LC Paper No. CB(2)1075/16-17(01)

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Testimony of James L. Repace on MD House of Delegates Bill 354,
Clean Indoor Air Act – Use of Electronic Cigarette Devices – Prohibition.
February 16, 2017

The intent of this legislation is to alter the Clean Indoor Air Act in part to prohibit of use of electronic cigarette devices under the Clean Indoor Air Act. [Accomplished by revising Article – Health – General Section 24–501 through 24–503, 24–505, 24–507, and 24–510 10 Annotated Code of Maryland 11, (2015 Replacement Volume and 2016 Supplement) as well as revising Article – Health – General Section 24–504 and 24–508 15 Annotated Code of Maryland (2015 Replacement Volume & 2016 Supplement)].

Summary: I strongly support the enactment of HB-354. E-cigarettes are devices that emit fine particle air pollution, toxic nicotine, as well as other toxic volatile organic compounds and cancer-causing metals when puffed. These chemicals pollute the air from the exhaled breath of E-cig users. Thus, the unrestricted use of E-cigs in workplaces such as restaurants, bars, casinos, and offices, pollutes the air previously cleansed by smoking bans and poses a health risk to the public. E-cigarettes should be banned wherever combustible cigarettes are banned.

Background: Unregulated production of e-cigarettes and e-liquids, in addition to the very limited scientific evidence regarding the chemical composition of the vapors and aerosols generated by e-cigarettes, have raised concerns about the potential adverse health effects of e-cigarette consumption, and secondhand exposure to the exhaled vapors in indoor spaces. Consider the following:

1. As of early 2014, there were 466 brands and 7764 unique flavors of e-cigarette products. These products are now widely available online and in retail outlets in many countries (Bhatnagar, 2014) .

2. There are between 400 and 500 brands of E-cigarettes (E-cigs) on the market. The number of e-cigarettes sold has increased exponentially annually. Wells Fargo has predicted that e-cigarettes sales could grow to $10 billion by 2017, surpassing conventional cigarettes. The big 3 major tobacco companies have been purchasing independent e-cigarette companies and may share 75% of the profit pool in 10 years. E-cigs are widely available through Vape Shops or the Internet.

3. E-cigs contain a variety of unknown and unregulated chemicals that are vaporized when the device is activated and inhaled. The exhaled breath of the smokers contains these chemicals, which pollute the indoor air, and thus be inhaled by non-smokers.

4. Researchers at Virginia Commonwealth University measured Ecig impacts on indoor air pollution at an Ecig Convention in a 142,000 cubic foot hotel meeting room. During 6 hours pre-and-post convention, fine particle air pollution ($PM_{2.5}$) ranged from 2 to 16 micrograms per cubic meter ($\mu g/m^3$). During 4.5 hours of measurement, an average of 61 to 81 vapers increased PM level to 330 to 870 $\mu g/m^3$. Soule et al. concluded that $PM_{2.5}$ concentrations at the ECIG event were higher than concentrations in hookah cafés and bars that allow cigarette smoking. That indoor Ecig use exposes non-users to secondhand smoke. And that regulatory bodies should prohibit Ecig use anywhere combustible cigarette use is prohibited (Soule et al., 2016).

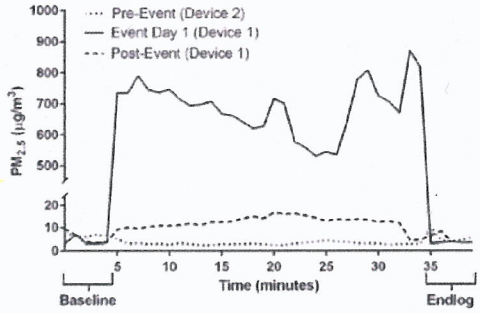

Figure 1 Representative particulate matter measuring <2.5 µm ($PM_{2.5}$) concentrations in ECIG event room measured before the event (pre-event), during the event (event day 1) and after the event (post-event). Each of these representative measurement sessions includes 5 baseline readings outside of event room, 30 readings in the event room and 5 endlog readings outside of event room.

