OBSERVATIONS ON FAA'S CONTROLLER-PILOT DATA LINK COMMUNICATIONS PROGRAM

Federal Aviation Administration

Report Number: AV-2004-101
Date Issued: September 30, 2004

Memorandum

Subject:	<u>ACTION</u>: Report on Observations on FAA's Controller-Pilot Data Link Communications Program AV-2004-101	Date:	September 30, 2004
From:	Alexis M. Stefani Principal Assistant Inspector General for Auditing and Evaluation	Reply to Attn. of:	JA-10
To:	Federal Aviation Administrator		

This report presents the results of our review of the Federal Aviation Administration (FAA) Controller-Pilot Data Link Communications (CPDLC) program. As requested by the Senate Appropriations Committee, we reviewed (1) the reasons for CPDLC's cancellation, (2) what work may be salvageable, and (3) what processes or controls FAA should adopt to avoid similar occurrences in the future.

The CPDLC program represented a new way for controllers and pilots to communicate that is analogous to wireless email. CPDLC was planned for use at the en route centers, the facilities that manage high-altitude air traffic. CPDLC was expected to reduce aircraft direct operating costs by reducing delays and improving efficiency by (1) reducing congestion on the voice channels, and (2) reducing misunderstood instructions and read-back errors between controllers and pilots. FAA and industry jointly invested in CPDLC and began using data link on a limited basis in high-altitude airspace managed by the Miami Center in October 2002. CPDLC was expected to play an important role in the Agency's Operational Evolution Plan for enhancing capacity and reducing delays over the next decade. However, FAA subsequently decided to cancel the current CPDLC program and plans to shut down CPDLC at Miami Center and terminate all the program's activities by March 2005.

RESULTS IN BRIEF

FAA decided to cancel the current CPDLC program for a number of reasons. FAA's reasons for canceling the CPDLC program included cost growth and schedule delays, caused by such factors as the emergence of unplanned additional integration requirements that posed a risk to the program, and concerns over how quickly airlines would equip with avionics. Although FAA may start another CPDLC program in the future, it is difficult to quantify precisely what can be salvaged from the dollars spent because it is unclear what the next CPDLC effort will resemble in terms of specific technology and related FAA infrastructure. We estimate, however, that $23 million of the $100 million spent on CPDLC may be salvageable for future data link efforts. Finally, we identified a number of lessons learned or processes and controls that FAA should establish to avoid similar outcomes in the future.

One of the reasons FAA canceled CPDLC was because the program encountered cost growth and schedule delays. The original program acquisition cost estimate of $166.7 million to implement CPDLC at 20 sites was no longer valid. FAA's revised cost estimate indicated it would cost $236.5 million to implement CPDLC at eight sites, less than half the sites originally planned for an additional $69.8 million. Further, the program would be 1.5 years behind schedule. FAA also was concerned about CPDLC's impact on its operations account, which is already overburdened.[1] For example, FAA's revised estimate indicated it would cost $345.2 million to operate a reduced CPDLC program effort from fiscal year (FY) 1999 through FY 2017. This estimate included, among other things, $63 million for controller training and overtime and $191 million for CPDLC messaging costs.

CPDLC experienced overruns and delays in part because certain program assumptions were invalid. For example, it was assumed the Display System Replacement (DSR) workstations, which controllers would use to input data link messages, would not require a software change to accommodate CPDLC. This proved wrong, increasing the cost and schedule estimate to accomplish the integration of CPDLC and DSR. This and other delays required FAA to integrate CPDLC with the En Route Automation Modernization (ERAM) architecture (an unplanned requirement), posing additional cost and schedule risk to both programs.

We also found that concerns over how quickly airlines would equip with the necessary avionics factored into the decision to cancel the program. CPDLC messages could only be sent and received by planes equipped with the appropriate

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[1] Testimony before the Senate Committee on Appropriations, Subcommittee on Transportation, Treasury and General Government; "Key Issues for the FAA's FY 2005 Budget," CC-2004-038; April 22, 2004.

avionics. Equipage rates, therefore, were important to the viability of the CPDLC program because CPDLC benefits could only accrue if users equipped. According to FAA, CPDLC benefits were derived from the expectation that use of CPDLC would reduce voice congestion and controller operational errors, thereby reducing delays and, ultimately, airline direct operating costs. For CPDLC benefits to exceed costs, FAA estimated that more than 200 equipped airplanes had to use CPDLC. Program documents note that FAA assumed at least 100 aircraft would be equipped by the time CPDLC became operational in Miami, and 200 to 400 would be equipped by the time the program was deployed nationwide. However, by mid-2003, only about 30 aircraft had been equipped.

