

November 3, 2014

Mr. John J. Hickey
Deputy Associate Administrator for Aviation Safety
Federal Aviation Administration
800 Independence Avenue
Washington, DC 20591

Dear John,

The Performance-based Operations Aviation Rulemaking Committee (PARC) is pleased to submit the enclosed report entitled, *Report on Data Link Recording (DLR) Rule Recommendations as Applied in Specific Cases of "Retrofit Aircraft"*.

The PARC provides you with this report because operators that desire to install controller-pilot data link communications (CPDLC) on retrofit aircraft, or modify existing CPDLC installations, likely will not proceed with the installation owing to the additional significant costs to include data link recording (DLR) capability. One operator reported that the cost associated with just complying with the DLR capability would be an average of \$100,000 per individual aircraft. Another operator has reduced the number of future air navigation system 1/A (FANS 1/A) CPDLC retrofit installations by 80% because of the costly DLR capability that would also be required, according to the current interpretation of the rule.

The enclosed report provides the results of a review of the DLR rule, its preamble and interpretive material, as they may apply to data link installations on aircraft with a certificate of airworthiness (CoA) dated before the effective date of the rule. It concludes that, since the promulgation of the DLR rule, the proven safety benefits of the data link capability justify a clarification of the interpretation of the DLR rule to indicate that it does not apply to specific cases of retrofit aircraft, particularly those that already have the FANS 1/A CPDLC installed, or a certified option to install FANS 1/A CPDLC had been available since before the effective date of the rule.

The report identifies 2,744 U.S. registered air transport aircraft—with a CoA before December 6, 2010—that are subject to the DLR rule; these aircraft operate under Part 121. As of September 2014, FANS 1/A CPDLC is already installed on 628 of those aircraft and FANS 1/A CPDLC options—certified prior to December 6, 2010—are available for installation on the remaining 2,116 aircraft.

In addition, the report identifies 5,600 U.S. registered business aviation/high end general aviation aircraft—with a CoA before December 6, 2010—that are subject to the DLR rule; these aircraft operate under Parts 91 and 135. As of September 2014, FANS 1/A CPDLC is already installed on 300 of those aircraft and FANS 1/A CPDLC options are available for installation on the remaining 5,300 aircraft.

The report also reviewed current and planned regulations of the European Aviation Safety Agency (EASA) and the International Civil Aviation Organization (ICAO) provision for airborne DLR capability in Annex 6. EASA currently has only a “forward fit” rule with an effective date of April 8, 2014. EASA has planned for a “retrofit” rulemaking task RMT.0294; however, it is not expected to begin before 2018. The International Civil Aviation Organization (ICAO) Annex 6 effective date for forward fit and retrofit data link installations is January 1, 2016. The ICAO DLR retrofit provision applies only to new data link (e.g. FANS 1/A CPDLC) installations; it does not apply to modifying existing data link installations that are being used or will be used before the effective date of the provision. Based on this review, the PARC recommends that FAA continue to work with EASA and ICAO to globally harmonize DLR rules, their applicability and timeframes.

The PARC recommendation to clarify the interpretation of the rule would be the first step to global harmonization of the DLR rules.

In summary, the report substantiates the recommendations and represents the views of the PARC, including those operators that have already made investments to install data link recording for retrofit aircraft. The PARC believes that if FAA follows these recommendations this will increase implementation of data link and enhance safety in the National Airspace System (NAS) and in worldwide operations in the public interest.

The PARC appreciates your continued support of its activities and invites you to discuss any aspects of these recommendations at your earliest convenience. The PARC respectfully requests the FAA to provide us with a formal response. We thank the members and constituents of PARC for their support in this activity.

Sincerely,



Mark Bradley
Chairman
Performance-based Operations Aviation
Rulemaking Committee

Enclosure: Report on Data Link Recording (DLR) Rule Recommendations as Applied in Specific Cases of “Retrofit Aircraft”

Cc: Tom Kraft
Arnold Oldach

Final DLR Rule Report

Data Link Recording (DLR) Rule Recommendations as Applied in Specific Cases of “Retrofit Aircraft”

October 31, 2014, Version 1.0

Prepared by:

Performance-based Operations
Aviation Rulemaking Committee

Communications Working Group
(PARC CWG)

Foreword

The Performance-based Operations Aviation Rulemaking Committee (PARC) is an FAA-sponsored activity that operates according to the Administrator's authority under 49 USC 106(p)(5). The PARC comprises members from the FAA and the aviation community at large, provides recommendations to FAA's Senior Management for action and implementation. The PARC has been effective over the last decade in implementing performance-based navigation. In 2005, the PARC established the Communications Working Group (CWG) to address a number of issues related to the implementation of aeronautical communication systems. These systems included, among others, the Future Air Navigation System (FANS 1/A), the aeronautical telecommunication network (ATN), and satellite voice communications.

The PARC CWG is committed to applying the performance-based concept, which aims to leverage existing capability and maximize benefits by:

- ❑ Enabling cost-effective alternatives, using different technologies and existing capabilities, that meet business needs in a more timely manner;
- ❑ Providing performance-based criteria to demonstrate aircraft equipment and capability without technological or implementation-specific constraints; and
- ❑ Enabling different levels of service in common airspace to a fleet of aircraft with varying capability and performance.

The PARC CWG develops recommendations that directly support matters that relate to the FAA's regulatory criteria and guidance material for implementation of voice and data communications within the United States (U.S.) National Airspace System (NAS). However, the PARC CWG recognizes that global harmonization is crucial to the success of any State or regional implementation initiative. As such, the PARC CWG prepares Coordination Drafts for broad review and solicits input on such matters of interest to the aviation community.

In September 2013, the PARC CWG initiated a project to review FAA regulations for crash-survivable airborne data link recording (DLR), in consideration with European Aviation Safety Agency (EASA) regulations and International Civil Aviation Organization (ICAO) provision for DLR capability. This report provides the results of that review and includes recommendations to the FAA to alleviate the impact of the DLR rule on retrofit aircraft.

If you would like more information on PARC CWG activities or would like to comment on this Report, please contact either Arnold Oldach (arnold.oldach@l-3com.com) or Tom Kraft (tom.kraft@faa.gov).

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Executive Summary

The preamble of the data link recording rule states that the benefits of data link recording on the aircraft outweighed the safety benefits of controller-pilot data link communications (CPDLC). However, experience since the rule was originally adopted, has led to a much better understanding of the safety benefits of such systems.

While the capacity benefits of CPDLC have been projected and quantified in several studies, the safety benefits have not had the same advantage. However, in 2012, the FAA began a preliminary analysis on the potential safety benefits arising from the Future Air Navigation System (FANS 1/A) CPDLC and automatic dependent surveillance – contract (ADS-C) implementation and presented the results to the North Atlantic Safety Analysis Reduced Separation Implementation Group (NAT SARSIG). As the summary of discussions and conclusions of the meeting states, “These preliminary results indicated a significant potential for enhancing safety in the International Civil Aviation Organization North Atlantic Region (ICAO NAT) Region, particularly in the vertical dimension.” (NAT SARSIG, 2012, p. 12)

Note.— FANS 1/A, in this report, refers to both FANS 1/A and FANS 1/A+, as defined in FAA AC 20-140B and ICAO Draft Doc [GOLD], which is expected to be published in 2015.

Areas of projected safety benefits include:

- ❑ Improved conformance monitoring and intervention capability. Early detection and resolution of errors via integrated FANS 1/A CPDLC and ADS-C. In fact, the aim of the Data Link Mandate in the ICAO NAT Region is specifically to enhance safety, minimize duration of large height deviations (LHDs), gross navigation errors (GNEs) and speed errors;
- ❑ Reduction in errors associated with manual pilot data entry of clearances due to the ability to load data link clearances directly into the Flight Management System (FMS); and
- ❑ Reduction in the duration of losses of communication between aircraft and air traffic control (ATC) due to the ability to send CONTACT [frequency] message.

