Australian Government
Civil Aviation Safety Authority

Airworthiness Bulletin

AWB 34-020 Issue 7 – 4 March 2022

Potential 5G Interference of Radio Altimeter Systems

An Airworthiness Bulletin is an advisory document that alerts, educates and makes recommendations about airworthiness matters. Recommendations in this bulletin are not mandatory.

1. Effectivity

Aircraft that utilise airborne Low Range Radio Altimeters (LRRA). Also known as Radio or Radar Altimeter (RA), RADALT, RALT.

2. Purpose

Raise awareness of the potential for interference to RA systems from 5th Generation (5G) telecommunications infrastructure. Highlight and encourage reporting of RA or RA integrated system faults.

CASA in conjunction with other services and authorities will use this data to help determine if airborne RA systems are affected by spurious interference.

At this time, the airworthiness concern described in this Airworthiness Bulletin is not considered an unsafe condition that would warrant an Airworthiness Directive to be issued under Part 39 of the *Civil Aviation Safety Regulations 1998*.

3. Background

Use of Radio altimeter

RAs are used to determine height above terrain and may be operated as a stand-alone instrument or as an input to numerous aircraft systems. Many RAs form part of and support critical safety-of-life aircraft functions throughout multiple phases of flight.

Issues with Radio altimeter

The radio altimeter is more precise than a barometric altimeter and for that reason is used where aircraft height over the ground requires precise measurement, such as during autoland or other low altitude, low visibility operations. The receiver on the radio altimeter is typically highly accurate, however it may deliver erroneous results in the presence of out-of-band radiofrequency emissions. The radio altimeter must detect faint signals reflected off the ground to measure altitude, in a manner similar to radar. Out-of-band signals could significantly degrade radio altimeter functions if the altimeter is unable to sufficiently reject those signals.

Anomalous, missing or erroneous radio altimeter inputs could cause these aircraft systems to operate in an unexpected way during any phase of flight - most critically during take-off,

approach, and landing phases. These anomalous inputs can get missed by the pilot in time to maintain continued safe flight and landing.

Band of operation

RAs operate within the 'C-band' of 4GHz to 8 GHZ of the radio frequency spectrum. Which is further segmented into an Aeronautical Radionavigation Service (ARNS) spectrum band of 4.2-4.4 GHz. This is internationally recognized and protected by the International Telecommunications Union (ITU).

Standards for Radio altimeter

TSO-87a is the current FAA technical standard for RAs. Although the TSO was updated in 2012, the TSO reference material, RTCA/DO-155 - Minimum Performance Requirements for Airborne Low-Range Radio Altimeters and EUROCAE/ED-30 - Minimum Performance Requirements for Low-range Radio (Radar) Altimeters were released in 1974 and 1980 respectively. TSO-C87A does not provide criteria for compatibility with adjacent band operations, including potential impacts associated with wireless communications system deployments.

There are recommendations from the FAA for manufacturers to complete analysis of each model in production, supported or still being employed to determine the susceptibility to interference.

With the rapid expansion of mobile telecommunication networks, the frequency spectrum directly adjacent to and below the RA band has been identified as compatible with both existing and emerging 5G technology. Coupled with outdated minimum design, certification and protection criteria, many approved RA systems may be unable to filter or block unwanted transmitted frequencies from existing and proposed new 5G deployments.

5G mobile technology is designed to increase speed, reduce latency, and improve flexibility of wireless broadband services. To achieve this 5G networks require additional transmit and receive Base Stations (BS). BSs using Advanced (Active) Antenna Systems (AAS) actively track 5G devices to allow connection to a mobile network. The increase in BSs, method of operation and close proximity to the RA band may impede the safe operation of airborne RA systems.

Power levels and location of 5G towers

CASA has not confirmed any RA system failure from 5G interference but continues to monitor this situation.

