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**US Environmental Protection Agency
Office of Pesticide Programs**

**Reregistration Eligibility Decision (RED)
for Tetramethrin**

June 23, 2008



United States
Environmental Protection
Agency

Prevention, Pesticides
and Toxic Substances
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Reregistration Eligibility Decision (RED) Document for Tetramethrin

June 2008

Reregistration Eligibility Decision (RED) for
Tetramethrin

List B

Case No. 2660

Approved by: *Steven Bradbury 6/23/08*

Steven Bradbury, Ph.D., Director
Special Review and Reregistration Division

Date: June 23, 2008

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Glossary of Terms and Abbreviations

a.i.	Active Ingredient
CFR	Code of Federal Regulations
CSF	Confidential Statement of Formula
DCI	Data Call-In
DFR	Dislodgeable Foliar Residue
DNT	Developmental Neurotoxicity
EC	Emulsifiable Concentrate Formulation
EEC	Estimated Environmental Concentration
EPA	Environmental Protection Agency
EUP	End-Use Product
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FFDCA	Federal Food, Drug, and Cosmetic Act
G	Granular Formulation
GLN	Guideline Number
HP	High pressure
LC ₅₀	Median Lethal Concentration. A statistically derived concentration of a substance that can be expected to cause death in 50% of test animals. It is usually expressed as the weight of substance per weight or volume of water, air or feed, e.g., mg/l, mg/kg or ppm.
LD ₅₀	Median Lethal Dose. A statistically derived single dose that can be expected to cause death in 50% of the test animals when administered by the route indicated (oral, dermal, inhalation). It is expressed as a weight of substance per unit weight of animal, e.g., mg/kg.
LOC	Level of Concern
LOAEL	Lowest Observed Adverse Effect Level
LP	Low pressure
mg/kg/day	Milligram Per Kilogram Per Day
mg/L	Milligrams Per Liter
MOE	Margin of Exposure
MRID	Master Record Identification (number). EPA's system of recording and tracking studies submitted.
MUP	Manufacturing-Use Product
N/A	Not Applicable
NDETF	Non-Dietary Exposure Task Force
NLAA	Not Likely to Adversely Affect
NR	Not Required
NOAEL	No Observed Adverse Effect Level
OPP	EPA Office of Pesticide Programs
OPPTS	EPA Office of Prevention, Pesticides and Toxic Substances
PCA	Percent Crop Area
PHED	Pesticide Handler's Exposure Data
PHI	Preharvest Interval
ppb	Parts Per Billion
PPE	Personal Protective Equipment
ppm	Parts per Million
RED	Reregistration Eligibility Decision
REI	Restricted Entry Interval
RfD	Reference Dose
RQ	Risk Quotient
SF	Safety Factor
SLC	Single Layer Clothing
SLN	Special Local Need (Registrations Under Section 24(c) of FIFRA)
TGAI	Technical Grade Active Ingredient
USDA	United States Department of Agriculture
UF	Uncertainty Factor
UF _{db}	Database Uncertainty Factor

TETRAMETHRIN TEAM MEMBERS

Office of Pesticide Programs:

Health Effects Risk Assessment

Becky Daiss
Marquea King
Abdallah Khasinawah
Matt Crowley
Susan Hummel

Ecological Fate and Effects Risk Assessment

William Eckel
Wanda Hall
Richard Lee
Ibrahim Abdel-Saheb
Dana Spatz

Biological and Economics Analysis Assessment

LaVerne Dobbins
Nikhil Mallampalli
Jihad Alsadek

Registration Division

Richard Gebken
Carmen Rodia

Risk Management

Jacqueline Guerry
Monica Wait
Neil Anderson

Abstract

The Environmental Protection Agency (EPA or the Agency) has completed the human health and environmental risk assessments for tetramethrin and is issuing its risk management decision. Tetramethrin is not registered for use on food and has no U.S. tolerances associated with its use; therefore, it is not subject to Food Quality Protection Act (FQPA). The risk assessments, which are summarized below, are based on the review of the required database supporting the use patterns of currently registered products and additional data provided by the technical registrants, Valent BioSciences Corporation and Sumitomo Chemical Company, Ltd.

