INTERNATIONAL STANDARD

ISO 13232-2

Second edition
2005-12-15

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

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 2: Définition des conditions de choc en fonction des données sur les accidents

Reference number
ISO 13232-2:2005(E)

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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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13232-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 22, *Motorcycles*.

This second edition cancels and replaces the first version (ISO 13232-2:1996), which has been technically revised.

ISO 13232 consists of the following parts, under the general title *Motorcycles — Test 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 2: Definition of impact conditions in relation to accident data

1 Scope

This part of ISO 13232 specifies minimum requirements for the collection and analysis of all motorcycle accident data, in order to provide:

- a standardized and representative sub-set of car/motorcycle accident data; and
- a sub-set of car/motorcycle impact conditions based on the analysis of this standardized accident data.

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; and
- 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: Definition, and general considerations*

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*

AIS-90:1990, Association for the Advancement of Automotive Medicine (AAAM), Des Plaines, IL, USA *The abbreviated injury scale, 1990 revision*

3 Definitions

The following terms are defined in ISO 13232-1. For the purposes of this part of ISO 13232, those definitions apply. Additional definitions which could apply to this part of ISO 13232 are also listed in ISO 13232-1:

— cell;

— cell range;

— centre line of the OV or MC;

— corner of the OV;

— MC front unsprung assembly;

— MC contact point;

— MC impact speed;

— nominal values;

— OV contact point;

— OV impact speed;

— overall length of the OV or MC;

— relative heading angle (rha);

— structural element of the MC.

4 Requirements

4.1 Impact variables

The following impact variables shall define an impact test or impact data for an accident:

— relative heading angle;

— opposing vehicle (OV) impact speed;

— motorcycle (MC) impact speed;

— OV contact point;

— MC contact point.

These variables shall be as defined in 4.3 for impact tests and in Annex A for accident reports.

4.2 Standardized accident configurations

Standardized accident configurations shall be used for overall evaluations of rider crash protective devices, for failure mode and effects analyses of such devices, and for full-scale impact tests intended to verify such analyses.

The standardized accident configurations and corresponding frequencies shown in Annex B, which are the result of applying the requirements of 4.2.2.1 and clause 5 to the combined accident data listed in Annex C, shall be used for such purposes.

NOTE The accident databases listed in Annex C were the only ones which met the requirements of this part of ISO 13232 and which were made available in a timely way to the group preparing ISO 13232.

4.2.1 Data collection for future revisions

In future revisions of ISO 13232, Annex B may be revised to account for different accident databases which may be included in Annex C. In this case, the requirements of 4.2 and clause 5, which are also subject to revision, shall be applied to the contents of Annex C. The results of such revisions to the standardized frequency of injury data, given in Annex D, along with the resulting frequency of occurrence data, given in Annex B, should be considered in potential revisions to the full-scale impact configurations, given in 4.3.

4.2.2 Accident sampling

The following impact configurations shall be used in defining impact conditions in relation to accident data.

4.2.2.1 Defining frequency of occurrence of various impact configurations

The accident database for each region shall include at least 200 MC accidents and shall be uniformly sampled data from all reporting facilities for a given region (i.e., a randomized sample). The samples shall be the result of in-depth investigations including on-site measurements and reconstructions. The subsample used, as determined in 5.1.1, shall consist only of those accidents involving impacts between motorcycles and passenger cars. The database shall include all of the impact variables listed in 4.1 and A.1 and shall be available for analysis and potential publication as part of ISO 13232.

4.2.2.2 Defining frequency of injury of various impact configurations

Additionally, for each accident the following injury data for each injury, as defined in A.2, shall be included:

— injury body region;

— injury type;

— injury severity, as defined by the AAAM abbreviated injury scale (AIS).

The database shall also include the variables listed in A.3 and should include the variables listed in A.4.

4.3 Impact configurations for full-scale tests

The following impact configurations shall be used for full-scale tests.

4.3.1 Required configurations

The impact configurations for full-scale tests shall include those shown in Figure 1 and listed in Table 1, as a preliminary assessment of the proposed protective device.

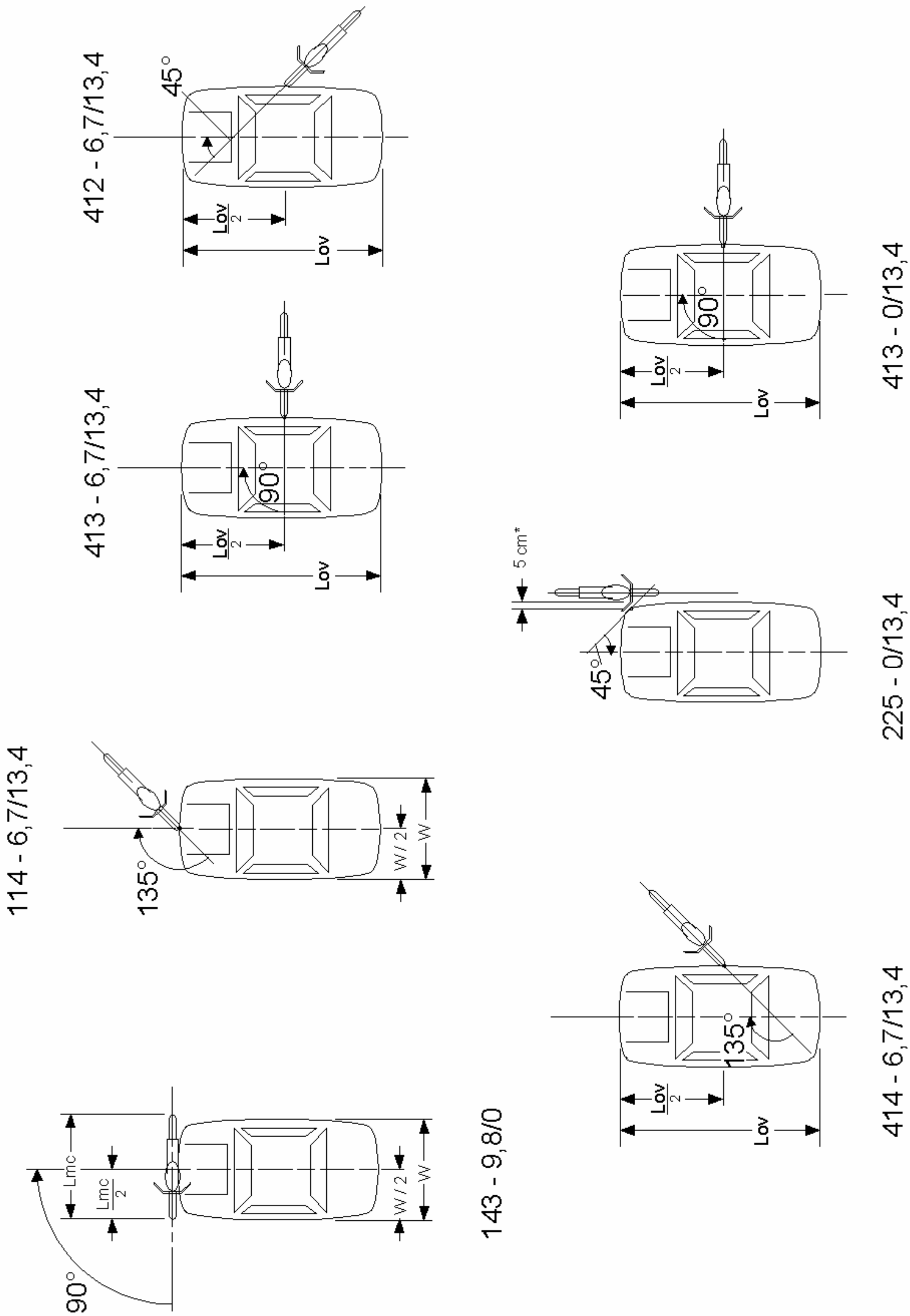


Figure 1 — Target impact geometries at first MC/OV contact for seven required impact configurations

Table 1 — Impact configurations for preliminary assessment

Configuration number	OV contact point code (Figure 2)	MC contact point code (Figure 3)	Relative heading angle code (Table 2 & Figure 4)	OV speed m/s	MC speed m/s
1	1	4	3	9,8	0
2	1	1	4	6,7	13,4
3	4	1	3	6,7	13,4
4	4	1	2	6,7	13,4
5	4	1	4	6,7	13,4
6	2	2	5	0	13,4
7	4	1	3	0	13,4

The impact configuration code shall comprise a series of three digits describing the OV contact point, the MC contact point, and relative heading angle, respectively, as generally defined in Figures 2, 3, and 4 and Table 2, followed by a hyphen (-), the OV impact speed, and the MC impact speed.

For OV corner contact (e.g., configuration 225-0/13,4 of Figure 1) the reference point on the MC shall be the most outboard structural element on the MC front unsprung assembly.

For testing purposes, the impact geometry may be reflected about the OV centre line (e.g., E45 instead of 225).

4.3.2 Permissible configurations from failure mode and effects analysis

Other impact configurations for which a proposed rider crash protective device might be harmful may be identified through computer simulation according to ISO 13232-7, or other analysis techniques, by analysing those configurations listed in Annex B. These failure mode configurations may be tested in order to verify the results of such analysis.

For full-scale tests and computer simulations, the impact geometries shall be as shown in Figures 1 and B.1, with the following general rules:

— OV corner contact points shall be the 45° tangent points, as shown in Figure 1;

— OV front and rear contact points shall be at the centre line of the OV;

— OV side front, side middle, and side rear contact points shall be the points corresponding to 1/4, 1/2 and 3/4 of the overall length of the OV, respectively, as measured from the foremost point on the OV;

— MC front contact point shall be such that the projection of the MC centre line, forward of the foremost part of the front wheel, at first contact between any portion of the MC or dummy and the OV, intersects a vertical line through the specified OV contact point;

— MC rear contact point shall be such that the projection of the MC centre line, rearward of the rearmost part of the rear wheel, at first contact between any portion of the MC or dummy and the OV, intersects a vertical line through the specified OV contact point;

— MC side contact shall use the conventions given in 4.3.1 and shown in Figure 1 (i.e., for OV front or rear contact use the 143-9,8/0 type of geometry; for OV corner contact use the 225-0/13,4 type of geometry);

— The relative heading angles shall be at the nominal values defined in Table 2 and Figure 4.

For testing purposes, the impact geometry may be reflected about the OV centre line (e.g., E45 instead of 225).

5 Analysis methods

5.1 Using accident data to determine frequency of occurrence of various impact configurations

Use the following methods when determining frequency of occurrence and injury.

Sort the accident data as described below.

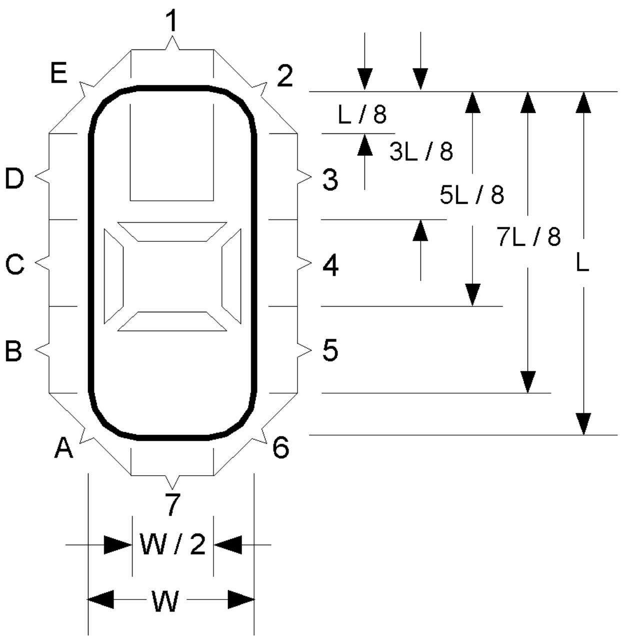


Figure 2 — OV contact point codes

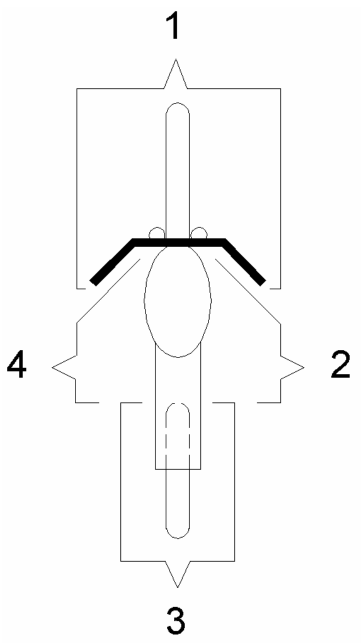


Figure 3 — MC contact point codes

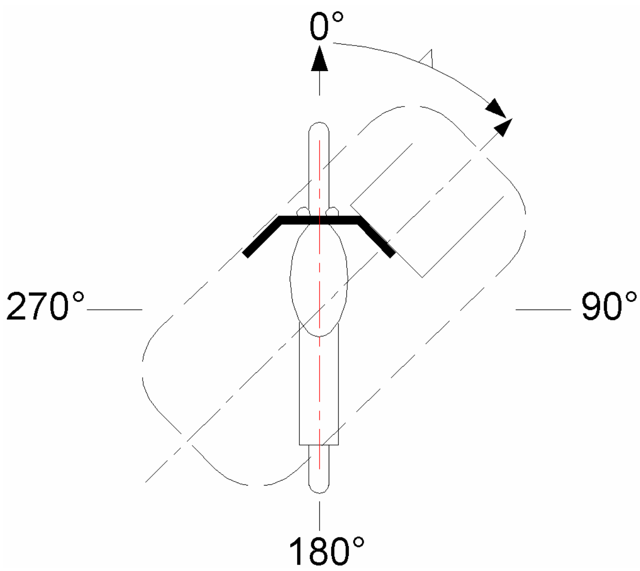


Figure 4 — Relative heading angle

Table 2 — Heading angle of OV relative to MC

Cell range deg	Nominal value deg	Code number
337,5 < rha ≤ 22,5	0	1
22,5 < rha ≤ 67,5	45	2
67,5 < rha ≤ 112,5	90	3
112,5 < rha ≤ 157,5	135	4
157,5 < rha ≤ 202,5	180	5
202,5 < rha ≤ 247,5	225	6
247,5 < rha ≤ 292,5	270	7
292,5 < rha ≤ 337,5	315	8

5.1.1 Sub-sample definition

Combine the databases listed in Annex C. From the combined, overall database, select all of the cases which have all of these conditions:

- passenger car impact;
- single rider;
- seated rider.

5.1.2 Categorization

For each case selected in 5.1.1, and for each impact variable, determine within which cell range the case lies and assign code numbers for the OV and MC contact points and relative heading angle, and nominal values for the OV and MC speeds, based on Tables 2 and 3 and Figures 2, 3, and 5.

5.1.3 Sorting

Sort all the subsample accident data into a matrix describing the combinations of the above cells. Determine the number of accidents which lie within the boundaries of each of the cells.

If the OV contact point involves the left side of the OV, then reclassify the OV and MC contact points and relative heading angle according to Table 4. In addition, reclassify all accidents that occur in the sorted geometry codes to the reclassified geometry codes as listed in Table 5, in order to resolve minor inconsistencies which may be present in the original accident data.

Remove all accidents in the cells listed in Table 6 which, as a result of categorization, correspond to untestable configurations.

5.1.4 Representation

Associate the number of accidents (frequency of occurrence) in each cell with the OV and MC contact point codes, relative heading angle codes, and OV and MC speed nominal values which will be considered to represent each cell.

Table 3 — OV and MC speed

Cell range m/s	Nominal value m/s
0 ≤ speed ≤ 4,0	0
4,0 < speed ≤ 8,5	6,7
8,5 < speed ≤ 13,3	9,8
13,3 < speed ≤ 17,5	13,4
17,5 < speed	20,1

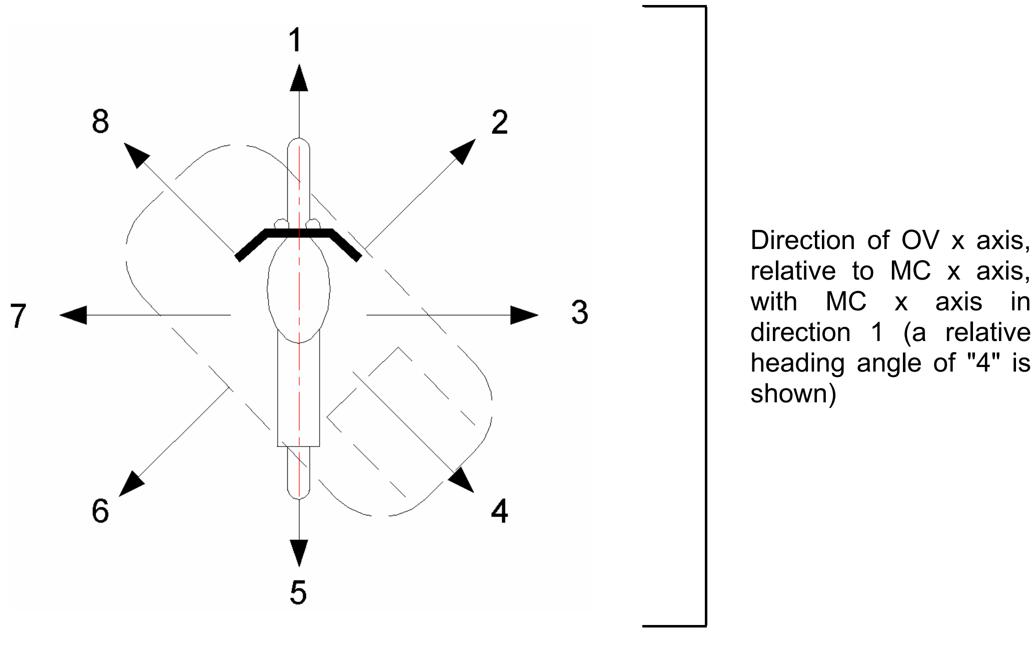


Figure 5 — Diagram of relative heading angle (angle of OV x axis relative to MC x axis, regardless of relative positions of OV and MC) with code numbers

Table 4 — Reclassification for left side OV contact point codes

Sorted	Reclassified
OV contact point code	
A	6
B	5
C	4
D	3
E	2
MC contact point code	
2	4
4	2
Relative heading angle code	
2	8
3	7
4	6
6	4
7	3
8	2

Table 5 — Reclassification of geometry codes

Sorted	Reclassified	Sorted	Reclassified	Sorted	Reclassified
113	143	216	114	442	412
116	114	217	143	443	413
117	143	221	131	523	513
121	131	223	313	524	514
125	115	224	314	542	512
126	114	231	131	543	513
127	143	232	132	611	711
128	132	233	143	612	712
133	143	236	226	613	513
137	143	237	227	614	514
138	132	244	114	621	711
141	131	245	115	622	712
142	132	323	313	642	512
144	114	324	314	643	513
145	115	342	312	721	711
212	312	343	313	722	712
213	313	423	413	741	711
215	115	424	414	748	712

Table 6 — List of removed configurations

OV contact point code	MC contact point code	Relative heading angle code	OV speed m/s	MC speed m/s
1	1	1-2, 8	All	All
1	2	2-4	All	All
1	3	4-6	All	All
1	4	6-8	All	All
2	1	1, 4, 8	All	All
2	2	2, 8	All	All
2	3	4-5, 8	All	All
2	4	6-8	All	All
3-5	1	1, 5-8	All	All
3-5	2	1-2, 5-8	All	All
3-5	3	1-8	All	All
3-5	4	1, 4-8	All	All
6	1, 2	5-8	All	All
6	2	3	OV speed > 0	All
6	3	1-8	All	All
6	4	4-7	All	All
7	1	3-7	All	All
7	2	3-7	All	All
7	3	1-8	All	All
7	4	2-7	All	All
1, 2	1-4	1	All	All ≥ OV speed
1	1-4	2, 8	All	All > OV speed
3-7	1-4	1-8	All	0
1-7	3	1-8	0	All
6-7	1	1, 2, 8	All	All ≤ OV speed
6-7	1	3, 4	OV speed > 0	All
1-7	1-4	1-8	0	0

5.2 Using accident data to determine frequency of injury by body region and injury type of various impact configurations

Sort the accident data using the same method as described in 5.1, except determine the number of accidents which have at least one injury of the selected body region, injury type and severity which lie within the boundaries of each of the cells. A recommended list of body regions and injury types and severities is included in Annex A.

Perform the analysis for the following injuries:

— head concussions, AIS ≥ 2;

- upper leg fractures, AIS ≥ 2;
- lower leg fractures, AIS ≥ 2.