Australian telecommunications companies are currently licensed to use frequencies up to of 3.7 GHz at a power level of 48dBm EIRP (Effective Isotropic Radiated Power) or 63 Watts. By comparison in the United States 5G cell towers can operate at a power level of 62dBm or 1584 watts.

Revision to Radio altimeter standards

In 2019, Special Committee 239 (SC-239) was formed by the RTCA, responsible for updating the DO-155 - Minimum Performance Requirements for Airborne Low-Range

Radio Altimeters. To understand the potential risks to RA system interaction between and 5G technology an analysis and subsequent white paper was developed, *Assessment of the C-band Mobile Telecommunications Interference Impact on Low Range Radar Altimeter Operations*.

The assessment concluded there was a major risk of harmful interference to radar altimeters on all types of aircraft from 5G systems in the 3.7 to 3.98GHz band.

At the same time, the Australian Communications and Media Authority (ACMA) who are responsible for the management of the Australian frequency spectrum assignment, raised an options paper followed by an outcomes paper looking at the reallocation of frequencies within the 3.7-4.2 GHz band.

ACMA's proposed re-allocation would allow telecommunication companies licences to utilise frequencies adjacent the RA band for Wireless Broadband (WBB) 5G operations.

CASA continues to work with ACMA, other relevant Australian organisations and international airworthiness authorities to monitor and manage potential interference of RA systems within Australia.

To date CASA has no confirmed reports of wireless broadband or telecommunication systems interfering with aircraft RA systems but is continuing to monitor this situation.

