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Crash Dynamics – Human Injury Criteria

Evaluating the Influence of Armrests and ATD Arm Position on Hybrid II and FAA Hybrid III Lumbar Loads

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The Federal Aviation Administration (FAA) utilizes various dynamic test conditions to evaluate occupant safety and potential injuries in aircraft seats and interiors. One type of test condition, Test 1 of 14 CFR 25.562(b), is primarily loaded in the vertical direction and evaluates Anthropomorphic Test Device (ATD) maximum compressive load of the lumbar spine, which must remain below 1,500 lbf per 14 CFR 25.562 (c)(2). This loading is caused by the mass and inertia of the upper body on the pelvis transferred through the lumbar spine once the seat cushion, seat pan, and seat structure have fully compressed.

During most aircraft dynamic seat testing in the Test 1 configuration, the seats have a standard cantilevered armrest that can be rotated up and out of the ATD arm potential load path. However, in certain seat types, mainly exit row or bulkhead seats, an in-arm tray table is used which requires a fixed armrest position. In these cases, the ATD forearm or elbows typically rest on top of the fixed armrest which can create a new load path for the upper torso. Instead of the entire force of the upper body transferring to the pelvis through the lumbar spine, the ATD arms contact the armrest and start sharing this load in a way that would not be representative of the human body. When loaded in this direction shoulders and clavicle are more malleable in the human body and would provide more compliance compared to the joints of the ATD. Due to this test configuration, Hybrid II and FAA Hybrid III ATDs may underestimate lumbar loads in aircraft seats with non-movable armrests due to off-loading of the upper torso through ATD arms, shoulder, and clavicles instead of the lumbar spine.

This project looks to quantify the influence of armrests and ATD arm position in both Hybrid II 50th percentile and FAA Hybrid III 50th percentile ATD lumbar loads. Experimental testing is conducted with an instrumented rigid seat, measuring seat pan and seat back forces and moments. The rigid seat has been modified to allow load cells to be placed to allow for the measurement of the armrest forces and moments. Tests will be completed for both ATDs in a configuration with armrests and without armrests. The test setup and ATD instrumentation will include all provisions for numerical model validation and verification. Computational analysis simulations will be utilized to determine the effects of various armrest locations and ATD arm positions.