

MEMORANDUM

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DATE: September 15, 2026

SUBJECT: COMPLETION OF TRIBUFOS MITIGATION

SUMMARY

Following a comprehensive review of updated risk assessments, use and sales data, illness reports, epidemiological studies, and registrant actions to cancel products or amend label requirements, the Department of Pesticide Regulation (DPR) has determined that no additional mitigation measures are necessary for the pesticide active ingredient (AI), tribufos. Use and sales data show a substantial decline in tribufos usage in California. Recent risk assessments by the U.S. Environmental Protection Agency (U.S. EPA), along with data from DPR's Pesticide Illness Surveillance Program (PISP), indicate a relatively low number of illness incidents and generally low severity of health impacts associated with tribufos exposure. Registrants have either canceled their products or agreed to implement label amendments proposed by U.S. EPA and DPR to address potential exposure risks. Collectively, these findings support the conclusion that, when used according to label requirements and instructions, tribufos does not present exposures of concern. Therefore, no further mitigation actions are warranted.

CLASSIFICATION AND USAGE

Tribufos (S,S,S-tributyl phosphorotrithioate) is an organophosphate (OP) pesticide registered for use as a cotton defoliant. The principal mechanism of adverse effects of organophosphates in animals is the irreversible inhibition of the cholinesterase enzyme which metabolizes the neurotransmitter acetylcholine. The resultant accumulation of acetylcholine causes

overstimulation of the nervous system in target and non-target organisms leading to cholinergic effects.

Tribufos is a California restricted material per §6400(e) of Title 3 of the California Code of Regulations¹; it is not a restricted use pesticide² at the federal level. Tribufos was added to Proposition 65 list³ as a carcinogen in 2011. U.S. EPA classified tribufos as “likely” to be a human carcinogen at high doses but “unlikely” at low doses; having high acute toxicity via the oral and dermal routes (Category II) and moderate toxicity via the inhalation route (Category III); and inducing mild eye and skin irritation (Category IV). Tribufos is not a dermal sensitizer (U.S. EPA, 2015).

In California, there is currently only one registered and active tribufos product, Folex 6 EC⁴ containing 70.5% AI, formulated as an emulsifiable concentrate (DPR, 2026a). The product is commonly mixed with water and applied to cotton using either ground or aerial equipment. The label carries the signal word DANGER.

Tribufos is registered solely as a cotton defoliant. Its annual use in California has declined significantly since 2000 (Stefanova-Wilbur, 2024a). In 2024, usage was approximately 2,800 lbs AI, representing a 150-fold decrease from 415,500 lbs in 2000 (DPR, 2026b). Since 2012, ground equipment applications have predominated, in contrast to patterns noted in the 2004 RCD (Lewis, 2024). Similarly, sales in California have shown a consistent decline over the past decade and align with the use data (DPR, 2026c).

REGULATORY HISTORY

DPR finalized the Exposure Assessment Document (EAD) and the Risk Characterization Document (RCD) for Tribufos in 2000 and 2004, respectively (Formoli, 2000; Lewis, 2004). The RCD identified cholinesterase inhibition effects and dermal irritation as the most sensitive non-oncogenic oral and dermal toxicological end points and established a target margin of exposure (MOE) of 100. The RCD concluded that the occupational risks for acute effects were not of concern (MOEs of 120-36,000). In contrast, eight out of ten seasonal exposures posed unacceptable risks to workers (MOEs of 23-75) (Lewis, 2004). In 2005, DPR issued a Risk Management Directive (RMD) for Tribufos, asking staff to monitor the proposed mitigation being developed by U.S. EPA at the time (increased restricted entry intervals [REIs] and “other measures”) (Gosselin, 2005).

¹ California Code of Regulations. Title 3, § 6400 - Restricted Materials: <https://www.cdpr.ca.gov/laws-and-regulations/california-code-of-regulations-title-3-food-and-agriculture-division-6-pesticides-and-pest-control-operations/chapter-2-pesticides/#6400-restricted-materials>

² U.S. EPA Restricted Use Products Report: <https://www.epa.gov/pesticide-worker-safety/restricted-use-products-rup-report>

³ California Proposition 65 List: <https://oehha.ca.gov/proposition-65/proposition-65-list>

⁴ Product: Folex 6 EC, Registrant: AMVAC Chemical Corp., Registration number: 5481-504AA, Latest CA label: 2022.