Recognizing the safety benefits of CPDLC and ADS-C and the cost-prohibitive nature of installing data link recording systems on retrofit aircraft, the European Aviation Safety Agency (EASA) currently has only a “forward fit” rule with an effective date of April 8, 2014. EASA has planned for a “retrofit” rulemaking task RMT.0294; however, it is not expected to begin before 2018. Under the current EASA rule, operators can voluntarily install FANS 1/A CPDLC to enhance safety without airborne data link recording.

Near-Term Recommendations

RECOMMENDATION 1. The PARC recommends that the FAA clarify the interpretive material that the data link recording rules are not applicable to specific cases of “retrofit aircraft”, including:

- a) Retrofit installations of the data link capability, where:
 - 1) the aircraft has an existing installation of the data link capability; or
 - 2) the aircraft has an existing certified data link capability option—to activate/install the data link capability—that was **originally** certified before the effective date of the rule; and
- b) Modifications to retrofit installations of the data link capability, as described in item a) and the modifications do not change the FANS 1/A or ATN B1 interoperability.

Note.— RECOMMENDATION 1 MAY BE ACCOMPLISHED BY CLARIFICATION OF THE EXISTING RULE and may provide more immediate “go” decisions for activations of data link capability for over 2,000 aircraft.

RECOMMENDATION 2 – The PARC recommends that the FAA revise the data link recording rules so that they are not applicable to “retrofit aircraft”, including retrofit installations or modifications to retrofit installations of the data link capability and the installations or modifications do not change FANS 1/A or ATN B1 interoperability.

Note.— This recommendation would apply for ALL retrofit aircraft, whether or not there was an existing data link capability option available before the effective date of the rule. RECOMMENDATION 2 MAY REQUIRE RULEMAKING AND MAY THEREFORE TAKE LONGER TIME FOR COMPLETION. If RECOMMENDATION 1 is accepted and implemented on an earlier schedule, possible rulemaking would only involve aircraft without an existing data link capability option before the effective date of the rule.

Longer Term Recommendation

RECOMMENDATION 3 - The PARC recommends that the FAA work with EASA and ICAO to continue harmonizing data link recording rules, their applicability and timelines.

In summary, this report substantiates recommendations that the PARC believes will best serve the public interest by helping to maximize implementation of data link and, thus, enhance safety not only in the National Airspace System (NAS) but worldwide. It represents the views of the PARC, including those operators that have already made investments to install data link recording on retrofit aircraft.

Introduction

The PARC CWG initiated a review of the FAA regulations for data link recording, in consideration with European Aviation Safety Agency (EASA) regulations and the International Civil Aviation Organization (ICAO) provision. The purpose of this review was to determine if there was justification for the FAA to consider revising existing data link recording regulations or clarifying their interpretation as they apply to retrofit aircraft.

Data link systems, such as Future Air Navigation System (FANS 1/A) CPDLC, were traditionally thought of as economic cost-saving and operational-enhancing systems. This is supported by marketing strategies of original equipment manufacturers (OEMs), and the fact that regions of the world are imposing mandates for CPDLC. However, in recent years, such CPDLC systems are increasingly also being recognized as safety-enhancing systems. Early adopters of CPDLC can point to enhanced margins of safety based on uplinked routings, improved conformance monitoring and clear communications in airspace where procedural separation is being applied. These improvements reduced the effects of operational errors and enabled reduced traffic separation.

Note.— FANS 1/A, in this report, refers to both FANS 1/A and FANS 1/A+, as defined in FAA AC 20-140B and ICAO Draft Doc [GOLD], which is expected to be published in 2015.

The PARC concluded with recommendations for FAA to alleviate the impact of the data link recording rule on retrofit aircraft. These recommendations have been justified based on the safety benefits of the data link capability. In light of these benefits, the FAA should clarify the interpretation of the applicability of the data link recording rule to retrofit aircraft and harmonize its rules with EASA and ICAO.

Scope

This project considered the data link recording requirements that impact retrofit aircraft defined as follows:

- a) Aircraft for which the individual certificate of airworthiness (C of A) is first issued before the effective date of the rule; and
- b) Aircraft with modifications to existing data link capability for which the data link recording capability is not installed.

The total number of aircraft, as of September 2014, affected in categories a) and b) includes 2,744 aircraft that operate under Part 121 (see [Figure 1](#)) and approximately 5,600 aircraft that operate under Parts 91 and 135 (see [Figure 2](#)).

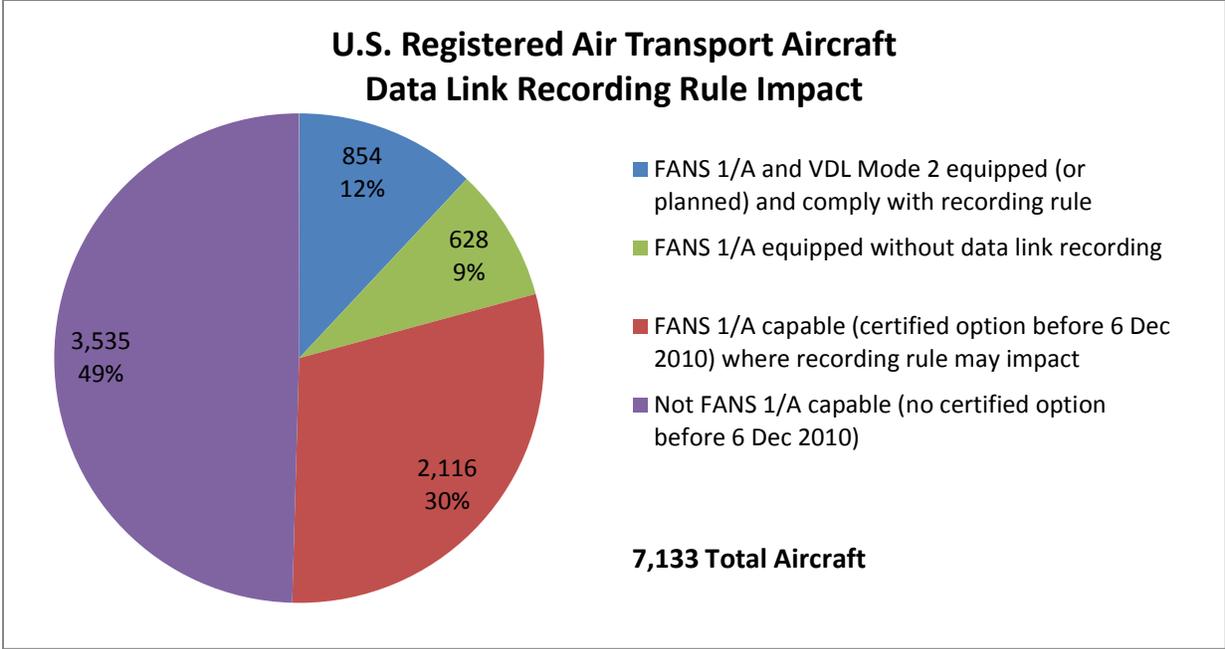


Figure 1. United States (U.S.) Registered Air Transport Aircraft – Data Link Recording Rule Impact

