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Human Engineering Recommendations for Data Link Systems

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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FOREWORD

The following members of the G-10K, Flight Deck Information Management Subcommittee, made significant contributions to the development of this document:

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1. SCOPE:

This document sets forth general, functional, procedural, and design criteria and recommendations concerning human engineering of data link systems. The recommendations are based on limited evidence from empirical and analytic studies of simulated data link communication, and on experience from operational tests and actual use of data link. However, because data are not yet available to support recommendations on all potentially critical human engineering issues these recommendations necessarily go beyond the data link research and include requirements based on related research and human factors engineering practice. It is also recognized that evolution of these recommendations will be appropriate as experience with data link accumulates and new applications are implemented.

1. (Continued):

This document focuses primarily on recommendations for data link communications between an air traffic specialist and a pilot, i.e., air traffic services communications, although some recommendations address use of data link for flight information services. Unless otherwise specified within the text, all recommendations apply to both flight deck and ground-based data link systems.

This document is intended as a guide for development and evaluation of data link systems. Human engineering considerations are an important element of data link system performance. As illustrated in Figure 1, human engineering recommendations address many component functions required for effective data link communication services in the operational environment. For presentation purposes, the recommendations are divided into five sections: General, functional, procedures, flight deck/air traffic service (ATS) workstation integration, and human-computer interface. To facilitate understanding and use of this document appropriate cross-references to interrelated recommendations appear in parentheses throughout the text.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of all SAE, FAA, RTCA, and ICAO documents shall apply. The documents are generally applicable to the subjects of flight deck and ATS workstation integration, human interface design, and procedures for data link. Appendix A contains a list of references that provide detailed support for the requirements.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS425C	Nomenclature and Abbreviations for Use on the Flight Deck
ARP4102/6	Communication and Navigation Equipment
ARP4101/2	Pilot Visibility from the Flight Deck
ARP4102/8	Flight Deck, Head-Up Displays
AIR1093	Numerical, Letter, and Symbol Dimensions for Aircraft Instrument Displays
ARP1782	Photometric and Calorimetric Measurement Procedures for Airborne Direct View CRT
ARP4032	Human Engineering Considerations in the Application of Color to Electronic Aircraft Displays
ARP4101	Flight Deck Layout & Facilities
ARP4102	Flight Deck Panels, Controls, and Displays
ARP4102/4	Flight Deck Alerting Systems
ARP4102/6	Communication and Navigation Equipment
ARP4102/7	Electronic Displays
AS8034	Minimum Performance Standard for Airborne Multipurpose Electronic Displays
ARD50027	Human Engineering Issues for Data Link Systems

