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Topic:

Crash Dynamics – Human Injury Criteria

Title: Assessment of Head and Neck Injury Potential During Aircraft Longitudinal Impacts

Abstract

The risk of head-neck injuries was evaluated for certain aircraft seat and interior configurations in aircraft longitudinal impacts. Two loading scenarios for the head-neck system were investigated: inertial (non-contact) loading in posterior-anterior and lateral direction using a forward facing seat and side facing couch respectively, and contact loading through impacts of the head with typical aircraft interior components. The sled tests simulate an impact along the longitudinal axis of the aircraft; however, the seat orientation causes either forward or lateral occupant loading. The FAA Hybrid III was used in the occupant-forward impacts, and the ES-2 Anthropomorphic Test Device (ATD) was used in the occupant-lateral impacts. The ATDs utilized a unique 9-accelerometer array (NAP) bracket. Techniques were applied to derive rotational acceleration and velocity from the NAP. Head rotational velocities were cross-validated using photometric techniques. Both ATDs were also equipped with upper and lower neck 6-axis load cells. The restraint configurations investigated for inertial loading were a forward facing pilot seat with a 4-point restraint, a forward facing passenger seat with a lap belt restraint, and a side facing passenger seat with a 3-point restraint. The contact load configurations utilized a forward facing passenger seat with a lap belt restraint with either a passenger seat back or simulated class divider as impact surfaces. The neck injury potential was evaluated by the Federal Motor Vehicle Safety

Standards Nij criterion, using the neck loads at the occipital condyle level. The NAP data were used to evaluate head injury potential with multiple versions of the Head Injury Criteria (HIC), Skull Fracture Correlate, and the Brain Injury Criteria (BrIC). Neck injury was not a significant risk in most of the forward facing configurations tested; the only test with a Nij value above the limit also exceeded the HIC limit. For the side facing test configurations, neck injury was a significant risk, particularly for seating systems that did not provide effective upper body support. For head injury risk, significant differences where seen between the aviation and automotive versions of HIC. In several tests, aviation HIC was not calculated because there was no contact, but the automotive versions of HIC and BrIC suggest a risk of head injury. Overall, these results indicate that using both HIC and BrIC to evaluate seating systems could provide a safety benefit by directly evaluating the risk of skull fracture and traumatic brain injury.