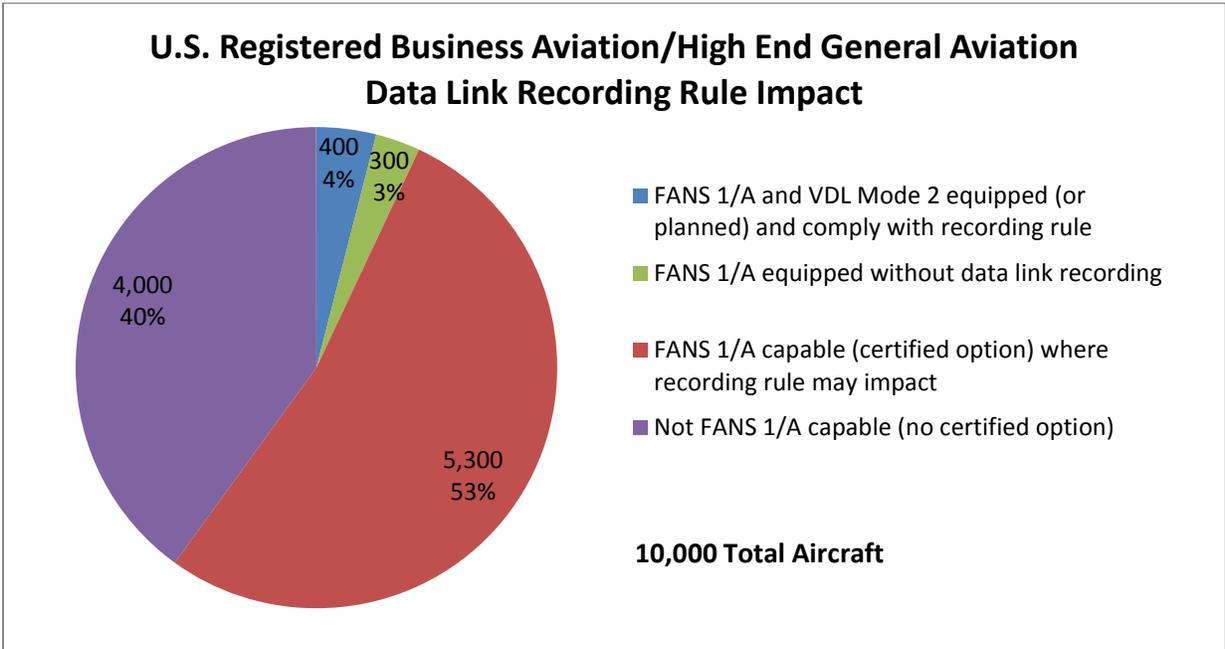


Figure 2. U.S. Registered Business Aviation/High End General Aviation – Data Link Recording Rule Impact

Note 1. — *The FAA Information for Operators InFO 10016, dated August 16, 2010, states that, “Data link capability refers to the approved message set (e.g., the Controller Pilot DataLink Communications [CPDLC] application) hosted in either the Flight Management Computer or Communications Management Unit (CMU), the datalink router (e.g., hosted in the CMU), any radios that are used by the approved message set (e.g., [very high frequency] VHF, [high frequency] HF Datalink, [satellite communications] Satcom), and associated antennas.”*

Note 2. — *The scope does not consider data link recording requirements for data link capability on aircraft for which the individual certificate of airworthiness was first issued on or after the effective date of the rule. The effective date of the rule is December 6, 2010 for Part 121, 125 and 135 operations; and April 8, 2012 for Part 91 operations.*

Note 3. — *As of the effective date of the rule, all 2,744 air transport aircraft had a FANS 1/A installation, which is considered a “certified option”. There are additional aircraft which did not have a certified option but which had FANS 1/A installed resident in a latent FMS option, not yet certified. Such aircraft are not included in the 2,744 total, but should be considered for relief from the DLR rule.*

Note 4. — *The FAA Advisory Circular (AC) 20-160, dated February 21, 2008, states, “... we consider the use of CPDLC to be defined by ICAO Document 4444, Procedures for Air Navigation Services/Air Traffic Management, Appendix 5, CPDLC Message Sets. When applicable, we also consider other proposed message sets that satisfy the Message Use/Intent column of the tables in ICAO Document 4444, Appendix 5, ‘mandatory’ for recording.” The only certified options available are based on either FANS 1/A (RTCA DO-258A) or ATN B1 (RTCA DO-280B) interoperability standards; both standards provide CPDLC message sets, consistent with Doc 4444.*

Background Information

FAA Data Link Recording Rules

In March 2008, the FAA issued a final rule to amend the digital flight data recorder (DFDR) and cockpit voice recorder (CVR) regulations for much of the U.S. fleet of aircraft. The requirements were adopted as aircraft certification or operating rules, some of which were to take effect on April 7, 2010. These rules included:

- The recording of data link communications, when the communications equipment was to be installed on or after April 7, 2010;
- Wiring requirements related to single electrical failure and their effect on the DFDR and CVR Systems;
- The addition of a 10-minute independent power source for the CVR;
- Requirements regarding the CVR location and housing;

- ❑ Requirements for the duration of the DFDR recording; and increased sampling rates for certain DFDR parameters.

In February 2008, the FAA issued AC 20-160, which provided means of compliance for the regulations that concerned the recording of data link communications.

Between May and December 2009, manufacturers and industry petitioned the FAA for either a change of dates or relief from the 2008 requirements. For various reasons those petitions were denied.

On April 5, 2010 the FAA amended its final rule:

- ❑ For the ten-minute backup power source for CVRs, the compliance date for newly manufactured aircraft operating under part 91 is April 6, 2012;
- ❑ For increased DFDR sampling rates, the compliance date for newly manufactured aircraft operating under *part 91* is April 6, 2012;
- ❑ For increased DFDR sampling rates, the compliance date for newly manufactured aircraft operating under *part 121, 125, or 135* is December 6, 2010;
- ❑ Part 121, 125, 135. For recording data link communications, the compliance date after which newly installed data link systems must include recording capability for aircraft operating under part 121, 125, or 135 is December 6, 2010; and
- ❑ Part 91. For recording data link communications, the compliance date after which newly installed data link systems must include recording capability for aircraft operating under part 91 is April 6, 2012.

In August 2010, the FAA issued Information for Operators (InFO) 10016, which provided clarification on the data link communication recording requirements. According to InFO 10016:

Each aircraft must have datalink recording capability installed if all of the following conditions are met:

- 1) The aircraft is required to have both a cockpit voice recorder and a flight data recorder.
- 2) The aircraft has datalink equipment that was installed after the effective date of the rule and that equipment uses an approved message set as defined in AC 20-160 (or the latest approved revision).
- 3) The installation of the datalink equipment requires a supplement type certificate (STC) or amended type certificate (TC), and the date that the STC or amended TC (applicable to that aircraft) was signed is after the effective date of the rule.

Note. — InFO 10016 has interpreted the data link recording rule to mean that for in-service aircraft, after the effective date of the rule, any significant changes to the type design that would impact data link functionality or performance would invoke the data link recording requirement.

European Aviation Safety Agency (EASA) Commercial Air Transport Rules

On November 26, 2010, the EASA issued its Comment Response Document (CRD) to Notice of Proposed Amendment (NPA) 2009-02B. In this document, EASA provided requirements for data link recording as follows:

CAT.IDE.A.195 Data link recording

- (a) Aeroplanes first issued with an individual C of A on or after 8 April 2014 that have the capability to operate data link communications and are required to be equipped with a CVR, shall record on a recorder, where applicable:
 - (1) data link communication messages related to air traffic services communications to and from the aeroplane;
 - (2) information that enables correlation to any associated records related to data link communications and stored separately from the aeroplane; and
 - (3) information on the time and priority of data link communications messages, taking into account the system's architecture.
- (b) The recorder shall use a digital method of recording and storing data and information and a method for retrieving that data. The recording method shall be such as to allow the data to match the data recorded on the ground.
- (c) The recorder shall be capable of retaining data recorded for at least the same duration as set out for CVRs in CAT.IDE.A.185.
- (d) The recorder shall have a device to assist in locating it in water.
- (e) The recorder shall start to record automatically prior to the aeroplane moving under its own power and shall continue to record until the termination of the flight when the aeroplane is no longer capable of moving under its own power.
- (f) Depending on the availability of electrical power, the recorder shall start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following engine shutdown at the end of the flight.

(EASA, 2010, p. 107)

ICAO Provision for Airborne Data Link Recording

ICAO Annex 6 contains requirements for flight recorders, including data link recorders. In November 2012, these requirements were amended as follows:

6.3.3 Data link recorders

Note. — *Data link recorders performance requirements are as contained in the EUROCAE ED-112, Minimum Operational Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

6.3.3.1 Applicability

6.3.3.1.1 All aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 2016, which utilize any of the data link communications applications listed in 5.1.2 of Appendix 8 and are required to carry a CVR, shall record on a flight recorder the data link communications messages.

