denotes a requirement of ISO 13232; "Rec" denotes a recommendation of ISO 13232; "Per" denotes an item which is permitted by ISO 13232.

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
Part 3 Motorcyclist anthropometric impact dummy (all referenced figures and tables are in ISO 13232-3) (continued)						
* 6.1 Frangible bone static bending deflection test (see Table 6)	√					
* 6.2 Frangible bone static torsional deflection test	√					
* 6.3 Frangible bone dynamic bending fracture test (see Figures A.20 - A.26)	√					
* 6.4 Frangible bone dynamic torsional fracture test	√					
4.11.2 Modified lower leg skin (see Figure A.19)	√					
5.1 Frangible component initial conformity of production	√					
5.2 Frangible component subsequent conformity of production (see Table 5)	√					
7.1 Marking	√					
7.2 Documentation	√					
Part 4 Variables to be measured, instrumentation, and measurement procedures (all referenced figures and tables are in ISO 13232-4)						
4.1.1 Required electronically recorded variables	√					
* 5.2.1 Electronic data reduction (see Table 7)	√					
a) first MC/OV contact occurrence	√					
* 5.1 Pre-test measurements related to data reduction	√					
* 5.2.4.1 Time base analysis	√					
b) head (nine linear accelerometers):						
1) a_1	√					
2) a_2	√					
3) a_3	√					
4) a_4	√					
5) a_5	√					
6) a_6	√					
7) a_7	√					
8) a_8	√					
9) a_9	√					
4.4.1.1 Head accelerometers (see Figures 1 and 2)	√					
c) chest:						
1) l_{uL}	√					
2) l_{uR}	√					
3) l_{lL}	√					
4) l_{lR}	√					
4.4.1.3 Chest potentiometers (see Figure 3)	√					
4.1.1.1 Upper neck:						
1) $F_{x,n}$	√					
2) $F_{y,n}$	√					

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
3) $F_{z,n}$	√					
4) $M_{x,n}$	√					
Part 4 Variables to be measured, instrumentation, and measurement procedures (all referenced figures and tables are in ISO 13232-4) (continued)						
5) $M_{y,n}$	√					
6) $M_{z,n}$	√					
4.4.1.2 Upper neck load cell	√					
4.1.1.2 Required for leg protective device evaluation						
a) left and right upper femur:						
1) $F_{z,uF}$	√					
2) $M_{x,uF}$	√					
3) $M_{y,uF}$	√					
4.4.1.5 Upper femur load cells	√					
b) left and right upper tibia:						
1) $M_{x,uT}$	√					
2) $M_{y,uT}$	√					
4.4.1.6 Frangible leg bone strain gauges (see Table 2 and Figure 4)	√					
* 5.2.2 Calibration of frangible leg bone strain gauges	√					
4.1.3 Permissible electronically recorded variables						
a) lumbar spine:						
1) $F_{x,l}$			√			
2) $F_{y,l}$			√			
3) $F_{z,l}$			√			
4) $M_{x,l}$			√			
5) $M_{y,l}$			√			
6) $M_{z,l}$			√			
4.4.1.4 Lumbar load cell			√			
b) left and right upper femur						
1) $F_{z,uF}$			√			
2) $M_{x,uF}$			√			
3) $M_{y,uF}$			√			
4) $M_{z,uF}$			√			
4.4.1.5 Upper femur load cells			√			
c) left and right lower femur:						
1) $F_{z,lF}$			√			
2) $M_{x,lF}$			√			
3) $M_{y,lF}$			√			
4) $M_{z,lF}$			√			

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
4.4.1.6 Frangible leg bone strain gauges (see Table 2 and Figure 4)			√			
d) left and right upper tibia						
1) $M_{x,uT}$			√			
2) $M_{y,uT}$			√			
3) $M_{z,uT}$			√			

Part 4 Variables to be measured, instrumentation, and measurement procedures (all referenced figures and tables are in ISO 13232-4) (continued)

4.4.1.6 Frangible leg bone strain gauges (see Table 2 and Figure 4)			√			
f) left and right lower tibia:						
1) $F_{z,lT}$			√			
2) $M_{x,lT}$			√			
3) $M_{y,lT}$			√			
4.4.1.6 Frangible leg bone strain gauges (see Table 2 and Figure 4)			√			
4.2 Mechanically recorded variables						
a) abdomen maximum residual penetration	√					
b) left and right femur fracture occurrence	√					
c) left and right knee varus valgus dislocation occurrence	√					
d) left and right knee torsional dislocation occurrence	√					
e) left and right tibia fracture occurrence	√					
4.4.2 Mechanical sensor specifications	√					
1) abdominal foam insert	√					
2) frangible femur and tibia bones	√					
3) knee compliance elements	√					
4) knee shear pins	√					
* 5.2.3 Frangible component data reduction	√					
* 5.2.3.1 Tibia and femur bones	√					
* 5.2.3.2 Knee torsional and varus valgus shear pins	√					
* 5.2.3.3 Abdominal insert	√					
4.3.1 Helmet centroid point						
* 5.2.4.2 Helmet trajectory analysis	√					
* 5.1 Pre-test measurements related to data reduction	√					
* Annex A Digitizing the helmet centroid point	√					
1) x_h	√					
2) y_h	√					
3) z_h	√					
4.3.2 Motorcycle photographic targets	√					
a) upper and lower centre line	√					
b) front and rear centre line	√					
c) main frame front and rear references	√					

