PETITION TO REGULATE SULFURYL FLUORIDE TO REDUCE THE USE OF THE HIGH GLOBAL WARMING POTENTIAL PESTICIDE

October 27, 2022

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California Air Resources Board
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Re: Petition to Regulate Sulfuryl Fluoride to Reduce the Use of the High Global Warming Potential Pesticide

Dear Ms. Randolph:

On behalf of the Center for Biological Diversity and Californians for Pesticide Reform ("Petitioners"), we write pursuant to California Government Code § 11340.6 to request that the California Air Resources Board ("CARB") initiate a rulemaking and other appropriate actions to add sulfuryl fluoride to CARB's greenhouse gas inventory and phase out the use of sulfuryl fluoride in California. Under the direction and authority of the California Legislature, CARB is tasked with developing and adopting the specific rules and regulations needed to achieve healthful air quality, therefore CARB has the duty and authority to phase out this dangerous fumigant.

This action is necessary due to sulfuryl fluoride's high Global Warming Potential ("GWP"). Sulfuryl fluoride is *4,800 times more potent* than carbon dioxide in trapping heat, consequently contributing to climate change, and it is a threat to public health. Sulfuryl fluoride also lasts in the atmosphere for 36 years, eight times longer than the lifespan previously assumed when CARB last considered the regulation of sulfuryl fluoride as a greenhouse gas.

The concentration of sulfuryl fluoride in the atmosphere is drastically increasing despite the development of successful alternatives to treat insect infestations. *California is the largest consumer of sulfuryl fluoride in the world*, consuming approximately three million pounds in 2021.

Sulfuryl fluoride is also recognized toxic air contaminant and a neurotoxin, which causes illness, disabilities, and death. At least 16 deaths have been attributed to sulfuryl fluoride use in California. The time has come for CARB—an agency committed to climate leadership and public health—to regulate sulfuryl fluoride and phase out its use.

I. Substance and Nature of Action Requested

Petitioners request that CARB 1) initiate a rulemaking to include sulfuryl fluoride in California's annual statewide greenhouse gas inventory pursuant to AB 32; and 2) initiate a rulemaking to phase out the use of sulfuryl fluoride.[1]

As discussed below, CARB "is the state agency charged with monitoring and regulating sources of emissions of greenhouse gases that cause global warming in order to reduce emissions of greenhouse gases."[2] Under the direction and authority of the California Legislature, CARB is tasked with developing and adopting the specific rules and regulations needed to achieve healthful air quality.[3]

II. Interest of the Petitioners

The Center for Biological Diversity's mission is to ensure the preservation, protection, and restoration of biodiversity, native species, ecosystems, public lands and waters, and public health through science, policy, and environmental law. Based on the understanding that the health and vigor of human societies and the integrity and wildness of the natural environmental are closely linked, the Center for Biological Diversity is working to secure a future for animals and plants hovering on the brink of extinction, to protect the ecosystems they need to survive, and for a healthy, livable future for all of us.

Californians for Pesticide Reform is a statewide coalition of more than 190 organizations, founded in 1996 to fundamentally shift the way pesticides are used in California. CPR has built a diverse, multi-interest coalition to challenge the powerful political and economic forces opposing change. Californians for Pesticide Reform's member organizations include public health, children's health, educational and environmental advocates, clean air and water organizations, health practitioners, environmental justice groups, labor organizations, farmers, and sustainable agriculture advocates.

III. Sulfuryl Fluoride Overview

Sulfuryl fluoride is a colorless, odorless gas and was first registered in the U.S. in 1959 for use as a structural fumigant.[4] It was subsequently registered in California in 1990 as Vikane Gas Fumigant and in 1997 as Vikane® for use in structural and other non-food fumigations to control dry-wood termites, powder post beetles, borers, bedbugs, clothes moths, rodents, and cockroaches in dwellings, buildings, construction materials, furnishings, and vehicles.[5] In 2005, the California Department of Pesticide Regulation ("DPR") also approved the registration of

[1] Cal. Health & Saf. Code § 39607.4.
[2] *Id.* at § 38510.
[3] CARB, *Rulemaking*, https://ww2.arb.ca.gov/rulemaking. Accessed June 1, 2022.
[4] C. Bond et al., *Sulfuryl Fluoride General Fact Sheet*, NATIONAL PESTICIDE INFORMATION CENTER, OREGON STATE UNIVERSITY EXTENSION SERVICES (2017), npic.orst.edu/factsheets/sfgen.html [hereinafter Bond]; Qiaoxiang Dong et al., *Sulfuryl Fluoride Addendum to the 2006 Risk Characterization Document Update of the Toxicology and Reference Characterizations*, at 1 (2020), https://www.cdpr.ca.gov/docs/risk/rcd/sulfuryl-fluoride_addendum.pdf. [hereinafter Dong].
[5] *Id.*

sulfuryl fluoride as ProFume® for use in food commodity fumigation of grains, nuts, and dried fruits.[6]

When released, sulfuryl fluoride rapidly spreads out through the air and into the atmosphere.[7] Its lifetime in the atmosphere is now estimated to be approximately 36 years, which means after a single emission, 36 years is the average amount of time it would take to return to the pre-release levels of sulfuryl fluoride in the atmosphere.[8]

IV. Adverse Impacts of Sulfuryl Fluoride

A. Sulfuryl Fluoride Contributes to Climate Warming Greenhouse Gas Emissions

Pesticide use in California has a significant, yet overlooked, impact on state greenhouse gas emissions. CARB must address these emissions. CARB has recognized sulfuryl fluoride as a "greenhouse gas," "climate pollutant," and a "toxic air contaminant."[9] In 2009, CARB stated "new research assigned a 100-year GWP of 4,090 and a 20-year GWP of 6,840."[10] Additionally, National Oceanic and Atmospheric Administration researchers calculated a 100-year GWP of 4,800.[11] In other words, kilogram for kilogram, sulfuryl fluoride is about 4,000 times more efficient than carbon dioxide at trapping heat although much less of it exists in the atmosphere.[12] To contextualize sulfuryl fluoride's climate impact, its use in California each year is equal to the carbon dioxide emitted from about one million vehicles.[13] Further, as sulfuryl fluoride remains in the atmosphere for about 36 years, eight times longer than previously understood, its impacts are long lasting.[14]

