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MEMORANDUM

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HSM-26001

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DATE: June 26, 2026

SUBJECT: EXPOSURE UPDATES AND MITIGATION STATUS FOR PHOSPHINE

Overview

Phosphine (PH₃, CAS #7803-51-2), also known as hydrogen phosphide, is a colorless, flammable, explosive, and highly toxic gas. It is used as a rodenticide and insecticide to fumigate stored agricultural products such as grains, nuts, processed foods, and animal feed; nonfood products such as wood, leather, and clothing; and rodent burrows. Phosphine is marketed as liquefied pressurized gas and in precursor products. The precursor products include solid aluminum phosphide (AlP, CAS #20859-73-8) and magnesium phosphide (Mg₃P₂, CAS #12057-74-8), also known as metal phosphides, both of which generate phosphine gas upon contact with moisture through hydrolysis. Zinc phosphide is also classified as phosphine, as it is a precursor and generates phosphine upon contact with stomach acid. However, zinc phosphide was specifically excluded from this grouping because it reacts with stomach acid rather than water (Rubin, 2014) and because its use patterns are significantly different from the fumigation uses of phosphine gas (U.S. Environmental Protection Agency [U.S. EPA], 2009).

Acute inhalation of phosphine can cause neurological, respiratory, and gastrointestinal symptoms, including headaches, dizziness, nausea, chest tightness, pulmonary edema, and tremors; convulsions may occur after apparent recovery. Chronic occupational exposure may lead to nasal and throat inflammation, systemic symptoms affecting the liver, bones, and central nervous system, including jaundice and increased bone density (U.S. EPA, 2016). Phosphine has been classified by U.S. EPA as Group D, not classifiable as to human carcinogenicity.

Purpose

This mitigation status memo covers the period from 2013 to 2024, updating the previous mitigation scoping document (Schaffner, 2015). The update includes the Department of Pesticide Regulation's (DPR) revised Pesticide Use Reporting (PUR) and sales data spanning from 2014-2024 (DPR, 2025a; DPR, 2025b), currently registered products (DPR, 2025c), and recent Pesticide Illness Surveillance Program (PISP) data spanning from 2013-2023 (DPR, 2025d). Additionally, this document reviews U.S. EPA's recent exposure and risk assessments (U.S. EPA, 2019; 2020), the 2024 Interim Registration Review Decision (U.S. EPA, 2024a), and associated mitigation actions (U.S. EPA, 2024b) and determine whether they address the exposure risk findings of DPR's Risk Characterization Document (RCD) (Rubin, 2014).

Regulatory Status

DPR Regulatory Status

In 2014, DPR completed an Exposure Assessment Document (EAD) for phosphine that evaluated a range of exposure scenarios and associated hazards and provided detailed calculations for estimated exposures. It also summarized pesticide illness and injury data through 2009, pesticide use data through 2010, and information on product formulations and labels (Reeve, 2014). In the same year, DPR completed an RCD for phosphine, which established critical toxicological endpoints for acute, sub-chronic, and chronic inhalation exposure; identified exposure scenarios of concern for occupational engagement and residential bystanders; and calculated target levels for acceptable risk (Rubin, 2014).

In 2015, DPR completed a Mitigation Scoping Document for phosphine that identified exposure scenarios of concern requiring mitigation based on the findings of the RCD; determined that use patterns, labeling restrictions, and illness report rates were consistent with those used when the RCD were completed; and identified tarped commodity fumigation application scenarios, commonly used in California, that were not addressed in the RCD and recommended collecting monitoring data to determine whether there are potential exposure concerns (Schaffner, 2015).

U.S. EPA Regulatory Status

U.S. EPA issued its Reregistration Eligibility Decision (RED) for aluminum phosphide and magnesium phosphide in 1998 (U.S. EPA, 1998), identifying various exposure scenarios and inhalation as the primary route of concern. The RED identified the following exposure scenarios: fumigators and helpers; bystanders during and post-fumigation (but before aeration); aerators; and bystanders during and post-aeration. Scenarios involved fumigants applied to concrete upright bins, bulk railcars, railroad boxcars, processing plants, tobacco warehouses, farm bins, flat bins, and in spot fumigation situations. Each site had workers in short term (1 to 7 days) and intermediate term (1 week to several months) exposure situations. Many of the sites had chronic situations (5 days/week for 6 months) as well. Based on the use pattern, the route of exposure of concern is inhalation; significant dermal exposure is not expected. Thus, doses and endpoints were selected only for inhalation exposure risk assessments.

In response to two exposure-related deaths in Utah, U.S. EPA expanded restrictions on aluminum and magnesium phosphide products used to control burrowing rodents (U.S. EPA, 2010). These restrictions prohibited all uses of aluminum and magnesium phosphide products near residential areas and increased buffer zones for treatments near non-residential areas that may be occupied.

In 2019, U.S. EPA released its Tier I Updated Review of Human Incidents and Epidemiology for Draft Risk Assessment, which reviewed data from U.S. EPA's Office of Pesticide Program's (OPP) Incident Data System (IDS)¹ (2014-2019) and the Centers for Disease Control/National Institute of Occupational Safety and Health (CDC/NIOSH) Sentinel Event Notification System for Occupational Risk-Pesticides (SENSOR-Pesticides)² (2010-2015) to identify potential patterns in the frequency and severity of health effects associated with exposure to aluminum phosphide, magnesium phosphide, and phosphine. In conclusion, incident cases involving magnesium phosphide and phosphine are relatively infrequent and generally of low severity. Although aluminum phosphide is also associated with a low number of reported incidents, improper use can lead to severe health effects or fatalities (U.S. EPA, 2019).

This document also reviewed findings from the Agricultural Health Study (AHS)³, a federally funded, high-quality prospective epidemiological study that investigates associations between pesticide exposure and various health outcomes, including cancer. Only aluminum phosphide is included in the AHS. Overall, the available evidence is insufficient to establish a clear associative or causal relationship between aluminum phosphide exposure and either carcinogenic or non-carcinogenic health outcomes (U.S. EPA, 2019).

In 2020, U.S. EPA completed its draft human health risk assessment of non-occupational bystander exposures from the registered uses of phosphine and the metal phosphides using the Probabilistic Exposure and Risk Model for Fumigants (PERFUM) modeling (U.S. EPA, 2020). Qualitative dietary, occupational, and residential exposure; and aggregate assessments from the registered uses of phosphine and the metal phosphides (phosphine/metal phosphides) were all conducted. It determines that bystanders who live or work near sites where commodity fumigations occur are potentially exposed to fumigant emissions that travel off-site.

In 2024, U.S. EPA published an Interim Registration Review Decision (ID) for Aluminum Phosphide, Magnesium Phosphide, and Phosphine, which included mitigation measures and changes to labeling to address risks of concern and identified data or information needed to complete registration review (U.S. EPA, 2024a). Key points from U.S. EPA's ID are as follows:

- **Reference concentration (RfC):** 0.3 parts per million (ppm) is considered protective and used in most assessments.

