Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies	)	ET Docket No. 13-84
	)	
Proposed Changes in the Commission's Rules Regarding Human Exposure to Radiofrequency Electromagnetic Fields	)	ET Docket No. 03-137

To: The Commission

JOINT REPLY COMMENTS OF MOMENTUM DYNAMICS CORPORATION AND OAK RIDGE NATIONAL LABORATORY

Momentum Dynamics Corporation ("Momentum Dynamics") and Oak Ridge National Laboratory ("ORNL") (together, the "Joint Parties") hereby submit Reply Comments on the Commission's Notice of Inquiry ("NOI") portion of the above captioned proceeding addressing whether the Commission should explore extending its rules to control radiofrequency exposure between the frequencies of 0 to 100 kHz.[1] In their Comments the Joint Parties urged that the Commission not consider extending radiofrequency exposure limits below 100 kHz. There is no documented evidence of a health risk from this low-frequency band of the spectrum and no commenter has provided any scientific basis that controverts this conclusion, whereas the likely administrative, economic, and opportunity costs of such an extension would be significant.

[1] *First Report and Order, Further Notice of Proposed Rule Making and Notice of Inquiry,* 28 FCC Rcd 3498 at 3580, ¶ 229 (2013).

The Joint Parties also argued that if the Commission nevertheless decides to consider such limits that its consideration be based on the latest relevant IEEE Standards, C95.1-2005, C95.6-2002 and C95.7-2005.[2] The Joint Parties submitted a study that details the many reasons why the IEEE standards are preferred. At least two parties, Sensormatic and the ICES of the IEEE, submitted filings that support this conclusion and include additional information confirming and adding to the reasons for preferring the IEEE standards.[3]

In these reply comments we discuss the record compiled to date in this proceeding and further substantiate the potential adverse and harmful effects on the transportation industry of regulation below 100 kHz. We note that *if* the Commission decides to consider regulation below 100 kHz, others support consideration of the IEEE Standards. As an initial matter at least two commenters express support adoption of the IEEE standards[4] while none rebut the basic premise that ICNIRP is fundamentally flawed.

The IEEE Standard is Scienticallly-Based and Preferred

Sensormatic and IEEE/ICES specifically expressed support for the IEEE C95.1-2005 standard over ICNIRP.[5] Sensormatic operates its business in another area of industry (*i.e.*, not electric transportation) and has decades of safe and successful experience operating in the sub-100 KHz technology arena. Its primary products utilize technology in the same sub-100 kHz spectrum that is in use and contemplated for use in the electric transportation industry. We agree

[2] Joint Comments of Momentum Dynamics Corporation and Oak Ridge National Laboratory, ET Docket Nos. 13-84 & 03-137, filed September 3, 2013. We note that in its filing, *infra*, IEEE/ICES attaches another study authored by J. Patrick Reilly “with significant review and input by ICES” that supports use of the IEEE standards. *Infra* note 3 at Annex.
[3] *See* Reply Comments of Sensormatic Electronics, LLC dated Nov. 18, 2013 (Sensormatic); Reply of the International Committee on Electromagnetic Safety (ICES) of the Institute of Electrical and Electronics Engineers, Inc. (IEEE) dated 16 November 2013 (IEEE/ICES).
[4] *Id.*
[5] *Id.*

with the Sensormatic position and specifically with their commentary setting out the flaws in ICNIRP.

Furthermore, as Sensormatic points out, the current discussion of human health risk due to time-varying magnetic emissions is very different from electromagnetic compatibility (EMC) that may influence medical implant devices.[6] We strongly agree with Sensormatic that medical implant device interaction is an issue of electromagnetic compatibility (EMC) clearly within the expertise and regulatory authority of the Food and Drug Administration (FDA) and not the FCC.