Tribufos was first registered in the United States in 1961 (U.S. EPA, 2000). U.S. EPA released the Reregistration Eligibility Decision (RED) for Tribufos in 2006, concluding that occupational risks exceeded the level of concern and proposing mitigation measures (U.S. EPA, 2006). A draft human health risk assessment was published in 2015 (U.S. EPA, 2015), followed by an updated risk assessment in 2023 that included additional mitigation measures to address occupational and spray drift risks (U.S. EPA, 2023). These measures included reducing the maximum application rate from 1.875 lbs AI/acre (A) for both aerial and ground applications to 0.75 lbs AI/A for aerial applications and 1.125 lbs AI/A for ground applications, limiting the amount of pesticide handled daily, increasing the REI from 7 to 10 days for applications above 0.75 lbs AI/A, controlling droplet size, and establishing buffer zones for residential areas. Revised federal product labels reflecting these changes became effective in September 2023 and were submitted to DPR by registrants in August 2024. In December 2024, U.S. EPA published an updated review of human incidents and epidemiological data for tribufos, continuing to identify a relatively low frequency of incidents and finding insufficient evidence to establish a clear associative or causal relationship between tribufos exposure and adverse health effects (U.S. EPA, 2024).

ILLNESS INCIDENTS

From 1992–2005, PISP data reported 15 illnesses associated with tribufos in California, mostly due to early reentry or spray drift exposures to fieldworkers (Stefanova-Wilbur, 2024a). However, no additional illnesses were reported from 2006–2023 (DPR, 2026d). U.S. EPA’s 2024 review of the Office of Pesticide Programs (OPP) Incident Data System (IDS)⁵ did not identify new tribufos incidents from 2019–2024. CDC/NIOSH SENSOR-Pesticides⁶ data identified ten tribufos-related cases from 2011–2021, mostly involving occupational exposure during aerial applications. Seven of the cases were classified as low severity and three were moderate.

Overall, U.S. EPA determined that tribufos incidents reported to IDS and SENSOR-Pesticides are relatively rare. Further, following a review of findings from the Agricultural Health Study⁷ and other peer-reviewed literature, U.S. EPA found insufficient evidence to establish a clear associative or causal link between tribufos exposure and adverse health effects (U.S. EPA, 2024).

CALIFORNIA MITIGATION ACTIONS

In 2024, DPR updated the estimates for the seasonal occupation MOEs identified as unacceptable in the 2004 RCD, to reflect the 2023 mitigation measures adopted by U.S. EPA (U.S. EPA, 2023), and to adjust for the typical tribufos use in California. As a result of U.S. EPA’s 2023 actions, the overall seasonal non-cancer occupational risk was mitigated, except for

⁵ Incident Data System: <https://ordspub.epa.gov/ords/pesticides/f?p=359:1>

⁶ SENSOR-Pesticide Program: https://www.cdc.gov/niosh/surveillance/pesticide/index.html#cdc_data_surveillance_section_2-sensor-pesticides-data

⁷ Agricultural Health Study Publications: <https://aghealth.nih.gov/news/publications.html>

two scenarios: mixing and loading in support of ground applications, and irrigator/weeder (Stefanova-Wilbur, 2024a). To address these remaining concerns, the Worker Health and Safety Branch (WHS) proposed reducing the maximum acres treated per day to 70 acres when the application rate is below 0.87 lbs AI/A and to 50 acres when the rate exceeds 0.87 lbs AI/A for mixer/loaders supporting ground applications. WHS also proposed increasing the REI to 14 days for applications using rates above 0.87 lbs AI/A and to 12 days for applications below 0.87 lbs AI/A for irrigator/weeder exposures (Stefanova-Wilbur, 2024b). WHS recommended that mitigation action be conducted via product label amendments.

WHS coordinated with the Pesticide Registration Branch to develop mitigation language and negotiated with registrants to amend their labels. Two of the three registrants decided to cancel their products, while the remaining registrant agreed to adopt label amendments to address the identified exposure concerns.

To address concerns for mixer/loaders, the label was amended to reduce the maximum acres treated to 50 acres/day for application rates > 0.75 lbs AI/A and 70 acres/day for application rates ≤ 0.75 lbs AI/A for ground applications in California. Rather than increasing the REI to address irrigator/weeder exposure concerns, the registrant prohibited irrigation and hand weeding activities after an application in California (Macedo, 2026).

CONCLUSION

Given the substantial decline in tribufos use in California since 2000 and the negligible number of reported illness incidents since 2006, there are minimal exposure concerns associated with tribufos. U.S. EPA reached similar conclusions after reviewing human health incidents recorded in the IDS and the SENSOR-Pesticides database. U.S. EPA proposed label amendments to address the majority of occupational exposure concerns for tribufos including reductions in application rates and daily handling limits, extended REIs, droplet size control, and expanded buffer zones. DPR proposed additional measures to address exposure concerns for certain seasonal worker scenarios including reductions in application rates and prohibiting certain reentry activities after application.