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
4.3.3 Opposing vehicle photographic targets (see Table 1)	√					
a) bonnet centre line, 100 mm rearward of bonnet leading edge	√					
b) bonnet centre line, 100 mm forward of bonnet trailing edge	√					
c) roof centre line, 100 mm rearward of roof leading edge	√					
d) boot lid centre line, 100 mm forward of boot lid trailing edge	√					

Part 4 Variables to be measured, instrumentation, and measurement procedures (all referenced figures and tables are in ISO 13232-4) (continued)

e) boot lid centre line, 100 mm rearward of boot lid leading edge	√					
f) body side reference	√					
4.3.4 Ground fixed photographic targets	√					
4.3.4.1 MC side view and MC top view	√					
4.3.4.2 MC rear or MC front view	√					
4.3.4.3 OV side view	√					
4.3.5 Dummy photographic targets	√					
* 5.3.5 Dummy position verification	√					
4.5 Internal data acquisition and recording system specifications	√					
a) no external cables attached to the dummy (except pre-crash, detachable)		√				
b) detachable cables required no more than 5 N to detach	√					
4.5.1 Not recommended external cables		√				
a) only detachable cables were used		√				
b) if used, individual non-detachable cable mass was not greater than 1/3 kg	√					
c) if used, individual non-detachable cable length was not less than 12 m	√					
d) if used, total non-detachable cable mass was not greater than 4 kg	√					
e) if used, non-detachable cables were arranged so that each was unrestrained	√					
f) if used, non-detachable cables were not attached to the MC, dummy, or any other cable, except at the cable extremities	√					
g) if used, non-detachable cables were attached to dummy at rear portion of the pelvis	√					
4.5.2 Data acquisition	√					
4.5.2.1 Sensor excitation	√					
4.5.2.2 Anti alias filtering for digital systems	√					
4.5.2.3 Analog to digital conversion specification for digital systems (see Table 3)	√					
4.5.2.4 Storage capacity	√					
4.5.2.5 Mechanical specifications for the internal data acquisition system	√					
4.5.2.6 Scaling of variables (see Table 4)	√					
4.6.1 High speed camera specifications	√					

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
4.6.2 Required high speed cameras (see Table 5 and Table B.1)	√					
a) MC top view	√					
b) MC side view	√					
c) MC rear or front view	√					
d) OV side view	√					
* 5.1 Pre-test measurements related to data reduction	√					
Part 4 Variables to be measured, instrumentation, and measurement procedures (all referenced figures and tables are in ISO 13232-4) (continued)						
4.6.3 Recommended high speed cameras						
a) MC oblique view		√				
b) MC front view (see Table 5)		√				
c) OV front or rear view		√				
d) OV side view		√				
4.7 Still photography						
a) dummy position verification (see Table 6)	√					
b) frangible component condition documentation	√					
* 5.2.3 Frangible component data	√					
* 5.3.1 MC and OV impact tests	√					
* 5.2.4.2.3 Depth correction factors	√					
* 5.3.2 Relative heading angle at impact	√					
* 5.3.3 MC roll angle at impact	√					
* 5.3.4 OV contact point (see Figures 8a, 8b, and 8c)	√					
* 6 Documentation	√					
Part 5 Injury indices and risk/benefit analysis (all referenced figures and tables are in ISO 13232-5)						
4.1.1 Injury assessment variables						
a) $G_{\max}$						
* 5.1.2 GAMBIT	√					
b) HIC						
* 5.1.3 HIC	√					
c) $a_{r,H,\max}$						
* 5.1.1 Resultants	√					
d) $C_{us,\max,norm}$, $C_{ls,\max,norm}$						
* 5.1.4 Upper and lower sternum compression (see Figure 1)	√					
e) $VC_{us,\max}$, $VC_{ls,\max}$ for V_{us}, $V_{ls} \geq 3$ m/s						
* 5.1.5 Upper and lower sternum velocity	√					
* 5.1.6 Upper and lower sternum velocity-compression	√					
f) $p_{A,\max}$	√					
g) NII						
* 5.1.8 Neck injury index	√					

