SCMagLev - Electromagnetic Fields and Our Health

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The Baltimore-Washington Rapid Rail (BWRR) (the project developer) and the Northeast MagLev (TNEM) (the promotional entity) have the short-term goal of obtaining Federal Railroad Administration (FRA) approval to build a magnetic levitation (maglev) train between Baltimore and Washington, DC, with the long-term goal of extending the train operation to New York City by way of Philadelphia. Japan's Superconducting Magnetic Levitation (SCMagLev) train is the high-speed, ground-based transportation system TNEM is promoting to build in the northeast corridor of the United States.

Information about the SCMagLev and BWRR's plans to build and operate the system have raised many questions and concerns. This is one of a series of articles that identifies and discusses some the many questions and concerns citizens and communities have identified with moving forward in building and operating the SCMagLev.

Article Summary

Electromagnetic fields (EMFs) surround us. Some EMFs occur naturally and some are man-made. In this article, we provide an overview of EMFs and the increasing medical concerns of man-made EMF effects on human health. While the medical and scientific communities take the general position that the evidence is inconclusive, the effects of increased exposure to man-made EMFs on human health is a growing concern. Current research is finding connections between EMF exposure and disease. A growing body of recent studies have found that long-term exposure to man-made EMFs negatively affects human health. Considering the increasing level of electromagnetic energy to which people are exposed, concerns about the additional exposure to the high-level of electromagnetic energy generated by the SCMagLev system needed to lift and propel the train and its potential to impact our health are arising.

Introduction

Over the last century, there has been increasing exposure to higher levels of man-made sources of EMFs. Recent technological developments have made the electromagnetic environment more prominent in our lives. Present both in occupational environments and daily life, these EMF-generating technologies include, but are not limited to, industry equipment (e.g., welding machines, induction heaters), telecommunications (e.g., television, radio broadcast stations), medical diagnostic tests, and in daily life (e.g., microwaves, mobile phones and 5G, mobile phone base stations, Wi-Fi).

The adverse health effects of exposure to EMFs are a growing source of great concern within governmental and non-governmental organizations responsible for public health. Ongoing studies include an explanation of non-thermal effects of radiofrequency electromagnetic fields (RF EMFs) on human health.

Questions & Concerns

(1) What are electromagnetic radiation and electromagnetic fields?

- The U.S. Environmental Protection Agency (EPA) defines electromagnetic radiation (EMR) and EMFs:[1]

  - Electromagnetic Radiation (EMR) consists of waves of electric and magnetic energy moving together through space. An example of electromagnetic radiation is visible light. Electromagnetic radiation can range from low to high frequency, which is measured in hertz, and can range from low to high energy, which is measured in electron volts. Wavelength, another term associated with electromagnetic radiation, is the distance from the peak of one wave to the next.

  - There are two general kinds of electromagnetic radiation: ionizing radiation and non-ionizing radiation. Ionizing radiation is powerful enough to knock electrons out of their orbit around an atom. This process is called ionization and can be damaging to a body's cells. Non-ionizing radiation has enough energy to move atoms in a molecule around and cause them to vibrate, which makes the atom heat up, but not enough to remove the electrons from the atoms.

  - Electromagnetic fields (EMF) associated with electricity are a type of low frequency, non-ionizing radiation, and they can come from both natural and man-made sources. For example, lightning during a thunderstorm creates electromagnetic radiation because it creates a current between the sky and the ground. Surrounding that current is an electromagnetic field. One example is the Earth's magnetic field. We are always in the Earth's magnetic field, which is generated at the Earth's core. This magnetic field makes compasses work and is also used by pigeons and fish to navigate.

(2) What is the best way to assess the effects of EMFs on human health and why should we be concerned?

