

APPENDIX A

Part 23 Regulations Related to Human Factors Note: There is not a one for one equivalent with Part 25

Section 23.45 General (f) Unless otherwise service. These procedures must be able to be executed consistently by **pilots of average skill** in atmospheric conditions reasonably expected to be encountered in service. FT

23.55 Accelerate-stop distance. (b) Means other than wheel brakes may be used (3) Is such that **exceptional skill is nor required to control the airplane**. FT

23.57 Takeoff Path. (c)(4) Except for gear retraction and automatic propeller feathering, the airplane configuration must not be changed, and no change in power that **requires action by the pilot may be made**, until the airplane is 400 feet above the takeoff surface. FT

Section 23.141 General. The airplane must meet the requirements of 23.143-23.253 at all ... and without **requiring exceptional piloting skill, alertness, or strength**. FT/HF

Section 23.143 General (control and maneuverability)

c) If marginal conditions exist with **regard to pilot strength, the control forces necessary must be determined by quantitative tests**. FT/HF

Section 23.145 Longitudinal Control

b) it must be possible to carry out the following maneuvers without requiring the **application of single handed control forces** exceeding those specified in 23.143 FT

d) it must be possible with a **pilot control force of not more than 10 pounds, to maintain...** FT

Section 23.149 Minimum control speed

e) at V_{mc} the **rudder pedal force required to maintain control must not exceed 150 pounds...** FT

23.153 Control during landings. It must be possible, while in the landing configuration to safely complete a landing without **exceeding the one hand control force limits** specified in 23.143 FT

23.155 specifies elevator control forces FT

23.161 Trim . **to ensure the pilot will not be unduly fatigued or distracted by the need to apply residual control forces exceeding those for prolonged application of** 23.143 (c). FT

23.173 (c) requires the stick force to vary with speed so that any substantial speed change results in a stick force **clearly perceptible to the pilot**. FT

23.181 Dynamic stability. (d) Any long period oscillation of flight path, phugoid oscillation, that results must not be so unstable as to **increase the pilot's workload or otherwise endanger the airplane**. FT

Section 23.207 Stall warning (a) **There must be a clear and distinctive stall warning...**a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. HF

(e) During stall test required by 23.203 the stall warning must begin sufficiently in advance of the stall for the stall **to be averted by pilot action taken after the stall warning first occurs**. FT

23.221 Spinning a (ii) no control forces or characteristics encountered during the spin or recovery may adversely affect prompt recovery. FT
(4) There must be no characteristics during the spin (such as excessive rates of rotation or extreme oscillatory motion) that might prevent a successful recovery due to **disorientation or incapacitation** of the pilot. FT

23.251 Vibration and buffeting. There must be... no buffeting severe enough to interfere with the satisfactory control of the airplane or cause **excessive fatigue to the flight crew**. FT/HF
23.253 High speed characteristics. The following recovery characteristics must be met
(b) (2) Buffeting that would impair the pilot's ability to **read instruments or control the airplane for recovery**.

23.395 Control system loads. a (1) The system limit loads need not exceed the higher of the loads that can be produced by the pilot and automatic devices operating the controls. However, autopilot forces need not be added to pilot forces. The system must be designed for the maximum effort of the pilot or autopilot, whichever is higher. In addition, if the pilot and the autopilot act in opposition, the part of the system between them may be designed for the maximum effort of the one that imposes the lesser load. Pilot forces used for design need not exceed the maximum forces prescribed in 23.397
(c) Pilot forces used for design are assumed to act at the appropriate control grips or pads as they would in flight, and to react at the attachments of the control system to the control surface horns. FT

23.397 Limit control forces and torques. This section calls out a table, which specifies limit pilot forces and torques for aileron, elevator and rudder. FT

23.399 Dual control system. Specifies pilot forces for dual control systems FT

23.405 Secondary control system. Secondary controls, such as wheel brakes, spoilers, and tab controls, must be designed for the maximum forces that a pilot is likely to apply to those controls. FT

23.611 Accessibility provisions. For each part that requires maintenance, inspection, or other servicing, appropriate means must be incorporated into the aircraft design to allow such servicing to be accomplished. Design for Maintainer Issue

23.671 General. (a) Each control must operate **easily, smoothly and positively** enough to allow proper performance of its functions. FT/HF
(b) Controls must be **arranged and identified to provide for convenience in operation and to prevent the possibility of confusion and subsequent inadvertent operation**. HF/FT

23.672 Stability augmentation and automatic and power operated systems.
(a) A warning, which is **clearly distinguishable to the pilot** under expected flight conditions without requiring the **pilot's attention**, must be provided for any failure to the stability augmentation system or in any other automatic or power-operated system that could result in an unsafe condition if the pilot was not aware of the failure. Warning systems must not activate the control system.
(b) The design of the stability augmentation system or of any other automatic or power-operated system must permit initial counteraction of failures without requiring **exceptional pilot skill or**

strength by either the deactivation of the system or a failed portion thereof, or by overriding the failure by movement of the flight controls in the normal sense.

