

March 7, 2011

Ms. Peggy Gilligan  
Associate Administrator for Aviation Safety  
Federal Aviation Administration  
800 Independence Ave, S.W.  
Washington, D.C.

Dear Peggy,

The Performance-Based Operations Aviation Rulemaking Committee (PARC) is pleased to submit the enclosed report entitled, *Future Air Navigation System (FANS) 1/A over High Frequency Data Link (HFDL) Recommendations*. This report supplements the *FANS 1/A over Iridium (FOI) and Performance-Based Concept Recommendations* report that I submitted to you on behalf of the PARC on September 17, 2010.

FANS 1/A provides controller-pilot data link communications (CPDLC) and automatic dependent surveillance – contract (ADS-C) in oceanic airspace to advance safety and provide operational and environmental benefits. FANS 1/A typically operates over satellite communications (SATCOM). However, there are also benefits from FANS 1/A over HFDL.

The PARC would like to highlight the benefits of using HFDL in FANS 1/A operations. While some operators are equipped only with HFDL, others are equipped with both SATCOM and HFDL. When an operator is equipped only with HFDL, leveraging this capability in FANS 1/A operations can reduce the effects of operational errors and pilot deviations. It can reduce congestion on the voice channel providing improved access to operators that are not FANS 1/A equipped. FANS 1/A over HFDL provides air traffic control (ATC) communication coverage in the Polar region, where coverage is not provided with commonly used communication services that use high-earth orbit geosynchronous satellites. It can provide greater reliability of the total system and facilitate safer transitions to alternative separations when the SATCOM service fails.

The PARC recognizes that while FANS 1/A over HFDL offers significant benefits, it may not be suitable for some reduced separations, such as 30 nautical mile (NM) lateral and 30 NM longitudinal separation. As a result, certain provisions may be necessary to recognize aircraft with lesser capability yet still leverage it to gain operational and safety benefits. Recommendation 2 in the *FOI and Performance-Based Concept Recommendations* report to implement a performance-based framework includes the provisions to address near- to midterm and long-term initiatives supporting the next generation air transportation system (NextGen). The *FANS 1/A over HFDL Recommendations* report substantiates the need to phase in the performance-based framework and expedite those portions needed to realize near-term gains in operational and safety benefits from FANS 1/A over HFDL operations.

For longer term gains in benefits, the *FANS I/A over HFDL Recommendations* report includes a recommendation for the FAA to work with industry to ensure that the standards for the next generation ADS-C application address the needs for both aeronautical operational control (AOC) and air traffic services (ATS) communications for more efficient and effective use of air-ground communications. This recommendation should be addressed by RTCA Special Committee (SC) 214 and EUROCAE Working Group (WG) 78 in cooperation with the ICAO Operational Data Link Panel (OPLINKP).

The PARC appreciates your continued support of our activities and invites you to join us in a discussion of these recommendations at your convenience. The PARC respectfully requests the FAA to provide us with a formal response to these recommendations. Please call me if you have any questions or would like to set up a discussion.

Sincerely,

A handwritten signature in black ink, appearing to read "Dave Nakamura". The signature is fluid and cursive, with a long horizontal stroke at the end.

Dave Nakamura  
Chairman  
Performance-based operations Aviation  
Rulemaking Committee

Final  
March 3, 2011

# FANS 1/A over High Frequency Data Link Recommendations



Prepared by:  
**Performance-Based Operations  
Aviation Rulemaking Committee**  
Communications Working Group  
(PARC CWG)



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## FOREWORD

In 2008, Hawaiian Airlines and ARINC, Inc, in cooperation with the Federal Aviation Administration (FAA) Oakland Center initiated the future air navigation system (FANS 1/A) over high frequency data link (HF/HFDL), or FOH, project. Designed with the best interest of the aviation community in mind, its purpose is to advance communication technology and leverage existing capabilities to meet operational needs. In July 2010, the Performance-based Operations Aviation Rulemaking Committee Communications Working Group (PARC CWG) accepted the project into its work program. The project, completed in August 2010, substantiates recommendations provided in this report through laboratory evaluations, pre-FOH operations to evaluate performance of aeronautical operational control (AOC) communications, and FOH operational trials.

All participants volunteered to participate in the FOH project, agreed to bear their own costs and provided information to support the evaluations. The PARC CWG appreciates the cooperation of operators, air navigation service providers (ANSPs), communication service providers (CSPs), avionics suppliers, aircraft manufacturers, regulators, and all those who were essential in bringing this project to completion. The PARC CWG relied on the FAA and central reporting agency's proper handling of the data and leveraged the resources and expertise needed to conduct data analysis and coordinate on corrective actions.