- Recent epidemiological studies provide evidence of the possible health effects of EMF exposure:

  - In 2020, research studies reported the association between maternal exposure to magnetic field non-ionizing radiation during pregnancy and the risk of Attention-Deficit/Hyperactivity Disorder (ADHD) in their offspring. The study was conducted at Kaiser Permanente Northern California with 1,482 mother-child pairs participating and EMF exposures captured during pregnancy in two studies conducted from October 1, 1996 to October 31, 1998, and from May 1, 2006 to February 29, 2012. The offspring were followed from May 1, 1997 to December 21, 2017. The main outcomes from the two studies showed physician-diagnosed ADHD and immune-related comorbidities (having multiple medical conditions) of asthma or atopic dermatitis up to 20 years of age in the offspring. These findings reveal probable new risk factors now prevalent in our modern-day life and should necessitate more scrutiny, possible restrictions, and at least more research on EMF.[2]

[1] U.S. Environmental Protection Agency. "Electromagnetic Radiation (EMR)" and "Electromagnetic Fields (EMF)." www.epa.gov/radtown/electric-and-magnetic-fields-power-lines.

[2] De-Kun L., H. Chen, J.R. Ferber, et al. "Association Between Maternal Exposure to Magnetic Field Nonionizing Radiation During Pregnancy and Risk of Attention-Deficit/Hyperactivity Disorder in Offspring in a Longitudinal Birth Cohort." *Journal of the American Medical Association*. March 24, 2020. https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2763232.

- Another study evaluated Electromagnetic Hypersensitivity Syndrome (EHS), characterized by a variety of nonspecific symptoms that can vary with individuals. The symptoms are real and vary in severity. EHS can be disabling for affected individuals. It is classified as a functional impairment in Sweden. Spain has recognized EHS as a permanent disability. (Note: The U.S. government has not recognized EHS as a disability as of this date of this article.) Below are the reported symptoms from individuals exposed to EMF:[3]

Abdominal pain	Headache	Numb limbs
Anxiety	Head pressure	Phosphenes
Appetite loss	Heart eat irregularity	Rash
Arousal decreased	Heart palpitation	Restlessness
Blood pressure increase	Hormonal disorder	Skin burning
Breathlessness	Hypersensitivity to medication	Skin redness
Chest pain	Hypersensitivity to noise	Skin tingling
Concentration difficulties	Intestinal trouble	Sleep disturbance
Crankiness	Irregular bowel movement	Stress
Daytime sleepiness	Irritation	Sweating
Digestive problems	Itching skin	Swollen eyes
Dizziness	Limb pain	Swollen joints
Dry skin	Metabolic disorder	Tachycardia
Exhaustion	Mood changes	Tenseness
Faintness	Mood depression	Tiredness
Fatigue	Muscle cramps	Toothache
Fear	Muscle pain	Trembling
Feebleness	Nausea	Unfeelingness
Feeling hot	Neck pain	Vision blurring
Forgetfulness	Neuralgia	Vomiting
Hair loss	Neurasthenia	Weariness

(3) What other medical studies have been reported to support the negative impact of EMFs on human health?

- Studies have been done worldwide on the effects of EMF exposure on human health. A key finding of these studies finds the closer the proximity to the source of the EMF, including a broadcast transmitter or a single phone base transmitter, the more symptoms were reported, including sleep disorders. Also, the type of EMF and its strength and duration can diminish or intensify with the variability of the RF EMFs. Some of these studies are described in the bullets below.

- As reported in 2019, the International Agency for Research on Cancer classified RF EMFs as possibly carcinogenic to humans (group 2B) in May 2011.[4]

- In 2015, the Scientific Committee on Emerging and Newly Identified Health Risks reported on the effects of EMF exposure in frequencies already used by mobile telephone companies. In this report, epidemiological studies were completed on RF EMF exposure. Researchers found an increased risk of

[3] Leitgeb, N. Chapter 5: Electromagnetic hypersensitivity. In: *Advances in Electromagnetic Fields in Living Systems: Volume 5, Health Effects of Cell Phone Radiation*, J.C. Lin, ed. New York, New York: Springer. 2009. gnusha.org/~nmz787/biological%20radio%20research/Electromagnetic%20Hypersensitivity.pdf.

