Radio Frequency Testing – P&DARCS Burley Field

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Flight Testing – Day 1.

Initial testing was completed on the North/South (Eastern) runway with the pilot operating from behind the steel pilots' box, with approximately 3 minutes of flight time with the transmitter situated below and directly behind the steel barrier. To attempt to flaw the result the pilot even operated from behind the steel signage attached to the pilots' barrier, however it did not adversely affect signal strength. This flight was for a total duration of 11 minutes, with a combination of high (400ft) and low altitude flight maneuvers. No Failsafe events were recorded.

The next tests were completed from the East/West – Main Runway, with the pilot operating from behind the temporary steel pilots' box, which is slightly taller than the one on the N/S Eastern runway. Once again the transmitter was held below and behind the steel fence. The pilot relocated mid-flight to the existing wooden pilots' box to conclude the remainder of the flight from this location. The total flight time duration was 13 minutes, again with a combination of high and low altitude maneuvers. Again, no Failsafe events were recorded.

A third test was performed on the North/South – Western runway, with the pilot situated behind the wooden pilots box. A combination of high (400ft approx.) and low altitude flight maneuvers were completed, involving some low level orbits to the north, over the power lines. No "failsafe events" were recorded during this part of the flight. At approximately 6 minutes into the flight, the aircraft was climbed to a safe altitude to the west and the transmitters were turned off. This was to simulate a "failsafe" event, to ensure all was working as expected and both transmitters and receivers would recover. The onboard flight logger recorded: 36Mhz 1 8.3S, 2.4Ghz 1 7.9S, which represents one "failsafe" event on each receiver and the time the transmitters were off, including recovery times for each transmitter/receiver. Controlled flight resumed with no further "failsafe" events. The total duration of this flight was 13 minutes.

Flight Testing – Day 2.

Two repeat tests were completed on both the North/South, Western and Eastern runways, due to concerns that the previous test may have been affected by the moisture in the Western paddock. The field had dried out considerably, so we had hoped the reduced range previously experienced, would be improved. The initial flight was conducted on the N/S Western runway, with a combination of high (500ft approx.) and low altitude flight maneuvers. The flight again involved some low level orbits to the north over the power lines. Total flight duration was 9 minutes. No "failsafe events" were recorded during the flight.

This time the range was significantly better than the previous test, with no low signal warnings until, placing the transmitter below and behind the metal placard attached to the pilot barrier. This was understandable, given the shielding effect it has. Orbits over the power line also produced some low signal warnings, but lifting the RC transmitter slightly higher eliminated that.

The next flight was conducted on the North/South (Eastern) runway, with pilot located behind the steel safety fence. This flight was with the pilot in crouched position, with the transmitter below and directly behind the steel fence, for approximately 3 minutes. The remainder of the test was conducted with the pilot standing in the pilots' box. The total flight duration was 12 minutes, with a combination of high (600ft approx.) and low altitude flight maneuvers. Some low level signal warnings were experienced when the transmitter was placed directly behind metal sign attached to the barrier, but no low signal warnings with the transmitter behind the steel mesh.

There was one "failsafe hit" recorded on the 36 Mhz receiver, which was for a duration of 0.8 second. This was when the aircraft was at its highest altitude and circling. The RC transmitter was behind the information safety sign and the antenna was pointing directly at the aircraft, so not unexpected. The pilot did not notice this event. No failsafe events were recorded on 2.4 Ghz.

Summary

The initial low signals experienced on day 1 of testing were while climbing, under full throttle and whilst orbiting over the powerlines on the North Western end of the field. The initial flight on the Eastern N/S runway had only one low signal warning when the transmitter was held below and behind the steel safety fence. The west side of the field experienced greater low signal strength warnings only on the initial day of testing and had no low signal warnings on the 2nd day of testing.

In conclusion of all tests completed, the low signal level warnings were predominantly experienced whilst the transmitter was being placed in a position directly behind the metal placards attached to the pilots' barriers. A recommendation is to have these metal placards removed to remove any risk of signal reflection from these signs.

Conclusion:

All measurements made have led to a conclusion that it is very unlikely that the metal barriers will be a problem at P&DARCS. During the testing, Ray Cooper sat crouched behind the metal grid a number of times and successfully flown the test model.

It is unlikely that anyone would behave that way as the normal operating position for pilots to be standing with the transmitters above the barriers. It is not a good idea that any pilot should try this test out and a recommended club rule could be that pilots must stand behind the barriers with line of sight from transmit antenna to receive antenna at all times. This is good advice in any situation anyway and may already be the rule.

Flight testing around the steel pilot safety fencing was satisfactory from all runways. The metal fencing on the Eastern runway is relatively low and the steel mesh grid is large enough to allow the propagation of 2.4 Ghz RF signals. The sheet metal information warning signs do have a shielding effect if the RC transmitter is placed directly behind the signs.

The low range indications that were experienced (in the initial day of testing) on the west side of the field, was most likely due to the water logged field at the time of the test (25/11/2020), as it was not present on the repeat test (4/12/2020) when the field had dried out. Having said that, the placement of the antenna on the aircraft could also have been a contributing factor, as they are not in "clear air" outside of the aircraft. No problems have been experienced at other flying locations with this configuration.

