























The findings also indicate that low severity impact tests for helmets in addition to tests at high levels of impact are unnecessary. Testing on a number of current helmet models suggests that helmet response to impacts within prescribed helmet capabilities is largely determined by the maximum severity test and the deceleration criterion set for any single impact severity in that range. Within that range, the peak deceleration versus impact severity for all the helmets tested is approximately linear; the designer can choose the range of severities and possibly the slope at which peak deceleration increases throughout that range but not much else. Tests and well selected criteria based on the most severe impacts for which the helmet is to be effective should be sufficient to establish reasonable compliance with the deceleration limits identified for injury reduction at all levels of impact severity. The concern that helmets might be somehow “excessively optimized” increasing the risk of injury in low severity crashes is baseless.

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## VII. REFERENCES

- [1] Cairns, H, Holbourn, H. Head Injuries in Motorcyclists: with special reference to crash helmets. *British Medical Journal*, May 1943: 591-598.
- [2] Ford, D. Blowing the Lid Off. *Motorcyclist*, Bonnier, Irvine CA, 2005, June: 68-90.
- [3] Halewood, C, Hynd, D. Safety Helmet Assessment and Rating Programme (Sharp) - Development of the Performance Evaluation Protocol. *Transport Research Laboratory*, England 2008.
- [4] Snell Memorial Foundation, Inc. *2015 Standard for Protective Headgear for Use in Competitive Automotive Sports (SA2015)*, Snell Memorial Foundation, Inc., North Highlands, CA, USA, 2014.  
(Internet: <http://smf.org/standards/sa/2015/SA2015Final3252014.pdf>, Date Updated: 2014 March 25, Date Accessed: 2015 March 12.)
- [5] DeMarco, A, Chimich, D, Gardiner, J, Nightingale, R, Siegmund, G. The Impact Response of Motorcycle Helmets at Different Impact Severities. *Accident Analysis and Prevention*, 2010, Vol 42: 1778-1784.
- [6] Snell Memorial Foundation, Inc. *2010 Standard for Protective Headgear for Use with Motorcycles and Other Motorized Vehicles (M2010)*. Snell Memorial Foundation, Inc. North Highlands, CA, USA, 2010.  
(Internet: [http://smf.org/standards/m/2010/m2010\\_final\\_booklet.pdf](http://smf.org/standards/m/2010/m2010_final_booklet.pdf), Date Updated: 2008 March 9, Date Accessed: 2015 March 12.)
- [7] U.S. Department of Transportation. *Federal Motor Vehicle Safety Standard No. 218. 49 CFR 571.218*. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC, US, 1974.
- [8] Whittaker, J. A Survey of Motorcycle Accidents, *Vehicle Safety Division, Safety Department, Transport Road and Research Laboratory*, Crowthorne, Berkshire, England, 1980.
- [9] British Standards Institution. *British Standard 2001:1956 (with revisions through 1968) Specification For Protective Helmets For Motor Cyclists*. British Standards Institution, London, England, 1968.
- [10] British Standards Institution. *British Standard 1869:1960 (with revisions through 1972) Specification For Protective Helmets For Racing Motor Cyclists*. British Standards Institution, London, England, 1972.
- [11] Becker, E. B. Voluntary and Mandatory Motorcycle Helmet Standards. *Proceedings of the 9th International Motorcycle Conference. Institute for Motorcycle Safety*, Cologne, Germany, 2012.