PETITION TO PROMULGATE CONSUMER PRODUCT SAFETY STANDARD

December 18, 2024

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Dear Commissioners:

National Carbon Monoxide Awareness Association ("NCOAA"), hereby petitions the Consumer Product Safety Commission ("the Commission"), pursuant to the Consumer Product Safety Act ("the Act"), 15 U.S.C. § 2056, the Administrative Procedure Act, 5 U.S.C. § 553(e), and regulations of the Commission, 16 C.F.R. 1000.5, to promulgate a consumer product safety standard for carbon monoxide ("CO") alarms. The current voluntary standard for CO alarms is insufficient to protect consumers from an unreasonable risk of injury. 15 U.S.C. § 2052(a)(5).

Carbon monoxide is a colorless, odorless, and non-irritating gas formed by incomplete combustion of carbon-based fuels. In indoor environments, common sources of CO include gas

stoves, furnaces, boilers, and clothes dryers. CO can also drift indoors from outdoor sources such as grills, generators, and vehicle exhaust from attached garages.

It is widely recognized that inhalation of CO can be significantly injurious to health.[1] Even at low concentrations, exposure to CO causes a wide range of health symptoms, including headache, nausea, weakness, dizziness, and confusion.[2] Chronic low-level exposure is also linked to adverse cardiovascular and reproductive outcomes.[3] Exposure to higher concentrations and for longer durations can result in lasting neurological effects, cardiological effects, and death.[4]

Certain populations are more susceptible to CO injuries. Low CO exposures can exacerbate pre-existing cardiovascular and respiratory conditions.[5] Children and the elderly may be more susceptible to CO injuries due to increased metabolic demand, underlying comorbidities, limited mobility, and limited recognition and vocalization of symptoms.[6] Outside the home, schools are another site where indoor CO poisoning occurs; one study found that schools were the second most frequent incident location for CO injuries (10% of injuries) after homes and apartments (39.9% of injuries).[7]

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[1] *See, e.g.*, Sharon Wilbur, et al., *Toxicological Profile for Carbon Monoxide Chapter 3. Health Effects*, U.S. Agency for Toxic Substances and Disease Registry (June 2012).
[2] *E.g.*, Brianna Sleezer, et al., *An Urgent Call to Action to Lower the Alarm Set-Point of Carbon Monoxide Alarms*, National Carbon Monoxide Awareness Association (2011, rev. Nov. 15, 2021).
[3] *See, e.g.,* Judith M. Graber, et al., *Carbon monoxide: the case for environmental public health surveillance*, 122 Pub. Health Reports 138–144 (Mar.-Apr. 2007) (noting a "growing body of literature that shows an ecological association between increased levels of ambient air carbon monoxide and adverse CVD [cardiovascular disease], stroke, and birth outcomes"); Michelle L. Bell, et al., *Emergency hospital admissions for cardiovascular diseases and ambient levels of carbon monoxide: results for 126 United States urban counties*, 120 Circulation 949 (Aug. 31, 2009) (even short-term exposures to low CO concentrations in the ambient outdoor air (1-hour maximums ranging from **0.2 to 9.7 ppm**) had a statistically significant association with an increased risk of hospital admissions related to cardiovascular disease).
[4] *E.g.*, Katherine Wheeler-Martin, et al., *Impact of Mandatory Carbon Monoxide Alarms: An Investigation of the Effects on Detection and Poisoning Rates in New York City*. 105 Am. J. Pub. Health 1623 (Aug. 2015) ("an estimated 50% of nonfatal cases develop neurologic sequelae, such as cognitive decline or movement disorders."); Feng-You Lee, et al., *Carbon monoxide poisoning and subsequent cardiovascular disease risk: a nationwide population-based cohort study*, 94 Med. e624 (Mar. 2015).
[5] *E.g.*, E. N. Allred, et al., *Effects of carbon monoxide on myocardial ischemia*, 91 Env't. Health Perspectives (Feb. 1, 1991) (doses of CO as low as **35 ppm for 1 hour** "produce significant effects on cardiac functioning during exercise in subjects with coronary artery disease," and noting that many conditions cause increased susceptibility to CO effects).
[6] Mikyong Shin, et al., *Morbidity and Mortality of Unintentional Carbon Monoxide Poisoning: United States 2005 to 2018*, 81 Annals Emergency Med. 309 (Mar. 2023).
[7] Sutapa Mukhopadhyay, et al., *Surveillance of carbon monoxide-related incidents - Implications for prevention of related illnesses and injuries*, 36 *Am. J. Emergency Med.* 1837 (Oct. 2018). CO poisoning in schools may be exacerbated by the fact that many states do not require CO alarms in schools. *See*

Further exacerbating risks of injury, CO poisoning is difficult to diagnose due to its variety of symptoms and limited diagnostic tools.[8] Diagnosis of CO poisoning typically involves blood sampling of carboxyhemoglobin ("COHb") levels, which requires victims to receive medical attention and for the medical provider or first responder to have awareness of potential CO exposure.[9] Even when performed, COHb testing does not always accurately reflect the extent of CO exposure. Time elapsed since exposure and the administration of oxygen prior to hospital admission can significantly reduce COHb levels in the blood, despite continuing effects of CO toxicity and risk of delayed neurological sequelae.[10]

The invisible nature of CO, its multiple sources in everyday settings, and its diagnostic difficulties all intensify the public health risk posed by CO poisoning. However, unintentional CO injuries are largely preventable with a combination of reducing CO sources and improving CO detection.[11] Effective CO alarms are critical: CO alarms not only alert users to life-threatening CO concentrations, but also provide victims with the necessary information to seek proper treatment and take action to prevent future exposure.

But while CO alarms are critical for protection, the current voluntary standard for CO alarms, UL 2034, contains several deficiencies that pose an unreasonable risk of injury for users. Under UL 2034, CO alarms perform conservatively to sound only when concentrations reach life-threatening levels and do not alert consumers to lower levels of CO that are still injurious. Alarms are prohibited from sounding below CO concentrations of 30 ppm, and CO concentrations of 30-69 ppm may only trigger an alarm if concentrations are in this range for 30

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generally, Carbon Monoxide Detector Installation Statutes, Nat'l Conference of State Legislatures (Aug. 29, 2023) (survey of CO alarm requirements in select state and local jurisdictions).