[4] Moskowitz, J.M. Electromagnetic Radiation Safety: International Agency for Research on Cancer (WHO) Position on Radiofrequency Radiation. November 4, 2019. www.saferemr.com/2019/11/IARC-RFR-cancerrisk.html. Röösli, M. "Radiofrequency electromagnetic field exposure and non-specific symptoms of ill health: A systematic review," pp. 277-287 in *Environmental Research* 107. 2008. https://media.ellinikahoaxes.gr/uploads/2017/04/rsli2008.pdf.

glioma (tumor in the brain or spine) and acoustic neuroma (a benign tumor that develops on the balance (vestibular) and hearing, or auditory (cochlear), nerves leading from your inner ear to the brain), in heavy users of mobile phones.[5]

- A 2017 study by Yang, et al., indicated long-term (over ten years) use (exposure) of the mobile phone increases the risk of intracranial tumors, mostly gliomas, particularly in the case of the same-side exposure. This means if the user has the phone to the right ear predominantly (not necessarily all the time), then the glioma occurs on the right side of the brain.[6] Additional 2017 research studies regarding the risk of mobile phone use and health impacts include Bortkiewicz et al., Carlberg and Hardell, Momli et al., and Prasad et al. (*See the Sources section at the end of this article for the references*.)

- In 2019, an advisory committee of the International Agency for Research on Cancer (IARC) recommended the agency reassess the cancer risks involved with RF EMFs and recommended this research should be "high priority." [7] "The group, with 29 members from 18 countries, suggests that the new evaluation take place between 2022 and 2024. In May 2011, an IARC expert committee classified RF radiation as possible human carcinogen [Group 2B]. Since then, the evidence has grown stronger."[8]

(4) What other medical issues are concerned with EMF exposure and human health?

- Within the modalities of medical diagnostic testing, specifically magnetic resonance imaging (MRI), patients with cardiac pacemakers, as well as implantable cardioverter-defibrillators (ICDs), are cautioned before having an MRI. The electromagnetic field generated by the MRI can interfere with the functioning of these devices and can alter or stop the functioning of the apparatus while exposed to the electromagnetic field. The current information from the Mayo Clinic[9] and Johns Hopkins[10] states that even with the newer models of pacemakers, the MRI electromagnetic field strength should not exceed 1.5 Tesla, along with other considerations, including the type of pacemaker and manufacturer, what type of leads are being used, the duration of the scan, and the type of scan. Type of scans are functional MRI, breast MRI, magnetic resonance angiography, magnetic resonance venography, and cardiac MRI. These same criteria apply to patients with embedded ICDs. Exposure to the electromagnetic field during an MRI can heat up leads on the older models of pacemakers. If not carefully controlled, the MRI can interfere with the functioning of the embedded devices, including altering or stopping their functioning.

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[5] Scientific Committee on Emerging and Newly Identified Health Risks. "SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks), Potential health effects of exposure to electromagnetic fields (EMF)." January 27, 2015. Download available at: https://www.researchgate.net/publication/291329105_SCENIHR_Scientific_Committee_on_Emerging_and_Newly_Identified_Health_Risks_Potential_health_effects_of_exposure_to_electromagnetic_fields_EMF_27_January_2015.

[6] Yang, M., W. Guo, C. Yang, J. Tang, Q. Huang, S. Feng, A. Jiang, X. Xu, and G. Jiang. "Mobile phone use and glioma risk: A systematic review and meta-analysis." PLoS One 12, e0175136. May 4, 2017. pubmed.ncbi.nlm.nih.gov/28472042/.

[7] International Agency for Research on Cancer. In *IARC Monographs on the Identification of Carcinogenic Hazards to Humans*: Report of the Advisory Group to Recommend Priorities for the IARC Monographs during 2020-2024, pp. 148-149. https://monographs.iarc.who.int/wp-content/uploads/2019/10/IARCMonographs-AGReport-Priorities_2020-2024.pdf.

