



400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE RECOMMENDED PRACTICE

SAE ARP 571C

Issued 12-15-56
Revised 10-1-85

Superseding ARP 571B

Submitted for recognition as an American National Standard

FLIGHT DECK CONTROLS AND DISPLAYS FOR COMMUNICATION AND NAVIGATION EQUIPMENT FOR TRANSPORT AIRCRAFT

CANCELLED

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Feb. 1994

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PREPARED BY
SAE COMMITTEE S-7,
FLIGHT DECK AND HANDLING
QUALITIES STANDARDS FOR
TRANSPORT AIRCRAFT

1. PURPOSE: This document presents a recommended practice for the functional control and display of communication and navigation equipment on the flight deck.
2. SCOPE: The equipment covered by this document includes:
 - a. Voice communications such as Ultra High Frequency (UHF), Very High Frequency (VHF) and High Frequency (HF) Radios, Cabin/Service Interphones, Public Address (PA), Select Call (SELCAL), Call Select (CALSEL), Satellite Communications (SAT COM).
 - b. Data Link Digital Communications such as Company and Air Traffic Control networks, Transponders, MODE-S, and others.
 - c. Navigation including Very High Frequency Omnidirectional Range (VOR), Satellite Navigation (SATNAV), Tactical Air Navigation (TACAN), Automatic Direction Finders (ADF), Distance Measuring Equipment (DME), Markers (MKR), Low Range Radio Altimeter (LRRR), Omega, Very Low Frequency (VLF), Inertial Navigation Systems (INS), Inertial Reference Systems (IRS), Microwave Landing Systems (MLS), Instrument Landing Systems (ILS). The Flight Management System (FMS) is covered under ARP 1570.
 - d. Weather Radar
3. APPLICABLE DOCUMENTS: The current revision of the following listed documents shall apply as specified herein or as a related reference document:
 - a. AS 264: Instrument and Cockpit Lighting for Transport Aircraft
 - b. ARP 268: Location and Actuation of Flight Deck Controls
 - c. AS 425: Abbreviations for Use in the Flight Deck
 - d. ARP 450: Flight Deck Visual, Audible and Tactile Signals
 - e. AS 580: Pilot Visibility from the Flight Deck - Design Objectives for Transport Aircraft
 - f. ARP 1068: Flight Deck Instrumentation Display and Associated Control Criteria for Transport Aircraft
 - g. ARP 1570: Flight Management System
 - h. ARP 1782: Color and Light Intensity Measurements for Direct View CRT
 - i. ARP 1874: Design Objectives for Electronic Displays in Transport Aircraft
 - j. AS 8034: Airborne Multi-Purpose Electronic Displays

4. DESIGN OBJECTIVES: Control and display equipment shall apply the following basic design objectives, taking into consideration the functions, their respective frequency of use and all aircraft operational and environmental conditions:
- a. Simplify operations.
 - b. Facilitate error-free operation.
 - c. Maximize crew situation awareness.
 - d. Minimize head down operation.
 - e. Provide consistency of operation for common functions.
 - f. Promote timely and accurate operations.
 - g. Ensure legibility of panel legends and displays throughout the wide range of flight deck ambient lighting conditions.
 - h. Ensure that single failures do not significantly degrade operational capability.

These design objectives, not necessarily in the order of importance, shall aim at minimizing flight crew workload.

5. GENERAL:

5.1 Definitions:

Primary: "Primary" indicates that the specified control and/or display must be readily accessible to that crew member to whom it is assigned while he is seated in his normal position with all required restraint harnesses normally required, including shoulder harness, if provided, with locking reel free.

Normal Position: For pilots "normal position" means that the pilot's seat is adjusted so as to bring the pilot to the design flight eye position (DFEP).

Accessible: For controls, "accessible" means that the control is within reach from the normal position and is capable of manual actuation by the crew member to whom it is assigned.

For instruments and displays "accessible" means that the instrument or display is unobstructed from sight of the crew member to whom it is assigned, and that it can be read or interpreted without undue strain or difficulty under the range of normal to emergency lighting conditions.

Secondary: "Secondary" indicates that operation of the specified control by the crew member to whom it is assigned may have some compromise regarding accessibility to that crew member.

- 5.2 Identification of Units: Where more than one control or display unit is installed, they should be designated as L, R, C. L refers to the Captain's side of the aircraft; R to the First Officer's side, and C to the center of the aircraft or to the auxiliary position. An alternative 1, 2, 3 designation respectively may be used.

Where other crew members are involved, it shall be so specified.

6. CONTROLS:

- 6.1 General: Controls should be designed to perform their intended function precisely, preclude overcontrol, yield predictable results, operate in consistent direction, and satisfy basic ergonomics (size, friction, torque and ease of use).

