

# **WiFi in the Sky, Convenient, Profitable and In-demand – Is It Safe?**

## **Radio-frequency (RF) – Wireless Microwave Radiation Exposure from Mobile Devices and WiFi Connectivity**

Is this technology a new aviation security, safety and health risk?

Incidents of flight crew and/or passengers becoming lightheaded – was WiFi a factor?

What are the insurance, liability and regulatory implications?

This Statement of Concern from flight surgeons, pilots, accident investigators and medical, scientific and technical experts was edited by Kerry Crofton, "I worked for many years with pilots and air traffic controllers in Canada and the US and served on the Canadian Civil Aviation Tribunal. The following experts are calling for a review and monitoring of WiFi in commercial aircraft; there is scientific evidence of harm at 'low' government-sanctioned, non-thermal levels."



On WiFi aircraft, what are the levels of microwave radiation, do these impact pilot performance and cockpit display units? Are there security issues?

*With quotes from flight surgeons, risk experts, pilots, physicians, scientists, electrical engineers:*

Captain N. Anderson, FAA Fast Team Representative and Aviation Human Factors Researcher  
Martin Blank, PhD (Columbia University College of Physicians and Surgeons)

Kerry Crofton, PhD (ret'd CDN Civil Aviation Tribunal)

Professor Devra Davis, PhD (Nobel Co-laureate, Epidemiologist)

Frank Clegg (Former President Microsoft Canada)

Katharina Gustavs (Building Biology Environmental Consultant)

Lawrence Gust (Electrical Engineer and certified Building Biologist for IBE)

Olle Johansson, PhD (Associate Professor of Neuroscience, Karolinska Institute)

Vini Khurana, MD (Neurosurgeon and Associate Professor of Neurosurgery)

Dietrich Klinghardt, MD, PhD (Physician specializing in environmental medicine)

Don Maisch, PhD (Researcher and EMR Consultant)

Robert Metzinger (Electronics Engineering Technologist)

Wilhelm Mosgoeller, PhD (Professor and Researcher at the Medical University of Vienna)

Alasdair Philips (Electrical/Electronic Engineer, Director of UK Powerwatch)

Hans-Christoph Scheiner, MD (German Environmental Physicians Initiative)

Peter Sierck (Industrial Hygienist with IBE and IBN certification)

Stephen Sinatra, MD (Board-Certified Cardiologist)

**Please note this is not a scientific paper nor an attempt to establish fact; it is a statement of concern raising significant questions, including where is the evidence that inflight WiFi is safe?**

## **Captain N. Anderson, FAA Fast Team Representative, Aviation Human Factors Researcher**

*Captain Anderson is a licensed Airline Transport Pilot who has worked with the US Federal Aviation Administration Wings Program, and as a human factors seminar leader on Pilot Proficiency and Cockpit Management.*

"RF frequency assaults (from WiFi-enabled aircraft and the inflight use of wirelessly-connect mobile devices) are a key issue and need to be considered in any accident/incident investigation.

With the amount of solar radiation normally received by pilots flying at high altitudes being studied as a concern for its health effects, we now have additional radiation in the form of RF signals from personal electronics and onboard Wi-fi as well as the all-electronic cockpits and more recent electronic flight bags being adopted by air crews.

Symptoms that can be traced to RF exposure, as well as time spent viewing electronic screens that can affect cognitive abilities can contribute to accidents or incidents deemed pilot error.

It is necessary for studies to be implemented by the FAA or NTSB as well as independent interests that can confirm or deny the potential effect from the widespread use of airborne electronics. I have been involved with educating the aviation community about conditions that can affect brain chemistry and cognitive breakdown.

I have been voicing concern about RF frequencies affecting pilot's abilities to make executive decisions and now am concerned about the impact frequencies emitted from wirelessly-connected electronic screens have on the biology of the brain.

Since most companies are transitioning to electronic flight bags instead of paper charts, and since most modern aircraft have all glass cockpit presentations, the pilots are being subjected to non-stop screen interference with their cognitive performance.

This can be critical when an emergency arises and a quick decision-making response is needed.

My communication with FAA personnel has resulted in a response from Kyle Copeland, Ph.D., Research Health Physicist, Radiobiology PI FAA, CAMI, AAM-630, Numerical Sciences Research Team who says

'I can say with certainty there is no ongoing research here at CAMI that deals with biological effects of nonionizing radiation (that is WiFi and the radiation emitted by wirelessly-connected mobile devices).'

**Note: Radiation exposure safety standards are based only on ionizing (thermal) levels – strong enough to warm human tissue; however, all of the adverse effects detailed in this document occur at non-ionizing (non-thermal) levels.** Dr Martin Blank. PhD

## CONTENTS

	Pg
1. Aviation Alert? .....	5
2. International RF Exposure Safety Standards In Question .....	9
3. Questions for the Aviation Industry and Inflight WiFi Providers .....	11
4. Scientific, Medical and Pilot Performance Issues .....	12
5. Partial Summary of Biological Effects .....	15
6. Commercial Pilots From Several Countries .....	17
7. Technology and Technical Experts .....	20
8. Threats to Security, including GAO Report .....	23

### Appendix:

A. Cardiac Effects and More Medical Issues, Cardiologist's letter .....	26
B. 2008/2012 Letters from group of European Physicians .....	28
C. UK Electrical Engineer and other Technical experts .....	33
D. Rough Draft of Sample Inflight Symptom Survey .....	38
E. References .....	40
F. FAA response to our letter concerning satellite transmissions .....	46
IN SUMMARY with 8 key points .....	47

*Aviation expert Dr Todd Curtis holds a PhD in Aviation Risk Assessment; he is a licensed pilot and Founder of AirSafe.com. In the US Air Force he was a flight test engineer, and while an airline safety engineer at Boeing, was directly involved in numerous plane crash investigations.*

"The issue of inflight WiFi has been brought to my attention by Dr Kerry Crofton, and her colleagues. Although the risk of RF radiation from WiFi routers and other equipment has not been looked at as a health and safety risk by the aviation community, the fact that some in the medical and scientific communities have shown that this may be a risk is a concern to me. It seems there is enough evidence to warrant further investigation.

I am not aware of any tests on inflight WiFi, or if there is a requirement, with respect to potential health effects on flight crews. It appears this new technology has been tested on the electrical systems and navigation systems but not on the flight crews.

Reportedly, there have been separate incidents of two pilots fainting inflight, and also reports of passengers – apparently on aircraft with WiFi installations. This could be a huge red flag. That sort of a medical event in the air, with pilots being medically incapacitated, is not necessarily reported. If there were a common cause, the major concern would be if both pilots in the cockpit became incapacitated.

Many of the experts contributing to this document have stated there is no evidence that this new WiFi technology has been tested on the crew, or that it is being monitored. This is the kind of issue that should be addressed. Airlines want new income streams, and passengers want uninterrupted and unfettered access. That may be best done with a non-wifi technology. Imagine a standard where airlines can charge for premium access, and the approved technology has none of the risks associated with WiFi."

*Todd Curtis, PhD*

**WiFi-enabled aircraft, also RF radiation being transmitted at high levels at high altitude:**

A commercial airline pilot raises these concerns, "The Google 300 kW transmitter balloons are up at 62,000 feet. Commercial aircraft can fly up to 60,000 feet. Boeing 737 and 787's have an AD or Airworthiness Directive that has four more years to go. All of these aircraft have to replace their DU's or display units because wi-fi is interfering with them and blanking them out. The AD also mentions that even other sources of wireless can come into the cockpit and cause these problems; directly mentioning satellites. See pages 8 and 47 for more details. Boeing applied for a patent for windows that block wireless."

As virtually all of these aircraft are also WiFi-enabled, shielding the windows will magnify the RF levels in the cockpit and cabin. Has anyone tested this shielding on pilot health and performance?

**Our experts in the fields of aviation, medicine, science, technology and engineering** urge you to hear their concerns about pilot performance being compromised by electro-magnetic radiation (EMR) exposure, especially radio frequency (RF) and microwave from WiFi and mobile communications. And, there are reports of security risks with mobile phone connectivity.

*As far as we know, there is no published evidence of pre-implementation testing of this technology on pilot performance nor ongoing monitoring to refute these concerns.*

## **1. AVIATION ALERT? The new hidden factor in Cabin Air Quality?**

There have been an increasing number of incidents of flight crew and passengers experiencing lightheadedness, feeling faint and with some losing consciousness mid-flight.

The most recent are two American Airlines flights: Jan 28, 2016 AA 904, enroute from Rio de Janeiro to Miami, was diverted to Brasilia after four people, including three crew members, complained of lightheadedness. Reportedly a few of them lost consciousness.

The day before, AA109 from London to Los Angeles was forced to turn back to Heathrow when several passengers and flight crew, fell ill from what was reported in the media as a "mystery illness."

"Our maintenance team conducted a thorough inspection of the aircraft, including a test flight, and found no issues," the airline said in a statement.

A specialist team from London Fire Service did tests for 'elevated levels of any substances', a spokesperson said, 'Everything was checked and tested but there were no readings for any substances of any sort that may have been a problem.' The spokesperson said firefighters had 'no idea' what may have caused people to fall ill. There is no indication that RF levels were measured, or considered, on these WiFi-enabled flights.

Having no access to the facts we have no idea if WiFi was a contributing factor, nor are we trying to establish a link. Pilots should know however, that the wireless radiation, at WiFi emission levels, has been shown to cause leakage of the blood-brain barrier and could contribute to lightheadedness and loss of consciousness. (Dr. Leif Salford, MD, is a neurology professor at Lund University. Persson and Salford 1996; Salford et al. 1992, 1993, 1994, 1997b, 2001.)

### **Pilot Advisory - Lightheadedness on your flight? Disable the WiFi**

RF exposure from WiFi and mobile devices can be a factor in: lightheadedness, feeling faint and/or losing consciousness, as well as nausea; it is advisable to disable the WiFi and instruct all flight crew and passengers to check all mobile devices and place them in airplane mode to disable the sending/receiving signal.

This radiation exposure may, or may not, be one of the causative factors in people feeling unwell, however, it is advisable to follow this protocol as a precautionary measure. In addition, if it is safe to do so, consider turning off the radar as this could also be adversely affecting some people.

If the primary cause is compromised cabin air – a problem with trace engine or hydraulic fumes leaking into the cabin, or other toxic fumes – disabling the WiFi could minimize

adverse effects, including lightheadedness. During the incident investigation/inspection of the aircraft we strongly recommend this RF/WiFi factor be included.

**February 2013. Alaska Airlines reports a pilot lost consciousness** while flying a Boeing 737-700. While the aircraft was at cruising altitude, the pilot – with 28 years of experience – stood up, became dizzy, lost consciousness and fell to the floor. There had been a similar fainting episode on January 22, also on an Alaska Airlines WiFi-enabled aircraft. In that case, the **copilot briefly lost consciousness** in flight. As potential adverse effects from RF exposure can include nausea, vertigo and fainting, could this have been one of the contributing factors? If ill health were the major cause, could the onboard RF radiation have exacerbated the effects? No one considered this possibility in the investigation, as far as we know.

Insomnia, emotional stress and depression can be related. There is evidence that RF radiation could also result in a sudden neurological event that could compromise brain function, impair cognitive abilities, or trigger life-threatening cardiac symptoms, even in an otherwise healthy individual with no previous related history. Occupational exposure for pilots is increasing because of enhanced security screening, the proliferation of WiFi in hotel rooms, vehicles and airports, and the extensive use of increasingly powerful mobile phones and WiFi devices.