For head concussion injuries, only include in the sorting process accidents where a helmet was worn.

6 Documentation and reporting

All individual motorcycle accidents shall be documented and reported using the motorcycle accident report form given in Annex A. Any aggregations of accident data should use the following column headings:

- reference number;
- OV contact point;
- MC contact point;
- OV impact speed;
- MC impact speed;
- relative heading angle;
- helmet use;
- number of reported injuries;
- maximum AIS;
- injury description, using a three digit code which defines:
  - injury body region,
  - injury type,
  - injury AIS.

Annex A
(normative)

Motorcycle accident report

A.1 Impact data (required)

Case identification (or reference number):____________________

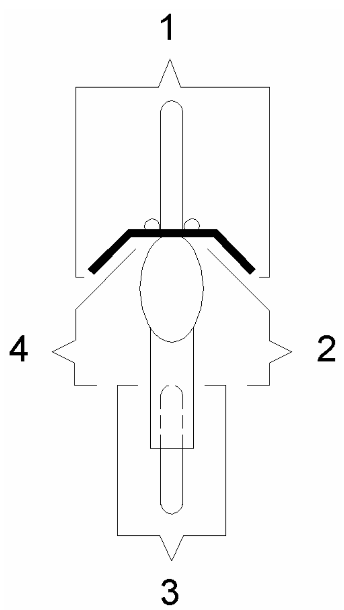
Collision category (single vehicle, multi-vehicle, object, pedestrian, etc.):____________________

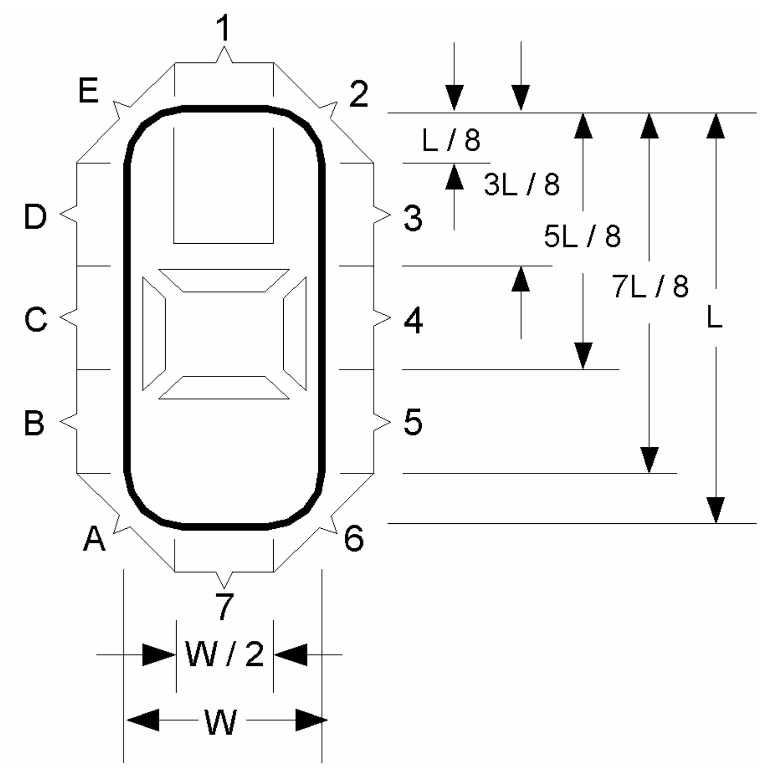
Motorcycle type (conventional, sport, scooter, moped, etc.):____________________

Motorcycle engine size (cc):____________________

Opposing vehicle type (saloon car, truck, etc.):____________________

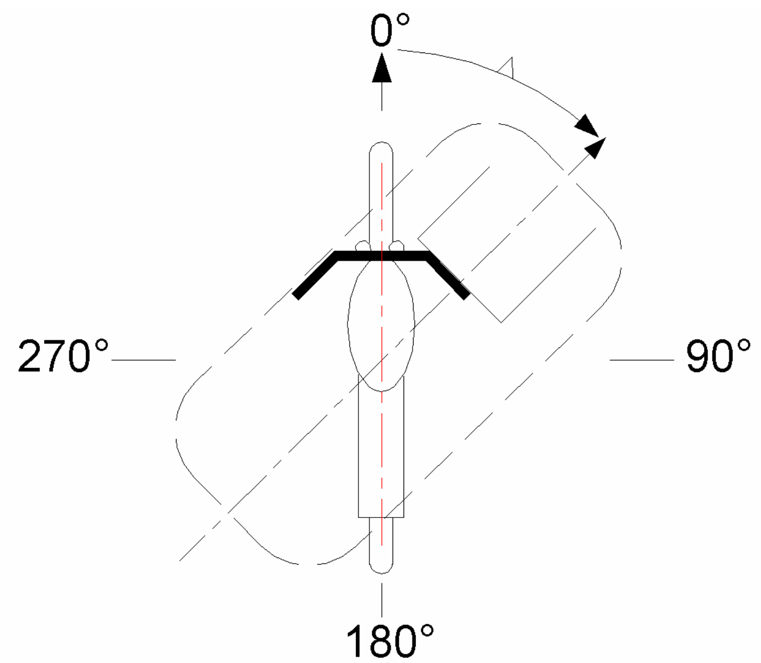
A.1.1 Contact points (primary damage region) circle one





Geometry code: ______ ______
OV MC

A.1.2 Relative heading angle (angle of OV x axis relative to MC x axis, regardless of relative positions of OV and MC)



A.1.3 Impact speed

OV (m/s): ______

MC (m/s): ______

A.2 Injury data (required)

Include data for each injury, up to 42 injuries (attach additional pages if necessary):

Injury body region (code from Table A.1)	Injury type (code from Table A.2)	Injury AIS[1)]
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Maximum AIS over all injuries: _____

1) As defined in AAAM, AIS90

A.3 Helmet data (required)

Helmet present (y or n)?______; Retained on head (y or n)? _______;

A.4 Protective clothing data (recommended)

Leather clothing worn, check as many as appropriate:

Combination suit:_____; Jacket:_____; Trousers:_____; Gloves:_____; Boots: _______;

Table A.1 — Injury body region codes

Body region	Code
Head	1
Face	2
Neck	3
Upper extremity	4
Chest	5
Abdomen	6
Thoracic spine and/or lumbar spine	7
Pelvis and/or hips	8
Thigh	9
Knee	10
Lower leg	11
Ankle and/or foot	12
Other injury location	13

Table A.2 — Injury type codes

Injury type	Code
Abrasion and/or contusion	1
Laceration	2
Rupture	3
Dislocation	4
Fracture	5
Amputation	6
Concussion	7
Crush	8
Hematoma	9
Other type of injury	10

Annex B
(normative)

Resulting frequency of occurrence for the combined Los Angeles and Hannover databases

The Los Angeles and Hannover databases have been combined and sorted by frequency of occurrence. The impact configuration geometries are shown in Figure B.1. The OV and MC speeds and frequencies of occurrence for the geometries are given in Table B.1. The three digits of the codes used in this Annex correspond to the OV contact point code, the MC contact point code, and the relative heading angle code, respectively.

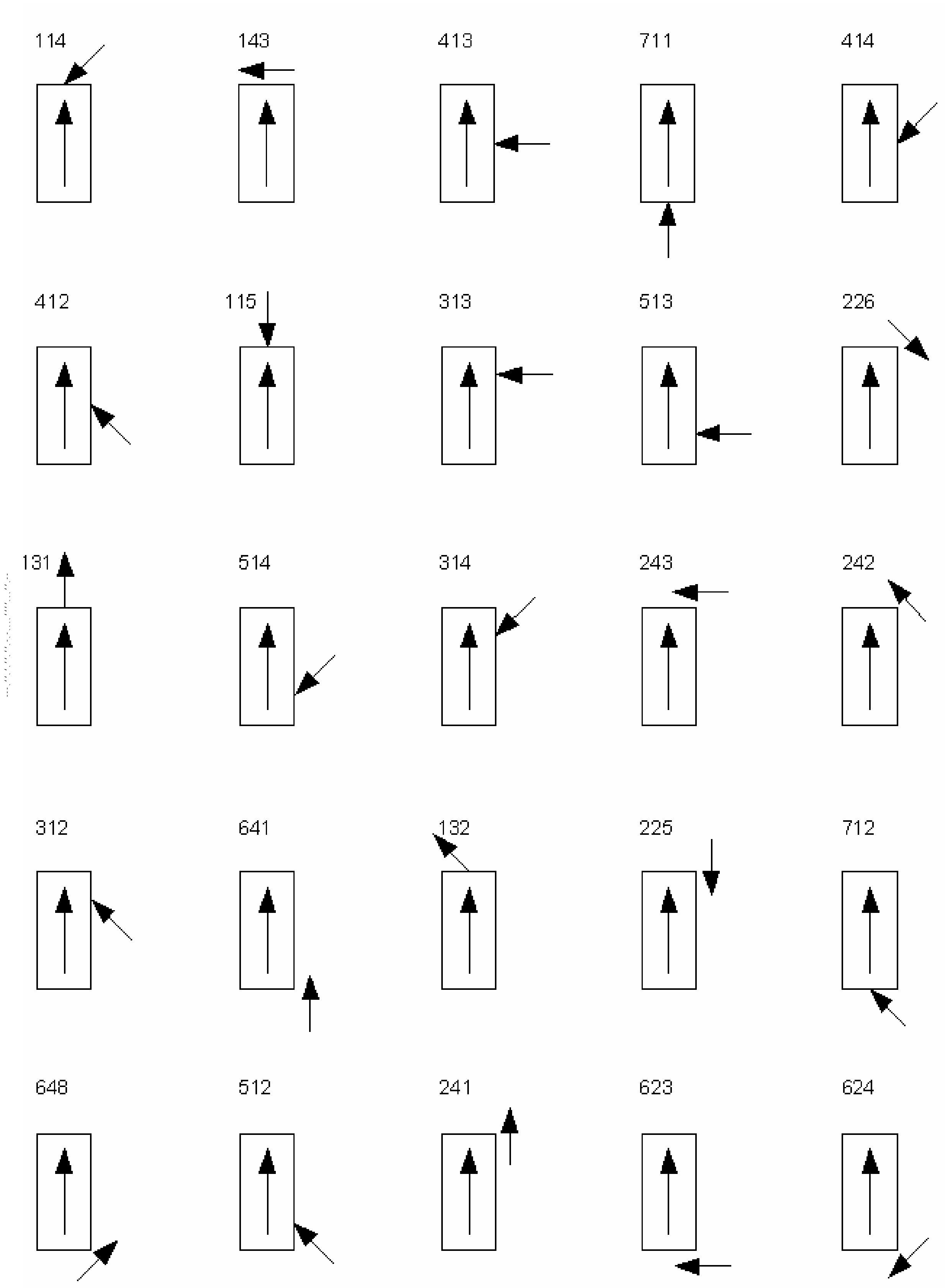


Figure B.1 — Geometries occurring for 200 combined Los Angeles and Hannover impact configurations involving 501 accidents

Table B.1 — Opposing vehicle and motorcycle speeds and frequencies of occurrence for 200 combined Los Angeles and Hannover impact configurations

Dimensions in metres per second

114

OVS	MCS	FO
0	6,7	3
0	9,8	6
0	13,4	3
0	20,1	1
6,7	0	2
6,7	6,7	11
6,7	9,8	14
6,7	13,4	7
6,7	20,1	2
9,8	0	1
9,8	6,7	5
9,8	9,8	3
9,8	13,4	2
9,8	20,1	1
13,4	0	1
13,4	6,7	1
20,1	6,7	2
TOTAL	=	65

143

OVS	MCS	FO
6,7	0	3
6,7	6,7	13
6,7	9,8	3
6,7	13,4	3
9,8	0	3
9,8	6,7	8
9,8	9,8	2
13,4	0	1
13,4	6,7	8
13,4	9,8	1
13,4	13,4	1
20,1	0	2
20,1	6,7	2
20,1	9,8	1
TOTAL	=	51

413

OVS	MCS	FO
0	6,7	6
0	9,8	3
0	13,4	5
0	20,1	1
6,7	6,7	6
6,7	9,8	8
6,7	13,4	4
6,7	20,1	1
9,8	6,7	3
9,8	9,8	4
9,8	20,1	3
13,4	6,7	1
13,4	9,8	1
13,4	13,4	3
20,1	6,7	1
TOTAL	=	50

711

OVS	MCS	FO
0	6,7	9
0	9,8	10
0	13,4	3
0	20,1	2
6,7	9,8	6
6,7	13,4	4
9,8	13,4	1
9,8	20,1	4
TOTAL	=	39

414

OVS	MCS	FO
0	6,7	3
0	9,8	2
0	13,4	2
0	20,1	3
6,7	6,7	3
6,7	9,8	7
6,7	13,4	3
6,7	20,1	1
9,8	6,7	3
9,8	9,8	1
9,8	13,4	2
9,8	20,1	2
TOTAL	=	32

412

OVS	MCS	FO
0	6,7	1
0	9,8	7
0	13,4	2
0	20,1	3
6,7	6,7	2
6,7	9,8	2
6,7	13,4	8
6,7	20,1	2
9,8	6,7	1
9,8	13,4	1
13,4	6,7	1
20,1	6,7	1
TOTAL	=	31

115

OVS	MCS	FO
0	6,7	3
0	9,8	3
0	20,1	2
6,7	6,7	4
6,7	9,8	2
6,7	20,1	1
9,8	0	1
9,8	9,8	1
9,8	13,4	3
9,8	20,1	3
13,4	6,7	4
13,4	9,8	2
13,4	20,1	1
TOTAL	=	30

313

OVS	MCS	FO
0	6,7	6
0	9,8	2
0	13,4	1
0	20,1	1
6,7	6,7	1
6,7	9,8	9
6,7	13,4	3
6,7	20,1	2
9,8	13,4	1
13,4	20,1	1
TOTAL	=	27

513

OVS	MCS	FO
0	6,7	2
0	9,8	1
6,7	6,7	5
6,7	9,8	4
6,7	13,4	4
6,7	20,1	2
9,8	6,7	2
9,8	9,8	3
13,4	6,7	1
TOTAL	=	24

226

OVS	MCS	FO
0	6,7	2
0	9,8	5
0	13,4	2
6,7	6,7	2
6,7	9,8	4
6,7	13,4	2
9,8	9,8	1
9,8	13,4	1
13,4	6,7	1
TOTAL	=	20

131

OVS	MCS	FO
6,7	0	5
9,8	0	4
9,8	6,7	1
13,4	0	1
13,4	6,7	1
20,1	0	1
20,1	6,7	1
20,1	9,8	1
20,1	13,4	4
TOTAL	=	19

514

OVS	MCS	FO
0	6,7	1
0	9,8	1
0	20,1	1
6,7	6,7	3
6,7	9,8	6
6,7	20,1	1
9,8	6,7	1
9,8	9,8	3
9,8	13,4	1
TOTAL	=	18

314

OVS	MCS	FO
0	6,7	1
0	13,4	1
6,7	6,7	3
6,7	9,8	4
6,7	13,4	6
9,8	6,7	1
9,8	9,8	1
TOTAL	=	17

243

OVS	MCS	FO
6,7	0	1
6,7	6,7	1
6,7	9,8	4
6,7	13,4	2
9,8	6,7	3
9,8	9,8	1
13,4	9,8	1
20,1	6,7	1
20,1	9,8	1
TOTAL	=	15

242

OVS	MCS	FO
0	6,7	1
0	9,8	4
0	13,4	1
6,7	6,7	2
6,7	9,8	2
6,7	13,4	1
9,8	6,7	1
9,8	9,8	1
9,8	13,4	1
TOTAL	=	14

312

OVS	MCS	FO
0	6,7	1
0	9,8	4
0	13,4	3
6,7	13,4	2
9,8	6,7	1
9,8	20,1	1
13,4	6,7	1
TOTAL	=	13

641

OVS	MCS	FO
0	6,7	1
0	9,8	2
0	20,1	1
6,7	9,8	2
6,7	20,1	1
9,8	13,4	1
TOTAL	=	8

132

OVS	MCS	FO
6,7	0	1
6,7	6,7	1
9,8	6,7	1
13,4	0	1
20,1	6,7	2
20,1	20,1	1
TOTAL	=	7

225

OVS	MCS	FO
0	9,8	2
0	13,4	1
6,7	9,8	1
6,7	13,4	2
20,1	9,8	1
TOTAL	=	7

712

OVS	MCS	FO
0	6,7	1
0	13,4	1
6,7	9,8	1
6,7	13,4	1
6,7	20,1	1
TOTAL	=	5

648

OVS	MCS	FO
0	6,7	1
0	9,8	1
0	13,4	1
TOTAL	=	3

512

OVS	MCS	FO
0	6,7	1
6,7	9,8	1
20,1	20,1	1
TOTAL	=	3

241

OVS	MCS	FO
13,4	9,8	1
TOTAL	=	1

623

OVS	MCS	FO
0	6,7	1
TOTAL	=	1

624

OVS	MCS	FO
6,7	20,1	1
TOTAL	=	1

Annex C
(normative)

Example accident data

Table C.1 defines the column headings and units used in Tables C.2 and C.3. The Los Angeles example data are given in Table C.2. The Hannover example data are given in Table C.3. These are the original data and are presented in non-SI units (miles per hour).

Table C.1 — Legend for Los Angeles and Hannover databases

Column heading	Definition	Units	Description
Ref no	Reference number	-	Each case has a reference number starting with 1 for each database. Case order is arbitrary.
OV cp	Opposing vehicle contact point	-	FO is front FC is front corner FW is front wheel (sorted with SF) SF is side front SM is side middle SR is side rear RW is rear wheel (sorted with SR) RC is rear corner RO is rear
MC cp	Motorcycle contact point	-	F is front S is side R is rear
OV sp	Opposing vehicle speed	miles per hour	-
MC sp	Motorcycle speed	miles per hour	-
RHA	Relative heading angle	degrees	See definition 3.1.12.1 in ISO 13232-1.
H	Helmet use	-	y if rider was wearing a helmet; n if rider was not wearing a helmet; "?" if unknown.
No inj	Number of reported injuries	-	The total number of reported injuries listed in column 10, Injuries.
MAIS	Maximum AIS	-	The highest AIS, as defined by AAAM, for all of the reported injuries.
Injuries	-	-	Description of injuries sustained during the accident. The 3-digit code for each injury defines the injury body region, the injury type, and the AIS for that injury.
BR	Injury body region	-	1 is the head 2 is the face 3 is the neck 4 is an upper extremity, including the shoulder 5 is the chest 6 is the abdomen 7 is the thorax 8 is the pelvis and/or hip 9 is a thigh 10 is a knee 11 is a lower leg 12 is an ankle and/or foot 13 is any other injury body region
T	Injury type	-	1 is an abrasion and/or contusion 2 is a laceration 3 is a rupture 4 is a dislocation 5 is a fracture 6 is an amputation 7 is a concussion 8 is a crush 9 is a hematoma 10 is any other type of injury
AIS	Abbreviated injury scale		The AIS describe the injury severity and are defined by AAAM as follows: 1 minor 2 moderate 3 serious 4 severe 5 critical 6 maximum 9 unknown