The PARC CWG embraced the International Civil Aviation Organization's (ICAO) Global Operational Data Link Document (GOLD) for the FOH project to provide:

- a) Globally recognized success criteria, in accordance with required communication performance (RCP) and surveillance performance specifications, provided at Appendix B and Appendix C, respectively; and
- b) Guidelines to monitor and analyze the data, in accordance with Appendix D.

The PARC notes that the FOH evaluation with Hawaiian Airlines is localized in Central East Pacific (CEP) and encourages follow-on evaluations in other parts of the world to show global applicability of the recommendations. The PARC looks forward to continuing its work with the FAA and other stakeholders to ensure FOH operations continue to perform as intended in an acceptably safe manner.

## **Introduction**

The HFDL service was launched in 1998 with only a few stations, an adventurous customer, and a great deal of promise. It has evolved into a robust service using 15 ground stations strategically placed across the globe covering the earth, especially the polar regions, with 31 independent, interlocking frequencies. They are actively managed to ensure redundant coverage and, in effect, to optimize continuous service anywhere on the planet. In the last twelve years, the service has enjoyed double-digit message growth year after year and boasts more than 72 customers, 1400+ equipped aircraft and worldwide coverage. Primarily, the HFDL service provides aircraft communications addressing and reporting system (ACARS) aeronautical operational control (AOC) messaging at a highly reliable success rate.

In the past few years, more and more ANSPs have been receiving position reports via FANS 1/A and flight management computer waypoint position reporting (FMC WPR) over HFDL in airspace where reduced separations are not applied and as a "back up media" mostly during anomalies with satellite communications (SATCOM). In most cases, the delivery times were well within the acceptable performance criteria using RCP 400 and surveillance performance 400 specifications provided by the GOLD.

Commercial airlines and cargo carriers, equipped with very high frequency (VHF) and HFDL, have been interested in accessing the highly desirable FANS 1/A routes for speed, efficiency and fuel savings. Coupling the carrier's needs with the ANSP's desire to automatically integrate aircraft data into flight data processing systems, minimize voice and optimize airspace usage, a trial was initiated in Oakland flight information region (FIR) between Hawaii and the mainland U.S.A. to test the operational performance of the HFDL system.

It is envisioned that operators of multi-media aircraft will benefit from use of the HFDL sub-network for FANS 1/A operations by more fully utilizing the existing aircraft capabilities.

## Purpose and scope

The PARC CWG evaluates technologies in a performance-based framework for their suitability in aeronautical applications, such as a long range communication system (LRCS). The PARC CWG is evaluating:

- a) Iridium short burst data (SBD) – Alternative to other aeronautical mobile satellite (route) service (AMS(R)S) capability;
- b) Inmarsat – Classic Aero and SwiftBroadband (SBB) (next generation) using the 4<sup>th</sup> generation (I4) Inmarsat satellites;
- c) ARINC – HFDL for some performance-based operations and backup to SATCOM data;
- d) SATCOM voice (Iridium and Inmarsat) providing an additional communication tool for use by controllers and pilots; and
- e) Communications supporting the next generation air transportation system (NextGen).

The results of these evaluations are intended to substantiate advice and recommendations to the FAA on operations, policy, standards, guidance material, and implementation. Global harmonization is also crucial to the success of any State or regional implementation initiative. Therefore, PARC CWG remains cognizant of developments on related international standards, guidance material and implementation, and includes matters of global harmonization in its advice and recommendations to the FAA.

This report specifically addresses recommendations related to FOH operations. It supplements the *FANS 1/A over Iridium (FOI) and Performance-Based Concept Recommendations* and further substantiates the need for the implementation of a performance-based framework for RCP and surveillance performance specifications.

The scope of work included an operational trial and the results were used to evaluate the HFDL sub-network with the goal of achieving approval for FANS 1/A operations using HFDL.

- a) The near-term goal is to use the HFDL sub-network for FANS 1/A applications supporting RCP 400 and surveillance performance 400 operations. The separation standards where FANS 1/A provides an acceptable data link capability for these operations include reduced separation to 50 nautical miles (NM) lateral on required navigation performance (RNP) 10 routes and existing time-based longitudinal separations.
- b) The longer term goal is to evaluate architectures that use dissimilar sub-networks, e.g., VHF and SATCOM (Iridium and/or Inmarsat), in conjunction with HFDL, to meet performance criteria required to support longer term oceanic/remote operations.