[8] Graber et al., *supra* note 3.

[9] *E.g.*, Agnese Veronesi. et al., *Use of carboxyhemoglobin as a biomarker of environmental CO exposure: critical evaluation of the literature*, 24 Env't. Sci. Pollution Rsch. Int'l. 25,798 (Nov. 2017) ("CO poisoning diagnosis is … usually confirmed by high [COHb] levels in the blood."); *See* Mathilde Papin, et al., *Accuracy of pulse CO-oximetry to evaluate blood carboxyhemoglobin level: a systematic review and meta-analysis of diagnostic test accuracy studies*, 30 European J. Emergency Med. 233 (May 31, 2023) (pulse oximetry, a noninvasive method to measure COHb levels used by some first responders, is not highly accurate and "should probably not be used to confirm (rule-in) or exclude (rule-out) CO poisoning with certainty.").

[10] Stefania Oliverio, *Current challenges in carbon monoxide poisoning diagnosis from an analytical perspective*, 10 Frontiers in Med. 1304294 (Nov. 7, 2023) (delayed neurological sequelae have been reported in "low-level chronic CO exposures," and that "these exposures are even more difficult to diagnose, since COHb levels are too low to be associated with CO poisoning.").

[11] *E.g.*, GBD 2021 Carbon Monoxide Poisoning Collaborators, *Global, regional, and national mortality due to unintentional carbon monoxide poisoning, 2000–2021: results from the Global Burden of Disease Study 2021*, 8 Lancet Public Health e839 (Oct. 6, 2023); Graber, et al., *supra* note 3 ("Carbon monoxide poisoning … is almost entirely preventable by the correct installation, maintenance, and operation of devices that may emit carbon monoxide, combined with the appropriate use of carbon monoxide detectors…carbon monoxide detectors could prevent at least half of all deaths attributable to nondisaster-related carbon monoxide poisoning.").

consecutive days.[12] Yet research has shown that adverse effects of CO begin at concentrations in the single digits[13] and multiple public health entities have required or recommended long-term CO exposure limits well below UL 2034 alarm thresholds.[14]

UL 2034 impedes the utility of CO alarms in several other ways: the standard fails to require all alarms to have accurate digital displays of CO concentration, allows unintuitive alarm signals, and relies on users to regularly and correctly replace batteries in battery-powered devices.[15] Combined with poor public familiarity with CO alarms, these design flaws that are allowed—if not mandated—under the existing voluntary standard create an unreasonable risk of injury for consumers.

Much advocacy has been dedicated to requiring the widespread installation of CO alarms,[16] but reducing preventable CO injuries also requires CO alarms that are effective, intuitive, and easy for consumers to maintain. To this end, NCOAA calls upon the Commission to close safety gaps left by UL 2034 by requiring:

a) Alarms to sound when CO concentrations reach 15 ppm for 30 days or 30 ppm for 1 hour;
b) Alarms to have digital displays of CO concentrations that are accurate to ±3 ppm, including accurate displays of CO concentrations below 30 ppm;
c) Alarm and trouble alerts using voice signals in multiple language options;
d) In battery-powered alarms, a battery or batteries designed to last the lifetime of the alarm and battery tamper-proofing features; and
e) Simplified user manual design to improve familiarity, operation, and maintenance.

I. Interest of Petitioner

This petition is brought by NCOAA, a non-partisan, grassroots, civic-minded advocacy organization focused on eradicating CO poisoning and helping CO poisoning survivors recover to lead happy, healthy, and productive lives. Charon McNabb founded NCOAA in 2015 after suffering from chronic low-level CO poisoning that was repeatedly misdiagnosed for over a

[12] UL Standards & Engagement (ULSE), *UL 2034* § 41 (5th ed. 2024).
[13] Bell, et al., *supra* note 3 (even short-term exposures to low CO concentrations in the ambient outdoor air (1-hour maximums ranging from 0.2 to 9.7 ppm) had a statistically significant association with an increased risk of hospital admissions related to cardiovascular disease).
[14] *Timeline of Carbon Monoxide (CO) National Ambient Air Quality Standards (NAAQS)*, U.S. Env't. Protection Agency (Jan. 16, 2024) (requiring ambient levels of CO to remain below 9 ppm); World Health Organization, *WHO global air quality guidelines: Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide* 135-136, Tables 3.25, 3.26 (2021) (recommending a health protective limit of 3.4 ppm (4 m/m^3) over 24 hours and 8.6 ppm over 8 hours).
[15] *See infra* notes 52, 76.
[16] *See, e.g.*, Perla Trevizo, et al., *Texas enabled the worst carbon monoxide poisoning catastrophe in recen38t U.S. history*, Texas Tribune (April 29, 2021, updated Aug. 17, 2021) (describing efforts of advocates to pass a state-wide mandate for carbon monoxide alarms in residences).

decade. Among other initiatives, NCOAA works with manufacturers, legislators, and standards committees to reduce CO poisoning incidence.