Tetramethrin is part of the pyrethroid class of pesticides and was first registered in 1968. It is a broad spectrum, non-systemic, synthetic pyrethroid used to control flying and crawling insects in a number of commercial, horticultural and residential applications. Commercial applications include space, broadcast and crack-and-crevice treatment in a variety of commercial, industrial, residential, and institutional sites. Horticultural applications include foliar and fogger treatment on non-food plants. Residential uses include pest control in homes and outdoor domestic structures, on gardens and direct application to cats, dogs and horses. The registered uses of tetramethrin are not expected to adversely impact groundwater or surface water; therefore, a drinking water assessment was not performed. There are no food uses of tetramethrin or potential for dietary exposures, so no dietary risk assessment was conducted. Therefore, the reregistration action considered only potential residential (inhalation and incidental oral), occupational (inhalation only), and ecological risks. No endpoints were selected for dermal exposure because no effects were observed at the limit dose in available acceptable dermal toxicity studies.

For residential handler inhalation risk, calculated Margins of Exposure (MOEs) for all scenarios assessed were below the Agency's Level of Concern (LOC) (MOEs \geq 1,000) and therefore are not of concern. For residential post-application inhalation and incidental oral risks, the MOEs are all greater than the target MOE of 1,000 at the 99.8 percentile of the CARES probabilistic risk assessment and are also not of concern.

Occupational handler and post-application inhalation exposures were assessed. All of the MOEs are greater than the Agency's target occupational MOE of 1,000 without respirators, and therefore, the inhalation risks are not of concern. The MOEs for the occupational post-application scenarios assessed exceed the Agency's target MOE of 1,000 and are not of concern.

The Agency evaluated potential ecological risk from both indoor and outdoor uses of tetramethrin. Although the Agency believes exposure to non-target organisms is unlikely, tetramethrin is considered highly toxic to aquatic organisms. Therefore, the Agency is limiting all outdoor uses to localized spot treatments, with the exception of (1) barrier, perimeter or band applications to soil or vegetation around structures up to a maximum of 10 feet away from the building; and (2) band applications to building foundations, up to a maximum of 3 feet up the walls of the building. Since outdoor uses will be limited to spot treatments, no additional mitigation measures for these uses are required. No direct or indirect effects to endangered species are expected due to applications of tetramethrin, except the potential for direct effects for Listed insects or indirect effects to plants if they have an obligate relationship with a Listed insect pollinator.

I. Introduction

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was amended in 1988 to accelerate the reregistration of products with active ingredients registered prior to November 1, 1984. The amended Act calls for the development and submission of data to support the reregistration of an active ingredient, as well as a review of all submitted data by the U.S. Environmental Protection Agency (referred to as EPA or “the Agency”). Reregistration involves a thorough review of the scientific database underlying a pesticide’s registration. The purpose of the Agency’s review is to reassess the potential risks arising from the currently registered uses of the pesticide, to determine the need for additional data on health and environmental effects, and to determine whether or not the pesticide meets the “no unreasonable adverse effects” criterion of FIFRA.

This document summarizes EPA’s human health and ecological risk assessments and reregistration eligibility decision (RED) for tetramethrin. The document consists of six sections. Section I contains the regulatory framework for reregistration; Section II provides an overview of the chemical and a profile of its use and usage; Section III gives an overview of the human health and environmental effects risk assessments; Section IV presents the Agency’s decision on reregistration eligibility and risk management; and Section V summarizes the label changes necessary to implement the risk mitigation measures outlined in Section IV. Finally, the Appendices list related information, supporting documents, and studies evaluated for the reregistration decision. The risk assessments for tetramethrin and all other supporting documents are available in the Office of Pesticide Programs (OPP) public docket (<http://www.regulations.gov>) under docket number EPA-HQ-OPP-2008-0014.