## Benefits

FANS 1/A provides benefits through the use of controller-pilot data link communications (CPDLC) and automatic dependent surveillance – contract (ADS-C) in oceanic airspace typically through satellite communications (SATCOM) to advance safety and provide operational and environmental benefits. However, there are also benefits from FOH such as the following:

- a) When an operator is equipped only with HFDL, FOH operations can reduce the effects of operational errors and pilot deviations when appropriate separation standards are applied, and reduce congestion on the voice channel providing improved access to operators that are not FANS 1/A-equipped.
- b) Additionally, FOH provides air traffic service (ATS) communication coverage in the polar region, where coverage is not provided with commonly used communication services that use high-earth orbit geosynchronous satellites.
- c) When an operator is equipped with both SATCOM and HFDL, FOH can provide greater reliability of the total system and facilitate safer transitions to alternative separations when the SATCOM service does fail for aircraft that are equipped also with HFDL.
- d) HAL, which operated flights during the trial, has appreciated the safety enhancement that FANS 1/A can offer. HAL reports that they enjoy these enhancements regardless of the data link medium used and highlights the following benefits:
  - 1) Provides automated position reports enabling enhanced route conformance monitoring (detects manual entry errors);
  - 2) Reduces flight crew work load;
  - 3) Provides communication means during normal operations and when voice communication is not available;
  - 4) Enhances air traffic control (ATC) communications when English is not the native language;
  - 5) Enables flight crew to automatically load ATC route clearances into the flight management system (FMS) removing potential flight crew input errors;
  - 6) Enables printing of ATC clearances for review minimizing flight crew transposition errors;
  - 7) Provides enhanced emergency communications (hijack, diversion, lost voice communications); and
  - 8) Reduces HF voice congestion.

## Recommendations

Significant operational and safety benefits will be lost unless actions are taken to sustain current communications and surveillance capabilities. Furthermore, NextGen operational improvements will depend on appropriate and operationally acceptable communications and surveillance capabilities together with performance-based navigation (PBN). Implementing the recommendations provided herein should promote expansion of data link services, provide incentives for fleet equipment and enable performance-based operations consistent with NextGen objectives.

While FOH offers significant benefits, it may not be suitable for some reduced separations, for example, 30 NM lateral separation, 30 NM longitudinal separation and 50 NM longitudinal separation. As a result, certain provisions are necessary to recognize aircraft with lesser capability, yet still leverage it to gain operational and safety benefits. However, it is noted that media type is not the only factor in determining aircraft with lesser capability.

*Note.* — The recommendations provided in this report are supplementary to those provided in the “FOI and Performance-Based Concept Recommendations” report.

**RECOMMENDATION 1.** Expedite the steps necessary to remove restrictions on current FOH operations to realize immediate gains in efficiency and safety benefits.

*Rationale.* HFDL is viable for CPDLC/RCP 400 and ADS-C/specification 400 operations. ARINC has committed resources to operate a sub-network for FANS 1/A CPDLC and ADS-C operations, which can exceed these performance specifications. In airspace where communication and surveillance performance specifications are CPDLC/RCP 400 and ADS-C/400, as a minimum, FOH provides features, which are not inherent in HF voice, that minimize the risks of pilot deviations and operational errors, such as:

- a) *Appropriate separations.* FOH will be limited to the separation standards that rely on RCP 400 and ADS-C/400 specifications, i.e., equivalent to HF voice.
- b) *ATS communications.* Allow use of FOH for normal (primary) means of ATS communications, when appropriate. Coordinate with Japanese Civil Aviation Bureau (JCAB) on the possibility of removing restrictions on using FOH in the Fukuoka FIR when appropriate separations are applied.

**RECOMMENDATION 2.** In the near term, plan for and implement those portions of the performance-based framework to enable use of RCP 400 and surveillance performance 400 specifications.

*Note.* — See RECOMMENDATION 2 of the “FOI and Performance-Based Concept Recommendation” report for the rationale to implement a performance-based framework for communications and surveillance. This report emphasizes the need to implement RCP 400 and surveillance performance 400 within that framework as soon as possible and reiterates those portions requiring early implementation.

**Rationale.** The North Atlantic Region is planning a data link mandate to begin in February 2013, which currently proposes use of RCP 400 and surveillance performance 400 specifications, for safety. The data link is intended to mitigate the effects of pilot deviations and operational errors. For example, the data link will enhance communications and surveillance to reduce and detect large height deviations, which has dramatically increased in the North Atlantic (NAT) Region over the last 7 years. Other regions, such as Asia-Pacific Regions, are already applying reduced separations, 30 NM laterally and longitudinally, to eligible aircraft pairs. These reduced separations require CPDLC/RCP 240 and ADS-C/surveillance performance 180 specifications. Eventually, the NAT intends to apply reduced separations, which may require more stringent specifications. The use of RCP 400 and surveillance performance 400 specifications within the performance-based framework for communications and surveillance will provide flexibility for operators to comply with varying airspace requirements for these near term operational improvements.

There are situations today (not related to FOH operations), where aircraft/operator performance is at a level less than what is required for the performance-based operation, yet there are no provisions for the operator to indicate qualification level and apply appropriate services to eligible operators. The ANSP would need to consider any special requirements or restrictions in service provisions and/or Regional Supplementary Procedures (SUPPs), Aeronautical Information Publication (AIP), or equivalent. The operator should show compliance to requirements and be approved for use by State of the Operator or State of Registry via appropriate approval processes. The ATC facility will need a capability to distinguish FANS 1/A performance level for eligibility of service level, e.g., applying reduced separations.

