Initial Requirements Document
for
Controller Pilot Data Link Communications (CPDLC) Service

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06/22/98

1. BACKGROUND

As stated in the Mission Need Statement (MNS) 042 for the Aeronautical Data Link System (ADLS) dated April 23, 1991, the Federal Aviation Administration (FAA) has established an operational plan for the Air Traffic Management (ATM) system of the twenty-first century. In order to realize the Communications, Navigation, and Surveillance/Air Traffic Management (CNS/ATM) system, the National Airspace System (NAS) will rely increasingly on advanced capabilities provided by ground and airborne automation systems. This will require timely and accurate communication and management of information concerning flight, navigation, and surveillance data in all operational domains. In the future ATM environment it will no longer be possible to rely exclusively on voice messages for the exchange of information. Transition from voice for pilot-controller communications to a mixture of voice and data communications has been identified as a key goal for Air Traffic Control (ATC).

This document focuses on data communications service requirements for the Controller Pilot Data Link Communications (CPDLC) portion of the Operational Requirements for the ADLS document dated January 3, 1995. The initial implementation of CPDLC includes en route and terminal air traffic operations, with the tower operations considered for later transition.

The goal of the CPDLC project is to provide a means of data communications in ATC operations which will be a supplement to air/ground voice communications. This addition of data communications will support improvements in airspace use and capacity. Data communications will:

- Provide for a more dynamic and efficient air/ground information exchange mechanism
- Provide an additional means of communication between pilots and controllers
- Reduce congestion on the voice channels
- Reduce operational errors resulting from misunderstood instructions and readback errors

Implementation of CPDLC will be evolutionary, facilitating early delivery of user benefits and provide an orderly transition to the use of more advanced equipment and integration with the future NAS Architecture, version 3.0, dated December 1997.

2. Operational Concept

2.1 Operations

CPDLC is envisioned to evolve into digital messaging that will take on an ever increasing role in controller to pilot communications, contributing significantly to the efficiency, effectiveness, and safety of the NAS. The evolution of Aeronautical Data Link (ADL) in the operational environment will be based upon the incremental implementation of new communication technologies. CPDLC represents the first phase of the transition from the current analog voice system to an International Civil Aviation Organization (ICAO) compliant system in which digital communication becomes the alternate and perhaps primary method of routine communication. Although plans for ADL include automation-to-automation dialog, as well as the automatic up and downlink of flight information for use by both ground and airborne systems, this operational concept deals specifically with CPDLC in the domestic enroute and Arrival/Departure Control (ADCON) domains. CPDLC focuses on moving a subset of pilot controller voice messages to data messages. (For a comprehensive view of the role of the mature ADLS, refer to the Air Traffic Service (*ATS) Concept of Operations for the National Airspace System in 2005*, and *Joint Government/Industry Operational Concept for the Evolution of Free Flight*.)

CPDLC capabilities will be fully integrated into the future controller workstations. In the contiguous NAS (excluding oceanic, offshore, and remote airspace), voice communication between controllers and pilots is the primary means of communication for the foreseeable future. CPDLC will provide an additional means for two way exchange between controllers and pilots for ATC clearances, requests, instructions and pilot reports. Information exchange between the air and the ground will become more robust due to the added clearance and instruction delivery capabilities provided by CPDLC service. As experience is gained, routine communications will be increasingly handled by CPDLC for appropriately equipped users. More information will be uplinked to the cockpit allowing for better strategic and tactical route and altitude planning.

Note: Within the context of this document, the ATC functions of the Tactical controller and the Associate Tactical controller directly correlate with the ICAO defined functions of "Executive" and "Planning" controllers respectively.

2.1.1 Air Traffic Service Provider Concept

An Air Traffic Service Provider Concept (ATSP) Team consists of a Tactical Controller, an Associate Tactical Controller, and an Area Coordinator. Each member of the ATSP team will be able to, via CPDLC, send messages to an aircraft, and view messages received from an aircraft. The CPDLC message set consists of several hundred messages, including Uplink Messages (UM) and Downlink Messages (DM). Implementation plans call for only a small number of CPDLC messages to be available at any single ATC position. This small subset of the full CPDLC message set will be tailored to specific operational needs at the ATC position (sector) through facility procedures and local adaptation. Because of the significantly different operations found in various types of ATC sectors, the larger message set is necessary to support operational ATC needs.

Human factors concerns have shown that it is unrealistic to expect controllers, and pilots also, to access large message sets in order to select messages. Likewise, controllers will not have to select message set elements for combining as this will be done in the pre-selected message menu made available at individual ATC positions.

2.1.2 Airborne/Flight Crew Concept

As the NAS evolves into a more digital environment, CPDLC will provide pilots with more flexibility in accessing arrival, departure, and routing information. Airborne avionics will include hardware and software required to receive, display, and acknowledge received messages and compose and transmit data link messages to the controller.

2.1.3 Operational Scenario

This section presents a concept of end-to-end CPDLC communications sequence between air traffic controllers and pilots . Initial implementation will involve a small number of CPDLC messages, increasing in phases to a state where controllers and pilots have access to a wide range of these messages. Scenario:

ABC123 is a domestic air carrier flight, departing Washington, DC to Chicago.

When ABC123 is ready for departure, the pilot initiates a data link connection via the Context Management Application (CMA). The downlink includes: aircraft flight identification, departure airport, destination airport, and estimated time of departure. This results in the correlation of the flight with the appropriate filed flight plan stored in the ground flight data processing system. Although CMA is necessary to initiate CPDLC, it is not a CPDLC application.

In order to initiate CPDLC, either the pilot sends a downlink request or the controller sends an uplink to the aircraft. Either of these actions creates a session, or connection, between the cockpit avionics and the controller position having current ATC authority for ABC123.

The pilot requests a departure clearance, known today as Pre-Departure Clearance, using message element DM#25 “REQUEST DEPARTURE CLEARANCE”. The controller responds with UM#73, which is the route details of the clearance.

After ABC123 departs, the routine communication for initial altitude restrictions and Transfer of Communications (TOC) between the ADCON controllers and the flight crew is delivered by CPDLC. Some of the message elements used in these communications are: UM#20 “CLIMB TO [xxx]”, UM#74 “PROCEED DIRECT TO [xxx]”, UM#120 “MONITOR [facility] [frequency]”. The flight transitions to the en route controller, where the flight crew checks in by entering the assigned altitude issued by the ADCON controller and downlinking it to the en route sector that has control of the flight. The downlinked assigned altitude, DM#38, “ASSIGNED LEVEL [xxx]” is automatically compared to the interim altitude contained in the HOST flight plan, and a discrepancy is noted. This discrepancy is presented to the tactical controller, who then sends a data link message to the aircraft with the correct altitude.

Later in the flight, ABC123 encounters moderate turbulence at the currently assigned altitude. The pilot requests a climb to a new altitude by selecting DM#6, "REQUEST [xxx]" from a menu on the cockpit display and inputting the requested altitude value. After entry, the pilot transmits the message to the controller.

The tactical controller receives the downlinked request and submits the request to a conflict probe. The tactical controller notes that the climb would result in a possible separation conflict within the next sector, and as a result, sends back UM#1, "STANDBY" as a response. The tactical controller directs the associate tactical controller to initiate coordination of the pilot's climb request with the next sector.

While the Associate Tactical controller is effecting this coordination, ABC123 encounters severe turbulence. The pilot uses voice communications to inform the tactical controller of the severe turbulence, and requests an immediate climb to the altitude requested in the data link message. The tactical controller issues a voice clearance approving the climb to the requested altitude. The associate tactical controller completes the coordination with the next sector, notes that the tactical controller had issued a voice altitude clearance, and closes the pending downlink by uplinking a matching altitude clearance.

As ABC123 approaches 250 nautical miles from its destination, the controller uplinks UM#232 "STATE TOP OF DESCENT". On the flight deck, the crew is alerted to the arrival of the message, which they then review and query the Flight Management System (FMS). The flight crew responds with DM#110, "TOP OF DESCENT [xxx]". The controller observes the top of descent point and uplinks UM#25, "AT [xxx] DESCEND TO [xxx]". Upon receipt, the pilot downlinks DM#0,Will Comply - "WILCO", which closes the transaction.

ABC123 begins descent to the airport at the prescribed point and the en route controller sends a TOC message for ABC123 to the ADCON facility. Upon receipt and WILCO of the TOC message, the flight crew monitors the ADCON radio channel, and sends a downlink message to the new controller indicating the transfer is complete. ABC123 receives an initial set of predefined arrival instructions for the expected approach that ABC123 will execute using a combined message consisting of UM#190, UM#23, and UM#99 "FLY HEADING [xxx], DESCEND TO [xxx], EXPECT [procedure name]".