Table C.2 — Los Angeles data

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
1	FC	S	8	10	10	y	2	1	11	2	1	11	1	1									
2	RO	F	15	30	0	y	3	3	11	2	1	10	1	1	8	4	3						
3	FC	S	10	35	35	y	3	3	9	5	3	8	1	1	12	1	1						
4	SF	F	0	14	90	y	2	1	9	1	1	10	1	1									
5	FO	S	15	15	100	n		1															
6	SR	F	20	28	150	n	1	1	4	1	1												
7	FO	S	0	35	110	y	1	3	11	5	3												
8	RO	S	10	17	75	y	1	1	10	1	1												
9	SF	F	5	15	100	y	2	1	10	1	1	10	1	1									
10	RC	F	99	26	20	n		3															
12	SM	S	23	28	10	n	3	1	4	1	1	4	1	1	8	1	1						
13	SM	F	10	30	120	n	4	2	2	2	1	2	2	1	1	7	1	2	5	1			
14	FC	S	30	15	120	n	2	1	11	2	1	6	1	1									
15	RO	F	0	15	0	n		1															
16	FO	S	28	10	100	n	5	3	11	5	3	12	4	3	4	1	1	11	1	1	2	2	1
17	SF	F	15	22	130	y	2	2	10	2	2	11	2	1									
18	SM	F	30	30	90	n		3															
19	RO	S	10	20	60	y	2	3	11	5	3	11	2	1									
20	SM	S	3	15	5	y	3	1	11	1	1	10	1	1	1	2	1						
21	RC	F	0	45	0	y	6	3	11	5	3	11	5	3	7	4	3	5	3	3	7	5	2
									1	7	2												
22	FC	S	10	30	10	n	5	5	11	5	2	12	2	1	4	1	1	1	7	5	1	1	1
23	RO	F	0	16	15	n	3	2	12	4	1	1	5	2	2	1	1						
24	RO	S	0	35	15	y	1	1	11	1	1												
25	FO	F	0	15	175	n		0															
26	SM	F	12	26	130	y	3	2	11	1	1	10	2	2	2	1	1						
27	RO	F	0	12	10	n		1															
28	SM	F	8	27	80	n	3	1	6	1	1	11	1	1	9	1	1						
29	RC	S	0	15	0	y	4	1	4	1	1	10	1	1	6	1	1	1	7	1			
30	FC	S	5	20	90	y	5	2	11	2	2	9	1	1	12	4	1	10	1	1	3	10	1
31	SF	F	10	30	90	n	3	1	8	1	1	9	1	1	10	1	1						
32	SM	S	25	30	150	n	8	3	9	5	3	11	5	2	4	1	1	7	1	1	7	1	1
									1	1	3	1	1	3	1	5	3						
33	FO	S	8	20	120	n	2	1	10	1	1	10	1	1									
34	SR	S	21	24	5	n		1															
35	SF	F	0	15	90	n	1	1	9	1	1												
36	FO	F	8	5	120	n		1															
37	SF	F	15	33	70	y	4	1	12	1	1	5	1	1	4	1	1	6	1	1			
38	SR	F	10	25	120	n	2	1	11	1	1	6	1	1									
39	SF	S	20	40	10	n		3															
40	FO	F	8	42	135	n		3															
42	FC	S	5	20	120	y	2	1	10	1	1	12	2	1									
43	SM	S	15	20	150	n	4	3	12	5	3	11	1	1	12	1	1	1	1	1			
44	FO	R	53	20	5	n		2															
45	RC	S	15	40	15	n	3	2	10	3	2	11	2	1	10	1	1						
46	SF	F	0	20	80	y	4	2	4	1	2	12	1	1	8	1	1	10	2	1			
47	FC	S	15	20	90	n		2															
48	SM	F	19	22	90	n	3	1	5	1	1	1	7	1	3	4	1						
49	FC	S	10	26	100	n		3															
50	FO	R	15	0	0	n		1															
51	SR	S	7	20	90	y	2	3	10	4	3	4	2	1									
52	SF	F	8	38	65	n	3	1	10	1	1	10	1	1	5	1	1						
53	FO	S	15	38	110	n	7	6	12	4	3	11	1	1	10	1	1	1	5	4	1	5	4
									1	3	6	3	5	3									
54	RC	S	0	32	35	y	4	3	12	5	2	11	5	3	11	2	2	8	1	1			
55	SF	F	12	27	90	y	3	2	5	5	2	4	5	2	9	1	1						
56	SF	F	35	40	90	n	8	5	4	1	1	4	4	2	5	2	1	10	2	1	1	5	3
57	FC	S	20	30	25	y	4	2	11	5	2	11	2	1	8	1	1	4	1	1			
58	SF	S	5	25	35	y	3	1	11	2	1	9	1	1	4	2	1						

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
61	SR	S	0	15	45	y	3	1	10	1	1	12	4	1	4	1	1						
62	FO	R	30	0	0	n		1															
63	SF	F	10	20	100	n	4	1	6	1	1	9	1	1	2	1	1	1	7	1			
64	FC	S	8	28	150	y	1	2	11	5	2												
65	FO	S	10	32	135	y	7	3	11	5	3	12	5	2	10	5	3	9	5	3	8	5	2
									4	5	2	10	2	2									
66	SM	F	15	38	120	n	4	1	6	1	1	11	1	1	11	1	1	4	1	1			
67	SR	F	10	18	105	n		1															
68	FC	S	0	27	45	n	5	2	12	4	2	12	1	1	10	1	1	7	1	1	4	1	1
69	FC	S	6	28	60	n	6	1	12	5	1	5	1	1	7	1	1	4	1	1	10	1	1
									5	1	1												
70	FO	S	15	28	110	n	5	1	4	1	1	10	1	1	12	1	1	9	1	1	12	1	1
71	SF	F	17	20	130	n	4	1	4	1	1	11	1	1	12	2	1	11	1	1			
72	RC	S	35	33	10	y	1	1	10	1	1												
73	SM	S	0	31	40	n	4	3	10	1	1	11	1	1	8	4	3	4	1	1			
74	FC	S	16	12	40	y	3	1	4	1	1	11	1	1	2	1	1						
75	FW	F	15	30	140	n	9	2	4	1	1	4	1	1	4	5	2	5	1	2	5	1	1
									9	1	1	11	1	1	1	1	1	2	1	1			
76	SM	S	25	20	150	n	5	3	4	5	2	5	5	3	10	1	1	1	5	3	1	3	3
77	SR	F	15	32	100	n		1															
78	SM	F	7	25	75	n	8	1	10	1	1	9	1	1	6	1	1	4	1	1	2	1	1
									3	4	1	2	1	1	2	1	1						
79	SM	S	7	25	115	y	4	3	4	5	2	11	5	3	10	1	1	4	1	1			
80	FO	S	10	25	140	n	5	3	6	1	1	5	1	1	6	1	3	4	1	1	6	2	1
81	FC	S	30	40	5	y	5	3	11	5	3	10	1	1	4	1	1	5	1	1	4	1	1
82	RO	F	20	55	10	n	5	1	4	1	1	10	1	1	10	2	1	4	2	1	6	1	1
83	RO	F	0	25	0	n	8	1	6	1	1	10	1	1	10	1	1	4	1	1	2	2	1
									2	2	1	2	1	1	2	1	1						
84	SM	F	10	28	105	y	6	1	10	1	1	4	1	1	7	4	1	12	1	1	8	1	1
									2	1	1												
85	SR	S	60	55	25	n	9	5	11	1	1	4	5	2	5	5	1	5	1	3	8	1	1
									1	1	2	1	5	3	1	1	5	1	3	4			
86	FC	S	10	30	90	n	7	1	4	1	1	10	1	1	8	1	1	7	1	1	4	1	1
									4	1	1	2	1	1									
87	FO	S	12	16	115	n	1	1	10	1	1												
89	SM	F	30	26	80	n	5	2	5	1	2	4	1	1	10	1	1	2	2	1	1	7	2
90	SM	S	12	16	80	n	2	1	9	1	1	12	1	1									
91	SM	S	12	18	25	y	3	1	4	1	1	6	1	1	12	4	1						
92	FC	S	23	38	135	n	9	6	5	5	1	5	2	5	5	2	6	6	2	3	6	2	4
									6	2	4	11	5	3	11	1	1	1	9	1			
93	SR	S	14	18	150	n		1															
94	SF	F	18	24	80	n		3															
95	FO	S	12	25	140	y	4	3	11	5	2	9	5	3	9	1	1	10	1	1			
97	SF	F	8	35	70	n		2															
98	RC	S	10	22	30	n	2	1	7	1	1	11	1	1									
99	SM	S	15	24	135	n	5	3	10	5	3	11	5	3	1	2	2	2	2	1	1	7	2
100	RC	S	0	24	0	n	4	2	12	5	2	8	1	1	4	1	1	6	1	1			
101	FC	S	0	30	135	y	1	2	10	2	2												
102	FO	R	67	30	0	n	2	2	9	1	2	10	2	1									
103	FC	S	5	39	30	y	2	1	8	1	1	11	1	1									
104	RC	S	12	40	140	n	2	2	12	5	2	4	1	1									
105	SF	F	6	35	120	y	6	1	5	1	1	4	1	1	4	1	1	9	1	1	10	2	1
									1	2	1												
106	SF	F	10	15	120	y	2	1	10	1	1	4	1	1									
107	FO	S	15	20	140	n		1															
108	SM	S	10	12	35	n		1															
109	SR	S	0	14	145	n	1	1	12	2	1												
110	RO	F	10	30	20	n	6	1	5	1	1	9	1	1	11	1	1	4	1	1	6	1	1
									2	1	1												

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
111	FO	S	12	30	150	n	10	5	2	1	1	6	2	4	5	2	5	9	5	3	5	2	1
									6	1	2	2	5	3	1	5	3	1	3	3	1	3	1
112	SR	S	20	23	135	y	2	1	10	1	1	8	1	1									
113	FO	S	13	17	135	n	2	1	11	1	1	11	1	1									
114	RO	F	15	26	0	n	3	1	11	1	1	10	1	1	12	1	1						
115	FC	S	18	30	130	n		2															
116	FC	F	12	20	135	n	3	2	6	1	2	12	1	1	1	9	1						
117	SM	F	15	20	110	n		1															
118	FO	F	10	26	150	n		1															
119	SR	S	12	14	10	n	5	2	12	1	2	12	2	1	4	1	1	1	1	1	1	7	2
120	FO	F	10	23	135	n		1															
121	RC	S	0	43	20	n	7	3	11	5	3	4	2	1	10	1	1	2	2	1	1	9	1
									1	7	2	1	2	1									
122	RO	S	10	30	45	n	5	3	11	5	3	12	2	1	4	1	1	4	1	1	7	1	1
123	SR	F	5	45	135	n	8	4	9	6	4	8	5	2	6	1	3	5	3	4	9	1	1
									6	1	1	2	1	1	1	3	3						
124	SM	S	8	25	30	n	3	2	10	1	1	4	1	2	2	2	1						
125	FW	F	12	32	140	y	8	3	10	5	3	4	1	2	11	1	1	2	5	2	2	5	2
									1	7	2	2	2	1	2	2	1						
126	SR	F	19	35	90	n	13	5	4	1	2	7	1	1	10	2	1	10	1	1	12	1	1
									6	1	1	1	5	2	1	1	3	1	1	5	2	1	1
									1	5	3	1	3	3	1	1	5						
127	SF	F	17	30	125	n	4	1	9	1	1	10	2	1	6	1	1	1	1	1			
128	SM	S	15	15	160	n		1															
129	FC	S	8	15	90	n		1															
130	FO	F	0	45	180	n		3															
131	RC	S	0	18	35	n	3	1	4	1	1	11	1	1	10	1	1						
132	SM	S	12	35	90	y	11	5	10	2	2	12	2	1	4	5	3	11	1	1	10	2	1
									1	1	1	1	3	1	1	5	3	1	2	5	1	3	5
									1	9	3												
133	RO	F	10	18	0	n		1															
134	FC	S	22	10	75	y	3	2	11	2	1	4	1	1	12	1	1						
135	SF	S	25	30	15	y	5	1	12	5	1	4	1	1	10	1	1	11	1	1	12	1	1
136	SR	F	10	14	90	y	2	1	8	1	1	4	1	1									
138	SM	S	23	20	20	y	2	1	10	1	1	4	1	1									
139	FC	S	12	25	135	y	6	1	12	4	1	10	1	1	10	1	1	12	4	1	4	1	1
									12	1	1												
140	RO	F	0	21	10	y	3	1	9	1	1	11	1	1	2	1	1						
141	FC	S	10	11	70	y	1	2	12	5	2												
142	FO	R	65	35	0	y	13	6	5	8	6	7	5	3	5	2	6	8	5	4	6	2	4
									6	2	4	4	5	3	9	5	3	12	5	3	1	5	6
									1	3	6	3	2	2	3	5	3						
144	SR	S	15	11	90	n	2	1	11	1	1	4	1	1									
145	RC	S	15	30	25	n	2	1	4	1	1	9	1	1									
146	FC	S	10	20	135	n	6	2	11	1	1	10	1	1	4	1	1	9	1	1	1	1	1
									1	7	2												
147	SF	S	15	42	15	n	11	5	4	1	1	7	1	1	4	1	1	5	1	1	10	1	1
									1	5	3	1	1	1	1	1	3	1	1	4	1	5	4
									1	1	5												
148	SF	S	15	30	35	y	2	1	4	1	1	10	1	1									
149	FC	S	25	15	25	y	4	2	12	2	1	11	5	2	8	1	1	4	1	1			
150	FC	F	10	22	85	n	3	1	10	1	1	11	1	1	1	9	1						
151	FC	S	14	25	135	n		1															
152	FO	S	12	20	135	n	3	1	11	2	1	11	2	1	1	2	1						
153	SM	F	7	22	135	n	6	1	9	2	1	10	1	1	5	1	1	10	1	1	2	5	1
154	RC	S	13	21	15	n	1	1	10	1	1												
155	FO	S	15	22	110	n	4	1	12	1	1	12	1	1	4	1	1	10	2	1			
156	FC	S	10	34	140	y	3	3	11	5	3	10	1	1	4	1	1						
157	FC	S	25	20	30	n	3	1	4	1	1	10	1	1	4	1	1						

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
158	SM	S	17	23	135	y	3	3	11	5	3	4	2	1	1	7	2						
159	SM	S	10	20	5	n	1	1	2	1	1												
160	SF	S	20	11	30	n		3															
161	RW	F	15	40	100	y	7	3	9	5	3	12	4	1	5	5	2	4	4	2	4	1	1
									6	1	1	6	1	1									
162	FC	S	0	27	135	n	5	3	11	5	3	10	4	3	12	5	2	12	2	1	4	1	1
163	FO	S	12	18	180	n	5	1	4	1	1	10	1	1	11	1	1	2	1	1	1	1	1
164	FC	S	5	20	135	n	10	5	5	5	4	5	2	5	4	5	3	5	1	1	5	2	5
									11	1	1	2	1	1	2	1	1	1	1	1	1	1	1
165	RO	F	20	35	10	y	2	1	10	1	1	4	1	1									
166	SM	S	8	27	35	n	6	2	4	1	1	4	1	1	10	1	1	12	1	1	2	2	2
									2	1	1												
167	RO	S	0	15	0	n		6															
168	FC	S	12	32	165	n	4	3	11	5	2	8	5	2	8	4	3	2	2	1			
169	RO	S	10	17	10	y	2	2	12	5	2	10	1	1									
170	SF	F	10	25	90	y	2	2	6	2	2	9	1	1									
171	SF	F	8	19	110	y	4	2	4	1	1	2	5	2	2	5	1	2	2	1			
173	FW	F	24	12	155	y	2	1	4	1	1	6	1	1									
174	FC	S	8	26	40	n		3															
175	FO	S	16	24	170	n	4	3	11	5	3	11	2	1	2	5	2	2	1	1			
176	SR	S	10	7	155	n	3	1	4	1	1	8	1	1	11	1	1						
177	SM	S	25	15	150	y	2	1	10	4	1	10	2	1									
178	FC	S	8	30	160	n	5	3	9	5	3	11	1	1	4	1	1	2	2	1	2	2	1
179	FO	S	46	30	10	y	3	2	10	1	1	10	1	1	12	5	2						
180	FO	S	8	28	135	y	3	2	11	2	2	10	1	1	4	1	1						
181	FC	F	8	20	150	n		1															
182	SF	F	5	22	80	n	4	2	10	5	2	9	1	1	4	1	1	10	1	1			
183	SF	S	25	25	5	y	3	2	2	5	1	2	2	1	2	5	2						
184	SF	S	8	15	40	n		1															
185	FC	F	13	25	90	n	3	1	6	1	1	11	1	1	4	1	1						
186	SF	F	18	30	140	n	7	2	10	4	1	12	5	2	4	1	1	9	1	1	6	1	1
									1	2	1	2	1	1									
187	SM	F	20	25	90	n	4	1	10	2	1	10	1	1	6	1	1	8	1	1			
188	FO	S	17	20	120	n		1															
189	SF	S	5	21	30	n		1															
190	FO	R	24	10	0	y	2	1	10	1	1	12	4	1									
191	SR	F	14	24	90	y	4	1	10	1	1	9	1	1	9	1	1	11	1	1			
192	FO	S	8	23	110	n		3															
193	SR	F	10	27	80	y	7	3	4	5	2	4	5	3	8	5	3	6	1	2	6	3	2
									9	2	2	10	2	1									
194	SM	F	10	35	120	n		2															
195	RO	S	0	15	80	n		3															
196	SM	F	0	12	135	n	3	2	10	1	1	7	1	1	2	1	1						
197	FO	R	26	0	0	n	4	3	11	5	3	10	1	1	1	2	2	1	1	1			
198	RC	S	0	25	0	n		1															
199	FO	S	14	12	165	y	1	1	12	5	1												
200	FC	S	21	18	85	y	5	1	8	1	1	11	1	1	7	1	1	12	4	1	4	1	1
201	SR	F	12	32	90	n		1															
202	FC	S	12	33	80	n	1	1	4	1	1												
203	SR	F	20	25	100	n	1	1	10	1	1												
204	FO	S	22	9	180	n	1	1	11	1	1												
205	SF	S	20	42	30	y	12	6	5	8	6	6	2	5	5	3	6	9	5	3	9	2	2
									8	5	4	6	2	5	1	1	1	1	5	3	1	9	1
									1	3	3	2	1	1									
206	FC	S	99	30	20	n	2	1	11	2	1	1	2	1									
207	FC	S	20	25	135	n		5															
209	SM	S	15	20	90	y	1	1	9	1	1												
210	RO	F	16	19	15	y	1	1	8	1	1												
211	FO	S	28	24	135	n	4	3	9	5	3	12	5	2	11	5	2	9	2	1			

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
212	SM	F	40	13	90	y	3	2	4	4	2	10	1	1	10	1	1						
213	RO	F	10	33	5	y	3	1	10	1	1	11	1	1	6	1	1						
214	FO	S	17	25	125	y	5	3	8	5	2	9	1	1	7	5	2	12	5	3	12	5	2
215	SM	F	26	16	85	n	4	1	9	1	1	10	2	1	4	2	1	1	9	1			
216	FW	F	20	37	90	n	10	5	5	1	3	5	3	4	6	1	1	11	1	1	9	2	1
									1	1	4	1	3	5	1	5	3	1	5	2	1	1	3
217	SR	S	10	20	170	y	4	1	10	1	1	4	1	1	6	1	1	1	7	1			
218	FC	S	34	28	0	n	2	2	11	5	2	12	2	1									
219	RO	S	10	23	0	n		2															
220	SF	S	8	20	30	y	4	1	12	4	1	12	2	1	8	1	1	4	1	1			
221	FC	S	13	25	90	n	4	3	11	5	3	12	5	2	8	1	1	1	1	1			
222	FO	R	25	7	0	y	4	2	11	1	1	4	1	1	5	1	1	1	7	2			
223	SR	S	35	40	10	n		1															
224	SM	F	12	35	100	y	6	4	5	1	1	4	1	1	6	1	1	11	1	1	1	1	1
									1	9	4												
225	SR	S	10	16	15	y	2	1	9	1	1	4	1	1									
226	FO	S	7	13	130	n	4	1	6	1	1	5	1	1	4	1	1	1	1	1			
227	SM	F	10	27	105	n	3	3	11	5	3	6	1	2	1	2	1						
228	FO	S	15	25	125	n		1															
229	SR	F	20	10	140	y	2	1	4	1	1	12	1	1									
230	SR	F	17	53	100	n	5	6	5	2	2	5	3	6	5	2	5	11	1	1	10	2	1
231	SM	S	20	36	30	n	5	1	11	2	1	10	1	1	4	1	1	4	1	1	1	9	1
232	RO	F	0	8	80	n		1															
233	FC	S	9	10	135	n		2															
234	FW	S	35	15	30	n	5	3	7	1	1	7	5	3	4	1	1	10	1	1	11	1	1
235	RO	F	10	25	0	y	1	1	8	1	1												
236	SR	S	12	20	135	y	4	3	8	5	3	10	2	1	4	1	1	4	1	1			
237	FC	S	10	22	60	n		3															
238	FC	S	7	30	135	y	6	3	11	5	3	4	1	1	5	1	1	8	1	1	9	1	1
									1	7	1												
239	SF	S	50	0	10	n		3															
240	SR	S	50	55	20	y	2	1	2	5	1	2	1	1									
241	SR	S	40	50	20	y	8	1	11	1	1	9	1	1	4	1	1	4	1	1	10	2	1
									4	2	1	2	2	1	2	1	1						
242	FC	S	14	28	85	n		3															
243	FC	S	15	4	90	n	5	2	11	5	2	12	4	1	4	1	1	10	1	1	1	2	1
244	SM	F	0	37	110	n	5	3	4	5	3	4	2	1	11	2	1	9	2	2	1	1	1
245	FO	S	12	17	115	n		1															
246	FO	S	27	11	135	y	4	5	4	5	3	1	1	1	2	1	1	1	7	5			
247	SR	F	20	35	130	y	6	3	9	5	3	11	1	1	4	4	2	4	1	1	9	2	1
									6	1	1												
248	FC	S	25	26	85	y	3	2	4	5	2	5	1	1	9	1	1						
249	SM	F	7	30	75	n	7	3	5	5	3	4	5	2	6	1	1	6	3	2	4	1	1
									4	1	1	1	7	3									
250	FC	F	15	18	120	n		1															
251	FC	S	0	25	160	n	3	3	11	5	3	12	5	2	4	1	1						
252	SR	S	8	18	90	n	6	2	5	1	1	9	1	1	2	5	2	2	2	1	1	7	2
									2	5	1												
253	SF	F	10	22	100	n	7	1	12	1	1	10	1	1	4	1	1	4	1	1	11	1	1
									6	1	1	1	9	1									
254	FO	R	10	6	0	n		0															
255	RC	S	0	15	85	n		1															
256	FO	S	12	20	130	y	3	1	12	1	1	11	1	1	8	1	1						
257	FO	F	0	18	170	n	1	1	1	2	1												
258	FC	S	14	16	15	n	3	1	4	1	1	2	2	1	2	2	1						
259	RO	S	0	24	10	n		3															
260	FC	S	15	16	60	y	7	3	11	5	3	8	4	3	9	1	1	6	1	1	4	1	1
									2	2	1	2	2	1									
261	SF	F	15	15	90	y	2	1	11	1	1	4	2	1									