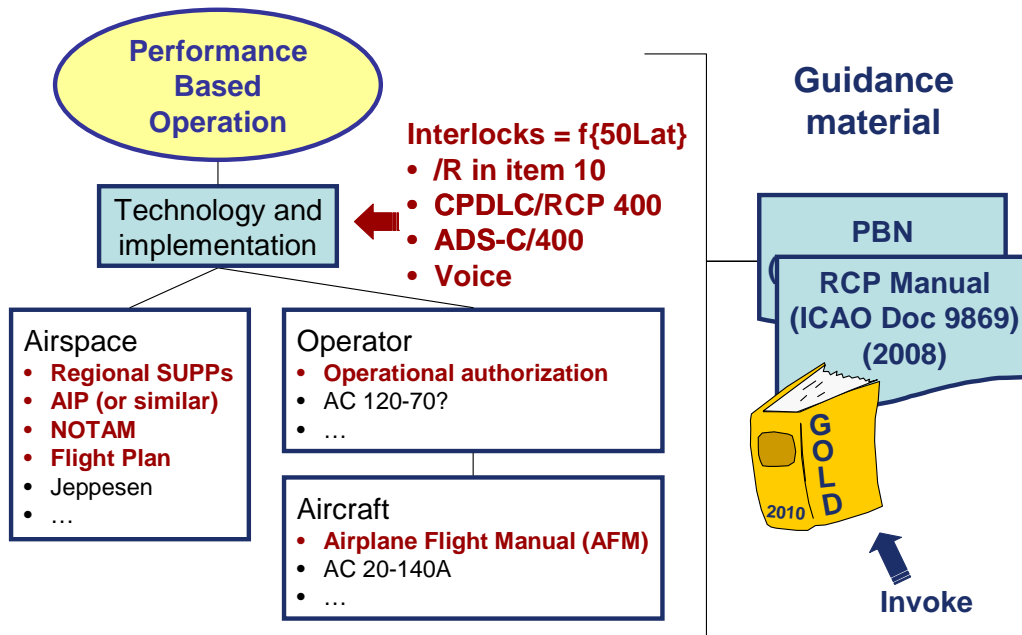
Implementing a performance-based framework for communications and surveillance and prescribing appropriate specifications will facilitate approval processes and promote seamless data link operations, including:

- a) **Flight plan.** Develop standards and guidance material to use 2012 flight plan provisions for indicating appropriate RCP specifications for communications, such as CPDLC, and performance-based specifications for surveillance, including ADS-C and automatic dependent surveillance – broadcast (ADS-B). Prior to 2012, consider changes to flight plan filing requirements to indicate performance specifications in the flight plan, under Item 18, that would coincide with ATC procedures and/or automation changes.
- b) **Operational Specifications.** Revise templates for the FAA A056, *Data Link Operational Specifications*, and *Letter of Authorization (LOA)* to provide for varying capability. Revise advisory circular (AC) 120-70B, *Operational Authorization Process for Use of Data Link Communication System*, and Order 8900.1, *Flight Standards Information Management System (FSIMS)*, to provide qualification criteria. In international forums, advocate a requirement for operational authorizations for non-U.S. operators issued by the State of the Operator or State of Registry.
- c) **ATC procedures and automation changes.** Develop and implement changes to ATC facility automation and/or procedures to apply appropriate level of service to eligible aircraft as determined by flight plan indicators that identify the aircraft capability and operator's authorization for use.
- d) **CPDLC RCP and ADS-C safety performance monitoring.** Continue to monitor CPDLC and ADS-C performance in accordance with the *GOLD*. Consider criteria applied to FOH when, outside VHF coverage area, HF DL is the only sub-network and HF DL is part of a multi-media configuration, e.g., in combination with SATCOM. Develop procedures to notify appropriate

parties (e.g., principal operations inspectors (POIs) and operators) of non-conforming operations and to implement corrective action.

- e) ***Service outages and availability.*** Coordinate with ICAO to assess criteria in the GOLD and determine if changes are needed taking into account use of the HFDL sub-network as a viable sub-network for FANS 1/A operations. Consider the means for tracking service availability when using the HFDL sub-network, including data to be collected related to solar activity, non-licensed transmitters, equipment degradations, and flight crew reports.

**Figure 1** provides an overview of an implemented performance-based framework for communications and surveillance using CPDLC/RCP 400 and ADS-C/400. The standards, such as the Regional SUPPs, AIPs and NOTAMs invoke the guidance material, such as the *PBN Manual* and the *GOLD*. The technology and implementation enable the ATC facility to provide the appropriate level of service to eligible operators. Operators are eligible as indicated in operational specifications and based on their filed flight plan.