**In 2015** there are more reports of **passengers feeling faint and losing consciousness** on Alaska Airlines flights, including one from DC to Seattle, "There were 5 people down, requiring oxygen. One fainted in the aisle. All were heart and BP related. I am very concerned that this could be from the inflight WiFi, as I feel it as well. There were no indications of toxic fumes or other apparent causes." Then a SkyWest/United flight where a nurse began feeling unwell when she went to assist passengers in medical distress. Were they sitting near an access point? Was this factor part of the investigation check list? We request that this aviation inflight entertainment product be re-evaluated including a risk assessment of what could happen in a worst-case scenario – cognitive impairment and/or cardiac dysfunction of the pilot, or loss of consciousness in cruise flight, for example. In accident investigations, we suggest, RF exposure should be routinely evaluated as a potential contributing factor, especially when there is not another clear cause.

In October an American Airlines pilot died mid-flight. His widow reports he had by-pass surgery in 2006. Was it a cardiac event? Was the WiFi in the cockpit a factor? Is anyone investigating this aspect?

Before this technology was implemented did anyone test for cardiac symptoms? We ask for a review of pre-implementation testing reports investigating potential effects on

human health and performance, and the inflight RF levels on WiFi-enabled aircraft.

We do not have all the facts but with up-to-date testing reports on navigational equipment and pilot performance, access for technical experts to measure inflight EMR/RF levels, we could recommend policies and procedures to reduce potential risks and suggest safer ways to use this technology.

The installation of this new technology should be properly tested and monitored as:

- There is no conclusive evidence that exposure from mobile phone radiation and inflight WiFi is without risk from health and/or aviation safety and security perspectives.
- There *is* evidence that even low levels of radio-frequency radiation can be harmful to human health and adversely effect human cognition and performance – even at government-sanctioned levels, as reported in the BioInitiative Report on Government Standards and in the Seletun Scientific Statement.
- There is no evidence, which we know of, that the accumulated exposures in a WiFi-enabled aircraft, with or without crew and passengers online, have been measured or monitored.
- There is scientific evidence of harm and many experts are calling for caution.

Dietrich Klinghardt, MD, PhD: "As a physician I have seen enough medical and scientific evidence to know that the radiation used in WiFi and mobile communications is hazardous to human health, and share the concerns of many other researchers about the risks of WiFi in aircraft. This could have short and long term consequences. Few aviation experts are aware of the potential dangers to the brain, and both **emotional and mental functioning of the pilot's brain during flight**, at existing safety standard levels."

Physician Hans-Christoph Scheiner, MD: "With RF radiation exposure, potential symptoms include: **Insomnia, Vertigo, loss of consciousness.**"

Scientist Professor Mosgoeller, PhD, University of Vienna: "With this type of radiation exposure, our research shows **cognitive impairment - wrong responses were given within shorter time periods.**"

Cardiologist Stephen Sinatra, MD: "Increased risk of **cardiac symptoms** including: arrhythmia, tachycardia, myocardial infarction (heart attack), TIA, and stroke. I would like tests on pilots for potential cardiac and cognitive effects."

IT expert, Frank Clegg: "There is **no proof that this technology is safe.**"

Technical Expert K. Gustav: "Since **an aircraft is a metal enclosure**, any wireless transmitter, as well as WiFi access points operating on the inside, will cause an exponential increase in RF radiation exposure. Due to reflection and resonance effects and multiple users, exposure levels can increase 1000% in hot spots, which may exceed official exposure limits."

**Alasdair Philips, UK Electrical Engineer:** "We are told that the radiation levels are 'well within government health and safety limits'. These **standards**, however, **are not accurate**. And at the levels of exposure measured in a WiFi-enabled aircraft, headaches, fatigue, **muddled thinking, confusion**, irritability, generally increased stress, and in principle also cardiac symptoms - yes, all seem possible, and likely, in some passengers and flight crew." [Appendix C - full letter and comments from other technical experts]

Few flight surgeons and aviation medical examiners are up to date with this research; most don't know how to diagnose or treat the emerging medical condition electro-hypersensitivity (EHS). The above are documented concerns before 2015. NOTE: there are many indications that worldwide exposure is intensifying – in the skies, and above.

**03/02/15 Honeywell Aerospace is planning 600 satellites** with OneWeb Ltd. to provide aircraft equipment and airtime services to expand inflight connectivity on business, commercial and military flights. "Our goal is to expand inflight connectivity through ambitious technology innovation," said VP Carl Esposito.



Others are planning WiFi coverage from outer space. Google: 200,000 high altitude balloons (62,500 feet); SpaceX: 4,000 satellites, 700 miles high; OneWeb: 2,400 satellites, 500 miles high; Facebook: Satellites and drones; Outernet: Low-orbit Micro-satellites, drones, and lasers. See page 47 for the FAA response to our letter of concern about newly installed GOOGLE transmission satellites and a comment from one of their engineers.

**Questions that demand answers:** What is the impact of this massive increase in radiation on human health? On planetary health? On pilot performance, even if aircraft were not WiFi-enabled? And if they were, how would this exposure affect the pilots, especially in a sudden emergency? Will the technology industry still insist these levels "fall well within government standards"? And who is examining the implications for terrorism and other global security issues?

Dr. Scheiner, physician who raised this alert in 2008: "**Equipping aircraft with WiFi is a dangerous experiment.** It is possible that a pilot could become incapacitated in flight."

## **2. International RF Exposure Safety Standards In Question**

**Wireless industry position:** "EMR/RF exposure levels are well within safety standards. There is no clear evidence of harm at these low levels."

**Former Microsoft Canada President, Frank Clegg** is now CEO, Canadians 4 Safe Technology (C4ST) disputes that position. He has worked in the information technology industry his whole career and urges regulators to re-examine standards.

"There is no proof that this technology is safe and we shouldn't wait for the government to catch up to the technology. The standards are outdated and failed to keep up with the times. More importantly, regulators have failed to keep up with the established science.

Our very strong message is that these safety codes fail to protect people. The World Health Organization has declared all wireless radiation as possibly carcinogenic. But many of those reviewing exposure standards have stated publicly there is no need for revision. They are ignoring the scientific proof of harm.

Many of the scientists sounding the alarm bell are the same individuals who warned us about acid rain, second-hand smoke, DDT, asbestos and other widespread public health disasters. As harmful as these banned agents are, none of them were more widespread than wireless radiation is now.

International experts recommended changes in the BioInitiative 2012 Report. It was prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MsC, MA or MPHs.

In 24 technical chapters, the report outlines evidence for Damage to Sperm and Reproduction; that Children are More Vulnerable; for Fetal and Neonatal Effects; for Effects on Autism; for Electro-hypersensitivity; for Effects from Cell Tower-Level RFR Exposures; for Effects on the Blood-brain Barrier; for Effects on Brain Tumors; for Effects on Genes (Genotoxicity); for Effects on the Nervous System (Neurotoxicity); for Effects on Cancer (Childhood Leukemia, Adult Cancers); for Melatonin, Breast Cancer and Alzheimer's Disease; for effects on Stress, Stress Proteins and DNA as a Fractal Antenna; of Weak-Field Interactions on Non-Linear Biological; for Oscillators and Synchronized Neural Activity."

Professor Martin Blank, PhD was one of the lead authors calling for exposure levels to be brought into line with the science – to be biologically based, "**The safety standards are irrelevant to WiFi and mobile phone radiation exposure and are not protecting us.**"

**Columbia University, College of Physicians and Surgeons  
Department of Physiology and Cellular Biophysics**

630 West 168 Street New York, NY 10032

February 18, 2012

**Re: Health effects of in-flight WiFi**

I have been active in research on biological effects of electromagnetic fields (EMF) for over thirty years at Columbia University. I was also one of the organizers of the Bioinitiative Report that reviewed the latest research on EMF safety and made recommendations to remedy existing errors and base standards on biological effects. The report was cited by the European Parliament when they voted to review EMF safety standards. **I am writing to urge a limit on WiFi, especially in-flight WiFi.**

There is now sufficient scientific data on the biological effects of EMF, and in particular radio frequency (RF) radiation, to argue for adoption of precautionary measures. EMF can cause single and double strand DNA breakage at exposure levels that are now considered safe.

EMF have been shown to cause other potentially harmful biological effects, such as **leakage of the blood brain barrier** that can lead to **damage of neurons in the brain, well below the current safety limits**. Probably the most convincing evidence of potential harm comes from living cells themselves when they start to manufacture protective stress proteins upon exposure to EMF. This means that when stress protein synthesis is stimulated by radio frequency or power frequency EMF, the body is telling us in its own language that RF exposure is potentially harmful.

Many potentially harmful effects, such as the stress response and DNA strand breaks, occur at non-thermal levels (field strengths that do not cause a temperature increase) and are therefore considered safe.

It is obvious that the safety standards must be revised downward to take into account the non-thermal responses that occur at much lower intensities. Since we cannot rely on the existing standards, the precautionary principle appears to be the most reasonable approach for those who must protect the health and welfare of the public.

Sincerely yours,  
**Martin Blank, Ph.D.**  
Associate Professor of Physiology and Cellular Biophysics

### **3. Questions for Regulators, Commercial Carriers and Inflight WiFi Providers**

A. Before implementation of this new technology was extensive risk evaluation research conducted for short- and/or long-term effects with inflight WiFi regarding:

- i) interference with navigational equipment
- ii) diminished pilot performance – aviate, navigate, communicate
- iii) health of flight crew – related symptoms
- iv) compromised security?

B. Who is monitoring these installations for adverse effects on the above areas of concern?

C. In the event of an accident where RF radiation is determined to be one of the causative factors what are the insurance liability issues? Is there an RF exclusion? Should there be one?

D. Have you measured RF exposure levels in each of your WiFi-enabled aircraft to determine if any or total exposures from fixed, portable and mobile RF-emitters can exceed existing safety standards?

E. Are you aware that these safety standards are being challenged by scientists as not being based on the current findings? (BioInitiative Report, 2012.)

#### **Frank Clegg, former President Microsoft Canada:**

"The standards are not accurate and I'm calling on the manufacturers and distributors of wireless devices to answer a simple question: **Are your products safe? Yes or no.**

So far, there is consistent evidence that manufacturers and distributors avoid the question.

So it's time to stand up and admit what they already write in fine print: Wireless devices may cause cancer. Handle with care and learn to use the technology safely."

The long-term health effects – evidence includes brain tumours and other cancers – are a serious issue and our experts are concerned about the implications of extensive use of mobile phones and WiFi, especially in schools as young people are most at risk. There is also strong evidence of pre-natal exposure harming the foetus. In this document we are focusing on the aviation risks.

#### **4. Scientific, Medical and Pilot Performance Issues: Cardiac, Neurological and Cognitive Impairment** - Statements From Scientists, Flight Surgeons, Pilots, Technical Experts

Adverse effects can include cardiac symptoms, or a sudden neurological event that could compromise brain function, mental stability and cognitive abilities, even in an otherwise healthy individual with no previous medical history. Even without inflight WiFi, pilots' EMR exposure is increasing from security screening (often with ionizing X-ray technology), the proliferation of WiFi, and the universal use of increasingly powerful mobile phones and WiFi devices. Our technical experts caution that effects are magnified in the confined metal space of the fuselage.

##### **Olaf W. Skjenna, MD, D AvMed, Chief Medical Officer Air Canada (1982–1990):**

"My specialty is Aerospace Medicine, I am a commercial pilot and flight surgeon, and was adjunct professor at USC in flight medicine.

As an aviation accident and human factors investigator I know how a combination of factors contributes to accidents. And I haven't seen enough evidence to rule out the possibility that the radiation exposure from in flight mobile devices could become a new human factor. I believe the issue of in flight WiFi merits further study."

##### **N. Harv Haakonson, MD, FCBOM, Colonel (Retired) Canadian Forces**

**Former military pilot, licensed Commercial Pilot, Flight Surgeon**

**Fellow of the Aerospace Medical Association:**

"Re: certifying commercial aircraft for use of in flight WiFi. There is clearly enough scientific literature available to cause any experienced reader concern about the potential health and flight safety risks if this certification (changing the air regs to allow in flight WiFi) is done without specific study of the potential implications.

