Department for Transport

SHARP
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THE HELMET SAFETY SCHEME

The Safety Helmet Assessment and Rating Programme

PROCEDURE FOR CALCULATING THE SHARP SAFETY RATING

Version 1.0

Disclaimer

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Summary of the SHARP rating procedure

32 linear and oblique impact tests completed for each helmet model to be rated

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Coefficient of friction of the helmet shell calculated using the oblique impact test results

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Linear peak ‘g’ and coefficient of friction used to calculate equivalent oblique peak ‘g’

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Peak ‘g’ values used to predict the risk of fatal injury for 30 linear and 15 oblique impacts

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‘Importance’ weighting for impact configuration calculated using distributions of impact location, impact shape and impact speed

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Injury risks weighted according to impact configuration ‘importance’

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Total risk for each helmet at each speed calculated

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Exposure population applied to risk

↓

SHARP safety rating

Calculation details

1 32 tests are performed on each model of helmet that is rated, comprising of 30 linear impact absorption tests and 2 oblique surface friction tests on a range of sizes.

Helmet test matrix – Example

Helmet size		**M**	**XL**	**L**
Nominal head form size		J	O	M
Linear impacts				
Nominal impact velocity (m/s)		**6.0**	**7.5**	**8.5**
Impact location	**Impact anvil**		(Test number)	
Front	Flat	1	6	11
Side Left	Flat	2	7	12
Side Right	Flat	3	8	13
Rear	Flat	4	9	14
Crown	Flat	5	10	15
Front	Kerb	16	21	26
Side Left	Kerb	17	22	27
Side Right	Kerb	18	23	28
Rear	Kerb	19	24	29
Crown	Kerb	20	25	30
Oblique impacts				
Nominal impact velocity (m/s)		**8.5**		
Side Left		31		
Side Right		32		

Table 1

2 The co-efficient of friction (µ) is calculated as the ratio of the tangential (F_T) and normal (F_N) anvil force readings from the oblique impact tests.

$$\mu = \frac{F_T}{F_N}$$

It is calculated for both the left (test 31) and the right (test 32) side at the point where the tangential force reaches its maximum during the impact sequence. The mean co-efficient of friction, calculated from these two results, is used in the subsequent calculations.

3 The results from linear impact absorption tests against the flat anvil are also used to evaluate the performance of helmets in oblique impacts. The linear impact velocity is taken as the normal component of an oblique impact at 37.5˚. Thus, equivalent oblique impact velocities can be calculated using the formula:

$$V_R = \frac{V_N}{\sin\theta}$$

This gives the equivalent oblique impact velocities (V_R) shown in table 2 below:

Linear impact velocity (m/s)	**Equivalent oblique impact velocity (V_R) [m/s]**
6.0	9.9
7.5	12.3
8.5	14.0

Table 2

4 Peak vertical accelerations (A_N) taken from the linear impact absorption tests against the flat anvil (test numbers 1-15) are used to calculate the peak resultant accelerations (A_R) for oblique impacts at the higher impact velocities using:

$$A_R = A_N\sqrt{1+\mu^2}$$

5 The results of the 30 linear impact absorption tests (paragraph 1) and 15 calculated equivalent oblique impacts (paragraphs 2,3&4) therefore provide 45 peak acceleration results.

6 The % risk of a fatal injury is calculated for each of the 45 peak acceleration results based upon the injury risk function below (the relationship between points on the injury risk function is assumed to be linear).

Peak acceleration (g)	0	150	200	275	375	500
Risk of fatality	0	0	7.1%	17.0%	23.5%	100%