6.3.3.1.2 All aeroplanes which are modified on or after 1 January 2016 to install and utilize any of the data link communications applications listed in 5.1.2 of Appendix 8 and are required to carry a CVR shall record on a flight recorder the data link communications messages.

Note 1. — *Data link communications are currently conducted by either ATN-based or FANS 1/A-equipped aircraft.*

Note 2. — *A Class B AIR could be a means for recording data link communications applications messages to and from the aeroplanes where it is not practical or is prohibitively expensive to record those data link communications applications messages on FDR or CVR.*

(ICAO, 2012, p. 6-8)

Applications listed in 5.1.2 of Appendix 8 are as follows:

- a) Data link initiation capability (DLIC);
- b) Controller–pilot data link communications (CPDLC);
- c) Data link – flight information services (D-FIS);
- d) Automatic dependent surveillance – contract (ADS-C); and

(ICAO, 2012, p. APP 8-7)

The messages from the following additional applications shall be recorded only as far as is practicable given the architecture of the system:

- e) Automatic dependent surveillance – broadcast (ADS-B); and
- f) Aeronautical operational control (AOC).

(ICAO, 2012, p. APP 8-7)

In September 2013, PARC CWG discussed the issues with the current FAA airborne data link recording rules and associated interpretive material provided in FAA AC 20-160 and InFO 10016. PARC CWG agreed to establish a project to review the issues further and provide recommendations to the FAA that would resolve the issues.

Problem Statement and Rationale

At the time the rule was promulgated, several commenters requested clarification on the applicability of the rule to aircraft equipped with data link equipment before the effective date of the rule. Some suggested that some aircraft are data link capable, but the option was never installed and that these aircraft should not be subject to the data link recording rule. The FAA responded:

The requirement for recording [datalink communication] DLC is determined when the DLC system is installed and certified. If the system is installed and certified before April 7, 2010, there is no requirement for those systems to record messages. If the DLC system is installed and certified (at manufacture or by retrofit) after April 7, 2010, the DLC system must be examined to determine whether its message set installed at the time must be recorded. The messages that must be recorded become the approved message set for that installation. If a provisional (inactive) system is installed and certificated before April 7, 2010, and requires no further certification when the system is activated, then there is no recording requirement for that system even if the activation occurs after two years. However, a change in such a system (especially a change to the message set being used) may trigger the requirement to record as though the whole system were a new installation under the regulation.

(FAA, 2008a, p. 12550)

While AC 20-160 and InFO 10016 have attempted to clarify the interpretation of the rule, experience in applying the rule has demonstrated that further clarification is needed. PARC recognizes that the requirement for recording data link messages is performance-based and the requirement is determined when the data link system is installed and certified. Therefore, the PARC believes that given the safety benefits of the data link capability, it is within the framework of the rule for the FAA to clarify that it is not applicable to retrofit aircraft.

For retrofit aircraft where FANS 1/A CPDLC is not installed because the data link recording rule inhibited operators from installing data link capability on their aircraft, tangible safety benefits will be lost.

Safety Benefits of CPDLC

While the capacity benefits of CPDLC have been projected and quantified in several studies, the safety benefits have not had the same advantage. However, in 2012, the FAA conducted a preliminary analysis on the potential safety benefits arising from the CPDLC and ADS-C implementation and presented the results to the North Atlantic Safety Analysis Reduced Separation Implementation Group (NAT SARSIG). The preliminary analysis examined all large error reports filed with NAT Central Monitoring Agency (CMA) during the period January 2010 through June 2012 and projected whether these events would have been avoided, or their outcomes mitigated, if the NAT Region Data Link Mandate had been in effect. While the results were stated as preliminary, they clearly identify expected safety benefits, such as less time spent at an incorrect flight level. As the summary of discussions and conclusions of the meeting states, “These preliminary results indicated a significant potential for enhancing safety in the ICAO NAT Region, particularly in the vertical dimension.” (NAT SARSIG, 2012, p. 12)

In 2013, the FAA had updated the preliminary analysis to include three years of data during the period January 2010 through December 2012.

2.29 The group’s review of the 297 [large height deviations] LHDs indicated that the Mandate would have played at least some part in either blunting the error occurrence or mitigating its effect in 96 instances. The principal value of the [Data Link] Mandate seen by the analysis group was the establishment of the [level range deviation event] LRDE contract with an aircraft, since a number of crew-related errors involving changing level without clearance would have been, in the view of the group, blunted or mitigated resulting in either no or less time spent at incorrect flight level.

2.30 ... The group’s analysis indicated that 84 of the 96 LHDs would have been blunted or mitigated by imposition of the [Data Link] Mandate alone. Applying its process for determining a reduced duration at incorrect flight level to these 84 events, the group reduced the original cumulative total of 708 minutes at incorrect flight level to 219.

(NAT SARSIG, 2013b, p. 11-12)

To examine the effects of the Data Link Mandate on safety, the FAA preliminary analysis specifically reviewed LHDs because the risk estimates in the vertical dimension have been increasing since 2002. An LHD is a deviation of 90 meters (300 feet) or more in magnitude from the cleared flight level. In 2012, the risk estimate was significantly higher than the target level of safety (TLS) in the vertical dimension. The effects of the Data Link Mandate on safety were not examined in the horizontal dimension because the risk estimates are within the TLS for that dimension.

The North Atlantic Mathematicians' Working Group (NAT MWG) estimates the collision risk in the vertical dimension. **Figure 3** shows the annual trend, fitted to an exponential distribution, for the operational vertical risk estimates from 2002 to 2013 in comparison to the TLS for the total vertical risk. In addition, the figure shows the operational vertical risk accounting for the observed usage of the strategic lateral offset procedure (SLOP), defined in Doc 4444, Chapter 16, which allows aircraft to fly on a parallel track 0, 1, or 2 nautical mile(s) (NM) to the right of the center line relative to the direction of flight.

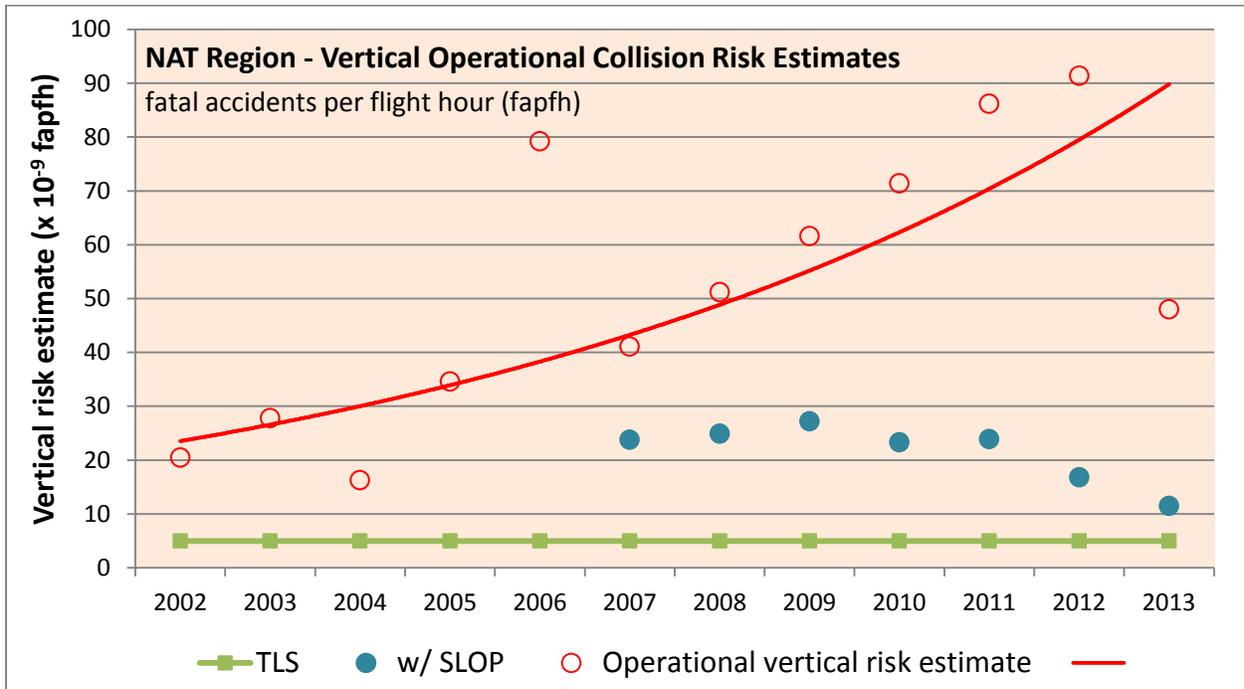


Figure 3. NAT Region – Vertical Operational Collision Risk Estimates (NAT MWG, 2014, Figure 6)