During this period, the Tactical controller has continued using a combination of voice and CPDLC communication with all aircraft to fine tune the sequence of arrivals. As ABC123 enters the main flow, and cockpit and controller workload increases, CPDLC messages become less the norm, as the timeliness of voice instructions is required to maintain minimum separation.

The final CPDLC message uplinked and acknowledged by ABC123 is UM#81, "CLEARED [procedure name]", the clearance for the approach and the TOC to the tower controller.

2.2 Maintenance

2.2.1 Hardware Maintenance

Maintenance support for CPDLC will be in accordance with FAA Order 6000.30, *Policy for Maintenance of the NAS through the Year 2000*, which details a two-level maintenance philosophy; field and depot. This concept assumes the use of modular designed equipment, which enables field level personnel to correct equipment failures on-site by replacing the failed Line Replaceable Unit (LRU). Field level maintenance consists of all maintenance activities performed on equipment installed in its operating environment and includes both periodic and corrective maintenance actions and the installation of authorized Electronic Equipment Modifications (EEMs). Depot level maintenance consists of the repair of failed LRUs shipped from the site to the depot repair facility. A decision for Federal Aviation Administration Logistics Center (FAALC) repair, vendor repair or discard, will be determined in accordance with FAA approved analytical methodologies.

CPDLC will provide an integrated logistics support infrastructure as required by the NAS Integrated Logistics Support (NAILS) requirement as defined in FAA Order 1800.58, NAS Integrated Logistics Policy.

Remote monitoring and control data will be provided by CPDLC System.

2.2.2 Software Maintenance

Software modifications, proposed by the vendor, beyond what was approved by the FAA during software product baseline will be approved and tested by the designated FAA operational support organization during the life-cycle of the system.

2.2.3 Second Level Engineering Support

Second Level Engineering support will be provided for both hardware and software. Both support infrastructures will be integrated and consistent with support strategies established for existing services/systems.

2.3 Quantities and Location

Quantities and locations will be determined during investment analysis.

2.4 Schedule Constraints

Project Events and Completion dates:

The following project milestones have been established in the NAS Architecture Version 3.0:

Initial Operational Capability (IOC) for En Route services	2002
Initial Operational Capability (IOC) for Terminal services	2005

3. PERFORMANCE REQUIREMENTS

3.1 Standards

3.1.1 International Compliance

The system shall comply with ICAO Standards and Recommended Practices SARPs, Aeronautical Telecommunications, Annex 10 to the Convention on International Civil Aviation, Volume III, Part I, *Digital Communication Systems*, Chapter 3, *Aeronautical Telecommunication Network (ATN)*.

3.1.2 Ground System (Key Parameter)

Ground systems supporting CPDLC service shall comply with ICAO 9705-AN/956, *Manual of Technical Provisions for the Aeronautical Telecommunication Network,* class VII operation (section 2.3.8).

Note: The requirements for CPDLC that follow are for domestic implementation within the NAS. The SARPs contain general requirements with optional requirements and performance parameters to be determined by each participating authority.

3.2 Operational Performance

3.2.1 User Identification

Note: In any data link dialogue the end-user must be able to positively identify the other end-user. The ICAO standard for an aircraft is a 24 bit address and a 4 to 8 character identifier for a ground system. The 24 bit address can be mapped to an aircraft Identification (ID).

3.2.1.1 Air-to-Ground Messages (Key Parameter)

The ground system shall identify to the controller the originating party of all received Air-to-Ground messages as a flight ID.

3.2.1.2 Ground-Ground Messages (Key Parameter)

The ground system shall indicate to the controller the originating party of all received Ground-Ground messages as a 4 to 8 character facility ID with reference to the associated flight ID.

3.2.2 Link Termination

3.2.2.1 CPDLC Termination Notification (Key Parameter)

The ground system shall inform the eligible controller* of each CPDLC link termination.

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* See Appendix B for definition

3.2.2.2 Termination of Current Data Authority (Key Parameter)

The ground system shall provide the capability for normal termination* of the CPDLC link.

3.2.2.3 Termination of Link without Next Data Authority (Key Parameter)

The ground system shall, upon normal link termination when DMs are outstanding and without Next Data Authority (NDA) specified, send UM #0 "UNABLE" to each of the outstanding DMs and continue termination of link.

3.2.2.4 CPDLC Service Failure Notification

In the event an unexpected CPDLC service termination is detected , both the pilot and controller shall be notified by the CPDLC system of the failure.

Note: Message sent to controller and pilot(s) informing them that they are no longer connected.

3.2.2.5 Outstanding Uplink Messages

Upon termination of CPDLC, when CPDLC UMs are outstanding*, the ground system shall:

a) inform the controller of outstanding CPDLC messages (regardless of the source);
b) allow the controller to delete messages, and;
c) continue termination of CPDLC upon controller input.

3.2.2.6 Addressing

The CPDLC system shall allow the controller to select the recipient of UMs.

3.2.2.7 Pre-Determined Uplink Messages Set

CPDLC service shall provide controllers the capability to initiate a data link UM using a pre-determined message set in accordance with appendix D.

3.3 Functional Performance

3.3.1 Link Establishment

3.3.1.1 Context Management Application (Key Parameter)

CMA service shall comply with ICAO ATN SARPs class II operation (section 2.1.8).

3.3.1.2 Context Management Application Request Message (Key Parameter)

The ground system shall use the following to associate CMA Context Management-Logon-request messages with a flight plan:

a) Flight ID

* See Appendix B for definition

b) Departure Airport
c) Destination Airport
d) Estimated Off Block Time

3.3.1.3 Ground System Logon

The ground system shall reject any CMA Context Management-Logon-request message not containing:

a) Flight ID
b) Departure Airport
c) Destination Airport
d) Estimated Off Block Time

3.3.1.4 Data Link Eligibility (Key Parameter)

Only one sector shall be eligible to send data link messages to an aircraft at any given time, within the ATC facility with CPDLC eligibility.

3.3.1.5 Eligibility Transfer (Key Parameter)

The ground system shall provide for transfer of CPDLC eligibility between ATC sector control positions.

Note: This is defined as between and within Air Traffic (AT) facilities.

3.3.1.6 Outstanding Downlink Messages

Upon initiated termination of CPDLC, outstanding DMs shall be forwarded to the next sector control position.

3.3.1.7 Message Response Attributes

Any message that is considered a response message (i.e., it contains a message reference number) shall have message urgency and alert attributes not less than the message to which it refers.

3.3.1.8 Logical Acknowledgment Response

The ground system shall prohibit the use of messages requiring a Logical Acknowledgment (LACK) in accordance with 2.3.7 of ATN SARPs.

3.3.1.9 Pre-Determined Downlink Messages

The ground system shall receive, store, process and display DMs received from aircraft in accordance with appendix E.

3.3.1.10 Pre-Determined Response Messages

The ground system shall automatically provide a positive, negative, stand-by, and clearance message, as appropriate, for controller use in responding to DMs listed in appendix F.

Note: "Automatically" is a key word that explains that the system will present a window of response messages appropriate to the received message without any

action on the part of the controller. "Appropriate" applies to the response messages that correspond to a particular dm. Not all messages are used with each DM that is received.

3.3.1.11 Service Unavailable

The ground system shall respond '*Service Unavailable'* to any received messages from the SARPs message set not contained in appendix E.

3.3.1.12 Messages Received Out of Order (Key Parameter)

The ground system shall indicate to the controller when messages are received out of order for a given link.

3.3.1.13 Message Errors (Key Parameter)

The CPDLC system shall detect errors contained in received messages and notify end users of the type error that occurred.

Note: When an error is detected in a received message, a response message indicating an error and providing the reason for the error will be sent by the system without controller initiation. This requirement is exclusive of errors in the error message, which will cause the system not to respond.

3.3.1.14 Local Message Errors

The ground system shall indicate to the controller when a local error is encountered during the processing of an UM.

3.3.1.15 Handling of Error in Error message

The ground system shall detect, discard, and indicate to the controller when message DM #62, as defined in the ATN SARPs, is received containing errors.

Note: The ground system is prohibited from responding to any DM #62 message containing an error.

3.3.1.16 Display of Time Stamp

The ground system shall display to the controller the time portion Hours/Hours/Minutes/ Minutes/Seconds/Seconds (HHMMSS) of the time stamp contained within the received message.

3.3.1.17 Archiving Messages

The ground system shall archive all CPDLC messages in accordance with FAA Order 7210.3, *Facility Operations and Administration*.

3.4 Technical Performance

CPDLC shall be classified an essential service* as defined in FAA NAS SR-1000.