The issues of human health risk fall into two categories: 1) low frequency emissions related to living tissue electro-stimulation, and 2) higher frequency thermal effects on human tissue. According to Reilly, low frequency electrostimulative effects are primarily noticeable at frequencies well below 1 kHz and are most prominent within the +0 to 100 Hz range, which is consistent with ordinary wall current. These are time-domain phenomena that are governed by the principles of neural bioelectric physiology; at higher frequencies, the nerves simply cannot be stimulated. There is well over a century of experience with these frequencies and exposure to billions of human beings throughout this time period with no scientifically sound reported injuries due to magnetic electro stimulation due to wall current and the myriad of electrical appliances that operate in this frequency range. Moreover, the implied costs of regulatory conformance and testing of this vast body of installed and existing devices and distributed wiring with no scientific showing of harm is incomprehensible and potentially economically disastrous.

[6] It should be noted that cardiac pacemakers are designed for EMC and have been immune to EMC for many years. Current pacemakers are designed for direct interaction within Magnetic Resonance Imaging (MRI) devices. Some legacy devices remain *in vivo*, though most have been replaced with more modern devices. However, the risk even to these legacy devices is well understood and has been examined by the test facility at the Georgia Tech Research Institute ("GTRI"), which is the industry standard and accepted testing authority. The magnetic fields produced by any contemplated inductive power device used for transportation will be many orders of magnitude lower than an MRI device.

The second risk issue is thermal injury, which is associated with much higher frequencies. As explained in our initial comments, these effects, again referencing Reilly, are noticeable at frequencies much higher than 100 kHz (as defined in IEEE C95.1-2005). The risk of injury due to thermal heating of tissue is not a concern below 100 kHz. Within this frequency band, living tissue is more transparent than the best quality optical glass, and there is no documented case on record of thermal tissue damage or injury. With such a long history of human interaction with magnetically emissive devices covering a vast population and multiple cultures (equal to the entirety of civilizations' experience with commercial electricity), we see no basis for regulating within this band as there is no known health risk.

Consequently, we respectfully request that the Commission use the IEEE C95.1-2005 standard and reject the ICNIRP Guideline as the basis of any sub-100 kHz RF exposure standards for the following reasons:

- The IEEE C95.1-2005 standard documents the entire intellectual progression from basic theory and experimental measurements to final exposure limits with each step clearly and numerically defined. It also includes a probability model to account for person-to-person sensitivity threshold variation.

- The IEEE C95.1-2005 standard provides consideration of four tissue types: brain and head; hands and wrist, feet and ankles; and other tissues. This is an important distinction because perception thresholds and potential for adverse effects vary radically among tissue groups, and because sub-100 kHz magnetic and electrical fields are tightly contained, and essentially non-radiating. The most likely public exposures would be limited to the extremities such as the hands and wrists such as an MRI attendant reaching into a MRI bore or the feet and ankles of a driver walking past a vehicle having an underside resonant induction wireless charging system. Special provision for extremities as opposed to whole body exposure is scientifically justified. First, neural stimulation thresholds are far higher for extremity neural tissues than for the neural tissues of the eyes and the brain. Second, the smaller cross sectional area of the extremities with respect to the head and the torso means smaller induced currents for the same magnetic field strength.

- The IEEE C95.1-2005 standard has been stable since inception. In the unlikely case there arises a reason to alter or extend the standard, its encompassing documentation and sound theoretical basis provides a solid foundation for further development.

• In contrast, the ICNIRP Guideline has no documented explanation of how exposure limits are derived from fundamental biological, theoretical and experimental considerations in the sub-100 kHz region, nor does it appear to have any intrinsic provision to account for person-to-person perception threshold variations. It considers two tissue types, brain and "other," and has no provision for separate consideration of extremities. This is a serious deficiency as the majority of human exposure to EM fields developed from resonant induction wireless power systems, be it from vehicle or consumer hand held devices, is likely to be the feet-ankles and the hands-wrist.