¹ Incident Data System: <https://ordspub.epa.gov/ords/pesticides/f?p=359:1>

² SENSOR-Pesticide Program: https://www.cdc.gov/niosh/surveillance/pesticide/index.html#cdc_data_surveillance_section_2-sensor-pesticides-data

³ Agricultural Health Study Publications: <https://aghealth.nih.gov/news/publications.html>

- **Dietary (Food + Water) Risks:** No exposure expected.
- **Residential Handler Risks:** No exposure expected.
- **Residential Post-Application Risks:** Residential post-application exposures from outdoor underground applications are not expected to exceed the RfC of 0.3 ppm and are therefore not of concern.
- **Bystander Risks:** Exposure scenarios with potential risks of concern are identified include those living, working, or otherwise near commodity fumigation facilities or treatment sites may be exposed to phosphine emissions that travel offsite; exposure may occur during fumigation, in the form of leakage from the fumigation structure, or post-application, during aeration. Some aeration scenarios are potentially above 0.3 ppm: scenarios with very large fumigation structures, structures aerated without a ventilation stack, and/or situations in which multiple fumigation structures were aerated concurrently at the same fumigation site.
- **Aggregate Risks:** No dietary or residential handler exposure expected to aggregate with the residential post-application exposure scenario.
- **Cumulative Risks:** Phosphine and metal phosphide are not a candidate common mechanism group.
- **Occupational Handler Risks:** Exposures do not exceed regulatory exposure levels (e.g., Occupational Safety and Health Administration [OSHA]: RfC of 0.3 ppm); there is potential acute-, short-, intermediate- term inhalation exposure; dermal exposure not expected.
- **Occupational Post-Application Risks:** Exposures do not exceed regulatory exposure level and dermal exposure is expected to be negligible. Thus, there is no risk of concern.

Risk Mitigation and Regulatory Rationale

U.S. EPA identified potential human health risks of concern to non-occupational bystanders associated with registered uses of phosphine and metal phosphides. Corresponding mitigation measures include adding label language specifying aeration buffer zones around application sites, adding/updating label language of fumigation management plan (FMP), and updating description of required personal protective equipment (PPE).

Human Health Data Needs

Ambient exposure above the RfC is unlikely. However, ambient air monitoring data are still needed to confirm bystander ambient exposures. U.S. EPA requested that registrants submit the outstanding non-guideline ambient air monitoring study.

As part of its 2024 ID, U.S. EPA proposed updated label language changes in order to address potential human health risks to non-occupational bystanders. The updated language responded to previous registrant questions and mainly clarified necessary aeration buffer zones for scenarios

in which aeration is facilitated by a mixture of no stack and stack configurations for multiple aeration events (U.S. EPA, 2024b).

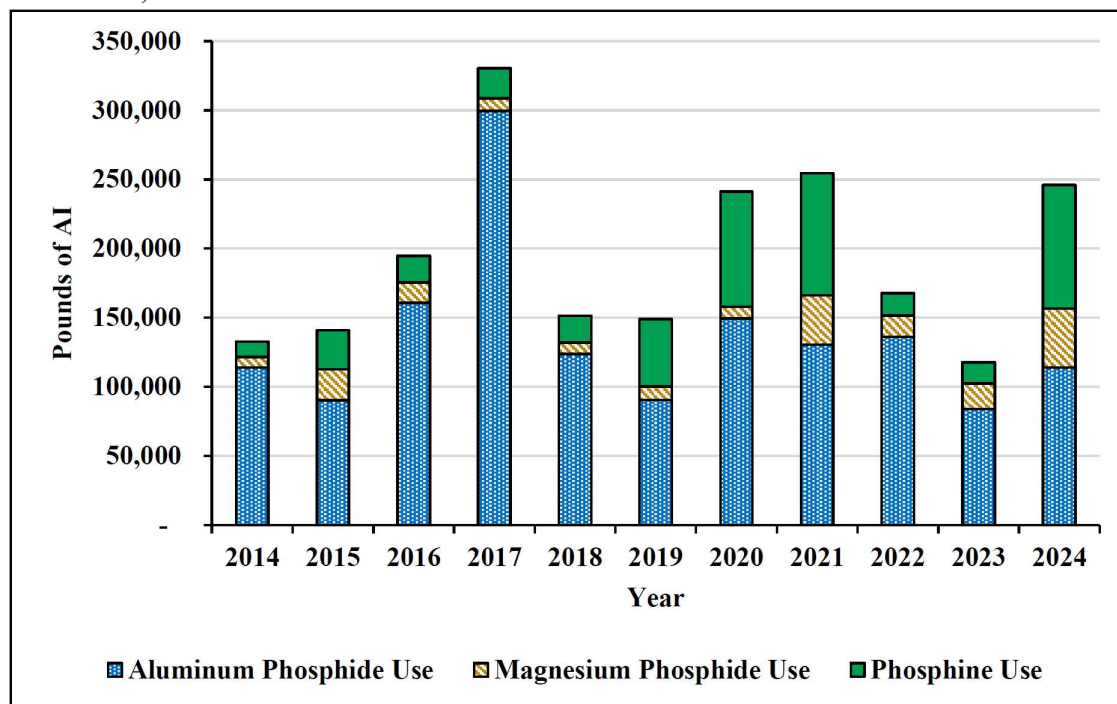
Label Review and Formulation

Aluminum phosphide and magnesium phosphide were first registered in the U.S. in 1958 and 1979, respectively, while phosphine gas was registered in 2001. Phosphine is marketed both as a pressurized gas and in solid precursor forms: aluminum phosphide and magnesium phosphide. The metal phosphides are formulated as impregnated materials, pellets, tablets, and granules (U.S. EPA, 2013). Currently, there are 14 active registrations for aluminum phosphide products, 4 for magnesium phosphide, and 3 for phosphine (DPR, 2025c). Since the completion of the RCD (Rubin, 2014), 4 new aluminum phosphide products, 1 magnesium phosphide product, and 2 phosphine products have been registered and remain active. Current registration details and product formulations are provided in [Appendix 1](#). The label requirements for workers are listed in [Appendix 2](#). Since 2024, U.S. EPA has updated the description of PPE fit and prohibited jewelry and watches when handling phosphine gas products and added the definition and guidelines about “aeration buffer zone” (U.S. EPA, 2024a).

Reported Use and Sales

All available PUR data (DPR, 2025a) and pesticide sales data (DPR, 2025b) of phosphine and metal phosphides in California from 2014 to 2024 are summarized below (Figures 1 and 2).