II. The Product

In this petition, "CO alarms" are defined as they are in UL 2034:

> "Electrically operated single and multiple station carbon monoxide alarms intended for protection in ordinary indoor locations and unconditioned areas."[17] "Ordinary indoor locations and unconditioned areas" include, but are not limited to, recreational vehicles, mobile homes, commercial vehicles, and recreational boats with enclosed accommodation spaces and cockpit areas.[18]
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> "Single station alarms" are alarms "consisting of an assembly of electrical and mechanical components including a sensor or sensors, an audible alarm, and an optional visual alarm constructed to detect the presence of carbon monoxide gas."[19] Single station alarms are "powered either from an external source by means of splice leads or a cord and plug arrangement or from an integral battery or batteries. Some devices have terminals for connection to remote audible signaling appliances or accessories. Some also contain an integral transmitter for energizing a remote audible signaling appliance."[20]

Where applicable, these requirements should also cover all remote accessories that may be connected to or are employed with a single or multiple station CO alarm.[21] For example, CO alarms intended for use with a remote controller should include a battery for the remote controller designed to last for the lifetime of the alarm.[22]

Devices excluded from the scope of this petition include CO gas detectors intended for use in hazardous locations as defined in the U.S. Coast Guard Electrical Engineering Regulations, as well as smoke alarms, fire alarms, and heat alarms as covered by the following

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[17] ULSE, *supra* note 12 § 1.1.
[18] *Id.*
[19] ULSE, *supra* note 12 § 5.4.
[20] *Id.*
[21] ULSE, *supra* note 12 § 37.2.1.
[22] One example of such a device is the X-Sense RC01 Pro Remote Controller, which includes a remote controller that can activate the "test" and "silence" features of connected CO alarms. The CO alarms with which the remote controller is designed to connect have an operating lifetime of ten years, but the battery accompanying the remote control only has a lifetime of one year. *RC01 Pro Remote Controller for Link+ Wireless Interconnected Alarms - 1-Pack*, X-Sense, https://www.x-sense.com/products/rc01-remote-controller-for-smoke-alarm (last visited Aug. 30, 2024).

standards: UL 217, ULC-S531, UL 268/ULC529, UL 539/ULC589, ULC-S530, UL 521, ULC-530.[23]

III. The Commission has authority to promulgate the mandatory performance standards requested in this petition.

CO alarms constitute "consumer products" within the Commission's jurisdiction. The Act defines "consumer product" as "any article … produced or distributed … for sale to a consumer for use in or around a permanent or temporary household or residence, a school, in recreation, or otherwise."[24] CO alarms are consumer products within the Commission's jurisdiction because they are produced for sale to consumers for use around residences and other living areas.

The Commission is authorized to promulgate performance requirements that are "reasonably necessary to prevent or reduce an unreasonable risk of injury associated with such product."[25] The safety standards requested herein are reasonably necessary to improve the performance of CO alarms that pose an unreasonable risk of CO injuries for consumers under the current voluntary standard. The Commission is not required to rely upon the existing voluntary standard because UL 2034 does not "eliminate or adequately reduce the risk of injury addressed."[26]

As described throughout this petition, the existing risk of injury posed by CO alarms is unreasonable because such injuries are preventable with feasible and modest changes. Manufacturers already make products that meet one or more of the performance standards requested in this petition, and this consumer product safety standard would simply bring all alarms up-to-par with the best-performing devices on the market.[27]

IV. CO alarms should alert consumers to the risks of injury presented by low-level CO poisoning.

To protect consumers from an unreasonable risk of injury, the Commission should initiate rulemaking for a standard that requires CO alarms to sound when CO concentrations reach 15 ppm for 30 days or 30 ppm for 1 hour.

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[23] ULSE, *supra* note 12 § 1.5.
[24] 15 U.S.C. § 2052(a)(5).
[25] *Id.* § 2056(a)(1).
[26] *Id.* § 2056(b)(1).
[27] For example, manufacturers make devices that alarm at and/or display CO concentrations less than 30 ppm, as well as devices that come with a pre-packaged 10-year lithium battery designed to last the lifetime of the alarm. E.g., *Kidde Sealed Lithium Battery Power Carbon Monoxide Alarm C3010*, Kidde, https://www.kidde.com/home-safety/en/us/products/fire-safety/co-alarms/c3010/ (last visited Sept. 8, 2024).

The current voluntary standard subjects CO alarm users to an unreasonable risk of injury from chronic low-level CO poisoning. Under UL 2034, CO alarms cannot sound at CO concentrations below 30 ppm, and alarms may be designed to sound at concentrations between 30±3 and 70±5 ppm only if CO concentrations are in this range for 30 consecutive days.[28] But these alarm thresholds far exceed CO concentrations that adversely impact human health, which can begin at single-digit concentrations.[29]

A significant body of scientific evidence shows that chronic exposure to low levels of CO—concentrations of 30 ppm and lower—can cause significant adverse health effects. Levels below 5 ppm have been found to increase risks of congestive heart failure, ischemic heart disease, myocardial infarction, stroke,[30] low birth weight,[31] and adverse neurodevelopmental outcomes.[32] These effects are exacerbated for the elderly and those with underlying comorbidities.[33] It is likely that chronic CO poisoning is commonly overlooked by medical professionals and victims due to its nonspecific and flu-like symptoms.[34]

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[28] ULSE, *supra* note 12 § 41.1 (Table 41.1).

[29] E.g., World Health Organization, *supra* note 14; Bell, *supra* note 3 (even short-term exposures to low CO concentrations in the ambient outdoor air (1-hour maximums ranging from **0.2 to 9.7 ppm**) had a statistically significant association with an increased risk of hospital admissions related to cardiovascular disease).

[30] *See* Wilbur, et al., *supra* note 1, Table 3-1 (citing studies finding CO levels of **0.3 to 2 ppm** linked to increased risk of congestive heart failure, ischemic heart disease, myocardial infarction, and stroke); Chun-Yuh Yang, et al., *Relationship Between Ambient Air Pollution and Hospital Admissions for Cardiovascular Diseases in Kaohsiung, Taiwan*, 67 J. Toxicology & Env't. Health, Part A 483 (2004) (finding significant relationship between the number of hospital admissions for cardiovascular disease and CO concentration in outdoor air pollution at CO levels ranging from **0.2 to 1.7 ppm**); Chun-Yuh Yang, *Air Pollution and Hospital Admissions for Congestive Heart Failure in a Subtropical City: Taipei, Taiwan*, 71 J. Toxicology & Env't. Health, Part A 1085 (2008) (finding a significant relationship between the number of hospital admissions for congestive heart failure and CO concentration in outdoor air pollution at CO levels ranging from **0.12 to 3.66 ppm**); Yun-Chul Hong, et al., *Effects of air pollutants on acute stroke mortality*, 110 Env't. Health Perspectives 187–191 (Feb. 2002) (finding a significant relationship between stroke mortality and CO concentration in outdoor air pollution at levels ranging from **0.4 to 3.4 ppm**).

