
For Information

DATE: October 15, 2019

REPORT TITLE: **REVIEW OF POTENTIAL HEALTH EFFECTS OF EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS FROM 5G WIRELESS TECHNOLOGY**

FROM: Cathy Granger, Acting Commissioner of Health Services
Jessica Hopkins, MD MHSc CCFP FRCPC, Medical Officer of Health

OBJECTIVE

To inform Regional Council on the findings of Public Health's research review on radiofrequency electromagnetic field (RF-EMF) exposure from 5G wireless technology and the potential impacts on human health.

REPORT HIGHLIGHTS

- 5G refers to the next iteration (fifth generation) of wireless cellular technologies.
- Safety Code 6, administered by Health Canada, encompasses the evidence-based safety limits for human exposure to RF-EMFs in the range of 3 kHz to 300 GHz, which includes the operating frequency range of 5G and other wireless communication technologies.
- Current evidence does not identify any health impacts associated with exposures to 5G wireless technology that fall within Health Canada's Safety Code 6 requirements.
- As 5G is a new technology, specific research on its human health impacts is ongoing. However, extensive research on similar exposures around RF-EMF has not demonstrated any human health impacts associated with technology operating within Health Canada's Safety Code 6 requirements.
- Reputable health agencies worldwide have concluded that, based on available evidence, there is no scientific evidence to indicate that RF-EMFs cause negative health outcomes.
- Public Health will continue to monitor and review new evidence on potential health impacts associated with exposure to 5G wireless technology and RF-EMF.

1. Background
a) Radiofrequency electromagnetic fields

Radiofrequency electromagnetic fields (RF-EMFs), also known as radiofrequency (RF) energy, are part of the electromagnetic field (EMF) spectrum. RF-EMFs range in frequency from 3 kilohertz (kHz) to 300 gigahertz (GHz) and are emitted by various devices including navigational radar, radios, baby monitors, microwaves and wireless communication technologies such as cell phones, cordless phones, and Wi-Fi (see Appendix I for a graph of the EMF spectrum). RF-EMFs are lower in energy than ionizing EMFs, such as x-rays and gamma rays, and cannot break bonds between atoms and

molecules. In contrast, ionizing EMFs are high in energy and can break the bonds between atoms and molecules, which can damage DNA and cells.

b) 5G wireless technology

5G refers to the next iteration (fifth generation) of wireless cellular technologies that will use RF energy to transmit data. 5G is being deployed to provide people with access to greater bandwidth, higher data speeds, improved network responsiveness, and to allow for many more electronic devices to be connected to the network. 5G will initially operate in conjunction with existing 4G networks before evolving to fully stand-alone networks in subsequent releases and coverage expansions. 5G technologies will operate within the RF-EMF range, both within the low-mid band (below 6 GHz) part of the spectrum that existing cellular technologies rely on, and at a higher frequency range called the millimetre wave spectrum (30 to 300 GHz).

Millimetre waves are easily blocked by obstacles such as walls and buildings and do not travel as far as the frequencies currently used for mobile communication. To overcome this, 5G networks will need a much greater density of small cells to help improve signal coverage and to add capacity. These are physically smaller radio installations and antennas placed on structures such as streetlights, the sides of buildings, and poles that complement larger radio installations (also known as cell towers or macro cells) in improving capacity and signal coverage, particularly in highly populated urban areas with high network demand.

5G technology is not yet available to the general public in Canada but is commercially available to consumers in certain areas within Switzerland, the United States of America, South Korea and China. It is expected to launch in Canada as early as 2020.

c) Concerns with RF-EMF Exposure and Human Health

A delegation to Regional Council on June 27, 2019, raised questions about the safety of 5G wireless technology and possible health impacts. The delegate expressed concern with how 5G will operate in the higher frequency millimetre wave part of the RF-EMF spectrum, and the possible close location of small cell antennae to homes, and facilities such as daycares. These concerns mirror similar questions raised in other settings internationally.