I believe that reasonable consideration has been given to flight operational concerns, though I am not sure the answers are clear, but I do not think the potential impact on the health of passengers, and especially flight crews, has been sufficiently studied to warrant certification at this time."

##### **Neurologist, Professor Salford, MD, Lund University:**

"The voluntary exposure of the brain to microwaves from WiFi and hand-held mobile phones is the largest human biological experiment ever. There is clear evidence that this radiation causes leakage of the brain's blood-brain barrier with adverse effects on brain function."

### **Hans-Christoph Scheiner, MD, Environmental Medicine Expert:**

"Even quite low levels of radio-frequency radiation – from WiFi and mobile devices – can open the blood-brain barrier and cause a lot of harm, including miniature edemas destroying brain cells which cannot be renewed.

This damage presents an increased risk of neurodegenerative conditions including Parkinson's disease. At the actual levels of 25,000 nW/cm<sup>2</sup>, which are expected to occur on board commercial airplanes equipped with WiFi, 100% of the animals tested had serious brain damage. Electro-hypersensitivity (EHS) is another issue: **People with this condition may faint, feel dizzy, or their vision might be impaired.** It's likely these are signs of opening of the blood-brain barrier. Doctors often tell them their symptoms are psychological. People may also experience nausea, lack of concentration, muscle weakness and skin reactions.

There is a wealth of evidence about the health risks associated with this technology, so it is not a question of insufficient evidence anymore. This is now about the conflict between commercial interests of an industry supported by the government and the protection of public health.

The BUND warns: 'The ubiquitous exposure to this unnatural type of radiation at unprecedented levels of power density harms human health. Short-term and long-term health impairments are preprogrammed and will especially manifest in the next generation if politically responsible actions are not taken immediately.'"

[Appendix B - full letter]

### **MORE EVIDENCE OF COGNITIVE IMPAIRMENT**

Dr Scheiner also reported:

"We have seen more human performance issues including a study on RF radiation by Horst Eger, MD (Eger and Buchner, Rimbach, Germany 2011) indicating adverse effects on neurotransmitters with sleep and rest, vertigo, and concentration problems.

In 2009, we saw evidence of **cognitive impairment from WiFi** and cell phone radiation by researchers Professors Kundt and Mosgoeller of the Vienna Medical University."

**Professor Wilhelm Mosgoeller, PhD, University of Vienna:**

"During the investigations of healthy human subjects, effects of GSM-900 and UMTS fields were studied under double-blind conditions whereby exposure levels were below current exposure guidelines at all times. During and after the actual exposure, certain brain waves (the so-called EEG alpha band, 8-13 Hz) changed. Some of the changes were statistically significant. And some CNS responses to acoustic and optical stimuli (so-called evoked potentials) mediated by brainwaves remained significantly changed even 30 minutes after the exposure. We noted faster response times during exposure, which, however, seem to occur at the expense of the quality of the response because wrong responses, in particular, were given within shorter time periods."

**Professor Olle Johansson, PhD of the Karolinska Institute:**

"The radiation emitted by mobile phones, and other wireless communication devices, has been shown to damage DNA – leading to possible mutations and cancer development, and is linked to impairments to immune function and neurological diseases and functions – including cognition and behaviour. If you look in the literature, you have a large number of various effects like chromosome damage, impact on the concentration capacity, and decrease in short term memory."

**Cardiologist Stephen T. Sinatra, MD, FACC:** [Appendix A - full letter] "As far as we know, no one has tested the accumulated exposures within the aircraft when a good number of passengers, and flight crew, are using their mobile devices. **It is unwise to install wireless technology (WiFi) in public transportation, especially aircraft.** We know that the heart is sensitive to, and can be adversely affected by, the same frequency used for WiFi (2.4 GHz) at levels a fraction of federal guidelines (less than 1%). I would like to see tests on pilots for potential cardiac – and cognitive – effects."

**Neurosurgeon Vini Khurana, MD:**

"The concern with mobile phone radiation is not just brain tumors, but other health effects including **behavioral disturbances**, salivary gland tumors and microwave sickness syndrome."

**Professor Devra Davis, PhD (Nobel Co-laureate, Epidemiologist):**

"The epidemiological approach that says the only proof of harm that really counts is enough sick or dead people has to change, particularly with the potential health hazards from WiFi exposure, as health problems may take years to develop. Should we wait? I don't think so, and neither does the European Parliament that has urged caution with this technology."

## **5. Partial Summary of Biological Effects [Appendix E - References]**

- A 2009 study by researchers in Israel confirmed human subjects exposed to wireless radiation from mobile phones had impaired cognitive functions, including slower response times to a spatial working memory task (Luria, Eliyahu, Hareuveny, Margalit, Meiran)
- Disruption to normal functioning of neurological, cardiovascular and endocrine systems (Lai, Salford, Becker, Cherry, Hurtado, Johansson, Karasek, Schilowsky)
- Impaired cognitive functions, including reaction time (Mosgoeller, Scheiner, Lai, Becker, Cherry, Luria, Eliyahu, Hareuveny, Margalit, Meiran)
- Increased agitation, sleep disruptions and food, chemical and electro-sensitivities (Becker, Holt, Rea)
- DNA damage and disruption of DNA repair (Lai, Singh, Philips)
- Suppression of the immune system (Johansson, Nakamura, Litovitz, Veyret, Hocking, Draper)
- Increased agitation, sleep disruptions and food, chemical and electro-sensitivities (Becker, Holt, Rea)
- Stress protein synthesis (body's reaction when stressed at the cellular level) (Blank, Goodman, Mosgoeller)
- Leakage of the brain's protective blood-brain barrier (Salford, Persson)

The blood-brain barrier is a vital filtering system in the blood vessels in the brain to keep toxins out and cerebrospinal fluids in, so that the environment of the brain is kept clean and the brain itself is cushioned against any contact with the skull.

Published, peer-reviewed research by **Leif Salford, MD, the neurology professor** at Lund University, shows that EMR is capable of causing leakage of the blood-brain barrier. (Salford et al. 1992, 1993, 1994, 1997b, 2001.) **Dr Salford**, "It is my sincere belief that non-thermal electro-magnetic fields from mobile phones and WiFi do have effects upon the human brain."

## More Evidence of Harm

Building Biology consultant and Industrial Hygienist, **Peter Sierck**, with his colleague **Thomas Haumann, PhD**, offer this summary of non-thermal biological effects from wireless technologies:

"Much experimental evidence of non-thermal influences of microwave radiation on living systems has been published in the scientific literature during the last 30 years – relating both to in vitro and in vivo studies.

- Changes in the electrical activity in the human brain,
- Increase in DNA single and double strand breaks from HF exposure to 2.45 GHz,
- Increased lymphoma rates (2 fold) in transgenic mice exposed twice a day to 30 minutes of cell phone (GSM) signals over 18 months,
- Increased permeability of the blood-brain barrier in rats,
- Observation of an increase in resting blood pressure during exposure,
- Increased permeability of the erythrocyte membrane,
- Effects on brain electrochemistry (calcium efflux),
- Increase of chromosome aberrations and micronuclei in human blood lymphocytes,
- Synergistic effects with cancer promoting and certain psychoactive drugs,
- Depression of chicken immune systems,
- Increase in chicken embryo mortality,
- Effects on brain dopamine/opiate electrochemistry,
- Increases in DNA single and double strand breaks in rat brain,
- Stressful effects in healthy and tumor bearing mice,
- Neurogenetic effects and micronuclei formation in peritoneal macrophage."

Are there medical concerns in heart conditions, pacemakers, or epilepsy? In 2014, the Israel Ministry of Health warned doctors about iPads and epilepsy, an alert from Dr. Scheiner, as well.

If a medical incident occurs onboard a WiFi-enabled aircraft will that be grounds for potential litigation?

Lloyds of London has recently stated they are developing exclusions for claims based on electro-magnetic radiation exposure. So far this does not include aviation insurance.

If aviation insurance carriers were to 'pull the plug' on inflight WiFi this will have been not only a risky health and safety experiment, but also a very costly one. Or, if it is determined this connectivity was a key factor in a terror threat, how long will this technology remain?

## **6. Commercial Pilots Report Potential Interference and Health & Safety Issues**

**A Captain for a Canadian commercial air carrier** writes:

"The number of airline employees, including pilots and flight attendants, who report having difficulty with WiFi is growing. There are some pilots off sick with mysterious Parkinson-like symptoms.

I experienced ill effects including nausea, shortness of breath, overall body weakness. I do not experience these symptoms when away from this exposure. I was an airline pilot for 22 years; working as a flight engineer on the 747 and then on the A320 for 14 years. Then I became electro-sensitive and had to withdraw myself from service."

In 2015 a CDN commercial pilot reports:

"I am very concerned about the wi-fi interference AD on B737 and B777. The wi-fi is blanking out display units in the cockpit. Companies still have 4 years to change the units; although I'm not sure why it wasn't immediate. Blanked out DU's seem pretty important to me.

Recently Google applied for a non-public experimental radio licence to broadcast over 99 % of the United States from 62,000 ft starting this January 2015. Your regular cell tower is 1-4 kW, new radio towers are about 7 kW and old TV/radio towers were about 36 kW. These airborne transmitters are going to be over 300 kW only a few miles over commercial air traffic. There is no public comment at all and if the FCC decides to open it up to the public, Google has asked to take back their application before they do so.

On page three of the AD is this excerpt: 'The intent of this AD is to eliminate this known susceptibility of the phase 3 DUs to RF transmissions, including those from sources outside the airplane.

This susceptibility is not limited to WiFi transmissions, but has been verified to exist in a range of the RF spectrum used by mobile satellite communications, cell phones, air surveillance and weather radar, and other systems.'

Obviously the power density of the 300 kW transmitter would be much great than a regular satellite or ground based cell tower.

A few years ago, a company "Lightsquared" tried to have 4G service from space and was stopped after FCC approval by NASA because of interference for GPWS and GPS systems. It just wrapped up in court very recently. What are these giant airborne transmitters going to do to aircraft; and the crews/passengers on board?"

**"I am a First Officer for a US air carrier.** When I fly the WiFi-equipped A321 my joints hurt with inflammation and arthritic-like pain. Other symptoms can include severe headaches, shortness of breath, sleep problems. I do not get the same symptoms flying the non-WiFi aircraft even though they are in the same family."

Another commercial captain reports: "I know some pilots, and flight attendants, who are becoming sensitive to these elevated radiation levels. This new radio frequency exposure is not the same as cosmic radiation and the earth's natural electro-magnetic fields.

People don't turn off the wireless component to these devices. You can't have complete assurance ever, but if stiff fines were imposed or people were thrown off if they turned on a phone while on the aircraft, then it certainly could be drastically reduced. Flight attendants cannot police every device they see being used. But they can police whether or not a device is being used.

These devices do cause interference for sure. I've seen it with my own eyes. These devices off of airplane mode also lead to huge amounts of radiation being emitted and reflected off the aircraft fuselage. Nobody is measuring that or taking it into consideration at all. Also aircraft that may pass some test for interference will over time and use probably not comply eventually. So to prevent any harm coming to innocent people who are just trying to travel, there needs to be no devices used on board at any time."

This pilot raises a good point. If mobile devices are looking for a signal, i.e. whenever not in airplane mode, harmful levels of radiation are being emitted even if the aircraft is *not* WiFi-enabled, or there is no available network signal.

### **British Commercial Pilot**

"Back in the 1960s I was a pilot in the Royal Air Force.

We did our pilot training straight on jets. The Jet Provost was equipped with UHF radio Comms and the Rebecca MkIV Distance Measuring and Directional Radar also operating on UHF frequencies. The comms radio antenna was situated right behind the transparent cockpit canopy about 4 feet from the heads of the pilots. A second antenna was situated underneath the aircraft. The DME radar also had a transmitting antenna underneath the fuselage. Out near the wing tanks were receiving antenna on each wing for the DME.