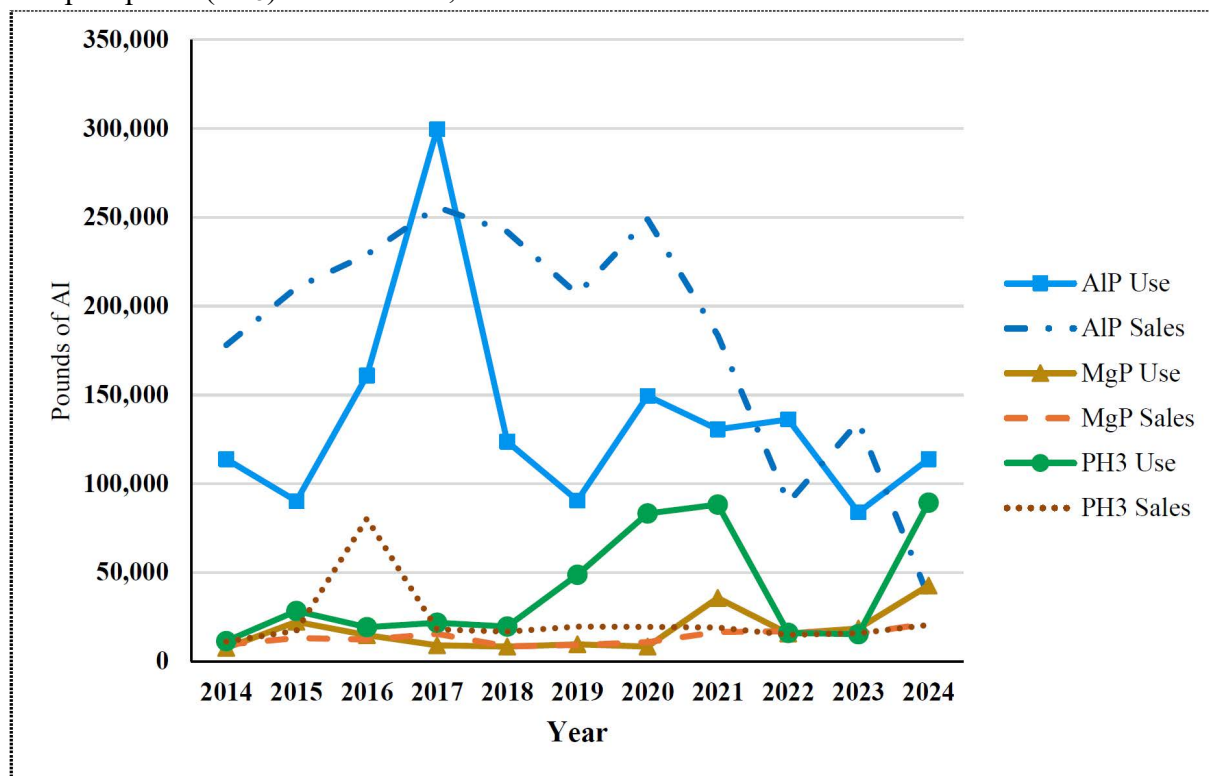
Figure 1. Reported use of aluminum phosphide magnesium phosphide, and phosphine in California, 2014-2024



The average annual sales of aluminum phosphide from 2014 to 2024 slightly decreased compared to 2009 to 2013, dropping from 221,600 lbs of AI to 183,000 lbs, a 17% reduction. Magnesium phosphide sales increased overall from 11,100 lbs (2009–2013) to 13,500 lbs (2014–2024), a 22% increase. Sales of phosphine also increased, from 12,100 lbs AI (2009-2013) to 23,000 lbs AI (2014-2024), an 89% decrease.

Between 2014 and 2024, the highest reported sales in California were approximately 256,000 lbs of aluminum phosphide in 2017, 21,000 lbs of magnesium phosphide in 2024, and 80,000 lbs of phosphine in 2016.

Figure 1. Reported use and sales of aluminum phosphide (AIP), magnesium phosphide (MgP), and phosphine (PH₃) in California, 2014-2024



Pesticide Illness Reports

Between 2013-2023, the Pesticide Illness Surveillance Program (PISP) database reported 75 aluminum phosphide exposure cases, 0 magnesium phosphide cases, and 22 phosphine cases (DPR, 2025d). About half of the cases (54%) were due to agricultural use, and the majority (76%) was due to occupational exposure. Cases occurring during these years are summarized by year in [Table 1](#) and by scenario in [Table 2](#).

Table 1. PISP illness cases and incidents for aluminum phosphide, magnesium phosphide, and phosphine exposure by year (2013-2023; DPR, 2025d).

Year Episodes Occurred	Total Cases			Total Episodes		
	Aluminum Phosphide	Magnesium Phosphide	Phosphine	Aluminum Phosphide	Magnesium Phosphide	Phosphine
2013	11	0	4	7	0	2
2014	5	0	1	5	0	1
2015	8	0	0	8	0	0
2016	4	0	6	4	0	2
2017	9	0	1	7	0	1
2018	13	0	0	8	0	0
2019	2	0	3	2	0	2
2020	4	0	0	4	0	0
2021	8	0	2	6	0	2
2022	6	0	5	5	0	1
2023	5	0	0	5	0	0
Total	75	0	22	61	0	11
Average (per Year)	6.8	0	2.0	5.5	0	1.0

Table 2. Illness data for aluminum phosphide, magnesium phosphide, and phosphine exposure by scenario (2013-2023; DPR, 2025d)

Exposure Scenario	Number of Illness Cases
Aluminum Phosphide	75
Occupational handler, agriculture	22
Occupational handler, non-agriculture	7
Occupational bystander, agriculture	9
Occupational bystander, non-agriculture	15
Residential handler, non-agriculture	7
Residential bystander, non-agriculture	7
Other (intentional ingestion)	4
Unknown	4
Magnesium Phosphide	0
Phosphine	22
Occupational handler, agriculture	5
Occupational bystander, agriculture	16
Unknown	1
Grand Total	97

In 2019, U.S. EPA conducted an updated review of human incidents on phosphine and metal phosphides (U.S. EPA, 2019). According to Main IDS records (2014 to 2019), there were 13 incidents involving aluminum phosphide, one involving magnesium phosphide, and one involving phosphine. Additionally, Aggregate IDS reported eight incidents involving aluminum phosphide, with no incidents reported for magnesium phosphide or phosphine. In the SENSOR-Pesticides database (2010–2015), there were 44 cases involving aluminum phosphide, 8 involving phosphine, and none involving magnesium phosphide.

Aluminum phosphide incidents reported in IDS ranged from major to minor severity, with five incidents resulting in fatalities. Two of the fatalities were due to illegal use of the product in a residential home, two were due to ingestion of the product to self-harm, and one had no exposure details. The two incidents reported for phosphine and magnesium phosphide in IDS were of moderate severity. Most phosphine/fumigant metal phosphide incidents reported in the SENSOR-Pesticide database were occupational in nature and nearly half of the incidents were of moderate (20 incidents) or high (4 incidents) severity. The remaining 28 incidents reported in SENSOR-Pesticides were of minor severity.

In the most recent query of the SENSOR-Pesticide database (2016–2024), 48 cases involved aluminum phosphide, 15 involved phosphine, and none involved magnesium phosphide. Most cases were occupational, and nearly half were classified as moderate (29 incidents) or high severity (one incident), with one fatality. The fatality was due to inhalation of aluminum phosphide in a warehouse.

Potential Exposure Scenarios and Risk Assessment

DPR has not found any significant change in the range of exposure scenarios since DPR's EAD (Reeve, 2014) and RCD (Rubin, 2014) were completed. As summarized in the RCD, potential exposures include:

- Occupational handlers (applicators, aerators, spent fumigant retrievers, and reentry workers) for all scenarios except spot fumigation.
- Occupational bystanders (nearby and assistant workers during and post-application and post-aeration) for all scenarios except burrowing pest fumigation.
- Residential bystander exposure for all scenarios except ship holds and ship containers.

In 2020, U.S. EPA identified exposure scenarios in non-occupational bystanders, involving those living, working, or otherwise near commodity fumigation facilities or treatment sites, where phosphine emissions may travel offsite; exposure may occur during fumigation, in the form of leakage from the fumigation structure, or post-application, during aeration (U.S. EPA, 2020).