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
262	FO	R	15	6	0	y	2	1	7	1	1	8	1	1									
263	SR	S	11	18	145	n	1	1	10	1	1												
264	FO	S	0	12	160	n	2	1	8	1	1	10	1	1									
265	FC	S	15	25	180	y	4	2	11	2	1	10	4	2	5	1	1	1	7	1			
266	SR	F	17	42	135	y	2	1	10	1	1	4	1	1									
267	SF	F	12	20	90	n		1															
268	SM	F	10	18	90	y	7	2	5	1	1	11	1	1	4	5	2	11	1	1	4	1	1
									8	1	1	1	1	1									
269	FO	S	8	10	45	n		1															
270	FC	S	9	25	160	n	4	2	11	5	2	10	1	1	1	5	2	2	5	1			
271	FO	S	8	15	10	n		1															
272	SM	F	30	35	90	n	4	4	11	5	2	10	2	1	1	5	4	1	7	2			
273	SR	F	12	20	75	y	3	1	4	1	1	10	1	1	12	1	1						
274	SF	S	10	14	20	n		1															
275	SM	F	15	23	70	n	7	2	8	1	1	6	1	2	10	1	1	5	1	1	1	2	1
									2	2	1	2	2	1									
276	FO	S	12	15	110	y	4	1	12	1	1	12	1	1	7	1	1	4	1	1			
277	SF	F	15	43	90	y	5	3	11	5	3	11	1	1	6	1	1	6	1	1	1	7	1
278	SR	F	21	23	140	n	4	3	12	5	3	4	3	2	6	1	1	4	1	1			
279	FC	S	3	15	90	y	2	1	10	1	1	4	1	1									
280	FO	S	19	11	150	n		1															
281	SM	F	5	15	85	n	1	1	4	1	1												
282	FO	R	60	47	0	n		1															
283	SF	F	15	30	130	n	5	4	5	5	2	4	5	2	6	1	1	11	1	1	1	7	4
284	SM	S	22	26	90	n		1															
285	RC	S	45	60	10	n	3	1	12	5	1	12	2	1	1	1	1						
286	RO	S	9	12	90	n	2	1	9	1	1	8	1	1									
287	SR	S	5	22	10	y	2	1	11	1	1	8	1	1									
288	SF	F	0	40	90	n	4	2	6	2	2	9	1	1	11	1	1	4	1	1			
289	FW	F	15	26	105	y	4	1	6	2	1	10	1	1	4	1	1	4	1	1			
290	RO	F	10	30	0	n	8	2	12	2	1	9	1	1	6	1	1	2	5	2	2	5	2
									2	1	1	2	3	1	2	2	1						
291	FO	R	17	0	0	y	2	1	10	1	1	11	1	1									
292	SR	F	25	12	90	y	3	2	4	1	1	11	1	1	6	1	2						
293	FC	S	46	18	90	n	4	3	8	5	2	9	5	3	12	1	1	1	2	1			
294	SM	S	5	20	25	y	5	2	12	5	2	11	2	1	12	2	1	11	1	1	10	1	1
295	SF	S	0	18	75	n	2	1	10	1	1	6	1	1									
296	SM	S	23	14	45	n		1															
297	SF	F	8	35	40	y	4	4	11	5	3	11	2	2	4	5	2	6	3	4			
298	FO	S	31	35	90	n		3															
299	FO	S	24	12	110	y	5	1	10	4	1	11	1	1	5	1	1	4	1	1	4	1	1
300	FC	S	7	12	150	n	2	2	11	5	2	4	1	1									
301	RO	S	0	14	30	n	3	1	9	2	1	6	1	1	2	2	1						
302	RO	F	4	16	20	n		0															
303	RW	F	12	35	90	n	5	3	4	1	1	9	1	1	6	1	1	11	1	1	1	1	1
304	SM	S	9	6	140	n		1															
305	SR	S	17	19	135	y	2	2	11	1	1	9	1	1									
306	SM	S	0	15	150	n	3	1	11	2	1	10	1	1	9	1	1						
307	FC	S	45	43	15	y	4	2	4	1	1	10	1	1	12	5	2	12	2	1			
308	RC	S	25	8	20	n		0															
309	SF	F	16	20	140	n	4	3	10	4	3	4	1	1	5	1	1	9	1	1			
310	RO	F	0	23	0	y	3	1	10	2	1	10	1	1	6	1	1						
311	FO	S	23	15	95	y	1	1	10	1	1												
312	RW	F	10	15	90	n	3	1	4	1	1	4	1	1	6	1	1						
313	SF	S	15	17	135	y	8	1	7	2	1	4	2	1	11	2	1	11	1	1	10	1	1
									2	2	1	2	2	1	1	2	1						
314	SM	S	0	26	170	n	5	3	8	1	1	5	1	1	4	2	1	1	7	3	3	4	1
315	SM	S	22	24	90	y	2	2	12	2	2	12	5	2									
316	SR	F	30	17	90	y	1	1	2	2	1												

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
317	RC	S	6	20	50	y	1	1	11	1	1												
318	SF	S	3	38	40	n		5															
319	RO	S	0	30	0	n	1	3	9	5	3												
320	SR	F	29	25	90	y	5	1	7	1	1	4	1	1	11	2	1	2	2	1	2	2	1
321	FO	R	60	50	0	y	1	3	11	5	3												
322	SR	F	20	11	90	n	1	1	11	1	1												
323	FC	S	28	10	90	n	3	2	11	5	2	2	2	1	1	7	1						
324	FO	S	20	15	150	n	4	2	9	2	1	8	1	1	9	1	1	1	7	2			
325	RO	F	0	30	30	n		1															
326	FO	F	25	35	125	n		6															
327	FW	F	16	26	135	n	5	1	8	1	1	6	1	1	2	1	1	2	1	1	2	1	1
328	FO	F	0	15	120	y	2	1	5	1	1	11	1	1									
329	FO	S	20	25	180	n	4	1	4	2	1	8	2	1	12	1	1	12	1	1			
330	FO	S	3	7	120	n		1															
331	SR	F	12	20	30	n		1															
332	RO	F	40	50	20	n		1															
333	FO	F	11	12	105	y	1	2	10	2	2												
334	SM	F	15	35	90	n	4	2	6	1	1	10	1	2	2	2	2	2	2	1			
335	SM	F	15	20	100	n		4															
336	SF	S	5	31	10	n	2	1	4	1	1	8	1	1									
337	SF	F	0	13	90	y	2	1	9	1	1	4	1	1									
338	RO	F	21	40	0	n		1															
339	FO	R	5	0	0	y	2	1	10	1	1	8	1	1									
340	RW	F	8	24	150	y	2	1	9	1	1	4	1	1									
341	FC	S	15	25	150	n	9	2	10	2	2	9	2	1	4	1	1	4	1	1	11	1	1
									5	5	1	2	5	2	2	5	2	2	2	1			
342	FO	F	8	15	125	n	3	1	12	5	1	11	1	1	4	1	1						
343	SF	F	10	35	90	y	8	5	9	2	1	6	1	2	10	2	1	11	1	1	10	4	1
									5	1	1	2	1	1	1	7	5						
344	FO	S	11	32	135	n	4	1	10	1	1	10	1	1	4	2	1	1	2	1			
345	SF	S	3	20	45	y	4	2	11	2	1	11	5	2	4	1	1	3	5	2			
346	RO	S	0	14	0	n		1															
347	FO	S	0	18	70	n		2															
348	RO	S	0	20	15	n		1															
349	SF	S	20	28	10	y	2	2	10	2	2	12	1	1									
350	FO	S	15	25	170	n	5	3	12	6	3	11	2	1	9	5	3	4	1	1	1	9	1
351	SF	S	18	32	25	y	1	1	11	1	1												
352	FC	S	40	20	170	n	3	3	9	5	3	11	1	2	10	1	1						
353	SF	F	15	40	100	n	9	4	11	1	1	6	1	1	8	4	3	4	1	1	4	5	2
									1	2	1	2	2	1	3	4	1	1	1	4			
354	FO	S	0	12	180	n	6	3	8	5	3	6	2	3	9	5	3	5	2	1	5	10	3
									1	7	2												
355	SM	S	5	7	100	n	4	1	4	1	1	11	1	1	11	3	1	3	4	1			
356	RO	F	0	15	0	y	4	1	10	2	1	10	1	1	11	1	1	2	5	1			
357	FO	S	10	38	140	n	5	3	11	5	3	10	5	2	11	3	1	8	4	3	11	3	1
358	FO	R	7	0	0	n		1															
359	SF	S	0	10	155	n		1															
360	FO	S	14	3	135	n	4	3	9	5	3	11	1	1	8	1	1	4	1	1			
362	RO	F	17	27	10	n	1	1	11	1	1												
363	SM	S	15	19	150	n		2															
364	FO	R	17	0	0	n	4	1	11	1	1	10	1	1	9	1	1	11	1	1			
365	SR	F	7	10	90	n		1															
366	FO	S	0	20	135	y	3	1	11	2	1	8	1	1	10	1	1						
367	SR	S	12	20	140	n	6	1	8	1	1	11	1	1	2	2	1	2	1	1	2	2	1
									1	7	1												
368	FO	R	10	3	0	y	4	1	8	1	1	10	1	1	11	1	1	6	1	1			
369	SM	S	99	18	120	n		3															
370	FC	S	42	25	90	n		6															
371	RC	S	10	18	90	n		2															

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
372	FC	F	8	12	160	n		1															
373	FO	S	25	33	135	n	5	3	12	5	3	12	1	1	12	1	1	8	1	1	4	1	1
374	SR	S	10	20	140	n	3	1	9	1	1	10	1	1	10	1	1						
375	FO	S	29	40	180	n		3															
376	FO	R	55	30	0	n	3	1	4	1	1	6	1	1	10	4	1						
377	SM	F	10	15	120	n	6	1	10	1	1	11	1	1	4	1	1	4	1	1	4	1	1
									2	2	1												
378	SM	F	25	43	90	n	9	5	4	1	1	4	1	1	6	2	5	11	1	2	11	1	1
									2	1	1	1	5	3	2	1	1	1	1	3			
379	SM	F	21	32	115	y	8	3	10	5	3	6	1	3	9	1	1	2	5	3	3	2	1
									1	7	2	2	5	1	2	2	1						
380	FC	S	15	36	160	y	6	3	12	5	2	11	5	3	4	1	1	4	1	1	6	1	1
									1	1	1												
381	SR	S	13	28	135	n		2															
382	FC	S	31	25	90	y	7	3	11	5	3	9	5	3	11	2	1	11	1	1	5	1	1
									1	1	1	2	1	1									
383	FC	F	10	27	150	y	3	3	9	5	3	8	5	3	1	1	1						
384	SF	F	12	31	115	n	4	1	7	1	1	8	1	1	11	2	1	1	2	1			
385	SF	F	15	20	100	n	2	2	10	5	2	11	5	2									
386	SM	S	25	30	10	n		2															
387	SM	F	20	5	50	n		1															
388	RC	F	8	12	20	n		1															
389	FO	S	13	8	105	y	2	1	4	1	1	7	1	1									
390	FO	S	15	33	135	n	9	3	11	5	2	12	2	1	11	5	2	6	1	2	2	1	1
									2	5	3	1	5	2	1	7	3	1	1	1			
391	SF	F	15	15	135	n	3	1	10	1	1	4	1	1	1	2	1						
392	FO	S	14	18	180	n		1															
393	RC	S	10	25	0	n		3															
394	FO	S	42	15	155	n	11	4	5	1	3	6	2	4	10	1	1	4	1	1	11	1	1
									9	1	1	1	5	3	1	2	1	1	3	4	2	1	1
									1	1	4												
395	SM	F	15	25	140	n	5	2	10	3	2	4	1	1	11	1	1	6	1	1	1	7	2
396	SM	F	20	10	80	y	4	1	12	2	1	11	1	1	8	1	1	4	1	1			
397	RC	S	25	30	15	y	2	1	12	5	1	10	1	1									
398	SM	S	25	15	15	n	2	1	10	1	1	4	1	1									
399	FO	S	7	10	90	y	1	1	10	1	1												
400	FC	S	10	15	115	n	2	1	11	1	1	12	1	1									
401	FW	F	20	22	150	y	2	3	4	5	3	8	1	1									
402	SR	F	15	20	90	n	3	2	10	1	1	12	5	2	9	1	1						
403	FC	S	8	26	135	n		1															
404	SR	S	18	20	140	n	3	1	9	1	1	11	1	1	2	1	1						
406	FO	S	10	15	120	n	1	3	9	5	3												
407	RO	F	0	12	0	y	4	1	6	1	1	5	2	1	6	1	1	2	1	1			
408	SR	F	10	15	90	n	4	1	11	1	1	12	1	1	11	2	1	4	1	1			
409	FC	S	10	27	45	n	5	1	10	3	1	8	1	1	12	1	1	10	1	1	2	1	1
410	FO	S	7	20	105	n	4	1	10	1	1	9	1	1	12	1	1	5	1	1			
411	FO	F	5	20	175	y	3	1	9	2	1	11	2	1	1	9	1						
412	SM	S	30	15	45	n	2	1	10	1	1	2	1	1									
413	SM	F	15	12	90	n	2	1	4	1	1	9	1	1									
414	FC	S	10	18	120	n	1	3	11	5	3												
415	RO	F	0	20	10	n	2	1	11	1	1	9	1	1									
416	RW	F	25	25	110	y	2	1	10	1	1	6	1	1									
417	FC	S	4	20	75	n	1	1	11	1	1												
418	FC	S	8	28	25	y	1	3	11	5	3												
419	FC	S	9	15	30	n		1															
420	SF	F	16	24	90	n	4	1	10	2	1	11	1	1	8	1	1	1	9	1			
421	RO	F	0	23	0	y	7	2	4	5	2	4	5	2	10	5	2	10	2	2	11	2	1
									6	1	1	2	1	1									
423	RO	F	0	34	10	n		2															

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	No inj	MAIS	Injuries BR	T	AIS

Total Cases: 410

Cases with Injury: 312

Table C.3 — Hannover data

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
1	FO	F	6	9	180	n	12	2	1	2	2	2	9	1	1	1	1	2	1	1	3	1	1
									11	9	1	11	1	1	4	1	1	4	1	1	9	9	1
									2	1	1	1	7	2									
2	FO	F	24	13	140	n	22	6	2	1	1	5	9	1	9	2	2	10	1	1	10	1	1
									11	1	1	11	1	1	11	1	1	11	1	1	4	1	1
									4	1	1	6	9	1	8	5	3	1	5	6	2	5	2
									2	5	2	5	5	4	5	2	5	5	3	5	5	5	4
									6	3	4												
3	FO	F	29	37	180	y	11	3	1	9	1	1	2	1	9	1	1	9	1	1	10	1	1
									11	1	1	5	1	1	4	5	2	8	5	2	9	3	3
									1	7	2												
4	FO	F	3	22	140	y	1	1	10	1	1												
5	FO	F	21	48	150	y	7	2	11	1	1	9	1	1	10	1	1	4	1	1	11	1	1
									8	5	2	4	5	2									
6	FO	F	9	26	170	y	6	1	10	1	1	10	1	1	11	1	1	11	1	1	10	1	1
									8	1	1												
7	FO	F	9	22	160	y	6	1	10	1	1	10	1	1	11	1	1	11	1	1	10	1	1
									8	1	1												
8	FO	F	22	38	162	y	5	2	4	1	1	10	1	1	11	1	1	10	1	1	11	5	2
9	FO	F	6	50	160	y	8	3	4	1	1	4	1	1	9	1	1	9	1	1	9	1	1
									10	2	1	10	5	3	10	5	2						
10	FO	F	13	50	160	y	9	2	1	2	1	5	1	1	6	1	1	12	1	1	12	1	1
									5	5	1	5	5	2	11	5	2	1	7	2			
11	FO	F	19	122	133	y	23	4	5	1	1	5	1	1	4	1	1	9	1	1	9	1	1
									9	3	1	9	3	1	10	1	1	10	1	1	11	1	1
									11	1	1	11	1	1	12	1	1	12	1	1	12	2	1
									9	3	2	3	5	9	9	5	4	10	5	4	9	5	3
									4	5	3	4	5	3	1	5	9						
12	FO	F	25	44	170	y	4	1	4	1	1	12	1	1	12	9	1	12	1	1			
13	FO	F	16	31	150	y	4	2	1	7	2	10	9	1	10	10	2	4	1	1			
14	FO	F	19	24	95	y	8	3	10	1	1	10	1	1	10	3	1	4	1	1	11	1	1
									10	3	3	9	3	3	11	3	3						
15	FO	F	26	28	90	y	8	2	1	7	2	2	2	1	4	1	1	11	1	1	12	9	1
									10	1	1	12	5	2	4	1	1						
16	FO	F	28	39	171	?	7	2	11	5	2	4	5	2	1	7	1	9	1	1	11	1	1
									9	1	1	11	1	1									
17	FO	F	13	105	151	y	24	6	1	2	1	2	1	1	1	1	1	1	1	1	2	2	1
									9	1	1	10	2	1	9	1	1	11	2	1	4	2	1
									5	10	3	5	10	5	5	10	4	5	10	4	1	5	3
									1	7	4	3	3	2	3	3	3	6	2	3	6	1	2
									6	5	3	6	5	3	4	5	2	4	5	2			
18	FO	S	13	16	110	n	10	3	6	9	1	10	9	1	11	1	1	12	9	1	10	1	1
									12	9	1	4	1	1	1	9	1	12	1	1	11	5	3
19	FO	S	6	28	135	y	5	1	1	1	1	4	1	1	11	2	1	10	2	1	10	2	1
20	FO	S	13	6	90	n	5	3	9	2	1	9	2	1	11	9	1	11	5	3	11	5	3
21	FO	S	3	16	100	n	9	3	1	1	1	4	1	1	4	1	1	4	1	1	2	1	1
									4	1	1	4	1	1	11	5	3	11	5	3			
22	FO	S	35	16	170	n	5	1	11	1	1	12	1	1	4	1	1	10	1	1	4	1	1
23	FO	S	21	13	90	n	6	2	12	1	1	12	2	1	4	1	1	2	1	1	2	1	1
									12	5	2												
24	FO	S	38	6	145	n	41	6	1	2	1	1	2	1	1	2	2	2	2	1	2	2	1
									2	9	1	2	9	1	2	2	1	2	2	1	2	2	1
									4	9	1	4	9	1	4	9	1	4	9	1	4	9	1
									4	9	1	4	1	1	4	1	1	4	1	1	4	1	1
									9	9	1	12	1	1	12	1	1	12	1	1	9	9	1
									9	9	1	9	9	1	10	1	1	11	9	1	12	2	1
									1	9	3	11	5	2	12	5	3	1	5	3	1	5	6
									2	5	4	1	9	5	2	5	3	5	1	3	5	1	3
									6	3	3												