d) The federal government's role in regulating RF-EMF

Health Canada's guideline document, titled Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz, commonly referred to as Safety Code 6 ('Safety Code') sets the exposure limits to RF-EMF to protect human health. The Safety Code outlines the evidence-based safety limits for human exposure to RF-EMFs including the portions of the RF spectrum in which 5G technologies will operate. The limits incorporate at least a 50-fold safety margin to provide a significant level of protection for the public as well as those working near RF-EMF sources. Innovation, Science and Economic Development Canada has adopted the Safety Code to protect the public against overexposure to RF-EMFs from wireless devices and antenna installations. The Safety Code is reviewed on a regular basis, most recently in 2015, to ensure that it provides protection against all known

potentially harmful health effects. The Safety Code is consistent with science-based limits used in other parts of the world including the United States, European Union, Japan and Australia.

e) Findings of past research on RF-EMF exposure from Wi-Fi in schools

In 2013, at the request of the two English school boards, Peel Public Health reviewed the research evidence on the health effects of exposure to Wi-Fi. The review found that the scientific evidence indicated that exposure to Wi-Fi was not harmful to humans. At that time, Public Health committed to monitoring and reviewing the evidence associated with exposure to Wi-Fi. In 2015, Public Health staff reviewed the Royal Society of Canada Expert Panel report, titled “A Review of Safety Code 6 (2013): Health Canada’s Safety Limits for Exposure to Radiofrequency Fields”. The Expert Panel found that the balance of evidence, at that time, did not indicate negative health effects from exposure to RF energy below the recommendations in the Safety Code. The Panel did note that research on many of the health effects was ongoing and that it was possible that the finding of future studies may alter this balance of evidence.

2. Findings

Public Health staff conducted a review of the research evidence on potential health effects associated with exposure to 5G wireless technology; completed an environmental scan to determine the publicly stated, evidence-based positions held by authoritative health related organizations on 5G exposure and health effects; and contacted Public Health Ontario and Health Canada to determine if either of those agencies were conducting a research review on 5G.

a) Evidence Review

A review of the literature was conducted using peer-reviewed articles on the health effects of exposure to 5G wireless technologies published from 2014 to July 2019. The literature search was built on the previous research review conducted in 2013 by Public Health staff on the health effects from Wi-Fi. Studies included in the literature review were guidelines, expert panel reports, literature reviews and human epidemiological studies.

Current evidence does not identify any health impacts associated with exposures to 5G wireless technology that fall within Health Canada Safety Code 6 requirements. 5G is a relatively new technology and no human epidemiological studies have been conducted. As a result, the research review was then focused on the health effects of exposure to millimetre waves (as 5G will operate partly in the millimetre wave range, a part of the RF-EMF spectrum currently unused for wireless communication). The best available research did not find negative impacts on human health at levels below exposure limits (i.e., Safety Code 6 or the International Commission of Non-Ionizing Radiation Protection guidelines). The research came from two expert panel reviews on RF-EMFs. The first by the Scientific Committee on Emerging and Newly Identified Health Risks (2015) from Europe, and the second from the Royal Society of Canada expert panel (2013).

b) Health Agency Reviews on RF-EMF and Potential Health Effects

Several authoritative health agencies worldwide have reviewed the evidence on the potential effects of RF-EMF on human health. Health agencies such as the International Commission on Non-Ionizing Radiation Protection and the Australian Radiation Protection and Nuclear Safety Agency have indicated that there is no established scientific evidence for an association between adverse health effects and exposure to RF-EMFs below allowable exposure limits. The World Health Organization (WHO), Public Health England and the U.S. Food and Drug Administration (FDA) have indicated that, to date, no adverse health effects have been established as being caused by RF-EMF exposure from mobile phone use or mobile phone base stations.