The NBN tower that is located 1.8 Km to the SW of the field has multiple fixed WiFi transmitters/receivers operating on frequencies of 3.4 and 3.5 Ghz. It also has a Microwave link (10 and 11 Ghz) pointing to the SW to Cranbourne South. Given its distance from the field and frequencies used, it would not impact operations at the field.

Electric field strength measurements were taken using a MIC METER 98195 3 Axis EMF Meter (50 MHz – 3.05GHz, 360^0 Capture). These measurements were in the millivolt/meter readings and of no concern. In contrast to Mt Hollowback, which has 3 to 20V meter readings!!

The radio spectrum has become very crowded and this will only increase in the future. 2.4 Ghz is the ‘ISM’ band (industrial – Scientific- Medical) and is available for any citizen or organisation to use.

The P&DARCS Burley Field is currently well cited in isolation, but civilisation is approaching. Notwithstanding, the VARMS club in Wantirna has successfully operated in a very hostile RF environment. The technology has enabled this to happen and will evolve over time to meet challenges. Ironically no one wants 36 Mhz and it is uncontested with no other real user.

The 2.4Ghz band is on the microwave frequency, with normal operations requiring line of sight. As such it can be easily reflected off metal surfaces. It’s range can also be effected by moisture in the air. Normal model flight operations at P&DARCS mitigates against such problems, the technology having the ability to provide safe flight under most circumstances. If a model is flown at height above the buildings, the line of sight rule should be met and CASA requires that all pilots maintain VFR (Visual Flight Rules), in any case. This means you must maintain visibility of the model. If a model receiver has two antennas, best practice is to have these orientated at right angles or as the manufacturer recommends. This will reduce the chance of the transmit antenna and receive antenna being end to end to each other, which is a condition of minimum signal strength.

There can never be any absolute guarantee when it comes to radio control. The technology has made any close in third order intermodulation products little danger to others as there is now no concept of ’an adjacent channel’ as was the case for 36 and 29 Mhz systems. The 2.4 Ghz systems were introduced by the industry as the panacea for radio control. This has proven not to be the case as there will always be unexplained events occurring under certain circumstances. Re-constructing these circumstances will usually be impossible and analysis without all the data the same.

The testing regime used at P and DARCS established successful flight operation requirements for both 36 Mhz and 2,4 Ghz at Mt Hollowback recently with no reports of loss of control when flights are made from the designated areas. In this case the radio installation contained a number of high powered transmitters fed to large dish antennas with high gain. These were just a few metres away from some model flight operations, significantly closer by many orders compared to the Telstra Tower to the West of Burley field. This Telstra Tower is unlikely to be of any concern.

The incident that occurred in May 2020, has been deemed an isolated case, given there have been no further events of the same type and seems unlikely to be related to the “field” as such. When these incidents occur, it is important to document them and conduct follow up range and failsafe testing of the equipment and systems. IE Tx/Rx Brand model, firmware (if known), ESC BEC or separate Rx battery, Rx antenna location, etc.

The above reported incident also serves as a timely reminder to club members the importance of correctly setting the “failsafe” on their transmitter/receiver equipment. What is set in the workshop may not be satisfactory after the aircraft has been flown and re-trimmed. Not all aircraft are the same and may require a different strategy to enable the failsafe to be set correctly. For example, an electric powered glider should have the failsafe setup to: Motor off, Spoilers/Flaps deployed (if fitted), a gentle turn (to minimize a fly away).

Everyone should be aware that occasionally there will be events that are inexplicable and often the reason is transitory and hence cannot be duplicated.

Kind Regards,

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<u>Aircraft and Radio Equipment</u>

Aircraft – MultiPlex Xeno (flying wing) pusher prop, running on 3S 1300mAH battery. Aircraft control is via a 36 Mhz PCM receiver mounted in the wing, outboard of the main fuselage area, with the antenna routed out along the wing to the tip. The 2.4 Ghz Transceiver is located in the nose alongside the logger board. Note: the 2.4 Ghz Transceiver was also used as a data down link for real time “Failsafe” count information.

Radio Equipment

Aircraft control is via a JR 3810 radio transmitter with a JR RS77S PCM Receiver. The frequency was 36.17MHz (CH 617). Failsafe was set to neutral aileron, elevator, motor off and gear channel to high. The gear channel is monitored by the Logger to record “**Failsafe Events”.**

The 2.4Ghz radio transmitter is a FrSky DHT module with a D4R-II Transceiver. Channel 1 is monitored by the Logger to record **“Failsafe Events”.** Channel 1 is set to high when a failsafe event occurs.

Logger

The logger is a custom made Arduino nano board and OLED display. It monitors the designated channels of the receivers and records a change of state of those channels. It also records and displays the maximum time of that change in state. For example, if channel 1 of the 2.4Ghz receiver goes into failsafe for 4 seconds, then the logger will record and display – **2.4G 1   4S.** If the next failsafe is longer, say 6 seconds, then the logger will record and display – **2.4G 2 6S.**