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
25	FO	S	21	26	155	y	6	3	4	1	1	11	1	1	8	5	3	8	4	3	11	5	3
									11	5	2												
26	FO	S	13	10	100	n	6	2	11	1	1	12	2	1	2	1	1	6	1	1	12	5	2
									12	5	2												
27	FO	S	24	16	140	n	9	2	1	2	1	1	2	1	2	2	1	10	1	1	12	1	1
									6	1	1	2	2	1	12	5	2	1	7	2			
28	FO	S	28	11	90	n	13	2	1	1	1	2	1	1	10	1	1	11	2	1	2	1	1
									12	1	1	1	2	1	2	2	1	11	1	1	4	1	1
									4	1	1	3	4	1	4	5	2						
29	SM	S	6	19	110	n	4	1	9	1	1	4	1	1	4	1	1	5	5	1			
30	SM	S	29	22	20	n	4	1	4	1	1	4	1	1	10	1	1	12	1	1			
31	SM	S	25	18	130	y	5	2	4	9	1	10	2	1	4	9	1	5	5	2	1	7	2
32	SM	S	31	25	15	y	2	3	9	9	1	9	5	3									
33	SM	S	36	9	45	n	17	2	1	1	1	2	1	1	2	1	1	10	1	1	10	1	1
									11	1	1	4	1	1	4	1	1	4	1	1	4	1	1
									4	1	1	4	1	1	11	5	2	3	5	2	11	5	2
									1	7	2	2	5	1									
34	SM	S	46	18	30	y	8	1	1	1	1	10	1	1	10	1	1	11	1	1	11	1	1
									11	1	1	11	1	1	6	1	1						
35	SM	S	3	13	48	n	7	3	2	1	1	4	1	1	9	1	1	10	1	1	10	2	1
									10	5	3	2	5	1									
36	SM	S	13	51	160	y	23	6	2	1	1	1	1	1	2	1	1	1	1	1	3	1	1
									5	1	1	4	4	3	4	1	1	4	1	1	9	1	2
									10	1	1	10	1	1	10	2	1	11	1	1	12	2	1
									12	1	1	12	1	1	12	5	1	12	5	1	5	5	4
									1	10	6	2	5	1	2	5	2						
37	SM	S	13	42	45	y	9	2	4	5	2	4	5	2	4	5	2	4	5	2	4	5	2
									4	5	2	4	5	2	4	5	2	1	7	2			
38	SM	S	13	36	37	y	3	1	9	1	1	10	1	1	10	1	1						
39	SM	S	9	25	160	y	6	2	9	1	1	10	2	1	11	1	1	11	1	1	11	1	1
									1	7	2												
40	SM	S	16	34	40	y	2	1	9	1	1	4	1	1									
41	SM	S	24	51	120	y	4	2	1	1	1	5	1	1	5	5	2	5	5	1			
42	SM	S	6	25	30	y	3	1	12	1	1	12	1	1	12	9	1						
43	SM	S	10	36	31	y	3	1	4	2	1	4	1	1	6	1	1						
44	SM	S	20	20	163	y	1	2	10	2	2												
45	SM	S	13	13	90	y	4	1	10	1	1	4	1	1	4	1	1	4	2	1			
46	SM	S	18	13	20	n	5	2	1	1	1	1	1	1	2	1	1	5	5	2	1	7	2
47	SM	S	13	24	30	y	2	1	11	1	1	4	1	1									
48	SM	S	6	33	20	y	7	3	4	1	1	4	1	1	10	1	1	10	3	2	4	2	1
									5	4	2	10	5	3									
49	SM	S	19	3	160	y	2	2	11	5	2	11	5	2									
50	SM	S	3	9	65	y	3	1	10	1	1	11	1	1	11	1	1						
51	SM	S	26	20	110	y	1	2	1	7	2												
52	SM	S	3	16	103	y	2	3	11	1	1	9	5	3									
53	SM	S	16	38	40	y	6	2	4	1	1	10	1	1	11	1	1	12	1	1	12	2	1
									4	5	2												
54	SM	S	3	84	129	n	13	3	1	1	1	2	1	1	6	1	1	6	1	1	6	1	1
									10	1	1	10	1	1	11	1	1	12	1	1	12	1	1
									12	1	1	4	5	3	8	5	2						
55	SM	S	3	38	12	y	17	1	4	2	1	4	2	1	4	1	1	4	1	1	4	1	1
									4	1	1	4	1	1	10	1	1	10	1	1	10	1	1
									11	1	1	12	1	1	12	1	1	4	1	1	11	1	1
									11	1	1												
56	SM	S	6	50	35	y	6	2	2	1	1	11	1	1	11	1	1	11	2	1	11	5	2
									11	5	2												
57	SM	S	16	28	48	y	4	1	4	1	1	4	1	1	4	1	1	10	1	1			
58	SM	S	13	28	120	y	3	2	9	1	1	12	5	2	12	2	1						
59	SM	S	0	32	0	y	2	1	11	1	1	11	1	1									

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
60	SM	S	9	34	90	y	2	1	11	1	1	11	1	1									
61	SM	S	14	39	28	y	5	1	11	2	1	11	1	1	12	1	1	10	1	1	4	1	1
62	SM	S	9	38	54	y	2	1	4	1	1	6	1	1									
63	SM	S	13	34	28	y	7	1	9	1	1	10	1	1	10	1	1	11	1	1	4	1	1
									4	1	1	4	1	1									
64	SM	S	19	14	180	y	8	1	4	1	1	11	1	1	12	1	1	12	1	1	12	1	1
									12	1	1	12	1	1	4	1	1						
65	SM	S	0	19	0	y	2	1	10	1	1	4	1	1									
66	SM	S	11	54	26	y	6	4	5	5	4	5	1	3	5	1	3	5	10	1	11	1	1
									12	1	1												
67	SM	S	20	41	95	y	2	1	10	1	1	10	1	1									
68	RO	F	19	25	0	n	6	2	1	2	1	1	2	1	2	2	1	10	1	1	11	1	1
									1	7	2												
69	RO	F	0	13	0	y	4	1	2	1	1	6	1	1	4	1	1	12	1	1			
70	RO	F	0	75	0	y	13	3	2	2	1	2	2	1	4	9	1	4	9	1	9	2	1
									9	1	1	10	1	1	11	1	1	12	1	1	12	1	1
									9	5	3	4	5	2	5	5	1						
71	RO	F	0	24	0	y	3	2	4	1	1	4	5	2	4	5	2						
72	RO	F	26	60	8	y	12	5	1	2	1	2	2	1	5	1	1	4	1	1	4	1	1
									4	1	1	10	1	1	10	1	1	1	5	3	1	7	5
									4	5	2	1	5	2									
73	RO	F	0	19	0	?		1															
74	RO	F	25	53	0	y	7	3	2	2	1	4	1	1	4	1	1	9	1	1	9	1	1
									10	1	1	9	5	3									
75	RO	F	0	48	0	y	14	2	2	1	1	2	1	1	2	9	1	5	1	1	6	1	1
									9	1	1	9	1	1	11	5	2	4	5	2	4	5	2
									4	5	2	4	5	2	4	5	2	1	7	2			
76	RO	F	0	28	0	y	7	4	1	1	1	2	5	2	2	2	2	2	5	1	4	5	2
									4	1	2	1	7	2									
77	RO	F	14	40	45	y	5	3	10	1	1	10	1	1	4	1	1	4	1	1	10	3	3
78	FO	S	33	16	95	n	8	2	1	9	1	2	1	1	1	1	1	1	2	1	2	1	1
									4	1	1	9	1	1	1	7	2						
79	FO	S	22	41	175	y	7	3	8	2	1	10	1	1	12	3	2	10	1	1	9	2	2
									12	1	1	9	5	3									
80	FO	S	11	9	115	n	9	3	2	1	1	2	2	1	4	2	1	5	1	1	6	1	1
									2	2	1	4	1	1	5	4	2	11	5	3			
81	FO	S	19	19	50	n	6	2	4	1	1	6	1	1	12	1	1	4	1	1	12	1	1
									12	5	2												
82	FO	S	39	16	90	y	14	5	11	1	1	12	2	1	4	1	1	1	1	1	2	1	1
									4	1	1	10	1	1	12	1	1	11	5	3	11	5	3
									11	5	2	4	5	2	12	5	2	1	7	5			
83	FO	S	55	9	70	n	12	2	1	2	1	1	2	2	1	2	1	1	1	1	9	2	2
									10	1	1	10	1	1	12	1	1	11	1	1	12	1	1
									1	2	1	1	7	2									
84	FO	S	21	16	110	?		1															
85	FO	S	26	23	100	n	5	2	12	1	1	4	1	1	1	9	1	5	5	2	1	7	2
86	FO	S	31	11	117	n	8	2	1	1	1	1	2	1	2	1	1	2	1	1	10	1	1
									10	1	1	10	1	1	1	7	2						
87	FO	S	51	16	10	n	6	3	1	2	1	4	1	1	9	1	1	4	5	2	4	5	3
									1	7	2												
88	FO	S	13	19	127	n	8	3	1	1	1	2	1	1	3	1	1	5	1	1	11	1	1
									12	1	1	1	7	3	1	5	3						
89	FO	S	11	16	0	n	4	2	11	10	1	4	10	1	11	5	2	11	5	2			
90	FO	S	16	21	123	y	5	2	10	1	1	11	1	1	11	1	1	11	5	2	11	5	2
91	FO	S	58	16	42	n	10	4	1	2	2	1	2	2	4	2	1	6	1	1	9	1	1
									5	5	2	9	5	3	9	5	3	1	7	4	6	1	1
92	FO	S	94	63	30	y	8	3	4	1	1	4	1	1	10	1	1	10	1	1	4	4	1
									11	5	3	11	5	1	4	5	1						
93	FO	S	0	16	85	y	1	1	11	1	1												

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
94	FO	S	33	16	110	n	8	3	1	2	1	10	3	2	4	1	1	12	1	1	1	7	1
									4	5	2	11	5	3	11	5	2						
95	FO	S	26	16	70	y	12	3	4	1	1	4	1	1	4	1	1	4	1	1	4	1	1
									10	1	1	9	1	1	9	1	1	12	2	1	9	5	3
									11	5	2	11	5	3									
96	FO	S	3	0	95	n	4	2	6	1	1	4	1	1	4	1	1	1	7	2			
97	FO	S	31	16	90	n	7	2	5	1	1	9	2	1	11	2	1	12	1	1	12	2	1
									12	4	1	1	7	2									
98	FO	S	49	3	85	n	19	6	4	1	1	3	1	1	6	1	1	4	1	1	6	2	1
									5	1	1	10	1	1	4	1	1	4	1	1	4	1	1
									6	1	1	10	1	1	1	9	5	10	2	2	10	9	2
									1	9	4	5	1	3	5	1	3	1	7	3			
99	FO	S	41	13	25	n	8	3	1	2	2	9	1	1	9	1	1	10	1	1	12	2	1
									11	5	3	2	5	2	1	5	6						
100	FO	S	26	13	90	n	4	1	10	1	1	6	1	1	11	9	1	12	9	1			
101	FO	S	21	0	75	n	10	3	9	1	1	9	9	1	11	9	1	11	1	1	4	1	1
									4	1	1	4	1	1	11	5	2	11	5	3	9	5	3
102	FO	S	9	16	68	n	1	1	10	1	1												
103	FO	S	15	15	114	y	5	1	10	1	1	10	1	1	12	1	1	12	1	1	4	1	1
104	FO	S	6	16	90	n	2	1	12	1	1	12	3	1									
105	FO	S	8	27	141	y	8	2	12	5	2	12	5	2	4	4	2	12	1	1	12	2	1
									11	1	1	11	1	1	1	1	1						
106	FO	S	35	24	161	y	7	3	1	1	1	10	1	1	4	1	1	4	1	1	4	5	3
									8	5	2	8	5	2									
107	FO	S	4	36	144	y	6	2	5	1	2	9	1	2	12	1	1	10	1	1	4	1	1
									4	2	2												
108	FO	S	16	35	124	y	12	3	8	5	3	8	4	3	12	5	2	1	1	1	11	1	1
									11	1	1	11	1	1	11	3	2	12	1	1	4	1	1
									4	1	1	12	2	2									
109	FO	S	7	14	89	n	3	1	6	1	1	12	3	1	12	1	1						
110	FO	S	31	15	96	y	1	1	3	1	1												
111	FO	S	13	18	93	n	5	1	4	1	1	4	1	1	11	1	1	11	1	1	10	1	1
113	FO	S	8	16	84	y	1	2	12	2	2												
114	FO	S	37	57	174	y	6	2	2	2	1	2	1	1	2	1	1	4	1	1	4	1	1
									10	2	2												
115	FO	S	18	22	119	y	6	1	1	7	2	9	1	1	6	1	1	4	1	1	10	1	1
									6	1	1												
116	FO	S	26	7	151	?	11	2	11	1	1	11	1	1	11	1	1	9	1	1	12	1	1
									4	1	1	4	1	1	4	1	1	10	1	1	4	5	2
									9	3	2												
117	FO	S	25	16	24	?	4	2	4	1	1	6	1	1	11	5	2	11	5	2			
118	RO	S	0	9	0	n	3	2	11	1	1	11	2	2	11	1	1						
119	RO	S	0	25	9	y	4	1	11	1	1	11	1	1	11	1	1	12	1	1			
120	RO	S	18	25	10	y	3	2	2	2	1	9	1	1	4	5	2						
121	RO	S	1	21	150	y	3	1	10	1	1	10	1	1	11	1	1						
122	FO	R	23	3	0	y	7	2	1	2	2	1	1	1	2	1	1	2	1	1	2	1	1
									5	1	1	1	7	2									
123	FO	R	15	9	40	n	10	2	2	2	1	1	9	1	2	9	1	2	1	1	4	1	1
									6	9	1	11	9	1	4	5	1	4	5	1	1	7	2
124	FO	R	50	0	0	n	25	6	1	2	1	1	2	2	6	9	1	10	1	1	10	1	1
									4	1	1	11	1	1	9	2	2	1	2	1	2	3	2
									4	1	1	4	1	1	2	5	3	1	5	3	2	5	3
									1	5	6	1	3	6	1	7	5	5	5	2	5	5	2
									2	5	3	1	5	6	2	5	1	2	5	3	1	9	3
125	FO	R	22	0	0	y	3	1	4	1	1	10	1	1	1	7	1						
126	SM	F	0	31	90	y	5	2	1	1	1	10	1	1	4	1	1	10	1	1	1	7	2
127	SM	F	6	54	25	y	7	3	4	1	1	4	1	1	9	1	1	8	1	1	10	1	1
									10	1	1	4	5	3									

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
128	SM	F	3	9	90	y	6	3	2	1	1	3	2	2	10	1	1	4	5	3	4	5	2
									1	7	2												
129	SM	F	13	38	100	y	23	3	1	2	1	2	1	1	10	1	1	10	1	1	10	1	1
									10	1	1	10	1	1	4	1	1	4	1	1	4	1	1
									4	1	1	4	1	1	5	1	1	6	1	1	8	5	2
									8	5	3	11	5	2	4	5	3	4	5	3	4	5	2
									4	5	2	4	4	2	1	7	3						
130	SM	F	27	6	110	n	3	3	2	1	1	4	1	1	10	5	3						
131	SM	F	38	34	70	n	11	3	1	1	1	2	1	1	2	2	1	4	5	2	5	5	2
									5	5	2	4	5	2	4	5	2	9	5	3	1	7	2
									10	1	1												
132	SM	F	9	42	157	n	16	2	1	2	1	2	2	1	4	1	1	4	1	1	4	2	1
									4	1	1	11	1	1	11	1	1	12	1	1	4	2	1
									4	1	1	4	2	1	4	5	2	5	5	2	1	7	2
									6	2	1												
133	SM	F	18	26	90	n	3	1	4	1	1	11	1	1	10	1	1						
134	SM	F	22	9	80	y	9	3	1	2	1	10	1	1	4	9	1	10	1	1	4	5	2
									9	5	3	10	3	2	1	7	2	5	5	1			
135	SM	F	0	25	0	n	8	2	1	2	1	2	2	1	2	2	1	4	1	1	4	1	1
									4	1	1	10	1	1	1	7	2						
136	SM	F	34	13	90	n	16	2	2	1	1	1	2	1	2	1	1	4	2	1	4	2	1
									4	2	1	4	2	1	4	2	1	4	2	1	10	1	1
									10	1	1	2	2	1	4	5	2	4	5	2	2	5	1
									1	7	2												
137	SM	F	3	3	90	y	5	2	9	1	1	10	1	1	11	1	1	4	1	1	5	5	2
138	SM	F	8	19	90	y	4	2	4	1	1	6	1	1	9	1	1	4	5	2			
139	SM	F	11	63	140	y	17	4	2	1	1	2	1	1	3	1	1	3	2	1	4	1	1
									4	1	1	9	1	1	9	1	1	10	1	1	12	1	1
									12	1	1	12	1	1	9	5	3	10	5	2	1	7	3
									3	10	3	6	3	4									
140	SM	F	21	14	133	y	9	3	9	1	1	10	1	1	10	1	1	12	1	1	4	1	1
									11	3	3	9	3	3	10	3	3	9	1	1			
141	SM	F	4	52	140	y	7	2	4	1	1	4	1	1	4	1	1	6	1	1	10	1	1
									11	1	1	4	5	2									
142	SM	F	6	30	123	y	13	3	1	2	1	2	1	1	2	1	1	4	1	1	4	2	1
									9	1	1	9	1	1	10	1	1	12	1	1	12	1	1
									12	1	1	12	1	1	9	5	3						
143	SM	F	13	16	145	y	3	1	4	1	1	9	1	1	10	1	1						
144	SM	F	9	29	47	n	9	2	11	2	2	1	2	1	1	2	1	1	1	1	2	1	1
									2	1	1	4	2	1	4	2	1	4	1	1			
145	SM	F	26	44	124	y	16	2	3	1	1	2	1	1	2	1	1	2	1	1	4	1	1
									3	1	2	4	1	1	10	1	1	10	1	1	10	1	1
									11	1	1	12	1	1	12	1	1	4	1	1	5	5	2
									1	7	2												
146	SM	F	16	19	92	y	5	1	6	1	1	4	1	1	4	1	1	4	1	1	4	1	1
147	SM	F	6	34	90	y	3	2	9	1	1	4	1	1	4	5	2						
148	SM	F	3	19	90	y	3	1	10	1	1	10	1	1	10	1	1						
149	SM	F	3	19	90	y	3	1	4	1	1	10	1	1	12	1	1						
150	SM	F	9	22	105	y	8	3	2	1	1	3	1	1	4	1	1	4	5	2	4	5	2
									1	7	2	9	5	3	5	5	2						
151	SM	F	4	54	64	y	4	2	2	2	1	11	2	2	9	1	1	9	1	1			
152	SM	F	0	9	70	y	10	1	2	2	1	2	2	1	2	2	1	2	1	1	2	1	1
									4	1	1	4	1	1	10	1	1	10	1	1	11	1	1
153	SM	F	9	50	80	y	6	2	11	1	1	9	1	1	10	2	1	4	9	1	11	5	2
									11	5	2												