[31] *E.g.*, B. Ritz & F. Yu, *The effect of ambient carbon monoxide on low birth weight among children born in southern California between 1989 and 1993*, 107 Env't. Health Perspectives 17 (finding a significant relationship between the frequency of low birth weight among neonates and CO concentration in outdoor air pollution at CO levels from **0.65 to 6.70 ppm**).

[32] Linda Dix-Cooper, et al., *Neurodevelopmental performance among school age children in rural Guatemala is associated with prenatal and postnatal exposure to carbon monoxide, a marker for exposure to woodsmoke*, 33 Neurotoxicology 246 (Mar. 2012) (mothers' exposure to concentrations of CO ranging from **0.6 to12.5 ppm** in the third trimester was significantly associated with impaired neuropsychological performance in children tested at 6 to 7 years of age).

[33] *Id*.

[34] *E.g.*, Syuichi Tetsuka, et al., *Repeated unconsciousness due to chronic carbon monoxide poisoning in an older patient: a case report*, 16 J. Rural Med. 289 (Oct. 1, 2021); J. Wright, *Chronic and occult carbon monoxide poisoning: we don't know what we're missing*, 19 Emerg. Med. J. 386 (2002) (describing

Other public health entities have required or recommended long-term CO exposure limits well below UL 2034 alarm thresholds. Under the Environmental Protection Agency's National Ambient Air Quality Standards ("NAAQS"), states must ensure that ambient CO in the outdoor air does not exceed 9 ppm over 8 hours or 35 ppm over 1 hour.[35] NAAQS must be set at a level requisite to protect the public health with an adequate margin of safety, meaning pollution levels above the NAAQS may be injurious to the public.[36] The National Institute for Occupational Safety and Health recommended exposure limit is 35 ppm over an 8-10 hour workday.[37] The Occupational Safety and Health Administration's permissible exposure limit is a 50 ppm over an 8-hour workday,[38] while the California Division of Occupational Safety and Health's permissible exposure limit is 25 ppm over an 8-hour workday.[39] While these agencies' specific protective levels differ for the different contexts in which these thresholds apply, all of these agencies have all concluded that long-term inhalation of CO impermissibly harms human health at levels from 9-50 ppm.

There is evidence that ambient indoor CO levels occur at or above injurious concentrations. EPA estimates that average CO levels in homes range from 0.5 to 15 ppm, with higher levels in homes with poorly adjusted gas stoves.[40] In studies of ambient in-home CO concentrations conducted by the Department of Energy and the Department of Housing and Urban Development, the ambient concentration of CO in most homes did not exceed 10 ppm over the weeklong monitoring period, but 20-30% of homes had peak events reaching or exceeding 9-10 ppm over the same period.[41] In those studies, the identified sources of CO included faulty appliances, cooking with gas ovens and ranges, and attached garages.[42] Ambient concentrations can reach levels of 25-50 ppm if gas stoves are used for heating.[43] These surveys

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studies of patients who presented with nonspecific symptoms and were screened for CO poisoning, which found a non-zero percentage with COHb toxicity).

[35] Env't. Protection Agency, *supra* note 14.

[36] 42 U.S.C. § 7409(b)(1).

[37] *Carbon monoxide*, National Institute for Occupational Safety and Health, https://www.cdc.gov/niosh/npg/npgd0105.html (last rev. Oct. 30, 2019).

[38] *Carbon Monoxide*, Occupational Safety and Health Administration, https://www.osha.gov/chemicaldata/462 (last rev. Nov. 1, 2024, last visited Dec. 11, 2024).

[39] *Table AC-1: Permissible Exposure Limits for Chemical Contaminants*, California Department of Industrial Relations, https://www.dir.ca.gov/title8/5155table_ac1.html (last visited Aug. 8, 2024).

[40] *Carbon Monoxide's Impact on Indoor Air Quality*, U.S. Env't. Protection Agency, https://www.epa.gov/indoor-air-quality-iaq/carbon-monoxides-impact-indoor-air-quality (June 6, 2024, last visited Dec. 11, 2024).

[41] Paul W. Francisco, et al., *Carbon Monoxide Measurements in Homes*, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2016).

[42] *Id.*

[43] W. Michael Alberts, *Indoor air pollution: NO, NO_2, CO, and CO_2*, 94 J. Allergy & Clinical Immunology 289 (Aug. 1994) ("[h]ourly CO concentrations during cooking with gas stoves range from 2 to 6 ppm, although 1-hour averages may exceed 12 ppm.").

show that there is an appreciable risk of ambient indoor CO pollution occurring at health-harming levels.

Currently, those who are sensitive to lower concentrations of CO must purchase alternative products to monitor CO levels below 30 ppm.[44] But it is unreasonable to expect at-risk populations to rely on alternative devices for protection. For vulnerable people to determine they need such a device, they first must be alerted that low-level CO is present, a function that current CO alarms cannot perform under UL 2034. Low-level CO monitors are discretionary purchases, so they will not provide protection to as many people as CO alarms can in jurisdictions that mandate CO alarms. Strengthening CO alarm performance by lowering the alarm setpoint is necessary to ensure more consumers are protected from unreasonable risks of CO injury.