Many of us suffered from headaches and severe sinus problems as well as extreme sweating from the head while flying especially in conditions requiring continuous RT such as formation flying, practice circuits and roller landings.

Other times on long navigation exercises and aerobatics when RT was at a minimum the effects were not experienced.

I wonder how many pilots and ex-pilots suffer from brain tumours? In those days no one would listen to our concerns, instead we were sent for sinus treatment, very painful and very unpleasant. Ground radio towers transmitting UHF frequencies carry warnings to keep away to avoid radiation burns, and yet high powered radio antenna are placed close to pilots heads."

### **Digital Distraction – a new risk factor in all modes of transportation**

WASHINGTON, October 2009 (Reuters) – "Pilots of a jetliner that overshot its destination by 150 miles last week told U.S. investigators they became distracted during an extended discussion of crew scheduling that included their use of personal laptops."

Some airlines now require flight crews to use online digital devices in flight. Do they tell them the risks? Pilots are highly trained and skilled professionals. Flight safety and the wellbeing of their flight crews and passengers are paramount. They would forego in an instant, with the flick of a switch, the convenience of inflight WiFi if they suspected it would impair flight safety in any way. No question.



#### **Interference concerns from Ask The Pilot:**

"Cockpit hardware and software use radio transmissions for a number of tasks. Whether transmitting, receiving or simply sitting idle, cell phones are able to garble these signals.

As you might expect, aircraft electronics are designed and shielded with this interference in mind. This should mitigate any ill effects, and to date there are no proven cases where a cell phone has adversely affected the outcome of a flight.

But you never know, and in some situations – for instance, in the presence of old or faulty shielding – it's possible that a telephone could bring about some sort of anomaly."

### **Another commercial airline pilot reported interference,**

"Recently, I had an HSI spin around for about 10 minutes in cruise on the A320, until a business class passenger was asked to stop his phone call on his cell. The needles immediately stopped when he turned off his phone. I have grave concerns about having WiFi and cell phones onboard." The industry response may be that they have recently revolved these interference issues. We would like to see evidence of this and to know who is monitoring this new aviation product.

Hans Scheiner, MD raised a medical alert explained some of the physiology,

"There are not yet any scientific studies of the biological effects on the crew and passengers, but there is enough evidence to cause concern. While the airplane is at an altitude between 8,000 and 12,000 metres, a reduced air pressure occurs inside of the plane, which equals the air pressure of 2,000 – 3,000 metres outside. Therefore the breakage of the blood-brain barrier is more likely because of the lack of oxygen and the well known altitude sickness.

The severe consequences of the brain and nerve damages and safety of passengers are very concerning especially those of the pilots, because they are already highly exposed from radar. The symptoms caused by high frequencies include: headaches, drowsiness, vertigo, nausea are often connected with loss of hearing and vision; lack of concentration and memorization. (Johnson-Liakouris, 1998, Mild 1998, Santini 2001, 2002, 2003, Navarro, Oberfeld 2003).

A British lab found that reaction time is much longer when someone is exposed to WiFi and mobile phones. This is particularly a concern with the pilot's reaction time, when these high frequencies open the blood-brain barrier. Researchers at the University of Toronto found that drivers of vehicles were nearly five times more likely to have an accident when people were using mobile phones in the car."

## **7. Technology and Technical Experts**

**Alasdair Philips, an electrical engineer in the UK**, has done onboard testing of the electro-magnetic fields in aircraft cabins and cautions: "Most airlines now provide in-flight mobile phone and WiFi service. They are installing a picocell base station – effectively, a small mobile phone mast – onboard the aircraft. Passengers web-browsing and video streaming greatly increase the RF levels in the cabin.

Most planes have in-flight video screens built into the back of each seat. The personal lights above the seats can be sources of significant electric fields. Turn yours off. With added wireless Internet and mobile devices, the RF radiation will bounce up and down the cabin 'metal tube'.

There are also signals from various plane transponders mounted under the fuselage which make their way up into the cabin at surprisingly high levels. Many planes also have an emergency Iridium phone system that is internally active all the time they are in the air."

#### **EMR/RF Technical Expert Katharina Gustavs**

"Since aircrafts are metal enclosures, any wireless transmitter will cause an exponential increase in RF radiation exposure. Due to reflection and resonance effects and multiple users, (secondhand) exposure levels can increase 1000% in hot spots, which in some instances may even exceed official exposure limits."

#### **Electrical Engineer Lawrence Gust**

"The WiFi base stations placed in the cabin are the least of the problem. The Airbus A319, for example, has a maximum seating capacity of 156 people. The big problem comes when 100 passengers all connect with the aircraft WiFi at the same time."

#### **EMR/RF Technical Expert Peter Sierck**

"It seems prudent to conduct proper RF testing to determine the levels the crew and passengers are exposed to before changing the air regulations."

#### **2013, Boeing receives approval from the FAA for "Earth Stations Aboard Aircraft."**

Our technical experts comment on remarks by an engineer connected with the committee who admitted they hadn't considered the effects with a planeload of people online.

Committee engineer: "Flight attendants and pilots have worse effects from gamma radiation."

Professor Johansson: "So then we can booster them with some harmful microwaves as well?"

Gustavs: "Yes, gamma radiation is worse. However, considering that two thirds of the radiation effects of gamma radiation are mediated through an excess of free radicals; it won't help matters when another agent such as WiFi radiation is added that is also known to cause free radical stress."

Metzinger: "Cosmic radiation has always been a serious concern when flying. Now we are adding a new type of radiation to the mix. Not a good idea especially for the flight crew."

Engineer: "There would be a lot of radiation from all of the devices but the antenna on top of the planes is directional to the satellite and then a wire feeds into the plane."

Gustavs: "Yes, the majority of the radiation exposure would come from the devices used inside the aircraft. But this wire from the outside antenna will be hooked up to an antenna or a number of [wireless] access points inside the aircraft, which would cause the highest exposure to those closest to them."

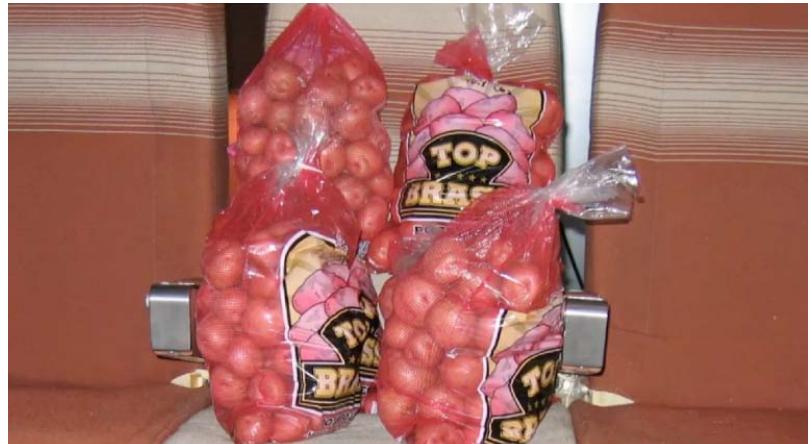
Engineer: "The metal protects one from the radiation and it is within the standards and safe."

Gustavs: "Yes, the metal will reduce the exposure to outside RF sources, which is most likely within the 'standards,' but I would not call this safe. There are so many WiFi-enabled devices that do not come with the option of a wired connection that, even if Ethernet ports are provided onboard, people would not be able to use them, unless they still have an old-fashioned notebook."

BBC News 21 December 2012

"US plane maker Boeing used an unusual substitute for passengers to test its in-flight wi-fi system - potatoes. Passenger seats on a decommissioned plane were loaded with huge sacks of the tubers for several days as signal strengths were checked.

The company's researchers say that potatoes "interact" with electronic signals in a similar way to humans. Boeing's engineers did a number of tests to ensure that passengers would get the strongest possible WiFi signal while in the air, all while meeting safety standards that protect against interference with an aircraft's electrical systems."



## **8. Threats to Security**

Maybe security concerns, not health and safety issues, will be the wake-up call.

### FCC To Look Into Security Of In-Flight Broadband Use

By Jenna Ebersole

Washington (February 1, 2016, 4:25 PM ET) -- The Federal Communications Commission said Friday it will work with the U.S. Department of Transportation to study how consumer telecommunications can be safely and securely used in-air, as the FCC takes comments on proposed rules to expand in-flight broadband Internet access. In a public notice, the FCC said that it will create and chair an interagency group with the Federal Aviation Administration with a focus on collaborating and coordinating on in-air technology and other overlapping issues.

Aviation security in the digital age is a new challenge. In 2015 there's global concern with new explosives: bombs undetected by security scanners hidden in laptops and other mobile devices. In the US, the TSA banned battery-dead cell phones from flights. In-flight WiFi could be next? The TSA has also expressed concerns about onboard mobile phones being used by terrorists as bombs and/or to co-ordinate attacks.

April 2015, The US Government Accountability Office (GAO) report, "FAA Needs a More Comprehensive Approach to Address Cybersecurity As Agency Transitions to NextGen" states, "Modern aircraft are increasingly connected to the Internet. This interconnectedness can potentially provide unauthorized remote access to aircraft avionics systems."

Members of the US House Transportation and Infrastructure Committee had requested this report which explains that on certain WiFi-enabled aircraft unauthorized 'hackers' could gain access through the entertainment network to the plane's multiple electronic communication and navigational systems.

House Committee member Rep. Peter DeFazio, D-Oregon commented, "This report exposed a real and serious threat – cyberattacks on an aircraft in flight. And the Federal Aviation Administration (FAA) must focus on aircraft certification standards that would prevent a terrorist with a laptop in the cabin or on the ground from taking control of an airplane... That's a serious vulnerability."

## **AVIONICS EQUIPMENT HACKED BY ONBOARD MOBILE DEVICES?**

August 2014

(Reuters) - Cyber security researcher Ruben Santamarta says he has figured out how to hack the satellite communications equipment on passenger jets through their WiFi and inflight entertainment systems - a claim that, if confirmed, could prompt a review of aircraft security.

Santamarta, a consultant with cyber security firm IOActive, is scheduled to lay out the technical details of his research at this week's Black Hat hacking conference in Las Vegas, an annual convention where thousands of hackers and security experts meet to discuss emerging cyber threats and improve security measures.

In theory, a hacker could use a plane's onboard WiFi signal or inflight entertainment system to hack into its avionics equipment, potentially disrupting or modifying satellite communications, which could interfere with the aircraft's navigation and safety systems, Santamarta said.

If he's correct, though, there would need to be a serious investigation into the safety of these satellite systems.

## **October 27, 2014 - SECURITY CONCERN WITH ONBOARD WIFI HOTSPOT**

### **LOS ANGELES INTERNATIONAL AIRPORT**

An American Airlines flight from Los Angeles International Airport to London was delayed Sunday after concerns over the name of a WiFi hotspot.

A passenger saw the WiFi connection, named "Al-Qaida Free Terror Network," and expressed concern to a flight attendant.

The plane was held at a remote part of the airport for three hours and passengers were told to turn off their electronic devices.

After an hour, the pilot announced said there was a security threat and that we didn't have clearance to take off.

Flight 136 was eventually taken back to the gate and was delayed until 1 p.m. Monday, American Airlines officials said.

## Airline WiFi sparks security concerns

**Christine Negroni, Nov. 17, 2010**

Does the coming of WiFi service to passengers pose any sort of danger aboard the plane? The question arose after Yemeni terrorists tried recently -- and failed -- to destroy two U.S.-bound cargo planes by stuffing printer cartridges full of explosives and then detonating the charges in flight.

British explosives consultant Roland Alford created a stir when he told New Scientist magazine that WiFi is a "Pandora's box" for terrorists and that giving passengers Internet access "gives a bomber lots of options for contacting a device on an aircraft."

A number of airline workers, security professionals and technologists say they agree WiFi can create serious security risks. A number of airline workers, security professionals and technologists say they agree that WiFi can create serious security risks. The Association of Flight Attendants, for example, has asked the government to ban WiFi.