**Figure 1. Relationship of standards, guidance material, technology and implementation**

**RECOMMENDATION 3.** Work with industry in appropriate standards organizations to ensure future ADS-C application standards meet the needs for both AOC and ATS communications.

This recommendation should be addressed by RTCA Special Committee (SC) 214 and EUROCAE Working Group (WG) 78 in cooperation with the ICAO Operational Data Link Panel (OPLINKP).

**Rationale.** During the FOH trial as well as the FMC WPR NAT trial, company position reports were required by operations as part of their flight following requirements. Part of that message includes the amount of fuel on board. This field is not part of the ADS-C report format.

In a single media environment, company position reports have delayed the ADS-C reports as well as CPDLC transactions. Augmenting the ADS-C report and distributing these reports to not only the ATS center but to the operator host system as well can leverage the information contained therein to satisfy both entities. Consolidating this information has proven to increase performance. In the NAT HFDL trials, the FMC WPR was shared with both the ATS and operator host system. The redundant voice report was given an eight-minute delay so as not to interfere with the data link transmission. In the CEP FOH trial, the flight crew manually sent the required company position report after the avionics automatically sent the ADS-C waypoint crossing report. This change made the largest jump in performance gains for the FOH trial.

- a) **ADS-C report definition.** In addition to information required by an ATS facility, ADS-C reports should include information required by AOC, such as fuel on board and expanded meteorological data that provides sky condition, turbulence level and icing condition.
- b) **Ground-ground distribution of ADS-C reports.** Include technical provisions to allow the CPDLC current data authority to distribute ADS-C reports accordingly to AOC and ATS facilities, via ground-ground communications.

## FOH project

HAL and ARINC in cooperation with FAA Oakland Center initiated an operational trial in 2008. This section provides a brief overview of the project.

### Operator and avionics requirements

Operators that participated in this trial were eligible for FANS 1/A operations per AC 120-70A, *Operational Authorization Process for use of Data Link Communications System*.

The operator's authorization from the State of the Operator or State of Registry did not include any special requirements or restrictions regarding the use of HF DL in FANS 1/A operations. The ANSPs did not specify any special requirements or restrictions in service provisions and/or Regional SUPPs, AIP, or equivalent.

The aircraft installation was certified in accordance with AC 20-140. The HF DL System was and must be compliant with ARINC 635-4.

### Stakeholders

HAL, ARINC, FAA and Airways New Zealand participated in the trial.

### Success criteria

The success criteria used to evaluate the viability of FOH are taken from the RCP 400 and the surveillance performance 400 specifications contained in the GOLD. The criteria in GOLD is based on RTCA DO-306/EUROCAE ED-122, *Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace*, October 11, 2007.

### Description of the trial

Hawaiian Airlines had upgraded their Honeywell HF data radios with ARINC 635-4 software. These aircraft were certified with the installation of a FANS 1/A package and an HF DL communications system. These aircraft were based in Honolulu, HI, and flew daily extended over water operations outside VHF coverage in airspace currently supporting FANS 1/A CPDLC and ADS-C services. Eighteen aircraft were included in this trial. The trial was conducted in the CEP area of the Oakland FIR (See [Figure 2](#)).

Because the HF voice and HF data share the same antenna, the FAA granted relief for the flight crew having to report positions by established voice methods. If the position report did not arrive in the expected time, the FAA controllers were instructed to contact the aircraft via HF voice.