23.673 Trim system . (a).... . In addition there must be means to indicate to the pilot the position of the trim device with respect to both the range of adjustment and, in the case of lateral and directional trim, the neutral position. This means must be **visible to the pilot and must be located and designed to prevent confusion. The pitch trim indicator must be clearly marked with a position or range within....** FT/HF

23.679 Control system locks. If there is a device to lock the control system on the ground or water;

(a) There must be a means to-

(1) give unmistakable warning to the pilot when lock is engaged; or

(2) Automatically disengage the device when the pilot operates the primary flight controls in a normal manner.

(b) The device must be installed to limit the operation of the airplane so that, when the device is engaged, the pilot receives unmistakable warning at the start of the takeoff.

(c) The device must have a means to preclude the possibility of it becoming inadvertently engaged in flight. HF/FT

23.685 Control system details. (b) There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

(d) Each element of the flight control system must have design features, or must be distinctively and permanently marked, to minimize the possibility of incorrect, assembly that could result in malfunctioning of the control system. DFM issue

23.689 Cable systems.

(a) **(3) there must be a means for visual inspection at each fairlead, pulley, terminal and turnbuckle.** DFM

23.691 Artificial stall barrier system.

(c) In addition to the stall warning required 23.07, a warning that **is clearly distinguishable to the pilot under all expected flight conditions without requiring the pilot's attention must be provided for faults that would prevent the system from providing the required pitching motion.** FT/HF

(d) Each system must be designed so that the artificial stall barrier can be **quickly and positively disengaged by the pilots to prevent unwanted downward pitching of the airplane by a quick release (emergency) control that meets the requirements of 23.1329(b)**

23.703 Takeoff warning system. For **commuter** category airplanes, a takeoff warning system must be installed and meet the following requirements.

(a) The system must provide to the pilots an aural warning that is automatically activated during the initial portion of the takeoff roll if the airplane is in a configuration that would not allow a safe takeoff. The warning must continue until-.... .

(a) The system must provide to the pilots an aural warning system that is automatically activated during the initial portion of the takeoff roll if the airplane is in a configuration that would not allow for a safe takeoff....HF

23.729 Landing gear extension and retraction system. (e) Position indicator. If a retractable

landing gear is used, there must be a landing gear position indicator (as well as the necessary switches to actuate the indicator) or other means to inform the pilot that each gear is secured in the extended (or retracted) position. If switches are used, they must be located and coupled to the landing gear mechanical system in a manner that prevents an erroneous indication of either “down and locked” if each gear is not in the fully extended position or “up and locked” if each landing gear is not in the fully retracted position.

23.733 Tires.

(b) If specially constructed tires are used, the wheels **must be plainly and conspicuously marked to that effect. The markings must include the make, size, number of plies, and identification marking of the proper tire.** DFM

23.745 Nose/tail wheel steering

(a) If nose tail wheel steering is installed, it must be demonstrated that its use **does not require exceptional pilot skill during takeoff and landing. In crosswinds or in the event of an engine failure; or its use must be limited to low speed maneuvering.**

(b) **Movement of the pilot’s steering control must not interfere with the retraction or extension of the landing gear.** FT

Section 23.771

(a) The compartment and its equipment must allow each pilot to perform his duties **without unreasonable concentration or fatigue.** HF

(b) Where flight crew are separated from the passengers by a partition, an **opening or openable** window door must be provided **to facilitate communications** between flight crew and passengers. HF

23.773 (a) Each pilot compartment must be-

(1) **Arranged with sufficiently extensive, clear and undistorted view to enable the pilot to safely taxi, takeoff, approach, land, and perform any maneuvers within the operating limitations of the airplane.**

(2) **Free from glare and reflections that could interfere with pilot’s vision.**

(3) **Designed to protect the pilot from the elements and so that moderate rain does not impair the pilots view of the flightpath.** HF/FT