Therefore, U.S. EPA's label amendments, and DPR's additional measures to address exposure concerns, together with all available state and federal product information, support the conclusion that pesticide products containing tribufos do not require any further mitigation with respect to potential exposure. Although no additional mitigation is needed for tribufos, DPR's continuous evaluation efforts continue to track tribufos and other OP pesticides. DPR conducts monitoring of OPs through environmental monitoring of surface water, groundwater, and air, as well as food residue monitoring program. OPs are also a focus of outreach to health care providers in the Medical Supervision Program.

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REFERENCES

- DPR. 2026a. Tribufos Pesticide Data. Pesticide Data Index. <http://apps.cdpr.ca.gov/ereglib/>. Accessed January 12, 2026.
- DPR. 2026b. Summary of Pesticide Use Report Data 2022-2024. California Pesticide Information Portal (CalPIP), Pesticide Use Report Database, indexed by Chemical. <http://www.cdpr.ca.gov/docs/pur/purmain.htm>. Accessed January 6, 2026.
- DPR. 2026c. Reports of Pesticides Sold in California 2004-2024. Pesticides Sold in California. <http://www.cdpr.ca.gov/docs/mill/nopdsold.htm>. Accessed January 7, 2026.
- DPR. 2026d. Tribufos (DEF) Pesticide Illness Reports 2006-2023. Pesticide Illness Surveillance Program (PISP), California Pesticide Illness Query (CalPIQ). <http://apps.cdpr.ca.gov/calpiq/>. Accessed January 12, 2026.
- Formoli, T. 2000. Estimation of Exposure of Persons in California to Pesticide Products That Contain Tribufos. HS-1552. Worker Health and Safety Branch, California Department of Pesticide Regulation, California Environmental Protection Agency, Sacramento, CA. August 8, 1990; Revision No. 1, June 20, 1995; Revision No. 2, December 2000.
- Gosselin, P. 2005. Risk Management Directive for Tribufos. California Department of Pesticide Regulation, California Environmental Protection Agency, Sacramento, CA. July 21, 2005.
- Lewis, C. 2004. S,S,S-Tributyl Phosphorotrithioate (Tribufos) Risk Characterization Document (Revision No. 1). California Department of Pesticide Regulation, California Environmental Protection Agency, Sacramento, CA. March 12, 2004. https://www.cdpr.ca.gov/wp-content/uploads/2024/10/def_r1.pdf
- Macedo, T. 2026. Completion of Mitigation of Occupational Exposure Concerns: S,S,S-Tributyl Phosphorotrithioate (Tribufos). Letter to Jordan Mosley, AMVAC Chemical Corporation from Tulio Macedo, Chief, Pesticide Registration Branch, Department of Pesticide Regulation, dated June 30, 2026.
- Stefanova-Wilbur, M. 2024a. Tribufos: Exposure Updates and Mitigation Status. HSM-24001. Worker Health and Safety Branch, California Department of Pesticide Regulation, California Environmental Protection Agency, Sacramento, CA. April 26, 2024.

Stefanova-Wilbur, M. 2024b. Mitigation Proposal to Reduce Occupational Exposures of Concern to Tribufos. HSM-24007. Worker Health and Safety Branch, California Department of Pesticide Regulation, California Environmental Protection Agency, Sacramento, CA. October 23, 2024.

U.S. EPA. 2000. Interim Reregistration Eligibility Decision for Tribufos.
<https://archive.epa.gov/pesticides/reregistration/web/pdf/2145ired.pdf>

U.S. EPA. 2006. Reregistration Eligibility Decision for Tribufos.
https://archive.epa.gov/pesticides/reregistration/web/pdf/tribufos_red.pdf

U.S. EPA. 2015. Tribufos: Human health draft risk assessment for registration review.
<https://www.regulations.gov/document/EPA-HQ-OPP-2008-0883-0011>

U.S. EPA. 2023. Tribufos. Updated Occupational and Non-Occupational Spray Drift Assessment for Registration Review. February 2, 2023. <https://www.regulations.gov/document/EPA-HQ-OPP-2008-0883-0059>

U.S. EPA. 2024. Tribufos: Tier I Update Review of Human Incidents and Epidemiology for Draft Risk Assessment. December 4, 2024. <https://www.regulations.gov/document/EPA-HQ-OPP-2008-0883-0068>