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[10] "Living with a Pacemaker or Implantable Cardioverter Defibrillator ICD." Johns Hopkins Medicine. www.hopkinsmedicine.org/health/wellness-and-prevention/living-with-a-pacemaker-or-implantable-cardioverter-defibrillator-icd#:~:text=Living%20with%20a%20Pacemaker%20or%20Implantable%20Cardioverter%20Defibrillator%20ICD,-Facebook%20Twitter%20Linkedin&text=Pacemakers%20and%20ICDs%20generally%20last,normal%20life%20with%20an%20ICD.

(5) How do EMF exposure and health issues relate to the SCMagLev?

- The same concerns of malfunctioning of cardiac pacemakers and ICDs could potentially arise with exposure to the far stronger electromagnetic field, upward of 15 Tesla in strength, needed to levitate and propel the SCMagLev. People with pacemakers and ICDs should be wary of riding the SCMagLev. The U.S. Department of Transportation (USDOT), Federal Railroad Administration (FRA), and Maryland Department of Transportation (MDOT) Draft Environmental Impact Study (DEIS), states:

  - "The electric fields associated with the SCMAGLEV may be of sufficient magnitude to impact operation of a few older-model pacemakers; in such cases, the older-model pacemakers may revert to an asynchronous pacing while in the presence of the SCMAGLEV Project. Cardiovascular specialists do not consider prolonged asynchronous pacing to be a problem. Cardiovascular specialists commonly use asynchronous pacing to check pacemaker operation; therefore, while the SCMAGLEV project's electric field may impact operation of some older-model pacemakers while in the presence of the SCMAGLEV, the result of the interference would be of short duration and not considered harmful. Pacemakers revert to their normal mode of operation once out of the immediate area of the SCMAGLEV Project."[11]

    Question: Who are these cardiovascular specialists and where are their reports?

  - As stated in the DEIS: "Unlike high voltage transmission lines, EMF exposure from the SCMagLev project would not be constant. EMF exposure would only occur as the train passes by. Additionally, the exposure level would be lower than a high-voltage transmission line, as the Shinkansen website states that the train reportedly complies [*underline added*] with the International Commission on Non-Ionizing Radiation Protection standards. As previously stated, the EMF inside the train and along the tracks is approximately one third of the International Commission on Non-Ionizing Radiation Protection guidelines and is safe for persons with medical pacemakers."[12]

    Question: Note the phrase "reportedly complies." When was this research done? There are no references provided to back up these statements.

    Question: Again, who are the authors, when were this research conducted, and where are the reports?

(6) Are the EMFs generated by the SCMagLev a potential health issue?

- With the implications of current research on EMF exposure and disease and the increasing impact on human health, adding exposure to the far stronger EMFs generated by the high-powered electromagnets used to operate the SCMagLev, there is the potential for an increase in, additional, and severe health issues.

  The USDOT-FRA-MDOT *Final Alternatives Report* states: ". . . superconducting maglev (SCMAGLEV) technology, which differs from other maglev systems (such as the German Transrapid system) in that

[11] U.S. Department of Transportation (USDOT), Federal Railroad Administration (FRA), and Maryland Department of Transportation (MDOT). Chapter 4, Section 18, Table 4.18-3, p. 9. *Baltimore-Washington Superconducting MAGLEV Project Draft Environmental Impact Statement and Draft Section 4(f) Evaluation*. February 2021. bwmaglev.info/index.php/project-documents/deis.
[12] Ibid. Appendix D.11-15.

SCMAGLEV accelerates and decelerates through an electromagnetic force generated between superconducting magnets on the vehicle and reaction coils on the guideway sidewalls. The superconducting magnetism is much stronger than ordinary normal conducting electromagnets."[13]

- Depending on the proximity of the person to the guideway and the number of exposures, the symptoms, conditions, and/or disease discussed in this article have the potential to become intensified due to the strength of the electromagnets used to levitate, propel, and brake the SCMagLev train.