- 6.1.1 Location: Controls should be located so as to permit their use by the crew member to whom they are assigned while seated at the normal station with all required restraint harnesses normally secured, including shoulder harness, if provided, with locking reel free.

- 6.1.2 Priority: Control panels should be allocated space according to the following considerations:

- a. Frequency of use during high workload flight conditions
- b. Importance of timely and accurate operations
- c. Use by one or both pilots

In accordance with the considerations above, control panels should be allocated space in the following order of preference:

- a. Glareshield panel/Pilot's forward console or desk (if the priority system is common to both pilots, it should be allocated space in the glareshield).
- b. Forward pedestal
- c. Forward overhead
- d. Forward side panel
- e. Other locations

As a point of clarification, Forward is defined as any position in front of the design flight eye position. Additional details are discussed in ARP 1068, paragraph 3.3.

- 6.1.3 Functional Grouping: The controls of each individual piece of communication and navigation equipment which are functionally, and/or directly related shall be grouped together. Equipment not directly related by function can be remote.

6.1.4 Indicator Selection: Where a control is used to select between items of equipment to operate a single indicator, the following actuation applies:

LEFT for No. 1 equipment, or equipment normally connected to the Captain's displays; RIGHT for No. 2 equipment or equipment normally connected to the First Officer's displays.

6.1.5 Accessibility: Control panels shall be designed to provide ready and full accessibility to all controls located thereon.

6.1.6 Functional Partitioning: The control panel shall be designed in an orderly and functionally partitioned manner conducive to error-free operation.

6.1.7 Non-obscuring Operations: Normal operation of the controls shall not obscure the associated display from the operator's vision.

6.1.8 Proximity of Controls/Displays: The controls and the associated displays shall normally be co-located to the maximum extent possible. Where ease and precision of control are enhanced by remote location, deviation from this provision is acceptable.

6.1.9 Inadvertent Control Actuation: Controls shall be designed and arranged so that their operation does not cause accidental or unintentional disturbance of any other control setting. In addition, controls shall be located such as to minimize inadvertent actuation due to normal flight deck activity, i.e. entering/leaving crew station and meal service.

Particular attention should be given to accessibility and non-intrusive stowage of the headset, the hand-held microphone, the boom microphone, and the oxygen mask when the equipment is not in use.

6.1.10 Test Function: The operational control panels should not contain dedicated test function controls.

6.2 Control Devices: This document neither approves nor disapproves of any control device. However, the equipment manufacturer is cautioned on industry application standards for various control devices. Where no specific actuation or application guidance is provided, the general recommendations of ARP 268 shall apply.

6.2.1 Rotary Controls: When used for function control, the associated parameter shall increase when rotated clockwise (CW) and decrease when rotated counterclockwise (CCW). An ON-OFF function may be combined with a rotary control provided the OFF position is at the extreme CCW position and clearly identified by a distinguishable detent. When used for a function selection, the selected function shall be clearly indicated and the selector position shall be identified by a distinguishable detent. The face of the rotary control should be clearly marked to enhance the identification of the control position.

6.2.1 (Continued):

Where rotary controls are used in close proximity for dissimilar functions, they shall be distinguishable by tactile means.

6.2.2 Push Buttons: A push button control should not be utilized for the selection of more than a single function. Latching push button switches shall be "ON" when in the "IN" position and visually annunciated. Momentary push button switches shall be annunciated.

6.2.3 Levers and Slew Controls: Levers and slew controls shall increase the associated function when moved towards the up/forward position for vertical control application and to the right position for horizontal control application.

6.2.4 Toggle Controls: Toggle controls should be so designed that the actuation thereof FORWARD or UPWARD will turn on or increase the desired parameter. Whatever convention is selected for the pilot overhead panel, toggle control actuation shall be consistent.

6.2.5 Keyboards: All keyboard actuation shall be confirmed by tactile means.

Keyboards should have round keys for numerical data entry, square keys for alpha data entry, and rectangular keys for functional/operational data entry.

Numeric data entry keys should be organized with 1, 2, 3 on the top row, 4, 5, 6 on the second row, etc; a clear and unambiguous visual means of differentiating between alpha, numeric and operational keys shall be employed.

Alpha/numeric operational functions should not be combined. If combination is unavoidable, visual means to aid the crew in distinguishing the multifunction keys shall be provided.

6.2.6 Soft Key Controls: Where legends are under computer control, the legends shall be visually relatable to the switches providing the actuation function.

6.2.7 Touch Controls: Touch controls may be acceptable means of control provided that all applicable requirements of this ARP are met.