FAA was concerned about users' ability and willingness to equip given the airline industry's economic downturn in 2001. In 2001, network carriers began incurring substantial net losses, accumulating to a total of $23.4 billion by the end of the first quarter of 2004. The financial health of the industry influenced FAA's decision because FAA was relying on voluntary equipage.

Airline representatives told us the financial state of the industry was not the only factor affecting equipage. They said that reduced CPDLC capabilities (FAA was going to deliver only four of nine planned services) affected the airlines equipment plans because important benefits were removed. For example, a capability to handle pilot-initiated altitude requests was deferred until later. FAA's decision affected airlines planned rates of equipage because benefits considered important to the airlines would not be provided until much later. This would have resulted in lengthening the period between airline's avionics investments and their costs recovery, a situation airlines wanted to avoid.

By the time FAA closes CPDLC program activities, about $100 million will have been spent, and about $23 million may be salvageable for future efforts. It is difficult to quantify precisely what can be salvaged from the dollars spent because it is unclear what the next CPDLC effort will be in terms of specific technology and related FAA infrastructure. We note that very little can be used "as is" largely because CPDLC was specifically designed to work with FAA's Host computer system, which is being completely replaced through the ERAM program.

We reviewed expenditures and accomplishments by major program component and assessed the potential for their use on a future data link program based on analysis provided by the CPDLC program manager. Work performed that was expected to require major revision in a future data link program has limited or no salvage value. Of the $100 million, we found that no more than $23 million may be usable for future efforts and note that the value diminishes as time elapses due to technology obsolescence.

- CPDLC "system development" was the largest cost element at $53.9 million and covers the engineering and development activities associated with CPDLC software and hardware development. About $19 million of these costs are salvageable, including communications software and network routers ($15 million) and portions of requirements and specifications documents ($4 million).

- Although difficult to quantify, FAA believes other documentation (i.e., security certification documents, controller and maintenance technician training packages, and test and evaluation plans) may have salvageable value of about $2.2 million.

- Additionally, FAA believes of the $4.7 million spent on communications network and messaging costs, some of the engineering efforts to determine the viability of the communications network (which enables air/ground data communications exchange) have value ($1 million) because they will not have to be repeated when developing a follow-on system.

- Some of the human factors work for controllers and pilots valued at $500,000 can be used for future efforts as well.

We identified a number of processes and controls that FAA should establish to avoid similar outcomes in future data link efforts. First, FAA must do a better job of developing reliable cost and schedule estimates. Additionally, FAA needs to more clearly define criteria for collaborative agreements with the private sector when joint investments are needed from both the Government and airspace users to move forward with an initiative.

When FAA and industry agreed to proceed with CPDLC in 1998, little thought was given to the criteria for moving forward with the program if problems arose or how subsequent decisions to continue would be made. FAA and industry officials believe that clearly defined entrance and exit criteria that consider both FAA and user goals in the "start," "continue," and "stop" decision-making process would have helped.

Entrance and exit criteria would have helped for several reasons. FAA and its CPDLC industry partners would have agreed on the ramifications of failing to meet or achieve particular events or conditions. This could have enabled better investments and program planning.

For example, if criteria for CPDLC had included the requirement that 100 airplanes be equipped by the start of daily use at Miami for the program to continue (to be followed by further equipage of more than 200 aircraft by a later date), FAA may have cancelled CPDLC sooner, because by mid-2003, only about

30 aircraft had been equipped. Consequently, had FAA established quantifiable avionics equipage level commitments by aircraft owner-participants before key site demonstration or national deployment decisions were made, FAA would have been better prepared to make a "start," "continue," or "stop" decision.

To ensure participation in future data link efforts, FAA and users need to identify agreed-upon incentives to garner a defined level of user participation. Before users invest, they will need to perceive benefits exist and when the benefits can be realized. These incentives/benefits should specify what services will be provided, when they will be delivered, and how costs (e.g., messaging costs) will be distributed between the participants.