  Note: The *Final Alternatives Report* states that people must maintain a distance of no less than 20 feet from the guideway because of the electromagnetic field strength.[14] DEIS Appendix D.11 indicates: "The American Conference of Governmental Industrial Hygienists also recommends that workers with pacemakers should not exceed 1 Gauss (1,000 mG or 0.1 µT)."[15] Note that they refer to the safety of the workers, but what about the safety of the passengers? How is this distance going to be assured, especially if there is an emergency and passengers are exiting the train, and emergency personnel are at the scene to provide emergency services? Also, as we indicated earlier, the DEIS itself notes the detrimental effect of being in proximity to the SCMagLev if one has a cardiac pacemaker or cardioverter-defibrillator.

(7) Besides passengers and maintenance employees, should anyone else be concerned with the SCMagLev EMF exposure?

- Although the personnel representing the SCMagLev recommend that people (passengers and maintenance workers) do not get within 20 feet of the guideway during operation of the SCMagLev, there is a concern for the residents and businesses near the SCMagLev system. Besides the potential danger coming from the ventilation structures (release of toxins, cancer-causing compounds, and radioactive gas released into the atmosphere and surrounding areas; see the 2021 MCRT-CATS Report about the impact of the SCMagLev on communities[16]), the EMFs generated by the SCMagLev, in addition to the increasing amount of the man-made EMFs continuously injected into our environment, have the potential to increase the negative health consequences of those living and working in proximity to the SCMagLev system.

  While Baltimore-Washington Rapid Rail (BWRR) cites the Japanese report that states the SCMagLev's generated EMFs are safe,[17] we have not seen the research to corroborate this statement. And while the EMF emission level from the SCMagLev may be at an acceptable level, its addition to an environment increasingly saturated with man-made EMFs may well act as a multiplier of the negative human health effects already identified by ongoing international research, findings, and issued precautions.

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[13] USDOT, FRA, and MDOT. *Final Alternatives Report*. November 2018. p. 42. www.bwmaglev.info/images/document_library/reports/alternatives_report/SCMAGLEV_Alts_Report_Body-Append-A-B-C_Nov2018.pdf.

[14] Ibid. Chapter 1, page 1, footnote 1.

[15] USDOT, FRA, and MDOT. Appendix D.11.1.4, p. 10. *Baltimore-Washington Superconducting MAGLEV Project Draft Environmental Impact Statement and Draft Section 4(f) Evaluation*. February 2021. bwmaglev.info/index.php/project-documents/deis.

[16] Woomer, D. "What Impact Would the SCMagLev Have on Our Communities?" January 11, 2021. https://storage.googleapis.com/wzukusers/user-28572454/documents/b2823d429be44c7c96202d0e3e75f309/CATS-MCRT%20Rpt%20-%20SCMagLev%20Community%20Impact%20-%2020210111.pdf.

[17] JP Central. Superconducting Maglev's magnetic field has no health impact. https://scmaglev.jr-central-global.com/about/magnetic/.

- Many questions that have arisen require sufficient and replicated independent research to assure that exposure to the EMFs required for the SCMagLev to operate is safe. Some of are the following:

    - How will the maintenance workers for the train system who are constantly exposed be protected?
    - What kind of exposure will SCMagLev riders have and what are the long-term or cumulative health effects?
    - What is the exposure for the workers constructing the train system (over years)? What is the cumulative effect on their health? How will their safety be maintained? What happens if the system is powered-up and workers are present?
    - What is a safe distance from electromagnets for homes and businesses along the train's route?
    - Where is the research to define and substantiate the "safe" distance?

    Aside from the questions about the safety and crashworthiness of the train itself (see Part 2 of the MCRT-CATS report on SCMagLev safety[18]), statements and assessments about EMF safety from the SCMagLev builder and operator—JP Rail and BWRR, respectively—do not constitute independent, unbiased reviews. If the FRA approves building the system, BWRR, JP Rail, and the Japanese government stand to make a profit as the builders and operators. Passengers, maintenance workers, and people in proximity to the system will then become the test subjects to determine if the system has little to no effect on human health.