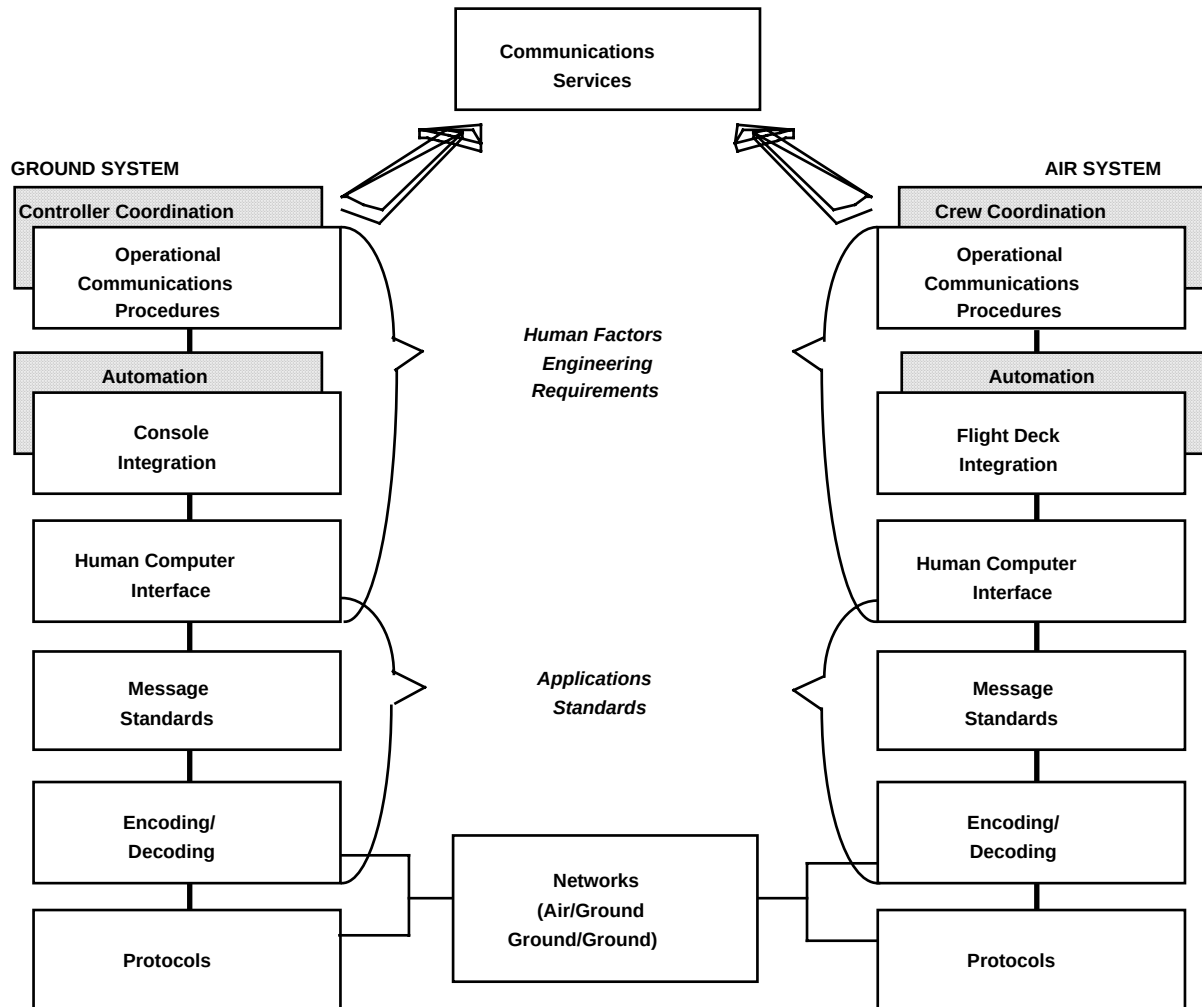


FIGURE 1 - Human Engineering Requirements in the Context of General Functional Requirements for Data Link Communication

- 2.1.2 FAA Publications: Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591.

FAA Order 7110.65	Air Traffic Control
FAA Order 7110.83	Oceanic Air Traffic Control
FAA-RD-81-38	Aircraft Alerting System Standardization Study: Volumes I, II, and III
FAA-AP-1992-2287	FAA Advanced Automation System Controller Interaction and Task Analysis: Volume I
FAA-ER-130-006	Display System Replacement System Specification
FAA-AC-20..DC (Draft)	Guidelines for Airworthiness Approval of Airborne Data Link Systems and Applications
FAA-AC-120.COM (Draft)	Interim Air Carrier Operational Approval for Use of Data Link, SATCOM, and Other Communication Systems Other Than Conventional VHF/HF Voice Systems

- 2.1.3 RTCA Publications: Available from RTCA, 1140 Connecticut Avenue, NW, Suite 1020, Washington, DC 20036.

RTCA DO-219	Minimum Operational Performance Standard for Two-Way Data Link Communications
RTCA (Draft)	Minimum Operational Performance Standards for Flight Information Service Data Link Request/Reply Communications
RTCA DO-212	Minimum Operational Performance Standards for Airborne Automatic Dependent Surveillance (ADS) Equipment

- 2.1.4 ICAO Publications: Available from ICAO, 1000 Sherbrooke Street West, Montreal Quebec, Canada H3A-2R2.

ICAO (Draft)	ICAO Manual of Air Traffic Services Data Link Applications
ICAO Circular 216	Fundamental Human Factors Concepts
ICAO Circular 234	Operational Implications of Automation in Advanced Technology Flight Decks
ICAO Circular 249	Human Factors in CNS/ATM Systems

2.2 Definitions:

ATS MESSAGE: A clearance or flight plan message. Included in this category are strategic messages associated with establishing the initial ATS clearance (user flight plan) and messages associated with revisions to the initial clearance. Also included in this category are tactical messages such as: (1) horizontal, vertical, or speed/time/delay instructions, (2) procedure-based instructions (instrument approach procedure), and (3) traffic and urgent advisories.

BROADCAST VERSUS DISCRETE ADDRESSED COMMUNICATIONS SERVICES: Broadcast services are carried over free-radiating media which transfer information intended for simultaneous receipt by multiple users; in contrast, discrete addressed services are carried over media which direct information between specific pairs of users.

2.2 (Continued):

COMMUNICATION TRANSACTION: The cycle of ground- and air-initiated messages required for the full handshake that constitutes an information exchange between ground and airborne ATS system elements. The transaction cycles vary according to message types. For air traffic specialist-pilot communications, a typical cycle begins with message transmission and concludes with the return, to the sender, of an acknowledgment or reply from the intended receiver.