3.4.1 Link Quality

A declaration of error shall be made by the ground system to NAS infrastructure management system when the link quality degrades below the ICAO SARPs, Amendment #73 ICAO, Annex 10, volume III.

3.4.2 Throughput Efficiency

Throughput Efficiency (TE) shall be equal to or greater than 0.90 measured by dividing the number of messages successfully receiving communication acknowledgment by the number of messages transmitted.

3.4.3 Data Error Rate

CPDLC service data error rate shall be compliant with ICAO SARPs, Annex 10 Vol. III, part 1, par. 6.3.4.1.

3.4.4 Electrostatic Discharge

CPDLC ground equipment shall meet Electrostatic Discharge (ESD) requirements referenced in International Electrotechnical Commission (IEC) 1000-2, *Testing and Measurement Techniques*, section 2: *Electrostatic Discharge Immunity Testing*, IEC 1000-4, *Electrical Fast Transient/Burst Immunity Test*, IEC 61000-4-2, *Electromagnetic Compatibility* Part 4: *Testing and Measurement Techniques*, Section 2: *Electrostatic Discharge Immunity Test* , MIL-STD-1686, *Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment*, and MIL-HDBK-263, *Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment*.

3.4.5 Electromagnetic Compatibility

CPDLC ground equipment shall meet electromagnetic compatibility requirements referenced in MIL-HDBK-237A, *Electromagnetic Compatibility Management Guide for Platform, Systems, and Equipment*.

3.4.6 Mean Time Between Failure

CPDLC ground hardware and firmware shall have a Mean Time Between Failure (MTBF) equal to or greater than 26,280 operational hours.

3.4.7 Mean Time to Restore

The CPDLC ground hardware Mean Time To Restore (MTTR), as defined by FAA Order 6040.15, *National Airspace Performance Reporting System*, par. 702f, shall be less than or equal to 0.5 hours.

3.4.8 Availability

* See Thresholds and Objectives matrix, appendix H

3.4.8.1 Service Availability

Communications service availability provided by CPDLC, as defined by FAA Order 6040.15, *National Airspace Performance Reporting System*, par. 702c, shall be 0.999 or greater in accordance with FAA-NAS-SS-1000, Volume I, par. 3.2.1.2.8.1g.

3.4.8.2 Equipment Availability

CPDLC ground system equipment shall have an inherent availability of 0.999 or greater.

3.4.8.3 Single Point of Failure

No single point of failure of the CPDLC ground system shall cause a loss of service outage for more than 10 minutes.

3.4.9 Transfer Delay Limits

CPDLC system shall provide the following levels of end-to-end transfer delay performance in the indicated domains:

Domain	Mean End-to-End Transfer Delay	95% End-to-End Transfer Delay	99.996% End-to-End Transfer Delay
Terminal	5 sec	8 sec	12.5 sec
En Route	10 sec	15 sec	22 sec

Table 3.1 Levels of performance

3.4.10 CPDLC Message Exchange Rates Per Aircraft

The CPDLC system shall support the following minimum message capacity within the indicated domain:

	En Route	Terminal
Uplink Messages/ No LACKs Required	5-7 per Sector 1 Route Clearance, 1 Contact Message, 1 NDA Message, 1-2 Altitude Messages 1-2 Standby/ Deferred/ Unable Messages	3-7 per Sector 1 Contact Message, 1 NDA Message, 1-3 Approach Instructions, 1-2 Standby/ Deferred/ Unable Messages
Downlink Messages/ No LACKs Required	4-6 per Sector Responses to above, Plus 1-2 Requests	3-6 per Sector Responses to above, Plus 1-2 Requests

Table 3-2. Per Aircraft Exchange Rates Expected for CPDLC Messages

3.4.11 Number of Aircraft Supported

The CPDLC system shall be capable of providing CPDLC service to a minimum of 1250 aircraft, per facility, at any given time.

4. Physical Integration

Note: Physical integration of CPDLC will be planned to ensure minimal disruption to Airways Facilities (AF) and AT operations.

4.1 Real Estate

FAA CPDLC ground system equipment shall be integrated into existing Air Traffic (AT) facilities.

4.2 Space

FAA CPDLC ground system equipment, when installed, shall comply with section 6.2 of the National Fire Protection Association Standard 70, National Electric Code, to provide sufficient space (clearance) to safely access and maintain the system.

4.3 Environmental

FAA CPDLC ground system equipment shall comply with Executive Order 12088, *Federal Compliance with Pollution Control Standards*, and Executive Order 12873, *Federal Acquisition, Recycling, Waste Prevention*, Code of Federal Regulations (CFR), Title 40, *Environmental Protection*.

4.4 Energy Conservation

FAA CPDLC ground system equipment shall meet the requirements of Executive Order 12902, *Energy Efficiency and Conservation at Federal Facilities*, Energy Policy Act of 1992.

4.5 Heating, Ventilation, and Air Conditioning

4.5.1 Equipment Operating Environment

FAA CPDLC ground system equipment shall be designed to meet the non-operating and operating environment requirements defined in FAA-G-2100, paragraph 3.2.1.2.4 and table III, *Electronics Equipment, General Requirements*.

4.5.2 Impact on Equipment Operating Environment

FAA CPDLC ground system equipment shall operate without requiring additional Heating, Ventilation, and Air Conditioning (HVAC).

4.6 Grounding, Bonding, Shielding, and Lightning Protection

All grounding and bonding of FAA CPDLC ground system equipment shall comply with FAA-STD-019, *Lighting Protection, Grounding, Bounding and Shielding for Facilities*, FAA-STD-020, *Transient Protection, Grounding, Bonding, and Shielding Requirements for Equipment*, FAA Order 6950.19, *Practices and Procedures for Lightning Protection Grounding, Bonding, and Shielding Implementation*, and FAA Order 6950.20 *Fundamental Considerations of Lightning Protection Grounding, Bonding, and Shielding*, and ANSI/IEEE 1100-1992, *Grounding Shielding and Bonding*. Where there is conflict between the documents FAA Orders will take precedence.

4.7 Cables

FAA CPDLC ground system equipment shall meet the requirements of National Fire Protection Association (NFPA) Standard 70, *National Electric Code*, FAA Order 6630.4, *Enroute Communications Handbook,* and FAA-C-1217, *Electrical Work, Interior*.

4.8 Hazardous Materials

FAA CPDLC ground system equipment shall be free of hazardous material, to include but not limited to:

- Asbestos
- Polychlorinated BiPhenols (PCBs)
- Lead
- Class 1 Ozone Depleted Substances

4.9 Power Systems and Commercial Power

Power required for FAA CPDLC ground system equipment shall be provided in accordance with NFPA Standard 70, *National Electrical Code*, FAA Order 6030.20, *Electrical Power Policy*, FAA Order 6950.2, *Electrical Power Policy Implementation, NAS Facilities*, and FAA Order 6950.25, *Use of Electrical Power Conditioning Devices at FAA Facilities*.

4.10 Telecommunications

4.10.1 Telecommunications Infrastructure

CPDLC telecommunications infrastructure shall comply with FAA Order 2500.8, *Funding Criteria for Operations, Facilities and Equipment (F&E), and Research, Engineering and Development (RE&D) Accounts*, FAA Order 4441.16, *Acquisition of Telecommunications Systems, Equipment and Services*, FAA Order 6000.22, *Maintenance of Analog Lines*, FAA Order 6000.36, *Communications Diversity*, and FAA Order 6000.47, *Maintenance of Digital Transmission Channels*.

4.11 Special and Other Considerations

4.11.1 Components Installation

CPDLC elements and components shall be installed in compliance with FAA-STD-032, *Design Standards for National Airspace System Facilities.*

4.11.2 Occupational Safety and Health Administration

Physical integration shall be accomplished in such a manner as to maintain facility compliance with Occupational Safety and Health Administration (OSHA) regulations.

Note: Currently, FAA facilities are required to be in compliance with applicable OSHA regulations for maintainability, fire protection, and fall protection. Any additions or modifications to these facilities to accommodate CPDLC will maintain or improve upon the current level of compliance.

4.11.3 Line Replaceable Unit Handling

LRUs shall be designed to permit removal and replacement by one person.