"We recognize the potential of the threat and are looking at it closely," said Gideon Ewers, the spokesman for the International Federation of Air Line Pilots' Associations. His reaction was mirrored by the Washington, D.C.-based Air Line Pilots Association.

"We need to fully explore what could the bad guys do, how could this be turned against us," said Robb Powers, a Boeing 737 pilot and chairman of the national security committee for ALPA.

Security expert and blogger Bruce Schneier dismissed such concerns in a blog posting last week: "Put together a sloppy and unsuccessful package bomb with an imagined triggering mechanism, and you have a *new and dangerous threat* that -- even though it was a threat ever since the first airplane got WiFi capability -- must be immediately dealt with right now," he wrote. "Please, let's not ever tell the TSA about timers. Or altimeters."

The Yemeni bomb plot demonstrates one way WiFi could facilitate terrorists, said Dinkar Mokadam, an occupational safety expert with the Association of Flight Attendants. He said WiFi and Internet-enabled calls could enable a terrorist to maneuver around the U.S. ban on the use of cell phones on airplanes and actually trigger a bomb.

"This sort of a detonation doesn't require a voice," Mokadam said. "It requires communication to a cell phone and you can text to a device and have it go off. You don't have to even talk to it."

Banning WiFi use completely or during high security-alert periods are two of several proposals the US Department of Homeland Security is considering.

## **Appendix A: CARDIAC EFFECTS AND MORE MEDICAL ISSUES**

Here is an open letter from a cardiologist concerned about potential cardiac impairment.

Stephen T. Sinatra, M.D., F.A.C.C.

February 28, 2012

### **RE: WiFi in Commercial Aircraft**

The heart is a delicate and complex electromagnetic organ that can be adversely affected by exogenous signals from wireless technology and its microwave radiation. For this reason it is unwise to adopt this popular, but untested technology, in transportation, especially exposing passengers, pilots and other flight crew to onboard WiFi radiation.

As far as we know, no one has tested the accumulated exposures within the aircraft when a good number of passengers, and flight crew, are using their mobile devices.

I would like to see tests on pilots for potential cardiac – and cognitive – effects.

Another issue is who will monitor the usage of in flight mobile devices? For example, a Sat phone could present additional problems. While pregnant women, infants and children are particularly vulnerable to this radiation exposure, we are all at risk. This global implementation of WiFi technology is creating a new environmental health hazard, and this electro-pollution is the greatest medical threat of our time. I know this because I am a board certified cardiologist and have been a Fellow of the American College of Cardiology since 1977. At the Manchester Memorial Hospital in Connecticut, I served in several roles, including Chief of Cardiology, Director of Cardiac Rehabilitation, and Director of Medical Education.

1. There are a growing number of people who have become electro-sensitive and develop adverse symptoms when exposed to even low levels of electro-magnetic radiation.
2. Symptoms – usually unrecognized – may include headaches, dizziness, nausea, feeling faint, pulsing sensations or pressure in the head, chest pain or pressure, difficulty concentrating, weakness, fatigue, and a racing or irregular heart accompanied by feelings of anxiety.

These symptoms may seem diverse but they indicate autonomic dystonia or dysfunction of the autonomic nervous system.

3. We know that the heart is sensitive to, and can be adversely affected by, the same frequency used for WiFi (2.4 GHz) at levels a fraction of federal guidelines (less than 1%).
4. In the future, it is quite possible that we may see the need to provide WiFi-free areas in public spaces like airports, schools, offices – and in public transportation. We do not know the long-term effects of low-level microwave radiation.

**The safety of this technology on human health has not been properly tested and I would advise that you follow the precautionary principle** that states the following:

'In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.' (Rio Conference 1992).

The principle implies that we have a social responsibility to protect the public from exposure to harm, when scientific investigations have found a plausible risk. That "plausible risk" exists for microwave radiation at very low levels.

These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result. In some legal systems the application of the precautionary principle has been made a statutory requirement.

**In conclusion it is unwise to install wireless technology (WiFi) in public transportation, especially aircraft.**

Stephen T. Sinatra, M.D., F.A.C.C.

## **Appendix B: 2008/2012 Letters from a group of European Physicians**

### **Hans-Christoph Scheiner, MD, February 27, 2012 [full letter]**

Equipping aircraft with WiFi is a dangerous experiment. The health and safety of passengers - and especially flight crews - are at risk. Accumulated electro-magnetic radiation exposure may become the new human factor in transportation.

Since our group the German Environmental Physician Initiative sent a letter in 2008 to the aviation industry stating our concerns, there has been a proliferation of WiFi in commercial aircraft, as you know.

In our view, before allowing the addition of WiFi, and its radio-frequency radiation, to the existing in flight exposures from cosmic radiation and solar flares, regulatory agencies should conduct an investigation into the short and long-term effects on human performance and human health. As far as we know, these tests have not been conducted, making the installation of WiFi and widespread in flight use of mobile phones, and other wireless devices, a very dangerous experiment, as I have stated.

We acknowledge WiFi is everywhere and there will be significant health consequences from these accumulated exposures. However, there are specific concerns in transportation, especially aviation which must be evaluated. Radiation effects are magnified in aircraft – a metal 'Faraday' cage - and other confined metal spaces, as they are with increased altitude.

The evidence that this presents health, and flight safety, hazards has increased. Is the government willing to take this risk? One of the issues is that no one knows how those who are affected will react. Reactions can include cognitive impairment and cardiac symptoms. Another concern is that no one is monitoring exposure for these or other adverse effects, including long-term cancer risks.

Even quite low levels of radio-frequency radiation - from WiFi and mobile devices - can open the blood-brain barrier and cause a lot of harm, including miniature edemas destroying brain cells cannot be renewed. **This damage presents an increased risk of neurodegenerative conditions including Parkinson's disease.**

May we ask that you also review the 2008 letter from our group of physicians.

Dr. med. Hans-Christoph Scheiner, Environmental physician, Münchner Ärzteappell

*[This is the full letter written to many airline executives by Dr. Scheiner and the German Environmental Physician Initiative.]*

### **Intended Authorization of Mobile Phones and Wireless LAN in Air Traffic**

The information was spread in the media, that it is planned to allow the use of wireless communication devices like cell phones, W-LAN, and similar electronic tools on commercial flights.

We are highly concerned about this fact. As a technical innovation the susceptibility of electronic board systems in relation to microwaves has decreased (to be questioned here are the remaining risks): the personal use of wireless communication technology on commercial flights leads to serious health risks to all passengers and flight personnel.

Therefore it should be treated as a fact of the overall security of commercial airlines.

Reason: If there are wireless systems permanently in use like cell-phone stations, W-LAN, Blue-Tooth, DECT, etc. in addition to active single cell phones and notebooks on flights with the duration of several hours, the passengers, crew and pilots would be exposed to excessive radiation of 25,000 nW/cm<sup>2</sup> and higher.

Even though these levels of exposure are just from 1/10 to 1/50 of the actual legal exposure limits, there are multiple scientific proofs of health risks. Even a radiation dose of 100-500 nW/cm<sup>2</sup> breaks the blood-brain barrier, which causes the entry of water, dissolving metabolism waste products, environmental toxins and blood proteins (especially albumins) into the central nervous system.

The fatal consequences are: miniature edemas occur in the complete brain, multiple selective swellings in non-renewable brain cells are irretrievably squeezed to death. They occur as dark neurons in the microscopic picture. Those dark neurons are proven to be possible starting points of very serious neurodegenerative diseases like Multiple Sclerosis, Parkinson's disease, Alzheimer's disease, senile dementia and so on.

Many scientific studies with animal tests showed significantly this opening of the blood-brain barrier. Even low levels of 100-500 nW/cm<sup>2</sup> caused in more than 50% of the animals tested an opening of the blood-brain barrier. At the actual levels of 25,000 nW/cm<sup>2</sup>, which are expected to occur on board commercial airplanes equipped with WiFi, 100% of the animals tested had serious brain damage.

The breakage of the blood-brain barrier under the influence of radio waves and high frequency, which happens at levels far underneath the current legal exposure limit, has obtained doubtless scientific evidence. This was significantly found and described by ALBERTS 1977, OSCAR AND HAWKINS 1977, NEILLY AND LIN 1986 SALFORD, BRUN, PERSSON, 1994, 1997, 2003 AUBINEAU AND TOERE 2001, 2003 SCHIRMACHER 1999, 2000 and many others.

Another fact: While the airplane is moving at an altitude between 8,000 and 12,000 metres, a reduced air pressure occurs inside of the plane, which equals the air pressure of 2000 – 3000 metres outside. Therefore the breakage of the blood-brain barrier is more likely because of the lack of oxygen and the well-known altitude sickness.

The severe consequences of the brain and nerve damage and safety of passengers are very concerning, especially those of the pilots, because they are already highly exposed from radar. The symptoms caused by high frequencies, like headaches, drowsiness, vertigo, nausea are often connected with loss of hearing and vision; lack of concentration and memorization are in this context known as the "Microwave-Syndrome" (JOHNSON-LIAKOURIS, 1998, MILD 1998, SANTINI 2001, 2002, 2003, NAVARRO, OBERFELD 2003).

Another dangerous result is the extreme slow down of the neuro-muscular response because of a doubled reaction time. Also the mental capacity is, in terms of cognitive disorders, verifiably heavily affected. Epidemiological studies and exposure trials with volunteers and animals show this clearly, see also the TNO-STUDY OF PROFESSOR ZWAMBORN 2003, KALODYSKI U. KALODYNKA 1996, PROFESSOR LAI U. SINGH 1966, 1997, 1998, ALTPETER U. ABELIN 1995, 1999, SEMM U. BEASOND 1996, ROSCHKE UND MANN 1996 and many more.

Because of the mostly fatal exits of flight accidents there are no special data about the influence from radio- and microwaves on flight safety and security available.

But the knowledge we have from other traffic systems on the ground is surely transferable: in 2002, The British Transport Research Laboratory found that the time of a reaction of a car driver is 30% lower if he has been exposed to radio waves than the reaction time of an alcoholized driver, and 50% lower than the reaction time of a driver who has not been exposed to either.

In 1997 the University of Toronto (REDELMEIER AND TIBSCHIRANI) found out on the basis of a big trial that in relation to the length of exposure to radio waves of the car drivers, the drivers were 5 times as likely to cause an accident and twice as likely to cause a deadly

crash. The same was confirmed by the RESEARCH GROUP OF VIOLENTI (1998) "CELLULAR PHONES AND FATAL TRAFFIC COLLISIONS", similar facts were proved by PROFESSOR UNGER AT BREMEN UNIVERSITY: Cell Phone influence while driving leads even for experienced drivers to a 30% increase in changing and stopping mistakes!

In this context the following is very interesting: it has been proven multiple times that the use of cellular phones cause electroencephalography changes of the brain waves!

Because of this it was possible for DR. VON KLITZING AT LUEBECK UNIVERSITY to prove that highly pulsed frequencies like mobile phones lead to pathologically EEG-patterns of the brain in the so called "alpha- rhythm". This EEG area represents our physical and mental relaxing and recovering phases. The "alpha-rhythm" is shown while we sleep and dream. Pathological EEG changes in this alpha-area – show up most at 10 Hz – are an indication of a deep radio wave caused disorder of our physical and mental health, which reaches deep into our subconscious.

Those EEG changes were already proven before DR. KLITZING by Russian and American researchers, and after him often reproduced, for example by the German Department for Work Safety and Occupational Medicine in 1998 (FREUDE ET. AL.), by THE UNIVERSITY OF ZUERICH UNDER PROF. ACHERMAN, HUBER, BORBELEY ET AL. 1999,2000,2002,2003).