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[6] Dong, *supra* note 4.
[7] Bond, *supra* note 4.
[8] Prior studies estimated its atmospheric lifetime at as low as five years, grossly underestimating the global warming potential. University of California Irvine, *Termite Insecticide Found to be Potent Greenhouse Gas*, SCIENCEDAILY (Jan. 30, 2009), www.sciencedaily.com/releases/2009/01/090121144059.htm [hereinafter UC Irvine]; Jenessa Duncombe, *Termite Fumigation in California is Fueling the Rise of a Rare Greenhouse Gas*, *EOS SCIENCE NEWS BY AMERICAN GEOPHYSICAL UNION* (Jan. 3, 2022), https://doi.org/10.1029/2022EO220008 [hereinafter Duncombe]; Benjamin Miller et al., *Sulfuryl Fluoride (SO_2F_2) Atmospheric Abundance and Trend from the GGGRN North American Tower and Aircraft Networks and the HATS Global Flask Network*, NOAA EARTH SYSTEM RESEARCH LABORATORY (2017), https://gml.noaa.gov/publications/annual_meetings/2017/posters/P37%20-%20Miller.pdf [hereinafter Miller]; Bond, *supra* note 4.
[9] CARB, *GHG Short-Lived Climate Pollutant Inventory* (2022), https://ww2.arb.ca.gov/ghg-slcp-inventory [hereinafter CARB SLCP]; California EPA & CARB, *Short Lived Climate Pollutant Reduction Strategy* (Mar. 2017); DPR, *Active Ingredient: Sulfuryl Fluoride Human Health Risk Assessments and Mitigation Documents and Activities*, (2022), https://www.cdpr.ca.gov/docs/whs/active_ingredient/sulfuryl-fluoride.htm [hereinafter, DPR, Active Ingredient]; *see also* G. Gallagher et al., *High-Global Warming Potential F-Gas Emissions in California: Comparison of Ambient-Based Versus Inventory-Based Emission Estimates, and Implications of Refined Estimates*, 48 ENVIRONMENTAL SCIENCE & TECHNOLOGY 1084-1093 (2014) [hereinafter Gallagher].
[10] CARB SLCP, *supra* note 9.
[11] University of California San Diego, *Termite Killer Lingers as Potent Greenhouse Gas*, SCIENCEDAILY (Mar. 15, 2009); Miller, *supra* note 8.
[12] UC Irvine, *supra* note 8.
[13] *Id.*
[14] CARB SLCP, *supra* note 9; Jens Mühle et al., *Sulfuryl Fluoride in the Global Atmosphere*, 114 JOURNAL OF GEOPHYSICAL RESEARCH (Mar. 12, 2009), https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2008JD011162 [hereinafter Mühle]; Duncome, *supra* note 8; Miller, *supra* note 8.

B. Sulfuryl Fluoride Harms Public Health

Sulfuryl fluoride is an extremely toxic pesticide and a neurotoxin, which causes illness, disabilities, and death.[15] As discussed below, it is CARB's mission to protect public health and welfare through the effective and efficient reduction of air pollutants, which includes sulfuryl fluoride.[16]

Sulfuryl fluoride is rapidly absorbed when inhaled and breaks down into several components that travel through the bloodstream, reaching the lungs, kidney, spleen, nasal tissues, and brain.[17] Individuals with a history of chronic respiratory disease have an increased risk of suffering adverse health effects from sulfuryl fluoride.[18] The gas particularly impacts fumigation workers—epidemiological studies show that fumigation workers using sulfuryl fluoride exhibited neurological effects, including reduced performance on cognitive and memory tests and diminished olfactory function.[19]

In 2011, EPA re-evaluated the current science on sulfuryl fluoride and stated it was "taking steps to begin a phased-down withdrawal of the pesticide sulfuryl fluoride" for use in food storage because the gas breaks down into fluoride, which "when combined with other fluoride exposure pathways, including drinking water and toothpaste, EPA has concluded that the tolerance (legal residue limits on food) no longer meets the safety standard under the Federal Food, Drug, and Cosmetic Act (FFDCA) and the tolerances for sulfuryl fluoride should be withdrawn."[20]

The DPR *Sulfuryl Fluoride Addendum's* Poison Control Database identified a total of 1,291 calls concerning sulfuryl fluoride between 2010 and 2016.[21] Further, between 1992 and 2017, 204 cases of exposure were reported to DPR.[22] Of the 204 DPR case exposure reports, 27

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[15] Geoffrey Calvert et al., *Health Effects Associated with Sulfuryl Fluoride and Methyl Bromide Exposure Among Structural Fumigation Workers*, 88 AM. J. OF PUB. HEALTH 1774, 1774 (Dec. 1998); Dong, *supra* note 4 at 11.
[16] CARB, *Enforcement Policy* (Apr. 2020), https://ww2.arb.ca.gov/resources/documents/enforcement-policy#:~:text=CARB%20adopts%20regulations%20designed%20to,the%20requirements%20of%20each%20regulation [hereinafter, CARB, *Enforcement Policy*].
[17] Tracy Barreau et al., *Sulfuryl Fluoride Poisonings in Structural Fumigation, a Highly Regulated Industry—Potential Causes and Solutions*, 66 INT. J. ENVIRONMENTAL RES. PUB. HEALTH 2026, at 6 (Jun. 6, 2019) [hereinafter Barreau]; DPR, *Sulfuryl Fluoride Risk Characterization Document Volume II*, California EPA, Medical Toxicology Branch (2006), http: //www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/sulfluor/final_rcd_vol2.pdf.
[18] Barreau, *supra* note 17.
[19] *Id.*; DPR, *Sulfuryl Fluoride Risk Characterization Document, Volume I: Health Risk Assessment*, California EPA Medical Toxicology Branch (2006), http://www.cdpr.ca.gov/docs/emon/pubs/tac/tacpdfs/sulfluor/final_rcd_vol1.pdf.
[20] EPA, *Pesticide News Story: EPA Proposes to Withdraw Use of Pesticide Sulfuryl Fluoride on Food* (Jan. 10, 2011), https://archive.epa.gov/pesticides/news/web/html/sulfuryl-flu.html; EPA, *EPA Proposed to Withdraw Sulfuryl Fluoride Tolerances* (last updated Feb. 20. 2016), https://archive.epa.gov/oppsrrd1/registration_review/web/html/evaluations.html.
[21] Barreau, *supra* note 17.
[21] Dong, *supra* note 4 at 11.
[22] *Id.*

individuals exposed to sulfuryl fluoride were hospitalized or unable to perform their normal activities due to illness and injuries from the exposure.[23]