23.775 Windshield and windows.(e) must have a luminance transmission of **not less than 70%**

(f) A means must be provided to prevent or clear accumulations of ice from the windshield so that the pilot has adequate view for taxi HF/FT

23.777 (a) Each cockpit control must be located and (except where its function is obvious) identified to provide **convenient operation and to prevent confusion and inadvertent operation.**

(b) The controls must be arranged so that the pilot, when seated, **has full and unrestricted movements of each control without interference from either his clothing or cockpit structure.** HF

(e). Identical powerplant controls for each engine must be located to **prevent confusion as to the engines they control.**

(f) Wing flap and auxiliary lift device controls must be located- (1) Centrally, or to the right of the pedestal or powerplant throttle control centerline; and (2) **Far enough away from the landing gear control to avoid confusion**

(h)each fuel speed selector control must comply with 23.995 and be located and arranged so

that the pilot can see **and reach it without moving any seat or primary flight control when his seat is at any position in which it can be placed.** HF

(1) Describes specifics for a mechanical fuel selector including a requirement to provide (I)positive identification and feel (detent, etc) of the selected position. (ii) locating the position indicator at the widest part of the handle measured from the center of rotation

(2) For electrical or electronic fuel selector:

(i) digital controls or electrical switches must be properly labeled.

(ii) Means must be provided to indicate to the flight crew the tank or function selected. Selector switch position is not acceptable as a means of indication. The “off “ or “closed” position must be indicated in **red** (won’t see at night unless lighted)

25.779 Motion and effect of cockpit controls. This section prescribes requirements for the motion and effect of cockpit controls.

23.781 Cockpit control knob shape. This section prescribes requirements for the shape of the cockpit control knobs.

23.783 Doors

provide a means to lock and safeguard against inadvertent opening

openable from the outside and inside when the internal lock is in the locked position

provide a simple obvious marked inside and out so that the door can be readily opened even in darkness

several other items are included under doors including warnings for opened doors and sizes of door openings and precluding entrapment in lavatories. HF

23.785 Seats, belts, harnesses.

Each seat/restraint system must be designed to support occupants weighing at least **215 lbs.**

(several other requirements are listed in this FAR)HF/FT

23.803 Emergency evacuation

Specifies an emergency evacuation under night conditions using exits on the most critical side of the aircraft. Evacuation **must be accomplished in 90 seconds.** HF

23.805 Flightcrew emergency exits

Specifies number and location of exits, specifies **size of exit 19x20 inch rectangular** (won’t work for me), specifies an assisting device (rope) if the exit is **higher than 6ft.** HF

23.807 Emergency exits. Specifies several requirements including **size of exit 19x26** (still won’t work for me) be readily accessible, requiring no exceptional agility to use, have a method of opening that is simple and obvious, be arranged and marked for easy location and operation. HF

There are many human factors issues that continue from 23.811 emergency exit marking, 23.812 Emergency lighting, 23.813 Emergency exit access, 23.815 Width of aisle and 23.831 Ventilation. HF plus Test Folks.

There are also items under 23.843 Pressurization, 23.851 Fire extinguishers, 23.853 Passenger and crew compartment interiors.

SUBPART E Powerplant, Part 23, starts with 23.901

23.901 Installation. (b) (2) Be **accessible for necessary inspection and maintenance**. DFM
(c) Engine cowls and nacelles must be easily removable or openable by the pilot to provide adequate access to and exposure of the engine compartment for preflight checks. HF

23.953 Fuel system. ... will not result in the loss of power of more than one engine or **require immediate action by the pilot** to prevent the loss of power of more than one engine.
HF/PROP

(3) Filler caps designed to minimize the probability of incorrect installation or inflight loss.
DFM

23.955 Fuel flow (f) (3) for single engine airplanes, require no pilot action after completion of engine starting phase of operations unless means are provided that unmistakably alert the pilot to take any needed action at least five minutes prior to the needed action; such pilot action must not cause any change in engine operation; and such pilot action must not distract pilot attention from essential flight duties during any phase of operation for which the airplane is approved.
WOW!! PROP/HF

23.991 Fuel pumps (c) warning means. If both the main pump and emergency pump operate continuously, there must be a means to indicate to the appropriate flight crewmembers a malfunction of either pump. HF/PROP

23.963 Fuel Tanks: General (c) each integral fuel tank must have adequate facilities for **interior inspection and repair**. DFM

23.969 Fuel tank expansion space. It must be impossible to fill the expansion space inadvertently with the airplane in the normal ground attitude. DFM