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
4.1.2 Injury potential variables						
a) x_h versus z_h	√					
b) $V_{r,h,fc}$	√					
c) $V_{x,h,fc}$	√					
d) $V_{y,h,fc}$	√					
e) $V_{z,h,fc}$	√					
* 5.1.7 Helmet centroid point component velocities	√					
4.2 Lower extremity injuries						

Part 5 Injury indices and risk/benefit analysis (all referenced figures and tables are in ISO 13232-5) (continued)

a) bone fractures	√					
b) knee dislocations	√					
* 5.2 Frangible component damage	√					
4.3 Injury severity probabilities						
a) $ISP_{Gmax,H}$, $ISP_{HIC,H}$						
* 5.3.1 Head ISP (see Table 1)	√					
b) $ISP_{C,us}$, $ISP_{C,ls}$						
* 5.3.2 Chest ISP (see Table 2)	√					
c) $ISP_{VC,us}$, $ISP_{VC,ls}$						
* 5.3.2 Chest ISP (see Table 3)	√					
d) ISP_A						
* 5.3.3 Abdomen ISP (see Table 4)	√					
e) ISP_n						
* 5.3.4 Neck ISP (see Table 5)	√					
4.4 Injury indices						
a) probability of discrete AIS injury severity level for each body region						
* 5.4.1 Head, neck, thorax, abdomen	√					
* 5.4.2 Lower extremities	√					
* 5.4.2.1 Number of injuries (see Table 5)	√					
* 5.4.2.2 Probability of an injury of a specific severity level (see Table 6)	√					
* 5.4.2.3 Permanent partial injury (see Table 7)	√					
b) medical costs						
* 5.5.1 Medical costs	√					
c) ancillary costs						
* 5.5.2 Ancillary costs	√					
d) cost of fatality						
* 5.5.3 Fatality cost	√					
e) probability of fatality						
* 5.6.1 Due to AIS 6 injuries	√					
* 5.6.2 Due to non-AIS 6 injuries	√					

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
* 5.6.3 Overall	√					
f) risk of life threatening brain injury						
* 5.6.4 Risk of life threatening brain injury (see Figure 2)	√					
g) PAIS						
* 5.7.1 By body region	√					
h) maximum PAIS						
* 5.7.2 Maximum PAIS	√					
i) total PAIS						
* 5.7.3 Total PAIS	√					
Part 5 Injury indices and risk/benefit analysis (all referenced figures and tables are in ISO 13232-5) (continued)						
j) normalized injury costs						
* 5.8 Normalized injury costs	√					
6 Documentation	√					
Part 6 Full-scale impact test procedures (all referenced figures and tables are in ISO 13232-6)						
4.1 Opposing vehicle						
* 5.2.1 Opposing vehicle set up (see Table 3)	√					
4.2 Motorcycle						
* 5.2.2 Motorcycle set up (see Figure 1)	√					
* 5.4 Stationary MC support	√					
4.3.1 Motorcyclist anthropometric impact dummy	√					
a) head calibration (see 49 CFR FMVSS 572.32)	√					
b) neck calibration (see 49 CFR FMVSS 572.33)	√					
c) thorax calibration (see 49 CFR FMVSS 572.34)	√					
d) knee calibration (see 49 CFR FMVSS 572.35)	√					
4.3.2 Instrumentation	√					
4.3.3 Sensor, data acquisition, and post processing systems verification	√					
* 5.3.1 Sensor, data acquisition, and post processing systems verification (see Figure 2 and Table 4)	√					
4.3.4 Joint tensions						
* 5.3.2 Joint tensions						
* Annex A Procedure to set dummy joint tensions	√					
4.3.5 Dummy clothing	√					
4.3.6 Position dummy on motorcycle						
* 5.3.4 Pre-mount preparation						
* Annex B Procedure for dummy pre-mount preparation	√					
* 5.3.5 Mount on motorcycle						
* Annex C Procedure for positioning the dummy on the motorcycle	√					
4.3.7 Dummy helmet						
* Annex D Procedure to install the helmet on the dummy and position the dummy head	√					

	Req[a]	Rec[a]	Per[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
				Yes	No	
4.4 Photographic equipment						
* 5.3.6 Film analysis targetting	√					
* 5.5 Camera set up	√					
4.5 Impact conditions	√					
4.5.1 Pre-test measurement	√					
* 5.6 Pre-test measurements	√					
4.5.2 Post-test measurement	√					
4.5.3 Vehicle speed control	√					
4.5.4.1 Required relative tolerances for paired comparisons (see Table 1)	√					

Part 6 Full-scale impact test procedures (all referenced figures and tables are in ISO 13232-6) (continued)

4.5.4.2 Recommended OV contact point relative tolerances for other impact configurations (see Table 2)		√				
4.5.4.3 Required absolute tolerances for paired comparisons (see Table 1)	√					
4.5.4.4 Number of tests for paired comparisons	√					
4.5.5 Ambient conditions	√					
* 5.7 Temperature soaking	√					
5.1 Impact conditions	√					
6 Documentation and reporting	√					

Test number _____

A.8 Resulting data

A.8.1 Post-test photographs (ISO 13232-4, 5.2.3)

	Yes	No
Dummy frangible element photographs attached	☐	☐
Was there a loss of dummy leg due to failure of the leg retaining cables?	☐	☐

A.8.2 Impact sequence

NOTE Complete the following table, describing the main impact events, as observed in the high speed films, including but not limited to: first MC/OV contact (at time 0,000 s); and all helmet contacts.