The above explanations include that radio waves also cause serious sleep disorders. It is also proven multiple times that radio waves cause a decrease in the sleep and body defense hormone Melatonin. (BURCH U.A. 1997, 1998, 1999, 2000, REITER U. ROBINSON 1994,1995, ABELIN U. ALTPETER 1995, 1999 U.A.M.)

Let's not forget about the intermediate massive impairment of our microcirculation and therewith the oxygen supply of our inner organs and brain caused by the tendency of our red blood cells to stick together under the influence of radio waves. (DR. PETERSOHN 1998, RITTER UND WOLSKI 2005). In addition to this PROF. KUNDI (Environmental hygienic department of Vienna University) found a high increase of heart attacks, strokes, thromboses and embolism in people who live near transmitter masts.

All of these are disorders that could lead to an immediate airplane crash, with hundreds of victims, if this would happen to pilots. And finally the following is for all airlines to consider: electrosensitivity and electroallergies to wireless electronic devices already bother 10% of the worldwide population, and this tendency is rapidly increasing.

Even short flights, but especially long ones, on which the passengers are constantly given a continual exposure of radio and microwaves would lead to a reduction of bookings and a recognizable decrease in sales for airlines which permit cell phone systems, notebooks and similar wireless instruments on board. This has already been seen in Germany and other countries where electro-sensitive or allergic people avoid high-speed trains because of permanently active "Repeaters" (amplifiers of HFsignals).

This is one of the facts that cause the above described microwave syndrome (headaches, nausea, drowsiness, vision disorders etc) and their change over to using different ways of transportation like cars, buses and trains without Repeaters.

The decrease of sales is doubtless continuing, and will do so even more as passengers realize what kind of danger permanent radio and microwaves on board hold for flight security.

**We ask you not to ignore these scientific facts about the dangers of radio and microwaves.**

Dr. med. Hans-Christoph Scheiner  
Environmental physician, Münchner Ärzteappell  
Munich, July 24<sup>t</sup>, 2008

By orders of the German Environmental Physician Initiative represented by:

Dr. med. Wolf Bergmann Freiburger Ärzte-Appell  
Dr. med. Horst Eger Ärztlicher Qualitätszirkel Naila  
Dr. med. Markus Kern Mobilfunk-Ärzteinitiative, Allgäu-Bodensee-Oberschwaben  
Dr. med. Peter Lackner Münchner Ärzteappell  
Dr. med. dent. Joh. Lechner München, Vorsitzender der GZM  
Dr. med. Joachim Mutter Universitätsklinik Freiburg

Kerry Crofton reports, "Dr Scheiner sent this letter in 2008 to many commercial air carriers. As far as we know, there was no response. He also contributed to my 2012 book. Sadly, a few years ago Dr Scheiner passed away and we lost a strong and wise voice. He left us with a remarkable legacy in the field of environmental medicine."

## **Appendix C:** Letter from UK Electrical Engineer and statements from other Technical experts

I am a practising electrical engineer and scientist, and have advised the British government and other groups on electro-magnetic radiation (EMR) issues. At first I thought wireless technology was brilliant. I now believe that the mistake we are making will have much **more serious long-term adverse effects on our well-being than either smoking tobacco or asbestos.** As you know, most airports and other public spaces are now wireless 'hot spots' of RF radiation. As you may not know, this is affecting us all.

And there are a growing number of people who are electro-sensitive (ES) and suffer mild to serious symptoms in a wireless environment. Most ES people already can't travel in planes, with the aircraft's electro-magnetic fields, with video screens built into the seats etc., let alone in-flight WiFi. I have measured fields in a Gulf Stream 550 taking off from and landing at national UK airports and circulating around the UK. I also measured the passenger cabin which was WiFi-enabled. Highest readings by far were the airport radars (10s of volts per metre). Next was the WiFi, which was similar to the aircraft DME signals from the transponders mounted below the fuselage. We are told the radiation levels are "well within government health and safety limits."

Planes are not an EMF-friendly environment even now. Most have in-flight video screens built into the back of each seat. These are a source of high-frequency fields both for the people watching the screen and for those whose seat it is fitted into. There are also signals from various plane transponders mounted under the fuselage which make their way up into the cabin at surprisingly high levels. Many planes also have an emergency Iridium phone system that is internally active all the time they are in the air, with active handsets at both ends of the plane using a pulsing DECT (digital) cordless phone like signal 24-7.

We are also told that in-flight WiFi – as well as airport security scanners – are safe and emit lower levels than what we receive from cosmic radiation during the flight, or being on the earth's electromagnetic fields. False assurances.

Security scanners present a significant problem for flight crews, with already high occupational exposure, and frequent flyers who must pass through these scanners frequently. The key point is the bombarding of the skin with a mass of electrons. That may, or may not be a significant problem, but there has been almost no work done to test it on animals (or humans) at these relatively low energy levels. And there's now the additional exposure of on-board WiFi. There are no long-term studies on this accumulated exposure. I would oppose WiFi being provided inside aircraft cabins. WiFi tests inside an in-flight aircraft have shown that those sitting closest to the Access Points will be highly exposed.

*Alasdair Philips, February 28, 2012*

**Katharina Gustavs, Cert. EOH, Building Biology Environmental Consultant IBN**

"Without any additional WiFi radiation exposure, air travel already puts a high level of stress on flight personnel and passengers, including cosmic radiation exposure, reduced oxygen and air pressure, extended periods of immobility in a confined space, etc. Even at levels below Health Canada's Safety Code 6 (10,000,000  $\mu\text{W}/\text{m}^2$ ), passengers may develop headaches, dizziness, and tachycardia, which is why all precautionary EMF guidelines recommend to keep ambient RF radiation levels as low as possible, certainly below 1000  $\mu\text{W}/\text{m}^2$  (Salzburg Resolution 2000) or 170  $\mu\text{W}/\text{m}^2$  (Seletun Statement 2011). In building biology, we prefer to keep RF exposure levels below 10  $\mu\text{W}/\text{m}^2$  (SBM-2008). These precautionary EMF guidelines are easily exceeded within close range of activated WiFi-enabled laptops and smartphones as well as WiFi access points.

Not only does low-level RF radiation interfere with the proper functioning of the human body, avionics systems are not immune, either. For example, an aircraft wireless terminal was found to interfere with a ground base station "even from a distance of 286 km" (Moraitis 2010). In a worst case scenario, Honeywell display units on a Boeing 737NG went blank during EMI certification testing of WiFi systems (Boeing 2011). The U.S. Aviation Safety Reporting System has many incidents on file where personal electronic devices used by passengers cause interference with the avionics systems (ASRS 2011). The current trend is to design aircrafts that are more immune to the ever-increasing level of RF radiation from personal electronic devices (Walen 2008), but where does that leave human health.

Unnecessary and potentially harmful RF radiation exposure as well as electromagnetic interference with avionics systems can be avoided by hardwiring each seat for Internet access. At minimum, any in-cabin wireless network for passengers should be based on

optical radiation, which would eliminate any interference issue with avionics systems. Moreover, with optical radiation it would be much easier to establish exposure-free zones within the aircraft for those who require them for medical reasons and those who prefer them for health reasons—just a simple curtain would block this form of radiation. For the protection of public health, of course, hardwired is the way to go."

**Rob Metzinger, Electronics Engineering Technologist, BBEC, President Safe Living Technologies Inc.**

"Having WiFi on a commercial airliner poses 2 concerns for me. One concern being the intensity of the exposure levels to the passengers, crew and the pilots the other concern being the risk of electromagnetic interference on the navigation equipment. As an EMF mitigation specialist, I have seen instances where electronics signals can impact other

electronics in their surroundings. This concerns me with the in-flight navigation equipment. With WiFi devices in an aircraft, the following signals would potentially be present: WLAN, Blue-Tooth, DECT, cell phones, Notebooks to name a few. Each of these devices radiates a unique wireless signal pattern which can couple onto the backbone wiring of the aircraft if it is not properly shielded.

If the signals are intense enough, electromagnetic interference "EMI" could result thus impeding the functionality of an in-flight control system. Exposure levels of the crew and passengers are also an issue as the fuselage of an aircraft is metal. Metal is a known reflector of radio waves and microwaves. This means that radio-frequency energy generated by the WiFi transmitters will be reflected around the cabin elevating RF exposure. As each person activates his or her personal WiFi device the exposure to all passengers and crew will increase as well. One of the side effects of exposures to this type of radiation is delayed reaction time. The last thing a pilot needs is having his reaction time impeded."

**Don Maisch, PhD Environmental Building Survey Consultant**

"I am a member of the Australasian College of Nutritional and Environmental Medicine (ACNEM) and have published numerous papers on various aspects of EMR exposure, from health related issues to reducing EMR in the workplace.

My concerns mirror those of Rob Metzinger. Electromagnetic interference (EMI) with the plane's electronic equipment is a potential problem given the endless introduction of wireless devices. It is my understanding is that the EMI problem with aircraft systems has still not satisfactorily been addressed. If we apply a risk/benefit approach, why provide the benefit of passengers being able to use these devices for entertainment for a few hours flight when the risk, even if very remote, is a catastrophic electronic failure at a critical time in the plane's journey. SAFETY SHOULD BE PARAMOUNT!

Another issue is that the microwave emissions will be reflected back into the cabin from the curved metal skin. This IS an occupational Health and safety concern for flight crews who will be spending much of their work time bathed in these emissions."

**Lawrence Gust, Electrical Engineer, and Faculty & Board of the International Institute for Building Biology & Ecology**

**RE: the installation of WiFi on airplanes**

The WIFI base stations placed in the cabin are the least of the problem. The Airbus A319, for example, has a maximum seating capacity of 156 people. The big problem comes when 100 passengers all connect with the aircraft WiFi at the same time.

Measurements made in Germany a few years ago quantifying the RF power density of a single PC at 5 feet as 1580  $\mu\text{W}/\text{m}^2$ . Multiply this by 100 and you get 158,000  $\mu\text{W}/\text{m}^2$ . All this radiation is bouncing off the metal skin of the plane running in to other radiation streams and reinforcing at the intersections. In my view this is an absolutely stunning power density that all passengers must sit through for the duration of the flight.

**This is worse than second hand smoke on planes** before smoking was banned. And on those planes the ventilation system provided 100% outside air, but now there is no escape from the RF pollution. If passengers knew what the attached RF Effects graph shows, non-using passengers would be very unwilling guinea pigs for this diabolical experiment. The installation of WiFi on airplanes is insane.

