

## **FANS Interoperability Team Meeting (FIT/19)**

**Nadi, Fiji, 28-29 February 2012**

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### **Agenda Item 4 – Working Papers**

#### **Dynamic Airborne Reroute Procedure (DARP) interoperability issues**

**Presented by Airways New Zealand**

#### **SUMMARY**

This paper identifies two interoperability issues between ANSP ground systems and aircraft that affect the Dynamic Airborne Reroute Procedure (DARP). The issues have been raised with the ISPACG CRA and are being tracked under Problem Report #1030. These interoperability issues have ramifications on the use of DARP in the South Pacific (SOPAC) and may affect DARP expansion in other regions. Additional procedural mitigations and agreement between stakeholders are required to enable DARP continuation in the SOPAC.

### **1. INTRODUCTION**

- 1.1. The optional latitude longitude field assigned to the published identifier (fix name) variable in CPDLC uplinks is used by aircraft to differentiate between duplicate fix names in their databases. Some aircraft FMS may be unable to resolve a duplicate fix name when an optional latitude and longitude is not included in the uplink and a load failure of the uplinked DARP clearance may result.
- 1.2. ICAO flight planning rules do not allow the construction of route strings using airway designators unless the airway designator is preceded and followed by a fix name which is part of the specified airway. Some aircraft are down linking route strings using a sequence of airway designators (airway name - airway name) without intervening fix names as required by ICAO.

### **2. DISCUSSION**

#### **Optional Latitude Longitude Issue**

- 2.1 The Boeing SR&O's have an ANSP requirement for ground systems to include the optional RTCA DO219 specification latitude and longitude when up-linking fix names e.g "The ATC facility shall include the optional [latitudelongitude] with any [publishedidentifier] for which duplicates exist". Most ground systems are unable to fully comply with this requirement because they only maintain a navigational database that is relevant to their area of operations and do not maintain a global database. In

many cases ANSP simply do not know the position of fix names outside their area of interest and are also unable to determine if a fix is a duplicate or not. The Airways OCS system was not compliant with the Boeing SR&O requirement when it entered service. A software upgrade in 2011 now has OCS partially compliant and the optional latitude longitude is uplinked with all known fix names.

- 2.2 Our partial compliance with the optional latitude longitude requirement in Boeing SR&O is because ANSP ground systems do not maintain global navigational databases. A ground system can only uplink the optional latitude longitude associated with the fix name variable if the relevant fix name is in the ground systems navigational database, or in the Airways OCS case, if the aircraft downlinks the optional latitude and longitude associated with to a fix name which enables the ground system to retain that information for subsequent uplinks. Our premise that all aircraft would downlink the optional latitude longitude for any duplicate fix name in their navigational database was flawed. Only a subset of current aircraft downlinks the optional latitude longitude.
- 2.3 We have attempted to mitigate the impact of this issue on the New Zealand – North American DARP routes by extending the OCS navigational database and including all fix names on routes into KLAX and KSFO and by using an external global database to identify known duplicates. Enabling our software to retain any optional latitude longitude down linked by aircraft provides further mitigation. While these mitigations will assist in minimizing load failures on the aircraft they will not prevent them.
- 2.4 One option discussed is that DARP should only be planned using latitude longitude and not fix names. While feasible in the en-route oceanic environment this is probably not feasible in other environments. Providing Airline AOC with visibility of problematic duplicate fixes so they could be avoided would assist in mitigating the issue.
- 2.5 The optional latitude longitude/ duplicate fix name issue requires further discussion and agreement by ISPACG stakeholders. Airways notes that some mitigation is available and that DARP continuation is possible but this should be agreed by all stakeholders. To assist in the discussion Appendix A contains information on aircraft capability. This issue is a candidate for inclusion in the Global Operational Data-link Document (GOLD).