EXAMPLE "helmet - impacts - roof edge - 0,107 s"; "MC - rotates - left - 0,030 s to 0,096 s")

Subject	Action	Object struck or direction of action	Approximate time s

Test number _____

A.8.3 Time histories of electronically recorded and calculated variables from full-scale tests

Yes No

Time histories for electronically recorded variables from full-scale tests (see A.5.6.1) are attached here: ☐ ☐

Time histories for the following calculated variables from full-scale tests are attached here in the following sequence:

Variable	Full-scale plotting range	Plot page sequence	Plot attached			
			Primary		Secondary	
			Yes	No	Yes	No
$a_{x,H}$	± 400 *g*	17				
$a_{y,H}$	± 400 *g*	17				
$a_{z,H}$	± 400 *g*	17				
$a_{r,H}$	0 *g* to 400 *g*	17, 19				
$\alpha_{x,H}$	± 40 krad/s^2	18				
$\alpha_{y,H}$	± 40 krad/s^2	18				
$\alpha_{z,H}$	± 40 krad/s^2	18				
$\alpha_{r,H}$	0 krad/s^2 to 40 krad/s^2	18, 19				
G	0 to 2,0	19				
NII	0 to 12	20				
$M_{x,oc,n}$	± 700 N•m	20				
$M_{y,oc,n}$	± 1000 N•m	20				
$D_{x,us}$ [a]	± 100 mm	21				
$D_{y,us}$	± 100 mm	21				
$D_{x,ls}$ [a]	± 100 mm	21				
$D_{y,ls}$	± 100 mm	21				
$C_{us,norm}$	0% to 80%	22				
V_{us}	0 m/s to - 5,0 m/s	22				
VC_{us}	0 m/s to 3,0 m/s	22				
$C_{ls,norm}$	0% to 80%	23				
V_{ls}	0 m/s to - 5,0 m/s	23				
VC_{ls}	0 m/s to 3,0 m/s	23				
$V_{x,h}$	- 6 m/s to 18,0 m/s	24			——	——
$V_{y,h}$	± 10,0 m/s	24			——	——
$V_{z,h}$	± 10,0 m/s	24			——	——
$V_{r,h}$	0 m/s to 18,0 m/s	24			——	——

[a] Place a note on the plot if $D_{x,us}$ or $D_{x,ls}$ exceeds 75 mm.

Plot for the following variables are attached here

z_h vs. x_h	z_h: -1 000 mm to -1 700 mm	25			——	——
	x_h: 0 mm to 2 500 mm					

Test number _____

— plot area for each variable is a rectangular box 50 mm high (variable axis) by 175 mm wide (time axis);

— maximum of four plots per page, in the order listed in A.5.6.1 and A.8.3;

— time axis labelling:

  — primary window: -0,050 s to 0,500 s in 0,050 s increments;

  — secondary window: 0,500 s to 3,000 s in 0,500 s increments;

  — each plot shall include all data points including data drop outs if present;

  — if data drop outs are present on a plot they shall be labelled as such;

— for each variable, the maximum and the minimum values and times of occurrence are listed inside the upper right corner of the plot;

— it data drop outs are present on a plot the listed maximum and minimum values affected by data drop outs shall be labelled as "invalid" and the maximum and minimum values and time of occurrence for all data points excluding the data drop outs shall be listed below the invalid values and identified as "with drop outs removed";

— for each variable, the physical units are labelled inside the upper left corner of the plot;

— for all electronically recorded variables, use the range values listed in A.5.6.1;

— for each plot, except for z_h, the upper edge of the box shall be labelled with the maximum value of the range, the lower edge with the minimum value of the range, and the midpoint with the middle of the range, to the left of the plot;

— the z_h plot shall be labelled with -1 700 at the upper edge and - 1 000 at the lower edge;

— for each plot, the variable name shall be labelled to the left of the plot;

— for each page, the test number shall be labelled in the upper right corner with the label "primary" or "secondary" in the upper left corner;

— for each page, the plot page number shall be specified at the centre bottom.