The NAT MWG asserts that the reduced collision risk estimate in the vertical dimension in 2013 is the result of a series of actions undertaken within the NAT Region over the course of several years. Included in that result are the improvements that come from the institution of CPDLC and ADS-C. However, those effects are also combined with other efforts that have also had a beneficial effect and it would not be possible to separate out these effects attributable exclusively to the increased use of CPDLC and ADS-C owing to the Data Link Mandate.

It is important to note that the FAA preliminary analysis did not attempt to project all safety benefits. For example, the projected effects of equipage on Gross Navigation Errors (GNEs) were not considered nor were events involving aircraft to which the NAT data link mandate would not apply (i.e., aircraft operating between flight levels 360 and 390, inclusive, on the two

“core” tracks of the NAT Organized Track System). The NAT SARSIG recognized that further analysis was necessary to assess the overall safety benefit of all aircraft equipping with CPDLC and ADS-C in the NAT Region. In response to the NAT SARSIG conclusions and supported by the NAT Safety Oversight Group, the NAT Systems Planning Group (NAT SPG) recognized that these benefits should be projected and tracked as part of the overall safety culture and performance monitoring. At its 49th meeting:

... The NAT SPG agreed that continuation of such safety analyses was necessary for it to make informed decisions about moving forward with Phase 2 of the data link expansion ... Accordingly, the NAT SPG agreed to the following:

NAT SPG Conclusion 49/18 – Safety Aspects of Data Link Mandate (DLM) Implementation

That the NAT Implementation Management Group (NAT IMG) ensure the continuation of the following safety analysis work ongoing under the auspices of its contributory Safety Analysis and Reduced Separation Implementation Group (NAT SARSIG):

- a) continued analysis and monitoring of the effect of data link, [air traffic service] ATS interfacility data communication (AIDC) and enhanced automation on safety;
- b) evaluation of [Data Link Mandate] DLM Phase 1;
- c) continued assessment of DLM equipage on the NAT Organised Track System (OTS) and in the ICAO NAT Region; and
- d) analysis of future scenarios for DLM Phase 2B and 2C.

(NAT SPG, 2013, p. 18)

As a result of the NAT SPG Conclusion, the NAT has taken actions for the NAT CMA to begin collecting the necessary data and for the NAT SARSIG to continue the analysis to support expansion of the Data Link Mandate in the NAT Region. (NAT IMG, 2013b, p. 18-19, R-6)

The Separation Standards Analysis Branch at the FAA Technical Center in Atlantic City compiled traffic samples in the NAT Minimum Navigation Performance Specification (MNPS) Airspace for 2010, 2011 and 2012 covering a five-month period observed as having the highest traffic levels in the North Atlantic airspace (NAT), May to September. The data were extracted from the FAA Enhanced Traffic Management System (ETMS). **Table 1** summarizes the approximate traffic volume for each sample as well as the percentage of the volume estimated to be contributed by U.S. operations.

Table 1. NAT traffic volume and contribution by U.S. operations

	Traffic volume (Average flights/day)	Estimate of % contributed by U.S. operations
May-Sep 2010	1,390	40%
May-Sep 2011	1,550	40%
May-Sep 2012	1,290	37%

The NAT SPG has accepted the FAA's preliminary analysis as demonstrating the potential safety benefits of CPDLC and ADS-C, and has taken action to continue the analysis in support of further expansion of the Data Link Mandate. With the significant U.S. contribution to traffic volumes in the NAT MNPS airspace, these efforts provide well-founded rationale to alleviate the applicability of data link recording rules to U.S. registered retrofit aircraft.

The safety benefits of CPDLC and ADS-C equipage in radar (domestic) environments can be qualitatively identified, but have not yet been quantitatively projected. For example:

- a) the flight crews' ability to load CPDLC clearances directly into the Flight Management System will reduce the number of pilot navigation errors and altitude excursions due to manual data entry; and
- b) the controllers' ability to send CPDLC CONTACT [frequency] messages would be expected to reduce the duration of losses of voice communication between aircraft and air traffic control due to an open microphone on frequency, or other reason.

As data link is implemented in the U.S., the FAA should establish a similar monitoring program and conduct the necessary analysis, similar to the ongoing analysis in the NAT Region, to quantify the safety benefits of the data link capability.

Data Link Mandates

Specifically for safety reasons, FANS 1/A CPDLC and ADS-C are required to operate in portions of the NAT Region, in accordance with ICAO Doc 7030 and State Aeronautical Information Publications (AIPs) or Circulars (AICs). The NAT Data Link Mandate is being implemented using a phased approach. Phase 1 was effective in February 2013, which requires FANS 1/A CPDLC and ADS-C on no more than two core tracks in the NAT Organized Track System (OTS). In June 2013, the NAT SPG agreed to expand the applicable airspace for the data link requirement in subsequent phases as follows:

- ❑ Phase 2A, commencing February 5, 2015: FL350 to FL390 within the NAT OTS;
- ❑ Phase 2B, commencing December 7, 2017: FL350-FL390 throughout the ICAO NAT Region; and
- ❑ Phase 2C, commencing January 30, 2020: FL290 and above throughout the ICAO NAT Region.

(NAT SPG, 2013, p. 12 and J-1)

ATN B1 (Link 2000+) CPDLC is required to operate in portions of the European (EUR) Region, in accordance with the European Implementing Rule for Data Link Services (EC 29/2009), which was effective in February 2013. Per ICAO Doc 7030, the applicable airspace is as follows:

- ❑ February 7, 2013, in the following [Flight Information Regions/Upper Flight Information Regions] FIRs/UIRs above FL285: Amsterdam FIR, Wien FIR, Barcelona UIR, Brindisi UIR, Brussels UIR, Canarias UIR, France UIR, Hannover UIR, Lisboa UIR, London UIR, Madrid UIR, Milano UIR, Rhein UIR, Roma UIR, Scottish UIR and Shannon UIR; and
- ❑ from February 5, 2015, in the following FIRs/UIRs above FL285: Bratislava FIR, Bucuresti FIR, Budapest FIR, Kobenhavn FIR, Ljubljana FIR, Nicosia FIR, Praha FIR, Sofia FIR, Warszawa FIR, Finland UIR south of 61°30', Hellas UIR, Malta UIR, Riga UIR, Sweden UIR south of 61°30', Tallinn UIR, Vilnius UIR.

(ICAO, 2010, p. EUR 3-2)

Concerning airborne data link recording, Article 13 of EC 29/2009 only requires ground-based recording:

1. ATS providers shall ensure that air-ground data exchanges of the air-ground applications defined in the ICAO standards specified in points 2 and 3 of Annex III, are recorded in accordance with the ICAO standards specified in points 6, 7 and 8 of Annex III, insofar as they relate to the ground-based recording function of data link communications.
2. The Eurocae document specified in point 9 of Annex III shall be considered sufficient means of compliance with regard to the requirements for recording of air-ground data exchanges referred to in paragraph 1 identified in the ICAO standards specified in points 6, 7 and 8 of Annex III.