Recommendation

We have made numerous recommendations over the years to FAA regarding the need to strengthen its processes for developing reliable cost and schedule estimates for major acquisitions, and we are not making any further recommendations about that at this time. However, the problems FAA and airspace users encountered with CPDLC show the need for the Agency to do a much better job of managing programs and setting expectations when both Government and industry need to make investments in new systems. Accordingly, we are recommending that FAA:

1. Implement a process by which FAA and industry agree on entrance and exit criteria for the execution of joint programs. Should FAA start another CPDLC program, such entrance and exit criteria should include:

   a. Quantifiable avionics equipage level commitments by aircraft owner-participants before any key site demonstration or national deployment receives FAA "start" or "continue" decisions, as well as private sector participation thresholds below which a "stop" decision is made; and

   b. FAA and industry agreed-upon incentives/benefits to garner a defined level of user participation.

Management Comments

On September 9, 2004, we met with FAA program officials from the Air Traffic Organization, En Route and Oceanic Service office to obtain their oral comments to our discussion draft report. FAA officials generally agreed with our finding and recommendation. We are requesting that FAA provide written comments to the final report within 30 calendar days.

BACKGROUND

FAA has pursued many different uses of data link technology over the years under one umbrella program known as Aeronautical Data Link. The individual applications of data link differ significantly in complexity and intended use. Some uses of data link are one-way only and, for example, broadcast weather information to pilots. CPDLC, on the other hand, is a much more complex use of data link technology and allows for two-way communication between controllers and pilots. Implementing CPDLC—and obtaining its expected benefits—required joint investments by FAA (in new ground systems) and airspace users (in new avionics).

In late 1998, FAA and industry (i.e., airlines, labor unions, and aviation service providers) reached a general agreement on the specific technology to transmit messages (Very High Frequency Digital Link Mode-2: VDL-2) and a phased approach for moving forward with CPDLC in the en route environment. American Airlines agreed to serve as the lead airline and begin equipping aircraft with new avionics for trials at Miami Air Route Traffic Control Center.

The acquisition strategy for implementing CPDLC was proposed as four "builds" or phases. FAA only approved costs to proceed with Build I and Build IA of the CPDLC program. The program acquisition cost estimate in 1999 for these two builds totaled $167 million.

The first phase of CPDLC—Build I—was a single site deployment at Miami Center that included four basic types of messages (referred to as services). CPDLC Build I would implement the services required to perform transfer of communications, initial contact, altimeter setting, and pre-defined free text messages. These messages would be sent to data-link equipped aircraft using a service provider's VDL-2 air/ground network. The second phase—Build IA—was to be deployed to all 20 domestic facilities that manage high-altitude traffic and was to increase CPDLC's message set by adding five additional services. The new messages would accommodate assignment of speeds, headings, and altitudes, as well as a route clearance function. A capability to handle pilot-initiated altitude requests would also be implemented. CPDLC Build II was to expand upon CPDLC Build IA services and messages provided. The deployment of Build III was expected to be the final phase of the FAA's CPDLC program, but details of the increased capabilities of Build III were never determined.

CPDLC was expected to play an important role in the Agency's Operational Evolution Plan for enhancing capacity and reducing delays over the next decade. According to FAA, CPDLC was expected to reduce aircraft direct operating costs by reducing delays and improving efficiency through decreasing (1) congestion on

the voice channels, and (2) operational errors resulting from misunderstood instructions and read-back errors.

In early 1999, FAA contracted with Computer Science Corporation (CSC) for the development of the software for the ground systems and links to controller displays. In January 2000, FAA awarded another contract to CSC for the Build IA effort to develop additional types of messages and subsequently deploy CPDLC nationwide. FAA and American Airlines began using the Build I phase of CPDLC in October 2002. In 2003 FAA cancelled the Build IA effort and subsequently decided to shut down the Build I system in Miami. FAA expects to terminate all CPDLC activities by March 2005.

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of our review were to determine (1) the reasons for CPDLC's cancellation, (2) what work may be salvageable, and (3) what processes or controls FAA should adopt to avoid similar occurrences in the future.

We conducted our audit between May 2004 and August 2004. To determine the reasons FAA cancelled CPDLC, we interviewed CPDLC program officials, as well as representatives from American Airlines, Continental Airlines, and ARINC, the CPDLC communications service provider. We reviewed data link program documents, relevant reports, and other literature on current and past data link activities. We also reviewed selected reports and testimonies issued by the DOT Office of Inspector General and the Government Accountability Office.