The Impact of Regulation below 100 kHz Would be Costly to Vehicle Electrifcation

The nation and the world are currently engaged in a transformational movement that will lead to the eventual replacement of internal combustion engine (ICE) vehicles by new classes of electrically-powered vehicles (EVs). EVs can reduce tailpipe emissions to zero while utilizing the existing and fully installed electricity generation and distribution infrastructure. No other alternative fuel can make this claim. All other alternative fuels either have prohibitively high infrastructure costs and/or they cannot produce a zero emission vehicle. The positive and ameliorative potential of this movement is profound and involves both economic and human health benefits. One can begin to appreciate these benefits by considering the inarguable health risks associated with today's petroleum fueled vehicles.

1. The reduction of air pollution from vehicle sources cannot be understated for its potential improvement of human health. Air pollution in the form of volatile organic compounds VOCs)[7], nitrous oxides (NOx)[8], sulfur oxides (SOx)[9], CO2, and diesel particulates[10] are produced in prodigious quantities by ICE motor transportation. The replacement of ICE

[7] Volatile organic compounds (VOCs) are organic chemicals. VOCs are numerous, varied, and ubiquitous and are produced as a byproduct of incomplete combustion of gasoline, diesel, and other hydrocarbon fuels. Some VOCs are dangerous to human health or cause harm to the environment. Harmful VOCs are typically not acutely toxic, but instead have compounding long-term health effects. Respiratory, allergic, or immune effects in infants or children are associated with man-made VOCs and other indoor or outdoor air pollutants. Some VOCs, such as styrene and limonene, can react with NOx or with ozone to produce new oxidation products and secondary aerosols, which can cause sensory irritation symptoms. VOCs are important in the creation of smog (http://www.ccme.ca/assets/pdf/pn_1257_e.pdf). Health effects include eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans (http://www.epa.gov/iaq/voc.html). See also: http://www.epa.gov/iaq/voc2.html . The above information is well established within environmental science and on information published by the US Environmental Protection Agency.

vehicles with electric vehicles presents the best and most easily realizable opportunity to remove the source of these pollutants. The known and pervasive human health risk of ICE pollutant emissions is incomparably greater than any perceived or presumptive health risk associated with magnetic field emissions.

2. Similarly, air pollution is not the only form of pollution that will be reduced by the movement to electric vehicles. Ground contamination from the disposal of toxic waste products (for example, crushed oil filters and waste oils), fuel spills on ground, leaking fuel storage tanks, refinery and pipeline leaks, marine fuel tanker spills, direct human sin and tissue contact with toxic fuel sources, are just a partial list of the enumerable instances of solid, liquid and gaseous pollution which are created by petroleum fueled vehicles. Again, all of these contribute significantly to disease, injury, and chronic health

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[8] NOx includes mono-nitrogen oxides NO and NO2 (nitric oxide and nitrogen dioxide). NOx gases react to form smog and acid rain. NOx is produced from the reaction of nitrogen and oxygen gases in the air during combustion. In large cities where high motor vehicle traffic in an everyday occurrence, the amount of nitrogen oxides emitted into the atmosphere as air pollution is significant. NOx gases are formed whenever combustion occurs in the presence of nitrogen – as in an internal combustion engines. NOx reacts with ammonia, moisture, and other compounds to form nitric acid vapor and related particles. Small particles can penetrate deeply into sensitive lung tissue and damage it, causing premature death in extreme cases. Inhalation of such particles may cause or worsen respiratory diseases, such as emphysema or bronchitis, or may also aggravate existing heart disease. NOx reacts with volatile organic compounds (VOCs) in the presence of sunlight to form ozone. Ozone can cause adverse effects such as damage to lung tissue and reduction in lung function mostly in susceptible populations (children, elderly, asthmatics). Ozone can be transported by wind currents and cause health impacts far from the original sources. The American Lung Association estimates that nearly 50 percent of United States inhabitants live in counties that are not in ozone compliance. NOx destroys ozone in the stratosphere. Ozone in the stratosphere absorbs ultraviolet light, which is potentially damaging to life on earth. NOx from combustion sources does not reach the stratosphere; instead, NOx is formed in the stratosphere from photolysis of nitrous oxide. NOx also readily reacts with common organic chemicals, and even ozone, to form a wide variety of toxic products: nitroarenes, nitrosamines and also the nitrate radical some of which may cause biological mutations. Recently another pathway, via NOx, to ozone has been found that predominantly occurs in coastal areas via formation of nitryl chloride when NOx comes into contact with salt mist (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2453175/). The above information is well established within environmental science and on information published by the US Environmental Protection Agency.