With lower alarm set-points, CO alarms would alert users to injurious concentrations of low-level CO without enabling frequent nuisance alarms due to ambient background concentrations. The prevailing alarm set-points under UL 2034 are informed largely by a spate of nuisance alarms causing a large volume of first-responder calls in Chicago in 1994 and Los Angeles in 1995. Early CO alarms had significantly lower set-points than alarms today, and the nuisance alarms were driven by atmospheric temperature inversions that trapped CO from vehicle exhaust close to the ground.[45] In response to the nuisance alarm events, UL adjusted alarm setpoints upward to sound only when concentrations reached 15 ppm for 30 days so that "an inversion layer won't make the detector go off anymore."[46] Previously, alarms rang when concentrations reached 15 ppm for 8 hours.[47] In the following years, UL continued adjusting alarm setpoints upward, and CO alarms ultimately became considered "life-safety, not injury-prevention devices."[48]

But the Chicago and Los Angeles nuisance alarm events do not support today's requirement of high CO alarm setpoints. Not only were those nuisance alarm events caused by irregular atmospheric phenomena, but outdoor CO levels have dropped significantly in the last few decades–CO emissions are approximately one-third of what they were in the mid-1990s, largely due to stronger vehicle emission standards.[49] Today, all areas in the U.S. are designated as

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[44] The relevant standard for these devices is UL 2075 (Gas and Vapor Detectors and Sensors).
[45] Sleezer, et al., *supra* note 2 at 14; James Rainey, *Fog Sets Off Gas Detectors, Causing Scares: Weather: Moisture traps carbon monoxide close to the ground, triggering false alarms and generating more than 3,300 calls to authorities. Newer devices avoid the problem*, LA Times (Dec. 8, 1995) (last visited Oct. 31, 2024).
[46] Rainey, *supra* note 45.
[47] *Id.*
[48] Sleezer, et al., *supra* note 2 at 15.
[49] *Annual carbon monoxide emissions in the United States from 1970 to 2023*, Statista, https://www.statista.com/statistics/501274/volume-of-carbon-monoxide-emissions-us/ (last visited Oct. 31, 2024).

either attaining or maintaining EPA's ambient air standards for CO.[50] Accordingly, outdoor CO pollution is unlikely to trigger residential CO alarms even in the case of temperature inversions.

To ensure consumers are protected, the Commission should adopt a requirement to lower the alarm setpoint to UL's initial adjustment of 15 ppm for 30 days, which was designed to alert users of injury-causing CO levels without alarming due to transient background CO concentrations. To ensure users are also protected from CO spikes, the Commission should also adopt a requirement that alarms sound at CO concentrations of 30 ppm for 1 hour.

V. CO alarms should have digital displays that show precise CO concentrations, including concentrations below 30 ppm.

To ensure consumers are protected from all levels of CO exposure, all CO alarms should be required to have digital displays reflecting the ambient concentration of CO detected.

There is currently no requirement for CO alarms to have digital displays. Mandating all CO alarms to have displays would bolster their protectiveness by allowing consumers to monitor ambient CO concentrations and enabling them to address potential CO issues before CO concentrations reach injury-causing levels.

Additionally, the Commission should adopt a requirement for digital displays to show the actual concentration of CO detected to an accuracy of ± 3 ppm.

UL 2034 requires alarms with digital displays to read "0 ppm" unless CO concentrations exceed 30 ppm.[51] Consumers are likely to reasonably believe that a readout of 0 ppm indicates no CO in the air even though concentrations may be as high as 29 ppm. Sub-alarm levels can still cause significant adverse health effects and likely indicate an abnormal source of CO in the home, but users would not be empowered to seek treatment for exposure nor to address potential sources of CO.

Requiring accurate low-level displays will bring alarm performance in line with existing consumer expectations. As shown from the Commission's pilot survey on CO alarms, 85% of users believed that CO alarms sound when CO is present.[52] Consumers also expect alarms with digital displays to show CO concentrations accurately. For example, this expectation is reflected

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[50] *Applying or Implementing the Outdoor Air Carbon Monoxide (CO) Standards*, U.S. Env't. Protection Agency, https://www.epa.gov/co-pollution/applying-or-implementing-outdoor-air-carbon-monoxide-co-standards (last visited Nov. 5, 2024).

[51] ULSE, *supra* note 12 § 38.8 ("Any indicator of CO concentration shall be accurate to within plus or minus 30% of the indicated amount and display the gas concentration … within this standard. No indication shall be given for CO concentrations less than 30 ppm.").

[52] U.S. Consumer Product Safety Comm'n. & EurekaFacts, *SCOA Survey Findings from the Washington DC Metro Area Door-to-Door Pilot* 11-12 (Sept. 15, 2020).

under the reviews for the UL-listed Kidde Carbon Monoxide Alarm (model no. KN-COPP-B-LPM) on Amazon.com, which has a 4.7-star rating out of over 18,000 ratings.

One reviewer stated they "like the display to show [them] if any Carbon Monoxide is / was present at all."[53] Similarly, another reviewer stated, "If I want to determine the safety of a specific area, … I can read if there is any CO present, even if it is below the trigger threshold. I prefer that to just alarming when it gets bad."[54] Some users were aware that the display does not show a reading of CO concentrations below 30 ppm, but expressed disappointment about this limitation. One reviewer noted, "[I]t is disappointing that the display will only show 0 until you hit 30ppm … This device will protect your average healthy adult from severe CO poisoning, but just because it's reading zero doesn't mean there isn't harmful amounts of CO present."[55]

The product listing does not include any mention that the digital display will only display concentrations over 30 ppm. The product description states that the display "indicates the level of CO that the unit is sensing" and "allows for easy monitoring of CO levels."[56] These descriptions reasonably lead a user to believe that the digital display accurately displays CO concentrations below 30 ppm. Thus, requiring displays to accurately display low-level CO concentrations would bring CO alarm performance in line with consumers' understanding and expectations for CO alarms.

It would be feasible for manufacturers to include low-level displays because these alarms can already measure, record, and display concentrations of CO below 30 ppm with their "peak level memory" feature. While users of the Kidde Carbon Monoxide Alarm can press the "peak level" button to show the highest level of CO detected since the last reset, this does not fix the safety gaps left by the misleading display. Consumers are likely to believe that a 0 ppm reading indicates an absence of CO, and so would not know to press the "peak level" button to investigate the potential presence of low-level CO. The alarm may also be installed in a location that is physically inaccessible for users to conveniently access the "peak level" button. And even with the "peak level" feature, this device only displays levels down to 11 ppm.