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
154	SM	F	6	63	10	y	43	5	1	1	1	5	1	1	9	1	1	11	1	1	11	1	1
									11	1	1	2	2	1	2	2	1	10	2	1	2	1	1
									5	1	1	6	1	1	5	1	1	9	1	1	10	1	1
									10	1	1	11	1	1	9	1	1	9	1	1	9	1	1
									9	1	1	9	1	1	10	1	1	10	1	1	5	9	5
									8	5	3	8	5	3	8	5	2	8	5	2	4	5	2
									4	5	2	1	5	3	1	9	3	5	5	1	5	5	1
									5	5	1	5	1	3	6	3	5	6	3	4	6	3	5
									6	1	3	6	3	4	5	2	5						
155	SM	F	0	25	65	y	3	2	10	2	1	4	1	1	9	10	2						
156	SM	F	13	16	90	y	4	1	9	1	1	10	1	1	10	1	1	11	1	1			
157	SM	F	9	36	142	y	1	2	5	5	2												
158	SM	F	8	0	0	7	1	1	10	1	1												
159	SM	F	22	51	100	y	2	1	10	1	1	9	1	1									
160	SM	F	17	48	101	y	10	3	1	1	1	1	5	2	1	9	3	1	7	3	1	7	3
									1	10	3	12	1	1	12	5	1	9	1	1	12	9	1
161	SM	F	21	18	89	y	7	3	2	2	1	12	1	1	5	10	3	6	10	2	9	10	2
									9	10	2	4	5	3									
162	SM	F	18	35	40	y	3	1	15	1	1	10	2	1	9	1	1						
163	SM	F	9	25	55	y	10	3	4	5	3	10	1	1	10	1	1	11	1	1	12	1	1
									4	1	1	5	1	1	12	3	2	9	1	1	6	1	1
164	SM	F	19	28	135	?	2	1	12	5	1	12	1	1									
165	SM	F	16	35	26	y	11	1	2	1	1	4	1	1	11	1	1	11	1	1	15	10	9
									11	1	1	12	1	1	11	1	1	11	1	1	12	1	1
									9	1	1												
166	SM	F	1	13	119	y	5	1	3	1	1	4	1	1	4	1	1	4	1	1	10	1	1
167	FO	S	18	13	150	n	4	3	4	1	1	12	2	1	11	5	3	11	5	3			
168	FO	S	36	16	90	n	7	5	6	1	1	9	1	1	10	1	1	11	1	1	12	1	1
									1	5	3	1	7	5									
169	FO	S	61	22	90	n	11	5	6	1	1	4	1	1	4	1	1	12	1	1	1	1	1
									1	1	1	9	5	3	9	5	3	11	5	3	1	5	3
									1	7	5												
170	FO	S	34	29	90	n	5	3	11	9	1	11	5	3	11	5	3	11	5	3	11	5	2
171	FO	S	23	6	90	y	5	1	1	2	1	2	1	1	2	1	1	10	1	1	11	1	1
172	FO	S	28	24	120	n	5	3	1	1	1	4	1	1	4	1	1	11	5	3	11	5	3
173	FO	S	13	31	105	n	3	2	9	1	1	10	2	2	12	2	1						
174	FO	S	32	18	160	n	16	3	1	1	1	4	1	1	9	1	1	4	1	1	4	2	1
									5	1	1	1	1	1	2	1	1	2	1	1	2	1	1
									9	5	3	9	5	3	11	5	2	12	5	2	1	7	2
									5	5	2												
175	FO	S	3	31	110	y	8	3	4	1	1	10	3	2	12	1	1	4	1	1	12	1	1
									8	4	3	11	5	2	1	7	2						
176	FO	S	13	19	155	n	5	1	1	2	1	4	1	1	12	10	1	12	10	1	12	4	1
177	FO	S	42	16	140	n	5	2	9	1	1	2	2	1	12	2	1	11	5	2	11	5	2
178	FO	S	15	16	100	n	7	3	11	2	1	10	2	1	4	1	1	10	2	1	9	9	1
									10	1	1	11	5	3									
179	FO	S	14	18	90	n	4	1	5	1	1	4	2	1	12	2	1	12	1	1			
180	FO	S	28	13	120	n	9	3	1	2	2	4	1	1	10	1	1	6	1	1	1	1	1
									11	1	1	11	5	2	9	5	3	1	7	3			
181	FO	S	30	20	160	y	11	2	1	1	1	4	1	1	4	1	1	9	1	1	12	1	1
									12	1	1	10	1	1	4	1	1	4	1	1	9	1	1
									1	7	2												
182	FO	S	33	19	160	y	3	3	8	5	3	11	5	2	12	5	2						
183	FO	S	13	13	105	n	5	2	1	1	1	11	1	1	11	1	1	12	2	1	11	5	2
184	FO	S	32	16	170	n	6	5	1	2	2	1	7	2	11	5	3	11	5	3	2	5	4
									1	5	3												
185	FO	S	17	13	150	n	2	3	4	1	1	11	5	3									
186	FO	S	6	22	90	y	3	2	2	2	2	11	1	1	2	5	2						

Ref no	OV cp	MC cp	OV sp	MC sp	RHA deg	H	No inj	MAIS	Injuries BR	T	AIS												
187	FO	S	40	19	90	n	12	3	1	9	1	1	1	1	2	2	1	2	1	1	4	1	1
									4	1	1	4	1	1	10	1	1	10	1	1	11	1	1
									4	1	1	1	7	3									
188	FO	S	18	16	90	y	6	2	10	1	1	10	1	1	12	1	1	12	1	1	9	4	2
									9	5	2												
189	FO	S	0	38	152	y	19	6	2	1	1	2	1	1	2	1	1	3	9	1	5	1	1
									4	9	1	9	1	1	9	1	1	9	1	1	10	1	1
									10	1	1	10	1	2	11	1	1	11	5	3	9	5	3
									11	5	3	1	7	5	5	5	4	3	5	9			
190	FO	S	13	29	117	y	3	3	10	1	1	11	5	3	11	5	3						
191	FO	S	58	15	100	y	4	2	4	1	1	4	1	1	4	5	2	1	7	2			
192	FO	S	18	3	75	n	5	2	6	1	1	10	1	1	11	1	1	11	5	2	11	5	2
193	FO	S	11	13	90	y	2	1	10	1	1	12	2	1									
194	FO	S	36	16	0	n	11	4	4	10	1	4	10	1	4	10	1	10	10	1	4	5	2
									8	5	2	11	5	2	11	5	2	11	5	2	1	5	4
									8	5	3												
195	FO	S	6	22	96	y	5	3	10	3	2	2	1	1	4	1	1	11	5	3	11	5	3
196	FO	S	0	41	85	y	5	3	10	2	2	12	1	1	12	2	1	12	2	1	12	3	3
197	FO	S	31	9	100	n	12	1	1	1	1	1	1	1	2	1	1	2	2	1	4	1	1
									11	1	1	11	1	1	12	1	1	12	1	1	12	1	1
									12	1	1	12	1	1									
198	FO	S	36	3	49	y	7	3	9	2	1	9	2	1	10	1	1	10	1	1	12	1	1
									12	1	1	11	4	3									
200	FO	S	13	28	30	y	3	3	4	1	1	11	2	2	12	4	3						
201	FO	S	19	13	150	?		1															
202	FO	S	19	19	165	y	10	1	4	2	1	4	1	1	4	1	1	4	1	1	4	1	1
									9	1	1	10	1	1	11	1	1	11	1	1	11	1	1
203	FO	S	18	16	90	y	6	2	2	2	2	1	1	1	10	2	2	10	1	1	10	1	1
									2	2	2												
204	FO	S	16	31	105	y	3	4	6	1	1	11	5	3	11	5	3						
205	FO	S	32	13	90	n	8	4	10	1	1	12	1	1	2	9	1	12	1	1	1	7	3
									1	9	4	12	5	3	2	5	2						
206	FO	S	9	31	110	y	5	2	10	2	2	11	1	1	12	1	1	4	1	1	4	1	1
207	FO	S	6	25	90	y	6	1	10	2	2	10	1	1	10	1	1	11	1	1	9	1	1
									4	1	1												
208	FO	S	25	3	90	n	5	1	2	2	1	2	1	1	2	1	1	4	1	1	4	1	1
209	FO	S	34	19	75	n	7	4	2	9	1	1	7	4	11	5	2	11	5	2	1	5	2
									1	5	2	1	5	2									
210	FO	S	9	22	100	y	4	1	10	1	1	10	1	1	11	1	1	11	1	1			
211	FO	S	13	21	136	?	2	1	11	1	1	11	1	1									
212	FO	S	7	31	124	?	8	1	12	2	1	11	1	1	12	1	1	12	1	1	4	1	1
									4	1	1	4	1	1	4	1	1						
213	FO	S	16	12	91	n	2	1	1	2	1	1	2	1									

Total Cases: 211

Cases with Injury data: 208

Annex D
(normative)

Resulting frequency of injury by body region and injury type for the combined Los Angeles and Hannover databases

The combined Los Angeles and Hannover databases have been additionally sorted by frequency of injury by body region and injury type and severity. The results are given in Tables D.1, D.2, and D.3. The three digits of the codes used in this Annex correspond to the OV contact point code, the MC contact point code, and the relative heading angle code, respectively.

Table D.1 — Head injury configurations (helmeted concussions, AIS ≥ 2) involving 67 accidents

Dimensions in metres per second

114

OVS	MCS	FO head injury
0	13,4	1
6,7	6,7	1
6,7	9,8	1
6,7	13,4	2
6,7	20,1	1
9,8	6,7	4
13,4	6,7	1
TOTAL	=	11

143

OVS	MCS	FO head injury
9,8	9,8	2
13,4	6,7	6
20,1	0	2
20,1	6,7	2
20,1	9,8	1
TOTAL	=	13

413

OVS	MCS	FO head injury
0	9,8	1
0	13,4	2
6,7	13,4	1
6,7	20,1	1
9,8	9,8	1
13,4	6,7	1
13,4	9,8	1
13,4	13,4	2
TOTAL	=	10

711

OVS	MCS	FO head injury
0	9,8	1
0	20,1	1
6,7	9,8	1
9,8	20,1	1
TOTAL	=	4

414

OVS	MCS	FO head injury
0	20,1	1
6,7	9,8	3
6,7	20,1	1
9,8	6,7	1
9,8	13,4	1
9,8	20,1	1
TOTAL	=	8

412

OVS	MCS	FO head injury
6,7	20,1	1
TOTAL	=	1

115

OVS	MCS	FO head injury
0	6,7	1
6,7	20,1	1
9,8	13,4	1
13,4	6,7	2
13,4	9,8	1
TOTAL	=	6

313

OVS	MCS	FO head injury
6,7	13,4	1
13,4	20,1	1
TOTAL	=	2

513

OVS	MCS	FO head injury
0	6,7	1
TOTAL	=	1

226

OVS	MCS	FO head injury
6,7	9,8	1
TOTAL	=	1

131

OVS	MCS	FO head injury
9,8	0	2
20,1	0	1
20,1	6,7	1
TOTAL	=	4

514

OVS	MCS	FO head injury
TOTAL	=	0

314

OVS	MCS	FO head injury
6,7	13,4	2
TOTAL	=	2

243

OVS	MCS	FO head injury
TOTAL	=	0

242

OVS	MCS	FO head injury
TOTAL	=	0

312

OVS	MCS	FO head injury
TOTAL	=	0

641

OVS	MCS	FO head injury
0	20,1	1
TOTAL	=	1

132

OVS	MCS	FO head injury
6,7	0	1
20,1	6,7	1
TOTAL	=	2

225

OVS	MCS	FO head injury
TOTAL	=	0

712

OVS	MCS	FO head injury
0	13,4	1
TOTAL	=	1

648

OVS	MCS	FO head injury
TOTAL	=	0

512

OVS	MCS	FO head injury
TOTAL	=	0

241

OVS	MCS	FO head injury
TOTAL	=	0

623

OVS	MCS	FO head injury
TOTAL	=	0

624

OVS	MCS	FO head injury
TOTAL	=	0

Table D.2 — Lower leg injury configurations (fractures, AIS ≥ 2) involving 80 accidents

Dimensions in metres per second

114

OVS	MCS	FO lower leg injury
0	13,4	1
6,7	0	1
6,7	6,7	2
6,7	9,8	3
6,7	13,4	3
9,8	6,7	1
9,8	9,8	3
13,4	0	1
20,1	6,7	1
TOTAL	=	16

143

OVS	MCS	FO lower leg injury
6,7	0	2
6,7	6,7	3
6,7	13,4	1
9,8	0	1
9,8	6,7	2
13,4	6,7	3
13,4	9,8	1
20,1	9,8	1
TOTAL	=	14

413

OVS	MCS	FO lower leg injury
0	20,1	1
6,7	9,8	1
6,7	13,4	1
13,4	13,4	1
TOTAL	=	4

711

OVS	MCS	FO lower leg injury
0	20,1	1
TOTAL	=	1

414

OVS	MCS	FO lower head injury
0	9,8	1
6,7	9,8	2
9,8	13,4	1
TOTAL	=	4

412

OVS	MCS	FO lower leg injury
0	20,1	1
TOTAL	=	1

115

OVS	MCS	FO lower leg injury
6,7	9,8	1
6,7	20,1	1
9,8	13,4	2
13,4	6,7	3
TOTAL	=	7

313

OVS	MCS	FO lower leg injury
6,7	9,8	1
6,7	20,1	1
TOTAL	=	2

513

OVS	MCS	FO lower leg injury
TOTAL	=	0

226

OVS	MCS	FO lower leg injury
0	6,7	1
0	9,8	2
0	13,4	1
6,7	6,7	1
6,7	13,4	1
9,8	13,4	1
TOTAL	=	7

131

OVS	MCS	FO lower leg injury
9,8	0	1
13,4	6,7	1
TOTAL	=	2

514

OVS	MCS	FO lower leg injury
TOTAL	=	0

314

OVS	MCS	FO lower leg injury
TOTAL	=	0

243

OVS	MCS	FO lower leg injury
6,7	0	1
6,7	9,8	1
9,8	6,7	1
13,4	9,8	1
TOTAL	=	4

242

OVS	MCS	FO lower leg injury
0	9,8	1
6,7	6,7	1
9,8	6,7	1
9,8	13,4	1
TOTAL	=	4

312

OVS	MCS	FO lower leg injury
0	9,8	1
0	13,4	1
TOTAL	=	2

641

OVS	MCS	FO lower leg injury
0	20,1	1
TOTAL	=	1

132

OVS	MCS	FO lower leg injury
9,8	6,7	1
20,1	6,7	1
20,1	20,1	1
TOTAL	=	3

225

OVS	MCS	FO lower leg injury
0	9,8	2
6,7	13,4	2
TOTAL	=	4

712

OVS	MCS	FO lower leg injury
6,7	9,8	1
6,7	13,4	1
TOTAL	=	2

648

OVS	MCS	FO lower leg injury
0	13,4	1
TOTAL	=	1

512

OVS	MCS	FO lower leg injury
TOTAL	=	0

241

OVS	MCS	FO lower leg injury
13,4	9,8	1
TOTAL	=	1

623

OVS	MCS	FO lower leg injury
TOTAL	=	0

624

OVS	MCS	FO lower leg injury
TOTAL	=	0

Table D.3 — Upper leg injury configurations (fractures, AIS ≥ 2) involving 37 accidents

Dimensions in metres per second

114

OVS	MCS	FO upper leg injury
0	13,4	1
6,7	0	1
6,7	6,7	1
6,7	9,8	1
6,7	13,4	2
6,7	20,1	1
9,8	6,7	1
9,8	9,8	1
TOTAL	=	9

143

OVS	MCS	FO upper leg injury
6,7	6,7	1
9,8	0	1
9,8	6,7	1
20,1	9,8	1
TOTAL	=	4

413

OVS	MCS	FO upper leg injury
0	6,7	1
0	9,8	1
13,4	13,4	1
TOTAL	=	3

711

OVS	MCS	FO upper leg injury
0	13,4	1
0	20,1	1
9,8	20,1	1
TOTAL	=	3

414

OVS	MCS	FO upper head injury
0	13,4	1
6,7	20,1	1
9,8	13,4	1
TOTAL	=	3

412

OVS	MCS	FO upper leg injury
TOTAL	=	
		0

115

OVS	MCS	FO upper leg injury
0	6,7	1
6,7	9,8	1
9,8	20,1	1
13,4	6,7	2
TOTAL	=	5

313

OVS	MCS	FO upper leg injury
TOTAL	=	0

513

OVS	MCS	FO upper leg injury
6,7	20,1	1
TOTAL	=	1

226

OVS	MCS	FO upper leg injury
TOTAL	=	0

131

OVS	MCS	FO upper leg injury
20,1	13,4	1
TOTAL	=	1

514

OVS	MCS	FO upper leg injury
9,8	13,4	1
TOTAL	=	1

314

OVS	MCS	FO upper leg injury
TOTAL	=	0

243

OVS	MCS	FO upper leg injury
13,4	9,8	1
20,1	6,7	1
TOTAL	=	2

242

OVS	MCS	FO upper leg injury
6,7	13,4	1
TOTAL	=	1

312

OVS	MCS	FO upper leg injury
9,8	20,1	1
TOTAL	=	1

641

OVS	MCS	FO upper leg injury
TOTAL	=	0

132

OVS	MCS	FO upper leg injury
20,1	6,7	1
TOTAL	=	1

225

OVS	MCS	FO upper leg injury
0	13,4	1
20,1	9,8	1
TOTAL	=	2

712

OVS	MCS	FO upper leg injury
TOTAL	=	0

648

OVS	MCS	FO upper leg injury
TOTAL	=	0

512

OVS	MCS	FO upper leg injury
TOTAL	=	0

241

OVS	MCS	FO upper leg injury
TOTAL	=	0

623

OVS	MCS	FO upper leg injury
TOTAL	=	0

624

OVS	MCS	FO upper leg injury
TOTAL	=	0

Annex E
(informative)

Frequency of occurrence data in non-SI units

The frequency of occurrence for the combined Los Angeles and Hannover databases are presented in non-SI units of miles per hour. Table E.1 corresponds to Table B.1, E.2 to D.1, E.3 to D.2, and E.4 to D.3.

Table E.1 — Opposing vehicle and motorcycle speeds and frequencies of occurrence for 200 combined Los Angeles and Hannover impact configurations

Dimensions in miles per hour

114

OVS	MCS	FO
0	15	3
0	22	6
0	30	3
0	45	1
15	0	2
15	15	11
15	22	14
15	30	7
15	45	2
22	0	1
22	15	5
22	22	3
22	30	2
22	45	1
30	0	1
30	15	1
45	15	2
TOTAL	=	65

143

OVS	MCS	FO
15	0	3
15	15	13
15	22	3
15	30	3
22	0	3
22	15	8
22	22	2
30	0	1
30	15	8
30	22	1
30	30	1
45	0	2
45	15	2
45	22	1
TOTAL	=	51

413

OVS	MCS	FO
0	15	6
0	22	3
0	30	5
0	45	1
15	15	6
15	22	8
15	30	4
15	45	1
22	15	3
22	22	4
22	45	3
30	15	1
30	22	1
30	30	3
45	15	1
TOTAL	=	50

711

OVS	MCS	FO
0	15	9
0	22	10
0	30	3
0	45	2
15	22	6
15	30	4
22	30	1
22	45	4
TOTAL	=	39

414

OVS	MCS	FO
0	15	3
0	22	2
0	30	2
0	45	3
15	15	3
15	22	7
15	30	3
15	45	1
22	15	3
22	22	1
22	30	2
22	45	2
TOTAL	=	32

412

OVS	MCS	FO
0	15	1
0	22	7
0	30	2
0	45	3
15	15	2
15	22	2
15	30	8
15	45	2
22	15	1
22	30	1
30	15	1
45	15	1
TOTAL	=	31

115

OVS	MCS	FO
0	15	3
0	22	3
0	45	2
15	15	4
15	22	2
15	45	1
22	0	1
22	22	1
22	30	3
22	45	3
30	15	4
30	22	2
30	45	1
TOTAL	=	30

313

OVS	MCS	FO
0	15	6
0	22	2
0	30	1
0	45	1
15	15	1
15	22	9
15	30	3
15	45	2
22	30	1
30	45	1
TOTAL	=	27

513

OVS	MCS	FO
0	15	2
0	22	1
15	15	5
15	22	4
15	30	4
15	45	2
22	15	2
22	22	3
30	15	1
TOTAL	=	24

226

OVS	MCS	FO
0	15	2
0	22	5
0	30	2
15	15	2
15	22	4
15	30	2
22	22	1
22	30	1
30	15	1
TOTAL	=	20

131

OVS	MCS	FO
15	0	5
22	0	4
22	15	1
30	0	1
30	15	1
45	0	1
45	15	1
45	22	1
45	30	4
TOTAL	=	19

514

OVS	MCS	FO
0	15	1
0	22	1
0	45	1
15	15	3
15	22	6
15	45	1
22	15	1
22	22	3
22	30	1
TOTAL	=	18

314

OVS	MCS	FO
0	15	1
0	30	1
15	15	3
15	22	4
15	30	6
22	15	1
22	22	1
TOTAL	=	17

243

OVS	MCS	FO
15	0	1
15	15	1
15	22	4
15	30	2
22	15	3
22	22	1
30	22	1
45	15	1
45	22	1
TOTAL	=	15

242

OVS	MCS	FO
0	15	1
0	22	4
0	30	1
15	15	2
15	22	2
15	30	1
22	15	1
22	22	1
22	30	1
TOTAL	=	14

312

OVS	MCS	FO
0	15	1
0	22	4
0	30	3
15	30	2
22	15	1
22	45	1
30	15	1
TOTAL	=	13

641

OVS	MCS	FO
0	15	1
0	22	2
0	45	1
15	22	2
15	45	1
22	30	1
TOTAL	=	8

132

OVS	MCS	FO
15	0	1
15	15	1
22	15	1
30	0	1
45	15	2
45	45	1
TOTAL	=	7

225

OVS	MCS	FO
0	22	2
0	30	1
15	22	1
15	30	2
45	22	1
TOTAL	=	7

712

OVS	MCS	FO
0	15	1
0	30	1
15	22	1
15	30	1
15	45	1
TOTAL	=	5

648

OVS	MCS	FO
0	15	1
0	22	1
0	30	1
TOTAL	=	3

512

OVS	MCS	FO
0	15	1
15	22	1
45	45	1
TOTAL	=	3

241

OVS	MCS	FO
30	22	1
TOTAL	=	1

623

OVS	MCS	FO
0	15	1
TOTAL	=	1

624

OVS	MCS	FO
15	45	1
TOTAL	=	1

Table E.2 — Head injury configurations (helmeted concussions, AIS ≥ 2) involving 67 accidents