U.S. EPA assessed bystander exposure to phosphine using a different approach—the Probabilistic Exposure and Risk Model for Fumigants (PERFUM) 3.0 (U.S. EPA, 2020). This model estimates air concentrations of phosphine at varying distances from fumigation facilities, allowing comparison to regulatory or recommended exposure limits. Inputs to PERFUM include local meteorological records, treatment facility size, emission release heights, ventilation rates, frequency of treatments, treatment concentrations, leakage rates, ventilation rates and utilization

of emissions recapture technology, and a regulatory exposure limit. PERFUM produced a wide range of outputs describing potential bystander exposure to phosphine.

Although the majority of modeling scenarios produced phosphine maximum concentrations that were below the OSHA regulatory limit of 0.3 ppm, there were some aeration scenarios that produced modeled concentrations of phosphine in the atmosphere around a fumigation site above 0.3 ppm, including scenarios with very large fumigation structures, structures aerated without a ventilation stack, and/or situations in which multiple fumigation structures were aerated concurrently at the same fumigation site. Buffer zone distances were suggested and further updated in U.S. EPA's 2024 ID (U.S. EPA, 2024a). U.S. EPA assessed bystander exposure at the 90th percentile of PERFUM output distributions, meaning 90% of the modeled outputs for a specific scenario must be below the RfC of 0.3 ppm to be considered acceptable. Still, U.S. EPA suggested an ambient air monitoring study to assess ambient air concentrations for communities in proximity to treated facilities and extended one generation reproductive toxicity study to evaluate the effects on parents and offsprings.

Mitigation Actions

In 2024, U.S. EPA proposed label changes that would address identified potential human health risks of concern to non-occupational bystanders associated with registered uses of phosphine and metal phosphides (U.S. EPA, 2024a; U.S. EPA 2024b).

U.S. EPA proposed language describing the implementation of aeration buffer zones around phosphine application sites to mitigate potential exposure to non-occupational bystanders. Aeration buffer zones are areas around fumigation sites that bystanders may not enter during the aeration phase of fumigation. Users would select from a series of aeration buffer zone tables the scenario that best describes their specific fumigation, aeration set-up, enclosure volume, and measured phosphine concentration to find the required aeration buffer zone distance.

U.S. EPA also made two changes to the post-application procedures section of existing product label FMP language. These changes implement the aeration buffer zones discussed above. First, U.S. EPA added instructions to the FMP language for the monitoring of phosphine gas concentrations in the fumigation enclosure prior to aeration. Second, U.S. EPA removed existing post-application procedures for fumigation in cold-storage fumigations, which are no longer necessary given the updated aeration buffer zone language.

Proposed label language also addressed generic labeling requirements for all phosphine and metallic phosphide products and uses. In addition, since tight clothing may trap phosphine gas against the skin, exacerbating potential dermal irritation, U.S. EPA has added language to labels that stipulate that handlers' PPE be loose-fitting to mitigate this risk. U.S. EPA also added language prohibiting jewelry and watches to be worn when handling phosphine gas products.

All the mitigation measures outlined above have been implemented through label amendment changes. DPR previously summarized potential risks of concern in its 2015 Mitigation Scoping Document (Schaffner, 2015). However, due to differences in risk assessment approaches and conclusions, as well as California-specific conditions, U.S. EPA's proposed mitigation measures will not fully address the risks identified by DPR. Key reasons include:

- DPR evaluated acute, sub-chronic (seasonal), and chronic (annual) risks, whereas U.S. EPA's assessment did not consider sub-chronic or chronic exposures.
- DPR has identified risks to occupational handlers & bystanders in addition to residential bystanders, while U.S. EPA has not released updated risk assessments or mitigation measures for these populations.
- DPR applied a more protective RfC in its residential bystander risk assessment:
 - DPR used an acute RfC of 0.05 ppm (based on a no-observed-effect-level of 5 ppm) for acute inhalation exposure and calculates margins of exposure accordingly.
 - U.S. EPA uses an RfC of 0.3 ppm (based on a no-observed-adverse-effect concentration of 3 ppm) and evaluates whether 90% of modeled exposure concentrations fall below this threshold.

While DPR will implement the label changes proposed by U.S. EPA, additional mitigation measures will need to be developed to address the remaining concerns.

Conclusions

U.S. EPA's most recent exposure and risk assessments and its 2024 ID for phosphine and metal phosphides determined that there were short-, acute-, and intermediate-term occupational handler exposure scenarios of concern, and there were bystander risks during fumigation or aeration in certain use scenarios. However, DPR's RCD identified acute, sub-chronic and chronic exposure concerns for most occupational handler, occupational bystander, and residential bystander scenarios. Additionally, DPR utilized a more stringent RfC in its risk assessment, likely rendering U.S. EPA's recent label changes insufficient to mitigate potential exposure risks identified in the RCD. Given these findings, DPR has determined that additional measures will need to be developed to address scenarios of concern identified in the RCD. Potential mitigation measures may include requirements such as increasing aeration buffer zone distances, reducing maximum application rates, or limiting the maximum area treated.

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Appendices

Appendix 1. Registered products containing aluminum phosphide, magnesium phosphide, and phosphine in California

Product	Registrant	CA Reg. No.	% AI	Formulation	Evaluated in Reeve 2014	Most Recent DPR Label
Aluminum Phosphide						
Degesch Phostoxin Tablets	D&D Holdings, Inc.	72959-4-ZB	55	tablet	x	2/13/2013
Degesch Phostoxin Pellets	D&D Holdings, Inc.	72959-5-AA	55	pellet	x	2/13/2013
Degesch Phostoxin Tablet Prepac	D&D Holdings, Inc.	72959-9-AA	55	gas-permeable blister pack of tablets	x	4/24/2014
Degesch Phostoxin Prepac Rope	D&D Holdings, Inc.	72959-8-AA	55	gas-permeable blister pack of tablets	x	3/15/2013
Fumitoxin Pellets	D&D Holdings, Inc.	72959-2-ZA	55	pellet	x	2/13/2013
Fumitoxin Tablets	D&D Holdings, Inc.	72959-1-ZA	55	tablet	x	2/13/2013
PH ₃ Aluminum Phosphide Fumigant Pellets	Douglas Products and Packaging Company	1015-74-AA	60	pellet		10/31/2019
PH ₃ Aluminum Phosphide Fumigant Tablets	Douglas Products and Packaging Company	1015-76-AA	60	tablet		10/31/2019
PH ₃ ALP Fumigant Pellets	Douglas Products and Packaging Company	70506-14-ZA- 1015	60	pellet		6/15/2022
PH ₃ ALP Fumigant Tablets	Douglas Products and Packaging Company	70506-13-ZA- 1015	60	tablet		6/15/2022
QuickPHlo-R Granules	UPL NA Inc.	70506-69-AA	77.5	granule	x	12/9/2011
Weevil-Cide Tablets	UPL NA Inc.	70506-13-AA	60	tablet	x	12/22/2021
Weevil-Cide Pellets	UPL NA Inc.	70506-14-AA	60	pellet	x	10/7/2022
Weevil-Cide Gas Bags	UPL NA Inc.	70506-15-AA	60	gas-permeable bag	x	5/7/2024