Sulfuryl fluoride exposure can also cause death. Of the 204 DPR case exposure reports, 16 deaths were reported. The cause of death was predominantly pulmonary congestion and edema, which is a buildup of fluid in the lungs where the body cannot get enough oxygen.[24]

According to DPR, exposure can cause skin burning, hives, rashes; eye swelling and burning; throat burning, swelling, and pain; shortness of breath, wheezing, asthma, and hyperventilation; chest pain, burning, and tightness; vomiting, abdominal pains, and diarrhea; headache, dizziness, weakness, exhaustion; numbness in the face, hands, feet, and mouth; lung congestion and edema; tremors, staggering, anxiety, and agitation; and finally, an irregular heartbeat and elevated blood pressure.[25]

Despite safety regulations for fumigations, sulfuryl fluoride poisonings from structural fumigations continue to occur.[26] Regulating sulfuryl fluoride as a greenhouse gas and reducing its use will decrease the associated health hazards. This is especially important given the increasing use of sulfuryl fluoride.

V. Sulfuryl Fluoride's Global Concentration and Amount Applied in California

A. Global Concentration and Emissions of Sulfuryl Fluoride

Multiple reports and studies illuminate the global increase in sulfuryl fluoride's concentrations and emissions. Global tropospheric background concentrations of sulfuryl fluoride have grown exponentially worldwide.[27] In 1978, it was 0.3 parts per trillion.[28] In 2022, it is more than 2.5 parts per trillion.[29] Additionally, the 2008 Intergovernmental Panel on Climate Change Report stated that sulfuryl fluoride has "rapidly increasing emissions."[30]

A 2009 study published in the *Journal of Geophysical Research* found the amount of sulfuryl fluoride released into the atmosphere is about 2,000 metric tons per year.[31] Also, an ongoing study conducted by the National Aeronautics and Space Administration ("NASA") and Massachusetts Institute of Technology ("MIT") found that since 2004, the amount of sulfuryl

[23] In 2019, a family came back to their fumigated house after it was certified safe for re-entry. Soon after, the family left the house because they became ill. Specifically, the toddler engaged in unusual head-banging and stopped using words in the months that followed the incident. In Florida, a 9-year-old boy suffered permanent brain damage from sulfuryl fluoride exposure after his family's home was fumigated. Dong, *supra* note 4 at 11.
[24] *Id.*
[25] *Id.* At 10-11.
[26] Barreau, *supra* note 17.
[27] Mühle, *supra* note 14 at 1.
[28] *Id.*
[29] Duncombe, *supra* note 8.
[30] G. Myhre et al., *Ch. 8 Anthropogenic and Natural Radiative Forcing, In: Climate Change 2013: The Physical Science Basis*, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, at 679 (2013), https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf.
[31] Mühle, *supra* note 14.

fluoride in the atmosphere has steadily increased.[32] The tables below summarize the findings of NASA and MIT:[33]

Table 1: Sulfuryl fluoride measured by the Advanced Global Atmospheric Gases Experiment in the lower atmosphere (troposphere) at stations around the world. Abundances are given as pollution free monthly mean mole fractions in parts-per-trillion.[34]

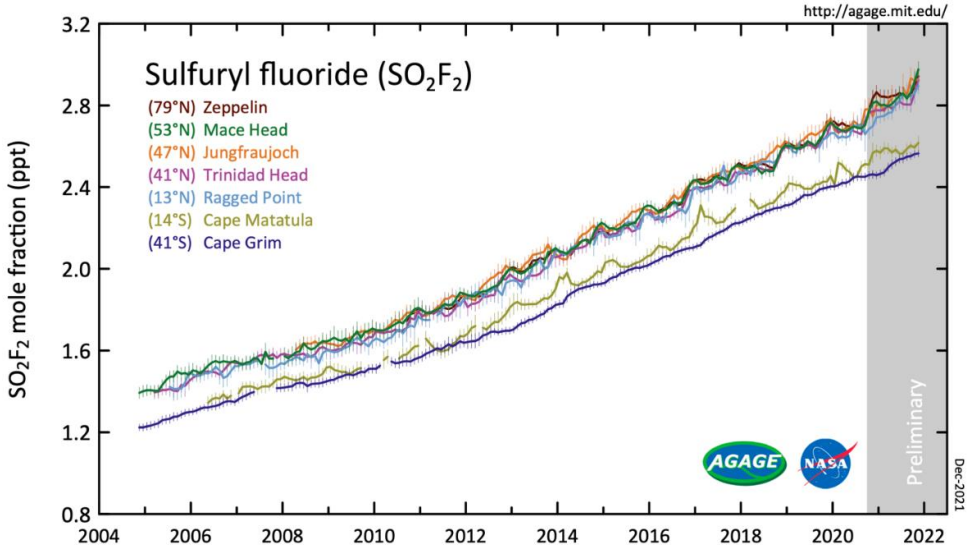
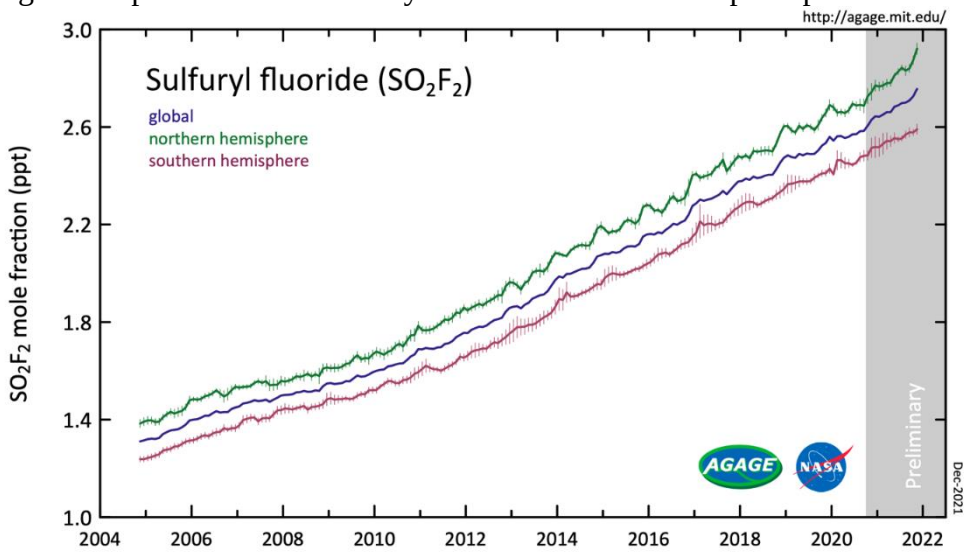