Dimensions in miles per hour

114

OVS	MCS	FO head injury
0	30	1
15	15	1
15	22	1
15	30	2
15	45	1
22	15	4
30	15	1
TOTAL	=	11

143

OVS	MCS	FO head injury
22	22	2
30	15	6
45	0	2
45	15	2
45	22	1
TOTAL	=	13

413

OVS	MCS	FO head injury
0	22	1
0	30	2
15	30	1
15	45	1
22	22	1
30	15	1
30	22	1
30	30	2
TOTAL	=	10

711

OVS	MCS	FO head injury
0	22	1
0	45	1
15	22	1
22	45	1
TOTAL	=	4

414

OVS	MCS	FO head injury
0	45	1
15	22	3
15	45	1
22	15	1
22	30	1
22	45	1
TOTAL	=	8

412

OVS	MCS	FO head injury
15	45	1
TOTAL	=	1

115

OVS	MCS	FO head injury
0	15	1
15	45	1
22	30	1
30	15	2
30	22	1
TOTAL	=	6

313

OVS	MCS	FO head injury
15	30	1
30	45	1
TOTAL	=	2

513

OVS	MCS	FO head injury
0	15	1
TOTAL	=	1

226

OVS	MCS	FO head injury
15	22	1
TOTAL	=	1

131

OVS	MCS	FO head injury
22	0	2
45	0	1
45	15	1
TOTAL	=	4

514

OVS	MCS	FO head injury
TOTAL	=	0

314

OVS	MCS	FO head injury
15	30	2
TOTAL	=	2

243

OVS	MCS	FO head injury
TOTAL	=	0

242

OVS	MCS	FO head injury
TOTAL	=	0

312

OVS	MCS	FO head injury
TOTAL	=	0

641

OVS	MCS	FO head injury
0	45	1
TOTAL	=	1

132

OVS	MCS	FO head injury
15	0	1
45	15	1
TOTAL	=	2

225

OVS	MCS	FO head injury
TOTAL	=	0

712

OVS	MCS	FO head injury
0	30	1
TOTAL	=	1

648

OVS	MCS	FO head injury
TOTAL	=	0

512

OVS	MCS	FO head injury
TOTAL	=	0

241

OVS	MCS	FO head injury
TOTAL	=	0

623

OVS	MCS	FO head injury
TOTAL	=	0

624

OVS	MCS	FO head injury
TOTAL	=	0

Table E.3 — Lower leg injury configurations (fractures, AIS ≥ 2) involving 80 accidents

Dimensions in miles per hour

114

OVS	MCS	FO lower leg injury
0	30	1
15	0	1
15	15	2
15	22	3
15	30	3
22	15	1
22	22	3
30	0	1
45	15	1
TOTAL	=	16

143

OVS	MCS	FO lower leg injury
15	0	2
15	15	3
15	30	1
22	0	1
22	15	2
30	15	3
30	22	1
45	22	1
TOTAL	=	14

413

OVS	MCS	FO lower leg injury
0	45	1
15	22	1
15	30	1
30	30	1
TOTAL	=	4

711

OVS	MCS	FO lower leg injury
0	45	1
TOTAL	=	1

414

OVS	MCS	FO lower head injury
0	22	1
15	22	2
22	30	1
TOTAL	=	4

412

OVS	MCS	FO lower leg injury
0	45	1
TOTAL	=	1

115

OVS	MCS	FO lower leg injury
15	22	1
15	45	1
22	30	2
30	15	3
TOTAL	=	7

313

OVS	MCS	FO lower leg injury
15	22	1
15	45	1
TOTAL	=	2

513

OVS	MCS	FO lower leg injury
TOTAL	=	0

226

OVS	MCS	FO lower leg injury
0	15	1
0	22	2
0	30	1
15	15	1
15	30	1
22	30	1
TOTAL	=	7

131

OVS	MCS	FO lower leg injury
22	0	1
30	15	1
TOTAL	=	2

514

OVS	MCS	FO lower leg injury
TOTAL	=	0

314

OVS	MCS	FO lower leg injury
TOTAL	=	0

243

OVS	MCS	FO lower leg injury
15	0	1
15	22	1
22	15	1
30	22	1
TOTAL	=	4

242

OVS	MCS	FO lower leg injury
0	22	1
15	15	1
22	15	1
22	30	1
TOTAL	=	4

312

OVS	MCS	FO lower leg injury
0	22	1
0	30	1
TOTAL	=	2

641

OVS	MCS	FO lower leg injury
0	45	1
TOTAL	=	1

132

OVS	MCS	FO lower leg injury
22	15	1
45	15	1
45	45	1
TOTAL	=	3

225

OVS	MCS	FO lower leg injury
0	22	2
15	30	2
TOTAL	=	4

712

OVS	MCS	FO lower leg injury
15	22	1
15	30	1
TOTAL	=	2

648

OVS	MCS	FO lower leg injury
0	30	1
TOTAL	=	1

512

OVS	MCS	FO lower leg injury
TOTAL	=	0

241

OVS	MCS	FO lower leg injury
30	22	1
TOTAL	=	1

623

OVS	MCS	FO lower leg injury
TOTAL	=	0

624

OVS	MCS	FO lower leg injury
TOTAL	=	0

Table E.4 — Upper leg injury configurations (fractures, AIS ≥ 2) involving 37 accidents

Dimensions in miles per hour

114

OVS	MCS	FO upper leg injury
0	30	1
15	0	1
15	15	1
15	22	1
15	30	2
15	45	1
22	15	1
22	22	1
TOTAL	=	9

143

OVS	MCS	FO upper leg injury
15	15	1
22	0	1
22	15	1
45	22	1
TOTAL	=	4

413

OVS	MCS	FO upper leg injury
0	15	1
0	22	1
30	30	1
TOTAL	=	3

711

OVS	MCS	FO upper leg injury
0	30	1
0	45	1
22	45	1
TOTAL	=	3

414

OVS	MCS	FO upper head injury
0	30	1
15	45	1
22	30	1
TOTAL	=	3

412

OVS	MCS	FO upper leg injury
TOTAL	=	0

115

OVS	MCS	FO upper leg injury
0	15	1
15	22	1
22	45	1
30	15	2
TOTAL	=	5

313

OVS	MCS	FO upper leg injury
TOTAL	=	0

513

OVS	MCS	FO upper leg injury
15	45	1
TOTAL	=	1

226

OVS	MCS	FO upper leg injury
TOTAL	=	0

131

OVS	MCS	FO upper leg injury
45	30	1
TOTAL	=	1

514

OVS	MCS	FO upper leg injury
22	30	1
TOTAL	=	1

314

OVS	MCS	FO upper leg injury
TOTAL	=	0

243

OVS	MCS	FO upper leg injury
30	22	1
45	15	1
TOTAL	=	2

242

OVS	MCS	FO upper leg injury
15	30	1
TOTAL	=	1

312

OVS	MCS	FO upper leg injury
22	45	1
TOTAL	=	1

641

OVS	MCS	FO upper leg injury
TOTAL	=	0

132

OVS	MCS	FO upper leg injury
45	15	1
TOTAL	=	1

225

OVS	MCS	FO upper leg injury
0	30	1
45	22	1
TOTAL	=	2

712

OVS	MCS	FO upper leg injury
TOTAL	=	0

648

OVS	MCS	FO upper leg injury
TOTAL	=	0

512

OVS	MCS	FO upper leg injury
TOTAL	=	0

241

OVS	MCS	FO upper leg injury
TOTAL	=	0

623

OVS	MCS	FO upper leg injury
TOTAL	=	0

624

OVS	MCS	FO upper leg injury
TOTAL	=	0

Annex F
(informative)

Rationale for ISO 13232-2

NOTE All references cited in Annex F are listed in Annex B of ISO 13232-1.

F.1 Specific portion of the Scope

One purpose of ISO 13232-2 is "to provide a statistical basis for defining impact test conditions": that is, which impact configurations occur relatively frequently in the real world and which configurations result in relatively frequent injuries to certain body regions, based upon actual, large, randomized samples of motorcycle accidents.

Another purpose of ISO 13232-2 is to provide "a standardized and representative set of accident data". Up until 1992, there was no agreed upon set of accident data upon which definitions of impact test conditions could be based. There has been a wide variety of accident studies (e.g., cited in TRRL, 1991; IMMA, 1992); however, most of these were small, biased, and informal samples, and/or were lacking the variables needed to define an impact test. A "standardized set of accident data" provides researchers with a common formal basis for test definition, using accident data which meet certain minimum quality requirements. It is hoped that the "standardized set" will be updated with data from other nations and over time.

"Representative" denotes use of suitably large randomized samples of accidents, from several regions worldwide, which comprise "stratified samples" of a worldwide sample of the global population of accidents. Stratified sampling is a common statistical sampling technique used for large populations.

Impact conditions based on an analysis of this standardized and representative set of accident data were selected based upon their real world frequency of occurrence, or their frequency of injury to a particular body region, or their providing special physical insight into the crash dynamics (e.g., because of the relatively high level of physical exposure of a particular body region or because of mainly frontal or mainly lateral motions). These selected test conditions could be referred to as a sub-sample of the "standardized and representative set of accidents".

The "representative sample" (equivalent to "standardized set of accident data") can be used for two purposes: "overall evaluations" (equivalent to "risk/benefit analyses") of proposed protective devices; or "failure mode and effects analysis" (FMEA) of such devices. Both of these types of analysis are relevant to the evaluation of safety related systems, and a "representative sample" of conditions is needed for both types of analysis.

Overall and FMEA evaluations of proposed devices can be done, at the user's option, using computer simulation or other analysis techniques. While computer simulation of a representative sample of impacts provides one means to do overall or FMEA analysis (e.g., Zellner, et al., 1991), it is not implied that computer simulation is the only conceivable means to do such analyses. Testing the entire representative sample of impacts, for example, would provide another means.

F.2 Requirements

F.2.1 Impact variables (see 4.1)

In general, for existing full-scale test facilities, in order to do an impact test between a motorcycle (MC) and opposing vehicle (OV), one must define relative heading angle (i.e., the angle between the vehicle centre lines at the moment of contact, or from a test facility standpoint, the angle between the planned tracks of the two vehicles); OV impact speed; MC impact speed; OV contact point; and MC contact point.

If one or more of these variables is unknown, then there exists the potential for uncertainty or variability in the test definition and results. Similarly, it follows that all five of these variables are needed to describe actual accidents, in order for a sample of accidents to be used to define impact conditions for testing. Of these five variables, "relative heading angle" and "impact speed" often were not included in past accident studies.

The "relative heading angle" is the relative Euler angle between the two vehicles, and as such, is a fundamental variable of physics. It is defined as the yaw angle between the vehicle's x axes, regardless of their relative positions. It is not dependent on the shape or orientation of the vehicle external surfaces; nor on the contact points or speeds of the two vehicles, and as such, it is an independent variable. Note that "impact angle" (the angle between a car surface and the motorcycle centre line) is not a good alternative to relative heading angle, since it is difficult to define for car corner impacts or impacts to the rear of the motorcycle, for example. Likewise, "approach (or path) angle" is not a good alternative, because it depends on the motorcycle and opposing vehicle speeds, i.e., it is a dependent variable, when what is needed for a test definition and set up is an independent variable. "Relative heading angle" is the unique independent variable which describes the two vehicles' relative inertial orientation at the time of impact.

F.2.2 Standardized accident configurations (see 4.2)

For accident samples which meet the above criteria, it is desirable to define standardized frequencies of occurrence as a basis for full-scale impact configuration test selection for all researchers in this field, overall (risk/benefit) analysis, as a description of the accident population, and FMEA analysis, as a description of the conditions of use.

Currently, all of the frequency tables are based upon the combined Los Angeles and Hannover databases, each of which meet the above criteria. The raw data are given in Annex C. It is hoped that other data for other nations and regions can be added in the future. The Los Angeles and Hannover data are considered to be stratified samples of a worldwide sample. Therefore, they (and any other available, suitable sample) are merged together, as an approximation of a worldwide sample. The frequency of occurrence (FO) numbers listed in Annex B are the number of accidents which lie in each cell, from the combined Los Angeles/Hannover data, using the analysis procedures described in 5.1. The frequency of injury numbers listed in Annex D are the number of accidents in which there was at least one injury of the specified region, type, and severity, using the analysis procedures described in 5.2. Multiple injuries occurring within one accident are counted as one injury, in order to be able to compare the individual cell counts to the total number of analysed accidents (i.e., to calculate a percentage of accidents in which a given injury occurred). The data in Annex B are listed in order of the most frequent geometry (referring to the three digit code) to least frequent geometry, and lowest speed to highest speed combinations within each geometry. Cells with zero population are not listed. The data in Annex D are listed in the same general order as those in Annex B.

F.2.2.1 Defining frequency of occurrence of various impact configurations (see 4.2.2.1)

One way to select pertinent impact configurations for testing is to select configurations which occur relatively frequently in the real world. For example, proposed protective devices should be at least non-harmful in impacts which occur relatively frequently. In order to determine "frequently occurring impacts", the sample needs to meet several minimum requirements.

Large randomized samples of the accident population are needed in order to provide a statistically suitable basis for describing the distribution of impact conditions. "Randomized" refers to the sampling protocols used, for example, including all motorcycle accidents from all reporting services (e.g., police, ambulance, hospitals, fire, etc.) within the sampling region. If the sample is biased (e.g., hospital only), the data will emphasize certain categories of accidents and injuries, and can not be used validly to describe the population of accidents. "Large" means in comparison to the number of variables of interest and number of ranges of the variables of interest. If, for example, there were five impact variables, and for each variable there were four ranges of values (or "cells"), there would be a total of 4^5 = 1 024 possible cells. In order to determine the distribution of accidents among these cells, in general, it is desirable, that the sample be large enough to populate this number of cells. For example, in this case the sample should be ideally of the order of 10^3 accidents or more. In the past, the largest motorcycle accident samples which meet the other criteria have been of the order of several hundred accidents. It is suggested that about 200 accidents would be an appropriate minimum sample size, since that is the approximate number of identifiable impact configurations which occur in existing data bases in see Annex B.

"In-depth investigations, including on-site measurements and reconstructions" are necessary. These typically involve measurements of distances and positions; estimation of impact speeds from physical evidence;

determination of likely geometry at the time of impact (reconstruction drawing); and documentation of the accident reconstruction on a case-by-case basis.

"All of the impact variables" are needed to describe impacts properly. Many past studies do not include all five variables. If one or more of the impact variables is missing, an accident cannot be placed in the appropriate cell. The accident (and corresponding crash test) outcome can be strongly influenced by a missing variable. For example, for offset frontal impacts, is the impact to the front or side of the MC? For a car side 90° impact, what is the MC speed? etc.

The data needs to be "available for analysis" because "independent verifiability" is a basic principle of this research International Standard, in general. If the accident database meets all of the other criteria, but is not available for analysis, it can not be analysed using the techniques described in clause 5.

F.2.2.2 Defining frequency of injury of various impact configurations (see 4.2.2.2)

Another way to select impact configurations for testing is by frequency of injury to specified body regions. For example, a proposed protective device should reduce injury potential to a specified body region in impact configurations where such injuries occur relatively frequently. In effect, the "frequent injury" impact configurations form a main part of the design goals for a given protective device, and would ordinarily be the first conditions to be tested.

Data describing all injuries for each accident by body region, type, and severity are needed in order to classify injuries properly. For example, if the "type" descriptor is missing, all leg injuries, e.g., fractures, soft tissue injuries, contusions, lacerations, abrasions, burns, etc., would be counted the same, even though the mechanisms of injury and proposed protective devices would be completely different. Therefore, in order to define impact configurations which result in specific injuries, it is necessary to define the injuries clearly.

F.2.3 Impact configurations for full-scale tests (see 4.3)

The current selection of impact configurations for testing was based upon a combination of statistical, test facility, and prior test experience factors.

A rigorous method for selecting a representative sub-sample for full-scale testing has yet to be defined, even when data for frequency of occurrence and injury exist (annexes B and D). One of the difficulties in defining a selection method is the very broad and relatively even distribution of accidents which occur. Other potential problems are the limitations and capabilities of current test facilities. These are further discussed below.

The impact geometries for four of the seven required impact configurations described in Table 1 correspond to the three most frequent impact geometries in the combined Los Angeles/Hannover database. (Note that there are two speed combinations for impact geometry 413). The fifth and sixth test configurations correspond to the fifth and sixth most frequent impact geometries. These five impact geometries account for 40% of the combined Los Angeles/Hannover accidents, as shown in Table B.1 (i.e., 198 out of 501 accidents).

The selection of the geometry for the seventh impact configuration, the offset frontal impact, 225, is based upon its historical use in leg protection research (e.g., Tadokoro, 1985; Sakamoto, 1988; Chinn and Karimi, 1990; Rogers, 1991a); and the apparent degree of physical exposure of the lower leg in this configuration. For the latter reason, 225 is considered to provide special physical insight into one type of leg injury mechanism. Note, however, that 225 is not a frequent impact geometry in terms of either occurrence or injury (18th of 21 ranks for occurrence; fourth of seven ranks for lower leg injury; fifth of six ranks for upper leg injury).

The choice of OV and MC speeds within each of the five top geometries was based upon a combination of statistical and practical factors. Among the practical factors are the facts that:

— some test facilities can only perform moving-moving tests where there is an integer speed ratio between MC and OV speeds (e.g., 2:1, 1:2, etc.);

— in the absence of active rider control, impacts involving low MC speeds (6,7 m/s or less), are very difficult to do, because of large variations in MC roll angle at these speeds. These variations tend to reduce repeatability.

For these reasons, the selected speed combinations were limited to those involving integer OV/MC speed ratios; and MC speeds either equal to zero or greater than 6,7 m/s.

F.2.4 Required configurations (see 4.3.1)

The attributes of the seven required impact configurations are as follows:

143-9,8/0[2]: In Table B.1, geometry 143 is ranked second of 21 ranks in frequency of occurrence, and in Tables D.1 through D.3 first of eight ranks in head injury frequency, second of seven ranks in lower leg injury frequency, and third of six ranks in upper leg injury frequency. Within 143, this speed combination had no head injuries, is third of three ranks in lower leg injury, and first of one rank in upper leg injury.

114-6,7/13,4: Geometry 114 is ranked first of 21 ranks in frequency of occurrence, first in lower and upper leg injury frequency, and second of eight ranks in head injury frequency. Within 114, this particular speed combination is ranked second of three ranks in head injury frequency, first of three ranks in lower leg injury frequency, and first of two ranks in upper leg injury frequency.

413-6,7/13,4: Geometry 413 is third of 21 ranks in frequency of occurrence, third of eight ranks in head injury frequency, fourth of seven ranks in lower leg injury frequency, and fourth of six ranks in upper leg injury frequency. Within 413, this speed combination is ranked second of two ranks in head injury frequency and first of one rank in lower leg injury frequency.

412-6,7/13,4: Geometry 412 is ranked sixth of 21 ranks in frequency of occurrence, eighth of eight ranks in head injury frequency and seventh of seven ranks in lower leg injury frequency, with no upper leg injuries. Within 412, this speed combination is first of five ranks in frequency of occurrence and had no head or leg injuries. Of all the required impact configurations in Table 1, 412-6,7/13,4 is the most frequently occurring impact configuration.

414-6,7/13,4: Geometry 414 is ranked fifth of 21 ranks in frequency of occurrence, fourth of eight ranks in head injury frequency, fourth of seven ranks in lower leg injury frequency, and fourth of six ranks in upper leg injury frequency. Within 414, this speed combination is second of four ranks in frequency of occurrence.

225-0/13,4: As noted above, 225 was selected for its apparent physical exposure of the leg, and for historical reasons.

413-0/13,4: Within 413, this speed combination is first of two ranks in head injury frequency and had no leg injuries. In addition, it is a relatively easy test to perform, because of the stationary OV. Also, because of this, it provides special insight, because of the relatively simpler (frontal only) motion of the MC and rider.

Taken together, the seven impact configurations account for 6,2% of all the accidents in Table B.1.

F.2.5 Permissible configurations from failure mode and effects analysis (see 4.3.2)

This sub-clause refers to tests which may be used to verify the failure mode and effects analyses, as described in ISO 13232-7. Obviously, if these tests were done, they may also be used to refine and validate any risk/benefit analyses which may be done, described in ISO 13232-5.