4.11.4 Telecommunications Infrastructure

(TBD)

5. Functional Integration

5.1 Integration with other NAS Elements

5.1.1 NAS Infrastructure Management System and Remote Maintenance Interface

CPDLC ground system shall interface with NAS Infrastructure Management System (NIMS) and provide Remote Maintenance Monitoring and Operational Command and Control of the equipment located at the remote facility as required by NIMS and consistent with FAA Order 6000.30, *Policy for Maintenance of the National Airspace System through the year 2000.*

5.1.2 Remote Maintenance Monitoring System Interface Capabilities

CPDLC ground system shall provide the following minimum interface capabilities for the remote maintenance monitoring system to allow the technician to perform monitor and control activities from a remote location:

- Status
- Control
- Performance
- Fault Isolation (indicate percentage of probability for finding a fault)
- Service/Equipment Certification
- Digital Link Integrity

5.2 Software Integration

5.2.1 Software

CPDLC application software shall be non-proprietary.

5.2.2 Software Design

CPDLC software shall be designed to permit the controller to accept recommended uplink messages from other applications without requiring the message to be copied and re-keyed.

5.2.3 Software Integration

Messages from other applications, that are provided to controllers, shall be integrated in all status lists with messages initiated by direct controller action.

5.3 Spectrum Management

CPDLC shall include spectrum management in activities to ensure that properly allocated aeronautical spectrum is available to support the program. Certification of spectrum support, as required by Office of Management Budget (OMB) Circular A-11, will be obtained from the National Telecommunications and Information Administration (NTIA) for CPDLC, as required, in four stages:

1. Conceptual - provides feasibility of obtaining certification of spectrum support at subsequent stages.
2. Experimental - prerequisite for NTIA authorization of radiation in support of experimentation for systems.
3. Developmental - prerequisite for NTIA authorization of radiation in support of developmental testing for systems.
4. Operational - prerequisite for NTIA authorization of radiation from a station with an operational station class.

Radio spectrum engineering criteria will be developed by, as needed, to ensure the new system operations are compatible with current NAS systems during transition and all applicable spectrum standards are met. Spectrum issues to be addressed include:

1. All current and planned services will be evaluated, and spectrum resources allocated in order to maximize NAS benefits.

2. Development of spectrum criteria which will ensure adequate protection to and from existing aeronautical mobile communications systems.

3. In order to ensure safety and spectrum efficiency, message priority and preemption will be implemented in accordance to International Telecommunication Union (ITU) Radio Regulations, Article S1.54 (formerly Article 51), and International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs) Annex 10, Chapter 5.

5.4 Standardization

5.4.1 Industry Protocols

The system shall exchange information using non-proprietary protocols.

5.5 System Qualification

CPDLC system qualification shall mitigate the delivery of hazardously misleading information to aircraft and ground systems.

5.5.1 Operational Environment Definition

Development of an operational environment definition shall be developed in accordance with FAA Advisory Circular, AC 20-DC, *Guidelines for Design Approval of Aircraft Data Communications Systems.*

5.5.2 Development of Operational Safety Assessment

An Operational Safety Assessment (OSA) shall be performed to identify and mitigate hazards.

Note: In the case of CPDLC, consideration will include, but not be limited to, the effect of the loss, mis-delivery, and corruption of CPDLC messages.

AC 20-DC, "Guidelines for Design Approval of Aircraft Data Communications Systems", provides guidance for the requirement for an OSA.

5.5.3 Designation of Design Assurance Levels

The CPDLC system shall comply with OSA identified software assurance levels.

Note: System qualification requires that the process used assures that the portions of the software that can cause hazardously misleading information be developed using a structured process that assures the integrity of the software. RTCA DO-178B "Software Consideration in Airborne System and Equipment Certification" is an acceptable means, but not the only means, for CPDLC software to meet that requirement.

5.6 Special Considerations

5.6.1 Interoperability with Aircraft

The FAA CPDLC and context management services shall be inter-operable with aircraft that have implemented ICAO 9705-AN/956, *Manual of Technical Provisions for the Aeronautical Telecommunication Network.*

Note: The standardization afforded by the SARPs provides assurances that aircraft implementations by different manufacturers will be interoperable with FAA ground systems. This interoperability is of paramount importance for the provision of air traffic services for international counterparts receiving services from the FAA, as well as for US flag aircraft operating abroad.

5.6.2 Interaction with NAS Systems

CPDLC service shall not adversely affect the operation of other NAS systems.

6. Human Integration

6.1 Lifecycle Factors

Human factors shall be applied to the CPDLC service from the inception of an integrated requirements team throughout the lifecycle of the system.

Note: See appendix I for a detailed listing of initial human factors requirements.

6.2 Human Factors Applications

Human factors application shall consider the system operator (air traffic control specialist staffing an en route, terminal, tower, or oceanic operational position) and the system maintainer.

6.3 Safety, Availability and Effectiveness Factors

Human factors issues are critical to safety, availability, and the effectiveness of the CPDLC. Early human-in-the-loop prototyping of the human interfaces shall be accomplished prior to major design commitments.

6.4 References

The evaluation of CPDLC human factors shall be in accordance with MIL-STD-1472D, *Human Engineering Requirements for Military Systems, Equipment and Facilities*; DOT VNSTC-FAA-95-3, *Human Factors in the Design and Evaluation of Air Traffic Control Systems*; Society of Automotive Engineers, Aerospace Recommended Practice (ARP) 4791, *Human Engineering Recommendations for Data Link Systems*; FAA Order 9550.8, *Human Factors Policy*; FAA Order 1810.1, *Acquisition Policy*, paragraph 1-10i(11); DOT/FAA/CT-96/1, *FAA Human Factors Design Guide*; and RTCA DO 238, *Human Engineering Guidance for Data Link Systems*.

7. Security

7.1 Physical Security

Physical security of the CPDLC ground system shall be provided in accordance with FAA Order 1600.6, *Physical Security Management Program***.**

7.2 Personnel Security

The CPDLC ground system personnel security shall be in accordance with FAA Order 1600.1, *Personnel Security*.

7.3 NAS Information Security

CPDLC system information security shall be in accordance with FAA Order 1600.54, *The FAA Automated Information Systems Handbook*, FAA Order 1600.66, *Telecommunications and Information Security Systems Policy*, and OMB Circular A-130, *Management of Federal Information Resources*.

7.4 Validation and Authentication

The CPDLC ground system shall be capable of ensuring the validity, and authenticity of all CPDLC and CMA messages.

8. In-Service Support

8.1 Staffing

8.1.1 Staffing Standards Analysis

Staffing Standards Analysis (SSA) shall be performed by Airways Facilities.

8.1.2 Staffing Levels

The operation and maintenance of CPDLC ground system shall not increase staffing requirements above present NAS staffing at sites, second level engineering activities, or the depot.

8.2 Supply Support

8.2.1 Initial Site and Depot Spares

CPDLC ground system shall be delivered with initial site and depot spares.

8.2.2 Life Cycle Cost Trade Off Analysis

A life cycle cost trade off analysis shall be performed by the FAALC to determine the repair policy for CPDLC ground system components.

Note: Any unique/developmental hardware will be treated as a developmental item and will be provisioned and be a candidate for depot repair. The FAALC will manage all succeeding vendor repair contract(s).

8.3 Support Equipment

8.3.1 Support Equipment, Test Equipment, and Tools

Support equipment, test equipment, and tools presently in the FAA inventory shall be used to maintain the CPDLC ground system.

Note: Any new specialized support test equipment or tools developed to support CPDLC maintenance at either site or depot levels, will require prior FAA approval.

8.4 Technical Data

8.4.1 Technical Instruction Books

Technical Instruction Books (TIBs) shall be approved by the cognizant FAA operational support organization prior to delivery to the field.

Note: Any changes to TIBs, after baseline delivery, will require FAA approval.

8.4.2 Second Level Hardware and Software Maintenance Documentation

Second level hardware and software maintenance documentation shall be delivered to the operational support organization prior to deployment of the CPDLC ground equipment.

8.4.3 Reprocurement Data Package

A Reprocurement Data Package (RDP) including engineering changes, drawings and associated lists for CPDLC ground equipment shall be delivered to the FAALC.

8.5 Training and Training Support

8.5.1 Training Development

Training shall be developed in accordance with FAA-STD-028, *Contract Training Programs,* to provide Air Traffic Controllers and Airway Facilities personnel with the knowledge, skills, and abilities to install, operate, and/or maintain the facility, system, subsystem, and/or equipment.

8.5.2 Controller Team Task and Procedures

CPDLC implementation shall include human factors considerations for reallocation of controller team tasks and new procedures.

8.6 Certification

The CPDLC ground system and communications service shall be certified in accordance with FAA Order 6000.15*, General Maintenance Handbook for Airway Facilities*.

8.7 First and Second Level Repair

8.7.1 First Level Maintenance

FAA Airway Facility personnel shall be trained and equipped to perform on-site maintenance and certification services at individual CPDLC facilities.

8.7.2 Second Level Maintenance

The FAALC will act as item managers for the CPDLC ground system and shall manage the CPDLC ground system supply support system.