Table 2: Global measurement of sulfuryl fluoride measured by the Advanced Global Atmospheric Gases Experiment in the lower atmosphere (troposphere). Abundances are given as pollution free monthly mean mole fractions in parts-per-trillion.[35]



[32] Jens Mühle, *SO2F2 Measurement*, ADVANCED GLOBAL ATMOSPHERIC GASES EXPERIMENT AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND NASA'S ATMOSPHERIC COMPOSITION FOCUS AREA IN EARTH SCIENCE (Dec. 2021), https://agage2.eas.gatech.edu/data_archive/data_figures/monthly/pdf/SO2F2_mm.pdf.
[33] *Id.*
[34] *Id.*
[35] *Id.*

B. Amount of Sulfuryl Fluoride Applied Annually in California

Sulfuryl fluoride is one of the most used fumigants in California.[36] The primary use is for structural fumigation.[37] Table 3 shows the pounds of sulfuryl fluoride applied statewide from 2021-2017.

Table 3: pounds of sulfuryl fluoride applied annually in California

Year	Pounds of Sulfuryl Fluoride Applied Statewide
2021	3,065,098[38]
2020	2,822,373[39]
2019	3,019,149[40]
2018	2,991,914[41]
2017	3,654,817[42]

It is difficult to compare California's annual use of sulfuryl fluoride to other jurisdictions in the U.S. because California is the only state that publicly releases a record of its sulfuryl fluoride use.[43]

It is clear that California is one of the world's largest consumers of sulfuryl fluoride.[44] According to a report published in *Environmental Science and Technology*, between 50 to 60% of the entire global usage of sulfuryl fluoride takes place in California.[45]

[36] DPR, *Summary of Pesticide Use Report Data—2018* (Jun. 2020), https://www.cdpr.ca.gov/docs/pur/pur18rep/pur_data_summary_2018.pdf at 51 [hereinafter DPR, *PUR 2018*].
[37] Records are from the California DPR's Pesticide Use Reports ("PUR") database and Product Label database obtained from a Public Records Request to the DPR. On file with the Center for Biological Diversity (PRA Sheet from DPR-Amount of Sulfuryl Fluoride 2020 & 2021).
[38] *Id.*
[39] *Id.*
[40] DPR, *Pesticide Use Annual Report—2019 Data Summary* (Aug. 2022).
[41] In 2018, 2,991,914 pounds of sulfuryl fluoride was applied statewide, primarily for structural fumigation but with 0.5 million pounds used for post-harvest fumigation of nuts and other commodities. DPR, *PUR 2018*, *supra* note 36 at 51.
[42] *Id.*
[43] Danielle Underferth, *Researcher Explains the Main Source of a Rare but Destructive Greenhouse Gas*, HUB John Hopkins University (Mar. 11, 2022), https://hub.jhu.edu/2022/03/11/sulfuryl-fluoride-greenhouse-emissions/ [hereinafter Underferth].
[44] Gallagher, *supra* note 9.
[45] *Id.*

VI. CARB Has the Legal Authority to Regulate Air Pollutants that Warm the Climate and Adversely Impact California's Public Health and Environment

A. CARB's Mission and Governing Code Require the Regulation of Greenhouse Gases to Protect Public Health and Ecological Resources and to Mitigate Climate Change

The mission of CARB "is to promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the economy of the State."[46] As sulfuryl fluoride negatively impacts public health and welfare and is a recognized toxic air contaminant, it falls within CARB's mission to regulate sulfuryl fluoride as a greenhouse gas. Additionally, CARB's enforcement policy provides that "CARB adopts regulations designed to reduce criteria pollutants, toxic air contaminants, and greenhouse gas…emissions."[47] Therefore, CARB has the authority and obligation to phase out the use of sulfuryl fluoride because it is a greenhouse gas and a toxic air contaminant.[48]

Further, the California Global Warming Solutions Act of 2006, or AB 32, which governs CARB, recognizes that climate change:

> [P]oses a serious threat to the economic well-being, public health, natural resources, and the environment of California. The potential adverse impacts of global warming include the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems.[49] Global warming will have detrimental effects on some of California's largest industries, including agriculture, wine, tourism, skiing, recreational and commercial fishing, and forestry. It will also increase the strain on electricity supplies necessary to meet the demand for summer air-conditioning in the hottest parts of the state.[50]

Under AB 32, CARB has a clear duty to reduce California's greenhouse gas emissions to prevent the warming of the climate and the catastrophic effects it will have on the health and well-being of Californians and California's economy. Sulfuryl fluoride is a greenhouse gas with a high GWP that heats the atmosphere substantially more than carbon dioxide by weight, and yet it is currently left unchecked by CARB—a violation of CARB's mission and duty to protect Californians from climate change.

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[46] CARB, *Enforcement Policy*, *supra* note 16.
[47] *Id.*
[48] DPR, Active Ingredient, *supra* note 9.
[49] Cal. Health & Saf. Code § 38501(a).
[50] *Id.* at § 38501(b).