II. Chemical Overview

A. Regulatory History

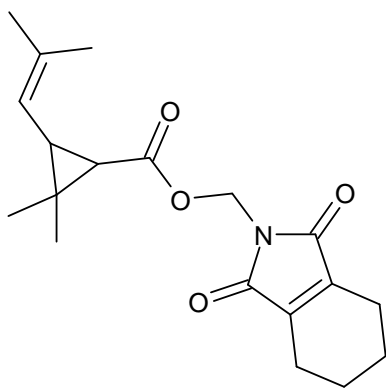
Tetramethrin was first registered in the United States in 1968. Current technical registrants include Valent BioSciences Company and Sumitomo Chemical Corporation. Tetramethrin is on reregistration List B; thus no Registration Standard was completed.

Currently, there are 58 end-use registrants and approximately 300 end-use products containing tetramethrin, of which approximately 20 are manufacturing formulations. Tetramethrin is not registered for direct application to agricultural crops and there are no food tolerances for specific raw agricultural commodities. There are no proposed new uses by any of the registrants for tetramethrin as part of this reregistration.

Prior to the reregistration of this active ingredient, the registrants have requested and the Agency has approved a number of amendments to delete uses or certain registrations for products containing tetramethrin. From 1996 through 2007, the registrants canceled all greenhouse uses of tetramethrin and have also voluntarily canceled certain tetramethrin products. These regulatory actions were published in the *Federal Register* for public comment and were subsequently approved by the Agency.

B. Chemical Identification

TETRAMETHRIN:



Tetramethrin, [(1,3,4,5,6,7-hexahydro-1,3-dioxo-2H-isoindol-2-yl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate] is a mixture of four stereoisomers designated as 1R - trans, 1R - cis, 1S - trans, and 1S - cis in an approximate ratio of 4:1:4:1. The first two isomers are the most insecticidally active, and a mixture of the two has been termed 'd-tetramethrin' and has the tradename Neo-Pynamin Forte (Sumitomo). Neo-Pynamin Forte is not registered in the U.S., but toxicity data on this material have been submitted to fulfill data requirements for tetramethrin.

Common Name: Tetramethrin

Chemical Name: (1,3,4,5,6,7-hexahydro-1,3-dioxo-2H-isoindol-2-yl)methyl 2,2-dimethyl-3-(2-methyl-1-propenyl)cyclopropanecarboxylate

Chemical Class: Synthetic pyrethroid

Case Number: 2660

EPA Chemical (PC) Code: 069003

CAS Number: 7696-12-0

Empirical Formula: C₁₉H₂₅NO₄

Technical Registrants: Valent BioSciences Corporation
Sumitomo Chemical Company

Parameter	Value
Melting point/range	68 - 70 °C
Molecular Weight	331.4 g/mol
Density	1.1 specific gravity at 20 °C
Water solubility	1.83 mg/L at 25 °C
Solvent solubility	>2 g/100 mL in acetone, ethanol, methanol, hexane and n-octanol
Vapor pressure	0.944 mPa at 30 °C
Dissociation constant, pK _a	Not available
Octanol/water partition coefficient, Log(K _{ow})	log P _{ow} = 4.6 at 25 °C
UV/visible absorption spectrum	Not available

C. Use Profile

The following information on the currently registered uses includes an overview of use sites and application methods. A detailed table of the uses of tetramethrin eligible for reregistration is contained in Appendix A.

Type of Pesticide: Tetramethrin is a broad-spectrum, first-generation synthetic pyrethroid insecticide. Pyrethroids are synthetic esters derived from naturally occurring pyrethrins (insecticides derived from the extract of chrysanthemum flowers). Tetramethrin is a rapid knockdown agent against flying and crawling insects. Tetramethrin may be co-formulated with synergists (e.g., PBO and MGK-264), other active ingredients such as pyrethrins and other pyrethroids (e.g., permethrin, allethrin, phenothrin, resmethrin, and cypermethrin), and growth inhibitors (e.g., fenoxycarb) for greater effectiveness and to control a broader spectrum of insect pests. These other active ingredients are more persistent than tetramethrin and provide residual activity against insects not exposed initially.