Soule EK, *et al. Tob Control* 2017;**26**:109–112. doi:10.1136/tobaccocontrol-2015-052772

5. While e-cigarettes lack tar and other carcinogens, their carcinogenic effects may be lower

than combustible cigarettes. However, a number of cardiovascular toxicants are present in tobacco smoke, e.g., particulate matter and carbonyls such as formaldehyde, acetaldehyde, acetone, acrolein, and butanol. These are also present in e-cigarettes, and these alone can increase cardiovascular disease risk by affecting blood pressure regulation, promoting coagulation, and accelerating the formation of atherosclerotic lesions. Notably, nicotine present in most e-cigarettes is a strong vasoactive drug that can profoundly affect cardiovascular function and health (Bhatnagar, 2017).

6. A new and more harmful way of inhaling Ecigs is becoming prominent: In a study of 7045 Connecticut high school students, 26% were "dripping" Ecigs instead of vaping. Dripping involves pouring E-liquid directly onto the heated coil (Krishnan-Sarin et al., 2016). Manufacturers are responding to this dripping trend by creating vaping devices that feature exposed coils, allowing users easier access to drip their liquid manually (NYT, 2017). Dripping is reported to cause volatile aldehyde, including formaldehyde emissions to "greatly exceed values reported in studies of conventional Ecigs and combustible cigarettes" (Talih et al., 2016).

7. Formaldehyde is defined as a toxic air pollutant by the Clean Air Act Amendments of 1990. It irritates airways and, at high exposure doses, produces nasal tumors in laboratory rats. There are no known thresholds for the harmful effects of these chemicals in indoor air. Formaldehyde is a significant indoor pollutant that causes eye and respiratory irritation as well.

8. Recent studies indicate that there are wide differences in the levels of nicotine as well as organic compounds, (such as propylene glycol and glycerol) in the vapors generated by different brands of e-cigarettes (Cheng, 2014; Cheah, 2012). Other studies reported emissions of organic species, including volatile organic compounds (VOCs), carbonyls, polycyclic aromatic hydrocarbons (PAHs) and glycols, in the vapors emitted from e-cigarettes compared to tobacco smoke).

9. Williams et al.(PLos One, 2013) analyzed particulate elements in the aerosol generated by e-cigarettes and reported the presence of tin, silver, iron, nickel and aluminum in super-micron particles, and tin, chromium and nickel in sub-micron particles due to the heating elements in E-cigs. Both nickel and chromium are known cancer-causing substances when inhaled. These studies indicate the lack of quality control in e-cigarette manufacture and raise important questions about the adverse health impacts of e-cigarette consumption.

10. Measurements of exhaled E-cig emissions under controlled conditions show that numerous organic chemicals are emitted to the air (Saffari, et al., 2015). Table 1 shows some of these measured organic pollutants, and their emission rates for one of the most popular European brands of e-cigarette, (Elips Serie C, Tank System, Ovale Europe Srl):

Table 1, Organic Alkane and organic acid emissions of one popular brand of E-cig (Saffari, et al., 2015)

Species (nanograms/hour)	Species (nanograms/hour)
Nicotine 7103	Nicotine* 2759
n-Eicosane 529.3	Tetradecanoic acid 8308
n-Docosane 477.3	Pentadecanoic acid 2289
n-Tetracosane 604.	Hexadecanoic acid 13 960
n-Pentacosane 255.5	Heptadecanoic acid 572.4
n-Hexacosane 125.5	Palmitoleic acid 1813
Triacontane 241.4	Linoleic acid 444.1
Hentriacontane 317.2	Eicosanoic acid 136.4
Dotriacontane 312.6	Docosanoic acid 160.4
Tritriacontane 274.3	Tricosanoic acid 112.6
Tetratriacontane 284.1	Tetracosanoic acid 449.3
Pentatriacontane 220.1	Pentacosanoic acid 208.2
Hexatriacontane 228.5	Hexacosanoic acid 218.6
Heptatriacontane 153.7	Octacosanoic acid 222.2
Octatriacontane 208.8	Triacontanoic acid 228.6
Decanoic acid 229.2	Suberic acid 282.3
Dodecanoic acid 2421	Azelaic acid 743.5

11. Some E-cigs contain tobacco instead of liquid. A study of a popular brand of Philip Morris Ecig the iQOS, uses actual tobacco in the shape of small Marlboro cigarettes that are heated at high temperatures, about 350 °C instead of nicotine-laced e-liquid. Measurements by Rupprecht et al. (2015) show the emissions of toxic aldehydes, including formaldehyde, acetaldehyde, and acrolein (Figure 1).

