



AEROSPACE RECOMMENDED PRACTICE

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CREW RESTRAINT SYSTEM

1. INTRODUCTION

This ARP is intended to make recommendations for flight crew and cabin attendant restraint systems in aircraft. A properly designed crew restraint system will avoid injury or debilitation during a survivable crash and enable post crash assistance to occupants and escape from the aircraft.

Consideration is given to existing requirements of the FAA and to the recommendations of aircraft operators and those involved in the manufacture or use of restraining devices. Crew member safety is the primary objective, with appropriate provisions for crew comfort taken into consideration. The criteria established herein are designed to standardize restraining systems without hindering the development of new, improved systems.

2. SCOPE

Part I of this document relates to the restraint systems for the flight deck crew.

Part II considers restraint systems for flight attendants and other crew members.

As applicable, the same criteria should be incorporated in both Part I and Part II installations.

The recommendations herein include coverage of such items as harness reels, shoulder harnesses, and safety belts. However, the intention is not to limit the design of restraint devices to these particular system components only.

These recommendations apply primarily to forward-facing and aft-facing seats. However, the design should take into account the fact that loads may be applied from any direction and be of a magnitude at least as great as those specified in current FAR's.

3. GENERAL RECOMMENDATIONS

- 3.1 All straps and hardware (adjusters, releases, attaching end fittings, structural attachments, etc.) in the restraint system should be designed and installed to avoid bodily injury to crew members under all normal and emergency conditions. Placement of hardware against skeletal or other easily injured parts of the body should be especially avoided.
- 3.2 The restraint system dimensions, adjustments, strength, attachment locations and hardware locations should consider characteristics of the female and male form and should be designed to anthropometric data using the 5th through the 95th percentile ranges for male and female crew members.

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4. PART I RECOMMENDATIONS - FLIGHT DECK CREW AND OBSERVERS

- 4.1 Shoulder Harness: A shoulder harness or a device which accomplishes a similar function should be provided for all flight deck crew members and should be easy to don, adjust and remove, yet should not be susceptible to inadvertent release during the dynamics of the crash impact. The device should permit ample upper torso freedom so that the crew member can efficiently and comfortably carry out his regular duties under all operating conditions. When the duties of the occupant are such that upper torso movement is not required, recommendations outlined in Part II of this document should be followed.
- 4.1.1 Shoulder Harness Installation: The shoulder harness should be installed in such a manner as to prevent snagging of the straps. Strap splices should pass freely through harness guides or fittings. The point from which the harness comes over the shoulder should be at or above the shoulder level of the occupant while he is sitting in a normal position, however, the harness should not exceed 45 degrees above the horizontal plane thru the shoulder level. The adjustment should be positive, simple, and easy to operate. The load imposed on the body by the retraction tension of the device should be negligible when the occupant is sitting in a normal position. Stowage of the shoulder harness should be automatic so as to prevent entanglement with the seat itself or with any adjacent structure. The harness should be installed to accommodate the ranges of body component dimensions.
- 4.2 Harness Reel: When required as a function of flight compartment design, an inertia reel or a similar device should be provided to allow ample torso movement of the crew member thereby permitting full operation of the aircraft under all conditions. Acceleration forces of more than 2.0 g's and less than 3.0 g's (or equivalent accelerations or strap "payout" rate) applied in any direction, causing the torso of the crew member to move away from the seat back, should activate the lock device within 60 milliseconds. Single or dual reels may be used, however, dual reels should be designed for simultaneous lockup within a 1.0 g lockup tolerance. The flight crew member should be automatically and positively restrained in the particular position he was in when accelerations were applied. If the flight crew member is leaning away from his seat during acceleration in any direction, the device should automatically reel in when he returns to a normal sitting position and relock if the force or acceleration is still being applied or is later reapplied. When the shoulder harness is released, the component design and/or the retraction rate should prevent injury exposure from adjusting or attaching hardware on the released harness.
- 4.2.1 Harness Reel Installation: The harness reel should be attached to the aircraft seat or structure in such a manner as to prevent snagging or chafing of cables and straps. Cable or strap splices should pass freely through harness guides or fittings so as to keep friction at a minimum. Means for checking the operation of the automatic "payout" locking action for inertia reels that automatically lock as a function of strap velocity or acceleration should be simple, permitting the crew member to make this check while he is sitting in a normal position.
- 4.2.2 Harness Reel Control: If installed, the harness reel "lockup" control should be of simple design and manually operable with one hand. The control should be located so that it is easily accessible to the occupant while he is sitting in a normal position. Installation should preclude snagging of the occupant's clothing when he is getting in or out of his seat.
- 4.2.3 Disabled Pilot Control: Some aircraft operators may desire a controlled power retraction for shoulder restraints to pull erect a disabled pilot in a critical phase of flight.