Target Organisms: The primary target pests are flying and crawling insects such as wasps, hornets, roaches, ants, fleas, and mosquitoes.

Mode of Action: Tetramethrin is a type 1 pyrethroid (i.e., lacking a cyano group at the α carbon position of the alcohol moiety). Type 1 pyrethroids act on axons in the peripheral and central nervous system by interacting with sodium channels in mammals and/or insects. Tetramethrin is a nerve cell membrane sodium channel modulator, which interferes with entrance of sodium ions into the channel, leading to hyperactivity of the nervous system which can result in paralysis and/or death.

Use Sites: Commercial applications include space sprays, broadcast surface treatments, and crack and crevice treatments in a variety of industrial and institutional sites including: indoor non-food areas; animal premises (not used for human consumption); and outdoors as localized space and contact sprays on ornamental plants and perimeter treatments (sidewalks, entranceways, outside surfaces of buildings, etc.).

Residential uses include: pest control in homes as a space spray, general surface spray, spot and crack and crevice applications, on house plants, clothing and bedding, pet premises, and direct applications to pets. Outdoors it is used as localized space and contact spray on ornamental plants and perimeter treatments (sidewalks, decks, patios, outside surfaces of buildings, etc.).

Horticultural applications include foliar and fogger treatment on non-food plants. There are no registered food use applications for tetramethrin.

Use Classification: Tetramethrin products are designated as general use. However, some end use products indicate they are for use by pest control operators (PCOs) only.

Formulation Types: Pressurized liquid, ready-to-use (RTU) liquids, emulsifiable concentrates, and liquid concentrates.

Application Methods: Tetramethrin is applied by aerosol can, handheld sprayers, foggers, and mechanical sprayers.

Application Rates: Tetramethrin application rates vary depending on the use pattern, indoor or outdoor use, and consumer and professional or commercial operator use. Typical concentrations of active ingredient (a.i.) in residential use products, including ready to use (RTU) (e.g. ant and roach sprays, wasp and hornet sprays) and indoor and outdoor aerosols or aqueous sprays for crawling and flying insects, range between 0.1 % and 0.25%. Indoor total release foggers are typically around 0.54% a.i. Sprays designed for use on pets are typically 0.063% a.i. Emulsifiable concentrate formulations are approximately 2.5% a.i. The maximum single application rate to an outdoor site is 0.00002 lb a.i./sq ft.

Application Timing: Tetramethrin is typically labeled for use “as needed.”

D. Estimated Usage of Pesticide

Based on data provided to the Agency by the tetramethrin registrants, it appears that tetramethrin usage has increased over the past 5 years. This is likely due to the fact that pyrethroids are alternatives to several organophosphate pesticides, which are no longer registered

for indoor residential areas. The Agency estimates annual usage of tetramethrin to be between 15,000 and 30,000 pounds (lbs) a.i. However, tetramethrin use data is extremely limited and difficult to interpret because tetramethrin products may be stored for periods of time and produced only as inventory is exhausted. In addition, based on its localized use pattern and “use as needed” directions, sales or production data does not accurately reflect usage.

Based on use information provided to the Agency by the tetramethrin registrants, the majority of tetramethrin use is in residential outdoor spaces. It appears residential indoor use sites and institutional and industrial sites make up a small percentage of tetramethrin use. Further, tetramethrin is primarily used by residential consumers as opposed to PCOs. Sources suggest that less than 1,000 lbs a.i. are used annually by professional applicators.

III. Summary of Tetramethrin Risk Assessments

The following is a summary of EPA's revised human health and ecological risk assessments for tetramethrin, as presented fully in the documents, *Tetramethrin Risk Assessment for Reregistration Eligibility Decision*, dated June 18, 2008 and the *Revised Environmental Fate and Ecological Risk Assessment for the Re-registration Eligibility Decision on Tetramethrin*, dated February 5, 2008, respectively. The purpose of this summary is to assist the reader by identifying key features and findings of these risk assessments, and to help the reader better understand conclusions reached in the assessments.

