CALLBACK

From NASA's Aviation Safety Reporting System

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Fifth Generation (5G) C-Band Co-Operations

The Aviation and Telecommunication industries are unmistakable giants of our national identity that are currently engaged in solving a high-stakes problem. New 5G cellular emissions lie near the frequencies used by Radio/Radar Altimeters (RAs) installed in many aircraft. Aviation groups have expressed concern that interference from the 5G signals can degrade performance of RAs and other dependent aircraft systems such that flight safety may be compromised.

Specific issues are many, diverse, and complex, but through collaboration among FAA, FCC, and industry stakeholders, interim fixes for this ongoing issue have been introduced. These temporary solutions employ ADs and NOTAMs prohibiting specific operations, FAA Alternative Methods of Compliance (AMOCs), and controlled 5G rollouts. Progress toward permanent solutions includes RA retrofits, re-designs, and more. For current 5G information, history, chronology, FAA actions, governance, and directives, and overall progress, go to https://www.faa.gov/5g.

This month, *CALLBACK* shares incidents reported during the recent 5G rollout period that identify possible effects on RAs and dependent aircraft systems, which crews suggested may have been linked to existing 5G signals at nearby airports.

After Takeoff

Shortly after takeoff, this flight crew experienced multiple abnormalities from what might seem to be unrelated systems. Observables were linked to the Captain's Radio Altimeter.

From the Captain's report:

■ *After rotation from Runway 7L at Phoenix, the Captain's Radio Altimeter appeared to be frozen at the normal 'on the ground' indication of -4 feet AGL. As the pitch attitude was increased above ten degrees on initial climb, the tail strike pitch limit indicator appeared in the Heads-up Display (HUD) in addition to the normal TOGA flight director cues. Due to the erroneous Radio Altimeter indication, the preselected pitch and roll modes did not engage automatically on climbout. I cross-checked the First Officer's (FO) Radio Altimeter, and it was operating normally. As we climbed through acceleration altitude, the aircraft was still in TOGA mode and commanding a pitch to maintain V2+20, so I asked the FO to select Level Change and set the speed bug to flaps up maneuvering speed. We accelerated and retracted flaps on schedule. Approaching SPRKY intersection, the flight director did not command a turn, so I initiated the turn manually to comply with the SID. I suspect the lateral navigation, which was armed before takeoff, had not engaged because the Radar Altimeter was still not indicating that the aircraft had left the ground. Approaching our first level-off altitude of 9,000 feet, the flight director command bars operated normally and engaged in altitude hold and lateral navigation. We continued the flight…uneventfully with all flight instrumentation operating normally. We suspected 5G interference affecting the Captain's Radio Altimeter. The FO's Radio Altimeter did not display any anomalies throughout the flight. We flew a visual approach…backed up with the ILS approach, with the HUD in AIII mode, and noted no anomalies with either Radio Altimeter. Based on my review of the bulletins disseminated by the Flight Department, I suspect we had an anomaly with the Captain's Radio Altimeter that may have been caused by 5G interference at Phoenix. I feel it's important to make these events known in order for contributing factors to be addressed by the parties responsible for the safe implementation of the 5G network.*

From the First Officer's report:

■ *…We both needed heightened awareness on the approach to make sure the Radar Altimeter functioned normally. It did.… In the future it is important for us as the crew to be vigilant in monitoring aircraft systems and always understand the details in the anomalies that result with the Radar Altimeter malfunctioning. Especially with the 5G issue still not being fully completed, we…need to be aware that it may happen even though it is supposed to be working correctly at these major airports. We…need to always fly the aircraft first and then ensure we are navigating correctly.*

Legality and Paperwork Proficiency

A Dispatcher reviewed the flight release and missed the fact that an alternate was required. An unconfirmed notion and a hint of confusion were in the mix, but the error was caught.

■ *The release did not have an alternate on it for the 5G NOTAM. As per the Company policy, we are supposed to add an alternate for 5G NOTAMs at destination. I missed the NOTAM in reviewing the flight release for release to*

the crew. The crew called for a new release for fuel uplift. On pass-off that morning, which happened coincidentally near the time of departure, the oncoming Dispatcher caught this. I ACARS'd the crew. The crew called, and we agreed to amend the flight planned instead of [generating] a new release. I amended the flight release for an alternate of ZZZ1, sent weather, and sent NOTAMs. The flight launched and terminated without incident.