Product	Registrant	CA Reg. No.	% AI	Formulation	Evaluated in Reeve 2014	Most Recent DPR Label
Magnesium Phosphide						
Degesch Fumi-Cel	D&D Holdings, Inc.	72959-6-AA	56	impregnated plate	x	3/25/2015
Degesch Fumi-Strip	D&D Holdings, Inc.	72959-6-ZA	56	impregnated plate	x	3/25/2015
Degesch Magtoxin Prepac Spot Fumigant	D&D Holdings, Inc.	72959-7-AA	66	gas-permeable blister pack of pellets	x	3/15/2013
Magnaphos Plate	UPL NA Inc.	70506-309-AA	56	impregnated plated		6/22/2021
Phosphine						
Eco2Fume	Cytec Industries, Inc.	68387-7-AA	2	pressurized gas (dry)		1/18/2023
U-PHOS Phosphine Fumigant	Degesch America Inc.	40285-22-AA	99.35	pressurized gas (dry)		8/21/2024
VaporPH ₃ OS Phosphine Fumigant	Cytec Industries, Inc.	68387-8-AA	99.3	pressurized gas (dry)	x	1/18/2023

Appendix 2. Label requirements for workers for products containing aluminum phosphide, magnesium phosphide, and phosphine

Label Requirements	Aluminum Phosphide, Magnesium Phosphide, and Phosphine Products
PPE	• Dry gloves • NIOSH/MSHA approved full-face gas mask-phosphine canister (at phosphine concentrations from 0.3-15 ppm) • NIOSH/MSHA approved self-contained breathing apparatus (SCBA) (at phosphine concentrations above 15 ppm or at unknown concentrations) Additional requirements when using cylinderized phosphine gas: • Leather or leather-faced cotton gloves • Safety glasses and steel-toed shoes when handling; hand truck when moving cylinders • Wear loose-fitting or well-ventilated long-sleeved shirt and long pants; do not wear jewelry or watches when handling this product. (U.S. EPA, 2024a)
Signal Word	Danger
Restricted Material	Yes, Federal and California restricted materials
Maximum Application Rate	See Appendix 3
Minimum Duration Treatment	See Appendix 3
Certified Applicator's Presence	• Present during container opening and during application; • Present from initial opening of fumigated structure for aeration and monitoring indicates aeration can be completed safely until aeration process is secure.
Persons Trained as Handlers	Receive, aerate and remove placards from vehicle, which have been fumigated in transit.
Exposure Limits	Not to exceed 8-hour TWA of 0.3 ppm or 15-minute TWA short-term exposure limit (STEL) of 1.0 ppm
Industrial Hygiene Monitoring	• Monitor phosphine (and CO₂ if used) concentrations in all indoor and neighboring areas during fumigation and aeration in workers' breathing zones to determine when and where respiratory protection is required. This monitoring is mandatory. • After exposures are adequately characterized, conduct spot checks when conditions change significantly, if an unexpected garlic-like odor is detected, or if a change in phosphine level is suspected. • Record all monitoring data in an operations log or manual.
Engineering Controls and Work Practices	• If monitoring shows exposures above permitted limits, use engineering controls (e.g., forced air ventilation) and/or work practices (e.g., personal exposure monitors) to reduce levels where possible. • PPE is required whenever phosphine and/or CO₂ exposure limits are exceeded or concentrations are unknown.
Aeration	Aeration must be conducted at least 48 hours (72 hours for tobacco) before commodities are made available to consumers or, for non-food products, until the phosphine gas concentration 0.3 ppm or lower. *An aeration buffer zone may be necessary during aeration following fumigation (U.S. EPA, 2024a).
Fumigant Management Plan	Required to be written prior to all applications

Appendix 3. Advisory application rates and durations for products containing aluminum phosphide, magnesium phosphide, and phosphine

Site	Advisory Rate Per Application	Advisory Duration
Aluminum Phosphide		
Tablets (5 products) ⁴		
Maximal Allowable Dosage	145 tablets/1,000 cu.ft.	10 days at 40-53°F, 5 days at 54-59°F, 4 days at 60-68°F, 3 days > 68°F.
Vertical storages	30-140 tablets/1,000 cu.ft.	
Farm bins	70-145 tablets/1,000 cu.ft.	
Bulk stored commodities in flat storage, bunkers, and commodities stored on ground covered by tarp	30-145 tablets/1,000 cu.ft.	
Packaged commodities	30-90 tablets/1,000 cu.ft.	
Nuts, dates, or dried fruit in bulk or in storage boxes	20-40 tablets/1,000 cu.ft.	
Railcars, containers, trucks, vans, and other transport vehicles	45-145 tablets/1,000 cu.ft.	
Space fumigation, processing plants, such as cereal mills, warehouses feed mills, food	20-60 tablets/1,000 cu.ft.	
Stored tobacco	30-50 tablets/1,000 cu.ft.	
Non-food products	30-90 tablets/1,000 cu.ft.	
Stored beehives, supers and other beekeeping equipment for wax moth control and Africanized bees with tracheal mites and foulbrood	30-45 tablets/1,000 cu.ft.	
Barges	50-145 tablets/1,000 cu.ft.	
Ship holds	30-66 tablets/1,000 cu.ft.	
Rodent burrows	2-4 tablets per burrow	

⁴ Degesch Phostoxin Tablets, Fumitoxin Tablets, PH₃ Aluminum Phosphide Fumigant Tablets, PH₃ ALP Fumigant Tablets, Weevil-Cide Tablets

Site	Advisory Rate Per Application	Advisory Duration
Pellets (4 products) ⁵		
Maximal Allowable Dosage	725 pellets/1,000 cu.ft.	8 days at 40-53°F, 4 days at 54-59°F, 3 days at 60-68°F, 2 days > 68°F.
Vertical storages	150-700 pellets/1,000 cu.ft.	
Farm bins	350-725 pellets/1,000 cu.ft.	
Bulk stored commodities in flat storage, bunkers, and commodities stored on ground covered by tarp	350-725 pellets/1,000 cu.ft.	
Packaged commodities	150-450 pellets/1,000 cu.ft.	
Nuts, dates, or dried fruit in bulk or in storage boxes	100-200 pellets/1,000 cu.ft.	
Railcars, containers, trucks, vans, and other transport vehicles	225-500 pellets/1,000 cu.ft.	
Space fumigation, processing plants, such as cereal mills, warehouses feed mills, food	100-300 pellets/1,000 cu.ft.	
Stored tobacco	100-250 pellets/1,000 cu.ft.	
Non-food products	150-450 pellets/1,000 cu.ft.	
Stored beehives, supers and other beekeeping equipment for wax moth control and Africanized bees with tracheal mites and fowlbrood	150-225 pellets/1,000 cu.ft.	
Barges	250-725 pellets/1,000 cu.ft.	
Ship holds	150-330 pellets/1,000 cu.ft.	
Commodity in small containers	1-2 pellets/10 cu.ft. (Degesche and PH ₃ products) 1-2 pellets/1.4-10 cu.ft. (Weevil-Cide products)	
Rodent burrows	10-20 pellets per burrow	

