ASOS Research Brief

Research Request:

Information on side facing aircraft seat safety

Research Response:

Based upon existing research and documentation throughout the industry, side facing seats are not as safe as forward or aft facing seats. In fact, aft facing seats are considered to be the safest seat in terms of impact forces. Most aircraft accidents will involve some type of rapid deceleration, so it is important to consider the forward forces that will occur when examining side facing seat safety. In accidents such as runway overruns, the risk is greater for occupants in side-facing couches (divan seating). According to Rick DeWeese, from the Federal Aviation Administration's (FAA) Civil Aerospace Medical Institute (CAMI), "We're (Humans) tougher fore and aft rather than laterally." DeWeese also explained that the neck is a vulnerable, complex structure of vertebrae bones and cartilage discs held together with ligaments. The FAA is currently researching neck injuries and side-facing seats. David Palmerton, the Federal Aviation Administration's expert on protection and survival, agrees; “Sideways seating on corporate -jet couches, by the way, is terrible for crash survival, this could result in serious neck injuries.”

Below are a few excerpts and recommendations from various organizations regarding side facing aircraft seats. As stated later in this report, Amsafe (www.amsafe.com) has a side facing restraint system, and has tested a side facing seat belt airbag system.

Transport Canada- Advisory Circular: Passenger and Flight Attendant Brace Positions

Side-facing Seats with Safety Belt Only:
Wherever possible, occupants should be relocated to forward-facing or aft-facing seats.
When forward-facing or aft-facing seats are not available:
Bend over and lean toward the front of the aircraft, then rest upper torso and head against whatever might be contacted to help reduce head flailing.
Side-facing Seat with Safety Belt and Shoulder Harness:
Place crossed arms over chest and tuck hands and thumbs under armpits, and bend head forward.

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Side Facing Seats with Seat Belt Restraint

Side facing seats without lateral support for the whole body including legs, do not provide good protection from impact loads. Legs will twist sideways during impact and twist the spinal column. The spinal column will also be bent sideways, and compressed as the torso flexes laterally and receives vertical impact forces.

This combination of loading can generate high stresses in the spinal column, perhaps causing fractures and spinal cord injury. It is difficult to reduce the injury potential of this seat configuration because the sideways twisting of the legs cannot be easily prevented. The best protection would be to sit facing forward in the seat and bend over the seat belt until the upper torso and head are resting on the legs, and wrap the arms around the legs. If there is not adequate space for this brace-for-impact position, then the passenger must lean towards the front of the aircraft, and res the upper torso and head against whatever might be contacted.

Side Facing Seat with Seat Belt and Shoulder Harness

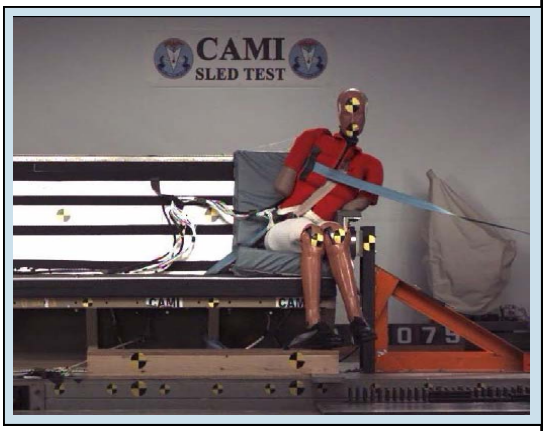
Instructions provided earlier for side facing seats with seat belt restraint also apply here, except for the limitation in upper torso movement provided by the shoulder harness. Unless legs are given full support by a sufficient lateral support surface, which is part of the seat or aircraft interior, they are likely to twist sideways and compound the stress on the spinal column. No brace-for-impact position has been devised to prevent this movement. Possible the only benefit that brace position could provide is to move the head in the direction of the anticipated impact to help reduce head flailing.

FAA Civil Aerospace Medical Institute Assessment of Injury Potential in Aircraft Side-Facing Seats Using the ES-2 Anthropomorphic Test Dummy– May 2007

A project was conducted to assess the injury potential of current side facing aircraft seat configurations using the ES-2 Anthropomorphic Test Dummy proposed for use in Federal Motor Vehicle Safety Standards. The ability of inflatable restraint systems to mitigate injuries in these configurations was also assessed. Impact sled tests were conducted at the Federal Aviation Administration's Civil Aerospace Medical Institute using a sidefacing sofa fixture with cushion construction representative of current business jets. The tests simulated three typical seating configurations: occupant in the middle seat, occupant seated next to a rigid wall, and occupant seated next to an armrest end closure. Two types of restraints were evaluated: a three-point body centered conventional restraint with inertia reel and a similar restraint incorporating a new inflatable shoulder restraint (airbag).

For the Center and Far Wall seat configurations, the calculated HIC values indicate that head injury is a significant risk. The lateral flail envelope of the conventionally restrained occupants allowed head contact with adjacent walls and seat structure. For

the Armrest configuration, the head did not contact any injurious objects; however, the value of HIC15 was at or near its established limit of 700. HIC15 is an automotive injury criterion used to assess the head injury risk for both contact and inertial loading situations.



None of the injury measurements indicated a significant risk of injury to the chest, abdomen, or pelvis for this group of seat configurations. The upper-shoulder belt tension was just below the limit in the Center configuration tests, and the upper-rib deflection approached the lower bound of the proposed limits in the Far Wall configuration test. All of the other injury criteria for these body segments were well below limits. This is likely due to the effectiveness of the body-centered lap belt in controlling lateral motion of the pelvis. This directly limits pelvic injuries and reduces the loads on the abdomen and chest by reducing the effective mass of the torso. This finding does not imply that injuries could not occur with other side-facing seat configurations. Placing the lap belt anchors at their conventional locations beside each hip could increase pelvis accelerations and forces. Inclusion of an armrest in a seat with a conventional restraint configuration could also lead to high abdominal loading. A combination of ineffective pelvic and torso restraints could also increase chest accelerations and deflections during impacts with adjacent walls. The high femur twisting-moment measured in the Armrest configuration is a unique loading condition for which an injury criteria has not been established. The intent of the femur compression limits in FAA transport aircraft regulations was to avoid injuries that would impede evacuation. In a similar fashion, a limit on the twisting moment may be necessary to provide the intended level of safety.

Inflatable Restraint Evaluation

In most cases, the inflatable restraints were effective in reducing the lateral flailing of the occupant and significantly reduced the head accelerations, neck loads, chest acceleration, rib deflections, and the injury criteria derived from these measurements. In only one case (the Far Wall configuration) were measured parameters significantly greater than without the inflatable. In this case, while the inflated torso restraint reduced the severity of impact with the adjacent wall, it acted as a fulcrum around which the head rotated laterally, increasing the upper-neck bending moment. The inflatable restraints did not limit the lateral flail envelope sufficiently to preclude significant “body to body” contact with an adjacent occupant (if present). Further development was conducted by AMSAFE to determine if it is possible with current technology to prevent “body to body” contact. Use of an inflatable restraint similar to the tested systems in conjunction with body-centered lap belt geometry may mitigate many of the injury risks presented by side-facing seat designs that are similar to the test seat configuration.