The human health and ecological risk assessment documents and supporting information listed in Appendix C were used to reach the safety finding and regulatory decision for tetramethrin. While the risk assessments and related addenda are not included in this document, they are available from the OPP Public Docket, located at <http://www.regulations.gov>, under docket number EPA-HQ-OPP-2008-0014.

EPA's use of human studies in the tetramethrin risk assessment is in accordance with the Agency's Final Rule promulgated on January 26, 2006, related to Protections for Subjects in Human Research, which is codified in 40 CFR Part 26.

A. Human Health Risk Assessment

The human health risk assessment incorporates all sources of potential exposure, hazard, and risks, including both residential and occupational applications. There are no registered food uses for tetramethrin, and the majority of use is in consumer home products (indoor and outdoor surface and space sprays). There are also commercial and horticultural uses for tetramethrin.

The EPA released its preliminary risk assessments for tetramethrin for public comment on February 27, 2008 for a 60-day public comment period (Phase 3 of the public participation process). The preliminary risk assessments may be found in the tetramethrin public docket. In response to comments received and additional data submitted during Phase 3, the human health risk assessment was updated and refined. Major revisions to the tetramethrin human health risk assessment include the following:

- Elimination of the post-application exposure scenario "outdoor total release fogger" due to comments received from McLaughlin, Gormley, King Company that there are no total release aerosols registered for outdoor use.
- Consideration and inclusion of a probabilistic risk assessment model, Cumulative and Aggregate Risk Evaluation (CARES), for residential post-application exposure to tetramethrin products in the revised residential exposure risk assessment.
- Identification of acute inhalation toxicity data, eye and dermal irritation, and skin sensitization data gaps.

For more information on the revised human health risk assessment, see *Tetramethrin Risk Assessment for Registration Eligibility Decision*, dated June 18, 2008, which is available under docket number EPA-HQ-OPP-2008-0014.

1. Toxicity of Tetramethrin

Toxicity assessments are designed to predict whether a pesticide could cause adverse health effects in humans (including: short-term or acute effects, such as skin or eye damage; and lifetime or chronic effects, such as cancer, developmental effects, or reproductive effects), and the level or dose at which such effects might occur.

The toxicity database for tetramethrin contains acceptable acute toxicity, subchronic, chronic, oncogenicity, and mutagenicity studies. However, the database lacks acceptable developmental studies and acceptable acute neurotoxicity, subchronic neurotoxicity, and developmental neurotoxicity (DNT) studies. Although developmental and neurotoxicity studies are available, these studies are considered inadequate based on the use of carboxymethylcellulose (CMC) as the dosing vehicle. CMC has been found to decrease the absorption rate and thereby lessen the potency and toxicity of pyrethroid compounds. Concerns regarding studies on pyrethroid compounds that used CMC as a vehicle are discussed in published literature and further emphasized in a EPA report released in a July 18, 2007 draft document, "Assessing Approaches for the Development of PBPK Models of Pyrethroid Pesticides" prepared jointly by EPA's Office of Pesticide Programs and Office of Research and Development. Therefore, new developmental toxicity, and acute, subchronic, and developmental neurotoxicity studies utilizing an appropriate dosing vehicle are required to fully evaluate potential risks from exposure to tetramethrin.

Since the tetramethrin database is currently incomplete with respect to data on developmental and neurotoxicity studies, the Agency applied a ten-fold (10x) database uncertainty factor (UF_{DB}) to account for this lack of data.

a. Acute Toxicity Profile

Tetramethrin is slightly toxic (Toxicity Category III or IV) by the oral and dermal routes of exposure. However, in acute oral studies in mice with technical tetramethrin and/or neopynamin forte, clinical signs sometimes included hyper-excitability, muscular fibrillation, tremor, ataxia, limb paralysis, irregular respiration, lacrimation, and salivation. These effects were also seen in acute percutaneous studies in rats. Acceptable data on the acute inhalation toxicity and acute eye and dermal irritation and skin sensitization for technical tetramethrin are unavailable. The Agency is requiring these data.