⁵ Degesch Phostoxin Pellets, PH₃ Aluminum Phosphide Fumigant Pellets, PH₃ ALP Fumigant Pellets, Weevil-Cide Pellets

Site	Advisory Rate Per Application	Advisory Duration
Gas bags (1 product) ⁶		
Maximal Allowable Dosage	13 bags/1,000 cu.ft.	14 days at 40-53°F, 9 days at 54-59°F, 6 days at 60-68°F, 4 days > 68°F, 3 days > 72°F.
Vertical storages	3-6 bags/1,000 cu.ft.	
Farm bins	6-13 bags/1,000 cu.ft.	
Bulk stored commodities in flat storage, bunkers, and commodities stored on ground covered by tarp	5-13 bags/1,000 cu.ft.	
Packaged commodities	3-6 bags/1,000 cu.ft.	
Nuts, dates, or dried fruit in bulk or in storage boxes	2-4 bags/1,000 cu.ft.	
Railcars, containers, trucks, vans, and other transport vehicles	3-6 bags/1,000 cu.ft.	
Space fumigation such as cereal mills, feed mills, food processing plants & warehouses	2-6 bags/1,000 cu.ft.	
Stored tobacco	2-4 bags/1,000 cu.ft.	
Stored beehives, supers and other beekeeping equipment for wax moth control and Africanized bees with tracheal mites and foulbrood	3-4 bags/1,000 cu.ft.	
Barges	3-7 bags/1,000 cu.ft.	
Ship holds	3-6 bags/1,000 cu.ft.	
Commodity in small containers	1 bag/77-500 cu.ft.	

⁶ Weevil-Cide Gas Bags

Site	Advisory Rate Per Application	Advisory Duration
Blister pack of tablets (2 products) ⁷		
Maximal Allowable Dosage	230 cu.ft./Tablet Prepac 7,360 cu.ft./Prepac Rope	10 days at 40-53°F, 5 days at 54-59°F, 4 days at 60-68°F, 3 days > 68°F.
Space		
Mills, warehouses, etc.	550-1,650 cu.ft./Tablet Prepac 17,600-52,800 cu.ft./Prepac Rope	
Bagged commodities	550-1,100 cu.ft./Tablet Prepac 17,600-35,200 cu.ft./Prepac Rope	
Processed dried fruits and nuts	825-1,650 cu.ft./Tablet Prepac 26,400-52,800 cu.ft./Prepac Rope	
Stored tobacco	825-1,650 cu.ft./Tablet Prepac 26,400-52,800 cu.ft./Prepac Rope	
Bulk Stored Commodities		
Vertical storages	550-1,100 cu.ft./Tablet Prepac 17,600-35,200 cu.ft./Prepac Rope	
Tanks	470-1,100 cu.ft./Tablet Prepac 15,040-35,200 cu.ft./Prepac Rope	
Flat storages	230-660 cu.ft./Tablet Prepac 7,360-21,120 cu.ft./Prepac Rope	
Farm bins	230-470 cu.ft./Tablet Prepac 7,360-15,040 cu.ft./Prepac Rope	
Bunkers and tarped ground storages	410-1,100 cu.ft./Tablet Prepac 13,120-35,200 cu.ft./Prepac Rope	
Railcars	510-1,100 cu.ft./Tablet Prepac 16,320-35,200 cu.ft./Prepac Rope	
Barges	230-660 cu.ft./Tablet Prepac 7,360-21,200 cu.ft./Prepac Rope	
Ship holds	500-1,100 cu.ft./Tablet Prepac 16,000-35,200 cu.ft./Prepac Rope	

⁷ Degesch Phostoxin Tablet Prepac, Degesch Phostoxin Prepac Rope

Site	Advisory Rate Per Application	Advisory Duration
Granules (1 product) ⁸		
Site Fumigation		6-15 days < 40°F, 4-10 days at 40-53°F, 3-5 days at 54-59°F, 2-4 days at 60-68°F, 2 days > 68°F.
Vertical storages	66-132 g/1,000 cu.ft.	
Farm bins	154-319 g/1,000 cu.ft.	
Railcars, vehicles containers, trucks, vans, and other transport	66-143 g/1,000 cu.ft.	
Space fumigation, processing plants, such as cereal mills, warehouses feed mills, food	44-132 g/1,000 cu.ft.	
Barges	66-176 g/1,000 cu.ft.	
Ship holds	66-143 g/1,000 cu.ft.	
Commodity Fumigation		
Bulk stored commodities in bunkers and commodities stored on ground covered by tarp commodities	66-176 g/1,000 cu.ft.	
Bulk stored commodities in flat storage and commodities stored on ground covered by tarp and commodities	110-319 g/1,000 cu.ft.	
Packaged commodities	66-132 g/1,000 cu.ft.	
Nuts, dates, or dried fruit in storage boxes	44-88 g/1,000 cu.ft.	
All other commodities	44-319 g/1,000 cu.ft.	
Stored tobacco	44-88 g/1,000 cu.ft.	

⁸ QuickPHlo-R Granules

Site	Advisory Rate Per Application	Advisory Duration
Magnesium Phosphide		
Impregnated plate (3 products) ⁹		
Maximal Allowable Dosage	230 cu.ft./Fumi-Cel or Magnaphos Plate 4,600 cu.ft./Fumi-Strip	Fumi-Cel & Fumi-Strip: 4 days at 40-53°F, 3 days at 54-59°F, 2 days at 60-79°F, 24-36 hours at 80°F or above. Magnaphos Plate: 4 days at 41-53°F, 3 days at 54-68°F, 2 days > 68°F.
Space		
Mills, warehouses, etc.	550-1,650 cu.ft./Fumi-Cel or Magnaphos Plate 11,000-33,000 cu.ft./Fumi-Strip	
Bagged commodities	550-1,100 cu.ft./Fumi-Cel or Magnaphos Plate 11,000-22,000 cu.ft./Fumi-Strip	
Dried fruits and nuts	825-1,650 cu.ft./Fumi-Cel or Magnaphos Plate 16,500-33,000 cu.ft./Fumi-Strip	
Stored tobacco	825-1,650 cu.ft./Fumi-Cel or Magnaphos Plate 16,500-33,000 cu.ft./Fumi-Strip	
Bulk Storage Commodities		
Vertical storages	550-1,100 cu.ft./Fumi-Cel or Magnaphos Plate 11,000-22,000 cu.ft./Fumi-Strip	
Tanks	470-1,100 cu.ft./Fumi-Cel or Magnaphos Plate 9,400-22,000 cu.ft./Fumi-Strip	
Flat storages	230-660 cu.ft./Fumi-Cel or Magnaphos Plate 4,600-13,200 cu.ft./Fumi-Strip	
Farm bins	230-470 cu.ft./Fumi-Cel or Magnaphos Plate 4,800-9,400 cu.ft./Fumi-Strip	
Bunkers and tarped ground storage	410-1,100 cu.ft./Fumi-Cel or Magnaphos Plate 8,200-22,000 cu.ft./Fumi-Strip	
Railcars	510-1,100 cu.ft./Fumi-Cel 550-1,100 cu.ft./Magnaphos Plate 10,200-22,000 cu.ft./Fumi-Strip	
Barges	230-660 cu.ft./Fumi-Cel or Magnaphos Plate 4,600-13,200 cu.ft./Fumi-Strip	
Ship holds	500-1,100 cu.ft./Fumi-Cel or Magnaphos Plate 10,000-22,000 cu.ft./Fumi-Strip	