In 2011, the International Agency for Research on Cancer (IARC), a World Health Organization agency, categorized RF-EMF as possibly carcinogenic (Group 2B). IARC classifies carcinogenicity into categories: Group 1 for definite human carcinogens; Group 2A for probable human carcinogens; Group 2B for possible human carcinogens; and Group 3 for agents not classifiable as to its human carcinogenicity. The Group 2B category is used when a cause and effect relationship is considered credible, but where the possibility that chance, bias, or confounding factors that could explain the association cannot be eliminated with reasonable certainty. Other substances classified in Group 2B include: extremely low frequency electromagnetic fields (power line frequency), ginkgo biloba extract and talc-based body powder.

IARC classified RF-EMF in Group 2B based on limited evidence for an association between wireless phones and glioma and acoustic neuroma (two types of brain tumour). However, the evidence was mixed, and the results may not represent a true relationship because of methodological limitations such as the inability to accurately assess level of exposure to RF-EMF. Of note, RF-EMF exposure is dependent on the generation of mobile technology, and studies considered in IARC's assessment would have been based on exposures to older mobile phone technology. Newer generations of mobile phone technology emit lower RF power than those of previous generations, and therefore would result in lower RF-EMF exposure levels from mobile phones.

c) Consultations with Federal and Provincial Agencies

Public Health consulted with Health Canada in June 2019 on the current state of research and to determine their plans to review the Safety Code. Health Canada indicated that they are not planning to review the Safety Code at this time. The Safety Code was last revised in 2015 and currently includes the frequencies used for 5G technology. They also stated that they are reviewing new research evidence in this area.

In 2010, Public Health Ontario conducted a review of the research evidence on wireless (Wi-Fi) technology and health outcomes. The review found that there was no plausible evidence that would indicate that public exposures to Wi-Fi were causing adverse effects on health. Staff contacted Public Health Ontario in May 2019, and again in August 2019, to inquire about their plans to update this research review. Public Health Ontario advised staff that they were in the process of completing a research review on RF-EMFs and 5G and expect it to be finalized in the fall of 2019.

3. Next Steps

As wireless communication technologies evolve, the body of research evidence on the impact of new technologies on human health will grow. Updated research reviews and guidelines on RF-EMF exposure from Public Health Ontario, World Health Organization and the International Commission on Non-Ionizing Radiation Protection are in progress. Staff will monitor and review new research evidence on health effects and issue new guidance if appropriate.

CONCLUSION

Current evidence does not identify any health impacts associated with 5G wireless emissions that fall within Health Canada Safety Code 6 requirements. There is good quality research available on exposure to RF-EMFs, including the higher frequency millimetre waves that 5G will use. The best available research found no negative impact on human health at levels below exposure limits (i.e. Safety Code 6 or the International Commission of Non-Ionizing Radiation Protection guidelines). The review findings are consistent with various other health-related organizations such as Health Canada. Staff will continue to monitor and review new evidence related to 5G wireless technology.



Cathy Granger, Acting Commissioner of Health Services



Jessica Hopkins, MD MSc CCFP FRCPC, Medical Officer of Health

Approved for Submission:



