Qualified Installer Guide to Understanding PAPR Failures

1 Revision History

Revision	Date	Comments
A	2/12/2019	Initial release
B	2/18/2019	QI release

Contents

2 Introduction

The FAA PAPR may show failures for a number of reasons. A large part of troubleshooting is determining the reason for the failure. There are six basic categories of failure.

- ADS-B System defective
- ADS-B system not configured correctly
- Installation or on-aircraft issues
- Other aircraft equipment failures
- User error
- Airspace/Coverage

Of the six categories, a defective ADS-B system is the least common issue, but it is the most common justification and assumption by customers for PAPR issues. The top two causes of failures are misconfiguration and airspace/coverage issues. User error and aircraft equipment failures do also occur regularly, with actual ADS-B equipment malfunction coming in dead last.

The tools below, along with this guide, will help you determine which category is most likely the cause for a perceived or actual performance issue.

3 Tools

3.1 FAA PAPR Request Website:

https://adsbperformance.faa.gov/paprrequest.aspx

  or

https://adsbrebate.faa.gov/PAPRRequest.aspx

PAPR reports are generally available 15 minutes after landing.

You can request PAPRs from the links above.

3.1.1 Requesting a PAPR

Requesting a PAPR is straightforward. 30 minutes after landing enter the information as requested by the webpage. You should receive an email within 15 minutes with the PAPR attached. If you receive failure to generate verify the information entered was correct. Remember the date and time of flight is in UTC/Zulu time. West coast evening flights will have been recorded as flown the next day UTC.

3.1.2 Multiple flights during the same day

The PAPR site does allow you to pull a report from a second or third flight. You must check the **Optional Time** box.

Optional Time: ☐ I flew multiple times during the day and would like to provide a specific time during my flight of interest.

Enter a time during the first half of the flight. If the customer knows the time they were *wheels-up* enter that Zulu time plus an additional 10-15 minutes.

3.2 FAA PAPR User Guide:

https://adsbperformance.faa.gov/PAPRUsersGuide.pdf

This is the official manual for how to read a PAPR. It's mentioned on the cover page of every PAPR. Copy of text from the cover page of the PAPR shown below.

Note: Items high-lighted in red within this report indicate the ADS-B Out system installed on this aircraft failed to meet the corresponding performance requirement as specified in § 91.227.

For more information on this report, reference the **User's Guide.**

The guide is very good and even provides troubleshooting suggestions so read it before continuing.

3.3 Additional Troubleshooting Tools:

FAA N-Number Inquiry:
https://registry.faa.gov/aircraftinquiry/NNum_Inquiry.aspx

ICAO Calc: http://www.avionictools.com/icao.php

FAA ADS-B Coverage KMZ (requires Google Earth):
https://www.faa.gov/nextgen/equipadsb/research/airspace/media/2020ADS-BAirspaceMap.kmz

UAT Tower List (unofficial):
https://www.dropbox.com/s/3384618cme8tt0w/ADS-B_Ground_Stations_as_of_12-12-16_KML%20%281%29.kml?dl=0

Avionics Check: 9-AWA-AFS-300-ADSB-AvionicsCheck@faa.gov

ADS-B Rebate Helpdesk: ADSBRebateHelp@FAA.gov

3.4 Dress for success:

In aviation everything is about the setup. The pre-flight, pilots health, pilots familiarity with the aircraft, and the details of the flight determined 99% of the outcome. ADS-B flights are no different. Poor behavior and lack of understanding leads to failed reports. The first part of support needs to be education. There have been a fair number of customers who are frustrated after failing to achieve a successful rebate because they didn't read or understand the rules.

3.5 Improve the chances of a passing PAPR and rebate approval:

- Fly in excellent coverage
- Give the aircraft a sufficient run-up
  - 8-10 minutes after avionics and ADS-B on
- Avoid any lengthy or aggressive maneuvers
- Keep turns to a minimum; contrary to FAA guidance for STC flights, no 360 degree turns are required
- If flying a rebate flight, 30+ minutes in rule airspace is required.