To assess what work may be salvageable, we reviewed CPDLC expenditures and accomplishments by major program component and assessed the potential for their use on a future data link program based on analysis provided by the CPDLC program manager.

To identify the processes or controls FAA should adopt to avoid similar occurrences in the future, we drew from conclusions obtained during interviews and our assessment of what led to the CPDLC program cancellation.

The audit was conducted in accordance with Government Auditing Standards prescribed by the Comptroller General of the United States and included such tests as we considered necessary to provide reasonable assurance of detecting abuse or illegal acts.

FINDING AND RECOMMENDATION

FAA decided to cancel the current CPDLC program for a number of reasons. FAA's reasons for canceling the program included cost growth and schedule delays, including the emergence of unplanned additional requirements that posed a risk to the program, and concerns over how quickly airlines would equip with avionics. Although FAA may start another CPDLC program in the future, it is difficult to quantify precisely what can be salvaged from the dollars spent because it is unclear what the next CPDLC effort will resemble in terms of specific technology and related FAA infrastructure. We estimate that $23 million of the $100 million spent to complete CPDLC close-out activities may be salvageable for future data link efforts. Finally, we identified a number of lessons learned or processes and controls that FAA should establish to avoid similar outcomes in the future. The Agency must establish guidelines for future joint investment demonstration programs that minimize the kinds of risks that contributed to CPDLC problems and led to its cancellation.

Several Factors Contributed to FAA's Decision To Cancel CPDLC

We found that a number of factors contributed to FAA's decision, including the fact that the approved program baseline of $166.7 million for acquisition costs was no longer valid. In 2003, FAA estimated that it would cost $236.5 million for eight locations, a $69.8 million increase for less than half the locations and capabilities originally planned. Additionally, deployment to the proposed final eighth site was to occur 1.5 years later than previously planned. The table provides the original and proposed CPDLC costs and schedule information.

Table 1. CPDLC Costs and Schedule Comparison
($ in Millions)

CPDLC Program	Estimated Costs and Schedule		Variance
Year Planned	1999	2003	
Facilities and Equipment	$166.7	$236.5	$69.8 million
Operations	$478.7	$345.2	-$133.5 million
Number of Sites Planned	20	8	-12 sites
Start	06/05	12/06	1.5 years
Complete	2015	2017	2.0 years

Source: OIG analysis of FAA Acquisition Program Baseline reports

CPDLC experienced overruns and delays in part because certain program assumptions were invalid. For example, it was assumed the DSR workstations, which controllers used to input data link messages, would not require a software change to accommodate CPDLC. This proved wrong and increased cost and schedule estimates for CPDLC and DSR integration.

CPDLC Impact on FAA's Facilities and Equipment (F&E) Account

Approximately 60 percent of the $69.8 million increase was attributable to growth in engineering, software development, testing, and associated program management costs. The remaining 40 percent is predominantly composed of messaging costs, which FAA was planning to initially pay for with F&E funds.

In addition to the $69.8 million increase, development costs would have increased because CPDLC was intended to integrate with the Host computer system, but program delays required FAA to integrate CPDLC with ERAM (Host's replacement system). FAA originally assumed CPDLC would be in place at facilities that manage high-altitude traffic before ERAM development began. When this assumption proved incorrect, ERAM software integration requirements posed a potential risk to both programs' cost and schedule. Significant changes to CPDLC software were likely to be needed to interface CPDLC with the ERAM infrastructure, which were not planned or budgeted for in the CPDLC program baseline. CPDLC also posed a schedule risk to ERAM because CPDLC related-software upgrades were now expected to occur during ERAM development.

If CPDLC had been deployed before ERAM, the ERAM program would have had to pay the cost and schedule impact to interface with CPDLC, because CPDLC would have been an existing fielded system. If not, the CPDLC program would have had to absorb the cost and schedule impact to interface with ERAM. The 2003 proposal to "re-baseline" CPDLC showed the program would have been deployed between 2005 and 2006, and ERAM is currently planned to be deployed between 2008 and 2010.

CPDLC Impact on FAA's Operations Account

Another important factor influencing the cancellation of the program was the impact on the Agency's operations account, which is already overburdened. FAA estimated it would cost $345.2 million to operate a reduced CPDLC from FY 1999 through FY 2017. This cost included, among other things, $63 million for controller training and overtime and $191 million for CPDLC messaging costs ($9 million in FY 2008 and $20 million annually from FY 2009 through FY 2017). While the $345.2 million was lower than the original estimate of $479 million, the program was significantly reduced in scope, because FAA was

planning to operate CPDLC at 8 sites as opposed to the 20 sites originally planned. Out-year operating costs would be even higher if all 20 sites were brought on line.