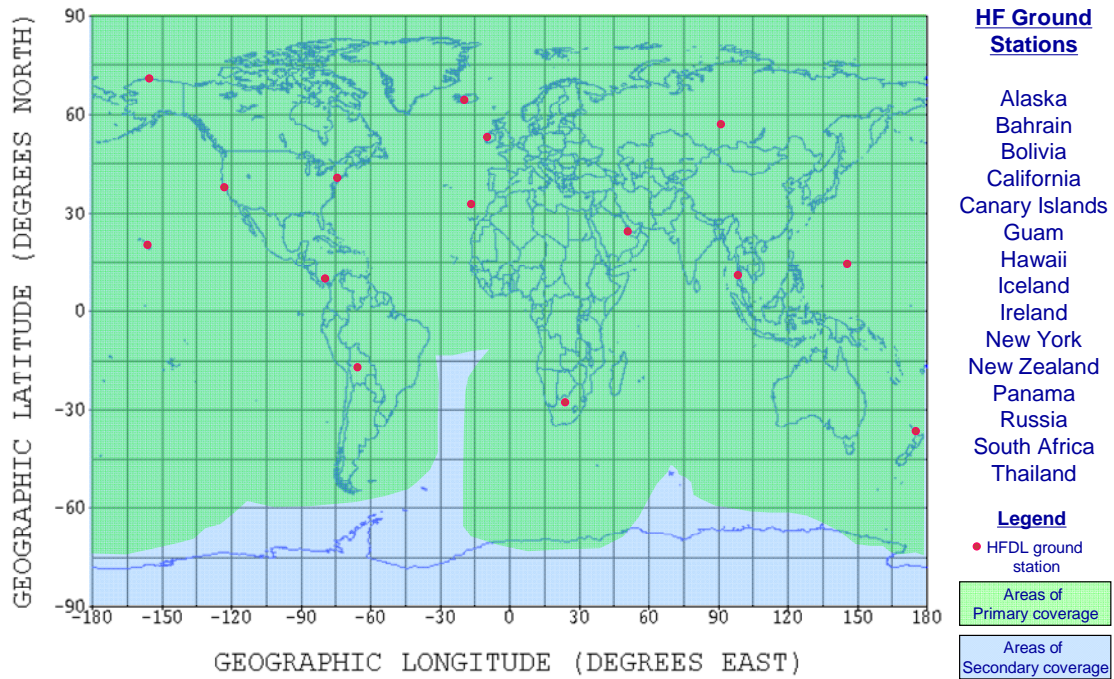


Figure 3. Coverage of HFDL sub-network and station locations

The FOH project evaluated performance on aircraft in the configuration as shown in **Table 1**.

Table 1. Aircraft/network configuration

Component Description	Component Configuration
Operator	Hawaiian Airlines
Number of aircraft and type	Eighteen B767
HF radio manufacturer and model:	Honeywell 964-0452-052
Compliance standard	ARINC 635-4 HF Data Link Protocols
	ARINC 739 multi-function control display unit (MCDU) Interface
	ARINC 758 communications management unit (CMU) Interface
	ARINC 429 high speed (HS) or low speed (LS) Data - Bus Standard.
ACARS type	Honeywell CMU p/n 965-0758-001
Flight management computer (FMC) manufacturer (with FANS 1 software)	Honeywell
Service Provider	ARINC



## Evaluation results

This section provides a summary of the FOH project evaluation results. Detailed results contain sensitive information and are provided as **Attachment A**, which is available only to FAA and FOH stakeholders.

### Lab evaluations

ARINC conducted an avionics qualification procedural (AQP) test to show full end-to-end functionality and interoperability of the HF data radio with the network. These standard tests passed and the radio was deemed acceptable to operate on the ACARS network.

### ACARS over HFDL (AOH) evaluations

ACARS over HFDL (AOH), or pre-FOH, evaluations considered AOC message traffic volume, uplink message failure rate, and message block latency.

Prior to the start of FOH operations, ARINC provided data on AOH operations. Initial installations began in August 2008 and by January 2009, HAL was ready with 18 AOH aircraft. ARINC began early analysis of the HFDL sub-network performance, and PARC CWG was able to determine over a longer period of time the stability and uniformity of that performance. By January 2009, all 18 aircraft were participating in data collection to support the FOH project. The PARC CWG evaluated data from January 2009 to August 2010. By August 2010, ARINC had recorded performance for approximately 70,138 uplink/downlink messages.

The AOH evaluations concluded the following:

- a) **Aircraft/performance variations.** There are performance variations on message delivery for different aircraft installations. These variations are attributable to different aircraft configurations, with multiple versions of radio software, hardware configurations, use of outdated hardware and software, aircraft system architecture, and can significantly affect both AOH and FOH performance. To mitigate these variations, operators using the HFDL sub-network should be equipped with the most recent hardware configurations and ARINC 635-4 compatible radio software.  
  
Over the last 20 months, HAL aircraft using ARINC 635-4 radio software, showed stability in performance using the transit delay metric. The HAL platforms averaged between 96 and 104 seconds for transit delay with an average success rate of 96%.
- b) **Solar events.** Solar events can affect system performance. Solar events are mitigated by the dynamic frequency management process established at ARINC.
- c) **Signal loss/no acknowledgement.** Downlink delivery time statistics show some long delays on messages caused by either signal loss (no communications (NO COMM) event triggers media advisory) or when the CMU retransmits a downlink message because it did not receive the acknowledgement from the ACARS network. These system behaviors ultimately cause delays in AOH and FOH message traffic.
- d) **Stability and uniformity of performance.** Overall, the data showed the HFDL sub-network performance in terms of message delivery failure rate and latency stabilized over a 20-month period, given the changes made over the period of evaluation to improve the system.

- e) ***Block message performance.*** ARINC measured block and message performance from HAL flights on 70,138 AOH messages, with an average length of 83 characters. Message performance is not provided in this report although it is available upon request. On average, AOC messages were relatively small in size and did represent typical CPDLC and ADS-C message size. While measurements are different, PARC concluded the performance was consistent with CPDLC/RCP 400 and ADS-C/400 criteria.