3.5.1 Coverage:

Let's start by quoting the FAA:

> *Be advised that flight operations occurring at the fringe of ADS-B ground station coverage (refer to the FAA ADS-B Coverage Map)* ***can cause intermittent signal losses with aircraft avionics. This condition may generate various false failure indications*** *(red flag for Percent Failure - PF and/or Maximum Consecutive Failure - MCF flag) within a Public ADS-B Performance Report (PAPR). Such failures will vary depending on the duration of the flight in this condition. If you receive a PAPR with suspected false failure indications, please email 9-AWA-AFS-300-ADSB-AvionicsCheck@faa.gov and request that your avionics performance be manually reviewed prior to taking maintenance action. Please attach the PAPR file and include (PAPR Review Request) in the subject line of the reply email to help expedite a response.*

How can I determine coverage from a PAPR? There is no flight track so how do I know where they flew?

This is easier than you might think. There are some pretty obvious clues.

- Review Duration vs Mod
- Look for extremely unlikely failures
- Compare the aircraft registration address against the ADS-B/Radar Coverage

3.5.1.1 Duration vs Mod:

The duration is the entire time the FAA recorded data for a given flight. To put it another way it's the total time between the first and last message recorded from the aircraft that the FAA deemed likely to be a single flight.

The Mod is the time from the flight less any gaps greater than 30 seconds.

That's a big clue. If more than 30 seconds is missing from a flight the ADS-B system either malfunctioned or the FAA failed to receive transmissions due to coverage and/or shadowing.

The duration and mod are shown on pages 2 and 3 of the PAPR

Duration: 00:31:15   **Mod:** 00:29:39   **Rule:** 00:00:00

Note this PAPR indicates the ADS-B system wasn't received for 00:01:36. Generally a good clue that the system may have been out of coverage. A classic cause of a 45-90 second gap is performing a touch and go.

3.5.1.2 Look for extremely unlikely failures

Missing Elements

Category	NACp	NACv	Vel	Flight Id	Mode 3A	Emit Cat	Baro Alt	Geo Alt
% Fail	0.00%	0.00%	0.00%	14.32%	0.00%	2.58%	0.00%	0.47%
Max dT	00:00:00	00:00:00	00:00:00	00:00:44	00:00:00	00:00:12	00:00:00	00:00:04
MCF	0	0	0	32	0	7	0	2

Integrity & Accuracy

Category	NIC	NACp	NACv	SIL	SDA	SIL Sup	NIC_SVT	NACp_SVT	Val	eVAL	eVal NIC
% Fail	0.00%	0.00%	0.00%	0.00%	5.40%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Max dT	00:00:00	00:00:00	00:00:00	00:00:00	00:00:17	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00
MCF	0	0	0	0	11	0	0	0	0	0	0

Category	NIC	NACp	NACv	SIL	SDA
Avg	8.0	9.0	1.0	3.0	1.9
Min	8	9	1	3	0
Max	8	9	1	3	2

Kinematics

	Velocity	Position Δ	Enh position Chk	Baro Alt	Baro Alt Δ	Geo Alt	Geo Alt Δ
% Fail	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
MCF	0	0	0	0	0	0	0

Other Checks

	Emitter Cat	Mode 3A	Link Version
% Fail	0.00%	2.82%	0.00%
Max dT	00:00:00	00:00:09	00:00:00
MCF	0	6	0

This PAPR shows a patchwork of failures all in very low percentages. The emitter and SDA are good clues to fringe coverage. **SDA** is hard coded. **Emitter** type is also not conditional or effected by any other metric. Even if the customer chooses the wrong emitter it will not be flagged as missing as shown above. Neither Emitter Category nor SDA should ever be missing. When you see an unlikely failure there is a good chance you are looking at coverage or momentary fringe issues. Typically caused by flying at low altitude or in an area of poor coverage. Touch and go maneuvers will contribute to this type of failure.