CPDLC Equipage Rates Impacted the Program

FAA was also concerned about users' ability and willingness to equip given the airline industry's economic downturn in 2001. In 2001, network carriers began incurring substantial net losses, accumulating to a total of $23.4 billion by the end of the first quarter of 2004. The financial shape of the airlines was important because FAA was relying on voluntary equipage.

Airline representatives told us that reduced CPDLC capabilities (including FAA's plan to deliver only four of nine planned services) also affected the airlines' equipage plans because important benefits were removed. For example, FAA's plan to deploy CPDLC with a capability to handle pilot-initiated altitude requests was deferred until later in the program. FAA's decision to defer delivery of the remaining five capabilities affected airlines rates of equipage because benefits the airlines considered important would not be provided until later in the CPDLC program. Delays in obtaining benefits resulted in lengthening the period between airlines avionics investments and their costs recovery, a situation airlines wanted to avoid.

Only Limited Work From CPDLC Can Be Salvaged for Future Data Link Efforts

It is difficult to quantify precisely what can be salvaged from the dollars spent on CPDLC because it is unclear what the next CPDLC effort will resemble in terms of specific technology and related FAA infrastructure.

We focused our analysis specifically on the FAA CPDLC Build I and Build IA efforts from 1999 to 2004. We estimate that $23 million of the $100 million FAA spent on CPDLC may be salvageable for future data link efforts. The following table illustrates what FAA spent on data link by specific activity and what we estimated can be salvaged.

Table 2. CPDLC Expenditures and Salvage Values
($ in Millions)

CPDLC Accounts	Spent	Salvageable
Facilities and Engineering (F&E) Costs		
Build I/IA		
Program Management	$17.1	$ 0.0
System Development	53.9	19.0
Test and Evaluation	9.4	1.5
Human Factors	1.2	0.5
Communications Network & Messaging Costs-Engineering	4.7	1.0
Training, Security, Maintenance, Implementation	6.1	0.7
Closeout/Shutdown	3.0	0.0
Subtotal Build I/IA	**95.4**	**22.7**
Build II		
Planning Documents	2.4	0.0
Total F&E	**$97.8**	**$22.7**
Operations Costs		
Controller Overtime	2.0	0.0
Total CPDLC	**$99.8**	**$22.7**

Source: OIG analysis of CPDLC cost data

We note that very little can be used "as is" because CPDLC was specifically designed to work with the current Host computer (the central nervous system for facilities that manage high-altitude traffic), which is being completely replaced through the $2.1 billion ERAM program. A future data link program, which has yet to be defined, can make use of portions of CPDLC. FAA's CPDLC program manager indicated, however, that the value of these potentially useful items diminishes as time elapses due to technology obsolescence.

CPDLC "system development" was the largest cost element at $53.9 million and covers the engineering and development activities associated with Build I and Build IA software and hardware development. About $19 million of these costs is salvageable: $15 million for communications software and network routers and $4 million for portions of requirements and specifications documents. Although difficult to quantify, FAA believes other documentation (i.e., security certification documents, controller and maintenance technician training packages, and test and evaluation plans) may have some salvageable value.

Additionally, FAA believes of the $4.7 million spent on communications network and messaging costs, some of the engineering efforts to determine the viability of

the communications network (which enables air/ground data communications exchange) have value ($1 million) because they will not have to be repeated when developing a follow-on system. Some of the human factors work for controllers and pilots valued at $500,000 also can be used for future efforts.

Industry stakeholders were reluctant to divulge exactly how much they had invested, but an airline official indicated the avionics equipment, knowledge gained from participation, and training modules had value for a future data link program. Likewise, the CPDLC's communications service provider, ARINC, indicated its communications network had value for a future data link program.

Better Processes and Controls Are Needed To Avoid Similar Occurrences in Future Data Link Efforts: Important Lessons Learned From CPDLC

Based on our discussions with FAA and industry officials, there are a number of lessons that need to be taken into account for future modernization efforts, particularly ones that involve joint industry/Government investments. Implementing CPDLC was challenging because it required synchronized investments between FAA (new ground systems) and airspace users (new avionics). At the same time, FAA and the airlines were responding to the economic slowdown of the early 2000s, which raised questions about how quickly airlines would equip. FAA's guidelines and procedures for managing major acquisitions as outlined in the Agency's Acquisition Management System do not sufficiently address joint investment programs.

