

Corona and Radio-Communications Disturbances

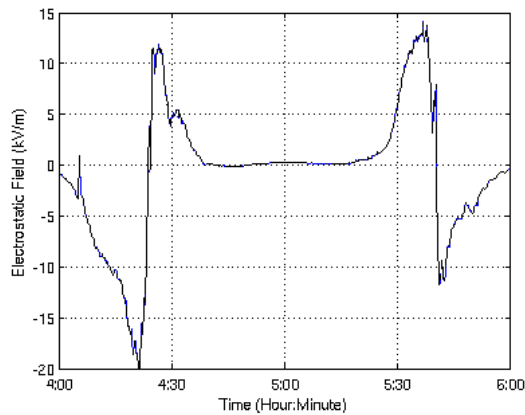
Civil radio communication system between pilots and flight control tower uses the Very High Frequency (VHF) band. This frequency permits communicating along distances of up to several hundred kilometers. The aeronautical exchange of information includes data about maintenance, weather, air traffic managements etc., and should be uninterrupted, available and free of noise.



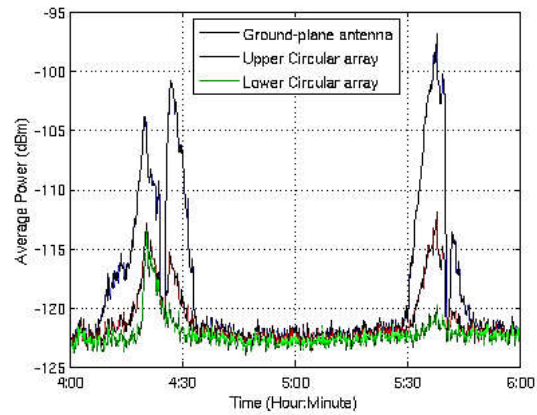
Ground station

Radio communication starts with transmitting signals that are modulated by a VHS carrier, transmitted by a transmitting antenna, travel in space, received by a receiving antenna and eventually demodulated hopefully back to the original signal. Along the path such a signal is susceptible to various physical factors that attenuate its strength and might as well distort and change it.

AM, the amplitude modulation commonly used for the VHF, is easily interfered by radiations from different sources such as: electric devices radiating VHF waves; natural electric discharges; electrostatic discharges such as lightning and also arc and corona discharges. A Study on the effect of corona discharges on VHF antennasⁱ by Mingtian Wang, identified the origin of the major and most prominent radio communication interferences experienced at the Champcueil, south of Paris, airport control stations, as corona and arcing, whose electrostatic waves typically reside in the large frequency band, including the VHF.



Electrostatic field measured by the field mill on August 2 2007



Average noise-per-voice-channel received at the different antennas on August 2, 2007

Wang described a situation where the Champcueil ground station, located south of Paris and operated by the French civil aviation authorities, witnessed several occurrences of radio interferences mainly when clouds covered the ground station. In his study, Wang

found that the communication noise received at the ground station was 25dB stronger than the ambient expected noise. Wang listed the optional noise origins and one by one refuted their influence except for corona: “The possible sources of the interference phenomenon have been listed and analyzed. The results show that the most probable source of the interference is corona discharges caused by the natural electrostatic field. The possibilities for other sources of interferences exist, but they are relatively weak”.

While investigating the airport surrounding, an overhead transmission pylon was detected at a distance of 1 km away. The pylon was flashing with corona discharges of noise frequencies that reached 900 MHz and arcing with frequencies that reached 8GHz. The loss of energy involved, in this case, was minor in comparison to the effect it had on risking the aircrafts. The cause for the corona and arcing discharges was attributed to a special meteorological phenomenon where a charged cloud approached the transmission pylon causing the e-field around the pylon to rise beyond a critical field value and leading to the corona and arcing discharges. A similar phenomenon is known for toll sailing masts, St. Elmo’s fire, where during thunderstorms fire appears on the masts.

As soon as the radio interference source was identified, the researcher searched for the corona location. Unfortunately, corona cameras were not involved in the study leaving the task of evaluation and detection to mathematical calculation and sonic devices, correspondingly. After finding the discharges’ sources solutions to eliminate these discharges were offered:

- Reduce the e-field on the antenna by increasing the length of the lightning arrestors
- Move the location of the antenna several meters away from the pylon top where the e-field intensity is high, and reduce the possibility of discharge
- Add more shielding rods to the antennas to reduce the e-field buildup and act like lightning arrestors
- Design antennas with extra care to sharp edges

“In 2004 FAA closed the airport in Rochester city NY, USA due to multiple and repeated complaints of radio interferences at the control



tower (left picture). The local electrical utility was asked to investigate

the case and found out that the source, as expected, was corona and arcing discharges emanating from nearby overhead distribution high voltage lines (see picture to the right). The utility used multiple technologies to seek the discharges but the most efficient tool that

actually lead to solving the issue was the use of Ofil's DayCor® II camera (a 2004 model). According to the Rochester electrical utility the event chronology was:

- Sep. 2003 at FAA Control Tower – RFI was experienced
- Duration of RFI: 1 to 20 Minutes
- Weather condition - wet
- RFI was sporadic at multiple locations
- Findings: problems on 4.16kV, 12.47kV, 115kV insulators due to grounding
- June 2004 - Repair work completed
- Nov. 2004 - FAA's gratitude Letter

..."The help that Dave Shields and his crew provided, through the support of RG&E Management, is testimony that RG&E is committed to Public Safety..."

Corona and Arcing are usually encountered by utilities maintenance engineers that seek to extend the lifespan of their electrical grid's installations and ensure the ongoing reliability of power supply. Corona and arcing are also encountered as annoying noise by those who reside next to overhead high voltage lines and seek to eliminate the nuisance. But, when aviation safety is at stakes due to radio communication interferences there is an adamant need to control the sources of the interference. Since corona and arcing were found to be the major sources of radio noise interference early detection of their existence and the ability to pinpoint the emitting places is a necessary need. Ofil's corona cameras can supply this valuable information in real time, accurately and clearly. Ofil's corona cameras display findings in a graphical manner, showing the real scene with the corona discharges superimposed, and thereby providing immediate access to information without a need for compilation or further interpretation.

ⁱ Mingtian Wang. Study of corona discharges on VHF antennas caused by a natural electrostatic _eld. Electromagnetism. Universit_e Paul Sabatier - Toulouse III, 2014. English.

ⁱⁱ David Shields, RFI at the FAA Control Tower in Rochester, NY USA, UGM 2005 USA