[9] SOx refers to all sulfur oxides, the two major ones being sulfur dioxide (SO2) and sulfur trioxide (SO3). Sulfur dioxide is a colorless gas with a pungent, irritating odor and taste. Sulfur dioxide can harm crops and trees, textiles, building materials, animals, and people either as a result of exposure to long-term low concentrations or short-term high concentrations. It turns leaves yellow and decreases the growth rate of crops. Sulfur dioxide corrodes metal, and causes building materials and textiles to deteriorate and weaken. Sulfur dioxide irritates the throat and lungs and, if there are fine dust particles in the air, can damage a person's respiratory system. Sulfur oxides combine with other substances in the air to produce a haze that reduces visibility. Sulfur dioxide is a major contributor to acid deposition through acid rain. The above information is well established within environmental science and on information published by the US Environmental Protection Agency.

[10] Diesel particulates: Diesel particulate matter (DPM), sometimes also called diesel exhaust particles (DEP), is the particulate component of diesel exhaust, which includes diesel soot and aerosols such as ash particulates, metallic abrasion particles, sulfates, and silicates. The main particulate fraction of diesel exhaust consists of fine particles. Because of their small size, inhaled particles may easily penetrate deep into the lungs. The rough surfaces of these particles are conducive to binding with other toxins in the environment, thus increasing the hazards of particle inhalation. Long-term exposures can lead to chronic and serious health problems such as cardiovascular disease, cardiopulmonary disease, and lung cancer. See: Appendix A for a list of toxic constituent compounds and also see EPA reference document found at: http://www.epa.gov/ttnatw01/dieselfinal.pdf Diesel particulates are also known to be associated with increased risk for autism and brain tissue disorders, see: Volk HE, Lurmann F, Penfold B, Hertz-Picciotto I, McConnell R. Traffic-Related Air Pollution, Particulate Matter, and Autism. JAMA Psychiatry. 2013; 70(1):71-77. doi:10.1001/jamapsychiatry.2013.266.

risks that are immeasurably greater than the alleged but unsubstantiated risk of exposure to magnetic fields.

The benefits of inductive charging with respect to the growth of the electric vehicles are extraordinary and unmatchable by any other method of supplying electrical power to mobile vehicles. The benefits of induction go far beyond convenience: inductive charging enables EVs to be charged automatically and under all weather and environmental conditions. This makes driving range extension possible through "opportunity charging" and works to reduce vehicle cost and extends the useful lifetime of batteries.

Automatic opportunity charging is especially important in the application of automatic charging to commercial vehicles where reliable driving range and the useful duty period of a vehicle are absolutely essential to their commercial viability. Such vehicles, when electrically propelled and inductively charged at intermittent periods of a work cycle, are capable of outperforming their gasoline, CNG, and diesel equivalents. "Opportunity charging" is where a vehicle is not connected to a charging station once per operational day for a long period of charging, but rather, at multiple times along its route or within its operating facility. Opportunity charging saves energy, permits greater reliability and productivity, and makes it possible for the users of larger commercial vehicles to transition to fully electric vehicles.