B. CARB Has the Authority to Add Sulfuryl Fluoride to Its Greenhouse Gas Inventory

In 2006, the California Legislature passed Assembly Bill 1803 (California Code of Health and Safety § 39607.4), which obligated that CARB "shall prepare, adopt, and update" an inventory of greenhouse gas emissions for California.[51] California's annual statewide greenhouse gas emission inventory is a tool used to establish emission trends and track California's progress in reducing greenhouse gases.[52] In 2016, CARB stated in a report that "sulfuryl fluoride was not recognized as a high-GWP GHG until 2009. Because sulfuryl fluoride was not identified as a high-GWP gas by the time AB 32 was enacted, it was not initially included as a part of ARB's statewide GHG inventory."[53] Now that sulfuryl fluoride is recognized as a greenhouse gas with a high GWP, it should be included in CARB's greenhouse gas inventory as CARB is statutorily required to update that list.

For the greenhouse gas inventory, CARB already inventories other fluorinated gases with high GWPs including hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.[54] Notably, sulfuryl fluoride has properties like the already regulated sulfur hexafluoride.[55] Further, the greenhouse gas inventory includes gasses that have shorter lifespans and smaller GWPs than sulfuryl fluoride.[56] As the inventory includes gases chemically similar to sulfuryl fluoride and gasses with a lesser impact on climate change, CARB should add sulfuryl fluoride to the emissions inventory.

Also, adding sulfuryl fluoride to CARB's greenhouse gas inventory is in line with California's goal to combat climate change. Governor Gavin Newsom recently stated, "no challenge poses a greater threat to our way of life, prosperity, and future as a state than climate change."[57] A record of how much sulfuryl fluoride is used is a crucial step to decrease California's greenhouse gas emissions. California is an international leader in its efforts to reduce greenhouse gases, and a record of sulfuryl fluoride's use and phase out will help California reach its reduction goals.[58] Dylan Gaeta, whose research focuses on sulfuryl fluoride emissions, stated "California's large sulfuryl fluoride emissions are a prime example of how uncounted emissions can threaten hard-earned progress toward emissions reductions goals."[59]

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[51] Cal. Health & Saf. Code § 39607.4.
[52] CARB, *Current California GHG Emission Inventory Data* (2022), https://ww2.arb.ca.gov/ghg-inventory-data.
[53] CARB, *Appendix C; California Short Lived Climate Pollutant Emissions* 13 (Nov. 28, 2016), https://ww2.arb.ca.gov/sites/default/files/2020-07/SLCP_Appendix_C.pdf.
[54] Cal. Health & Saf. Code § 39730.
[55] A. F. Holleman & E. Wiberg, *Inorganic Chemistry*, Academic Press: San Diego (2001).
[56] CARB, *GHG Global Warming Potentials* (2022), https://ww2.arb.ca.gov/ghg-gwps.
[57] Office of Governor Gavin Newsom, *Governor Newsom Joins Groundbreaking for World's Largest Wildlife Crossing as State Launches Nature-Based Strategies to Fight Climate Change and Protect Biodiversity* (Apr. 22, 2022), https://www.gov.ca.gov/2022/04/22/governor-newsom-joins-groundbreaking-for-worlds-largest-wildlife-crossing-as-state-launches-nature-based-strategies-to-fight-climate-change-and-protect-biodiversity/.
[58] CARB, *Latest GHG Inventory Shows California Remains Below 2020 Emission Target* (Jul. 28, 2021), https://ww2.arb.ca.gov/our-work/programs/ghg-inventory-program#:~:text=The%20total%2C%20statewide%202018%20GHG,tons%20below%20the%202020%20target.
[59] Underferth, *supra* note 43.

Finally, adding sulfuryl fluoride to CARB's greenhouse gas inventory fits within SB 605, which states "the state board shall complete a comprehensive strategy to reduce emissions of short-lived climate pollutants in the state."[60] Sulfuryl fluoride falls within the definition of a short-lived climate pollutant and is classified as such.[61] Additional requirements of SB 605 that must be achieved include:

- "[c]omplete an inventory of sources and emissions of short-lived climate pollutants";
- "[i]dentify existing and potential new control measures to reduce emissions";
- "[a]ssessment of the current status of controls that directly or indirectly reduce emissions of short-lived climate pollutants";
- "[i]dentification of opportunities and challenges for controlling emissions"; and
- "[r]ecommendations to further reduce emissions."[62]

Petitioners request that CARB add sulfuryl fluoride to the emission inventory for greenhouse gases.

C. CARB Has the Duty to Regulate Greenhouse Gases in Order to Reduce Greenhouse Gas Emissions

CARB's regulatory and associated enforcement authority is specified in AB 32, which applies to the greenhouse gas sources CARB regulates.[63] AB 32 tasked CARB with several responsibilities to help address the threat of climate change. Under AB 32, CARB "is the state agency charged with monitoring and *regulating* sources of emissions of greenhouse gases that cause global warming *in order to reduce* emissions of greenhouse gases."[64] Therefore, as sulfuryl fluoride is a greenhouse gas, which efficiently traps heat and consequently contributes to global warming, CARB is charged with regulating this gas to reduce its emissions. Hence it is appropriate that CARB, rather than DPR, phases out sulfuryl fluoride.

In *Harbor Fumigation, Inc. v. County of San Diego Air Pollution Control District* ("*Harbor Fumigation*") the court acknowledged that CARB has primary jurisdiction over pesticide toxic air contaminant emissions once they are released into the air.[65] Sulfuryl fluoride is a toxic air contaminate and it is released into the air in the fumigation process. Therefore, following the reasoning in *Harbor Fumigation*, CARB has jurisdiction over sulfuryl fluoride.[66]

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[60] Cal. Health & Saf. Code § 39730.
[61] *Id.*; CARB SLCP, *supra* note 9.
[62] Cal. Health & Saf. Code § 39730.
[63] CARB, *Enforcement Policy*, *supra* note 16.
[64] Cal. Health & Saf. Code § 38510 (emphasis added).
[65] *Harbor Fumigation, Inc. v. County of San Diego Air Pollution Control Dist*. (1996) 43 Cal. App. 4th 854, 870 ("It is DPR's primary purpose to regulate the *use* of pesticides in a manner safe to human beings and the environment, while it is a primary purpose of ARB and Districts to regulate *emissions* of TAC's, including pesticides, into the ambient air to protect human beings and the environment." (emphasis in original).)
[66] *Id.*

AB 32 states "[i]t is the intent of the Legislature that the State Air Resources Board coordinate with state agencies, as well as consult with the environmental justice community, … environmental organizations, and other stakeholders in implementing this division."[67] Petitioners request the opportunity to consult with CARB to initiate a rulemaking to phase out sulfuryl fluoride and determine the best method to regulate sulfuryl fluoride's use.