3.5.1.3 Registration vs Coverage:

If not present for the flight test, you can ask where the flight took place and use the Google Earth tool to verify whether or not the issue is lack of coverage. You can also look up the aircraft registration address through the FAA N-number inquiry page and match up registration address with the flight area.

Example look up the aircraft registered address:

Enter the N-number N7409D in the FAA N number inquiry page:
https://registry.faa.gov/aircraftinquiry/NNum_Inquiry.aspx

Aircraft Description			
Serial Number	22-5170	Status	Valid
Manufacturer Name	PIPER	Certificate Issue Date	09/23/1998
Model	PA-22-150	Expiration Date	05/31/2021
Type Aircraft	Fixed Wing Single-Engine	Type Engine	Reciprocating
Pending Number Change	None	Dealer	No
Date Change Authorized	None	Mode S Code (base 8 / oct)	52373041
MFR Year	1957	Mode S Code (base 16 / hex)	A9F621
Type Registration	Individual	Fractional Owner	NO

Registered Owner			
Name	BARTLETT DONALD R		
Street	1215 SHAWNEE TRL		
City	CARTERVILLE	State	ILLINOIS
County	WILLIAMSON	Zip Code	62918-1659
Country	UNITED STATES		

The aircraft is registered in Carterville, IL.

Now pull up Carterville, IL on Google Earth and turn on the ADS-B and Radar coverage at 500' AGL.

At 500AGL the radar (dark green) and ADS-B (light green) coverage are both non-existent. Depending on the field the aircraft departed from, and the direction of flight, a large gap and random failures are very likely. The data from the PAPR and the coverage map all support the fact that this flight likely failed due to coverage issues and not configuration or defective equipment. Detailed data can be requested to verify

that coverage was the cause. You or the customer can also contact the ADS-B rebate help desk ADSBRebateHelp@faa.gov with the date and callsign to request a manual review.

3.5.2 Give the aircraft a sufficient run-up

The aircraft run-up and equipment *power-on* time directly contribute to PAPR performance. Be sure to and advise customers to turn on ADS-B and other avionics immediately after engine start.

3.5.2.1 GPS Startup

Certified aviation GPS units need a decent amount of time to download almanac and ephemeris data. Small percentage NIC issues have been traced to very short startup times.

3.5.2.2 Transponders/Altitude Encoders warmup

We've resolved several odd Flight ID and Mode 3A issues by providing sufficient time for the transponder and/or altitude encoder to come online. We've witnessed on a particular encoder that needs 10 minutes of startup time after every power cycle before it sends a valid altitude. 91.227 Compliance requires an ADS-B device and an operable Mode C or S transponder. Without valid squawk and pressure altitude the flight will fail.

Customers may adhere to outdated guidance suggesting manual cycling of the transponder from Standby to On and to ALT. According to current guidance, and for best ADS-B data, the transponder should remain in ALT at all times. Some transponders may have means to automatically switch between modes; this is not beneficial and customers should be encouraged to remove any automated transponder mode switching.

Indicators that an aircraft run-up may have been too short.

- Low percentage NIC failure < 2%
- Low percentage FID failure < 3%

3.5.3 Avoid sustained maneuvers or unusual attitudes:

GPS, ADS-B and transponders are all line-of-sight radios. They perform best when the antennas are unobstructed. Prolonged banks can hide GPS satellites from view or point the transponder antenna way from ground radar stations. The FAA rebate site references AC 20-165B which calls for two 360 degree turns in each direction and in each aircraft configuration. The FAA rebate desk folks have advised against following

this guidance. They recommend a very flat profile with minimal banking or maneuvering.

Indicators of sustained maneuvers:

- Low percentage NIC failure <2%

You can verify maneuvering may have been the issue this with the customer.