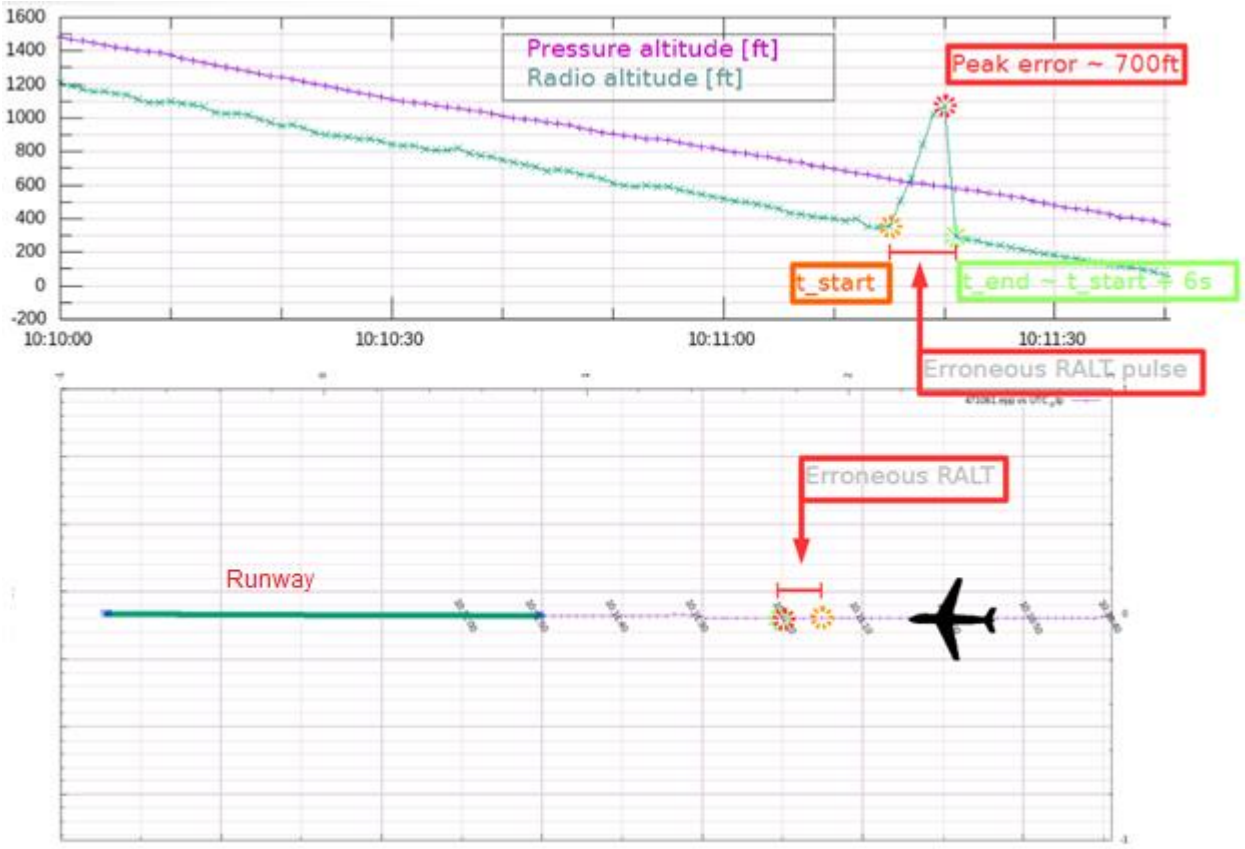

Figure 1 - Radio altimeter over-read

Depicted in figure 1, is an international example of an erroneous RA indication/output where licensed communications networks are suspected as the cause. Figure 1 maps the RAs output against the aircrafts pressure altitude. The RAs erroneous indication/output lasted for approximately 6 seconds. Other reported malfunctions have lasted to up to 60 seconds. Depending on the aircraft and the degree of integration of radio altimeter systems, a variety of different system malfunctions could occur.

Reported Discrepancies

CASA has received notification from operators of errors or discrepancies with radio altimeter systems. These reports have been de-identified. The failures show erratic values, RA failures, autopilot disengagement, terrain warning systems and flight director failures. Where possible it is suggested to review the data output from radio altimeter systems such as in Figure 2 to check for discrepancies.

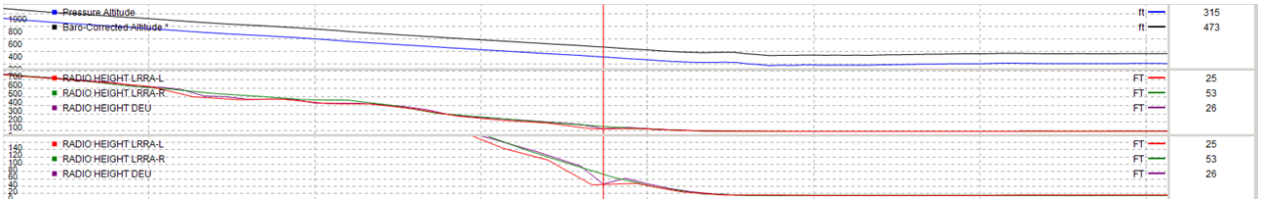

Figure 2 - Radio altimeter values compared to barometric altimeter

Below are some recent Australian reported malfunctions:

- Amber RA failure flag on F/O'S PFD during approach. RA returned to normal after approx 60sec
- Intermittent RA flag on capt PFD from 1000ft on final
- Captains radio altimeter failed at 400' with boxed 'RA' flag. Returned to normal after landing
- Spurious indication on capt PFD altimeter @ 4000' on descent, indication spiked rapidly plus 2000'
- RA flag showed very briefly 5 times on descent
- F/O ra flag came on passing through 2000 - 1300ft. Again, momentarily after landing.
- No radio altimeter '50' call out at 50 ft. All other audio normal.
- During climb #1 RA flag illuminated momentarily several times. Problem did not present again afterwards
- 'No autoland' message at 800' on approach.
- On final approach to Runway with the Captain flying, at approximately 2300’ the Captains RA Flag appeared and then the Autopilot A disengaged. The aircraft was then hand flown whilst both occurrences were identified. Autopilot B was then selected and operations were normal. RadAlt1 stuck at 2640 ft reading for 11 sec approx. and then back to normal at 2430 ft