This all happened before block-out. I scanned through the NOTAMs but did not see the 5G NOTAM. The 5G NOTAM to Runway XXR was there. I had thought ZZZ2 was not a 5G NOTAM airport. Better diligence [is needed] on my part in checking and noticing 5G NOTAMs that will affect added alternates and fuel.… I have reviewed the Alternative Method of Compliance 5G alert again and will include alternates when needed. Can we [also] have a monthly update on what is happening between the airlines, FAA, and our internal department? The more clear communication [we get] on updates to this [procedure], the better we are.

Well-Informed and Ill-Timed

This transport pilot's approach was interrupted by several abnormal, ill-timed terrain warnings. When one came at low altitude, 5G awareness and good judgment were required.

■ *After receiving a clearance from Approach to conduct an RNAV approach for Runway 9R, we were able to execute a fully stable approach. We then received clearance to land from O'Hare Tower Control, and as we continued a stable descent below 500 feet toward the runway, we received two abnormal terrain warnings around 300 feet AGL. That false warning discontinued around 250 feet AGL. Furthermore, as we continued the descent toward the runway, around 50 feet above the Runway 9R threshold, we received another single "TOO LOW TERRAIN" warning.*

Situational facts: We were in VMC…all the time. 5G related NOTAMs were in effect. [We had] full Alternative Methods of Compliance (AMOC) approval. Since we were in VMC and were in a safe position to land the aircraft, we decided to continue the approach and land safely.

Human Factors in 5G, Too

This First Officer describes serious system difficulties during approach and landing, possibly due to 5G interference but unknown at the time. An age-old Human Factor is involved, and a fundamental aviation principle is reiterated, yet again.

■ *[This is a] possible 5G event. On arrival in the terminal area, the crew noticed the autobrakes disarmed twice after arming. I was the Pilot Flying (PF). The Pilot Monitoring (PM) ran the procedure, and we set manual braking for the arrival. At 2,500 feet MSL and again at 900 feet, the Captain's Radar Altimeter became inoperative with a red flag. This was noticed by the Captain (PM) only, and only on his side. He did not tell the PF. In the flare I noticed a resistance to pitching up. It almost felt like the autopilot was still engaged. I overcame the resistance to set the landing attitude. Additionally, the Autothrottles (AT) did not go to idle at 27 feet, as normal. I manually closed the thrust levers prior to touchdown. The spoilers worked normally. As the nose wheel contacted the runway, the thrust levers started to move forward. I held them back and disarmed the AT. This delayed my engaging the thrust reversers a few seconds. The aircraft was stopped without incident.*

The Captain wrote up the Radio Altimeter at the gate. We did not recognize a possible 5G event. The Captain did not communicate his Radio Altimeter failure to the PF. If someone gets a red flag on their side, alert the other pilot. The approach should have been flown with the AT off for both the Radio Altimeter failure and the current 5G policy.

Beware, the Landing Phase

This Captain received a rare, unwelcome surprise during the landing phase of flight. 5G interference was suspected, and a personal mitigating action is served with a dash of humor.

■ *The FO made a normal hand flown ILS approach to Runway 28R at San Francisco. We broke out of the clouds at 500 [feet] AGL, and the flare was normal. Right before we made ground contact and before I could react, the speedbrake lever motorized up and deployed the speedbrakes, which made us plop onto the runway from about 3 feet or so. It wasn't a hard landing, but it ruined what would have been a good landing for the First Officer. There were no Engine Indicating and Crew Alerting System (EICAS) messages or any other system failures annunciated. With over 18,000 hours as Captain of Boeing airliners, of which 3,000 are in this type, I have never had the auto speedbrakes deploy uncommanded before ground contact. I find it curious that this should occur on my first arrival at San Francisco after publication of the 5G NOTAM. After arriving at the gate, we made log entries to document the event, and I also contacted the pilot office to advise them so appropriate investigation could begin. Hopefully the data recorded by the aircraft will allow determination of the cause. In the meantime, I will closely monitor the speedbrake lever on all landings to prevent it happening again, especially at a greater distance above the pavement. While I operate in the 5G environment, I have no intention on being the first to make a 5G landing.*

ASRS Alerts Issued in December 2022	
Subject of Alert	**No. of Alerts**
Aircraft or Aircraft Equipment	8
Airport Facility or Procedure	10
ATC Equipment or Procedure	7
Hazard to Flight	1
TOTAL	**26**

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https://asrs.arc.nasa.gov

December 2022 Report Intake	
Air Carrier/Air Taxi Pilots	4,633
General Aviation Pilots	1,132
Flight Attendants	709
Controllers	320
Military/Other	232
Mechanics	191
Dispatchers	162
TOTAL	**7,379**