Test number _____

A.8.4 Table of results

Table A.1 — Primary impact results

Body region	Injury assessment variable	Value	$IC_{i,norm}$	PAIS or AIS
Head	G_{max}			
	HIC value:			
	t_1/t_2	/		
Neck	NII_{max}			
Chest	$C_{us,max}$			
	$C_{ls,max}$			
	$V_{Cus,max}$ (for $V_{us} \geq 3$ m/s)[a]			
	$VC_{ls,max}$ (for $V_{ls} \geq 3$ m/s)[a]			
Abdomen	$p_{A,max}$			
Femur L	Fracture	No ☐ Yes ☐		
Femur R		No ☐ Yes ☐		
Tibia L	Fracture	none ☐ non-disp ☐ disp ☐		
Tibia R		none ☐ non-disp ☐ disp ☐		
Knee L	Dislocation	none ☐ part ☐ compl ☐		
Knee R		none ☐ part ☐ compl ☐		
Legs	———	———		———

[a] for V_{us} or V_{ls} < 3 m/s, enter "N/A"

P_{fatal}	MAIS	TAIS	IC_{norm}

$Risk_{HIC}$

PPI

Head injury potential variables

z_h vs x_h	(see A.8.3)
$V_{r,h,fc}$	
$V_{x,h,fc}$	
$V_{y,h,fc}$	
$V_{z,h,fc}$	

Time of head to OV contact =_____s

Test number _____

Table A.2 — Entire impact sequence results

Body region	Injury assessment variable	Value	$IC_{i,norm}$	PAIS or AIS
Head	G_{max}			
	HIC value:			
	t_1/t_2	/		
Neck	NII_{max}			
Chest	$C_{us,max}$			
	$C_{ls,max}$			
	$VC_{us,max}$ (for $V_{us} \geq 3$ m/s)[a]			
	$VC_{ls,max}$ (for $V_{ls} \geq 3$ m/s)[a]			
Abdomen	$p_{A,max}$			
Femur		No Yes		
L	Fracture	☐ ☐		
R		☐ ☐		
Tibia		non- none disp disp		
L	Fracture	☐ ☐ ☐		
R		☐ ☐ ☐		
Knee		none part compl		
L	Dislocation	☐ ☐ ☐		
R		☐ ☐ ☐		
Legs	———	———		———

[a] for V_{us} or V_{ls} < 3 m/s, enter "N/A"

P_{fatal}	MAIS	TAIS	IC_{norm}

$Risk_{HIC}$

PPI

Annex B
(normative)

Forms for computer simulation documentation

The forms which are required to be completed for documentation of all computer simulations for each motorcycle and protective device are given below.

Form B.1 is the document cover page. The modelling information forms for the motorcycle are contained in B.2, for the protective device in B.3, for the opposing vehicle in B.4, and for the dummy in B.5. B.6 contains the simulation calibration data forms for the laboratory and full-scale tests. B.7 contains the checklist for the computer simulation procedures. B.8 contains the failure mode and effects analysis results forms.

B.1 Documentation for motorcycle/opposing vehicle impact computer simulation

According to ISO 13232

Motorcycle: _____

Protective device: _____

Computer simulation facility: _____

NOTE Complete all information on the following pages. For items requiring yes/no responses, indicate "no" if the response is unknown or negative. Wherever a negative response (i.e., "no") is given, attach an explanation.

Test number _____

B.2 Motorcycle modelling information (ISO 13232-7, 6.1)

B.2.1 General information

Manufacturer:
Model:
Year:
Total mass: kg
Wheelbase: cm
Highest point of seat behind dummy (immediately prior to impact): cm
Overall handlebar width: cm
Yes No Photograph or scaled drawing of model attached (side, front views): ☐ ☐

B.2.2 List of rigid bodies used (attach additional pages if necessary):

Body name	Joints		Contact surfaces	
	Name	Type	Name	Type
Front wheel[a]	Axle	Pin	Wheel surface	Ellipsoid

[a] "Front wheel" is given as an example body, only.

B.2.3 List of finite element bodies used (attach additional pages if necessary):

Body name	Finite elements	
	Type	Number
Front wheel[a]	Shell	300

[a] "Front wheel" is given as an example body, only.

Test number _____

B.3 Protective device modelling information, if fitted (ISO 13232-7, 6.1)

B.3.1 General information

Description:	
Total mass:	kg
Overall x_{MC} dimension:	cm
Overall y_{MC} dimension:	cm
Overall z_{MC} dimension:	cm
	Yes No
Photograph or scaled drawing of model attached (side, front views):	☐ ☐

B.3.2 List of rigid bodies used (attach additional pages if necessary):

Body name	Joints		Contact surfaces	
	Name	Type	Name	Type

B.3.3 List of finite element bodies used (attach additional pages if necessary):

Body name	Finite elements	
	Type	Number

Test number _____

B.4 Opposing vehicle modelling information (ISO 13232-7, 6.1)