- Forthcoming research studies will probe further into EMF exposure and its negative effects on the human body, particularly as EMF-producing technologies continue to be developed and expand into the future. The additional electromagnetic radiation introduced with the operation of the SCMagLev could be a multiplier of the impact on human health from the increasing levels of man-made EMFs. As shown in the recent studies cited above, exposure to more EMFs will likely put more people at risk of experiencing the symptoms stated in this paper, not to mention the possibility of experiencing more intense symptoms, conditions, and disease. Furthermore, we have not yet considered the effects of continuous exposure to the SCMagLev's high-level EMF impact on the health of wildlife.

- It is anticipated that additional studies will provide stronger evidence of the correlation between our EMF-rich environment, human exposure, and human health problems. Our already non-ionized, radiation-rich environment is replete with man-made and naturally occurring EMFs. What kind of additional or increased instances of human and wildlife health issues will likely manifest with the addition of the SCMagLev's high level of EMFs?

Findings/Conclusion

This article highlights concerns about impacts on human and wildlife health from the addition of high-level electromagnet fields needed to operate the SCMagLev train system. It should give the reader pause when considering that only a small number of people will use this transportation system, one that does not provide services to our communities. The reader may ask whether, along with the destruction of irreplaceable natural research areas and lands, unanswered questions about the safety of the train system and structures, and the potential of impacts on human and wildlife health, is it worth building a transportation system only the more affluent can afford to ride?

[18] Woomer, D. "Is the Maglev Safe (Part 2)?" January 11, 2021. https://drive.google.com/file/d/1IFIOBDY7oQY7jYHqdKFrCcHupn8_srgX/view.

Want to Help?

(1) Share this information with your family, friends, neighbors, and community.
(2) Join our Facebook page: www.facebook.com/groups/CitizensAgainstSCMaglev.
(3) Contact your elected officials to express your opposition to building the SCMagLev, go to: myreps.datamade.us.
(4) Submit multiple public comments often at www.bwmaglev.info/index.php/contact-us. State your objection(s), and always end by saying you support the "No Build Alternative."
(4) Learn more about the concerns and impacts the SCMagLev will have on our communities, see: www.stopthistrain.org/.
(5) Make a contribution to support Citizens Against the SCMagLev (CATS) and Maryland Coalition for Responsible Transit (MCRT) at mcrt-action.org. Your donation, in any amount, is appreciated. Thanks for your support!

About the Author

Suzzane Schuyler is a retired Pet/Ct, nuclear medicine, mammographer, and radiologic technologist, having worked 38 years in conjunction with CT and MRI units. Ms. Schuyler holds a bachelor's of science degree in professional health. With her long career, she has expertise with ionizing and non-ionizing radiation and the acute precautions taken to protect employees and the public. She also taught courses in radiologic technology, which included procedural processes, safety, and radiation protection. Ms. Schuyler is an active member of community organizations, including the Linthicum-Shipley Improvement Association, where she has served as a voting Board member and held elected officer positions, including president. She has investigated the SCMagLev plans, proposals, and other information for several years, and has engaged with the Anne Arundel County Council and the Maryland state legislature, and met with Maryland Congressional leaders to express the community's opposition to building the SCMagLev.

Sources

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Citizens Against the SCMagLev (CATS) is a confederation of scientists, engineers, experts, community organizations and citizens in support of transportation infrastructure improvements that benefit our communities, state, and nation. CATS opposes the construction of an expensive transportation system serving a small minority of the wealthy at the cost of taxpayer funds far better used to maintain and improve the transportation infrastructure needed and used daily by all citizens, businesses, and commerce. For up-to-date information on the SCMagLev opposition, see our Facebook page at: https://www.facebook.com/groups/CitizensAgainstSCMaglev.