### **FANS 1/A over HFDL evaluations**

FANS 1/A over HFDL evaluations considered ADS-C report delivery and CPDLC transaction latencies, in accordance with the ADS-C/400 and CPDLC/RCP 400 latency criteria. While the FOH trials began in November 2008 and continue presently, the FOH evaluations focused on the period from April to July 2010, with 18 HAL aircraft.

The operational evaluations considered latency on ADS-C reports, actual communication technical performance (ACTP), actual communication performance (ACP), and pilot operational response time (PORT) in Oakland FIR for HAL. This report includes HFDL performance charts covering all of 2010, specifically for HAL and, in general, for all operators using HFDL in multi-media configurations, including Anchorage and New York FIRs. The report also includes HFDL performance charts for 2009 and 2010 in Auckland FIR, provided by Airways New Zealand. During the evaluation period, any changes in the end-to-end configuration were correlated with notable changes in actual performance as far as practicable.

Since FANS 1/A operations were new to HAL, flight crew training and FANS 1/A operations may have affected performance. These aspects of the evaluation did not relate directly to the viability of the HFDL technology. Generally, the latency, continuity and availability data indicated that the HFDL technology was viable for CPDLC/RCP 400 and ADS-C/400 operations.

*Note.* — *The integrity of FANS 1/A operations is provided by the end system and, therefore, is not based on the type of media used. Integrity of the FOH installation on the aircraft was satisfied by the certification process for the FANS 1/A installation.*

The FOH evaluations concluded the following:

- a) ***Configuration changes.*** Changes were made during the HAL FOH evaluation to update the HF radios, adaptation of the Ocean21 system at Oakland Center, processing of AOC messages in HAL's flight planning system, the HF antenna at Hawaii and the HFDL network.
- b) ***Performance factors.*** A number of factors (some are not related specifically to HFDL sub-network) can affect latency on ADS-C report delivery and CPDLC transactions. For example, AOC and ATS functions compete to use the HF radios, which rely on a single antenna, sub-network media selection, FMC flight plan changes, ATC system timers and logon processes, NO COMM status, inter-networking delays, and flight crew response times, can all affect latency measurements for ADS-C report delivery and CPDLC transactions on the HFDL sub-network.
- c) ***Procedures.*** Procedures have been established for the flight crew to:
  - 1) Manually send company position reports after sending the ADS-C or CPDLC position report.
  - 2) Avoid use of HF voice when ADS-C position reports are being processed.

- 3) Track when periodic position reports are sent to avoid interference between CPDLC messages and ADS-C periodic reports.
- 4) Ensure logon while just leaving VHF coverage to ensure that the next periodic report 27 minutes later is well outside VHF fringe coverage.
- 5) Avoid edits to flight plan legs while in oceanic operations to reduce the number of ADS-C downlinks.
- 6) Maintain the pre-flight CSP until logon is complete to avoid routing uplinks to the wrong CSP.
- 7) When necessary, accomplish a CMU RESET to clear messages from the message queue.

Additionally, while procedures have not been established, some flight crews will:

- 8) Maintain HF DL off the network until the logon is completed using the VHF sub-network.
  - 9) Cycle power on HF radio when the radio is struggling to connect to a GOOD or better-rated station approximately 300 NM from an HF radio station.
- d) **ADS-C report delivery/CPDLC transaction latency.** Some operations and implementations can affect latency. As a result, HAL met latency criteria at 95% ADS-C/400 and CPDLC RCP 400 criteria for some months and not for others. When HF DL is part of a multi-media configuration, the time it takes to try other mediums, such as SATCOM, is included in the measurement, so that aircraft with these configurations typically would not meet 95% criteria. However, consideration should be given to ICAO Doc 4444, *Procedures for Air Navigation Services/Air Traffic Management*, paragraph 5.4.2.6.4.3.2, which allows 10½ minutes to complete an ATC communication transaction, and paragraph 5.4.2.6.4.3.3, which allows six minutes to obtain an overdue position report (assumed to be at 95%), following a failure of the normal means of communication. To date, HF DL aircraft are not meeting the latency criteria at the 99.9% requirement, similar to most SATCOM aircraft when compared to the 99.9% criteria of the RCP 240 and ADS-C/180 specifications. The following summarizes latency for ADS-C report delivery and CPDLC transactions:
- 1) **ADS-C report delivery.** HAL met the ADS-C/400 95% latency criterion for May through September and November through December. For the months of January through April, it is believed that degraded performance was primarily owing to lack of procedures to minimize the effects of competing AOC applications, use of HF voice, and media selection algorithms used in VHF fringe coverage areas. Furthermore, HAL met the ADS-C/400 95% latency criterion for 11 aircraft in the fleet during the period July through September 2010. HAL is currently investigating possible causes of “poor performing” aircraft. In addition, since the FOH evaluations were isolated within a single ATC facility, automatic transfers between two facilities and the effects of multiple ADS contracts on performance should be evaluated.
  - 2) **CPDLC transaction.** The data is limited; however, HAL met the ACTP 95% criterion for all months in 2010, except for March and December. HAL met the ACP 95% criterion for all months, except for March, August, September, October and December. However, the year aggregate met the criterion. ACP is affected by PORT, which is not related to the HF DL sub-network performance.

