

Rationale for New Brace Position Guidance

Presented to: FAA Triennial International Fire and Cabin Safety Conference

By: Richard DeWeese FAA CAMI

Date: October, 2019



**Federal Aviation
Administration**



Background

- **Assuming an appropriate brace-for-impact position can increase the chance of survival in an aircraft crash.**
- **FAA guidance concerning brace position contained in AC 121-24D has been recently revised to reflect the latest research findings summarized in DOT/FAA/AM-15/17.**

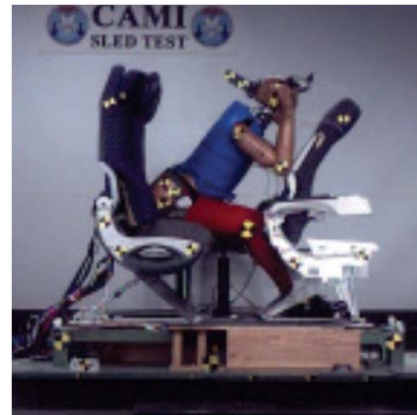
Research Findings

- Previous guidance for occupants of typical passenger seats was to place their hands and head on the seat back in front of them if there was not room to bend over completely.



Research Findings

- The FAA's research revealed that for some seat back designs, the inertia of the passenger's arms can push the seat back forward, which tends to increase head strike severity.



Research Findings

- This significant issue was addressed by having the passengers place their hands down by their lower legs. This position provided the same level of protection regardless of the specific seat back design.



New Guidance

- The new guidance not only changed the recommended arm placement for the row-to-row passengers, it also updated the hand and foot placement in all of the figures. These positions reflect:
 - Recent research findings
 - Expected occupant response to impact
 - Operational experience
- The goal of all changes was to minimize injury risk during most likely impact scenarios.

Forward-Facing w/lap belt (passenger)

- **Hands:** *Wrap arms under legs behind the knees*, AC ref: 3.a (1). (Figure 1)
 - To reduce head impact and flailing injuries. Guidance is essentially unchanged from previous AC.



Forward-Facing w/lap belt (passenger)

- **Feet:** *Place as far back as possible*, AC ref: 3.a (1) and 3.a (2). (Figure 1)
 - To reduce the chance of leg flailing and the associated leg injury risk. In crash tests, this position prevented leg flailing for 50th percentile size occupants. It would not be effective for small occupants whose feet cannot touch the floor. (DOT/FAA/AM-15/17)



Forward-Facing w/lap belt (high-density passenger seating)

- **Hands:** *Grasp lower legs*, AC ref: 3.a (2). (Figure 2)
 - To prevent inertia of hands/arms from pushing seat back forward, which defeats its energy absorbing function. The gap created between the head and seat back increases head injury risk. (DOT/FAA/AM-15/17)



Forward-Facing w/lap belt (high-density passenger seating)

- **Feet:** Same position as for low-density passenger seating. (and for the same reasons)



Forward-Facing w/shoulder belt (passenger and attendant)

- **Hands:** *In Lap*, AC ref: 3.b (1) and 4.a. (Figure 3)
 - To minimize injury during flailing. Inertia forces can pull the arms forward, away from their initial position during a forward impact.



Forward-Facing w/shoulder belt (passenger and attendant)

- **Hands continued:**
 - Grasping the side of the seat, as was previously recommended, may prevent or delay arm flailing during a minor impact, but may increase the risk of hand injury if inertia forces are sufficient to overcome the occupant's grasp and pull the arms forward.

Forward-Facing w/shoulder belt (passenger and attendant)

- **Hands continued:**
 - Although not specifically called for in the previous AC, sitting on the hands has been recommended by some Flight Attendant training programs. That practice has the *additional* risk of hand injury during a crash with a high vertical component (it could be smashed between the pelvis and the seat pan).

Forward-Facing w/shoulder belt (passenger and attendant)

- **Feet: *Flat on Floor, knees at 90 degrees*, AC ref 3.b (1) and 4.a. (Figure 3)**
 - This vertical position of the lower legs is intended to prevent the legs from being trapped if seat pan deflects downward significantly. It would also tend to decrease loading on seat pan by directing more of the leg's inertia to the floor during a vertical impact.



Aft-Facing (passenger and attendant seats)

- Hand: *In Lap*, AC ref: 3.c and 4.b (Figure 4)
 - To minimize injury during flailing. Just as in a forward facing seat, inertia forces can pull the arms forward, away from their initial position, during a forward impact.



Aft-Facing (passenger and attendant seats)

- Hand continued:
 - As in a forward facing seat, grasping the side of the seat or sitting on the hands can increase the risk of hand injury in a significant forward or vertical impact.

Aft-Facing (passenger and attendant seats)

- **Feet:** *Flat on floor, knees at 90 degrees*, AC ref 3.b (1) and 4.a. (Figure 4)
 - As in the forward facing seat, this vertical position of the lower legs is intended to reduce the chance the legs from being trapped if seat pan deflects downward significantly.



Aft-Facing (passenger and attendant seats)

- **Feet continued**
 - This position would also tend to decrease loading on seat pan by directing more of the leg's inertia to the floor during a vertical impact.



Helicopter (all passenger and attendant seats)

- **Hand:** *Grip edge of seat pan*, AC ref: 5.a.
 - This specific instruction for rotorcraft passengers is intended to help with orientation in the event of inversion after a water impact. Maintaining orientation with respect to exit location is an important factor in evacuation from an inverted and submerged helicopter. Based on real world experience of operators (IA SA 13-01)
 - Feet: Same as similar seats for other aircraft.

Unchanged Guidance

- **Some brace position guidance was not revised:**
 - Pillows and Blankets (AC ref: 3d)
 - Children (AC ref: 3e)
 - Pregnant or Handicapped Passengers (AC ref: 3f)
 - Planned and Unplanned Briefings (AC ref: 5b)
- **Guidance was either:**
 - Determined to be still applicable
 - No new information available to base changes on.

Conclusion

- **An optimum brace position would be dependent on so many factors that it is impossible to describe a single position that would be best for every occupant in every case.**
- **The positions described in the advisory circular are based on general crash safety principles applicable to most occupants.**