The Legislature has also tasked CARB with the obligation to "[p]eriodically review and update its emission reporting requirements" related to greenhouse gases "as necessary."[68] As a potent greenhouse gas it is necessary for CARB to update its emission reporting requirements to include and phase out sulfuryl fluoride to meet the statutory requirements to reduce the California's greenhouse gas emissions. CARB is also required to "present an informational report on the reported emissions of greenhouse gases, criteria pollutants, and toxic air contaminants from all sectors covered by the scoping plan" to the Joint Legislative Committee on Climate Change Policies.[69] CARB's scoping plans cover the Commercial and Residential and Agriculture sectors.[70] As both a greenhouse gas and criteria pollutant CARB is obligated to include sulfuryl fluoride in its reporting to the Legislature. That information is readily available from DPR and should be presented by CARB to the Legislature. Finally, CARB is further required to include any restrictions or prohibitions that may be applicable to sulfuryl fluoride as a fluorinated gas.[71]

VII. Alternatives to Sulfuryl Fluoride that Successfully Mitigate Termite Infestations

There are several viable alternatives to sulfuryl fluoride fumigation, including: temperature manipulation for whole structure treatment, numerous localized treatment options, and prevention methods established through Integrated Pest Management. Generally, the treatment alternatives are comparable in price to sulfuryl fluoride and many have proven comparably effective.[72]

A. Whole-Structure Treatment—Heat

Heat is a nonchemical option for whole-structure treatment and localized treatment.[73] The treatment process involves heating all wood in the structure to a minimum of 120°F and holding

[67] Cal. Health & Saf. Code § 38501(f).
[68] *Id.* at § 38530.
[69] *Id.* at § 38531(b).
[70] CARB, *California's 2017 Climate Change Scoping Plan* (2017) at ES1, https://ww2.arb.ca.gov/sites/default/files/classic/cc/scopingplan/scoping_plan_2017.pdf; CARB, *Draft 2022 Scoping Plan Update* (2022) at 34, https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf.
[71] Cal. Health & Saf. Code § 39734(a) ["The Legislature finds and declares that certain fluorinated gases are potent causes of global warming, and it is in the public interest that restrictions or prohibitions on the use of these gases be maintained and enhanced as appropriate in the state."]
[72] Price of drywood termite treatments: gas fumigation: $10-$20/linear foot, bait stations: $7-11/linear foot, heat treatment: $10/linear foot. Christin Perry & Samantha Allen, *How Much Does Termite Treatment Cost*, FORBES (Jul. 18, 2022), https://www.forbes.com/home-improvement/pest-control/termite-treatment-cost/; Pest Control Operators of California, Long-Awaited Nonchemical Alternatives to Drywood Termite Control Study Completed (1996).
[73] Daniel Perry & Dong-Hwan Choe, *Volatile Essential Oils Can Be Used to Improve the Efficacy of Heat Treatments Targeting the Western Drywood Termite: Evidence from a Laboratory Study*, 113 JOURNAL OF ECONOMIC ENTOMOLOGY 1373, 1373 (2020) [hereinafter Perry & Choe].

this temperature a minimum of 33 minutes.[74] The benefit of heat treatment is the ability to treat the entire structure without using chemicals and the relatively short period of time the structure must be vacated—typically a few hours compared to the days required with sulfuryl fluoride fumigation.[75] An additional advantage of heat treatment is that portions of large structures can be treated separately, which is very useful in apartments and condominiums.[76]

A recent study published in the *Journal of Economic Entomology* found that the use of volatile essential oils with heat treatment makes it possible to effectively kill drywood termites even in areas which might not reach lethal temperatures, such as structural heat sinks, improving the overall efficacy of heat treatments.[77]

B. Localized Treatments

Current reliance on the whole-structure treatment option is often justified by real estate transaction concerns over missed infestations (i.e., undetected drywood termites). But in reality, many localized drywood infestations may not require whole structure treatments, but rather localized treatments suffice.[78]

Research indicates that if you correctly locate the colony and get the chemical or non-chemical treatment directly onto the termites, the effectiveness of control will be high.[79] For failed treatments, an additional callback treatment may lead to better results, and the use of termite detection equipment enhances the performance of any localized treatments applied.[80] Further, many pest control companies using orange oil offer multi-year warranties, and will retreat the structure if needed.[81]

1. Orange Oil and Other Essential Oils

Orange oil is an alternative treatment extracted from orange peels. The major components of the oil are chemicals called terpenes or terpenoids and the major active ingredient is d-limonene. D-limonene is considered safe and has a low toxicity.[82] Further, d-limonene does not pose a mutagenic, carcinogenic, or nephrotoxic risk to humans.[83]

Orange oil has been registered in California under the brand name XT-2000TM for control of drywood termites.[84] Orange oil is also currently available as an insecticide (Orange

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[74] V.R. Lewis et al., *Pest Notes: Drywood Termites*, UNIVERSITY OF CALIFORNIA AGRICULTURE AND NATURAL RESOURCES STATEWIDE INTEGRATED PEST MANAGEMENT PROGRAM (Aug. 2014), http://ipm.ucanr.edu/PMG/PESTNOTES/pn7440.html [hereinafter Lewis].
[75] *Id.*
[76] *Id.*
[77] Perry & Choe, *supra* note 73.
[78] Bill Mashek & William Quarles, *Orange Oil for Drywood Termites: Magic or Marketing Madness*, THE IPM PRACTITIONER (2008) [hereinafter Mashek & Quarles].
[79] Lewis, *supra* note 74.
[80] *Id.*
[81] "We provide a 2 year warranty…on an XT-2000 Orange Oil Plus™ treatment." Pacific Coast Termite Inc., *XT-2000 Orange Oil Plus* (2022), https://www.pacificcoasttermite.com/termite-control/treatments/xt2000-orange-oil/].
[82] Jidong Sun, *D-Limonene: Safety and Clinical Applications*, 12 ALTERN. MED. REV. 259, 259 (Sept. 2007).
[83] *Id.*
[84] Mashek & Quarles, *supra* note 78.