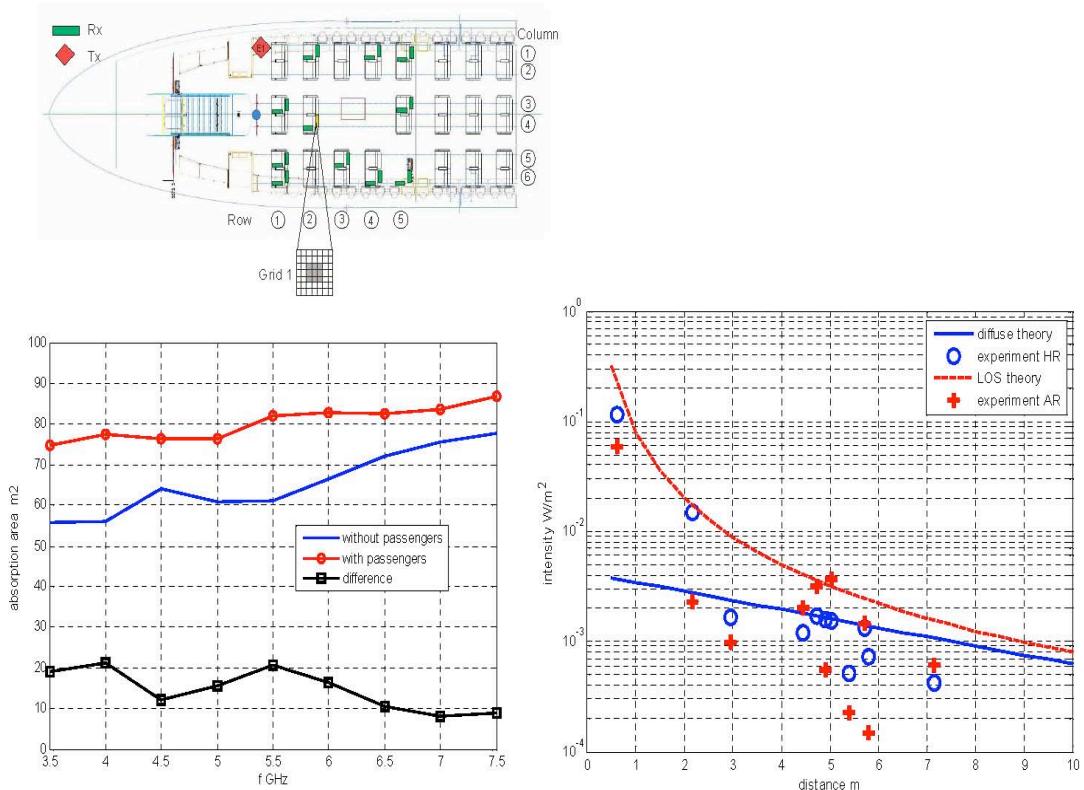
With 3% of the population reacting to smart meters the minute they are installed and another 15% becoming sensitized in four or so weeks we will have a great number of very uncomfortable passengers and some no doubt will be permanently impaired. The radiation from all digital wireless devices having the same qualities can be expected to invoke a reaction in many people and I think it's going to murder some passengers through stroke or heart attack.

*Larry Gust,  
March 3, 2012*

Alasdair Phillips: "In the graphic below, from Professor Anderson of Aalborg University, who specializes in antennas and mobile communication, the WiFi access point (transmitter/receiver) is marked in the top front corner of the cabin and then they calculated and measured the RF power density exposure of the passengers. The lower right-hand-side graph shows the exposure levels and, as would be expected, they get much higher in the seats closest to the WiFi access point. These are the only measurements I have heard of w.r.t. WiFi in aircraft."

Larry Gust: "Assuming that is the Full Wave power density and using what I assume to be statistically smoothed experimental data (LOS theory line) these are the results at three distances from the source. These levels could induce cardiac arrest."

Katharina Gustavs: "Any RF exposure above 100  $\mu\text{W}/\text{m}^2$  is considered a significant concern. At 10 m the background level is still between 600 and 800  $\mu\text{W}/\text{m}^2$ ."



Measuring whole-body-absorption by real people

Incident power density determines whole-body SAR . The closest takes all!

## **Appendix D: ROUGH DRAFT ONLY - NOT FOR DISTRIBUTION** Sample Inflight Symptom Survey

There have been an increasing number of reports of pilots, flight attendants and passengers experiencing: nausea, panic attacks, vertigo/dizziness, light-headedness, feeling faint, losing consciousness and/or cardiac problems at altitude, requiring oxygen/medical intervention. Investigations are ongoing. Someone needs to collect data and compile a report for aviation regulatory agencies and commercial air carriers.

### **Six Questions to Consider**

1. Type of aircraft (affects pressurization levels) FIN number?
2. Was that flight WiFi-enabled, if so, what was location of the WiFi access points? Often in the ceiling compartment above the passengers heads in certain rows.  
If this was not a WiFi flight, were all mobile devices in airplane mode? (if not, they still emit RF looking for a signal)
3. Phase of flight? cabin altitude? location at the aircraft? (With newly-installed Google transmission balloons at 60,000 ft. and an increasing number of fixed and non-fixed orbit satellites, the proximity of the aircraft to these should also be considered in the investigation.)
4. Who was affected? Their primary symptoms.  
Flight crew - position?  
Passengers seat numbers and were they using a WiFi-connected device?
5. Other possible causes to be checked - reports of toxic fumes?
6. Was the radar on?

(If more than one person was affected on this flight, please do a report for each person.)

Date of Report: \_\_\_\_\_ Date of Incident: \_\_\_\_\_

Airline and Flight # \_\_\_\_\_ Aircraft: \_\_\_\_\_

Passenger Information: Seat #: \_\_\_\_\_ Gender: \_\_\_\_\_ Age: \_\_\_\_\_

Blood Pressure at time of adverse event: \_\_\_\_\_

Rx Medications: \_\_\_\_\_

Pre-existing medical condition: \_\_\_\_\_

Medical implants - pacemaker: \_\_\_\_\_

Symptoms: \_\_\_\_\_

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Alcohol consumption: \_\_\_\_\_

Treatment/intervention onboard: \_\_\_\_\_

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Weather, approximate altitude, phase of flight:

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Cabin air quality – toxic fumes, smoke, electrical problems, other - sprays etc.:

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WiFi-enabled aircraft?; Cabin WiFi system on, or off, at time of incident:

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Was this passenger (and/or abutting passengers - front/back/sides) using a mobile device at the time, if so, what device, and in what mode:

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Pilot/co-pilot response – emergency/precautionary landing, reduce altitude:

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Other comments re this incident and/or flight crew members experiencing 'unexplained' symptoms inflight:

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Optional: Submitted by – your flight crew position (can add name or initials)

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Optional: Long-term health and wellbeing of the flight crew: There are reports of an increase in insomnia, depression, tinnitus, brain and other cancers, as well as cardiac and neurological conditions. Comment here if you have personal knowledge of flight crew dealing with these medical issues. No names, please. Privacy must be respected.

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## **APPENDIX E. Partial List of References**

### **Summarizing the Science – by researcher Henry Lai, PhD**

Reporting biological effects of radio frequency radiation (RFR) at low intensities

Kolodynski and Kolodynska (1996)- school children who lived in front of a radio station had less developed memory and attention, their reaction time was slower, and their neuromuscular apparatus endurance was decreased.

Mann et al. (1998)- a transient increase in blood cortisol was observed in human subjects exposed to cellular phone RFR at 0.02 mW/cm<sup>2</sup>. Cortisol is a hormone involved in stress reaction.

Persson et al. (1997)- reported an increase in the permeability of the blood-brain barrier in mice exposed to RFR at 0.0004 - 0.008 W/kg. The blood-brain barrier envelops the brain and protects it from toxic substances.

Santini et al. (2002)- increase in complaint frequencies for tiredness, headache, sleep disturbance, discomfort, irritability, depression, loss of memory, dizziness, libido decrease, in people who lived within 300 m of mobile phone base stations.

Tattersall et al. (2001)- low-intensity RFR (0.0016 - 0.0044 W/kg) can modulate the function of a part of the brain called the hippocampus, in the absence of gross thermal effects. The changes in excitability may be consistent with reported behavioral effects of RFR, since the hippocampus is involved in learning and memory.

### **Studies cited by neuroscientist Sarah Starkey, PhD**

Lai, H., 2007, Evidence for effects on neurology and behaviour, Bio-Initiative Report, [www.bioinitiative.org](http://www.bioinitiative.org) (accessed August '08).

Landgrebe M., Hauser S., Langguth B., Frick U., Hajak G. and Eichhammer P., 2007, Altered cortical excitability in subjectively electrosensitive patients: results of a pilot study, *J. Psychosom Res.*, 62(3), 283-288.

Lopez-Martin E., Relova-Quinteiro J. L., Gallego-Gomez R., Peleteiro-Fernandez M., Jorge-Barreiro F. J. and Ares-Pena F. J., 2006, GSM radiation triggers seizures and increases cerebral c-fos positivity in rats pretreated with subconvulsive doses of picrotoxin, *Neuroscience Letters* 398, 139-144.

Maachi M. M., and Bruce J. N., 2004, Human pineal physiology and functional significance of melatonin, *Frontiers in Neuroendocrinology* 25, 177-195.

Maby E., Le Bouquin R. and Faucon G., 2006, Short-term effects of GSM mobile phones

on spectral components of the human electroencephalogram, Proceedings of the 28th IEEE EMBS Annual International Conference 1, 3751-3754.

Maier R., Greter S.-E. and Maier N., 2004, Effects of pulsed electromagnetic fields on cognitive processes - a pilot study on pulsed field interference with cognitive regeneration, *Acta Neurol Scand* 110, 46-52.

Nittby H., Grafstram G., Tian D. P., Malmgren L., Brun A., Persson B. R., Salford L. G., Eberhardt J., 2008, Cognitive impairment in rats after long-term exposure to GSM-900 mobile phone radiation, *Bioelectromagnetics* 29(3), 219-232.

Vecchio F., Babiloni C., Ferreri F., Curcio G., Fini R., Del Percio C. and Rossini P. M., 2007, Mobile phone emission modulates interhemispheric functional coupling of EEG alpha rhythms, *European Journal of Neuroscience* 25, 1908-1913.

Wiart J., Hadjem A., Wong M. F., Bloch I., 2008, Analysis of RF exposure in the head tissues of children and adults, *Phys Med Biol* 53(13), 3681-3695.

WHO (World Health Organisation), 2006, Electromagnetic Hypersensitivity, Proceedings of the International Workshop on EMF Hypersensitivity, Prague, 2004, [https://www.who.int/peh-emf/publications/reports/HS\\_Proceedings\\_June2006.pdf](https://www.who.int/peh-emf/publications/reports/HS_Proceedings_June2006.pdf)

Lai, H. and Singh, NP., 1995: "Acute low-intensity microwave exposure increases DNA single-strand breaks in rat brain cells". *Bioelectromagnetics* 16: 207-210.

Lai, H. and Singh, NP., 1996: "Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation". *Int.J. Radiation Biology* 69 (4): 513-521.

Phillips JL, Campell-Beachler M, Ishida-Jones T, Haggren W, Adey electric and magnetic fields with humans. *Health Phys* 53:583 – WR (1995)

Ching S, Zhang H, Belevych N, He L, Lai W, Pu X A, Jaeger L B, Chen Q, Quan N. Endothelial-specific knockdown of interleukin-1 (IL-1) type 1 receptor differentially alters CNS responses to IL-1 depending on its route of administration. *J Neurosci*. 2007;27:10476–10486.

Leif G salford, *Environ Health Perspect*, v. 111(7): June 2003

Rier SE, Martin DC, Bowman RE, Dmowski WP, Becker JL 1993 Endometriosis in rhesus monkeys (*Macaca mulatta*) following chronic exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin. *Fundam Appl Toxicol* 21:433–441.

Cherry, N.J., 2001: "Schumann Resonances, a plausible biophysical mechanism for the human health effects of Solar/Geomagnetic Activity". *Journal of Natural Hazard*.

Hurtado DE, Molina-Porcel L, Carroll JC, Macdonald C, Aboagye AK, Trojanowski JQ, Lee VM: Selectively silencing GSK-3 isoforms reduces plaques and tangles in mouse models of Alzheimer's disease. *J Neurosci* 2012, 32:7392-7402.  
Disturbance of the Immune System by EM (Electromagnetic) Fields (Dr. Olle Johansson, 2009) *Pathophysiology*, Received 23 August 2008; accepted 30 January 2009

Karasek R. A Tool for Creating Healthier Workplaces: The Conductivity Process. *Bull Sci Technol Soc* 2004;24:471-9

Salford L. G., Brun A. E., Eberhardt J. L., Malmgren L. and Persson B. R. R., 2003, Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones, *Environ Health Perspect* 111, 881-883.

Persson B. R. R., Salford L. G. and Brun A., 1997, Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication, *Wireless Networks* 3, 455-461.

Becker, R., 2000: Author of *The Body Electric* (William Morrow & Co., 1987) v1

Goldfried, M. R., & Davison, G. C. *Clinical behavior therapy*. New York: Holt, Rinehart, and Winston, 1976.