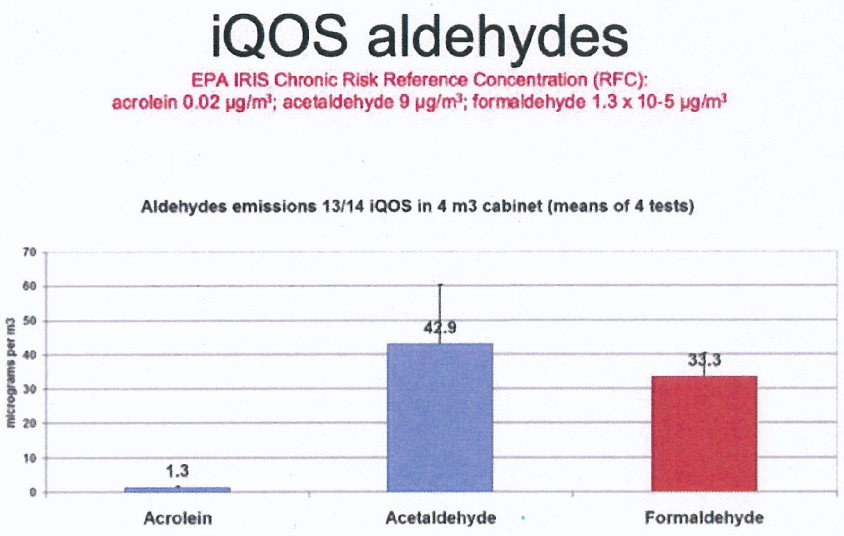

Figure 1. Emissions of aldehydes from a Philip Morris-brand E-cig (Rupprecht et al. 2015).

12. Such toxic aldehydes are also present in regular cigarettes, and are known for their lung-damaging and irritating properties. The study reported that there were substantial emissions of organic species (n-alkanes and organic acids), detected from iQOS, although less than that of normal cigarette, these emissions were still high. These volatile organic chemicals will pollute indoor air. Since all of the chemicals in Table 1 also are emitted by regular cigarettes, Ecigs will expose nonsmokers involuntarily to these chemicals with adverse consequences. Moreover The levels of nicotine, tobacco-specific nitrosamines

(TSNAs), aldehydes, metals, volatile organic compounds (VOCs), flavours, solvent carriers and tobacco alkaloids in e-cigarette refill solutions, cartridges, aerosols and environmental emissions vary considerably (Cheng, 2014).

13. The delivery of nicotine and the release of TSNAs, aldehydes and metals are not consistent across products. Furthermore, the nicotine level listed on the labels of e-cigarette cartridges and refill solutions is often significantly different from measured values. Toxic phenolic compounds, carcinogenic polycyclic aromatic hydrocarbons and drugs have also been reported in e-cigarette refill solutions, cartridges and aerosols. Varying results in particle size distributions of particular matter emissions from e-cigarettes across studies have been observed. Performance characteristics of e-cigarette devices also vary across and within brands. As of September 2013, 29 published non-clinical studies evaluated the chemistry of e-cigarettes.

14. Various chemical substances and ultrafine particles known to be toxic, carcinogenic and/or to cause respiratory and heart distress have been identified in e-cigarette aerosols, cartridges, refill liquids and environmental emissions. In addition to the uniqueness of the liquid compositions in each brand, inconsistency of both the device performance properties and the data collection methodologies used by researchers contribute to the observed variation in constituent levels and to the range of particle size distributions among products. Moreover, few of these methods are well validated (Cheng, 2014).

15. A recent Johns Hopkins clinical study of the inhalation of E-cig aerosol by mice concluded E-cig exposure results in immune system impairment similar to those observed after exposure to cigarette smoke. The authors conclude that their results indicate that despite the common perception that E-cigs are safe, E-cig use, even for relatively brief periods, may have significant consequences to respiratory health, especially for especially for susceptible populations (Sussan et al., 2015).