8.7.3 Second Level Engineering Support

Second Level Engineering support shall be provided for both hardware and software by the cognizant FAA operational support organization.

8.8 Packaging, Handling, Storage, and Transportation

8.8.1 Packaging, Handling and Transportation

Packaging, handling, storage and transportation shall be in accordance with ASTM-D3951, *Standard Practice for Commercial Packaging*.

8.8.2 Storage

CPDLC ground equipment shall be capable of being stored at any location in non-climate controlled environments.

8.8.3 Transportation

LRU's, including shipping containers, shall be bar coded for transportation**.**

8.9 Disposal

8.9.1 Disposal Plan

A disposal plan shall be developed in accordance with FAA Order 4800.2 that will describe the future disposal of the CPDLC ground System.

8.9.2 Periodic Maintenance

8.9.2.1 Periodic Maintenance Frequency

CPDLC ground equipment shall require onsite periodic maintenance no more frequently than annually.

8.9.2.2 Periodic Maintenance Tasks

Periodic maintenance tasks shall require no more than one person to accomplish in accordance with FAA NAS-SS-1000, Volume 1, par. 3.2.3.2.

8.9.2.3 Periodic Maintenance Tasks Duration

Time to complete periodic maintenance tasks shall be no more than 12 staff hours per year in accordance with FAA NAS-SS-1000, Volume I, par. 3.2.3.2.

8.10 CPDLC Lifecycle

(TBD)

9. Test and Evaluation

Testing shall be conducted to ensure that functional and subnetwork performance requirements can be met in a operational environment, and to resolve the following Critical Operational Issues (COI):

Note: Test planning and conduct will involve all the stakeholders.

9.1 Critical Operational Issues

- COI 1: Does CPDLC interface and operate with existing equipment and systems?
- COI 2: Does CPDLC disrupt or degrade ATC operations?
- COI 3: Does CPDLC provide the required level of reliability, maintainability and availability?
- COI 4: Can CPDLC be maintained without disruption or degradation of current ATC operations?
- COI 5: Does CPDLC maintain at least the current level of efficiency and accuracy of communications between the controller and pilot?
- COI 6: Does CPDLC time performance allow for effective exchange of controller and pilot communications?
- COI 7: Does CPDLC Computer Human Interface (CHI) effectively and suitably support AT and AF operations?
- COI 8: Is AT/AF training sufficient to allow effective operation and maintenance of the CPDLC system?

9.2 Test and Evaluation Requirements

Test and Evaluation (T&E) is conducted by the FAA, in accordance with *Acquisition Management System Test & Evaluation Process Guidelines*, to evaluate the subsystem operational effectiveness and suitability including compatibility, interoperability, degraded operations, maintainability and supportability. T&E also identifies deficiencies in NAS hardware, software, human performance factors, COIs and/or operational concepts.

9.2.1 System Test Requirements

The following categories and classes of tests shall be conducted for CPDLC:

1. Functional Testing - This testing will verify all functional threads. The objective is to verify the complete message set and associated functions have been properly implemented. Testing will be conducted in a simulated environment.

2. Performance/Load Testing - This testing will use the actual air-ground subnetwork with real operational scenarios. Simulation will be used as required to create realistic levels of traffic.

3. Up-level/Regression Testing - This testing will ensure that CPDLC application changes have been integrated into the automation system without adversely affecting the baseline system.

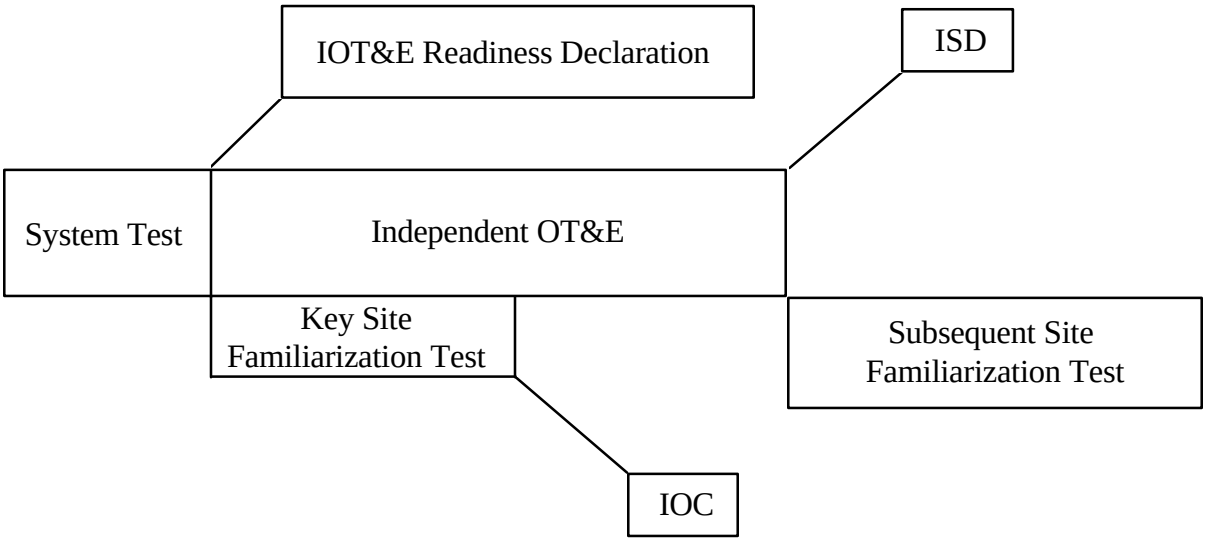
4. End-to-End Testing - This testing will be conducted using the air-ground subnetwork and avionics. This testing will verify end-to-end interoperability using scenarios that exercise the complete end-to-end CPDLC service.

5. Independent Network Test - This testing will determine subnetwork performance independent of CPDLC messages.

6. Operational Suitability and Effectiveness - This testing will evaluate the operational suitability and effectiveness of CPDLC Services with respect to ATC controller operations, flight deck operations, ground/air communications network, FAA maintenance and FAA support functions.

9.2.2 IOT&E Requirements

This testing will evaluate CPDLC in a realistic operational environment to confirm the operational effectiveness and suitability of the system. These IOT&E assessments of operational readiness will be reported to ATS-1 and utilized in support of the in service decision.



IOT&E Readiness Declaration (IOTRD)

- Written declaration by ARA-1 to ATS-1 of system's readiness to enter Initial Operational Test and Evaluation (IOT&E)
- Applies only to products designated for the IOT&E process
- Includes "exceptions" to the readiness of IOT&E (Concurrence by ATS-1 doesn't mean acceptance of "exceptions" for deployment)
- If ATS-1 concurs, IOT&E commences

In-Service Decision (ISD)

- Via IOT&E, ATS Test Team provides final evaluation of operational readiness by operators/users
- Report is provided directly to ATS-1 and ISD decision maker
- May be used to support other acquisition decisions via report to Joint Resources Council (JRC)

9.2.3 Field Familiarization

AT and AF site personnel perform field familiarization to confirm readiness for integration of the system into each NAS site, leading to system commissioning.

10. Implementation

10.1 Project Implementation Plan

Project Implementation Plan shall be generated utilizing FAA-STD-036, *Preparation of Project Implementation Plans*.

10.2 Ground Infrastructure Implementation

CPDLC shall provide a transition approach that ensures the continuity of ATC services.

10.3 Transition

The transition approach shall include a process for moving between systems, elements and components, as well as a fallback process that is operationally acceptable.

10.4 ATC Facilities Interface

The CPDLC ground system shall be capable of interfacing with all appropriate ATC facilities regardless of the transition state or level of technical evolution of each site.

10.5 Service Provider Data Presented

The data presented to any service provider during initial system transition shall be consistent with the current NAS system.

10.6 Current NAS Software

(TBD)

10.7 Coexistence with Present System

CPDLC shall coexist with present NAS systems.

11. Quality Assurance

The CPDLC Quality Assurance Program (QAP) shall be established and maintained in accordance with the requirements of ANSI/ASQC-Q-9001, *Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*, and ISO-9000-3, *Quality Management and Quality Assurance Standards* - Part 3: *Guidelines for the Application of OSI 9001 to the Development, Supply and Maintenance of Software*, and provide at a minimum:

1. A quality assurance organization that has sufficient responsibility and authority to identify and evaluate quality problems, and to initiate, recommend, or provide solutions.

2. Procedures and controls to assure adequate configuration management during all operations through final acceptance.

3. Controls to assure that all inspection and testing is performed in compliance with contract requirements and that all test data is complete, correct, traceable, repeatable, and acceptable.