The potential is not only fuel and energy savings for the vehicle operator, but the reduction of tailpipe emissions to zero. Air pollution is eliminated in such vehicles. The risk of petroleum fuel spills are eliminated, as is the risk of ground water contamination from leaking fuel storage tanks. Since these vehicles offer the best alternative to today's heavy diesel engines, in vehicles such as municipal buses the known health risk of diesel particulate pollution is eliminated. This is particularly true in densely populated urban environments where exhaust fumes such as SOx, NOx, VOCs, and diesel particulates are known to concentrate and recombine into more dangerous secondary compounds.

Therefore, we believe Inductive charging is essential to the technical enablement and growth of the electric vehicle industry. Potential FCC regulation below 100 kHz, which includes the spectrum of particular interest to our industry, could be detrimental to and may threaten the growth of not just inductive charging of EVs, but also all forms of charging, and indeed, the very electronic devices that make electric vehicles operable – including motors, motor controllers, and related devices.

Any impediment to the growth of this industry will protract the exposure of Americans to genuinely dangerous and harmful pollutants which are known to be produced by ICE vehicles. The known risk of all of these pollutants, listed herein in an abbreviated form but well understood by the US Environmental Protection Agency and experts worldwide, is far greater than any risk alleged to be associated with magnetic fields in the sub-100 kHz frequency spectrum. Indeed, as noted above, there is no scientifically documented evidence of any health risk from below 100 kHz.

The electric vehicle industry is growing and is expected to continue growing. According to published industry sales data current adoption of EVs by consumers is outpacing the initial adoption rate of the Toyota Prius by a factor of 2 or more. This adoption rate is expected to climb. Pure electric vehicles, hybrid electric vehicles, and extended range electric vehicles, will combine to cover all classes of vehicles ranging from small cars to heavy duty trucks and buses. The combined market forces of reduced fuel cost, reduced maintenance cost, consumer social consciousness, and environmental compliance by automakers will accelerate this market trend.

For automakers to make a profit, it is not sufficient for them to manufacturer so-called "compliance vehicles" in limited numbers. Compliance vehicles are produced to allow an automaker to comply with fleet fuel efficiency standards (for example, the US CAFE mandate), but are not expected to sell in large numbers or generate large profits. But it has been recognized that electric vehicles offer automakers an opportunity to produce large vehicles, which have traditionally been more popular and more profitable, as profitable lines that also contribute to CAFE mandate compliance. This is a win-win scenario for automakers, their suppliers, and for the public interest. As a result, virtually every automaker in the world has recognized this trend and either has introduced or is planning to introduce at least one model line of electric vehicle.

The key, however, is to provide such vehicles with a fast and safe means of connecting to the existing power supply grid in a way that meets consumer needs and expectations. Failure to do so will result in commercial failure. But success portends a far more rapid adoption rate, and a faster pathway to profit, for the automaker. Only wireless or inductive charging systems can meet this requirement. Plug-in chargers are expensive and have been rejected by consumers. In Europe, this consumer behavior has been recognized and the movement to inductive charging is accelerating.

All electric vehicles, regardless of the method of charging, contain multiple subsystems which utilize power electronics. All involve motors, motor controllers, and inductive components that emit alternating magnetic fields in close proximity to vehicle occupants. This entire industry could be jeopardized needlessly if the Commission acts to regulate below 100 kHz with no demonstrated scientific basis for doing so.

Recommendation Regarding a Liaison Commission is Misplaced

Medtronic and AAMI (CRMD-WG02) in their comments recommend that the

Commission designate a liaison with the AAMI CRMD committee so that the Commission can avail themselves of the technical knowledge of this organization.[11] We agree with AAMI that the FCC has the difficult but essential task of balancing the interests of the public and of industry, but as Sensormatic correctly points out, the issue of electromagnetic interference (EMC) falls outside the purview of the FCC and more appropriately is within the regulatory authority of the FDA. Additionally, such an exclusive and cozy relationship with one particular industry would contravene the policies of the Administrative Procedures Act (APA) and the Federal Advisory Committee Act as well as public policy and fairness. All concerns should be considered, of course, but through the regular governing processes that ensure fairness and objectivity.