There is also precedent for this display accuracy standard. CSA 6.19-17 (R2022), the standard for residential CO alarms published by the Canadian Standards Association, allows

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[53] *Customer Review*, Amazon.com, https://www.amazon.com/gp/customer-reviews/R3R9QV0CCAL7UT/ref=cm_cr_arp_d_rvw_ttl?ie=UTF8&ASIN=B004Y6V5CI (May 29, 2024, last visited Sept. 8, 2024).
[54] *Customer Review*, Amazon.com, https://www.amazon.com/gp/customer-reviews/R3MD62HRB0MA0F/ref=cm_cr_getr_d_rvw_ttl?ie=UTF8&ASIN=B004Y6V5CI (Feb. 12, 2024, last visited Sept. 8, 2024).
[55] *Customer Review*, Amazon.com, https://www.amazon.com/gp/customer-reviews/R2SCF38348EZHI/ref=cm_cr_getr_d_rvw_ttl?ie=UTF8&ASIN=B004Y6V5CI (June 22, 2017, last visited Sept. 8, 2024).
[56] *Kidde Carbon Monoxide Detector, AA Battery Powered CO Alarm with LEDs, Test-Reset Button, Low Battery Indicator, Portable*, Amazon.com, https://tinyurl.com/up22mrun (last visited Sept. 8, 2024).

approval of alarms with digital displays that show concentrations below 30 ppm.[57] This change was implemented as a request from Health Canada, the Canadian government's public health agency.[58] In 2018, Kidde proposed a change to UL 2034 that would incorporate this standard, which would allow manufacturers to design a common product eligible for both UL 2034 and CSA 6.19-17 approval.[59] For reasons not made clear in UL's online materials, this change was not adopted.

Requiring an accurate display on CO alarms supports the Commission's ongoing effort to "improve consumer use and awareness regarding the operability of [smoke and CO] alarms."[60] Although consumer education can improve alarm understanding, the success of such efforts will be limited without regulations that eliminate the need to universally educate consumers about the limitations of CO alarms.

VI. CO alarms should use voice signals.

Alarm and trouble signals must be made more communicative as to the presence of CO and as to what response is required. The Commission should adopt a requirement for CO alarms to alert users using a voice signal that communicates the presence of dangerous levels of CO and that directs users to exit to fresh air (e.g., "Warning, carbon monoxide detected, evacuate to fresh air."). The Commission should also adopt a requirement for ancillary signals to be communicated with voice signals (e.g., "Detector error, end of life."). These voice signals can be used in addition to the current 4-beep signal.

The effectiveness of CO alarms is limited by consumers' familiarity with CO alarm signals and their understanding of what to do when the devices sound.[61]

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[57] Canadian Standards Association (CSA), *CSA 6.19-17 (R2022)* (2d. ed. 2022), https://www.csagroup.org/store/product/2425029/ (last visited Dec. 11, 2024) ("The Scope has been expanded to include devices that numerically display low (<30 ppm) CO levels."). This change does not require digital displays to provide a non-zero numerical readout when concentrations below 30 ppm are detected, but rather allows alarms that provide this information to obtain CSA 6.19 certification. Such alarms cannot be certified under UL 2034.

[58] *UL Collaborative Standards Development System ("CSDS") Proposal* at 1 (April 6, 2018) (describing the change to CSA 6.19 as a request from Health Canada, the Canadian government's public health agency).

[59] *Id.* The proposal was submitted by Larry Ratzlaff of Kidde Residential and Commercial, a manufacturer of CO and smoke alarms.

[60] 83 Fed. Reg. 12,178, *Agency Information Collection Activities; Proposed Collection; Comment Request; Submissions, Survey on Smoke and Carbon Monoxide Alarms* (Mar. 20, 2018).

[61] Wheeler-Martin, et al., *supra* note 4 ([T]he effectiveness of CO alarms or smoke alarms…is limited by human awareness of the appropriate actions to take when an alarm sounds…Even without impairment, taking action when a CO alarm activates can seem counterintuitive when nothing appears to be out of the ordinary, because of the odorless and colorless nature of CO.").

Under the current standard, high CO levels are conveyed in a four-beep sequence.[62] This signal can be easily confused with a smoke alarm signal, which alerts users of smoke in a three-beep sequence. Users who hear a CO alarm but do not smell or see smoke can mistake the CO signal as a false smoke alarm and make a life-threatening decision to stay indoors or neglect to seek medical treatment. Such users would also remain unaware of the need to address the source of CO that triggered the alarm, remaining vulnerable to future exposures. In addition, the four-beep sequence does not point to a necessary response—consumers may not know about the need to escape to fresh air and may not appreciate the presence of an emergency given the imperceptible nature of CO. In one survey, more than half of respondents were unable to distinguish the difference between beeps from a CO alarm, smoke alarm, and microwave signal.[63] Older adults in particular are less likely to be knowledgeable about CO safety.[64]

Although UL 2034 requires instruction manuals and devices to indicate that four beeps mean dangerous CO levels, written materials are insufficient to convey how users should react in the case of an alarm.[65] It is unreasonable to expect consumers to have ready access to the user manual, which may have been disposed of, hard to find, or in the possession of a landlord or past tenant who installed the alarm. Users also may not think to reference the user manual, particularly if they are impaired.

Alarm users may also be unfamiliar with ancillary signals (i.e., "trouble signals") meant to indicate a fault in the device, such as an open or shorted condition of a component in the device or the loss of power.[66] While UL 2034 requires alarms to be marked with information distinguishing various signals,[67] it is unreasonable to rely on consumers to reference the device itself to decode an alarm's different sound patterns. CO alarms are typically mounted on the ceiling or high on a wall, making it impossible to read alarm markings without the device in hand. This leaves critical information out-of-reach for users who may be impaired or simply without a stepladder. Users who do not recognize the meaning of trouble signals may neglect to maintain or replace faulty devices and consequently increase their vulnerability to CO poisoning.