4. Maintenance of proper record keeping function to provide objective evidence and traceability of operations performed.

5. If applicable, procedures and controls for assuring that all software products of services procured from subcontractors conform to contract requirements.

6. Procedures and controls to assure that all documentation is adequately reviewed and meets contract requirements.

7. Procedures and controls for the prevention of software deficiencies, detection and analysis of deficiencies when they do occur, as well as procedures for corrective action.

A system of periodic internal quality audits or reviews to verify quality activities and related results are in compliance with planned arrangements, and to verify that the QAP is performing effectively.

12. Configuration Management

12.1 NAS Configuration Management Change Control Procedures

CPDLC Configuration Management shall be in accordance with MIL-STD-973, *Configuration Management*.

12.2 Bar Coding and Asset Tracking

The CPDLC ground system equipment shall use the Bar Coding and Asset Tracking System (BCATS) for managing and requisitioning system components.

13. IN-SERVICE MANAGEMENT

13.1 Product Baseline

The product baseline for CPDLC elements shall be updated as a result of technology refreshment, pre-planned product improvement, upgrade Engineering Change Proposals (ECPs), NAS Change Proposals (NCPs), and requests for deviation and waiver.

13.2 Performance Monitoring

Performance shall be monitored using NIMS in accordance with FAA Order 6000.30 *Policy for Maintenance of the National Airspace System through the year 2000.*

Appendix A Acronyms

AC	Advisory Circular
ADCON	Arrival/Departure Control
ADL	Aeronautical Data Link
ADLS	Aeronautical Data Link System
AF	Airways Facilities
AMS	Acquisition Management System
ARA	Office of the Associate Administrator, for Research and Acquisition
ARP	Aerospace Recommended Practice
ARR	Requirements Development Organization
ARS	Air Traffic System Requirements Service
AT	Air Traffic
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSP	Air Traffic Service Provider
BCATS	Bar Coding and Asset Tracking System
CDA	Current Data Authority
CHI	Computer Human Interface
CMA	Context Management Application
CNS	Communications, Navigation and Surveillance
COI	Critical Operational Issue
CPDLC	Controller Pilot Data Link Communications
DM	Down-Link Message
ECP	Engineering Change Proposal
EEM	Electronic Equipment Modification
ESD	Electrostatic Discharge
ETD	Estimated Time Of Departure
FAA	Federal Aviation Administration
FAALC	Federal Aviation Administration Logistics Center
FMS	Flight Management System
F&E	Facilities and Equipment
HHMMSS	Hour Hour Minute Minute Second Second
HVAC	Heating, Ventilation, and Air Conditioning
ICAO	International Civil Aviation Organization
ID	Identification
IEC	International Electrotechnical Commission
IOC	Initial Operational Capability
IOT&E	Independent Operational Testing and Evaluation
IOTRD	IO&T Readiness Declaration
ISD	In-Service Decision
JRC	Joint Resources Council

LACK	Logical Acknowledgment
LRU	Line Replaceable Unit
MNS	Mission Needs Statement
MTBF	Mean Time Between Failure
MTTR	Mean Time to Restore
N/A	Not Applicable
NAILS	National Airspace Integrated Logistics Support
NAS	National Airspace System
NCP	NAS Change Proposal
NDA	Next Data Authority
NFPA	National Fire Protection Association
NIMS	NAS Infrastructure Management System
NTIA	National Telecommunications and Information Administration
OMB	Office of Management Budget
OSA	Operational Safety Assessment
OSHA	Office of Safety, Health Administration
QA	Quality Assurance
QAP	Quality Assurance Program
RDP	Reprocurement Data Package
SAE	Society of Automotive Engineers
SARPs	Standards And Recommended Practices
SSA	Staffing Standards Analysis
T&E	Test and Evaluation
TE	Throughput Efficiency
TIB	Technical Instruction Book
TBD	To Be Determined
TOC	Transfer of Communications
UM	Up-Link Message
WILCO	Will Comply

Appendix B Definitions

Aircraft Identification: A group of letters, figures or a combination thereof which is identical to or the code equivalent of the aircraft call sign. It is used in Field 7 of the ICAO model flight plan.

Aircraft Address: A unique combination of 24 bits available for assignment to an aircraft for the purpose of air-ground communications, navigation, and surveillance.

Availability: The ability of a system to perform its required function at the initiation of the intended operation. It is quantified as the proportion of the time the system is available to the time the system is planned to be available.

Certification: The technical verification performed prior to commissioning and/or service restoration after a scheduled/unscheduled interruption affecting certification parameters, and periodically thereafter inclusive of the insertion of the prescribed entry in the facility maintenance log. The certification validates that they system is providing an advertised service to the user, and/or that the system/equipment is capable of providing that advertised service. It includes independent determination about when a system/equipment should be continued in, restored to, or removed from service.

Certification Parameter: Certification parameters are selected critical indicators of the quality of the required or advertised services being provided to the user of systems, subsystems, and equipment.

Continuity: The probability of a system to perform its required function without unscheduled interruptions during the intended period of operations.

Controller Pilot Data Link Communications (CPDLC): A data link application that provides a means of communication between controller and pilot using data link for ATC communications.

Controller Pilot Data Link Communications (CPDLC) Service: The capability for controllers and pilots to exchange ATC messages in a digital data format.

Controller Pilot Data Link Communications (CPDLC) System: The end-to-end infrastructure (including hardware and software) that enables the capability for controllers and pilots to exchange Air Traffic Control (ATC) messages in digital format. This includes aircraft avionics, ground system, and any service provider. The term digital format does not preclude the possible use of voice recognition and synthesis technology.

Current Data Authority (CDA): The ground authority which is permitted to conduct a CPDLC dialogue with an aircraft.

Eligible Controller: The individual responsible for providing ATC services to aircraft within a specified area.

End -to-End: Pertaining to or relating to an entire communication path, typically from (1) the interface between the information source and the communication system at the transmitting end to (2) the interface between the communication system and the information user or processor or application at the receiving end.

End-to-End Data: Data that is passed between the processor at the controller's position and the airborne processor.

End-to-End Transfer Delay: The period elapsed from the time at which the originating user initiates the triggering event until the time the transmitted information is available for display to the intended recipient.

End User: An ultimate source and/or consumer of information.

Enhanceability: The capability of a system to interface with additional unspecified systems, process data from those systems, and accommodate improvements to hardware and software elements, with the original architecture (no system or architecture modifications required).

Estimated Off Block Time: The ICAO terminology for "Estimated Time of Departure" (ETD).

Failure: The event or inoperable state in which any function, within a subsystem that is being used as an integral part of the NAS primary function, does not or would not perform as specified.

Integrity: The probability that errors will be mis-detected. This may be when a correct message is indicated as containing one or more errors, or when a message containing one or more errors is indicated as being correct.

> ***Note: Integrity relates to the trust which can be placed in the correctness of the information provided.***

HOST: The Enroute computer system (not an acronym)

Key Parameter: Requirements that must be met to provide a minimally acceptable level of service. When key parameters are not met the program will be subject to termination by the Joint Resources Council.

Lowest Replaceable Unit: The lowest replaceable component at the site.

Mean Time Between Failures: A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

Mean Time to Repair: Mean Time to Repair includes diagnostic time, removal of the failed LRU, replacement and installation of the new LRU including any adjustments or data loading

necessary to initialize the LRU, and all adjustments required to return the subsystem to normal operation and to perform certification.

Mean Time to Restore: The mean time required to restore functionality, performance, and the operational state existing prior to any failure.

Media Integrity: The ability of a media unit and associate input and output devices to ensure the completeness and incorruptibility of stored data.

Next Data Authority: The ground system so designated by the Current Data Authority.

Normal Termination: Is the intentional discontinuation of service

Operational Availability: The probability that a system will be operational during any randomly selected instant in time measured as probabilities (e.g. 0.99999).

Outstanding Messages: Messages that have not received a qualified response from the intended recipient.

Qualification: Evaluation of the implementation and performance to its requirements document.

Reliability: The probability that the system will deliver a particular message without errors.

Threshold: Minimum or maximum acceptable operational value for system capability or characteristic which, in the user's judgment, is necessary to provide an operational capability that will satisfy the mission need.

Appendix C References

Note: The latest version of all referenced material will be used.

