United States
Consumer Product Safety Commission

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Ballot Vote Sheet

TO: The Commission
Alberta E. Mills, Secretary

DATE: March 5, 2025

THROUGH: Asha Allam, Acting General Counsel
Brien Lorenze, Executive Director

FROM: Daniel R. Vice, Assistant General Counsel, Regulatory Affairs
Charlotte G. Alton, Attorney, Regulatory Affairs

SUBJECT: Petition Requesting Rulemaking to Establish a Consumer Product Safety Standard for Carbon Monoxide Alarms; Defer Agency Action

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BALLOT VOTE DUE: March 11, 2025

On December 18, 2024, Charon McNabb (Petitioner), President and Founder of the National Carbon Monoxide Awareness Association (NCOAA), filed a petition requesting that the Commission initiate a rulemaking to establish a mandatory standard for carbon monoxide alarms. NCOAA asserts that the current voluntary standard, UL 2034 *Single and Multiple Station Carbon Monoxide Alarms*, is "insufficient to protect consumers from an unreasonable risk of injury." The Office of the General Counsel has docketed the petition. Staff recommend the Commission vote to defer action on the petition while staff work with UL to update the UL standard.

Please indicate your vote on the following options:

I. Defer action on the petition.

_____ _____
(Signature) (Date)

U.S. Consumer Product Safety Commission
4330 East-West Highway
Bethesda, MD 20814

National Product Testing and Evaluation Center
5 Research Place
Rockville, MD 20850

II. Do not defer action on the petition and instead direct staff to re-evaluate the petition.

(Signature) (Date)

III. Take other action specified below.

(Signature) (Date)

Staff Briefing Package

2025 Petition for Rulemaking to Establish Requirements for Carbon Monoxide Alarms

March 5, 2025

United States
Consumer Product Safety Commission

Memorandum

TO: The Commission
Alberta E. Mills, Secretary

DATE: March 5, 2025

THROUGH: Asha Allam, Acting General Counsel
Brien Lorenze, Executive Director
DeWane Ray, Deputy Executive Director for Safety Operations

FROM: Matt Brookman P.E. Project Manager
Division of Mechanical Engineering
Directorate for Laboratory Sciences

SUBJECT: Petition Requesting Rulemaking to Establish Requirements for Carbon Monoxide Alarms

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I. Introduction

On December 18, 2024, the National Carbon Monoxide Awareness Association (NCOAA or Petitioner) submitted Petition 25-1 to the U.S. Consumer Product Safety Commission (Commission or CPSC) requesting that the Commission initiate rulemaking under the Consumer Product Safety Act, 15 U.S.C. § 2056, to address the Petitioner's claims of deficiencies in the UL Standards & Engagement (UL) standard, UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Alarms,* associated with Carbon Monoxide (CO) exposure hazards. The Petitioner is a member of the UL 2034 Technical Committee (the Committee).

The NCOAA is an organization focused on eliminating chronic and acute CO poisoning. The organization is active in promoting awareness of the hazards associated with CO poisoning and CO alarms. The NCOAA works with entities such as advocacy groups, manufacturers, government agencies, researchers, and legislators through the Carbon Monoxide Safety Coalition. The Coalition's areas of focus include increasing public awareness of CO hazards, developing codes and standards, promoting CO poisoning prevention regulations, CO hazard data collection, improving diagnostics and treatment, survivor support, and enhancing research activities.

Petition 25-1 requests that CPSC initiate rulemaking to develop a rule that establishes the following performance and design requirements related to CO alarms:

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

Currently, features such as digital displays, voice signals, and alarm "lifetime" tamper-resistant batteries can be found in various models of CO alarms on the market. The Petitioner requests the Commission mandate these features, as well as additional changes to UL 2034, to address potential effects from chronic low-level CO exposure and to enhance user familiarity with CO alarms and CO hazards.

UL 2034 applies to electrically operated single and multiple station CO alarms for use in ordinary indoor locations and unconditioned spaces. The alarms can be standalone devices or connected to a remote panel for building monitoring. Currently, compliant CO alarms are required to activate prior to an exposure that is assessed as likely to poison an individual and prevent their ability to take effective measures against the dangers associated with CO exposure. The current UL standard does not require digital displays, voice alarm signals, or alarm lifetime batteries, but also does not restrict their use.[1] The standard also provides thorough instruction and marking requirements that were recently updated with participation from the Petitioner.