N. Polsinelli, Interim Chief Administrative Officer

APPENDICES

Appendix I – Examples of Energy Sources on the Electromagnetic Spectrum

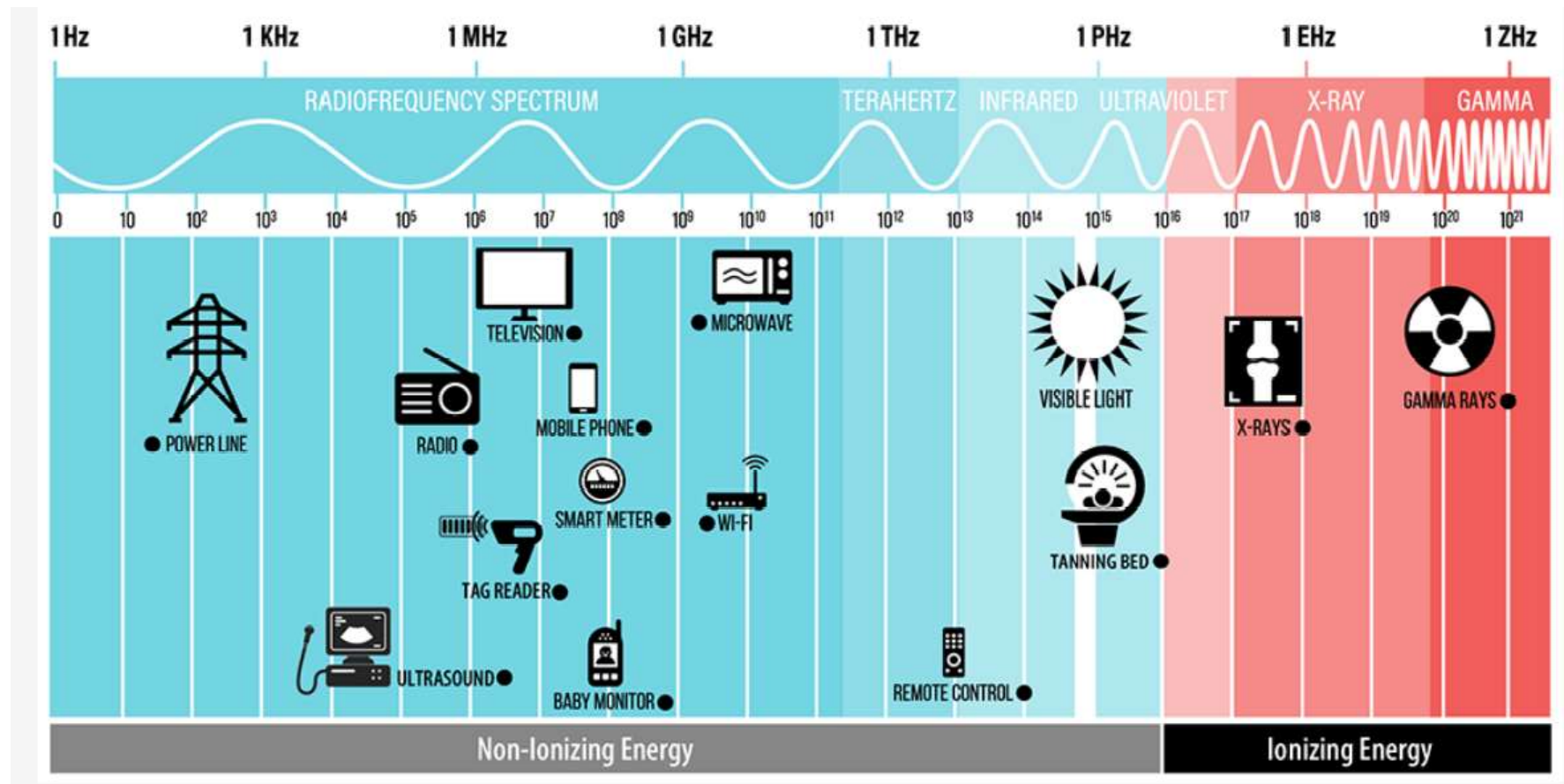
For further information regarding this report, please contact Louise Aubin, Acting Director, Health Protection, extension 2479, louise.aubin@peelregion.ca.

Authored By: Michelle Ng, Analyst Research and Policy extension 2472

APPENDIX I

REVIEW OF POTENTIAL HEALTH EFFECTS OF EXPOSURE TO RADIOFREQUENCY ELECTROMAGNETIC FIELDS FROM 5G WIRELESS TECHNOLOGY

EXAMPLES OF ENERGY SOURCES ON THE ELECTROMAGNETIC SPECTRUM



Source: Industry Canada. Radiofrequency energy and safety. [updated 2019 Feb. 14]. Available from: <https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11467.html#s8>