#### **Non ICAO Airway – Airway route construction**

- 2.6 While some ANSP ground systems can process non-ICAO airway - airway strings without intersection fixes in CPDLC downlinks other ANSP ground systems cannot. Failures in the DARP process are occurring:
  - At the CPDLC DARP route request stage for those ground systems that are unable to process airway-airway definitions without the required join fix names;

- During subsequent AIDC notification or co-ordination of a DARP where an airway name – airway name definition passed in an AIDC exchange is rejected by the receiving ANSP.
- 2.7 The GOLD Table 6-1 describes the AOC initiated DARP. Step 1 in Table 6-1 describes the creation of the amended route uplink to the aircraft and Note 2 of this step states that: “Where an airway designator is used it should be preceded and followed by a fix name or navaid designator that is defined on the airway described.” While the Airline Operational Control (AOC) may correctly following this process in their uplinks the Flight Management System (FMS) on some aircraft do not downlink the join fix between airways designators even though the cockpit display may display the intersection fix to the crew. This is not compliant with the requirements of ICAO PANS/ATM Doc 4444; however neither DO-219 or DO-258A/ED-100A specify this as a requirement. Appendix A contains an analysis of current aircraft functionality.
- 2.8 The OCS will process CPDLC downlinks containing airway name- airway name definitions and will add any missing intersection fix names if they are known both for controller display and when sending the route in AIDC exchanges. The uplink sent back to the aircraft will not include the intersection waypoints but replicates the received downlink. The FAA ATOP system has the same functionality and we understand the Fijian Aurora system also has the same functionality. We believe that Australia’s TAAAT’s and Tahiti’s TIARE are unable to process downlinks containing airway – airway strings if they are missing the ICAO required fix name intersections.
- 2.9 AIDC failure is occurring when a ground system that can process an airway name – airway name definition from the aircraft is unable to resolve a downstream airway name - airway name intersection because it is outside the coverage of its navigational data base. In this specific circumstance both OCS and ATOP will send the airway name-airway name string in the AIDC route which can cause a failure of the AIDC exchange with other ground systems. Testing here shows that if we receive an ABI with an airway name-airway name string we will process it and add any known intersection fix for transmission to the next facility. However, if the airway name – airway name string is outside our area of interest and the intersection fix is not known then we will send the airway name-airway name string as received.
- 2.10 We have noted that the AIDC failure may be transparent to the initiating ANSP. If the route is considered syntactically correct by the receiving ground system a LAM may be transmitted. We are advised that TAAAT’s for example will send a LAM to the initiating ANSP and post the ABI to an error queue for manual correction.
- 2.11 The FAA has provided an example of an actual DARP that illustrates the issue:
- Requested Route per crew display: 27N170W 30N180W 32N170E 34N160E 35N150E SEALS OTR13 VACKY Y813 RADIS Y811 ABBOT
  - Route down linked by FMS: 27N170W 30N180W 32N170E 34N160E 35N150E SEALS **OTR13 Y813 Y811** ABBOT
  - Route up linked to aircraft: 27N170W 30N180W 32N170E 34N160E 35N150E SEALS **OTR13 Y813 Y811** ABBOT

- Route displayed to crew: 27N170W 30N180W 32N170E 34N160E 35N150E SEALS **OTR13 Y813 Y811** ABBOT
- Route sent in ABI/CPL to next facility: 32N170E 34N160E 35N150E SEALS **OTR13 Y813 Y811** ABBOT (We assume the intersecting fixes for these routes are not in the Oakland navigational database)
- The next facility accepted the route change but subsequently queried the aircraft regarding the route. The airline subsequently queried the FAA regarding why the uplink did not contain the intersection fixes.

### **DARP continuation in the SOPAC**

- 2.12 In the SOPAC we have a number of different FMS implementations for both the optional latitude/longitude and the airway-airway downlink issue. Boeing advise that: B777 is a candidate for an upgrade that will resolve both issues in the 2013/2104 timeframe and confirms that the B777 does not currently use the optional latitude/longitude nor downlink the intersection fix between airways; the B744 does not use optional latitude/longitude but will downlink the intersection fix between two airways; the B737, B757, B767, and B748 use both the optional latitude/longitude and downlink the intersection fix between airways. Airbus functionality is: on Airbus aircraft fitted with Honeywell FMS the optional latitude/longitude is not used; on Airbus aircraft fitted with Thales FMS the optional latitude/longitude is always used; on aircraft with Thales FMS upgraded to R1A or later and with Honeywell FMS the intersection fix between airways is used in downlinks. The status of A330/A340 fleets in SOPAC in regard to Thales FMS R1A installation is unknown.
- 2.13 DARP availability in the different SOPAC Flight Information Regions is dependent on the interoperability between the aircraft and the ANSP ground systems. Currently a number of different scenarios are possible:
- Ground systems unable to process downlinks containing airway-airway intersections without the intersecting fix will deny the DARP request.
  - Ground systems able to process downlinks containing airway-airway intersections without the intersecting fix will issue the DARP clearance to the aircraft.
  - Ground systems able to issue clearances to aircraft where airway-airway intersections do not have an intersecting fix will either:
    - Resolve the missing intersection and successfully complete AIDC coordination with subsequent ANSP.
    - Be unable to resolve the missing intersection yet successfully complete AIDC coordination with subsequent ANSP because subsequent ANSP can resolve the missing intersection.
    - Be unable to resolve missing intersection and have AIDC coordination fail with subsequent ANSP because they are also unable to resolve the missing intersection.
  - Aircraft receiving DARP uplinks containing duplicate fix names without the optional latitude longitude attached may be unable to resolve the ambiguity and