- 4.3 **Safety Lap Belt:** The seats should be provided with a safety lap belt or a similar device. The belt should be dependable and simple to operate, and in conjunction with the shoulder harness, should provide maximum protection to the occupant, particularly in the event of a crash. The restraint system should be so designed that when it is subjected to the maximum design load, the safety lap belt will never be pulled above the occupant's pelvic structure. The adjustment should be positive, simple, and easy to operate yet not susceptible to inadvertent release during a crash.

NOTE: Refer to ARP 682, Safety Lap Belts (For Civil Transport Aircraft), and to Technical Standard Order TSO C22.

- 4.3.1 **Safety Lap Belt Installation:** Provisions should be made for easy stowage of the lap belt to prevent entanglement with the seat, controls, or structure. When the action of the stowage device is automatic, its operation should not interfere with, or be mistaken for, the safety lap belt length adjustment. The resultant angle of the loaded lap belt (45 deg to 55 deg up from horizontal), considering the effect of the shoulder harness, should be compatible with the geometry of the seat, and accommodate the ranges of body component dimensions.
- 4.3.2 **Shoulder Harness and Safety Lap Belt Release Mechanism:** The restraint system should be provided with a quick release mechanism operable with one hand in a single motion, or a device which accomplishes a similar function. This device should be simple to operate and dependable. It should be permanently attached to the safety belt. It should also lay flat and snug against the body and be positioned to prevent inadvertent release of the mechanism. Provisions for connecting the shoulder harness to this release mechanism should also be incorporated. The mechanism should be capable: (a) of releasing the shoulder harness independently from the safety lap belt, and (b) releasing all connections of the safety lap belt and the shoulder harness simultaneously. It should be possible to do this even under those crash conditions where the occupant is physically hanging by the restraint device when the aircraft is inverted.
- 4.4 **Overall System Requirements:** The strength of the restraint system and its components should be sufficient to preclude failure under loads equal to the designed ultimate load of the seat and its structural attachments under both static and dynamic loading conditions.

The design should encourage tightening the lap belt before adjustment of the shoulder restraints, otherwise, a loose lap belt gives exposure to the belt being pulled up on application of upper torso loads to the shoulder restraints. The resultant movement of the lap belt above the pelvic region could then result in "submarining" of the occupant down under the lap belt. Upward movement of the lap belt can also be prevented by use of an adjustable tie-down strap (crotch strap) to counteract shoulder harness loads.

The complete restraint system should provide a maximum area for force distribution in the upper torso and pelvic regions to avoid injury from decelerative forces in a potentially survivable crash.

5. PART II RECOMMENDATIONS - FLIGHT ATTENDANTS & OTHER CREW MEMBERS

NOTE: See ARP 583, Flight Attendant Stations

- 5.1 **Shoulder Harness:** All flight attendant seats, including jump seats, should be provided with a shoulder harness or a device which accomplishes a similar function yet should not be susceptible to inadvertent release during the dynamics of the crash impact. The prime function of the shoulder harness is to retain the occupant in the seat and, in conjunction with a safety lap belt, to provide maximum protection to the body in the event of a crash. Appropriate provisions for comfort should also be considered. Means should be provided to adjust this device. The adjustment should be positive, simple, and easily made and not susceptible to inadvertent release during the dynamics of the crash impact. When the duties of the occupant are such that upper torso movement is required, recommendations outlined in Part I should be followed.