Acquisition Management System (AMS) Test & Evaluation Process Guidelines

ANSI/ASQC-Q-9001, *Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing*

ANSI/IEEE 1100-1992, *Grounding Shielding and Bonding*

ASTM-D3951, *Standard Practice for Commercial Packaging*

Air Traffic Service (*ATS) Concept of Operations for the National Airspace System in 2005*

Code of Federal Regulations (CFR), Title 40, *Environmental Protection*

Department of Transportation VNSTC-FAA-95-3, *Human Factors in the Design and Evaluation of Air Traffic Control Systems*

Department of Transportation /FAA/CT-96/1, *FAA Human Factors Design Guide*

Energy Policy Act of 1992

Executive Order 12088, *Federal Compliance with Pollution Control Standards*

Executive Order 12873, *Federal Acquisition, Recycling, Waste Prevention*

Executive Order 12902, *Energy Efficiency and Conservation at Federal Facilities*

FAA Advisory Circular (AC) 20-DC *Guidelines for Design Approval of Aircraft Data Communications Systems*

FAA-C-1217, *Electrical Work, Interior*

FAA Circular 4610.30, *Management and Control of NAS Facilities and Equipment Project/Material*

FAA Human Factors Job Aid, Office of the Chief Scientific and Technical Advisor for Human Factors

FAA-G-2100, *Electronic Equipment, General Requirements*

FAA NAS System Requirements Document, NAS-SR-1000

FAA NAS System Specification, NAS-SS-1000

FAA Order 1600.1, *Personnel Security Program*

FAA Order 1600.6, *Physical Security Management Program*

FAA Order 1600.54, *FAA Automated Information Systems Security Handbook*

FAA Order 1600.66, *Telecommunications and Information Security Systems Policy*

FAA Order 1800.58, *National Airspace Integrated Logistics Support Policy*

FAA Order 1810.1, *Acquisition Policy*, paragraph 1-10i(11)

FAA Order 2500.8 *Funding Criteria for Operations, Facilities and Equipment (F&E), and Research, Engineering and Development (RE&D) Accounts*

FAA Order 3000.6, *Training*

FAA Order 4441.16 *Acquisition of Telecommunications Systems, Equipment and Services*

FAA Order 4650.30, *Management And Control Of NAS F&E Project/Material*

FAA Order 4800.2, *Utilization and Disposal of Excess and Surplus Personal Property*

FAA Order 6000.15, *General Maintenance Handbook for Airway Facilities*

FAA Order 6000.22, *Maintenance of Analog Lines*

FAA Order 6000.30, *Policy for Maintenance of the National Airspace System (NAS) Through The Year 2000*

FAA Order 6000.36, *Communications Diversity*

FAA Order 6000.47, *Maintenance of Digital Transmission Channels*

FAA Order 6030.20, *Electrical Power Policy*

FAA Order 6040.15, *National Airspace Performance Reporting System*

FAA Order 6950.2, *Electrical Power Policy Implementation, NAS Facilities*

FAA Order 6950.19, *Practices and Procedures for Lightning Protection Grounding, Bonding, and Shielding Implementation*

FAA Order 6950.20 *Fundamental Considerations of Lightning Protection Grounding, Bonding, and Shielding*

FAA Order 6950.25, *Use of Electrical Power Conditioning Devices at FAA Facilities*

FAA Order 7110.65, *Air Traffic Control*

FAA Order 7210.3, *Facility Operation and Administration*

FAA Order 9550.8, *Human Factors Policy*

FAA-STD-019, *Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities*

FAA-STD-020, *Transient Protection, Grounding, Bonding and Shielding Requirements for Electrical Equipment.*

FAA-STD-028, *Contract Training Programs*

FAA-STD-032, *Design Standards for National Airspace System Facilities*

FAA-STD-036, *Preparation of Project Implementation Plans*

ICAO Manual of ATS Data Link Applications

ICAO SARPs, *Aeronautical Telecommunications,* Annex 10 to the Convention on International Civil Aviation, Volume III, Part I: *Digital Communication Systems*, Chapter 3: *Aeronautical Telecommunication Network*

ICAO 9705-AN/956, *Manual of Technical Provisions for the Aeronautical Telecommunication Network*

IEC 1000-2, *Testing and Measurement Techniques*, section 2: *Electrostatic Discharge Immunity Testing*

IEC 1000-4, *Testing and Measurement Techniques*, Part 4: *Electrical Fast Transient/Burst Immunity Test*

IEC 61000-4-2, *Electromagnetic Compatibility* Part 4: *Testing and Measurement Techniques*, Section 2: *Electrostatic Discharge Immunity Test*

ISO 9000-3, Quality Management and Quality Assurance Standards - Part 3: *Guidelines for the Application of ISO 9001 to the Development, Supply and Maintenance of Software*

Joint Government/Industry Operational Concept for the Evolution of Free Flight.

MIL-HDBK-237A, *Electromagnetic Compatibility Management Guide for Platform, Systems, and Equipment*

MIL-HDBK-263, *Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies, and Equipment*

MIL-STD-973, *Configuration Management*

MIL-STD-1472D, *Human Engineering Requirements for Military Systems, Equipment and Facilities*

MIL-STD-1686, *Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment*

Mission Need Statement 042, *Aeronautical Data Link System (ADLS)*

NAS Architecture, Version 3.0

NAS Configuration Management Change Control Procedures, Revision

National Fire Protection Association Standard 70, National Electric Code

National Institute Of Standards And Technology's *User Guide For Developing And Evaluating Security Plans for Unclassified Federal Automated Information Systems*

OMB Bulletin 90-08, *Guidance for Preparation of Security Plans for Federal Computer systems Containing Sensitive Information*

OMB Circular A-11, *Preparation and Submission of Budget Estimates*

OMB Circular A-130, *Management of Federal Information*

Operational Requirements Document for the Aeronautical Data Link System

RTCA DO-178, *Software Consideration in Airborne System and Equipment Certification*

RTCA DO 238, *Human Engineering Guidance for Data Link Systems*

Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 4791, *Human Engineering Recommendations for Data Link Systems*

Appendix D Pre-Determined Uplink Message Set

The table references refer to the tables contained in Chapter 2.3-7 of the CPDLC SARPs

Table 2.3.7-5 Responses/Acknowledgments UM#: 0-5, 235, 211, 218

Table 2.3.7-6 Vertical Clearances UM#: 6, 8, 10, 14, 16, 19, 20, 22, 185, 23, 25, 186, 26-29, 192, 209, 30-32, 219, 220, 36-39, 171-174

Table 2.3.7-7 Crossing Constraints UM#: 42-51, 55-58, 61, 63

Table 2.3.7-8 Lateral Offsets UM#: 64, 65, 67, 68, 70, 71, 72

Table 2.3.7-9 Route Modifications UM#: 73-81, 82-88, 90-94, 215, 190, 96, 97, 98, 99

Table 2.3.7-10 Speed Changes UM#: 101, 102, 106, 188, 107-109, 111-116, 222, 223

Table 2.3.7-11 Contact/Monitor/Surveillance Requests UM#: 117, 118, 120, 121, 123, 179

Table 2.3.7-12 Report/Confirmation Requests UM#: 127, 128, 175, 200, 130, 181, 228, 131-137, 143-145, 182, 147, 216, 217, 229, 231, 232

Table 2.3.7-13 Negotiation Requests UM#: 148-151

Table 2.3.7-14 Air Traffic Advisories UM#: 153, 213, 154, 155, 156, 157, 158, 212, 214, 224-226

Table 2.3.7-15 System Management Messages UM#: 159-162, 234, 163, 233

Table 2.3.7-16 Additional Messages UM#: 164, 230, 165, 166, 167, 168, 176, 177, 169, 170, 194, 195-199, 201-204, 183, 205, 206, 187, 207, 208

Note: This constitutes 184 of 235 UM's available in the CPDLC SARPs

Appendix E Pre-Determined Downlink Message Set

The table references refer to the tables contained in Chapter 2.3-7 of the CPDLC SARPs. A SARPs compliant CPDLC Application is required to be capable of responding to "ALL" DMs. For DMs that have not been listed, the ground system responds with UM 162, "SERVICE UNAVAILABLE", and no further processing is required.

Table 2.3.7-17 Responses DM#: 0-5

Table 2.3.7-18 Vertical Requests DM#: 6, 7, 9-12, 69

Table 2.3.7-19 Lateral Offset Requests DM#: 15, 16

Table 2.3.7-20 Speed Requests DM#: 18.

Table 2.3.7-21 Voice Contact Requests DM#: 20, 21

Table 2.3.7-22 Route Modification Requests DM#: 22-27, 70

Table 2.3.7-23 Reports DM#: 28-31, 78, 32-34, 113, 35, 37, 38, 39-41, 47, 48, 79, 89, 102, 104-106, 109-111

Table 2.3.7-24 Negotiation Requests DM#: 49, 51-53, 87, 88

Table 2.3.7-25 Emergency Messages DM#: 55, 56, 112, 57-61, 80

Table 2.3.7-26 System Management Messages DM#: 62, 63, 99, 64, 107, 73, 100

Table 2.3.7-27 Additional Messages DM#: 65, 66, 74, 75, 101, 103, 108, 67, 68, 90-98

Table 2.3.7-28 Negotiation Responses DM#: 81-84

Note: This represents 95 of 113 available DM's in the CPDLC SARPs.