On January 13, 2025, the Petitioner, as a member of the Committee, proposed requirements two through five of the Petition to the Committee for consideration.[2] The Committee agreed to establish a task group to address these concerns. Under UL's process, the proposed requirements and claimed health effects presented by the Petitioner will be evaluated by subject matter experts, advocacy groups, and industry members within the Committee to determine validity and feasibility. Additionally, lower activation levels such as requirement one of the Petition, were discussed in the January 13 meeting, however no specific activation levels were proposed.

In addition to the ongoing voluntary standards activity, the Fire Protection Research Foundation (FPRF) is performing a review of CO alarm and detection thresholds. The purpose of this review is to determine if new information is available regarding the dangers of CO exposure at different levels for various populations. The review will identify knowledge gaps and provide recommendations to address them. Once published, this information may be used to validate the existing alarm thresholds or support changes to UL 2034 through voluntary standards development. New information could address chronic low-level CO exposure and associated symptoms, which have been difficult to study due to limited incident reporting, differentiation of symptoms from other illnesses, and comorbidities.

II. Discussion

Carbon monoxide is a colorless, odorless, and poisonous gas that results from the incomplete combustion of fuels, such as natural or liquefied petroleum (LP) gas, gasoline, oil, wood, coal, and other fuels. Fuel burning appliances such as furnaces, water heaters, stoves, charcoal grills, and portable generators emit CO in various amounts. The amount of CO emitted from any appliance may increase if it is not operating properly due to circumstances such as poor maintenance, inadequate ventilation, or faulty exhaust pathways.

The health effects related to CO depend upon its concentration in blood, which, in turn, depends upon its concentration in air, an individual's duration of exposure, and an individual's general health. Carbon monoxide combines with the body's hemoglobin (Hb) with an affinity about 250 times that of oxygen, forming carboxyhemoglobin (COHb) and interfering with oxygen uptake, delivery, and use by the cells.

[1] UL 2034 provides requirements for digital displays, including display value and accuracy specifications.
[2] https://www.cpsc.gov/s3fs-public/01-13-2025-UL2034-STP-Meeting-Log-Petition-Proposals-and-CSA-Harmonization.pdf?VersionId=rkeG1EbKdxMv3r5wqxtiG5ZBLJ6mog5I.

Generally, in healthy individuals, no perceptible health effects or symptoms occur at COHb levels below 10 percent. Symptoms associated with blood levels at or above 10 percent COHb include headache, fatigue, nausea, and cognitive impairment. Loss of consciousness, coma, and death can occur at COHb levels greater than 20 percent; but for healthy adults, CO deaths typically require levels above 50 percent COHb.[3]

CPSC's Directorate of Epidemiology continues to report on estimates of fatalities associated with CO poisoning from consumer products. Its latest report[4] found evidence of a statistically significant upward trend in non-fire CO deaths for the 11-year period from 2010 to 2020. The estimated annual average from 2018 to 2020 was 225 unintentional, non-fire CO poisoning deaths. This reporting largely focuses on acute poisonings (those for which health effects occur immediately or in the near-term after higher exposures). Chronic poisonings, which the petitioner also focuses on, occur at lower and variable exposures, over longer periods of time. The petitioner asserts that these effects include adverse cardiovascular, developmental, and neurological outcomes. Data for these chronic poisonings are more limited.

The following discussion provides an overview of each proposal in the Petition and the current UL 2034 requirement.

A. Alarm Activation at 15 ppm for 30 Days or at 30 ppm for One Hour

The Petitioner is requesting that the Commission promulgate a rule that will require CO alarms to activate if the CO concentration is measured to be 15 ppm for a duration of 30 days or is measured to be 30 ppm for one hour. The Petitioner claims that there is an unreasonable risk of injury from chronic low-level CO poisoning. These activation limits are intended to address the potential health effects that the Petitioner claims.