- Suspected Radio Altimeter interference. During practice approach, “APCH WARN” displayed at approx 50 feet. Rollout caution displayed after touchdown. No Faults found.
- SGL SOURCE RAD ALT displayed on final approach at approximately 2000ft. Associated message NO AUTOLAND also displayed. Messages cleared by themselves at approximately 1000ft. In this instance RadAlt2 stuck at 4487 ft reading for 12 sec approx. and then back to normal at 4177 ft.
- On departure the Captains side radio altimeter indication was rapidly disappearing and reappearing with the ten second highlight box on continuously until the display was removed as per normal at 2500’. On descent the display was normal. Two unusual spikes observed in "RADIO HEIGHT 1" at around 400 ft
- RA failed passing 400’ on approach with amber failure flag and FOs Flight Directors blanked. Rad Alt returned to normal after touchdown. Radalt stuck at 547 ft reading for 47 sec approx. and then back to normal after touchdown.
- During approach potential interference of the radio altimeter system. At 150’ on approach the RAD ALT flag appeared on the F/Os PFD for approximately 2 seconds. Few unusual spikes observed in "RADIO HEIGHT 2" at around 447 ft and below until touchdown. Amber RA failure flag on F/O'S PFD during approach. RA returned to normal after approx 2-3 seconds. RA flag displayed around 500ft on approach to runway. no other system malfunctions observed.

Many of these malfunctions occur at critical phases of flight where radio altimeter systems are providing essential data. These types of failures are generally not replicated again through ground testing. Smaller commercial operations, general aviation and rotorcraft may be more susceptible dependent on their equipment fitted and operational/mission profile.

Malfunctions have also been known to occur with Terrain Awareness Warning Systems (TAWS). Radio altimeters are predominately an input into TAWS. A recent example notes,

‘after take-off at 500 ft AGL, TAWS caution "Too Low, Terrain" occurred while climbing away positively towards the coastline with no terrain ahead. Caution only lasted for one callout and did not occur again. No other A/C systems were observed to be affected.’ The operator reported the aircraft had no history of RA faults and was subsequently tested serviceable.’

There is also a possibility that older model radio altimeters are more susceptible to interference.

FAA AD and NOTAMs

Power output of 5G transmitters in the USA are higher at 62dBm EIRP or 1584 Watts. The FAA has released two general Airworthiness Directives (AD) FAA AD 2021-23-12 and 2021-23-13, that under Part 39 of the *Civil Aviation Safety Regulations 1998,* are automatically accepted as Australian ADs. The ADs relate to all commuter, transport aircraft and helicopters that are equipped with RAs. Each AD respectively requires an update of the aircraft/rotorcraft flight manual limitations section, prohibiting certain

operations requiring radio altimeters when in the presence of 5G C-Band wireless broadband interference.

These operational restrictions only apply when operating within U.S. airspace and in conjunction with an FAA issued NOTAM. The FAA NOTAMs are based on 4 scenarios:

- Airspace – in a 3 dimensional area
- Aerodrome – public airport or heliport
- Instrument Approach Procedure using a public landing location
- Special Instrument Approach Procedure at a private landing location

The FAA has been assessing these scenarios by conducting flight tests in these areas in conjunction with telecommunications providers.

FAA AMOCs have been issued to the type certificate holder. These AMOCs are acceptable to CASA without issuing a unique CASA AMOC. For further information on automatic acceptance of FAA AMOC refer to paragraph 11.1.2 of AC 39-01.

CASA assesses new FAA ADs on specific types of aircraft to determine if there is a need for any further action.

CASA response to FAA AD

CASA has published instrument CASA 114/21 which requires operators to only comply with the FAA AD 2021-23-12 and AD 2021-23-13 when operating in the airspace of the United States of America. If operators are only operating in Australian airspace there is no need to comply with these ADs as per CASA 114/21. There is no intention to publish NOTAMs for Australian airspace restricting operations due to 5G interference in Australia.