3.5.4 30+ minutes in rule airspace is required for a rebate flight

There have been several very frustrated customers because they failed the rebate requirements but couldn't find a failure on the PAPR report itself. In almost every case the aircraft did not have sufficient time in rule airspace.

Duration: 00:33:19 **Mod:** 00:33:19 **Rule:** 00:00:00

The report above shows 33+ minutes of flight but zero time in rule airspace. The report will not show a failure and the customer will not receive the incentive code required to process the rebate. It is important to ensure the flight has spent sufficient time in rule airspace.

4 Troubleshooting Specific Failures

4.1 Failure to Generate/Missing Flights

Failure to generate a report can be the result of several different issues. Customers may state they have *missing flights.*

"I keep requesting my second flight but I'm only getting back the same flight that day every time I make a request."

The FAA PAPR system will always send the same (typically first or longest) flight. The user must enter the UTC/Zulu time during the second or third flight to receive additional reports.

4.1.1 Requesting PAPR for the wrong date UTC/Zulu

PAPR flights are recorded according to the first message received UTC. Western U.S. flights conducted late afternoon/evening will need to be requested by day flown UTC which is typically the following day relative to local time.

4.1.2 Pilot error

The most common pilot error is forgetting to turn on the ADS-B system.

4.1.3 Transmit Disabled

Flying with the skyBeacon transmit disabled will return a failure to generate. Verify the Transmit is enabled in the mobile application.

4.1.4 Incorrect Vs0

Entering a Vs0 that is higher than the aircraft cruise will cause a report to fail to generate. Some installers have mistakenly entered VNE instead of Vs0 during set up of skyBeacon.

4.1.5 Incorrect ICAO/Call sign

On occasion installers/customers enter an incorrect call sign. This isn't so much a failure to generate as it is an invalid request to the PAPR website. Requesting N8664B when the customer entered 8644B will not generate a report. If the report will not generate using the callsign you can attempt a second request using the ICAO.

Flying in anonymous mode also has the same effect as an incorrect ICAO/callsign.

4.1.6 Coverage

The screenshot below shows a portion of South Dakota. The thumb tack icons are ADS-B ground stations. The orange represents ADS-B coverage at 1500'AGL. A flight flown inside a majority of the yellow circle will not be able to generate a report. The nearest ground station from the two airports shown in the center of the image is over 100 miles away. The failure likely has nothing to do with equipment.
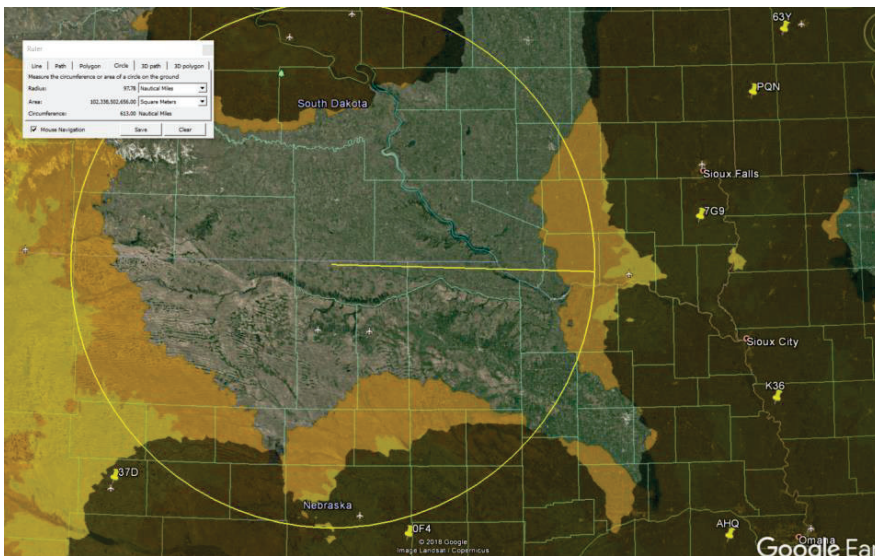
4.2 Mode 3A

The most common error currently seen in the field is Mode 3A. Mode 3A failure indicates the squawk from the transponder was missing/unavailable.