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[62] ULSE, *supra* note 12 § 5.3 (requiring alarm signals to be a 4-beep sequence with 5-60 seconds between sequences).
[63] Knox Safety, *Survey Shows Less Than 50% of Respondents Recognize the Sounds of Home Safety Emphasizing Need for Technologically Advanced Carbon Monoxide Alarms*, https://ksalarms.com/Advanced-Carbon-Monoxide-Alarms.html (Sept. 30, 2021, last visited Dec. 11, 2024).
[64] Wendy C. Shields, et al., *Knowledge and injury prevention practices in homes of older adults*, 34 Geriatric Nursing 19 (Jan-Feb 2013).
[65] ULSE, *supra* note 12 § 91.1(d) (CO alarm instructions must include a directive that if a "4-beep pattern" sounds, occupants must immediately evacuate and alert emergency responders).
[66] *Id.* § 5.24 (requiring trouble signals to consist of one short beep repeating every 30-60 seconds ±10%).
[67] *Id.* § 89.2(h) (requiring markings to include a "[d]istinction between alarm, pre-alarm, end-of-life, and trouble signals on units employing these signals").

Voice signals that state exactly what they mean can address these problems by making it clear how a user must respond to the situation. In addition to being more communicative, voice signals have the advantage of being more effective at waking sleeping children than tone alarms.[68] Implementing voice signal technology is also feasible because manufacturers already sell CO alarms with voice signals, including alarms that allow users to select voice signals in multiple languages.[69]

To ensure voice signals are communicative to non-English speakers, the Commission should also require an option for users to select voice signals in common languages spoken in limited English-speaking households (e.g., Chinese, Vietnamese, Spanish, and Arabic).[70] Language accessibility is particularly important to protect elderly immigrant populations, who are more likely to have limited English proficiency in addition to health and mobility factors contributing to higher risks of CO injury.[71]

VII. Battery-powered CO alarms should include batteries designed to last the lifetime of the alarm.

To protect the public from an unreasonable risk of CO injury, the Commission should adopt a requirement for all manufacturers of battery-powered CO alarms to provide a battery or

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[68] Gary A. Smith, et al., *Effectiveness of a Voice Smoke Alarm Using the Child's Name for Sleeping Children: A Randomized Trial*, 205 J. Pediatrics 250 (Feb. 2019) (sleeping children were 2.9-3.4 times more likely to be awakened by voice alarms than tone alarms); Gary A. Smith, et al., *Do Sleeping Children Respond Better to a Smoke Alarm That Uses Their Mother's Voice?*, 20 J. Pediatrics. 319 (Apr. 2020) (voice alarms and a low-frequency tone alarm "significantly outperformed" a high-frequency tone alarm in waking children and reducing their time taken to perform an escape procedure); *see also* U.S. Consumer Product Safety Comm'n., *A Review of the Sound Effectiveness of Residential Smoke Alarms (CPSC-ES-0502)* 32-33, 24 (rev. Dec. 2004) (concluding that current smoke alarms do not reliably wake sleeping children or alert seniors with hearing loss, and recommending further exploration of alternative signals, including voice signals).

[69] *E.g.*, *Carbon Monoxide Alarm Direct Plug-in AC, Model 7200,* Knox Safety, https://ksalarms.com/carbon-monoxide-alarm-direct-plug-in-ac.html (last visited Oct. 29, 2024) (voice signal communicates warnings and emergency instructions in English or Spanish); *First Alert Wireless Interconnect Battery Operated Carbon Monoxide Alarm With Voice Location - CO511B*, First Alert Store, https://www.firstalertstore.com/store/products/wireless-interconnect-carbon-monoxide-alarm-with-voice-co511b.htm (last visited Oct. 29, 2024) (voice signal communicates which room the alarm was triggered in; upon installation, users can designate the location of each alarm from a pre-set menu of locations (e.g., "Basement," "Child's Bedroom")).

[70] *See What Languages Do We Speak in the United States?* Fig. 5, U.S. Census Bureau, https://www.census.gov/library/stories/2022/12/languages-we-speak-in-united-states.html (last visited Oct. 29, 2024) (about one-third of Chinese- and Vietnamese-speaking households and about one-fifth of Spanish-speaking households are limited English-speaking households).

[71] Stephanie Zemba & Meeta Mehrotra, *"What's your accent, where are you from?": Language and belonging among older immigrants*, 67 J. Aging Studies 101189 (Dec. 2023) ("Language barriers are a pressing issue for older immigrants … over half (55.4%) of foreign-born older adults speak a language other than English at home while also reporting a limited proficiency in English.").

batteries designed to last the life of the alarm without replacement. Manufacturers today routinely provide starter batteries with battery-powered CO alarms,[72] and many offer CO alarms that include a 10-year lithium battery designed to last the life of the alarm.[73] Such long-lasting batteries eliminate the need for users to identify and purchase specific replacement batteries on a recurring basis. Requiring all manufacturers to abide by this practice avoids placing the burden on consumers to correctly and consistently replace batteries.

Under UL 2034, batteries in battery-powered CO alarms are only required to provide power to the unit under ambient conditions for one year.[74] The standard also requires users to obtain specific battery brands and models as replacements.[75] This relies on users to correctly and consistently replace CO alarm batteries, and users who fail to do so can have gaps in their protection from CO poisoning.

The current standard's user expectations are unreasonable and introduce periods of time where users with CO alarms are not protected by them. Consumers may put off replacing their batteries when faced with the cost of buying batteries on a recurrent basis. Consumers are unlikely to discern that specific battery brands and models are required to ensure reliable power for the device; they are more likely to assume that any replacement battery of the same type will suffice. Even if consumers are aware of the specific battery requirements, those battery models may be discontinued or be hard to find consistently over the 5-10 year lifespan of the device. And these burdens are multiplied by each alarm in the home—if the home has different alarm

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[72] *E.g.*, *CO410 Battery Operated Carbon Monoxide Alarm with Backlit Digital Display*, First Alert, https://www.firstalert.com/us/en/products/alarms/carbon-monoxide-alarms/co410-battery-operated-carbon-monoxide-alarm-with-backlit-digital-display-co410/ (last visited Sept. 8, 2024).