UL 2034 does not require alarm activation at these low levels. The current alarm activation requirements can be found in § 41.1.1 of UL 2034 and are listed in Table 1 below. The alarm signal must activate within the response times corresponding to the concentrations at or above 70 ppm as specified in Table 1. In addition to the primary alarm signal at CO concentrations of 70 ppm or greater, the standard allows for a pre-alarm signal for gas concentrations below 70 ppm, but above 30 ppm. A compliant alarm may be designed to alert to concentrations within this pre-alarm range. A pre-alarm signal is allowed to alarm after 1 hour of exposure. The pre-alarm signal is unique from a trouble signal or primary alarm signal and is intended to provide early notification of the presence of CO prior to activation of the primary alarm signal. The Petition incorrectly asserts that a CO alarm may only alert to concentrations between 30 and 69 ppm if concentrations remain in this range for 30 days, rather than 1 hour as the standard actually specifies.

[3] Inkster S.E. Health hazard assessment of CO poisoning associated with emissions from a portable, 5.5 kilowatt, gasoline-powered generator. Washington, D.C.: U.S. Consumer Product Safety Commission, 2004

[4] Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products 2020 Annual Estimates

Table 1. UL 2034 CO Sensitivity Requirements

UL 2034 CO Concentration vs. Time for Alarm Test Points Based on 10 % COHb	
Concentration, ppm	Response Time, minutes
70 ±5	60-240
150 ±5	10-50
400 ±10	4-15
False Alarms – CO Concentration Resistance Specifications	
Concentration, ppm	Exposure time, (no alarm)
30 ±3	30 days
70 ±5	60 minutes

Background CO concentrations will vary over time based on the number and source strength of sources (e.g. different appliances or combustion sources) in or near the home/building, whether smoking occurs in the home/building, air exchange rates in the home/building, and interzonal air flow rates of air in between rooms of the home/building. Background CO levels can range from near detection limits (e.g., 1 ppm) to levels approaching or potentially exceeding false alarm levels (e.g., 30 ppm).

Background CO concentrations can be considered alongside false-alarm and pre-alarm levels. The optional pre-alarm in UL 2034 would alert when CO concentrations exceed 30 ppm. False alarm avoidance requirements, which the Petitioner suggests limiting or eliminating, are included to prevent alarm activation from CO concentrations that do not present short-term adverse health effects in a healthy individual. These requirements reduce nuisance alarms due to lower levels of CO (below 30 ppm over 30 days or 70 ppm for less than one-hour), which could result in unneeded emergency response calls, reduced consumer confidence in the alarm performance, or even lead to temporary or permanent disablement of the alarm.

The CO alarm activation requirements currently in the UL 2034 standard include a specified concentration and duration for when an alarm must activate to prevent COHb levels in the blood from exceeding 10 percent. A 10 percent COHb concentration in the blood is associated with low potential for adverse health effects in a healthy individual. This level is much lower than what would be considered life threatening; however, vulnerable population groups may be more susceptible to adverse health effects from CO exposures when compared to healthy individuals. Examples of population groups with higher susceptibility to adverse health effects from CO exposures are individuals with pre-existing diseases such as heart disease, or certain individuals such as pregnant women, children, and the elderly. Individuals from vulnerable populations may experience symptoms or adverse health effects at COHb levels lower than 10 percent. Exposure to the false alarm levels in UL 2034 would result in COHb concentrations below 10 percent.

The 10 percent COHb limit is derived from the Coburn-Forster-Kane (CFK) model. This equation has been validated by empirical data from human studies, and it is widely regarded as a reasonably reliable and broadly applicable COHb model for modeling acute CO exposures.[5,6] The calculation of the COHb

[5] Coburn RF, Forster RE, Kane PB, Considerations of the Physiological Variables that Determine the Blood Carboxyhemoglobin Concentration in Man, J. Clinical Investigation, 44:1899-1910, 1965.
[6] Peterson JE, Stewart RD, Predicting the Carboxyhemoglobin Levels Resulting from Carbon Monoxide Exposures, J. Applied Physiology, 39:633-638, 1975.

percent for UL 2034 requirements is conservative because it includes consideration of an elevated respiration rate. As an individual's activity level increases, their respiratory rate increases, and COHb levels rise faster when an individual's respiratory rate is higher. If an individual's respiration does not in fact increase, then they will take in less CO than the model assumes.