(EU, 2009, p. L 13/9)

Points of Annex III

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2. Chapter 3 – Aeronautical Telecommunication Network, Section 3.5.1.1 ‘Context Management’ (CM) application items (a) and (b) of ICAO Annex 10 – Aeronautical Telecommunications – Volume III, Part I (Digital Data Communication Systems) (First edition July 1995 incorporating Amendment 81 (23.11.2006)).
3. Chapter 3 – Aeronautical Telecommunication Network, Section 3.5.2.2 ‘Controller-Pilot Data Link Communications’ (CPDLC) application items (a) and (b) of ICAO Annex 10 – Aeronautical Telecommunications – Volume III, Part I (Digital Data Communication Systems) (First edition July 1995 incorporating Amendment 81 (23.11.2006)).

...

6. Chapter 3 – General procedures for the international aeronautical telecommunication service, Section 3.5.1.5 of ICAO Annex 10 – Aeronautical Telecommunications – Volume II, (Communication Procedures) (Sixth edition October 2001 incorporating Amendment 81 (23.11.2006)).
7. Chapter 2 – General – Sections 2.25.3 of ICAO Annex 11 – Air Traffic Services (13th edition July 2001 incorporating Amendment 45 (16.7.2007)).
8. Chapter 6 – Air traffic services requirements for communications – Sections 6.1.1.2, of ICAO Annex 11 – Air Traffic Services (13th edition – July 2001 incorporating Amendment 45 (16.7.2007)).
9. Eurocae ED-111, Functional specifications for [Communication, Navigation Surveillance/Air Traffic Management] CNS/ATM ground recording, July 2002, including Amendment 1 (30.7.2003).

(EU, 2009, p. L 13/14)

Note.— Changes to EC 29/2009 are expected in November 2014 owing to technical difficulties (EASA, 2013).

Data Link Capability for Accident/Incident Investigation

In November 2013, the ICAO Air Navigation Commission (ANC) approved amendments to the ICAO Annex 10 and Doc 4444 to address recommendations from the 2010 High Level Safety Conference (HLSC) concerning the Air France 447 accident in June 2009. The amendments take advantage of existing ADS-C data link capability to improve locating aircraft in accident/incident investigation. The FANS 1/A packages that are available today provide ADS-C capability, but also include CPDLC; excluding CPDLC from the package to avoid data

link recording is not an option nor is it desired. ADS-C improves surveillance capability and CPDLC improves the controller's intervention capability. (ICAO, 2014b)

More recently, a new global initiative has arisen out of the loss of Malaysia 370 (as well as the older Air France 447 accident). This addresses the perceived need to constantly track aircraft on a global basis for the purpose, *inter alia*, of reducing the size of the potential search area should aircraft be lost. An international meeting convened by ICAO concluded that the International Air Transport Association (IATA), with support from ICAO, would investigate solutions to effectively implement global tracking of aircraft. Subsequent to the meeting, the ICAO ANC established an *ad hoc* working group of experts in the relevant fields to assist by developing a concept of operations for global tracking. (ICAO, 2014a)

The *ad hoc* working group has completed a Final Draft – Version 4.1 of the *Concept of Operations, Global Aeronautical Distress & Safety System (GADSS)*. Currently, use of ADS-C, which is part of the integrated FANS 1/A package that also includes CPDLC, is among the near-term options for global tracking to advance safety. The group identified improvement areas, among them is, “Increase the use of aircraft capability to transmit their 4D position and identity for aircraft tracking purposes,” based on an analysis that concluded, “Aircraft operators are not using ADS-C capability to the degree possible.” (ICAO, 2014g, p. 15)

The results of this work are expected to be presented at the ICAO HLSC in February 2015. Efforts to improve aircraft tracking are continuing. The ICAO Operational Data Link Panel (OPLINKP) held its second panel meeting October 6-17, 2014. At the meeting, the panel reviewed significant comments from the United States on the recent amendments to Annex 10 and Doc 4444, and considered new information in light of the recent loss of Malaysia 370. The panel agreed to propose further amendments to take advantage of existing capabilities with FANS 1/A capabilities. (ICAO, 2014d)

The PARC believes that because operators are opting not to install the FANS 1/A capability because of the costs to install the data link recording capability, the FAA's data link recording rule is compromising these improvement areas that are taking advantage of FANS 1/A capabilities to support a global aeronautical distress and safety system.

International Compatibility

At the time the DLR rule was promulgated, three commenters proposed that FAA rules be harmonized with Joint Airworthiness Authorities (JAA). In response, the FAA stated:

The FAA believes the proposed DLC recording regulation is compatible with the DLC regulations proposed by the JAA. The proposed rule is designed to be performance-based, with the message set to be recorded and approved at the time of aircraft certification. Since we do not define the message set, we do not foresee an instance in which a DLC system certificated under the regulations proposed by the JAA would not be in compliance with our requirement as proposed.

... We acknowledge that the two proposals are not harmonized, and we believe the scope of the current NPA would result in significant costs on some operators without a resulting safety benefit.

(FAA, 2008a, p. 12549)

The PARC believes that this FAA response was based on the data link messages to be recorded, since the European rule requires the recording of more than just CPDLC messages. However, the significant costs are associated with the retrofit installation of the data link recording capability. Recognizing this, the JAA rule—now the EASA rule—only applies to aircraft with a certificate of airworthiness dated on or after April 8, 2014. Under the current EASA rule, operators of non-U.S.-registered aircraft with a CoA dated before April 8, 2014, can voluntarily install FANS 1/A CPDLC to enhance safety without incurring the additional costs of airborne data link recording. Under the current interpretation of the FAA rule, these aircraft would not be in compliance with FAA requirements. The harmonization of the data link recording rules should be reconsidered taking into account applicability and effective dates.

Data Link Recording Requirement Applicability

At the time the DLR rule was promulgated, several commenters proposed that the rule be applicable only to aircraft with a C of A on or after the effective date of the rule owing to high costs. They indicated that the data link recording requirement applicability would diminish the safety benefits associated with data link operations. The FAA responded:

The FAA recognizes these concerns, but we continue to believe that the two year applicability in the rule provides the best balance of compliance time and technological development. If an operator cannot justify the expense of a recording system for a new DLC installation, then it is because the benefits of having the system will be outweighed. This is why we tied the requirement to the voluntary installation of DLC systems. The recording requirement remains the same as proposed—that new installations (at certification or on retrofit) of datalink accomplished two years after the compliance date must be recorded.

(FAA, 2008a, p. 12550)

Since then, however, the safety benefits of CPDLC and ADS-C have been recognized and it can no longer be said that the benefits of aircraft recording on retrofit aircraft out-weigh the benefits of increased CPDLC equipage on these aircraft. In light of this, and the approved and planned amendments to ICAO provision that take advantage of the existing data link capability for the purposes of accident/incident investigation, the PARC believes that the FAA needs to reconsider the applicability of the data link recording rule on retrofit installations.

Ground Recording of Data Link Messages

At the time the DLR rule was promulgated, six commenters supported the use of a ground recording system, noting that ground recording is a more cost efficient means of capturing data link messages since the same data that will be recorded on the aircraft is available for accident investigation at the receiving ground based stations. On the other hand, one commenter recommended that the proposal to record two hours of data link messages on the aircraft be extended to record them for the entire duration of flight. The FAA agreed that ground recording systems are a useful tool to assist in accident investigation and that recording more than two hours was not necessary since, “Ground stations also record CPDLC messages, so any messages that occur outside of the 2-hour minimum could be retrieved from a ground source.” (FAA, 2008a, p. 12551). However, the FAA noted that:

“...these systems cannot be adopted as the primary source of data recording. In the past, the [National Transportation Safety Board] NTSB and other accident investigators have encountered significant problems in acquiring ground recorded data. Liability and other legal concerns have caused some private entities that perform ground recording and some foreign governments to delay the release of recorded data for long periods. The NTSB and other accident investigators have repeatedly expressed their desire that recorded data remain on the aircraft because of the immediate availability of the data once the recorders are located.