[73] E.g., *1039752 10-Year Battery Carbon Monoxide Alarm w/Digital Temperature Display*, First Alert, https://www.firstalert.com/us/en/products/alarms/carbon-monoxide-alarms/1039752-10-year-battery-carbon-monoxide-alarm-w-digital-temperature-display-1039752/ (last visited Sept. 8, 2024); *Universal Security Instruments Sensing Plus Multi Criteria Smoke, Fire and Carbon Monoxide Alarm With 10 Year Tamper Proof Sealed Battery (AMIC3511SB)*, Universal Security Instruments, https://www.universalsecuritystore.com/store/products/sensing-plus-combination-smoke-fire-and-co-alarm-10-year-battery-amic3511sb.htm (last visited Sept. 8, 2024).

[74] ULSE, *supra* note 12 § 66.1 ("If a battery is employed as the main source of power of a single station carbon monoxide alarm, it shall provide power to the unit under intended ambient conditions for at least 12 months in the standby condition...").

[75] ULSE, *supra* note 12 §§ 89.2(e) (requiring the device to be marked with "[i]dentification of batteries by part number, manufacturer's model number or equivalent, located adjacent to the component"), 89.2(m) (requiring user manuals for battery operated alarms to include "Use Only Batteries Specified in Marking. Use Of a Different Battery May Have a Detrimental Effect on Alarm Operation"). For product examples, *see, e.g.*, SimpliSafe, *SimpliSafe Carbon Monoxide Detector Manual (SSCO3-0)* 3 (Apr. 2021) (instructing users to replace batteries with the following "approved" products: Energizer #E91 Alkaline batteries, Energizer #L91 lithium batteries, or GP #LR6 lithium batteries); First Alert, *First Alert User's Manual for 120V Plug-In Carbon Monoxide Alarm With Battery Back-Up and Silence Feature (Model CO606)* 3 (June 2019) (instructing users to use the "exact batteries specified": Duracell MN1604, Energizer 522, and Ultralife U9VL-J-P).

models, the task of replacing batteries might require identifying and purchasing different sets of batteries and replacing each in the correct device.

There is evidence showing that a significant percentage of users fail to maintain working batteries in CO alarms. Surveys have found that a majority of people living in residences with CO alarms rely on a low-battery signal to check for battery life, rather than proactively checking battery life every week as instructed by manufacturers under UL 2034.[76] Even when provided with battery replacement instructions and spare batteries, users do not reliably replace batteries as required.[77] In situations where the battery has died completely, users may not be alerted to the need for battery or device replacement.

In sum, the battery requirements of UL 2034 unnecessarily complicate alarm maintenance and introduce risks of unprotected periods of time between working batteries. Requiring manufacturers to include long-lasting batteries, as they already do for some products on the market, would ameliorate these problems and ensure that battery-powered devices function for their operational lifetime. Additionally, to ensure that included batteries power CO alarms as intended, the Commission should also require included batteries to be protected with tamper-proofing features. These features should mirror the battery tamper-proofing features required under the UL standard for smoke alarms, UL 217.[78]

VIII. CO alarm user manuals and device markings should be made more accessible.

To encourage users to familiarize themselves with the information contained in user manuals, the Commission should gather information on ways to make CO alarm manuals simpler and more digestible to users. For example, the manual and/or CO alarm packaging could be required to include a top-level summary of the necessary operation and maintenance information contained therein. With more accessible information, CO alarm users will be better equipped to interpret alarm signals and conduct proper maintenance, thereby improving the alarms' ability to prevent CO injury. Although CO alarm manuals contain critical information for users to

[76] Michael E. King & Scott A. Damon, *Attitudes about Carbon Monoxide Safety in the United States: Results from the 2005 and 2006* HealthStyles *Survey*, 126 Pub. Health Reports 100 (2011) (over half of respondents who owned a CO detector reported checking the battery only when it beeps); ULSE, *supra* note 12 § 89.2(i) (requiring markings on battery-powered alarms to instruct users to test the alarm at least once per week).

[77] *See* Lara B. McKenzie, et al., *Distribution and Evaluation of a Carbon Monoxide Detector Intervention in Two Settings: Emergency Department and Urban Community*, 79 J. Env't. Health 24 (May 2017) ("Our results suggest that the educational tool and messages on battery replacement were not effective in motivating participants to change the battery, even when a replacement battery was provided.").

[78] ULSE, *UL 217* (10th ed. 2024) (relevant sections include § 15.1.4 ("When the battery is capable of powering the alarm for a minimum of 10 years, the battery shall not be user replaceable")).

understand the capabilities and maintenance needs for their alarms, it is likely that few users take the time to thoroughly review these documents.[79]

IX. Action Requested

For the reasons described above, NCOAA requests that the Commission exercise its authority under 15 U.S.C. § 2056 to initiate rulemaking for a consumer product safety standard that improves the performance requirements for CO alarms. Specifically, the petitioner requests that the Commission initiate rulemaking for a rule that adopts the following performance standards that are reasonably necessary to protect CO alarm consumers from an unreasonable risk of injury:

a) Alarms to sound when CO concentrations reach 15 ppm for 30 days or 30 ppm for 1 hour;
b) Alarms to have digital displays of CO concentrations that are accurate to ±3 ppm, including accurate displays of CO concentrations below 30 ppm;
c) Alarm and trouble alerts using voice signals in multiple language options;
d) In battery-powered alarms, a battery or batteries designed to last the lifetime of the alarm and battery tamper-proofing features; and
e) Simplified user manual design to improve familiarity, operation, and maintenance.

Thank you for your consideration of this petition.

Sincerely,

/s/ Charon McNabb
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[79] *See* Michael S. Wogalter & Kenneth R. Laughery, *Product Manuals: Reported Reading and Beliefs*, in G. Lindgaard & D. Moore (Eds.), *Proceedings of the 19th Triennial Congress of the International Ergonomics Association*, 1474-1476 (2015).