Conclusion

Momentum Dynamics and Oak Ridge National Laboratory continue to urge the Commission not to regulate below 100 kHz. We concur with those in other industries as well as our own that there is no known health risk associated with inductive charging equipment. We emphasize that there is no documented evidence of a health risk from this low-frequency band of the spectrum and no commenter controverts this conclusion.

We urge the Commission to weigh the comparative risks between the known and factually confirmed health threat that comes from air and other forms of pollution associated with internal combustion engine vehicles, and the alleged but scientifically unsubstantiated risk of magnetic field interaction with human tissue below 100 kHz.

11 *See* Comments of the Cardiac Rhythm Management Device Committee (CRMD) / Working Group WG02 on EMC Protocols of the Association for Advancement of Medical Instrumentation (AAMI) dated Sept. 3, 2013; Comments of Medtronic, Inc. dated Sept. 3, 2013.

Should the Commission determine to enact regulation below 100 kHz, we respectfully urge that the IEEE C95.1-2005 Standard be relied upon. ICNIRP, regardless of iteration, should be rejected as it is scientifically unsubstantiated and subject to the vicissitudes of a closed body of authors who are beyond peer review.

Respectfully submitted,

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Appendix A

Table of Toxic Constituents in Diesel Exhaust Fumes

The following table presents a summary of known dangerous compounds in diesel emissions from transportation sources. Source: Lippmann, Walter, Environmental Toxicants, Wiley-Interscience; 2nd edition (December 16, 1999). Dr Lippmann is Professor of Environmental Medicine at the New York University School of Medicine, and the Director of the Research Center for the Health Risks of Ambient Particulate Matter, supported by the U.S. Environmental Protection Agency. He also directs the Human Exposure and Health Effects Research Program at New York University's Nelson Institute of Environmental Medicine.

Contaminant	Note
acetaldehyde	IARC Group 2B carcinogens
acrolein	IARC Group 3 carcinogens
aniline	IARC Group 3 carcinogens
antimony compounds	Toxicity similar to arsenic poisoning
arsenic	IARC Group 1 Carcinogens, endocrine disruptor
benzene	IARC Group 1 Carcinogens
beryllium compounds	IARC Group 1 Carcinogens
biphenyl	It has mild toxicity.
bis(2-ethylhexyl)phthalate	endocrine disruptor
1,3-butadiene	IARC Group 2A carcinogens
cadmium	IARC Group 1 Carcinogens, endocrine disruptor
chlorine	
chlorobenzene	It has "low to moderate" toxicity.
chromium compounds	IARC Group 3 carcinogens
cobalt compounds	
cresol isomers	
cyanide compounds	
dibutyl phthalate	endocrine disruptor
1,8-dinitropyrene	Carcinogen[citation needed]
dioxins and dibenzofurans	
ethyl benzene	
formaldehyde	IARC Group 1 Carcinogens
inorganic lead	endocrine disruptor
manganese compounds	
mercury compounds	IARC Group 3 carcinogens
methanol	
methyl ethyl ketone	It may cause birth defects.[citation needed]
naphthalene	IARC Group 2B carcinogens
nickel	IARC Group 2B carcinogens
3-Nitrobenzanthrone	One of the strongest carcinogens known
4-nitrobiphenyl	
phenol	endocrine disruptor[citation needed]
phosphorus	
polycyclic organic matter, including polycyclic aromatic hydrocarbons (PAHs)	
propionaldehyde	
selenium compounds	IARC Group 3 carcinogens
styrene	IARC Group 2B carcinogens
toluene	IARC Group 3 carcinogens
xylene isomers and mixtures: o-xylenes, m-xylenes, p-xylenes	IARC Group 3 carcinogens