Further, for ground recording systems to function as intended, all countries or private entities recording data would need compatible systems, the specifications for which have not been proposed. There are no international standards in place for such recording, and we have no way of ensuring that it would happen.”

(FAA, 2008a, p. 12554-12555)

In response to these concerns, the PARC notes that ICAO Annex 11 and Annex 10, Volume II, include a provision for international collaboration on ground recording:

Annex 11— Air Traffic Services

6.1.1.3 When direct pilot-controller two-way radiotelephony or data link communications are used for the provision of air traffic control service, recording facilities shall be provided on all such air-ground communication channels.

Note.— Requirements for retention of all automatic recordings of communications in ATC are specified in Annex 10, Volume II, 3.5.1.5.

6.1.1.4 Recordings of communications channels as required in paragraph 6.1.1.3 shall be retained for a period of at least thirty days.

(ICAO, 2013, p. 6-1)

Annex 10—Aeronautical Telecommunications, Volume II, Communication Procedures including those with PANS status

3.5.1.5 Telecommunication logs, written or automatic, shall be retained for a period of at least thirty days. When logs are pertinent to inquiries or investigations they shall be retained for longer periods until it is evident that they will be no longer required.

(ICAO, 2008, p. 3-2)

Further, in 2010, the ICAO OPLINKP began the development of proposed amendments to include a provision for implementation of performance-based communication and surveillance (PBCS). The proposed amendment is consistent with ICAO Doc 4444, Appendix 5, FAA AC 20-160 and the FAA's response supporting PARC's previous recommendation on the need for PBCS. PBCS includes a requirement for air navigation service providers to establish post-implementation monitoring programs and the global exchange of information, based on compatible systems. Many air navigation service providers, particularly in the North Atlantic and Pacific Regions have already implemented compatible systems and are exchanging information. The OPLINKP has already agreed to the proposed amendments and ICAO is targeting November 2016 for publication of amendments to Annex 6, Annex 11, Annex 15 and Doc 4444 to include this provision and a PBCS Manual to ensure compatibility. (ICAO, 2014e and ICAO, 2014f)

The data link capability enhances safety by helping to prevent accidents and to aid in an accident investigation when recorders cannot be easily located, such as the cases of Air France 447 and the loss of Malaysia 370. The PARC supports airborne data link recording for "forward fit" installations and views ground recording only as a consideration for alleviating the impact of the data link recording rule on specific cases of "retrofit aircraft".

Impact of the Data Link Recording Rule

FANS 1/A CPDLC and ADS-C have been in use worldwide. A world coverage map, which Boeing maintains based on State issued aeronautical information, is provided in **Figure 4**. This operational experience has demonstrated safety benefits through conformance monitoring, improving the ability to detect large height deviations and gross navigational errors, and allowing the controller to quickly intervene thereby limiting the exposure of navigation errors.

Data link services continue to expand globally to introduce new air traffic management operations and advance safety in airspace where procedural separations are being applied and in continental Europe. However, the costs associated with retrofit installations of CPDLC recording capability are hindering the voluntary equipage and advances in safety not only for the Next Generation Air Transportation System (NextGen) implementation, but for U.S. registered aircraft that operate worldwide.

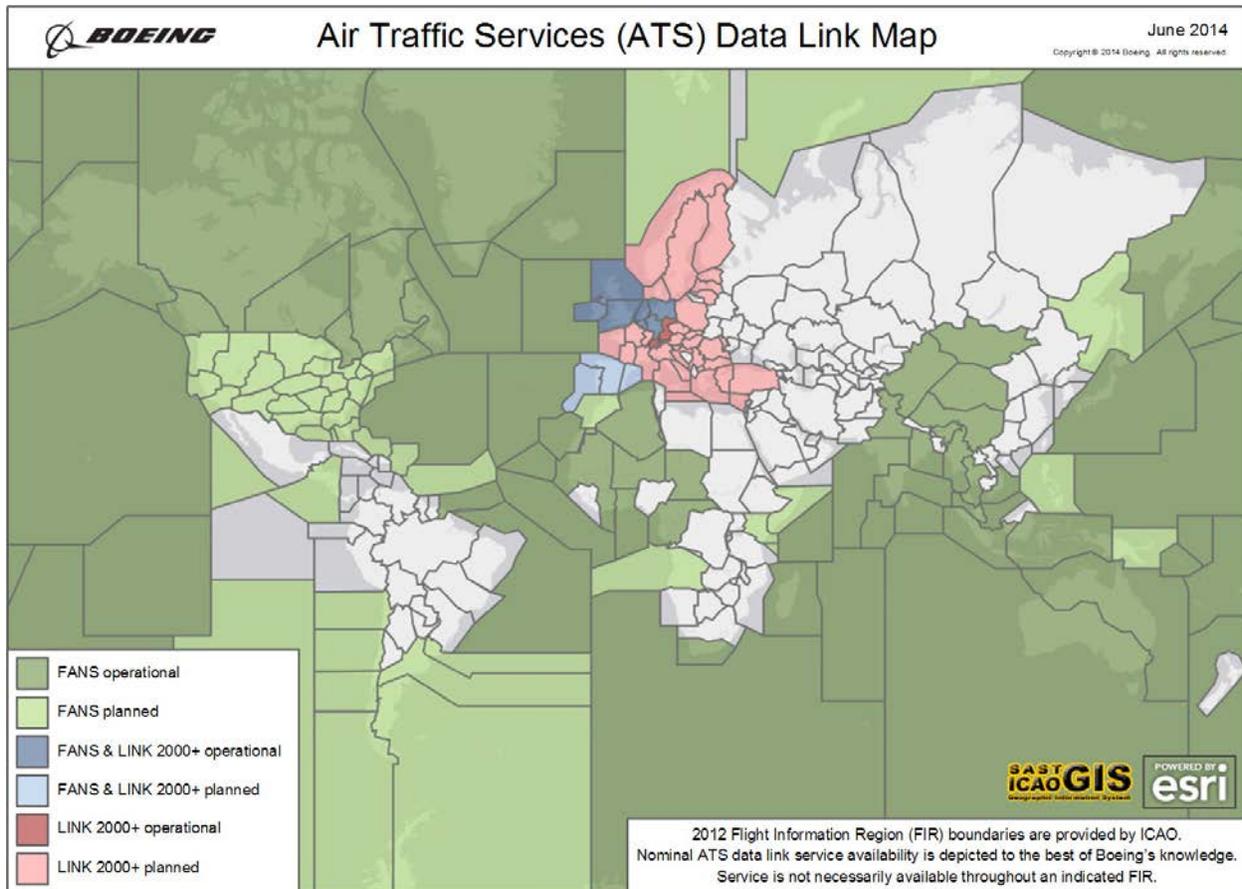


Figure 4. Air Traffic Services (ATS) Data Link Map

From a global perspective, a vast investment has already been made by aircraft operators and air navigation service providers in FANS 1/A systems to provide more efficient air traffic management (ATM) operations and to advance safety. The current interpretation of the applicability of the FAA’s data link recording rule is negatively impacting equipage rates for U.S. registered aircraft. The FAA has an obligation to consider the global impact of the data link recording rule on advancing safety through data link implementation.

FANS 1/A and ATN B1 (Link 2000+) products, both which include CPDLC, are readily available to operators for a number of aircraft types, but if a design approval is required to install CPDLC after the effective date, data link recording capability must also be installed, according to the interpretive material for the rule. Additionally, even when CPDLC is already installed on the aircraft and in use, the interpretive material has led certification offices to require data link recording capability when any change is made to the CPDLC installation.

Note. – The total cost of data link recording capability may include replacement of communications management unit, wiring provisions, recorders and certification costs.

For the industry, the installation for data link recording is a significant expense that will discourage the efforts to promote and upgrade aircraft to FANS 1/A to advance safety in oceanic and domestic operations.