⁹ Degesch Fumi-Cel, Degesch Fumi-Strip, and Magnaphos Plate

Site	Advisory Rate Per Application	Advisory Duration
Using Degesch Speedbox for Fumi-Cel		
Dates, nuts, fresh commodities	8-40g/1,000 cu.ft. (825-4,125 cu.ft./Fumi-Cel)	2 days at 54-79°F
	20-40g/1,000 cu.ft. (825-1,650 cu.ft./Fumi-Cel)	24-36 hours at 80-95°F.
Raw commodities, processed foods, and non-food commodities	8-145g/1,000 cu.ft. (230-4,125 cu.ft./Fumi-Cel)	2 days at 54-79°F
	20-145g/1,000 cu.ft. (230-1,650 cu.ft./Fumi-Cel)	24-36 hours at 80-95°F.
Blister pack of tablets (1 product) ¹⁰		
Maximal Allowable Dosage	10 Prepacs/1,320 cu.ft.	34 hours at 40°F or above
Phosphine		
Cylinderized gas (3 products) ¹¹		
Ambient temperature fumigation		
Maximum Allowable Rate for fresh commodities	2,500 ppm/1,000 cu.ft.	6 days at 32-39°F, 4 days at 40-53°F, 3 days at 54-59°F, 2 days at 60-79°F, 24-36 hours at 80°F or above.
Maximum Allowable Rate for all other commodities	3,625 ppm/1,000 cu.ft.	
Food/feed commodities in bulk storage	500-3,625ppm/1,000 cu.ft.	
Packaged commodities	500-2,250 ppm/1,000 cu.ft.	
Stored tobacco	200-1,250ppm/1,000 cu.ft.	
Non-food products	500-2,250 ppm/1,000 cu.ft.	
Nuts, dates, or dried fruit in bulk or storage boxes	250-1,000 ppm/1,000 cu.ft.	
Space fumigation	200-1,500 ppm/1,000 cu.ft.	
Wood or wood products	750 -1000 ppm/1,000 cu.ft.	10 days
Rodents and other vertebrate pests (not for use in burrows)	200 ppm/1,000 cu.ft.	1-4 hours
Cocoa beans (for moth control)	500-1000 ppm/1,000 cu.ft.	24 hours at 40°F or above
Fumigation under cold storage (for perishable commodities)		
Fresh commodities; processed foods and non-food commodities kept refrigerated or in cold storage	1,000-2,500 ppm/1,000 cu.ft.	24-72 hours at 28-43°F
	750-2,500 ppm/1,000 cu.ft.	24-48 hours at 28°F or above
False Chilean Mites in cold storage	>300 ppm/1,000 cu.ft.	>9 days at 28-43°F

¹⁰ Degesch Magtoxin Prepac Spot Fumigant

¹¹ Eco2Fume, U-PHOS Phosphine Fumigant, and VaporPH₃OS Phosphine Fumigant

Appendix 4. Top sites and counties using aluminum phosphide, magnesium phosphide, and phosphine

Table 1. Aluminum phosphide use on top five sites in top five counties from 2014-2024

Year	Site	Pounds AI Applied	County	Pounds AI Applied	Total Pounds Applied
2014	Commodity Fumigation	32,551	Fresno	20,532	113,910
	Fumigation, Other	13,422	Sutter	17,638	
	Almond	12,325	Kern	10,587	
	Fruits (Dried or Dehydrated)	11,335	Stanislaus	9,391	
	Pistachio (Pistache Nut)	9,355	Madera	9,270	
2015	Fumigation, Other	17,141	Fresno	22,218	90,315
	Commodity Fumigation	16,252	Kern	10,920	
	Almond	14,012	Tulare	8,556	
	Fruits (Dried or Dehydrated)	9,481	Madera	6,570	
	Pistachio (Pistache Nut)	6,617	Monterey	4,613	
2016	Almond	59,384	Tulare	68,583	160,806
	Pistachio (Pistache Nut)	34,545	Fresno	24,276	
	Fruits (Dried or Dehydrated)	14,641	Kern	19,430	
	Commodity Fumigation	14,179	Madera	7,563	
	Fumigation, Other	9,706	San Luis Obispo	7,514	
2017	Rice (All or Unspec)	81,603	Colusa	146,043	299,644
	Pistachio (Pistache Nut)	64,996	Tulare	45,646	
	Storage Areas & Processing Equipment	63,546	Fresno	28,869	
	Almond	21,572	Kern	24,674	
	Vertebrate Pest Control	16,649	San Joaquin	15,684	
2018	Rice (All or Unspec)	23,788	Colusa	31,356	123,661
	Fumigation, Other	19,958	Fresno	24,319	
	Pistachio (Pistache Nut)	17,197	Kern	15,909	
	Landscape Maintenance	11,564	Madera	11,105	
	Almond	10,210	Tulare	9,723	
2019	Pistachio (Pistache Nut)	15,662	Fresno	27,089	90,506

Year	Site	Pounds AI Applied	County	Pounds AI Applied	Total Pounds Applied
	Fumigation, Other	13,440	Kern	18,926	
	Commodity Fumigation	11,492	Tulare	7,757	
	Almond	11,414	Madera	6,765	
	Fruits (Dried or Dehydrated)	9,608	Los Angeles	5,016	
2020	Commodity Fumigation	58,153	Fresno	52,224	
	Fumigation, Other	28,814	Kern	33,327	
	Almond	18,532	San Joaquin	21,555	149,498
	Fruits (Dried or Dehydrated)	10,959	Madera	10,694	
	Pistachio (Pistache Nut)	9,504	Tulare	6,109	
2021	Commodity Fumigation	60,693	Stanislaus	40,996	
	Almond	23,187	Fresno	29,813	
	Pistachio (Pistache Nut)	11,805	Kern	18,912	130,580
	Fruits (Dried or Dehydrated)	7,633	Madera	8,155	
	Landscape Maintenance	7,615	Tulare	8,052	
2022	Commodity Fumigation	39,180	Tulare	30,557	
	Almond	36,927	Kern	20,338	
	Landscape Maintenance	16,625	Fresno	19,116	136,134
	Fumigation, Other	11,190	Los Angeles	12,707	
	Pistachio (Pistache Nut)	7,467	Stanislaus	11,367	
2023	Commodity Fumigation	16,623	Fresno	22,620	
	Pistachio (Pistache Nut)	15,446	Kern	22,405	
	Almond	13,003	Tulare	8,098	83,886
	Fruits (Dried or Dehydrated)	11,262	Madera	7,970	
	Landscape Maintenance	6,180	Colusa	4,240	
2024	Commodity Fumigation	22,028	Fresno	26,676	
	Pistachio (Pistache Nut)	18,421	Kern	23,497	
	Landscape Maintenance	15,191	Madera	12,645	113,890
	Almond	14,262	Tulare	12,497	
	Fruits (Dried or Dehydrated)	9,274	Colusa	9,292	

Table 2. Magnesium phosphide use on top five sites in top five counties from 2014-2024