23.977 Fuel tank outlet. (d) Each strainer must be accessible for inspection and cleaning. DFM

23.991 Fuel pumps. (c) Warning means. If both the main pump and emergency pump operate continuously, there must be a means to indicate to the appropriate flight crewmembers a malfunction of either pump. PROP/HF

23.995 Fuel valves and controls. provide a **rapid shutoff** to flight crew in flight for each engine.

must guard against **inadvertent shutoff**.

allow for **rapid reopening** of closed valve.

fuel valve handle and connections must be designed to **minimize incorrect installation**.

check valves must be designed to **preclude incorrect assembly or connection**.

fuel selector valves must require **separate and distinct action** to place the selector in the OFF position and have the tank selector positions located such that it is impossible for the selector to pass through the OFF position when changing from one tank to another. These are all HF issues.

there are more in the fuel and oil sections, cooling, induction systems, exhaust systems, and fire detector systems that I am not listing many of which deal with **design for maintainer human factors issues**.

Subpart F Equipment.

23.1301 Function and installation. **Each item of installed equipment must-**

(a) **Be of a kind and design appropriate to its intended function.**

(b) **Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors:** HF/Avionics

23.1303(e) (2) ... The speed warning device must give effective aural warning (**differing distinctively from aural warnings used for other purposes**) to the pilots whenever the speed exceeds VMO+6 knots. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed. The lower limit of the warning device must be set to **minimize nuisance warning.** HF/ Avionics

(f) When an attitude display is installed, the instrument design must not provide any means, accessible to the flightcrew, of adjusting the relative positions of the attitude reference symbol and the horizon line beyond that necessary for parallax correction. ?

(g) (3) Having a passenger seating configuration of 10 or more, excluding the pilot's seats and that are approved for IFR operations, **a third attitude instrument must be provided that:**

(I) Is powered from a source independent of the electrical generating system;

(ii) Continues reliable operation for a minimum of 30 minutes after total failure of the electrical generating system;

(iii) Operates independently of any other attitude indicating system;

(iv) Is operative without selection after total failure of the electrical generating system;

(v) Is located on the instrument panel in a position acceptable to the Administrator that **will make it plainly visible to and usable by any pilot at the pilot's station;** and

(vi) Is **appropriately lighted** during all phases of operation. HF/Avionics

23.1305 prescribes the powerplant instruments that are required. (b)(4) (i) That continuously indicates, to the pilot, the fuel pressure or fuel flow; or

(ii) That continuously monitors the fuel system and **warns the pilot of any fuel flow trend that could lead to engine failure.**

(4) Commuter category airplanes

(b) ...Each item of equipment.. to ensure safe flight or landing or whose failure would significantly reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions, must be designed to comply with the following additional requirements;

(1) It must perform its intended function under any foreseeable operating condition.

(2) When systems and associated components are considered separately and in relation to other systems-

(i) The occurrence of any failure condition that would prevent the continued safe flight and landing of the airplane must be extremely improbable; and

(ii) The occurrence of any other failure condition that would significantly reduce the capability of the airplane or the ability of the crew to cope with adverse operation conditions must be improbable.FT/HF

(b) (3) Warning information must be provided to alert the crew to unsafe system operation conditions and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors that could create additional hazards.

(4) Compliance with the requirements of paragraph (b)(2) of this section may be shown by

analysis and, where necessary, by appropriate ground, flight or simulator tests. The analysis must consider-

- (I) Possible modes of failure, including malfunctions and damage from external sources;
- (ii) The probability of multiple failures, and the probability of undetected faults;
- (iii) The resulting effects on the airplane and occupants, considering the stage of flight and operation conditions; and
- (iv) The crew warning cues, corrective action required and the crew's capability of determining faults. HF/FT

23.1311 Electronic display instrument systems.

Addresses legibility, arrangement, visibility, requires that primary display info not be inhibited, also specifies that primary engine data not be inhibited.

Requires independent mag dir indicator and an independent secondary mechanical indication of airspeed, alt., and attitude. Requires redundant power sources. Requires equivalent sensory cues, requires certain markings for operational values. Inhibits single failure designs.