At PARC CWG meetings, reports from operators with active FANS 1/A installations prior to the December 6, 2010 indicated that the DLR rule has restricted safety upgrades to data link communications. One operator shared that the airline wanted to upgrade their CMU to accommodate added memory to facilitate automated runway calculations for normal and slippery runway conditions and upgrade to VHF data link mode 2 (VDL M2) in preparation for the FAA's domestic Data Communication Program. The operator has abandoned these safety and NextGen upgrades due to the cost of the DLR rule. Another operator has abandoned the installation of Iridium satellite radios to enable data link operations in the Polar Regions.

KEY POINT: In the end, operators that desire to install CPDLC on retrofit aircraft or modify existing CPDLC installations likely will not proceed with the installation or modification owing to the additional significant costs to include data link recording capability. One operator reported that the cost associated with just complying with the data link recording capability would be an average of \$100,000 per individual aircraft. Another operator shared that they have already reduced the number of FANS 1/A retrofit installations by 80% because of the costly data link recording capability that would also be required.

As indicated in the preamble to the final rule, operators may be required to install CPDLC owing to mandates in the NAT and EUR Regions, without any consideration of cost. The costs and benefits associated with the data link recording systems must be considered by the FAA as they are for operators, independently of the costs and benefits of CPDLC retrofit installations. The costs of complying with the data link recording capability far exceed the benefits for retrofit aircraft. Recording on the ground captures the messages sent. Recording on the aircraft would indicate if the message was received by the aircraft, but not if the pilot read the message. If the pilot acted on the message by making a change to the aircraft trajectory, this action would be captured on the DFDR. The PARC contends that the safety benefits of CPDLC and ADS-C on retrofit aircraft far out-weigh the benefits of an airborne data link recording capability.

Recommendations

Near-Term Recommendations

RECOMMENDATION 1. The PARC recommends that the FAA clarify the interpretive material that the data link recording rules are not applicable to specific cases of “retrofit aircraft”, including:

- a) Retrofit installations of the data link capability, where:
 - 1) the aircraft has an existing installation of the data link capability; or
 - 2) the aircraft has an existing certified data link capability option—to activate/install the data link capability—that was **originally** certified before the effective date of the rule; and
- b) Modifications to retrofit installations of the data link capability, as described in item a) and the modifications do not change the FANS 1/A or ATN B1 interoperability.

Note.— RECOMMENDATION 1 MAY BE ACCOMPLISHED BY CLARIFICATION OF THE EXISTING RULE and may provide more immediate “go” decisions for activations of data link capability for over 2,000 aircraft.

A modification to the data link capability can include, for example, CMU update, changes to modify or add radios to communicate over VDL Mode 2, satellite and/or mobile broadband communication networks, and other changes to improve safety enhancing features of the data link capability.

FANS 1/A and ATN B1 are designators to indicate the interoperability standards that are applicable to the aircraft system or ground system. FANS 1/A interoperability is based on RTCA DO-258A / EUROCAE ED-100A (or equivalent); ATN B1 interoperability is based on RTCA DO-280B / EUROCAE ED-120B. Both FANS 1/A and ATN B1 CPDLC message sets are consistent with the CPDLC message set defined in ICAO Doc 4444, Appendix 5.

Note.— FANS 1/A, in this report, refers to both FANS 1/A and FANS 1/A+, as defined in FAA AC 20-140B and ICAO Draft Doc [GOLD], which is expected to be published in 2015.

RECOMMENDATION 2 – The PARC recommends that the FAA revise the data link recording rules so that they are not applicable to “retrofit aircraft”, including retrofit installations or modifications to retrofit installations of the data link capability and the installations or modifications do not change FANS 1/A or ATN B1 interoperability.

*Note.— This recommendation would apply for ALL retrofit aircraft, whether or not there was an existing data link capability option available before the effective date of the rule. **RECOMMENDATION 2 MAY REQUIRE RULEMAKING AND MAY THEREFORE TAKE LONGER TIME FOR COMPLETION.** If RECOMMENDATION 1 is accepted and implemented on an earlier schedule, possible rulemaking would only involve aircraft without an existing data link capability option before the effective date of the rule.*

Longer Term Recommendation

EASA currently has only a “forward fit” rule with an effective date of April 8, 2014. EASA has planned for a “retrofit” rulemaking task RMT.0294; however, it is not expected to begin before 2018. Under the current EASA rule, operators of non-U.S.-registered aircraft can voluntarily install FANS 1/A CPDLC to enhance safety without incurring the additional costs of airborne data link recording. The ICAO Annex 6 effective date for forward fit or retrofit installations is January 1, 2016, however the retrofit provision applies only to new data link (e.g. FANS 1/A CPDLC) installations, not modifying existing data link installations that are being used or will be used before the effective date of the provision.

RECOMMENDATION 3 - The PARC recommends that the FAA work with EASA and ICAO to continue harmonizing data link recording rules, their applicability and timelines.

Finally, it is important to note that this report represents the views of the PARC, including those operators that have already made investments to install data link recording for retrofit aircraft. The PARC believes that following these recommendations will best serve the public interest by removing existing impediments to optimal implementation of data link, and thus, enhance safety in the NAS and worldwide.

Acronyms

ADS-B	Automatic dependent surveillance – broadcast
ADS-C	Automatic dependent surveillance – contract
AIC	Aeronautical Information Circular
AIDC	ATS interfacility data communication
AIP	Aeronautical Information Publication
AIR	Airborne image recorder
AOC	Aeronautical operational control
ATC	Air traffic control
ATM	Air traffic management
ATN	Aeronautical telecommunication network
ATN B1	Aeronautical telecommunication network – baseline 1
ATS	Air traffic service
C of A	Certificate of airworthiness
CM	Context management
CMA	Central Monitoring Agency
CMU	Communications management unit
CNS/ATM	Communication, navigation surveillance/air traffic management
CPDLC	Controller-pilot data link communications
CRD	Comment Response Document
CVR	Cockpit voice recorder
CWG	Communications Working Group
D-FIS	Data link – flight information service
DLC	Datalink communication
DLIC	Data link initiation capability
DLM	Data Link Mandate
DLR	Data link recording
DFDR	Digital flight data recorder
EASA	European Aviation Safety Agency
ETMS	Enhanced traffic management system
EUR	European
FAA	Federal Aviation Administration
FANS 1/A	Future air navigation system 1/A, includes FANS 1/A and FANS 1/A+
fapfh	Fatal accidents per flight hour
FIR	Flight Information Region
FMS	Flight management system
GADSS	Global Aeronautical Distress and Safety System

GNE	Gross navigation error
GOLD	Global Operational Data Link Manual
HF	High frequency
HLSC	High Level Safety Conference
ICAO	International Civil Aviation Organization
ICAO ANC	Air Navigation Commission
JAA	Joint Airworthiness Authorities
LHD	Large height deviation
LRDE	Level range deviation event
MOPS	Minimum Operational Performance Specifications
NAS	National airspace system
NAT	North Atlantic
NAT IMG	NAT Implementation Management Group
NAT MNPS	NAT Minimum Navigation Performance Specification
NAT MWG	NAT Mathematicians' Working Group
NAT OTS	NAT Organized Track System
NAT SARSIG	NAT Safety Analysis Reduced Separation Implementation Group
NAT SPG	NAT Systems Planning Group
NextGen	Next Generation Air Transportation System
NM	Nautical mile
NPA	Notice of Proposed Amendment
NTSB	National Transportation Safety Board
OEM	Original equipment manufacturer
OPLINKP	Operational Data Link Panel
PARC	Performance-based Aviation Rulemaking Committee
PBCS	Performance-based communication and surveillance
Satcom	Satellite communications
SLOP	Strategic lateral offset procedure
STC	Supplemental type certificate
TC	Type certificate
TLS	Target level of safety
U.S.	United States
UIR	Upper Flight Information Region
USC	United States Code
VDL M2	VHF data link – Mode 2
VHF	Very high frequency

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