EASA response to FAA AD

EASA have determined that FAA ADs 2021-23-12 and 2021-23-13 are not eligible for adoption, as the risk of operations in U.S. airspace will be adequately controlled by NOTAMs issued by the FAA.

EASA have released SIB 2021-16 - *Operations to aerodromes located in United States with potential risk of interference from 5G ground stations (as published through aerodrome NOTAMs)*, that recommends various awareness and risk assessments operators may wish to consider.

Transport Canada AD

Transport Canada has published Airworthiness Directives CF-2021-52 and CF-2021-53. These Canadian AD are aimed at Canadian registered aircraft operating in US airspace. AD CF-2021-53-E overlap with FAA AD 2021-23-13 and CF-2021-52-E would overlap with AD 2021-23-12. They also identify the need to be equipped with radio altimeters. For helicopters the only Canadian ones listed are Bell Textron Canada Limited and for aeroplanes it is likely to be Bombardier, Gulfstream, De Havilland Aircraft of Canada Limited and Viking Air. At this time the FAA ADs would cover the same aircraft with radio altimeters and there is no need to issue an exemption against the Transport Canada ADs.

4. Recommendations

Coexistence

Already certified RA systems will not be retrofitted in the short term nor removed from service. Therefore, CASA and other agencies through ACMA are currently looking at co-existence between radio frequency services, including interference management criteria.

Where to find RA failures

All operators are encouraged to report RA failure and fault events. Incidents may be derived from,

- Flight crew reporting
- Maintenance reporting
- Aircraft Health Monitoring/Management systems
- Flight Operations Quality Assurance (FOQA) downloads
- Quick Access Recorder (QAR) downloads
- Flight Data Recorder (FDR) download reports
- Aircraft Communication Addressing and Reporting System (ACARS)
- Airservices (Air traffic control) reports.

Radio altimeter data output

Spurious interference and its effects can be difficult to confirm as the interference may not be continuous nor happen every flight. Erroneous RA occurrences should be reported. If possible, check the output of the radio altimeter over the time of the event occurring if this data is easily retrieved. Discrepancies have been found in the radio altimeter data stream.

5G tower location against flight path

If possible review the approach or where the interference occurred compared to 5G tower locations from ACMA or RFNSA to identify if 5G interference is a likely source.

Operations into the USA

Operators flying into United States Airspace should review and consider the impacts of SAFO 21007, FAA AD 2021-23-12, FAA 2021-23-13 and SAIB AIR 21-18 on their operations.

Operations into Canada

Operators flying into Canadian airspace should review and consider the impacts of Transport Canada document CASA 2021-08.

Part 121 operations

Part 121 operators should consider using Safety Management Systems (SMS) tools to assess the risk to each type of radio altimeter configuration and how it impacts typical flight operations.

Operators may have existing procedures for allowing use of personal electronic devices which may not have considered 5G technology. Consider setting all 5G devices to non-transmitting mode or switching off. The use of personal electronic devices which use 5G may introduce impact on safety of flight if radio altimeter systems are affected.

RNP-AR procedures

Consider the impacts of RNP AR procedures as TAWS equipment predominantly uses radio altimeter supplied information. Standard Operating Procedures (SOP) should identify alternate procedures especially when flying under Instrument Flight Rules (IFR).

Helicopter operations

Assess the impact of radio altimeter system inaccuracy or failure on helicopter operations that may include:

- Night Vision Goggles (NVG) or Night Vision Imaging Systems (NVIS) operations without external lighting should consider the impact of potential 5G interference for operations that rely on radio altimeter inputs.
- Offshore helicopter operations (oil/gas platforms etc.) within the presence of known 5G infrastructure should not be conducted under IFR unless there is an alternate means to identify obstacles and terrain because the radio altimeter may not be reliable.
- Low level operations should not be conducted without alternative altitude reference (known barometric height for example) because the radio altimeter may not be reliable.
- Helicopter auto hover – Consideration should be given to an alternate means of height and drift references.
- For essential communications, limit the use of 5G devices used for external crew communications during medical service operations (EMS) to 3G or 4G systems.