Year	Site	Pounds AI Applied	County	Pounds AI Applied	Total Pounds Applied
2014	Fumigation, Other	2,978	Yolo	2,295	7,562
	Almond	2,321	Merced	1,241	
	Commodity Fumigation	1,065	Glenn	803	
	Rice (All or Unspec)	282	Colusa	557	
	Structural Pest Control	265	Butte	547	
2015	Almond	10,846	San Joaquin	14,005	22,316
	Commodity Fumigation	4,638	Yolo	3,983	
	Nut Crops, Nut Trees (All or Unspec)	3,686	Merced	1,548	
	Fumigation, Other	2,394	Glenn	549	
	Structural Pest Control	279	Butte	539	
2016	Almond	8,675	Merced	5,047	14,766
	Fumigation, Other	2,962	Yolo	3,774	
	Commodity Fumigation	2,533	San Joaquin	3,080	
	Rice (All or Unspec)	255	Butte	610	
	Wheat, General	108	Alameda	397	
2017	Fumigation, Other	3,458	Fresno	2,147	9,021
	Almond	2,540	Yolo	2,116	
	Commodity Fumigation	2,013	Merced	1,983	
	Rice (All or Unspec)	438	Butte	431	
	Prune	138	Glenn	431	
2018	Commodity Fumigation	3,860	Yolo	2,513	8,344
	Almond	2,406	Merced	2,025	
	Fumigation, Other	845	Kern	622	
	Pistachio (Pistache Nut)	621	Colusa	593	
	Beans, Dried-Type	199	Stanislaus	445	
2019	Almond	2,455	Kern	2,504	9,660
	Pistachio (Pistache Nut)	2,269	Merced	1,962	
	Fumigation, Other	2,190	Yolo	1,816	

Year	Site	Pounds AI Applied	County	Pounds AI Applied	Total Pounds Applied
	Commodity Fumigation	2,066	Fresno	921	
	Beans, Dried-Type	159	Stanislaus	400	
2020	Commodity Fumigation	3,284	Merced	1,756	
	Fumigation, Other	2,194	Yolo	1,693	
	Almond	2,103	Kern	1,482	8,313
	Pistachio (Pistache Nut)	178	San Joaquin	809	
	Fruits (Dried or Dehydrated)	177	Fresno	392	
2021	Structural Pest Control	27,505	Orange	15,913	
	Almond	2,506	San Bernardino	8,985	
	Commodity Fumigation	2,218	Riverside	2,614	35,652
	Fumigation, Other	1,505	Kern	2,123	
	Pistachio (Pistache Nut)	1,418	Merced	1,934	
2022	Commodity Fumigation	6,914	Kern	5,037	
	Almond	3,107	Merced	2,676	
	Fumigation, Other	2,745	San Bernardino	2,551	15,674
	Structural Pest Control	2,553	Yolo	2,117	
	Regulatory Pest Control	164	Fresno	916	
2023	Pistachio (Pistache Nut)	8,430	Kern	8,412	
	Almond	3,746	Merced	2,663	
	Structural Pest Control	2,439	Los Angeles	2,548	18,563
	Commodity Fumigation	2,019	Yolo	1,365	
	Fumigation, Other	1,299	Madera	958	
2024	Pistachio (Pistache Nut)	36,243	Kern	34,649	
	Almond	2,616	Madera	2,279	
	Commodity Fumigation	1,846	Merced	2,037	42,742
	Fumigation, Other	1,531	Yolo	1,078	
	Rice (All or Unspec)	112	Glenn	786	

Table 3. Phosphine use on top five sites in top five counties from 2014-2024

Year	Site	Pounds AI Applied	County	Pounds AI Applied	Total Pounds Applied
2014	Commodity Fumigation	3,403	Kern	2,709	11,399
	Pistachio (Pistache Nut)	3,024	Fresno	1,973	
	Fumigation, Other	2,127	Yolo	1,312	
	Almond	948	Madera	1,165	
	Grapes	591	Sacramento	1,019	
2015	Commodity Fumigation	17,882	Colusa	14,775	28,397
	Pistachio (Pistache Nut)	3,916	Kern	2,706	
	Almond	2,289	Madera	2,626	
	Fumigation, Other	1,358	Fresno	1,634	
	Corn, Human Consumption	801	Sacramento	1,256	
2016	Fumigation, Other	6,994	San Joaquin	4,496	19,234
	Pistachio (Pistache Nut)	3,513	Kern	3,372	
	Commodity Fumigation	3,169	Fresno	2,002	
	Almond	2,565	Madera	1,554	
	Fruits (Dried or Dehydrated)	561	Yolo	1,213	
2017	Pistachio (Pistache Nut)	8,742	Kern	7,878	21,700
	Almond	3,706	Fresno	2,130	
	Commodity Fumigation	3,034	Madera	2,073	
	Fumigation, Other	2,746	Yolo	1,621	
	Walnut (English, Persian)	757	Sacramento	1,615	
2018	Commodity Fumigation	6,911	San Joaquin	4,649	19,561
	Fumigation, Other	6,046	Fresno	2,978	
	Almond	2,748	Stanislaus	2,394	
	Fruits (Dried or Dehydrated)	881	Yolo	1,556	
	Pistachio (Pistache Nut)	647	Kern	1,476	
2019	Commodity Fumigation	35,636	San Joaquin	30,624	48,814
	Almond	3,554	Madera	3,518	
	Corn, Human Consumption	3,161	Fresno	2,658	

Year	Site	Pounds AI Applied	County	Pounds AI Applied	Total Pounds Applied
	Fumigation, Other	2,126	Stanislaus	2,518	
	Pistachio (Pistache Nut)	1,464	Sacramento	2,011	
2020	Commodity Fumigation	72,182	San Joaquin	65,985	
	Almond	4,595	Stanislaus	3,056	
	Fumigation, Other	1,760	Sacramento	3,026	83,260
	Pistachio (Pistache Nut)	1,108	Fresno	2,539	
	Fruits (Dried or Dehydrated)	654	Tulare	1,659	
2021	Commodity Fumigation	78,766	San Joaquin	71,038	
	Almond	3,346	Stanislaus	4,273	
	Fumigation, Other	2,645	Fresno	2,708	88,343
	Pistachio (Pistache Nut)	1,605	Kern	1,979	
	Walnut (English, Persian)	491	Tulare	1,574	
2022	Commodity Fumigation	7,610	Stanislaus	3,402	
	Almond	4,105	Kern	2,503	
	Pistachio (Pistache Nut)	1,408	Fresno	2,299	15,933
	Fumigation, Other	1,321	Sacramento	1,792	
	Walnut (English, Persian)	483	Tulare	1,361	
2023	Commodity Fumigation	5,311	Stanislaus	2,546	
	Almond	3,582	Tulare	2,440	
	Pistachio (Pistache Nut)	2,367	Kern	1,942	15,383
	Walnut (English, Persian)	1,767	Sacramento	1,872	
	Fumigation, Other	1,112	Butte	1,702	
2024	Commodity Fumigation	74,313	Stanislaus	68,902	
	Almond	6,040	Madera	6,287	
	Corn, Human Consumption	4,661	Kern	3,611	89,424
	Pistachio (Pistache Nut)	1,393	San Joaquin	2,348	
	Fumigation, Other	1,332	Fresno	1,540	