GuardTM and ProCitra®) and as an herbicide (Green MatchTM).[85] In its application, exterminators locate the drywood termites, the affected wood is drilled into and then injected with pure orange oil.[86] Once the orange oil is pumped into the wood it will kill the termites by contact and fumigation action.[87]

In a 2020 study, orange oil coupled with heat treatment and d-limonene vapors resulted in either complete or almost complete mortality after several days of exposure, including in what would be a heat sink area.[88]

Other essential oils have similar properties.[89] In a 2020 study, a small amount of the essential oil methyl salicylate or wintergreen oil was added to drywood termite infested wooden blocks prior to heat treatment.[90] All blocks placed in uninsulated wall voids had 92–100% termite mortality by day seven.[91] A heat sink, a large concrete wall, hindered heating of the infested wooden blocks therein when there was no essential oil treatment.[92] But, with the incorporation of the essential oil there was a more than 90% mortality rate of the termites.[93]

Some other effective essential oils include clove oil, which can kill termites by fumigant action.[94] Additionally, basil and citronella oils kill by contact, act as antifeedants, and are a repellent to termites.[95]

2. Microwaves

Microwave devices are also available for termite control.[96] Microwaves kill termites by causing fluids inside their cells to boil, which destroys cell membranes.[97]

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[85] Mashek & Quarles, *supra* note 78.
[86] *Id.*
[87] Michael Rust & Jody Venturina, *Evaluation of Chemical Localized Treatment for Drywood Termite Control*, DEP'T. OF ENTOMOLOGY UNI. OF CAL. RIVERSIDE 31 (2009), https://www.pestboard.ca.gov/howdoi/research/2009_drywood_rpt.pdf; Mashek & Quarles, *supra* note 78.
[88] Perry and Choe, *supra* note 73, at 2448.
[89] Daniel Perry & Dong-Hwan Choe, *Volatile Essential Oils Can Be Used to Improve the Efficacy of Heat Treatments Targeting the Western Drywood Termite: Evidence from a Laboratory Study*, 113 JOURNAL OF ECONOMIC ENTOMOLOGY 1373, 1374 (2020) [hereinafter Perry & Choe, *Evidence from a Laboratory Study*].
[90] *Id.*
[91] *Id.*
[92] Perry & Choe, *Evidence from a Laboratory Study*, *supra* note 85 at 1374.
[93] *Id.*
[94] Il-Kwon Park & Sang-Chul Shin, *Fumigant Activity of Plant Essential Oils and Components from Garlic (Allium Sativum) and Clove Bud (Eugenia Caryophyllata) Oils Against the Japanese Termite (Reticulitermes Speratus Kolbe)*, 53 J. AG. FOOD CHEM. (Jun. 2005), https://pubmed.ncbi.nlm.nih.gov/15913300/; Mashek & Quarles, *supra* note 78.
[95] A.C. Sbeghen et al., *Repellence and Toxicity of Basil, Citronella, Ho-Sho and Rosemary Oils for the Control of the Termite Cryptotermes brevis (Isoptera: Kalotermitidae)*, 40 SOCIOBIOLOGY 585 (2002); Mashek & Quarles, *supra* note 78.
[96] Lewis, *supra* note 74.
[97] *Id.*

3. Electrocution

High voltage electricity, or electrocution, is another nonchemical option.[98] The device used emits high voltage (90,000 volts) but a low current (less than 0.5 amps).[99] Death to drywood termites occurs by electric shock, although delayed mortality may also occur from the destruction of intestinal protozoa.[100]

4. Baiting

Research is currently underway under California's DPR Pest Management Grant to explore the concept of "in-wood" baiting system for drywood termites using chitin biosynthesis inhibitors, which are synthetic hormones, as active ingredients.[101] With the bait, the affected termites return to the central part of the colony and die in the vicinity of reproductive termites and eggs.[102] According to the grant proposal, "the bait with toxicant will be injected into the wood, isolated from environmental exposure and non-target organisms. Thus, the bait will … make drywood termite control possible with minimal impact on human health and the environment."[103]

C. Prevention and Integrated Pest Management

According to the University of California, Integrated Pest Management is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, and modification of cultural practices.[104] The Integrated Pest Management approach is grouped into different categories: biological controls, cultural controls, mechanical and physical controls, and finally chemical controls.[105]

A biological control is the use of the natural enemies of termites—predators, parasites, pathogens, and competitors—to control the termite and their damage.[106] Certain fungi (preconidial mycelium and extracts of preconidial mycelium from entomopathogenic fungi) can control pest populations.[107] Additionally, beneficial nematodes can be applied to termite nests

[98] Lewis, *supra* note 74.
[99] *Id.*
[100] *Id.*
[101] Dong-Hwan Choe, *Research Grant Proposal: Development of an In-Wood Baiting System for Western Drywood Termites*, submitted to DPR (2021).
[102] *Id.*
[103] *Id.*
[104] University of California Integrated Pest Management, *What Is Integrated Pest Management*, https://www2.ipm.ucanr.edu/what-is-IPM/?src=redirect2refresh [hereinafter UC Integrated Pest Management].
[105] *Id.*
[106] *Id.*
[107] U.S. No. 9,399,050 B2 (filed Jul. 26, 2016).

through water, which has been done for years.[108] As the water contacts the termites, they become infected with nematodes.[109]

Cultural controls are practices that reduce pest establishment, reproduction, dispersal, and survival.[110] The design and maintenance of a structure is important for this control. One cultural method is to implement building practices where wood used in construction is properly treated with a substance that repels pests (borates provide many advantages), or wood that termites are less likely to infest is used, to provide protection from many wood-destroying insects.[111]

Mechanical and physical controls kill a pest directly, block pests out, or make the environment unsuitable for it.[112] There is overlap with this control and the cultural control. Methods incorporate maintenance of the structure such as: filling any cracks or other access points, implementing moisture control in the structure to keep wood dry (as termites are attracted to moisture), and installing easily removable baseboards for efficient inspection behind walls.[113] Inspection and structural maintenance are important considerations and should be done regularly throughout the structure's lifetime.[114]

For grain or other commodity storage facilities, including modern food processing and storage practices, prevention of pest infestations can be achieved through careful management of equipment and conditions, such as keeping the product at appropriate humidity levels. Also, updating the facility itself to be well sealed, clean, and regularly maintained creates a space much easier to be kept pest free.[115]

Finally, in Integrated Pest Management, chemicals are used only when needed and in combination with other approaches for more effective, long-term control.[116] Chemicals are selected and applied in a way that minimizes their possible harm to people, nontarget organisms, and the environment.[117] Treatment would start with the alternatives discussed above, such as orange oil.