Other information from National Airworthiness Authorities

CASA is collecting and collaborating information from radio altimeter anomalies with EASA, Transport Canada, the FAA and CAA NZ. CASA will update this reference list as more information becomes available.

Several other airworthiness authorities have produced safety information and awareness documents highlighting the potential risks.

French Civil Aviation Authority (DGAC)

Transport Canada 2021-08

Transport Canada CF-2021-52

Transport Canada CF-2021-53

FAA AD-2021-23-12

FAA AD-2021-23-13

FAA SAIB AIR-21-18

FAA SAFO 21007

EASA SIB 2021-16

EASA Mandatory Continuing Airworthiness Information

UAE General Civil Aviation Authority 2021-03

UK CAA SN-2021/017

Getting involved in community consultation

The Radio Frequency National Site Archive (RFNSA) contains a list of new proposed mobile phone towers, there are links on this website to community consultation. The website shows both active and proposed mobile phone tower locations including the carrier that intends to operate the installation and the intended operating frequency.

Proposed locations include an Environmental Electromagnetic Effect (EME) report that references electric field in volts per meter and power density at certain distances refer Figure 3. The reports also reference public health exposure limits which is set by Australian Radiation Protection and Nucelar Safety Agency (ARPANSA).

	Existing configuration			Proposed configuration		
Distance from the site	Electric field (V/m)	Power density (mW/m^2)	Percentage of the public exposure limit	Electric field (V/m)	Power density (mW/m^2)	Percentage of the public exposure limit
0-50m				19.29	986.54	10.12%
50-100m				17.57	818.89	11.06%
100-200m				16.95	761.87	10.59%
200-300m				9.82	255.83	3.54%
300-400m				6.49	111.70	1.56%
400-500m				4.83	61.95	0.86%

Figure 3 - Example of EME report for proposed installation

Reporting interference involving in consultation for new ground installations

CASA is not responsible for interference from ground stations, this responsibility lies with ACMA. Report aircraft related issues and their effects on aircraft to CASA. For further information or concerns relating to 5G ground infrastructure, CASA recommends contacting ACMA for further assistance.

5. Reporting

To ensure CASA is able to monitor and document effects on RA systems, also the effectiveness of any restrictions implemented, please report any occurrences at or below 2500ft AGL of:

a. all spurious RA displays or indications during take-off and landing.
b. any aircraft system faults/failures caused by RA inputs/data such as
    i. Enhanced Ground Proximity Warning Systems (EGPWS)
    ii. Aircraft Alert and Collision Avoidance Systems (ACAS)
    iii. Take-off guidance systems
    iv. Flight Control (control surface)
    v. Tail strike prevention systems
    vi. Windshear detection systems
    vii. Envelope Protection Systems
    viii. Altitude safety call outs/alerts
    ix. Autothrottle
    x. Thrust reversers
    xi. Flight Director
    xii. Primary Flight Display of height above ground
    xiii. Alert/warning or alert/warning inhibit
    xiv. Stick pusher / stick shaker
    xv. Engine and wing anti-ice systems
    xvi. Automatic Flight Guidance and Control Systems (AFGCS)

When submitting a defect report please include the following information that will assist in conducting a trend analysis and identification of possible interference sites.

a. Airport/aerodrome/heliport, including the specific approach/departure used
b. Runway
c. Aircraft phase of flight
d. Approximate altitude
e. Systems affected, including particulars on the manufacturer and/or model numbers.
f. Weather (rain, snow, fog etc)

6. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link email address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

Airworthiness and Engineering Branch
National Operations and Standards
Civil Aviation Safety Authority
GPO Box 2005, Canberra, ACT, 2601