B.4.1 General information

Manufacturer:	
Model:	
Year:	
Total mass:	kg
Overall length:	cm
Overall width:	cm
Overall height:	cm
	Yes No
Photograph or scaled drawing of model attached (side, front views):	☐ ☐

B.4.2 List of rigid bodies used (attach additional pages if necessary):

Body name	Joints		Contact surfaces	
	Name	Type	Name	Type

B.4.3 List of finite element bodies used (attach additional pages if necessary):

Body name	Finite elements	
	Type	Number

Test number _____

B.5 Dummy modelling information (ISO 13232-7, 6.1)

B.5.1 General information

Total mass:	kg
Overall height (standing):	cm
Overall width:	cm
Overall thickness:	cm
	Yes No
Photograph or scaled drawing of model attached (side, front views):	☐ ☐

B.5.2 List of rigid bodies used (attach additional pages if necessary):

Body name	Joints		Contact surfaces	
	Name	Type	Name	Type

B.5.3 List of finite element bodies used (attach additional pages if necessary):

Body name	Finite elements	
	Type	Number

Test number _____

B.6 Simulation calibration data (ISO 13232-7)

B.6.1 Laboratory component test calibration (4.5.1)

Simulation and test data for the following laboratory component tests are attached (using the form provided in ISO 13232-7, Figure A.1):	Yes	No
Motorcycle:		
fuel tank		
seat		
rear spring-damper (static)		
rear spring-damper (dynamic)		
front wheel		
Protective device:		
Opposing vehicle:		
roof rail		
side/disc edge		
side/disc side		
front bumper/disc edge		
front bumper/disc side		
rear bumper/disc edge		
rear bumper/disc side		
bonnet		
front windscreen		
front suspension		
rear suspension		

Test number _____

Simulation and test data for the following laboratory component tests are attached (using the form provided):	Yes	No
Dummy:		
helmeted head		
upper arm		
lower arm		
dummy thorax		
abdomen		
pelvis		
upper leg		
knee		
lower leg		
dummy knee torsion		
dummy knee varus valgus		
forward neck flexion		
rearward neck extension		
lateral neck flexion		
neck torsion		

B.6.2 Motorcycle laboratory dynamic test (ISO 13232-7, 4.5.2)

Measured MC/barrier impact speed (using procedures similar to ISO 13232-4, 5.3.1):		m/s
Simulation and laboratory time history plots of the following variables are attached (using plotting conventions similar to those described in A.8.3):	Yes	No
Front axle displacement		
Front suspension compression		
Fork bending angle		
MC centre of gravity x acceleration, left and right sides, as close as possible to cg		
MC centre of gravity y acceleration, left and right sides, as close as possible to cg		
MC centre of gravity z acceleration, left and right sides, as close as possible to cg		
MC centre of gravity x displacement		
MC centre of gravity y displacement		
MC centre of gravity z displacement		
MC pitch angle		
Barrier force		

Test number _____

B.6.3 Full-scale impact test correlation (4.5.3)

Number of full-scale impact tests for which data is available, for this MC (with and without the protective device fitted):		
List of full-scale test data available (attach additional pages, if necessary):		
Impact configuration code	Motorcycle (indicate "x" if data are available)	
	Baseline	With protective device

Test number _____

B.6.3.1 Electronic data

Overlaid simulated data full-scale test time histories and trajectories for the following variables are attached, for all tests.	Yes	No
Electronically recorded data:		
Head:		
$a_{x,H}$		
$a_{y,H}$		
$a_{z,H}$		
$a_{r,H}$		
$\alpha_{x,H}$		
$\alpha_{y,H}$		
$\alpha_{z,H}$		
$\alpha_{r,H}$		
G		
Neck:		
$F_{x,n}$		
$F_{y,n}$		
$F_{z,n}$		
$M_{x,n}$		
$M_{y,n}$		
$M_{z,n}$		
NII		
Chest:		
$C_{us,norm}$		
V_{us}		
VC_{us}		
$C_{ls,norm}$		
V_{ls}		
VC_{ls}		

Test number _____

Upper femurs (for leg protective device tests):	Yes	No
$F_{z,uF,L}$		
$M_{x,uF,L}$		
$M_{y,uF,L}$		
$F_{z,uF,R}$		
$M_{x,uF,R}$		
$M_{y,uF,R}$		
Upper tibias (for leg protective device tests):		
$M_{x,uT,L}$		
$M_{y,uT,L}$		
$M_{x,uT,R}$		
$M_{y,uT,R}$		

B.6.3.2 Data

Time histories:	Yes	No
Helmeted head:		
x displacement[a]		
y displacement		
z displacement		
resultant displacement		
resultant velocity		
Pelvis:		
x displacement		
y displacement		
z displacement		
resultant displacement		
resultant velocity		
Torso:		
pitch angle		
Motorcycle:		
pitch angle		
yaw angle		

Test number _____

z vs x trajectories:[b]	Yes	No
helmeted head		
shoulder		
hip		
knee		
ankle		

[a] Displacements are for helmet centroid and targets for test data, centre of gravity for simulation data.