will be unable to load the clearance. If GOLD procedures are followed the DARP clearance will be rejected (UNABLE).

- 2.14 DARP availability will be assisted if AOC planning DARP with aircraft that are known to not use the intersection waypoints between airway names do not use airway – airway intersections in their DARP.
- 2.15 DARP availability will be assisted if ANSP and AOC audit all known DARP reroute regions between city pairs and identify duplicate fix names. Coordination between ANSP and AOC will be required to minimize the possibility of uplink rejects from aircraft because of an inability to resolve duplicate fix names in DARP.
- 2.16 All ANSP and Airline stakeholders need to review current DARP procedures in light of the identified interoperability issues and determine if adequate mitigations exist to enable the continuation of DARP.

### **3. ACTION BY THE MEETING**

- 3.1 The meeting is invited to:
  - a) Note the current issues regarding interoperability between ANSP ground systems and the aircraft.
  - b) Review current DARP procedures in light of the identified interoperability issues and agree a way forward.

## Appendix A: Airway Intersection Waypoints and Optional Lat/longs

### Boeing Aircraft

Airplane Model	Optional Latitude/Longitude	Airway Intersection Waypoint	Plan
B737	Includes lat/lon for non-unique waypoints	Includes wpt name for defined xings, cannot have unnamed intersections	None needed
B747-400	Not included.	Included for defined xings, omitted for FMC-computed xings	No update planned
B747-8	Includes lat/lon for non-unique waypoints	Includes wpt name for defined xings, lat/lon for FMC-computed xings	None needed
B757/B767	From Peg 98, lat/lon for non-unique wpts & PBDs included.	From Peg 98, wpt name for defined xings included	None needed
B777	Lat/lon not included. Not in ATS SR&O	Airway intersection not included. Not in ATS SR&O	Planned fix in next Block Point (2013)
B787	Defect in ATS Cap. Doc. Not included.	Defect in ATS Cap. Doc. Not included.	Fix with 787-9 (2014)
MD-11, 717 and MD-10	Includes lat/lon for non-unique waypoints	Included for defined xings, omitted for FMC-computed xings	None needed

### Note:

1. No operators have purchased FANS-1 on the 717
2. MD-10 has the software (disabled) for FANS-1 but is not certified
3. Retrofit testing of 747-8 FMS on B744 is underway.

### Airbus Aircraft

**Note:** Data extracted from: Airbus Technical Report – FANSA/A+ Function Integration with FMS dated 11 October 2011. Report applies to FMS standards for A320 and A330/A340 families: Thales FMS Rev2+ & R1A and Honeywell FMS P1, P3, R1A. - Honeywell FMS for A380

Special case of airway intercept waypoints in message #24: From FMS Release 1A Thales & Honeywell, when the flight plan contains a succession of airways, airways and computed intercept waypoints are downlinked in message #24.

**Note:** For standards preceding Thales FMS R1A, computed intercept waypoints are not downlinked in message #24.



Specificity Thales FMS: The Thales FMS always inserts the latitude and longitude of the fix or navaid after the fix or navaid name in downlink message #24.

**Note:** DO219 states that it is optional to add lat/long coordinates to fix or navaid name.

**Airways Note:** The Airbus technical report only references Honeywell FMS on A380 aircraft. The conclusion we draw from this is that the optional latitude/longitude is not used by the A380. We understand that the Thales FMS R1A release is relatively recent, and SOPAC fleet status with regards to this release on A330/A340 is unknown.