Currently, the Fire Protection Research Foundation (FPRF) is reviewing CO alarm and detection thresholds to determine if there is new information regarding the effects of CO exposure for various populations. Once published, this information may be used to validate the existing alarm thresholds or to support changes to UL 2034 through voluntary standards activity. New information from FPRF or other data sources could address longer-term and lower-level CO exposures and their potential associated symptoms, which have been difficult to study due to limited incident reporting, similarities of symptoms to other illnesses, and comorbidities.

B. Digital Display Requirements Including Accuracy Within 3 ppm and Display of Concentrations Below 30 ppm

The Petitioner proposes that CO alarms should be required to have a digital display that is accurate to within 3 ppm of the exposure concentration and should numerically display concentrations below 30 ppm. This could potentially allow susceptible populations, such as those with an affected pre-existing disease, to better make choices that limit or change their CO exposures based on the values displayed.

Currently, UL 2034 does not require digital displays, but does not prohibit them. The standard requires indicators of CO to be accurate to within ±30 percent of the indicated amount and displays must indicate the CO concentration for the concentrations listed in Table 1. The Petitioner states that UL 2034 requires digital displays to read 0 ppm unless CO concentrations are above 30 ppm. The Petitioner continues that this is deceptive to consumers because there may be CO concentrations in the air that are higher than 0 ppm when the concentration is between 0 and 29 ppm. However, the Petitioner is incorrect on this point. The standard does not allow a display to indicate 0 ppm. If the measured CO concentration is below 30 ppm, the display must not indicate any value.

UL is currently working toward harmonizing the requirements in UL 2034 with the requirements in the CSA Group (formerly the Canadian Standards Association) Standard, CSA 6.19-17, *Residential Carbon Monoxide Alarming Devices*. CSA 6.19-17 allows alarms with low-level CO indication to display concentrations below 30 ppm. The Committee's efforts to harmonize the two standards may address the Petitioner's proposed display requirements. Therefore, such an update to the UL requirement may satisfy the Petitioner's request.

The Petitioner's proposal for digital display accuracy is not a requirement in the current version of UL 2034. The capability of CO alarm gas sensors to achieve the requested level of accuracy will need to be evaluated. UL's technical committee is well positioned to make this evaluation with participation from members representing alarm and sensor manufacturers.

C. Alarm and Trouble Alerts Using Voice Signals in Multiple Language Options

The Petitioner is requesting a requirement for CO alarms to have alarm and trouble alerts that use voice signals, with multiple language options. UL 2034 does not require the use of voice alerts and does not prohibit such alerts. In fact, several alarm manufacturers, including First Alert, Kidde, Nest, X-Sense, and

Knox, currently offer this feature. Staff has continued to monitor the CO alarm market, and the voice alert feature has become more prevalent over the past several years.

D. Lifetime Battery Requirement with Tamper-Proofing Features for Battery Powered Alarms

The Petitioner seeks a requirement for battery powered alarms to have batteries that last the full manufacturer-specified life of the alarm and to require tamper-proof features. Regardless of the power supply, the UL standard requires alarms to have a minimum 3-year useful life. Currently, there are several models of CO alarms in the market that are designed to operate with a non-replaceable and inaccessible battery that will last the life of the alarm. Some of these alarm models have up to a 10-year useful life.

UL 2034 does not require batteries to last the specified life of the alarm. The standard allows alarms to use replaceable batteries. Although UL 2034 does not require the use of a sealed, non-replaceable battery for all in-scope alarms, it does require this type of battery to be the primary power source for CO alarms intended to be used in commercial vehicles. Regardless of which battery type is used, the standard requires them to power the alarm for at least 12 months. CPSC currently recommends consumers replace alarm batteries at least once a year, which is congruent with this standard's battery life requirement.[7]

The standard provides several requirements to ensure alarm batteries are tamper resistant and to prevent alarm deactivation. For example, if an alarm with a non-replaceable battery is deactivated, the alarm unit must be resistant to being reinstalled onto its base. One method to prevent the alarm from being reinstalled onto the base is to block one of the mounting tabs with the deactivation switch when the alarm is deactivated. When either a non-replaceable or user-replaceable battery is used, the standard requires readily apparent and prominent indication if the alarm is deactivated, or the battery is removed. According to the standard, if an alarm is deactivated either due to the alarm reaching its end-of-life, tampering, or removal of the battery, the alarm must provide an indication via one of the following:

1. A visible warning flag when the battery is removed and the cover is closed;
2. A swing-out or pull-out battery compartment that will remain open if it does not have a battery installed;
3. An audible or a combination audible and tactile trouble signal for AC powered CO alarms using battery back-up;
4. A method to resist reinstallation of the unit if the battery is removed or if the alarm is deactivated;
5. An audible, combination audible or tactile, or visual signal at the control panel.