[b] Trajectories are for corresponding dummy target locations in the simulation and full-scale test.

Test number _____

B.6.3.3 Frangible element damage data (attach additional pages, if necessary)

Impact configuration code	Baseline MC, or with protective device (B or P)	Damage occurrence (variables in parentheses, ( ), are for simulation)								
		Abdomen $p_{A,max}$ mm	Femur		Knee-varus valgus		Knee-torsion		Tibia	
			L	R	L	R	L	R	L	R
413-6,7/13,4	B	5(7)	N(N)	F(F)	N(D)	N(N)	N(N)	N(N)	F(F)	N(F)

NOTE 1 Example data shown.

NOTE 2 "F" denotes fracture

NOTE 3 "N" denotes none.

NOTE 4 "D" denotes dislocation.

Test number _____

B.6.3.4 Correlation results

B.6.3.4.1 Motion data for each full-scale test (attach additional pages as necessary) (ISO 13232-7, 4.5.3)

Item	Variable	Component	Correlation factor
Helmet centroid	Displacement	x	
		y	
		z	
		resultant	
	Velocity	resultant	
Hip target	Displacement	x	
		z	
		resultant	
	Velocity	resultant	
Torso	Angular displacement	pitch	
		Average	

	Yes	No
Meets minimum average		

Test number _____

B.6.3.4.2 Injury assessment variables and injury index data for each full-scale test, if data for 14 or more tests are available (attach additional pages as necessary) (ISO 13232-7, 4.5.3 and 5.4)

Impact configuration code	Baseline MC or with protective device (B or P)	Variable (value in parentheses, ( ), is for simulation)						
		Head	Femur fracture		Knee dislocation		Tibia fracture	
		$a_{r,H,max}$						
		g	L	R	L	R	L	R
225-0/13,4	B	80(92)	N(N)	N(N)	F(F)	N(N)	N(N)	F(F)

NOTE 1 Example data shown.

NOTE 2 "F" denotes fracture

NOTE 3 "N" denotes none.

NOTE 4 "D" denotes dislocation.

B.6.3.4.3 Results: (5.4)

Head, r^2:

Fraction correctly predicted, f:

- Femur
  - L:
  - R:
- Knee
  - L:
  - R:
- Tibia
  - L:
  - R:

Test number _____

B.7 Checklist for computer simulation procedures

	Req[a]	Rec[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
			Yes	No	
Part 7 Standardized procedures for performing computer simulations of motorcycle impact tests (all referenced figures and tables are in ISO 13232-7)					
4.1 Modelling (see Tables 1 and 2)	√				
4.2 Parameters	√	√			
4.3 Outputs (see Tables 1 and 2)	√				
4.4 Post processing	√				
4.4.1 Three dimensional animation	√	√			
4.4.2 Injury analysis	√				
4.4.3 Risk/benefit analysis and failure mode and effects analysis of proposed crash protective devices	√	√			
5.1.1 Calculations of injury assessment variables and injury indices (see Table 5)	√				
5.1.2 Potential failure modes and effects	√				
4.5 Simulation calibration	√				
4.5.1 Laboratory component test calibration (see Tables 1, 2, and 3)	√				
5.2 Simulated characteristics for laboratory component tests	√				
5.2.1 Static force/displacement tests (see Table 6)	√				
5.2.2 Dynamic force/time and force/displacement tests (see Tables 7, 8, and 9 and Figure 1)	√				
4.5.2 Motorcycle laboratory dynamic test	√				
5.3 Motorcycle barrier test	√				
4.5.3 Full-scale impact test correlation	√				
5.4 Full-scale impact test correlation (if data for 14 or more tests are available)	√				
5.4.1 Head maximum resultant linear acceleration correlation	√				
5.4.2 Leg injury correlations (see Table 10)	√				
4.5.4 Full-scale impact test comparisons (see Table 4)	√				
6.1 Simulation documentation (see Table 11)	√				
6.2 Laboratory component test calibration documentation (see Annex A)	√				
6.3 Motorcycle dynamic laboratory test documentation	√				
6.4 Full-scale test correlation documentation	√				
	a "Req" denotes a requirement of ISO 13232; "Rec" denotes a recommendation of ISO 13232.				

Test number ___________

B.8 Failure mode and effects analysis results (ISO 13232-7, 5.1)

Potential failure modes and effects (attach additional pages as necessary).

Complete the following table for the 200 impact configurations and place a box (□) around any positive value which occurs in a "C" column.