### Service outages and availability

The GOLD provides criteria for evaluating service outages and availability. However, for a number of reasons, the PARC was unable to obtain historical data to adequately evaluate impairments of FOH operations against these criteria. ARINC did provide information on the HFDL sub-network architecture and system management to minimize the effects of high solar activity, other non licensed transmitters using the aeronautical frequencies, and equipment degradations on FOH service availability and outages. HAL provided a flight deck and operational perspective based on their experience.

Evaluations concluded the following:

- a) ***Monitoring for FOH service availability.*** FAA should coordinate with ICAO to assess criteria in the GOLD and determine if changes are needed taking into account use of the HFDL sub-network as a viable sub-network for FANS 1/A operations. Consider the means for tracking service availability when using the HFDL sub-network, including data to be collected related to solar activity, non-licensed transmitters, equipment degradations, and flight crew reports.
- b) ***FANS 1/A outages and availability.*** Currently, ATC facilities provide FANS 1/A services to a mixed fleet, i.e., some using HFDL only some using SATCOM and some using SATCOM in combination with HFDL. In airspace, where HF voice meets requirements for ATS communications, CPDLC and ADS-C has provided more effective and efficient ATS communications over HF voice, even when HFDL is the only medium for the applications. In the polar region where SATCOM using geosynchronous satellites is not available, and HF voice meets requirements, HFDL provides data communication services, meeting communication and surveillance requirements for more efficient and safer operations. FANS 1/A operations using HFDL, in combination with SATCOM (Inmarsat or Iridium), can provide higher availability and enable smoother transition to alternative separations when SATCOM service or equipment fails.
- c) ***Notification of service degradation.*** Notification of outages to ATC facilities and operators is an important part of operations. When timely notification of an outage is received, the ATC facilities can safely transition airspace to separations that are not dependent on ADS-C and CPDLC. For RCP 400/type 400 operations, the criterion for notifying the ATC facilities and operators of an outage is within ten minutes from when the outage begins. Currently, this criterion is not met, regardless of type of media used for FANS 1/A operations. Additionally, the aviation community needs to agree on the definition of a service outage versus a service degradation, taking into account all media types, to determine the time when a degradation becomes an outage from a user perspective, i.e., the data is “aged” and is of little to no value. A standardized process is needed to ensure that when outages occur timely notifications are issued, appropriate personnel receive the notifications and take action, as necessary.

## Acronyms

Acronym	Description
AC	Advisory circular
ACARS	Aircraft communications addressing and reporting system
ACP	Actual communication performance
ACTP	Actual communication technical performance
ADS-B	Automatic dependent surveillance – broadcast
ADS-C	Automatic dependent surveillance – contract
AIP	Aeronautical Information Publication
AMS(R)S	Aeronautical mobile satellite (route) service
ANSP	Air navigation service provider
AOC	Aeronautical operational control
AOH	ACARS over HF DL
AQP	avionics qualification procedural (test)
ATC	Air traffic control
ATS	Air traffic service
CEP	Central East Pacific
CMU	Communications management unit
CPDLC	Controller-pilot data link communications
CSP	Communication service provider
FAA	Federal Aviation Administration
FANS 1/A	Future air navigation system 1/A
FIR	Flight information region
FMC WPR	Flight management computer waypoint position reporting
FMS	Flight management system
FOI	FANS 1/A over Iridium
FOH	FANS 1/A over HF DL
GOLD	Global Operational Data Link Document
HAL	Hawaiian Airlines
HF	High frequency
HF DL	HF data link
HS	High speed
I4	Inmarsat 4 <sup>th</sup> generation satellites
ICAO	International Civil Aviation Organization
JCAB	Japanese Civil Aviation Bureau
LRCS	Long range communication system
LS	Low speed

Acronym	Description
MCDU	Multi-function control display unit
NAT	North Atlantic
NextGen	Next generation air transportation system
NM	Nautical mile
NO COMM	No communications (indication)
OPLINKP	Operational Data Link Panel
PARC CWG	Performance-based Operations Aviation Rulemaking Committee Communications Working Group
PBN	Performance-based navigation
POI	Principal operations inspector
PORT	Pilot operational response time
RCP	Required communication performance
Regional SUPPs	Regional Supplementary Procedures (ICAO Doc 7030)
RNP	Required navigation performance
SATCOM	Satellite communications
SBB	SwiftBroadband
SBD	Short burst data
SC	Special Committee
VHF	Very high frequency
WG	Working Group