7.1-7



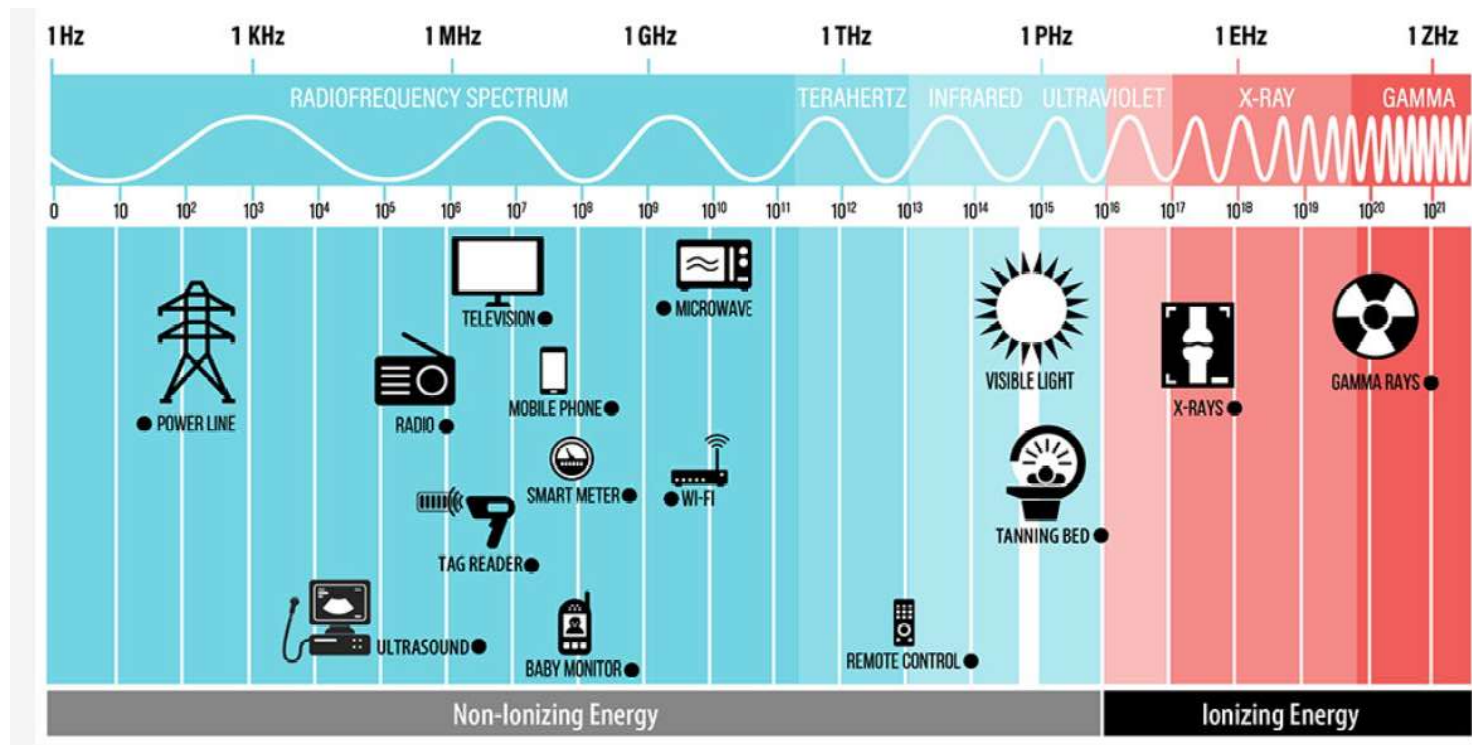
Review of potential health effects of exposure to radiofrequency electromagnetic fields from 5G wireless technology

October 24, 2019
Regional Council

Jessica Hopkins, MD MHSc CCFP FRCPC
Medical Officer of Health, Region of Peel

7.1-8

Radiofrequency Electromagnetic Fields (RF-EMF)



Source: Industry Canada. Radiofrequency energy and safety. [updated 2019 Feb, 14]. Available from: <https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11467.html#s8>