Impact configuration code	Values																																			
	Head															Neck PAIS			Chest PAIS			Abdomen PAIS			Femur (L & R) PAIS			Knee (L & R) PAIS			Tibia (L & TR) PAIS			IC_{norm}		
	$a_{r,H,max}$			$\square_{r,H,max}$			G_{max}			HIC			PAIS																							
	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C
225-0/13,4	100	80	-20	1,510	1,310	-200	0,4	0,3	-0,1	420	305	-115	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	2	[2]	2	0	-2	0,160	0,11	-0,05

NOTE 1 Example data shown

NOTE 2 "B" denotes baseline motorcycle.

NOTE 3 "P" denotes motorcycle with protective device.

NOTE 4 "C" denotes change due to protective device, i.e., "P" - "B".

Annex C
(normative)

Forms for risk/benefit analysis documentation

The forms which are required to be completed for documentation of all risk/benefit analyses for each motorcycle/protective device combination are given below.

Form C.1 is the document cover page. C.2 contains the risk/benefit analysis results forms. C.3 contains the checklists for risk/benefit analysis procedures.

C.1 Documentation for risk/benefit analysis

According to ISO 13232

Motorcycle:_____

Protective device:_____

Organization:_____

NOTE Complete all information on the following pages. For items requiring yes/no responses, indicate "no" if the response is unknown or negative. Wherever a negative response (i.e., "no") is given, attach an explanation.

C.2 Risk/benefit analysis results (see ISO 13232-5, 5.10)

C.2.1 Risk/benefit analysis data

Complete the following table for the 200 impact configurations (attach additional pages, as necessary).

Impact configuration code	Values																																					
	Head																	Neck PAIS			Chest PAIS			Abdomen PAIS			Femur (L & R) PAIS			Knee (L & R) PAIS			Tibia (L & TR) PAIS			IC_{norm}		
	$a_{r,H,max}$			$\square_{r,H,max}$			G_{max}			HIC			PAIS			hT	hV																					
	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	C	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C	B	P	C
225-0/13,4	100	80	-20	1,510	1,310	-200	0,4	0,3	-0,1	420	305	-115	0	0	0	-58	15	0	0	0	0	0	0	0	0	0	3	3	0	0	0	2	2	0	-2	0,160	0,11	-0,05

NOTE 1 Example data shown

NOTE 2 "B" denotes baseline motorcycle.

NOTE 3 "P" denotes motorcycle with protective device.

NOTE 4 "C" denotes change due to protective device, i.e., "P" - "B".

NOTE 5 "hT" denotes change in helmet trajectory, in millimetres

NOTE 6 "hV" denotes percentage change in helmet velocity at helmet impact, in percent.

C.2.2 Basis for risk/benefit analysis

Complete the following table for the 200 impact configurations (attach additional pages, as necessary).

Impact configuration code	Basis is: (mark with "x")			Required documentation per ISO 13232 is attached	
	ISO 13232				
	Full-scale test	Computer simulation	Other (describe)	Yes	No
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐
				☐	☐

C.2.3 Summary of risk/benefit analysis results

Complete the following tables, as specified in ISO 13232-5, 5.9.4

	Head			Neck	Chest				Abdomen	Normalized injury costs							
Percentage of impacts which are:	G_{max}	HIC	$a_{r,H,max}$	NII	$C_{us,max,norm}$ (%)	$C_{ls,max,norm}$ (%)	$VC_{us,max}$ (m/s)	$VC_{ls,max}$ (m/s)	$P_{A,\,max}$ (mm)	$IC_{H,norm}$	$IC_{n,norm}$	$IC_{Th,norm}$	$IC_{A,norm}$	$IC_{F,norm}$	$IC_{K,norm}$	$IC_{T,norm}$	IC_{norm}
Percentage beneficial																	
Percentage no effect																	
Percentage harmful																	
Average benefit																	
Average risk																	
Average risk/benefit percentage																	
Average net benefit																	
Average benefit per beneficial case																	
Average risk per harmful case																	

C.3 Checklist for risk/benefit analysis procedures

	Req[a]	Rec[a]	Complied with		Explanation, if not complied with (If necessary, attach additional pages)
			Yes	No	
Part 5 Injury indices and risk/benefit analysis (all referenced tables are in ISO 13232-5)					
5.10.1 Calculations of injury assessment variables and injury indices (see Table 9)	√				
5.10.2 Change in head injury potential	√				
5.10.2.1 Change in helmet trajectory	√				
5.10.2.2 Percentage change in helmet velocity at helmet impact	√				
5.10.3 Distributions of injury assessment variables, change in head injury potential, and injury indices (see Table 10)	√				
5.10.4 Risk/benefit calculations	√				
	a "Req" denotes a requirement of ISO 13232; "Rec" denotes a recommendation of ISO 13232.				

ICS 43.140

Price based on 58 pages