HF/Avionics/FT

23.1321 Arrangement and visibility.

(a) Each flight, navigation, and powerplant instrument for use must be located **so that any pilot seated at the controls can monitor the airplane's flight path and these instruments with a minimum head and eye movement.**

(b) For each multiengine airplane, identical powerplant instruments must be located so as to prevent **confusion as to which engine each instrument relates.**

(d) Defines the basic T arrangement in items (1) through (4)

(e) Requires that malfunction flags be readable under all cockpit lighting conditions. HF

232.1322 Warning, Caution, and Advisory lights. Specifies **color and readability** requirements. HF

23.1326 Pitot heat

Indication must be provided to show when the system is not operating via an amber light in clear view of the pilot.

HF

23.1329 Automatic Pilot system.

(a) Each system must be designed so that the automatic pilot can-

(1) Be **quickly and positively disengaged by the pilots to prevent it from interfering with their control of the airplane; or**

(2) **Be sufficiently overpowered by one pilot to let him control the airplane.**

The quick release emergency control must be located on the control wheel.... without moving the hand from its normal position on the control. HF/Flight controls

(c) Unless there is automatic ... indicate to the pilot the alignment of the actuating device in relation to the control system it operates. HF/Flight controls

(d) Each manually... must be readily accessible to the pilot. Each control must operate in the same plane and sense of motion as specified in 23.779 for cockpit controls. The direction of motion must be plainly indicated on or near each control. HF

(e) Each system must it cannot produce hazardous loads ... or create hazardous deviations in the flight path...

Flight Controls/FT

(h) If the automatic pilot system can be **coupled to airborne navigation equipment, means must be provided to indicate to the flight crew the current mode of operation. Selector switch position is not acceptable as a means of indication. HF/ Flight cont.**

23.1331 Instruments using a power source. Requires a visual power annunciator or separate power indicator to show when power is not adequate. Also requires the indicator be located so the pilot using instruments can monitor it with **minimum head and eye movement.**

HF/Elect.

23.1335 Flight director system. Requires a means to indicate to the flight crew its current mode of operation. Switch position alone is not satisfactory.

23.1357 Circuit protective devices.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be so located and identified that it can be **readily reset or replaced in flight,**

(e)(2) The spare fuse(s) must be readily accessible to any required pilot. HF/ELECT

23.1361 Master switch arrangement.

(a) There must be a master switch arrangement to allow ready disconnection of each electric power source.....The point of disconnection must be adjacent to the sources... If separate switches are incorporated into the master switch arrangement, a means must be provided for the switch arrangement to be operated **by one hand with a single movement.**

(c) The master switch or its controls must be so installed that the switch is **easily discernible and accessible** to a crewmember. HF/Elect

23.1367 Switches.

Each switch must be

c) **accessible** to appropriate flight crewmembers; and

d) **labeled** as to the operation and the circuit controlled.HF

23.1381 Instrument Lights.

The instrument lights must

a)make each instrument and control easily readable and discernible:

b) Be installed so that their direct rays, and rays reflected from the windshield or other surface, are shielded from the pilot's eyes. HF

23.1401 Anticollision light system.

(a)(1)Consists of one or more approved anticollision lights located so that their **light will not impair the flight crewmember's vision or detract from the conspicuity of the position lights** HF

23.1431 Electronic Equipment.

(c) The cockpit must be evaluated to determine if the flightcrew members, when seated at their duty station, can converse without difficulty under the actual cockpit noise conditions when the airplane is being operated.

(e) If provisions for the use of communication headsets are provided, it must be demonstrated that the flightcrew members will receive all aural warnings under the actual cockpit noise conditions when the airplane is being operated when any headset is being used. HF/FT

Did not go past 23.1431 for this version remainder covers Hydraulics, Pneumatics, Oxygen, Voice & Flight Recorders

23.1523 Minimum Flight Crew

(a) The workload on individual crewmembers and, in addition for commuter category airplanes, each crewmember workload determination must consider the following.

(1) Flight path control

(2) Collision avoidance

(3) Navigation

(4) Communications

(5) Operation and monitoring of all essential airplane systems,

(6) Command decisions, and

(7) The accessibility and ease of operation of necessary controls by the appropriate crewmember during all normal and emergency operations when at the crewmember flight station:

(b) The accessibility and ease of operation of the necessary controls by the appropriate crewmember:and

(c) The kinds of operation authorized under 23.1525 HF/FT

23.1541 Markings and Placards- General 23. 1541 through 23. 1567 cover several areas of marking instruments and placards HF/FT

Airplane Flight Manual and Approved Manual Material are covered under 23.1581 through 23.1589

Other regulatory references:

Section 21.21 (2) “For an aircraft, that no feature or characteristic makes it unsafe for the category in which the certification is requested.”