Appendix F Pre-Determined Response Messages

When the listed DM is displayed to the controller, the ground system automatically presents a negative, a standby, and the listed UM(s) response below to the controller for decision making. Unless UM 162 was sent to the aircraft in accordance with Appendix E, the ground system automatically provides a positive, negative, and standby response, as dictated by the response attribute for the received message, for uplink by the controller for any received message not shown in the list below.

DM# Request	UM# Response
6	20 & 23
7	31 & 32
9	20
10	23
11	22
12	25
69	176
15	64
16	65
18	106
20	117
21	3
22	74
23	81
24	80
25	79
26	79
27	82
70	190
49	101
51	70
52	10
53	8
87	14
88	16
55	3
56	3
112	235
57-61	3
80	3
74	176
101	161 (this combination may require additional service level processing)
103	154 + 123 (code 1200 is default variable entry)
108	3

Appendix G Mission Needs Correlation Matrix

Need Statement MNS Location	FRD Section Number
1. The CPDLC System will provide a globally interconnected air-ground and ground-ground data communications network .	3.1.1, 3.2.1, 3.3.1.8, 3.3.1.15
2. The CPDLC system will provide a data link service whose characteristics are particularly suited to enhance safety and efficiency of the enroute and terminal environments.	3.2.1.1, 3.2.1.2, 3.2.2, 3.2.2.1, 3.2.2.2, 3.2.2.7, 3.3.1.11, 3.3.1.12, 3.3.1.13, 3.3.1.14, 3.3.1.16, 3.3.1.17
3. Development and implementation of the Aeronautical Telecommunication Network (ATN) will provide the unified communications network	3.2.2.3, 3.2.2.4, 3.2.2.5, 3.2.2.6, 3.3, 3.3.1, 3.3.1.1, 3.3.1.2, 3.3.1.3, 3.3.1.4, 3.3.1.5, 3.3.1.6, 3.3.1.7, 3.3.1.9, 3.3.1.10, 3.4.1, 3.4.2, 3.4.3, 3.4.4, 3.4.5, 3.4.6, 3.4.7, 3.4.8, 3.4.8.1, 3.4.8.2, 3.4.8.3, 3.4.9, 3.4.10, 3.4.11

Appendix H Threshold/Objective Matrix

Section	Requirement	Threshold	Objective
3.4	**Technical Performance**	Essential	Critical
3.4.2	**Throughput Efficiency**	>90%	99.9%
3.4.3	**Data Error Rate**	< ICAO SARPs criterion	Meet ICAO SARPs criterion
3.4.6	**Mean Time Between Failure**	MTBF of 8,760	MTBF of 26,280
3.4.9	**Transfer Delay** (Mean End-to-End)	Terminal: 5 Seconds En Route: 10 Seconds	Terminal: 1 Seconds En Route: 3 Seconds
3.4.11	**Number of Aircraft Supported**	Capability of providing CPDLC service to a minimum of 1250 aircraft, per facility, at any given time	Exceed criterion by 10%

Appendix I Initial Human Factors Requirements

Note: This appendix captures the currently known human factors issues that relate to CPDLC. During the investment analysis process, and writing of the final requirements document, human factors requirements will be evaluated and this appendix update to address any modifications or out standing issues.

During CPDLC concept formulation, prototyping, and design, user representatives (controllers and maintainers) and qualified human factors specialists shall be involved to ensure human factors and user acceptance issues are considered.

Safety

There shall be no reduction in the level of safety as a result of the change from a voice radio-based communications system to a data-based communications system.

The air traffic control environment shall allow safe recovery from response delays, nonresponse, data link failures, and other data link management errors, to at least match the current level of safety.

Data Presentation

The CPDLC message display function shall ensure that the sender's message and intent is fully and accurately represented on the receiver's display.

CPDLC implementation shall minimize any increase in controller visual attention to display locations that will interfere with attention to high priority tasks.

CPDLC implementation shall minimize any increase in operator "head down" time. The increase in "head down" time that results from CPDLC implementation should not compromise safety or reduce operator situation awareness. (operator refers to either controller and/or pilot)

CPDLC shall be compatible with other workstation implementations.

Use of CPDLC must not impose undue competition for display or control resources. CPDLC shall not preclude access to other functions or unduly conflict with higher priority operations.

When speech technology is used to present messages, it should be used redundantly with visual display, unless research demonstrates that such redundancy is not required. Speech applications shall meet or exceed current levels of intelligibility and comprehensibility achieved with voice radio without increasing operator workload.

Any unrecognized or unreasonable entry shall prompt an error message from the system and shall not result in any data changes. The system shall provide the information needed to assist the controller in determining the nature of the error and how the error could be corrected.

On the air traffic controller workstation, pilot-initiated messages shall be identified by a visual alert. Urgent and distress messages shall be discriminated from routine pilot-initiated messages.

CPDLC message formats shall use standard phraseology and construction with unambiguous terms as established in ATC procedures (FAA Order, 7110.65, *Air Traffic Control*) or data link standards.

Operations Mode

All information required by the operator during CPDLC operations must be available for display. The operator must not be required to rely solely on memory at any point during the transaction.

The CPDLC should enhance or replace the voice environment as a source of information for weather, traffic, and traffic flow management without placing additional demands on pilots or on controllers who are actively controlling traffic.

The system shall facilitate the controller's ability to select the most appropriate communications mode (voice or data link) with each aircraft and to use the data link capabilities most appropriate for that particular aircraft. The system should minimize undue complication due to mixes of equipage and services. Differences in controller management of communications information and related tasks for equipped and unequipped aircraft should be minimized.

To the extent possible, CPDLC functions shall operate consistently across operational domains (en route, terminal, tower, and oceanic).

The CPDLC shall be capable of communication, and be fully compatible with, ground-based air traffic control systems and consoles.

The CPDLC shall be capable of delivering messages associated with error notification and recovery within the time required for safe recovery. Data link delivery, priority transmission, and alerting should facilitate error notification and recovery.

The CPDLC shall be designed to detect and trap potentially critical errors as early in the process as possible.

CPDLC installations should not prevent the operator from performing other high priority tasks by either requiring full devotion of the operator's attentional resources or by tying up the equipment needed for the other tasks with CPDLC functions.

Air traffic control procedures and CPDLC human–computer interface (HCI) designs shall accommodate all possible mixes of data link and voice communications.

All aspects of CPDLC operations shall be designed so that when any one or a combination of them fails, the procedures required to perform the tasks and functions usually supported by them can be done without compromising safety, requiring an undue amount of operator attention, or incurring errors.

Communication procedures for voice and data link should be consistent in the dual media controller-pilot operational communications system.

Operators shall not be required to transmit messages concurrently over both communication media.

CPDLC procedures and HCI design shall provide responses to data link messages quickly enough to maintain flight crew/controller coordination and to enable the controller to effectively manage traffic.

As CPDLC evolves beyond its initial services, and new services are added, implementation of these additional services should minimize changes in procedures in place at that time and enhance operator responses.

Maintenance Mode

If any portions of CPDLC must operate continuously, those portions must be capable of undergoing maintenance without interrupting CPDLC services.

When warranted by its importance, any portion of the CPDLC system that has a partial failure shall be designed to operate in a degraded mode while awaiting maintenance. Degraded operation and faults shall be sensed and appropriate information identified to the maintainer.

Controls and displays for maintenance should comply with the design criteria in the FAA Human Factors Design Guide.

The CPDLC shall be designed to minimize the numbers and types of auxiliary equipment and tools required to accomplish maintenance tasks. Whenever possible, the CPDLC shall be designed so that maintenance can be accomplished with common test equipment and tools.

Fault isolation, inspection, and checkout tasks shall be automated to the extent practical. CPDLC design shall facilitate rapid and positive fault detection and isolation of defective items.

Employee Safety and Health

CPDLC implementation shall comply with Occupational Safety and Health Association (OSHA), National Fire Protection Association (NFPA) and other safety and health regulations and standards.

CPDLC design and implementation shall ensure maintenance personnel are protected from exposure to high intensity levels of radio frequency (RF) and other non-ionizing electromagnetic energy hazards, thermal hazards, electrical hazards, and high noise levels.

Specialized Skills and Capabilities

The implementation of CPDLC shall not require any specialized skills or capabilities on the part of the controller.

The balance between ease of maintenance and the need for special skills on the part of the maintainers shall be optimized.