[2] The first three digits denote the geometry code. The pair of numbers following the hyphen are the OV and MC speeds, respectively.

F.3 Analysis methods

F.3.1 Sub-sample definition (see 5.1.1)

"Overall database" refers to the set of all of the stratified (regional) sub-samples of MC accident data which meet the criteria of 4.1 and 4.2. Currently, this includes the Los Angeles and Hannover databases.

Within each regional sub-sample, the analysis is limited to a certain category of MC accidents (passenger car impact with single, seated rider). The reasons for this are as follows:

— it is consistent with the defined scope of ISO 13232, and the scope of most of the related research, to date;

— "passenger cars" are the OV because they predominate in the accident data (Hurt, et al., 1981a, 1981b; Otte, 1980). To mix in other opposing objects (e.g., trucks, or bridge supports) would be to mix in other patterns of occurrence and injuries. This would distort the standardized population sample, which is intended to be of use in the research and testing of MC/passenger car impacts;

— "single riders" and "seated riders" are the focus because "multiple riders" or "standing riders", for example, could distort the occurrence and injury patterns, from those which are the main ones of interest in ISO 13232 (i.e., those used for defining relevant test configurations and injuries for single, seated riders).

F.3.2 Categorization (see 5.1.2)

In order to describe the frequency of various impact configurations, it is first necessary to create a system of impact "categories"; and then to "sort" the accidents into the appropriate categories.

The category system involves dividing each of the five impact variables defined in 4.1 into several ranges or "cells".

The philosophy which was used to define the cells included the following considerations, resulting from a 1988 meeting among MC accident researchers (Hurt, Pedder, Newman):

— the approximate "resolution" for each of the impact variables, related to the estimated accuracy of the reconstruction;

— reaching a balance between cell sizes which are "too coarse" (resulting in vastly different kinds of impacts being grouped inappropriately together); and cell sizes which are "too fine" (resulting in an enormous number of potential configurations, with very few accidents in each one);

— attempting not to split the natural grouping or "clustering" of accidents for some variables, notably speeds and relative heading angle;

— the desirability of using equally sized cells for each variable, so that the cell mid-point (used for testing) would not be too far (too dissimilar) from the cell edges.

In addition, for testing and simulation purposes, it was necessary to represent each cell with a "nominal value", in order to be able to perform an impact test or simulation corresponding to that cell. With the few exceptions noted below, the cell nominal value was chosen to be the mid-point of the respective cell.

The application of these considerations is described in more detail below.

For "OV contact point" the car is divided into 12 contact zones (see Figure 2) with a contact point representing each zone. These were selected:

— so as to differentiate between very different kinds of impact (e.g., "side middle" where the rider may tend to impact the roof structure versus "side front" where the rider may tend to travel over the bonnet);

— so as to have some association with the different structural zones of typical cars (front versus rear wheel arches, front versus rear corners, etc.);

— for measurement convenience (e.g., 1/4, 1/2, 3/4 of overall length, etc.).

For "MC contact point" (see Figure 3), the MC is divided into four zones ("front", "left side", "right side", "rear") with a nominal value for each. As with the OV contact points, the nominal values are chosen to be evenly spaced in terms of the MC overall length. For testing and simulation purposes, it is necessary to define a lateral offset for the "side" contact points (e.g., to identify a target point for MC "side" impacts with the OV "corners"), in addition to the longitudinal position. This was chosen to be 5 cm outboard from the most outboard structural element on the MC front unsprung assembly, the intention being that this would allow clearance of the front forks (and therefore, the "front") of most MC's, and yet still ensure contact with the MC "side" region.

For "relative heading angle" (see Table 2 and Figure 5), eight relative angles were selected, at 45° increments corresponding to a compass rose (e.g., north, north-east, east, etc.). The reason for the use of 45° increments were twofold:

— the accident reconstructionist discussion (Hurt, Pedder, and Newman, 1988 meeting) indicated this to be the approximate worst case resolution of reconstruction (for example, in many accidents it is difficult to determine from tyre skid marks and damage patterns more than that the OV and MC were "perpendicular" or "parallel" or "angled". For other cases, nevertheless, the accident data (see Annex C) contain a continuous, fine resolution of angles);

— the distribution of the raw Los Angeles/Hannover accident data across relative heading angles (shown in Figure F.1, where left and right OV side impacts have been summed) shows that the accidents are "clustered" (or have "modes") at 0°, 90° and 135°, suggesting a 45° increment. Whether this pattern is associated with traffic geometry, or with the aforementioned reconstruction resolution problem, is unknown; but in either case, the pattern is clear. There is no indication in the Figure F.1 data of any modality at 30° increments. To the extent that distributions can be effectively represented by their modes, 45° is an appropriate angle increment, from an accident data standpoint.

The cells are defined to be ± 22,5° ranges about each of the eight relative heading angle directions.

In the future, addition of new accident databases could result in proposed changes in the relative heading angle increments and codes used in Table 2 and Figure 5. In this case, a general method that could be used to determine the relative heading angle increment and code numbers in Table 2 and Figure 5, for all accident databases, and which for the Los Angeles and Hannover databases results in a 45° increment, is as follows:

— combine the available accident databases from all regions;

— graph the histogram of percentage of total accidents versus relative heading angle, at 1° relative heading angle increments;

— identify the three largest peaks in the histogram;

— determine the largest common denominator for the relative heading angles of the three largest peaks and 180°, to the nearest 5°;

— set the relative heading angle increment to be equal to the largest common denominator, or 15°, whichever is greater;

— set the cell nominal values and ranges, beginning with a nominal value of zero, and progressively adding one relative heading increment to this value; and dividing the cell ranges into equal portions, centred on each nominal value;

— assign relative heading angle codes, beginning with a relative heading angle of zero and a code of one, proceeding clockwise, increasing the code number by one for each relative heading angle increment.

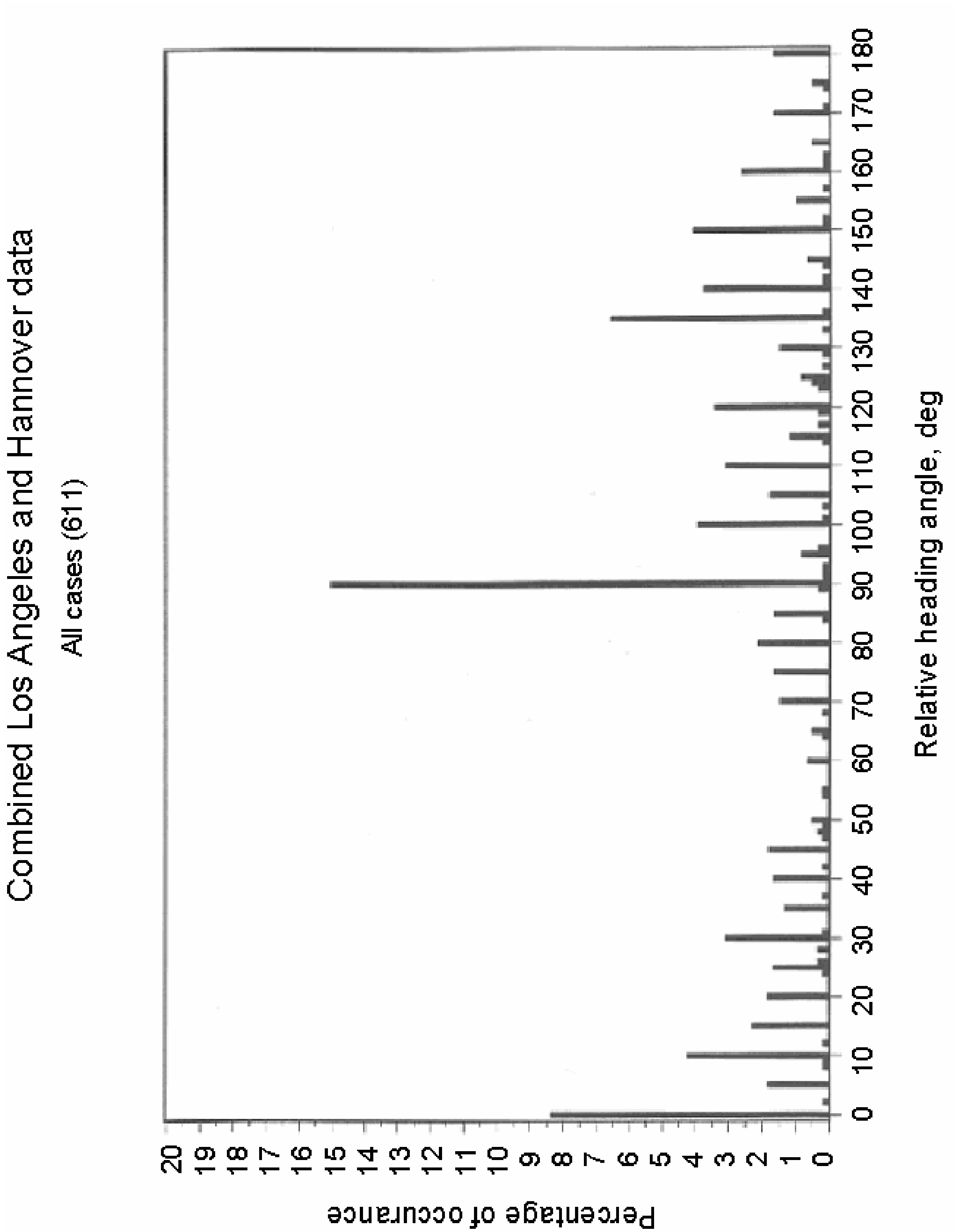


Figure F.1 — Distribution of raw relative heading angles for Los Angeles and Hannover accidents

Note that this method is applicable to the process of revising ISO 13232 in the future, but should not be incorporated into the text of ISO 13232. To do so would suggest that it could be applied to any accident database at any time, without international coordination. This could result, once again, in different test facilities using different test angles, which is contrary to the purposes of an International Standard. Instead, the stated method could be used to revise the numbers entered in Table 2 and Figure 5, in possible future revisions of ISO 13232.

For "OV and MC speed" (see Table 3), five speed ranges were selected. This was based on estimates of the reconstruction resolution, and on a study by Hurt, et al. (1981b) wherein the same physical data were analyzed in a "round robin" manner, by several reconstructionists. Those results indicated agreement to within ± 5 mi/h (± 2.2 m/s) for nearly all cases examined. Therefore, 10 mi/h ± 5 mi/h was selected as the speed increment.

The cell boundaries were selected to be at 9, 19, 29 mi/h (4, 8,5, 13,3, 17,5 m/s), etc., so as to avoid splitting clusters which might be centred at, e.g., 10, 20, 30, mi/h, etc.

The nominal values were selected to be in the middle of each speed range, except for the lowest and highest ranges. For the lowest range, the nominal value was chosen to be 0 m/s, because it allows for test simplification (e.g., one stationary vehicle) and also because MCs may have large roll angle variations at, say, 5 mi/h. For the upper range, the nominal value was chosen to be the lower boundary of the range (17,5 m/s), to allow integer MC and OV speed ratios to be used (e.g., 3:1 or 2:1, etc.) for compatibility with existing testing facilities.

F.3.3 Sorting (see 5.1.3)

All of the accidents in the database are sorted into the matrix containing all of the cells of the five variables. This results in a matrix of 9 600 theoretically possible cells (twelve OV contact points times four MC contact points times eight relative heading angles times five OV speeds times five MC speeds). The OV is considered to be symmetric, so that after sorting:

— the left side OV contact points (A-E) are reclassified as right side OV contact points (see Table 4);

— the associated MC side contact points are reversed (i.e., 2 replaces 4 and 4 replaces 2);

— the associated relative heading angle codes are reclassified to give a "mirror image" of the relative heading angle (i.e., the relative heading for the OV left side contact point, subtracted from 360°).

This is done in order to minimize the total number of cells used to sort the impact test configurations.

Certain geometries are reclassified (Table 5) in order to resolve minor inconsistencies in the original accident data. Examples of this reclassification procedure are shown in Figure F.2, where the MC contacts had originally been coded as "side" (presumably from damage patterns). From a test set up viewpoint, it is more consistent to designate such configurations as MC "front", although the principal damage may be to the MC "side". In other cases, the geometries were restored to being physically realizable by, for example, changing the motorcycle contact point from the right side to the left side, changing the relative heading angle to its mirror image (as noted above, i.e., 360° minus the relative heading angle), or by changing the motorcycle contact point from the "side" of the motorcycle to the "front". An alternative approach, not used here, would have been simply to reject such inconsistently coded cases.

Certain cells were removed (Table 6) because, although correctly coded, after categorization, the resulting configuration was physically unrealizable (e.g., MC front contact with the OV side at 90° at zero speed); or because they were cells in which the front (leading edge) of the motorcycle was impacting the corner of the opposing vehicle, which is very difficult to test or simulate accurately and repeatably. Some examples of removed cells are shown in Figure F.3.

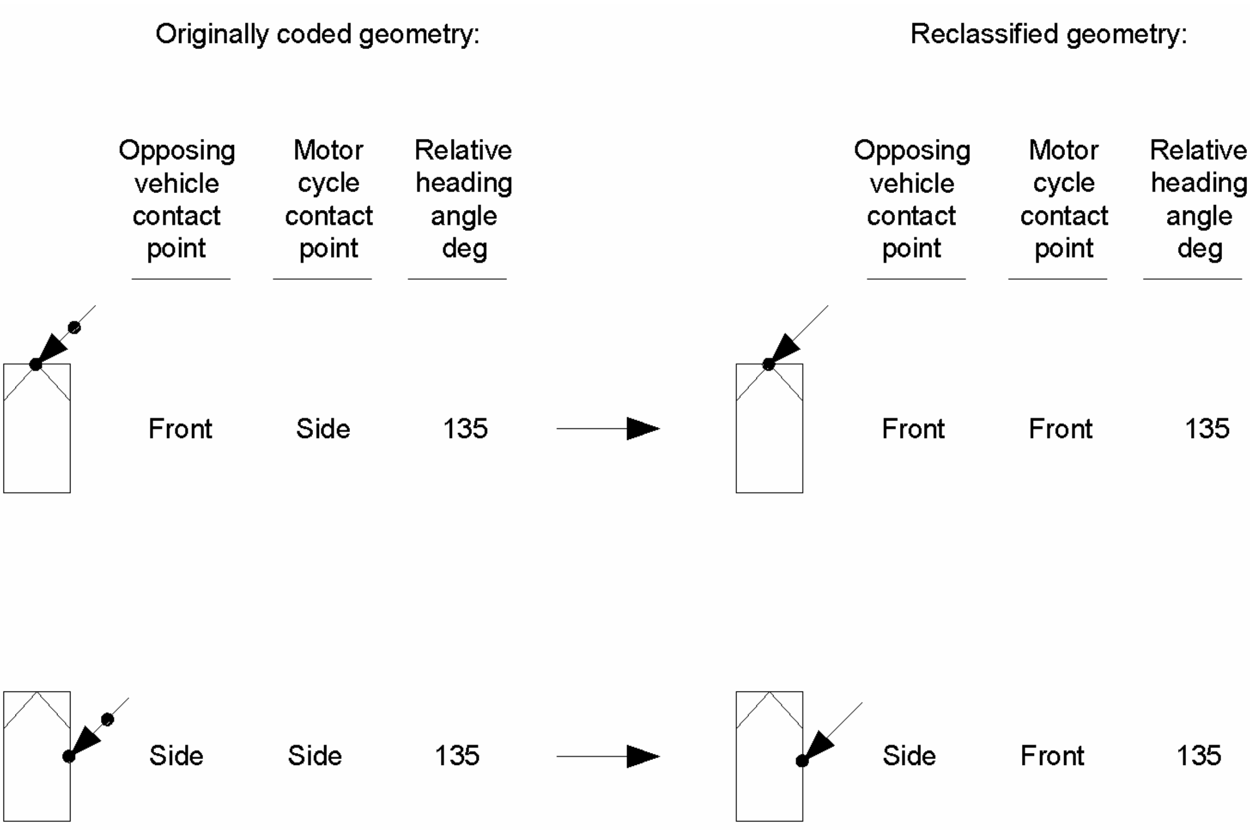


Figure F.2 — Examples of geometry reclassification

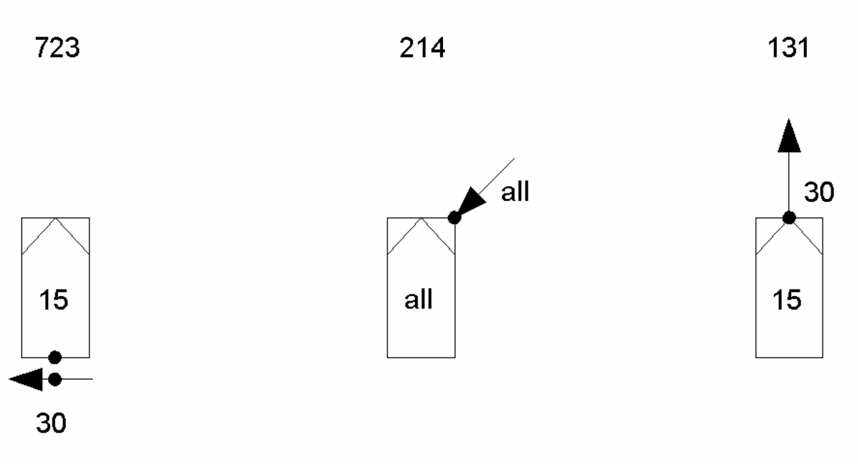


Figure F.3 — Examples of removed configurations

F.3.4 Using accident data to determine frequency of injury by body region and injury type of various impact configurations (see 5.2)

The procedure for determining injury frequency is the same as that used for occurrence frequency, except that the sorting is done for a specific body region, injury type, and injury severity. The sorting is performed only for head concussions and upper and lower leg fractures with AIS greater than or equal to 2 because these are among the primary types of injures occurring in motorcycle/car accidents (e.g., Hurt, et al., 1981a, 1981b; Otte, 1980; Otte, et al., 1981); and they are capable of being monitored by the MATD dummy and injury indices; and because these AIS levels correspond to "moderate" or worse injuries (e.g., "slight" injuries are not considered in this analysis). The sorting is done on the basis of whether at least one injury of the specific region, type, and severity occurred. Multiple repeat injuries are not considered.

Sorting for head concussive injuries is limited to "helmeted" cases. This is done to ensure consistency with the scope of ISO 13232. Also, the impact configurations (and corresponding protective devices) for unhelmeted head injury may be different from those for helmeted head injury, so that the inclusion of unhelmeted cases may bias, inappropriately, the selection of impact configurations for testing.

F.4 Annex A (normative) Motorcycle accident report

Clause A.1 lists the impact variables needed for the analyses described in 4.1 and 4.2. In addition, MC type and engine size are included to the extent this may be useful in the future in understanding the applicability of a particular protective device for a given class of MC.

Clause A.2 contains injury descriptions which are believed to be compatible with both the 1990 AIS system and the Los Angeles and Hannover databases (Biokinetics, 1990).

Clauses A.3 and A.4 describe protective gear, in so far as they may influence the injuries analyzed in 5.2, as discussed below.

F.5 Annex B (normative) Resulting frequency of occurrence for the combined Los Angeles and Hannover databases

These geometries and frequencies of occurrence result from the application of the categorization and sorting method to the combined Los Angeles and Hannover databases.

The resulting 25 geometries in Figure B.1 are presented in order of decreasing frequency, from left to right then top to bottom.

The geometries for the resulting 200 impact configurations in Table B.1 are listed in the same order as the geometries in Figure B.1. Those configurations (of the 9 600 theoretically possible configurations) which do not appear in Table B.1 had zero frequency of occurrence in the Los Angeles/Hannover combined databases.

F.6 Annex C (normative) Example accident data

These data have been provided in order to be of use in verifying the analysis procedures and results, and to serve as a basis for possible future expansion to include other databases or refined analysis procedures. They are summary data files which have been provided by D. Otte (Hannover data) and the National Highway Traffic Safety Administration (Los Angeles data), via H. Hurt, Biokinetics and Associates, and Dynamic Research.

F.7 Annex D (normative) Resulting frequency of injury by body region and injury type for the combined Los Angeles and Hannover databases

These geometries and frequencies of injury result from the application of the categorization and sorting method to the combined Los Angeles and Hannover databases.

As noted above, the head injuries are for helmeted heads; and all of the injuries are for AIS equal to or greater than 2 ("moderate" or worse injuries).

The geometries for each of the injury producing configurations are listed in the same order as in Figure B.1.

F.8 Annex E (informative) Frequency of occurrence data in non-SI units

These data tables are included for the convenience of users of ISO 13232.

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