Guideline No.	Study Type	MRID	Results	Toxicity Category
870.1100	Acute oral [rat]*	42146405	LD50 > 5,000 mg/kg	IV
870.1200	Acute dermal [rat]	00063574	LD50 > 5,000 mg/kg	IV
870.1200	Acute dermal [rabbit]	40276101	LD50 > 2,000 mg/kg	III
870.1300	Acute inhalation [rat]			No data
870.2400	Acute eye irritation [rabbit]			No data
870.2500	Acute dermal irritation [rabbit]			No data

Guideline No.	Study Type	MRID	Results	Toxicity Category
870.2600	Skin sensitization [guinea pig]			No data

* Clinical signs of neurotoxicity (e.g., hyper-excitability, muscular fibrillation, tremor, ataxia etc.) were present at 2,500 and 5,000 mg/kg/day in acute oral studies in rodents.

b. Toxicological Endpoints

The toxicological endpoints used in the human health risk assessment for tetramethrin are listed in Table 3 below. There are no registered food uses for tetramethrin and dietary and drinking water exposure to tetramethrin is not expected based on use patterns. Therefore, acute and chronic reference doses are not required and were not selected for this assessment. Non-cancer endpoints were selected for inhalation and incidental oral exposures only.

The short-term incidental oral endpoint was selected from a two-generation rat reproduction study (MRID 00161842) with 1 litter per generation. The systemic toxicity NOAEL of 25 mg/kg/day was selected based on parental and offspring LOAELs of 150 mg/kg/day. The parental LOAEL is based on decreased body weight and food consumption in both sexes of F0 and F1 parental animals and bile duct hyperplasia in F1 animals. The offspring LOAEL is based on decreased pup body weight during lactation.

There are no dermal absorption studies available with tetramethrin. However, based on available dermal absorption studies in pyrethrins/pyrethroid compounds, dermal absorption of tetramethrin is expected to be very low (i.e., less than 2%). Tetramethrin was tested in a 21-day dermal toxicity study in rats (MRID 41995004) at doses of 0, 100, 300, or 1,000 mg/kg/day in 5/sex/dose Sprague-Dawley rats. There were no treatment-related systemic toxic effects and a LOAEL was not established. No endpoints were selected for dermal exposure because no effects were observed at the limit dose in available acceptable dermal toxicity studies.

The short and intermediate term inhalation exposure endpoint was selected based on two 90-day inhalation toxicity studies in rats conducted in 1991 (MRIDs 42012101 and 41995003). The systemic toxicity NOAEL of 19.8/20.3 mg/m³ (3.5 mg/kg/day) was selected based on: increased clinical signs (irregular respiration and bradypnea); decreased body weight gain; changes in hematology, urinalysis, and blood chemistry; gross necropsy findings in liver; hepatocellular hypertrophy; and hyaline droplets in kidney in both sexes at the LOAEL of 134 mg/m³ (23.5 mg/kg/day).

A combined uncertainty factor or margin of exposure (MOE) of 1,000 for residential and occupational scenarios is based on 10x and 10x for interspecies and intraspecies variation plus an additional database uncertainty factor (UF_{DB}) of 10x for the absence of adequate acute neurotoxicity, subchronic neurotoxicity, and DNT studies. The neurotoxicity studies are needed since the target site of tetramethrin is the nervous system and adequate neurotoxicity data are lacking. The 10x database uncertainty factor is applicable to workers because occupational exposures may pose neurotoxic and developmental risk concerns. The uncertainty factors (UF) used to account for interspecies extrapolation and intraspecies variability are also described in Table 3.