7.1-9

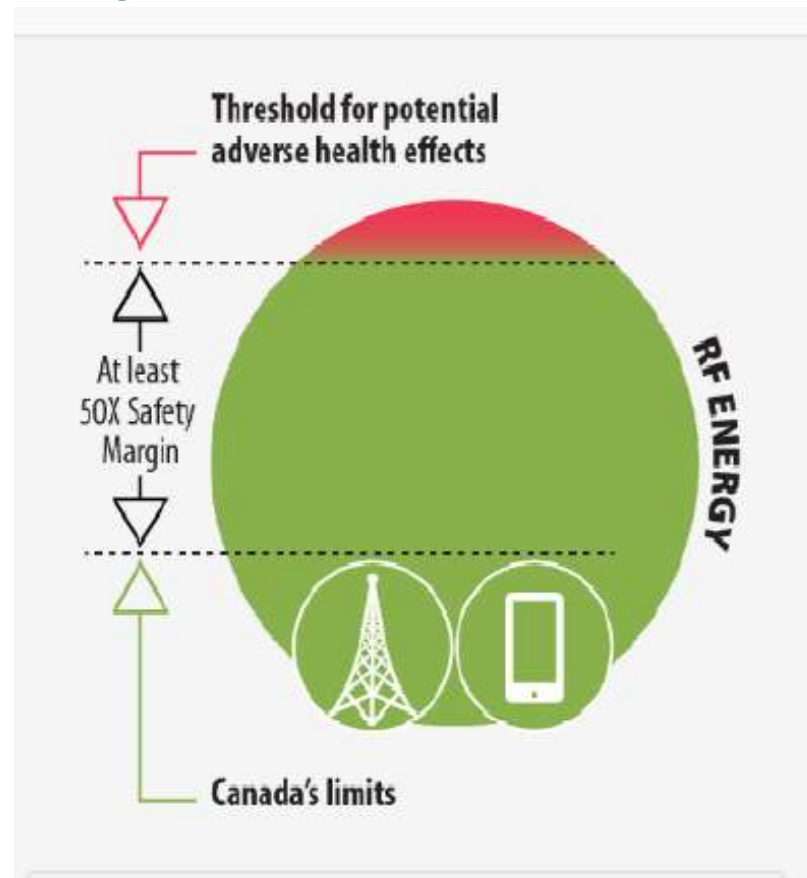
5G Wireless Technology

- The fifth generation of wireless cellular technologies that will operate:
 - within the current RF-EMF range for wireless technology (below 6 GHz), and
 - at a higher frequency range called the millimetre wave spectrum (30 to 300 GHz)
- Requires a dense network of small cells
- Expected to launch in Canada as early as 2020

7.1-10

Health Canada's Safety Code 6

- Science-based
- Consistent with other countries



Source: Industry Canada. Radiofrequency energy and safety. [updated 2019 Feb. 14]. Available from: <https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11467.html#s8>

7.1-11

Research Review: Potential Health Impacts of 5G

- Reviewed peer-reviewed literature and health and scientific agency reports published since 2014
- No 5G specific research was identified

7.1-12

Review of Potential Health Impacts of Millimetre Waves

- Expanded the review to identify relevant studies on the health effects of exposure to millimetre waves
- Two higher-quality reports found:
 - 2015 SCENIHR Opinion
 - 2014 Royal Society of Canada Expert Panel report

7.1-13

Key Findings

- Current evidence does not identify health impacts associated with exposure to 5G wireless technology that complies with Safety Code 6.
- Although 5G is new, extensive research has been conducted on similar exposures around RF-EMF, which found no human health impacts of technology that meet Safety Code 6.

7.1-14

Health-Related Organizations: Evidence-Based Positions

- Several health agencies (e.g., World Health Organization) have reviewed the evidence on the effects of RF-EMF on human health.
- **General consensus:**
Currently no convincing scientific evidence that RF-EMF below the allowable exposure limits causes negative health outcomes.

7.1-15

Next Steps

- Updated research reviews and guidelines are in progress from:
 - Public Health Ontario,
 - the World Health Organization, and
 - the International Commission on Non-Ionizing Radiation Protection
- Peel Public Health will continue to monitor and review new evidence on health impacts associated with exposure to 5G and RF-EMF.

7.1-16



Questions?