DATA LINK SYSTEM: Digital telecommunications capability which supports communication between airborne and ground-based computers and their operators.

END-SYSTEM: System which originates a message or is designated as the recipient of a message.

FLIGHT INFORMATION MESSAGE: An informational message that does not imply any change in operating behavior on the part of the pilot or the controller. Information messages are generally not time-critical. Included in this category are routine weather observations and forecasts, reports on the status of facilities and equipment, and routine position reports.

OPERATOR: Term that refers to the human responsible for handling data link communications. In actual operations, the operator could be an aircraft flight crew member or an air traffic specialist staffing an en route, terminal, tower, or oceanic operational position.

SUBNETWORK: One of the interoperable communications networks, such as HF, VHF, satellite, or Mode S Secondary Radar, that will support aeronautical data communications.

3. GENERAL REQUIREMENTS:

Included in this section are ATS system-level requirements that must be supported during and after the transition to data link as a supplementary or primary communication system. They address safety-related concerns and concerns that arise from transitional stages of implementation in which aircraft and ground systems may have varying levels of data link capabilities.

- 3.1 Safety is a function of the interaction of numerous factors, including communication, navigation, and surveillance systems; flight crews; air traffic specialists; and the operating environment. There shall be no reduction in the overall level of safety related to the use of data communications as measured by testing and operational evaluation. After implementation, the level of safety shall continue to be monitored through means such as the "Aviation Safety Reporting System" and other safety data reporting sources (5.1, 5.2, 5.7, 6.1, 6.2, 6.8).
- 3.2 Some means shall be available for urgent communications. A backup means of communication shall be provided and procedures shall be maintained for cases where no communications are available (4.12, 5.1, 5.13, 7.2.6).
- 3.3 The traffic and obstacle separation environment shall allow safe recovery from response delays, nonresponse or unable responses, data link failures, and other data link management errors, to at least match the current level of safety (4.4, 4.6, 4.19, 5.1, 5.10, 5.13, 7.2.1, 7.2.2, 7.2.6, 7.4.3).

- 3.4 To the extent that data link system performance can vary based on subnetwork performance and message urgency attributes (see RTCA DO-219), it is important that data link messages are reviewed in sequence. Furthermore, the sequence must be based on the time at which the message was sent. If a data link system detects an out of sequence situation, the receiver should be notified of the problem and the situation should be clarified as soon as possible (4.5, 4.6, 4.12, 4.14, 4.16, 4.15, 7.7.8).
- 3.5 Party line communications in the voice environment currently provide information used by pilots for situation awareness. In a data link environment, some means shall be provided to compensate for the loss of party line information without placing additional demands on pilots or on air traffic specialists. For example, the data link system should be used to enhance or partially replace party line as a source of information on weather and traffic information. This could include windshear, convective activity, turbulence, aircraft positions, and traffic flow management information such as congestion reports, or holding and speed restrictions (5.11).
- 3.6 Information about risk levels, controller workload, traffic densities, request urgency, and other aspects of the situation can be inferred from characteristics of voice communications and should be available in the data link environment as appropriate to the application. For example, an indication of sector workload may be provided. To the extent that such inferences are valid and useful, safety and efficiency should not be compromised due to the unavailability of such information.
- 3.7 Data link transmission of weather information must be timely and reliable. Transmission must not be subject to delays or nontransmission due to air traffic specialist workload, unavailability of weather personnel, or other factors. Flight crews must be notified as soon as possible of critical weather conditions which may affect them. Immediate notification of known windshear, microburst, visibility minima, crosswinds, or other automatically derived critical weather information may require a direct channel from weather sensing/processing systems to the aircraft. The air traffic specialist should have the same weather information available in order to maintain awareness of pilot constraints (7.6.1).
- 3.8 Air traffic specialists must be notified of advisories or other hazardous weather information that is broadcast over a data link channel automatically and may affect their operation. A means for air traffic specialist review of recently transmitted broadcast messages shall be available (7.6.1).
- 3.9 The system shall facilitate the air traffic specialist's ability to communicate with each aircraft and the pilot's ability to communicate with each ATS facility in the most appropriate mode (voice or data link) and using the data link capabilities most appropriate for a particular aircraft or facility. The system shall indicate to the air traffic specialist and pilot what mode of communication is available and which capabilities are appropriate (5.1, 7.2.1, 7.2.3).
- 3.10 The system should be developed to minimize undue complication due to specific mixes of equipment and services (5.9, 6.16).
- 3.11 Differences in the air traffic specialist's management of communications information and related tasks for equipped and unequipped aircraft should be minimized (5.2, 5.4, 5.9, 6.1, 6.5, 6.13, 7.2.4).