Park-Min KH, Ji JD, Antoniv T, Reid AC, Silver RB, Humphrey MB, Nakamura M, Ivashkiv LB. IL-10 suppresses calcium-mediated costimulation of receptor activator NF-kappa B signaling during human osteoclast differentiation by inhibiting TREM-2 expression. *J Immunol.* 2009 Aug 15; 183(4):2444-55.

Litovitz TA, Montrose CJ, Doinov P, Brown KM, Barber M (1994a) Superimposing spatially coherent electromagnetic noise inhibits field- induced abnormalities in developing chick embryos. *Bioelectromagnetics* 15: 105-113.

Veldhoen M., Hocking R. J., Atkins C. J., Locksley R. M., Stockinger B. (2006). TGF- $\beta$  in the context of an inflammatory cytokine milieu supports de novo differentiation of IL-17-producing T cells. *Immunity* 24, 179–89.

Cherry N. (1996). "Swiss shortwave transmitter study sounds warning." *Electromagnetics Forum* , Volume1, No.2 Article 10. *Microwave News*. Sept/Oct. page 14.

There are hundreds more published, peer-reviewed studies available in the BioInitiative Report and the Seletun Scientific Statement.

## **Biological Effects – Evidence of Damage**

### **Functioning of Our Cells**

As the research of Columbia University's Dr. Martin Blank demonstrates, electro-magnetic fields can affect our cells even when present at very low intensities – low enough that our senses can't detect them, let alone feel any heat. (Could this be the crux of the problem?)

Along with Dr. Reba Goodman, Dr. Blank has been studying these biological effects on the stress response in cells. He explains for us how the cells interpret this stimulus.

The cells react as if this energy is harmful! They make stress proteins only when they sense they're in a bad situation, such as when they are exposed to heat, toxins or the wrong pH. The research is showing that when exposed to low frequency they're responding in this way, even without thermal stressors. When the cell starts making stress proteins, it's trying to tell you something!

There are other troubling signs of reactivity. In 2011 Drs. Blank and Goodman published a new paper on DNA in the International Journal of Radiation Biology 87(4): 409-15, 2011. This review of the responses of DNA to electro-magnetic fields, in different frequency ranges, shows that the DNA in cells can react as a fractal antenna, able to pick up many frequencies. This property of DNA is probably due to its structure. This DNA damage could account for increases in cancer.

### **Our Immune and Other Systems**

Another scientist, Dr. Ted Litovitz, who was Emeritus Professor of Physics and Bioelectro-magnetics, Catholic University of America, Washington, DC, found that when a cell is subjected to too much stress, this fundamental protective response itself becomes stressed and stops making proteins. (Litovitz 2002) In other words, the cell becomes less able to protect itself and this impairs our immune system strength and affects every system in the body.

### **Our Cells' Ability to Communicate**

The pioneer in the field of environmental health, Dr. Neil Cherry of New Zealand, described this mechanism in detail. Sadly, this highly respected scientist died in 2003 after suffering from Motor Neuron disease (ALS). Professor Cherry wrote: Nature has developed many advanced and complex biological processes in, and between, cells for cell-to-cell communication, intra-cellular communication and regulation, and brain and CNS systems. Dr. Ross Adey's description of cells 'whispering to each other' in this cell-to-cell caring society, checking on the health of their neighbours and suggesting subtle changes to keep them healthy are part of biological homeostasis.

Our brains and cells primarily use calcium ions for these processes and Dr. Adey's laboratory, followed by Dr. Carl Blackman's monumental work, confirms that the natural and vital processes for cellular health are interfered with at the cell membrane level, by the oscillating signals from mobile phone base stations.

These waves of radiation confuse and damage the cell's signal system while the strong emissions of a mobile or wearable almost drown out the signals. This can alter the EEG and hormones, damaging the cells and producing acute symptoms such as headache, concentration problems, memory loss, dizziness and nausea, as well as brain tumors, Alzheimer's Disease and depression.

The cardiologist Dr. Stephen Sinatra told me about this hypothesis: Receptor sites on the cell membrane do not recognize the chaotic electrical disturbances from mobile phones and other wireless exposures, and interpret this as a foreign invader, sending the cell membranes into a protective 'lock down' mode.

## **Our DNA**

Free radicals interfere with DNA repair and alter future DNA. Damaged DNA is passed along to the next generation of cells. This is worrying, because, as Adey explains, the cells can no longer 'whisper' with each other, they can no longer call in the immune system to remove dead cells and damaged DNA.

The researchers Drs. Henry Lai and Narendra Singh have been studying DNA for many years, and their results are strong evidence. Even with brief exposures, at very low levels of EMR, there are signs of significant damage to DNA, and they report this can lead to changes in cellular functions and cell death. (This study, with J.L. Philips, was published in *Pathophysiology* 16 (2009) 79–88.)

I asked Dr. Lai and Dr. Singh about security scanners and our DNA – yes, they are another new hazard. And that's just before you step onto the WiFi-enabled aircraft. Great for those who want to stay connected in the sky, great income source for the industry – however, not so great for all of you if your pilot becomes lightheaded from the microwave radiation exposure.

Consider some of the following research and see if you are still clamouring for a WiFi flight. Or still excited about your new wearable technology.

Think about it, you are have this radiation-emitting device close to your head, close to your body when experts tell us what we need between us and such devices is distance. For example, using the speaker phone on your mobile phone is much less risky than holding it against your head and your vulnerable brain.

## **Our Blood-Brain Barrier**

This complex mechanism is a vital filtering system in the blood vessels in the brain. It's important that the cells of the blood-brain barrier keep toxins out and cerebrospinal fluids in, so that the environment of the brain is kept clean and the brain itself is cushioned against any contact with the skull.

Research by Leif Salford, MD, the neurology professor at Lund University, shows that wireless radiation is capable of causing leakage of the blood-brain barrier. (Persson and Salford 1996; Salford et al. 1992, 1993, 1994, 1997b, 2001)

Dr. Salford's research team reported rat brain cross-sections showed first ever evidence of brain damage from cell phone radiation. While the controls appeared healthy, the test subjects – exposed to a 2-hour dose of cell phone radiation of varying intensities over a period of seven days – were heavily spotted with proteins leaked from the surrounding blood vessels, and show signs of significant neuronal (brain) damage.

Maybe you're thinking that what applies to rat brains doesn't necessarily apply to humans?

Professor Salford pointed out that the blood-brain barrier is anatomically the same in both species and cautioned: "With a long series of significant effects demonstrated in the animal models, it is my sincere belief that it is more probable than unlikely that non-thermal electro-magnetic fields from mobile phones do have effects upon the human brain."

### **Our Cognitive Abilities**

A study by researchers in Israel confirmed human subjects exposed to wireless radiation had impaired cognitive functions, including slower response times to a spatial working memory task (Luria, Eliyahu, Hareuveny, Margalit, Meiran). Professor Wilhelm Mosgoeller, PhD, University of Vienna, studies this issue and reports: "During our investigations of healthy human subjects and RF exposure, certain brain waves changed. We noted faster response times during exposure which seem to occur at the expense of the quality of the response. Wrong responses were given within shorter time periods."

### **Evidence of Cognitive Impairment** Excerpts from Dr. Dunkley's article in *Psychology Today*:

Multiple studies have shown atrophy (shrinkage or loss of tissue volume) in gray matter areas (where “processing” occurs) in internet/gaming addiction ([Zhou 2011 \(link is external\)](#), [Yuan 2011 \(link is external\)](#), [Weng 2013 \(link is external\)](#), and [Weng 2012 \(link is external\)](#)). Areas affected included the important frontal lobe, which governs executive functions, such as planning, planning, prioritizing, organizing, and [impulse control](#) (“getting stuff done”). Volume loss was also seen in the striatum, which is involved in reward pathways and the suppression of socially unacceptable impulses. A finding of particular concern was damage to an area known as the *insula*, which is involved in our capacity to develop empathy and compassion for others and our ability to integrate physical signals with emotion. Aside from the obvious link to violent behavior, these skills dictate the depth and quality of personal relationships.

**Compromised white matter integrity:** Research has also demonstrated loss of integrity to the brain’s white matter ([Lin 2012 \(link is external\)](#), [Yuan 2011 \(link is external\)](#), [Hong 2013 \(link is external\)](#) and [Weng 2013 \(link is external\)](#)). “Spotty” white matter translates into loss of communication within the brain, including connections to and from various lobes of the same hemisphere, links between the right and left hemispheres, and paths between higher (cognitive) and lower (emotional and survival) brain centers. White matter also connects networks from the brain to the body and vice versa. Interrupted connections may slow down signals, “short-circuit” them, or cause them to be erratic (“misfire”).

## Appendix F: RESPONSE FROM FAA



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

800 Independence Avenue, S.W.  
Washington, DC 20591

JAN 29 2016

Dr. Kerry Crofton  
[Kerry108@telus.net](mailto:Kerry108@telus.net)

Dear Dr. Crofton:

Thank you for your December 20<sup>th</sup> email regarding display unit interference and pilot health issues. In response to your question on the impact of balloon-borne transmitters on aircraft and their avionics and navigation systems, the FAA requires civil aircraft electrical and electronic systems must be protected against effects of radio frequency (RF) transmitters. The aircraft electrical and electronic systems must be protected against RF field strengths ranging from 50 to 300 volts per meter average and 50 to 3000 volts per meter peak. The FAA regulations specify RF field strengths up to 40 GHz, and the features incorporated into aircraft electrical and electronic systems and installations for protection up to 40 GHz are also effective for frequencies in the range of 73 to 84 GHz. With aircraft operations below 51,000 feet, the RF field strengths from the Google balloon transmitters around 62,000 feet are on the order of one volt per meter or less, so we expect no RF safety effects on civil aircraft electrical and electronic systems.

You also asked the specific impact of balloon-borne transmitters on Boeing 737 and 777 Honeywell display units. The actual susceptibility for these display units is significantly higher than one volt per meter, not taking advantage of the RF attenuation provided by the airplane structure. Therefore, we expect no RF safety effects on Boeing 737 and 777 Honeywell display units.

Human hazards associated with RF transmitters are under the authority of the Federal Communications Commission (FCC) in Title 47 Code of Federal Regulations part 2.

Sincerely,

*Susan J. M. Cabler*

Susan J. M. Cabler  
Acting Manager, Design, Manufacturing, &  
Airworthiness Division  
Aircraft Certification Service

We showed this letter to a satellite engineer working at GOOGLE who (anonymously) disagreed with the FAA, "A balloon is far stronger radiation density maker at the altitude of 51000 feet than a satellite...tens times stronger... to be accurate."

As Captain Anderson commented at the beginning of this document,

"My communication with FAA personnel has resulted in a response from Kyle Copeland, Ph.D., Research Health Physicist, Radiobiology PI FAA, CAMI, AAM-630, Numerical Sciences Research Team who says 'I can say with certainty there is no ongoing research here at CAMI that deals with biological effects of nonionizing radiation (that is WiFi and the radiation emitted by wirelessly-connected mobile devices).'"

## **IN SUMMARY - Eight Key Points**

1. Our intention with this document is not to establish a case that inflight WiFi is the primary, or contributing, cause in 'unexplained' incidents; it is to raise the alert with several red flags.
2. Aviation experts with a range of expertise are calling for testing to be done to determine the facts and seeking an answer to this vital question: WiFi in the sky – is it safe?
3. Please show us the pre-implementation testing reports on inflight WiFi and pilot health and performance. Where these conducted?
4. And explain why regulators continue to support thermal-only safety standards that are irrelevant to WiFi and mobile phone radiation when their non-thermal levels have been shown to cause a series of adverse effects.
5. Advise us who is monitoring this new technology for potential adverse effects on flight crew and passengers - in the cockpit and the cabin.
6. One government agency and aviation regulator after another have passed us along to a different department without answering our questions, or showing us any evidence of safety.
7. Where is the aviation standard of 'abundance of caution'?
8. In the interim, we suggest a **Pilot Advisory - Lightheaded inflight? Disable the WiFi to minimize symptoms during this medical emergency.**