As we have previously reported,[2] FAA also needs to develop reliable cost and schedule estimates. Costs and schedule problems with ongoing modernization efforts have serious consequences because they result in postponed benefits (in terms of safety and capacity), the crowding-out of other modernization projects, costly interim systems, or a reduction in units procured.

FAA and Industry Must Agree on "Entrance" and "Exit" Criteria for the Execution of Data Link Programs

When FAA and industry agreed to proceed with CPDLC in 1998, little thought was given to the criteria for moving forward with the program if problems arose or how subsequent decisions would be made. In retrospect, FAA and industry officials believe that clearly defined entrance and exit criteria that consider both

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2 Testimony before the Senate Committee on Appropriations, Subcommittee on Transportation/Treasury and General Government; "Key Issues for the FAA's FY 2005 Budget," CC-2004-038; April 22, 2004.

FAA and user goals in the "start," "continue," and "stop" decision-making process would have helped.

Entrance and exit criteria would have helped for several reasons. FAA and its CPDLC industry partners would have agreed on the ramifications of failing to meet or achieve particular events or conditions. This would have prevented surprises among the participants and enabled better investment and program planning.

For example, if criteria for CPDLC had included the requirement that 100 airplanes be equipped by the start of daily use at Miami for the program to continue (to be followed by further equipage of more than 200 aircraft by a later date), FAA may have cancelled CPDLC sooner, because by mid-2003, only about 30 aircraft had been equipped. Consequently, had FAA established quantifiable avionics equipage level commitments by aircraft owner-participants before any key site demonstration or national deployment decisions were made, FAA would have been better prepared to make a "start," "continue," or "stop" decision.

To ensure participation in future data link efforts, FAA and users need to identify agreed-upon incentives to garner a defined level of user participation. Before users invest, they will need to perceive benefits exist and when the benefits can be realized. These incentives/benefits should specify what services will be provided, when they will be delivered, and how costs (e.g., messaging costs) will be distributed between the participants.

RECOMMENDATION

We have made numerous recommendations over the years to FAA regarding the need to strengthen its processes for developing reliable cost and schedule estimates for major acquisitions, and we are not making any further recommendations about that at this time. However, the problems FAA and airspace users encountered with CPDLC show the need for the Agency to do a much better job of managing programs and setting expectations when both Government and industry need to make investments in new systems. Accordingly, we are recommending that FAA:

1. Implement a process by which FAA and industry agree on entrance and exit criteria for the execution of joint programs, should FAA start another CPDLC program, such entrance and exit criteria should include:

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private sector participation thresholds below which a "stop" decision is made; and

    b. FAA and industry agreed-upon incentives/benefits to garner a defined level of user participation.

MANAGEMENT COMMENTS

On September 9, 2004, we met with FAA program officials from the Air Traffic Organization, En Route and Oceanic Service office to obtain their oral comments to our discussion draft report. FAA officials generally agreed with our finding and recommendation.

ACTION REQUIRED

In accordance with DOT Order 8000.1C, we would appreciate receiving your written comments on this report within 30 calendar days. If you concur with the finding and recommendation, please indicate the specific action taken or planned for the recommendation and the target date for completion. If you do not concur, please provide your rationale. You may provide alternative courses of action that you believe would resolve the issues presented in this report.

We appreciate the courtesies and cooperation of FAA representatives during this audit. If you have any questions concerning this report, please call me at (202) 366-1992 or David Dobbs, Assistant Inspector General for Aviation Audits, at (202) 366-0500.

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EXHIBIT A. ACTIVITIES VISITED OR OFFICIALS CONTACTED

FAA Air Traffic Organization, Vice President for En Route and Oceanic Services

FAA Controller Pilot Data Link Communications Program Officials and Staff

American Airlines, Managing Director of Systems Operations Engineering

Continental Airlines, Regulatory Affairs Official

ARINC, Vice President Aviation and Air Traffic Services

ARINC, Director, Global Link Services, Aviation and Air Traffic Services

EXHIBIT B. MAJOR CONTRIBUTORS TO THIS REPORT

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