6.2.8 Remote Controls:

6.2.8.1 Cursor Control: Cursor control or other remote data input devices, when associated with an appropriate CRT or other display may be an acceptable means of control provided the requirements of this ARP are met and basic ergonomic factors are considered and employed. Where necessary, data to be entered by these controls should be displayed for validation prior to entry. If the data entered from such devices is common to more than one system, it should be simultaneously entered into all applicable systems.

- 6.2.8.2 Voice Recognition: Voice input may be an acceptable means of control provided that it has safeguards to preclude unintentional commands being introduced via normal flight deck conversation, incoming communications or extraneous sound energy sources. It should not unduly increase the flight deck noise level nor require special procedures for operation when oxygen mask is used. Acknowledgement to the pilot of voice inputs should be considered prior to actuation by a secondary command or manual means.
- 6.3 Dedicated Controls: In addition to the general design objectives specified in Paragraph 4 and the control guidelines in Paragraph 6.1 and 6.2 inclusive, the following specific design criteria will apply for the dedicated communications and navigation equipment listed.
- 6.3.1 Audio Controls:
- 6.3.1.1 Audio Selection Capability: The Captain and the First Officer shall each have an independent audio selection capability covering all voice communications and aural radio navigation equipment. Other crew members shall be provided with individual audio selectors as deemed necessary.
- The audio selector panels for the Captain and the First Officer shall be primary to the respective user and should be visible to the other pilot. The audio selectors shall enable the user to select any desired transmitter.
- The audio selectors shall have separate audio level controls for all systems. These level adjustments shall not affect the levels set by other crew members.
- The audio selectors shall provide means to enable the user to select aural information for his headset (and speaker, if installed) from any combination of receivers.
- 6.3.1.2 Ident Signal: A switch or automatic means should be provided to automatically decode and display audio ident signals. If this capability is not provided, as a minimum, a switch to select between audio ident/voice communication and the selection of voice communication only shall be provided.
- 6.3.1.3 Volume Control: It shall be possible to decrease volume with all audio volume controls to the point where no signal is audible. A preset working level volume shall be available where the transmitter is selected, and no visual means of displaying the volume level is provided.
- 6.3.1.4 PA and Interphones: The ability to utilize PA, as well as Flight, Cabin and Service interphones shall be provided from the boom, oxygen mask, and hand held microphones.

6.3.1.5 Oxygen Mask Microphone: Consideration should be given for the automatic selection of the oxygen mask microphone upon oxygen mask deployment.

6.3.1.6 Push to Talk Switch (PTT): A PTT switch shall be located on the outboard horn of each yoke or on each sidestick controller. In addition, there may be a PTT switch located in an area inboard of and forward of each pilot's reference eye position. An optional third PTT switch may be located on the outboard glareshield sub-panels or pilot's side panels.

An open mike should automatically be deactivated after an appropriate length of time and this condition shall be indicated to the pilots. If automatic deactivation is not provided, the open mike condition shall be clearly indicated.

Lack of transmitter output signal due to simultaneous transmission should also be annunciated.

6.3.1.7 Loud Speakers: If individual loud speakers are installed for crew members for the reception of aural communication and navigation signals, an ON-OFF and/or volume control means shall be provided for each.

Side tone and speaker muting shall be provided i.e., MIC-1 PTT muting SPKR-1 and MIC-2 PTT muting SPKR-2 except for Audio Warnings which should not be muted.

There shall be no undesirable interference between speakers when more than one is installed. However, all transmissions must be intelligible to both pilots throughout the full range of movement of the respective seats under all flight conditions.

6.3.2 Communication Equipment Control:

6.3.2.1 VHF Transceiver: Frequency selection capability shall be provided.

If a receiver requires squelch controls, the squelch shall be located adjacent to the frequency selector. Volume control shall be per paragraphs 6.3.1.1 and 6.3.1.3. Consideration should be given to the retention of the last active frequency to facilitate reselection and for the capability to preselect desired frequencies. In the case where automatic squelch control is provided, consideration should be given to providing a squelch disable function:

6.3.2.2 HF Transceiver: Controls for frequency and mode selections shall be provided. Squelch and volume control may also be provided.

Consideration should be given to the retention of the last active frequency to facilitate reselection and for the capability to preselect desired frequencies.

- 6.3.2.3 SELCAL/CALSEL: A SELCAL system may be installed for providing visual and aural annunciation of a radio call intended for the particular aircraft.

A CALSEL system may be installed for selective alerting of a ground station and if installed, aural feedback of the CALSEL actuation shall be provided.

The aural and visual annunciation provided for each receiver called shall conform to ARP 450 guidelines.

- 6.3.2.4 Flight, Cabin and Service Interphones and PA System: The selected microphone shall provide direct access to the selected interphone service or the PA system. This approach does not preclude the use of dedicated microphones for either service.

The capability may be provided for any flight deck station to call directly any or all service and cabin locations.