About the Author:

JAMES REPACE holds a MSc. in physics from the Polytechnic Institute of Brooklyn. A retired senior air policy analyst at the U.S. EPA, and a former research physicist at the Naval Research Laboratory, he is now a consultant performing research on indoor air pollution, especially from secondhand smoke (SHS). He has advised governments in North and South America, Europe, and the Pacific Rim, as well as the World Health Organization. He has published 85 scientific research papers on the hazard, exposure, dose, risk, and control of SHS, and has conducted numerous field studies of SHS. For his work on SHS, he has received the Constance L. Mehlman award from the International Society of Exposure Science (2015), the Flight Attendant Medical Research Institute Distinguished Professor Award (2002), the Robert Wood Johnson Foundation Innovator Award (2002), a Lifetime Achievement Award from the American Public Health Association (1998), and the Surgeon General's Medallion from Dr. C. Everett Koop (1989). He has been a visiting assistant clinical professor at the Tufts University School of Medicine, a consultant to the Stanford University Department of Civil and Environmental Engineering, and to several branches of the U.S. Government.

References

Bhatnagar A., et al. **Electronic Cigarettes, A Policy Statement From the American Heart Association**. *Circulation* (2014;130:1418-1436.)

Cheng T., **Chemical evaluation of electronic cigarettes.** *Tobacco Control*, 2014, 23, ii11–ii17.

Cheah NP, Chong NWL, Tan J, Morsed FA, and Yee SK, **Electronic nicotine delivery systems: regulatory and safety challenges: Singapore perspective.** *Tobacco Control*, 2012, 050483.

Bhatnagar A., et al. **Are Electronic Cigarette Users at Increased Risk for Cardiovascular Disease?** *JAMA Cardiology* Published online February 1, 2017 E1.

Krishnan-Sarin, Morean M, Kong G, Bold KW, Camenga DR, Cavallo DA, Simon P, Wu R. E-cigarettes and "Dripping" Among High-School Youth. *PEDIATRICS* 139 (3), (2017): e201663224.

New York Times (2017). Plain Old Vaping Gives Way to 'Dripping' Among Teenagers, Study Says. By JACEY FORTIN FEB. 7, 2017, https://nyti.ms/2kKchuK.

Ruprecht AA. , C. De Marco, Boffi R, Pozzi P, Mazza R, Veronese C, Angellotti G, Munarini E, Westerdahl D, Sioutas C., Saffari A., Hasheminassab S., Repace J. **ENVIRONMENTAL POLLUTION COMPARISON OF E-CIGARETTES, HEAT-NOT-BURN TOBACCO PRODUCTS AND CONVENTIONAL CIGARETTES**. Presented at the International Society of Exposure Science 2015 Conference, Henderson, NV, Oct 21-23.

Saffari A, Daher N, Ruprecht A, De Marco C, Pozzi P, Boffi R, Hamad S, Martin M. Shafer, James J. Schauer, Dane Westerdahl and Constantinos Sioutas. **Particulate metals and organic compounds from electronic and tobacco-containing cigarettes: comparison of emission rates and secondhand exposure**. Environmental Science Processes & Impacts, 2015, DOI: 10.1039/c4em00415a.

Soule EK, Maloney SF, Spindle TR, et al. **Electronic cigarette use and indoor air quality in a natural setting.** *Tobacco Control* 2017;26:109–112.

Sussan TE, Gajghate S, Thimmulappa RK, Ma J, Kim J-H, Sudini K, et al. **Exposure to Electronic Cigarettes Impairs Pulmonary Anti-Bacterial and Anti-Viral Defenses in a Mouse Model.** PLoS ONE (2015) 10(2): e0116861. doi:10.1371/journal.pone.0116861.

Talih S, Balhas, Z, Salman R, Karoghlanian N, Shihadeh A. **"Direct Dripping": A High-Temperature, High-Formaldehyde Emission Electronic Cigarette Use Method.** . *Nicotine Tob Res.* 2016 Apr;18(4):453-9. doi: 10.1093/ntr/ntv080. Epub 2015 Apr 11.

Williams M, Villarreal A, Bozhilov K, Lin S, Tabot P. **Metal and Silicate Particles Including Nanoparticles Are Present in Electronic Cigarette Cartomizer Fluid and Aerosol.** *PLoS ONE* (2013); 8(3): e57987. doi:10.1371/journal.pone.0057987.

New research suggests teenagers are finding new ways to use electronic cigarettes – even though federal law prohibits them for people under 18 (New York Times, 2017).