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[108] Orkin, *Desert Drywood Termite Facts & Information*, ORKIN (2022), https://www.orkin.com/pests/termites/drywood-termites/desert-drywood-termites [hereinafter Orkin, *Info Sheet*]; Elaine Ingham, *Soil Nematodes*, U.S. DEPT. OF AG. NATURAL RESOURCES CONSERVATION SERVICE https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053866 [Beneficial nematodes help control disease and cycle nutrients and are not plant parasites].

[109] Orkin, *Info Sheet*, *supra* note 108.

[110] UC Integrated Pest Management, *supra* note 104.

[111] Dennis Ring, *Integrated Pest Management of Termites and Other Wood Attacking Organisms: A Louisiana Perspective*, LOUISIANA STATE UNIVERSITY AG CENTER (Mar. 23, 2005), https://lsuagcenter.com/topics/environment/insects/termites/integrated-pest-management-of-termites-and-other-wood-attacking-organisms--a-louisiana-perspective#:~:text=Make%20no%20mistake%20about%20it,pressure%20treated%20wood%20and%20containme [hereinafter Ring]; Orkin, *Info Sheet*, *supra* note 108.

[112] UC Integrated Pest Management, *supra* note 104.

[113] Ring, *supra* note 111.

[114] *Id.*

[115] Beyond Pesticides, *Will Sulfuryl Fluoride Phase-Out Shift Market Away from Toxic Fumigants?* (Jul. 12, 2011), https://beyondpesticides.org/dailynewsblog/2011/07/will-sulfuryl-fluoride-phase-out-shift-market-away-from-toxic-fumigants/.

[116] UC Integrated Pest Management, *supra* note 104.

[117] *Id.*

With a state-wide implementation of an Integrated Pest Management plan, the use of sulfuryl fluoride would dramatically decrease, thereby reducing the amount of the gas released into the atmosphere and its consequent contribution to climate change and harm to the public welfare.

D. Application

Removing sulfuryl fluoride after fumigation to contain the gas has not been comprehensively studied. The process of tenting is how the gas is partially contained during fumigation. However, the gas still leaks into the atmosphere. Sulfuryl fluoride can have a prolonged release into the air because the sorption and desorption of the gas on household materials occurs at different rates.[118] For example, in one study, sulfuryl fluoride was measured desorbing from different household materials, such as polyester fibers, for up to 40 days.[119] Further, after a fumigation, sulfuryl fluoride can be temporality trapped in structural voids and enclosed spaces such as wall voids, wall sockets, light switches, crawl spaces, attics, and cabinets.[120] The gas can then diffuse from these spaces.[121] Therefore, as there is an ongoing release of the gas and exposure, the structure would have to be tented for weeks to recapture the gas.

However, a 2015 study published by *Environmental Engineering Science,* concluded sulfuryl fluoride can be absorbed by sodium hydroxide solution packed into a column.[122] More research is needed to determine if this method would be effective in the fumigation of an entire structure.

VIII. Conclusion

Now that it is known and well supported by science that sulfuryl fluoride is a highly potent greenhouse gas that can remain in the atmosphere for 36 years, and there are viable alternatives to the fumigant, Petitioners request that CARB 1) initiate a rulemaking to include

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[118] Barreau, *supra* note 17 [Sorption is a physical and chemical process by which one substance becomes attached to another. Desorption is the physical process where a previously adsorbed substance is released from a surface.]; Rudolf Scheffrahn et al., *Desorption of Residual Sulfuryl Fluoride from Structural and Household Commodities by Headspace Analysis Using Gas Chromatography*, 39 ENV'T CONTAMINATION TOXICOLOGY 769 (1987), https://pubmed.ncbi.nlm.nih.gov/3690002/ [hereinafter Scheffrahn, *Desorption*]; Rudolf Scheffrahn et al., *Indoor Airborne Residues of Methyl Bromide and Sulfuryl Fluoride Following Aeration of Fumigated Houses*, 2 INDOOR AIR 1992, 78 (1992), https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1600-0668.1992.02-22.x [hereinafter Scheffrahn, *Indoor Airborne Residues*].

[119] Barreau, *supra* note 17 at 8; Scheffrahn, *Desorption*, *supra* note 118.

[120] Barreau, *supra* note 17 at 8; California Department of Public Health, *Pesticide Hazard Alert—Workers Became Ill after Bank Was Fumigated*, Occupational Health Branch, https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OPIPP/CDPH%20Document%20Library/PestAlertBank1.pdf; Scheffrahn, *Indoor Airborne Residues*, *supra* note 118.

[121] Barreau, *supra* note 17 at 8; Cal. Dep't of Pub. Health, *Pesticide Hazard Alert—Workers Became Ill after Bank Was Fumigated*, Occupational Health Branch, https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/OHB/OPIPP/CDPH%20Document%20Library/PestAlertBank1.pdf; Scheffrahn, *Indoor Airborne Residue*, *supra* note 118.

[122] Yong Nie et al., *Harmless Treatment of Sulfuryl Fluoride Chemical Absorption*, 32 ENV'T ENG'G SCI. 789 (2015) https://www.researchgate.net/publication/282391840_Harmless_Treatment_of_Sulfuryl_Fluoride_by_Chemical_Absorption.

sulfuryl fluoride in California's annual statewide greenhouse gas inventory pursuant to AB 32 and 2) initiate a rulemaking to phase out the use of sulfuryl fluoride.

In accordance with California Government Code § 11340.7(a), we look forward to CARB's response within 30 days.

Thank you for your time and attention to this matter. If you have any questions, please do not hesitate to contact us.

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