Table 3. Summary of Toxicological Doses and Endpoints for Tetramethrin for Use in Human Risk Assessments			
Exposure Scenario	Dose Used in Risk Assessment, UF	Safety Factor and Level of Concern	Study and Toxicological Effects
Acute and Chronic Dietary (general population)	Acute and Chronic RfD's were not selected because there are no registered food uses		
Short-Term Incidental Oral (1 - 30 days)	NOAEL = 25 mg/kg/d UF _A =10 UF _H = 10 UF _{DB} = 10	Residential LOC for MOE = 1,000 Occupational LOC for MOE = N/A	2-Generation Reproduction (rats) LOAEL = 150 mg/kg/day based on ↓ body wt., ↓ food consumption; and bile duct hyperplasia in F1 females
Short-, Intermediate- Term Dermal (1 - 30 days, 1-6 months)	No risk is expected from this exposure scenario as no hazard was identified in a 21/28 day dermal toxicity study conducted at the limit dose of 1,000 mg/kg/d.		
Inhalation Short-, Intermediate-Term (1 - 30 days, 1-6 months)	Inhalation NOAEL = 19.8 mg/m ³ (3.5 mg/kg/d (oral equivalent)) UF _A =10 UF _H = 10 UF _{DB} = 10	Residential LOC for MOE = 1,000 Occupational LOC for MOE = 1,000	90 Day Inhalation Toxicity (rats) LOAEL = 134 mg/ m ³ (23.5 mg/kg/day) based on ↑ clinical signs, absolute/relative kidney and liver weights; ↓ body weight, changes in hematology, urinalysis, hypertrophic and gross liver necropsy findings, and hyaline droplets in the kidney
Cancer (oral, dermal, inhalation)	Group C, possible human carcinogen based on evidence of benign testicular tumors in rats and increased hepatocellular carcinomas in male mice at the HDT of 1134 mg/kg/day. Based on a recent review of the cancer data, HED has determined that tetramethrin would likely be reclassified under EPA's 2005 Guidelines for Carcinogen Risk Assessment as "Suggestive Evidence of Carcinogenic Potential."		

UF = uncertainty factor (A= Animal/Interspecies, H= Human/Intraspecies, DB=Data Base)

NOAEL = no observed adverse effect level

LOAEL = lowest observed adverse effect level

MOE = margin of exposure

LOC = level of concern

N/A = Not Applicable

2. Carcinogenicity of Tetramethrin

The Agency concluded that, based on the available information, tetramethrin meets the criteria for Group C, possible human carcinogen. Tetramethrin administered to Sprague-Dawley rats was associated with a statistically significant dose-related increase in the incidence of interstitial cell adenomas in the testes in mid- and high-dose males. These results were reproducible in a second study in Sprague-Dawley rats and another study in Long-Evans rats. This increase was outside the historical control range for Sprague-Dawley rats. No historical control data were available on Long-Evans rats. Tetramethrin administration to B₆C₃F₁ mice did not alter the spontaneous tumor profile for this strain of mice. Therefore, the Agency determined that no chronic cancer risk assessment was necessary. The Agency based its decision on the fact that this type of tumor (interstitial cell adenomas of the testes) is a benign tumor that does not progress to a malignant tumor in rats; the tumors occurred at a later stage of the study; the exposure started in utero; and the treatment did not cause reduction in latency.

3. Metabolites and Degradates

The Agency reviewed the metabolism of tetramethrin (MRIDs 42448901 and 42448902), and concluded that for risk assessment, the parent compound, tetramethrin, is the only residue of toxicological concern. For additional details, refer to the *Tetramethrin Risk Assessment for Registration Eligibility Decision*, dated June 18, 2008.

4. Endocrine Disruption

EPA is required under the FFDCA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) “may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or other such endocrine effects as the Administrator may designate.” Following recommendations of its Endocrine Disruptor and Testing Advisory Committee (EDSTAC), EPA determined that there was a scientific basis for including, as part of the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC’s recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When additional appropriate screening and/or testing protocols being considered under the Agency’s EDSP have been developed, tetramethrin may be subjected to further screening and/or testing to better characterize effects related to endocrine disruption.