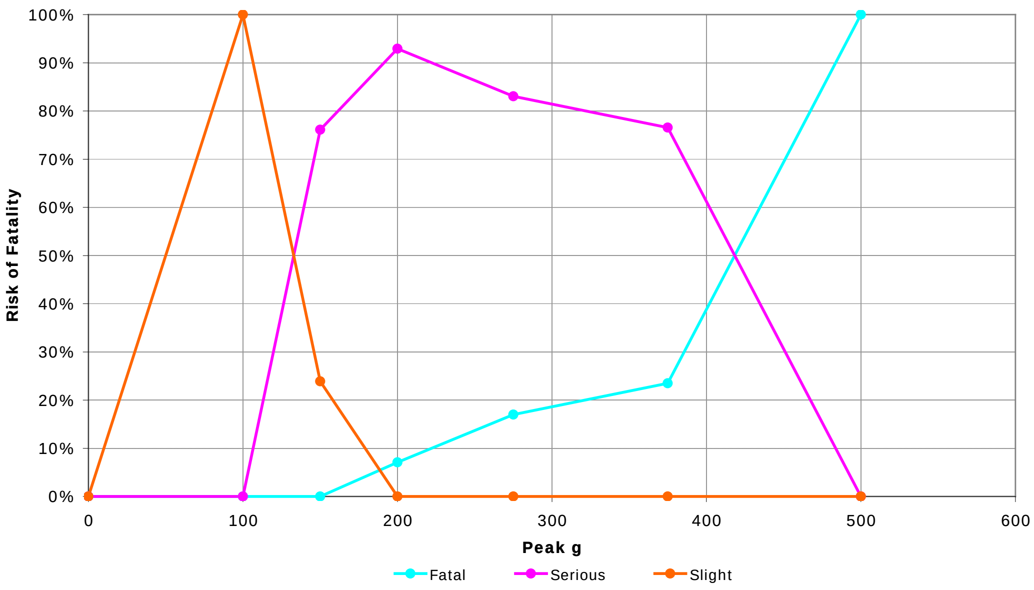

Figure 1 Risk of Injury Severity According to Peak g (Based on COST 327 and TRL S0232)

7 For each of the 45 impact configurations an impact weighting factor is calculated (the probability of each accident configuration occurring). The following probability distributions are applied:

Impact site	Front	Side R	Side L	Crown	Rear
Distribution (%)	23.6%	26.6%	26.6%	2.2%	21.0%

Impact surface	Flat	Kerb	Oblique
Distribution (%)	38.4%	1.6%	60.0%

Head impact velocity (m/s)	6.0	7.5	8.5	9.9	12.3	14.0
Distribution (%)	6.35%	6.35%	5.08%	3.81%	4.96%	4.96%

Impact Weighting = Probability % (Impact Site) x Probability % (Impact Surface) x Probability % (Head Impact Velocity)

8 For each of the 45 impact configurations, a weighted injury risk can then be calculated:

Weighted injury risk = Impact weighting x Risk of fatality

The 45 weighted injury risks are summed to provide a total weighted injury risk for the helmet model being rated.

The total weighted injury risk is multiplied by an exposure population of 7078 (derived from DfT accident statistics) to provide a predicted number of fatalities. The predicted number of fatalities is used to determine the SHARP safety rating:

Predicted number of fatalities	Safety Rating
<155	5 stars
<230	4 stars
<305	3 stars
<380	2 stars
>380	1 star

9 Any helmets falling within the 5 Star rating band (predicted number of fatalities <155) are subject to additional criteria; if the peak acceleration seen in any valid linear impact test performed against the flat anvil is equal to or greater than 300g, the rating is modified to 4 Stars.

10 Example of calculation table:

Test number	Anvil	Impact velocity	Impact location	Peak acceleration results (see paras 1-5)	Risk of fatality (see para 6)	Impact Weighting (probability of impact) (see para 7)	Weighted risk of fatality (see para 8)
1	Flat	6.0	Front				
2	Flat	6.0	Side Left				
3	Flat	6.0	Side Right				
4	Flat	6.0	Rear				
5	Flat	6.0	Crown				
6	Flat	7.5	Front				
7	Flat	7.5	Side Left				
8	Flat	7.5	Side Right				
9	Flat	7.5	Rear				
10	Flat	7.5	Crown				
11	Flat	8.5	Front				
12	Flat	8.5	Side Left				
13	Flat	8.5	Side Right				
14	Flat	8.5	Rear				
15	Flat	8.5	Crown				
16	Kerb	6.0	Front				
17	Kerb	6.0	Side Left				
18	Kerb	6.0	Side Right				
19	Kerb	6.0	Rear				
20	Kerb	6.0	Crown				
21	Kerb	7.5	Front				
22	Kerb	7.5	Side Left				
23	Kerb	7.5	Side Right				
24	Kerb	7.5	Rear				
25	Kerb	7.5	Crown				
26	Kerb	8.5	Front				
27	Kerb	8.5	Side Left				
28	Kerb	8.5	Side Right				
29	Kerb	8.5	Rear				
30	Kerb	8.5	Crown				
31	Oblique	9.9	Front				
32	Oblique	9.9	Side Left				
33	Oblique	9.9	Side Right				
34	Oblique	9.9	Rear				
35	Oblique	9.9	Crown				
36	Oblique	12.3	Front				
37	Oblique	12.3	Side Left				
38	Oblique	12.3	Side Right				
39	Oblique	12.3	Rear				
40	Oblique	12.3	Crown				
41	Oblique	14.0	Front				
42	Oblique	14.0	Side Left				
43	Oblique	14.0	Side Right				
44	Oblique	14.0	Rear				
45	Oblique	14.0	Crown				