E. Simplified User Manual Design to Improve Familiarity, Operation, and Maintenance.

The Petitioner requests mandatory changes to user manuals and device markings to improve user familiarity, operation, and maintenance. The Petitioner's request does not provide specific requirements but rather makes generalized suggestions for improvements to the standard.

UL 2034 currently has requirements for user instructions and device markings. These include information about the hazards of CO and exposure symptoms; a description of audible and visual signals; what to do

[7] https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/Carbon-Monoxide-Information-Center/CO-Alarms?language=en.

when the alarm activates; alarm features; installation, operation, and maintenance; and recommendations for individuals with medical problems to use devices that provide audible and visual signals for CO concentrations below 30 ppm, among other requirements. Furthermore, in December2023, the Committee approved a ballot to update instruction and marking requirements in the standard. The 5th edition of UL 2034 was subsequently published on June 4, 2024. The Petitioner submitted the proposal and was a member of the UL 2034 Markings Task Group. The 2024 changes included improvements to marking layout, simplification of guidance for what actions occupants should take in the event of an alarm, elimination of obsolete requirements, and implemented marking permanence requirements. These changes appear to address the Petitioner's concerns regarding simplification of the information provided and user comprehension. The UL 2034 technical committee continues to develop the requirements in these areas.

III. Conclusion

Petition 25-1 requests that the Commission initiate rulemaking under the Consumer Product Safety Act, 15 U.S.C. § 2056, to address the Petitioner's claims of deficiencies in UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Alarms,* associated with CO exposure hazards. Subsequently, the Petitioner submitted proposals to the UL 2034 Technical Committee for four of the five performance requirements outlined in the Petition. The first requirement proposed in the Petition regarding lower alarm activation levels of CO was discussed within the Committee and can be evaluated as part of the ongoing voluntary standards activity. The Committee is currently considering these proposals and critical research is underway to find new information to evaluate the CO alarm and detection thresholds.

The Committee is continually improving the standard, most recently in 2024, by publishing a 5th edition that incorporates changes to the marking and instruction requirements that appear to address the Petitioner's request for improvements to user manuals and markings. The Committee has formed a task group that is currently evaluating these requirements.

Further, the FPRF is coordinating a review of CO alarm and detection thresholds to determine if new information is available regarding the dangers of CO exposure at different levels for various populations. This new information will support a technical evaluation of the lower alarm activation levels that the Petitioner requested.

Lastly, UL is beginning the process of harmonizing the requirements of UL 2034 and CSA 6.19-17, which may address the Petitioner's request for displays to indicate CO concentrations below 30 ppm.

IV. Staff Recommendation

Staff recommends that the Commission defer action on Petition 25-1 and direct staff to continue to engage in ongoing voluntary standards activity by UL that may address the Petitioner's proposals, as well as ongoing research evaluating CO alarm activation thresholds. Staff assesses that the mandates requested in the Petition could be effectively addressed through voluntary standards activities with support from CPSC and FPRF research activities. As part of the Fiscal Year 2026 Operating Plan, the Commission may also wish to direct staff to deliver a briefing package providing an update on the UL 2034 Committee's progress in addressing the issues raised in Petition 25-1.

Appendix A

CO Alarm Petition 25-1

Petition to Promulgate Consumer Product Safety Standard

PETITION TO PROMULGATE CONSUMER PRODUCT SAFETY STANDARD

December 18, 2024

Alexander Hoehn-Saric
Chair
U.S. Consumer Product Safety Commission
4330 East West Highway
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Peter A. Feldman
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Douglas Dziak
Commissioner
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4330 East West Highway
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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]
>
> "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

[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

[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
Charon McNabb
President and Founder
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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).

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]
>
> "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

[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).