6.3.3 Navigation Equipment Control:

- 6.3.3.1 NAV Controls: Each receiver shall be provided with a frequency/channel selector that complies with the basic requirements in 4, 6.1 and 6.2. Selection of a VOR or ILS localizer frequency or an MLS channel shall set the paired DME/Glideslope or precision DME where provided. This does not preclude the possible use of separate VOR/DME equipment which provides manual pairing capability. DME "HOLD" function capability is discouraged.

Each VHF navigation receiver shall be provided with both automatic and manual individual means for selecting a desired course.

Each MLS receiver shall be provided with both automatic and manual means for selecting elevation (glideslope) and azimuth angles.

Where two navigation receivers are used, the No. 1 receiver shall be connected to the Captain's navigation instruments and the No. 2 shall be connected to the First Officer's navigation instruments. A switching arrangement for each crew member's indicator may be used. Each crew member for whom switching is provided shall have an independent means of connecting his navigation instruments to either receiver and also be provided with a display clearly indicating which receiver is being displayed on his navigation instruments.

The controls providing the capabilities discussed above shall be primary to the crew member whose instrument is being controlled.

6.3.3.2 ADF Controls: Each receiver shall be provided with a frequency selector that complies with the requirements in 4 and 6.1.

The receiver control panel shall provide for selecting the various functions of the receiver, including an "OFF" position if desired. These controls shall be located as specified in 6.1.

Consideration should be given to the retention of the last active frequency to facilitate reselection and for the capability to preselect desired frequencies.

6.3.3.3 Marker Beacon Controls: Where two sensitivities are provided they shall be referred to as High and Low. The Low sensitivity shall be used where only one is provided. The receiver shall always be active, i.e., no "off" position shall be provided. The audio shall be provided with an ON/OFF switch.

6.3.3.4 INS Controls: The INS should provide dedicated panel(s) to control the following system functions:

- a. Alignment and Attitude/Heading reference data (Mode Selector).
- b. Navigation and System Status.

The design and operation of the control panel shall comply with the basic requirements contained in paragraphs 4, 6.1, 6.2 and other sections of 6.3 of this document. In addition, the control panel shall be capable of controlling and displaying navigation and system status information during all phases of flight.

6.3.3.5 Omega/VLF, VLF/Omega and SATNAV: Omega/VLF, VLF/Omega and SATNAV controls should comply with paragraph 6.3.3.4 (above) with the exception that they will control system initialization as opposed to system alignment and Attitude/Heading reference data.

6.3.4 Weather Radar Controls: Means of selecting up to 6 display ranges should be provided in nautical miles. Ranges selectable shall be a multiple of 2 consecutively increasing from the lowest selectable range. A tilt control referenced to the inertial horizon or flight path angle shall be provided.

6.3.5 Data Link Control: Controls shall be provided for pilot authorization of air ground air data link communication systems including satellite systems with both manual and automatic modes. Systems included under this generic heading are ATC transponders, Mode S, and Company and ATC data link communication systems.

6.3.5.1 ATC Transponder Controls: The ATC transponder shall be automatically ON during flight and automatically OFF on the ground. A manual override capability shall be provided. Means shall be provided to select and annunciate any one of 4,096 discrete codes for ATC use.

6.3.5.1 (Continued):

Means shall be provided for the ON/OFF selection of Mode C.

Means shall be provided for pilot actuation of the ident feature in response to ATC request.

Means shall be provided to indicate transponder failure. All controls should be readily accessible to the flight crew.

6.3.5.2 Data Link Communications System Controls: Data link for ATC communications is considered to be a "Primary Data Link" system and data link for company communications is considered to be a "Secondary Data Link" system.

For a primary data link system, the controls shall be readily accessible to Captain and First Officer from their normal operating position.

For a secondary data link system, the controls shall be readily accessible to any one flight crew member.

The data link control unit should preferably be combined with a display unit, i.e., a control and display unit (CDU).

Selection of frequently used, routine communications should be provided via menu drivers.

Immediate access standby voice communication must be provided in case the crew is unwilling or unable to comply with ATC directives by Data Link.

All ATC Data Link messages must be acknowledged.

If automatic tuning of data link and/or voice frequencies is utilized, the autotuned frequency shall be displayed and autotune failure shall be annunciated. For ATC and company data link, automatic tuning is preferred.

6.4 Integrated Controls: Integration of controls and displays for communications and navigation equipment is desirable. The following guidelines must be considered as basic requirements when integration of systems is proposed. The overlying requirement is for increased efficiency of operation without undue increase in complexity of handling characteristics.

- a. Improved accessibility.
- b. Reduced workload.
- c. Operational flexibility.
- d. Compatibility with other flight deck control and display units.