

## The Head Injury Criterion

The Head Injury Criterion (HIC) describes the probability of individuals developing head injuries from an impact. HIC reflects acceleration over time, as measured by an accelerometer at the centre of gravity of an ATM's head.<sup>1</sup> Impact-induced head injuries were initially studied over six decades ago. Further studies led to development of the Wayne State Tolerance Curve (acceleration vs. pulse duration) from which HIC was derived.<sup>2</sup>

More calculations led to construction of cumulative distribution curves, giving probabilities of skull fracture and brain damage.<sup>3</sup> A HIC of 1500 was found to have a 56% of “apparent risk of brain damage/skull fracture”, which was considered “too high”.<sup>3</sup> A HIC of 1000 had a 16%<sup>3</sup> to 18%<sup>4</sup> probability of “life-threatening” head injury. This HIC level was therefore chosen in aviation as the standard against which aircraft cabin furnishings and equipment are tested. As described in, e.g., FAA Advisory Circular AC No: 25.562-1B (2015),<sup>5</sup> a score above 1000 fails; a score of 999 passes - with only one test run required.

What does this mean for passengers? At a HIC of 900 - 1254, the average adult passenger has a

- 90% probability: ‘moderate’ head injury, leading to loss of consciousness for up to 1 hour, and a linear skull fracture;
- 55% probability: ‘serious’ head injury, with loss of unconscious for 1-6 hours, and a depressed skull fracture.<sup>1</sup>

Airlines, and aircraft and aircraft seat manufacturers spend millions of dollars to show regulatory compliance. Yet, a HIC of 1000 and its associated clinical conditions suggest the FAA mandated 90-second limit for passenger evacuation<sup>6</sup> – could not possibly be met. The FAA’s John Swearingen warned about this more than 50 years ago: “*In airline crashes it is important for the passengers to remain conscious so that they can escape rather than be asphyxiated or burned to death even though otherwise uninjured.*”<sup>7</sup>

Swearingen emphasized specific seat construction to minimize head injuries.<sup>7</sup> But might this be a band-aid approach to the underlying problem – not only a HIC of 1000 but HIC itself? In this paper we review HIC’s development and comparative choices of different HIC levels in other transportation modalities.

1. McKay, 2007
2. Chandler, 1995
3. Prasad & Mertz, 1985
4. Tyrrell et al, 1995
5. Advisory Circular AC No: 25.562-1B, 2015
6. Advisory Circular AC No: 85.803-1A, 2019
7. Swearingen 1966