4.2.1 100% failure

Review the transponder threshold settings. In severe cases we can send out the Tiny Interrogator package to help installers who are struggling find the right threshold value. In rare cases a 100% failure can be coverage related.

4.2.2 Low percentage failures

Low percentage failures can be challenging to resolve.

4.2.2.1 Review airspace.

Coverage is a common reason for 1-5% failures. You cannot tune out a coverage issue. Do not adjust the threshold on an aircraft that is failing Mode 3A by less than 5%. Several customers have received rebate approvals for low percentage Mode 3A failures after review by the FAA ADS-B rebate help desk.

4.2.2.2 Transponder Mode

Verify the transponder is in ALT mode at all times. Using automatic air/ground detection with a Mode C transponder is not recommend with a skyBeacon and does not follow FAA guidance. Current guidance is that the transponder should always be in ALT mode.

4.2.2.3 Inoperable Transponder

It may seem unlikely but we've had a couple of customers with completely dead transponders. The panel lit up but the transponder didn't function.

4.3 Flight ID

Flight ID failures have been traced to three specific sources. Configuration, faulty altitude encoder in either the aircraft or skyBeacon, or improper transponder threshold adjustment.

4.3.1 100% failure

Review the Flight ID block at the bottom of page 4.

	Flight ID	Mismatch	Non-US	No "N"	Only "N"	Partial	Spaces	All Spaces	Illegal Char	Unavail Char
% Fail	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Max dT	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00	00:00:00
MCF	0	0	0	0	0	0	0	0	0	0

If any of the blocks are red review the PAPR User guide and correct the call sign. The most common cause is installer did not configure the call sign with the required leading N. If this is the case the *No "N"* block will show a 100% failure. If there are no red blocks in the Flight ID the issue is transponder threshold configuration or equipment malfunction.

4.3.1.1 Verify the Altitude Encoder in the skyBeacon.

Power up the skyBeacon and keep the transponder powered OFF. Verify the pressure altitude shown matches the aircraft altimeter at 29.92 within =/- 125'. If the pressure altitude from the skyBeacon shows "--" or a very large discrepancy from the altimeter, the skyBeacon should be replaced. Remember the transponder needs to be turned OFF for this test. Also remember the pressure altitude will not align with AMSL altitude. Amazing but pilots do forget this fact which is why we're placing the altimeter at 29.92 for verification and not field elevation.

4.3.1.2 Ask about the last time the aircraft had the altitude encoder tested

There have been several Flight ID failures that were resolved by replacing the altitude encoder. Please do not recommend customers undertake maintenance actions on their aircraft without extremely good supporting data. Transponders are required to be tested every 24 months but many encoders in VFR airplanes have never been tested. More detailed data may need to be requested from the FAA to resolve this issue.

4.3.2 If the Flight ID failure is a low value <5%

Low percentage flight ID issues have been equally resolved by longer run-ups to allow the encoder to come online or by encoder replacement. Low percentage failures can be tricky to diagnose and in many cases require a review of detailed data from the FAA.

4.4 NIC/NACp failures

NIC and NACp failures are related to GPS integrity. NIC issues are generally not a result of flying in poor coverage. Coverage issues are usually indicated by multiple random failures. If only the NIC and occasionally the NACp are failing it is not a coverage issue.

4.4.1 High percentage NIC failure 20-100%

This is likely an equipment issue. Please contact support@uavionix.com for this type of failure.

4.4.2 Low percentage NIC failure 1-5%

Review run-up procedures with customer. We've resolved several by advising that the skyBeacon needs time to acquire a high integrity fix. Several more have been resolved by asking customers to reduce maneuvering during PAPR flights. In some cases detailed data is required to determine the failure.