5. Dietary Exposure and Risk (Food and Water)

Tetramethrin currently has no registered food uses and there are no tolerances for specific raw agricultural commodities. Tetramethrin is not registered for direct application to agricultural crops, livestock animals, or livestock premises, where livestock are used for food. Although there are no registered food uses for tetramethrin, there are uses in the home where food may be exposed (e.g., kitchens), but labels for these uses have restrictions to prevent / limit food exposure such as, “In the home, all food-processing surfaces and utensils should be covered during treatment or thoroughly washed before use. Cover exposed food.” Therefore, dietary exposure is not of concern.

The Agency did not conduct a quantitative drinking water assessment for tetramethrin, given the limited extent of potential exposure and the chemical’s environmental fate properties. Tetramethrin is used by individual homeowners or industrial / commercial property owners, in individual, isolated areas, and in small amounts as opposed to wide scale uses (i.e., for agriculture or mosquito abatement by public authorities). Because tetramethrin products are not expected to adversely impact groundwater or surface water (the sources of drinking water), a quantitative drinking water assessment is not warranted.

6. Residential Exposure and Risk

Residential exposure assessments consider all potential non-occupational pesticide exposure. Tetramethrin has a wide variety of residential uses, including use in/on indoor and outdoor surfaces, and use on pets. Therefore, the Agency has determined that there is a potential for exposure to tetramethrin in residential settings for homeowners who handle (mix, load, and apply) products containing tetramethrin, as well as post-application exposure from entering tetramethrin-treated areas. Non-occupational post-application exposures can result following use of pesticides by homeowners themselves or following applications by professional pest control operators in residential or non-residential settings.

Risk assessments have been completed for both residential handler (inhalation only) and post-application scenarios (inhalation and incidental oral). Though dermal exposure is possible and expected for residential handler and post-application scenarios of tetramethrin, the Agency determined a dermal assessment was not necessary because no systemic effects were observed at the limit dose in dermal toxicity studies in animals.

To estimate residential (inhalation and incidental oral) risks, the Agency calculates a margin of exposure (MOE), which is the ratio of the toxicity endpoint (NOAEL) selected for risk assessment to the exposure value. The MOE is then compared to a level of concern (LOC), which is the same value as the uncertainty factor (UF) applied to a particular toxicity study. The standard UF is 100x (10x to account for interspecies extrapolation and 10x for intraspecies variation). However, since the tetramethrin database is currently incomplete the Agency applied a ten fold (10x) database uncertainty factor (UF_{DB}) to account for this lack of data; thus, for residential exposures to tetramethrin, MOEs greater than the target LOC of 1,000 are not of concern to the Agency. For detailed information on the residential risk assessment, see the *Tetramethrin Risk Assessment for Registration Eligibility Decision*, dated June 18, 2008.

a. Residential Handler Risks

The Agency determined that exposure to homeowners handling a tetramethrin product is likely to occur via the inhalation route during the residential use of tetramethrin in a variety of indoor and outdoor settings. The risk assessment considered three major residential exposure scenarios, based on the types of equipment and techniques that can potentially be used to make tetramethrin applications. While some tetramethrin products are packaged as RTU trigger sprayer bottles, the handler risks calculated from aerosol can application are protective of risks from trigger sprayer applications because the unit exposure values are lower for trigger sprayer application. The Agency only considered short-term (1-30 days) inhalation exposure due to infrequency of use associated with homeowner products and the non-persistence of tetramethrin. Additionally, as discussed above, dermal exposures were not assessed, because no effects were observed at the limit dose in available acceptable dermal toxicity studies. The following scenarios were assessed:

- Mix / Load / Apply liquids with a backpack sprayer or low pressure hand wand.
- Aerosol can application
- Load / Apply liquids with a trigger-pump sprayer.

Pesticide handler exposure database (PHED) unit exposure values were used to assess exposures, because chemical-specific monitoring data were not available. The following assumptions were also used in estimating risks from residential handler exposure to tetramethrin:

- The body weight of an adult handler is 70 kg.
- The amount handled per day is based on formulation type:
 - Aerosol can: One 16 ounce can is used per day.
 - Trigger- pump Sprayer: 1 gallon of diluted solution per day.
 - Low-pressure handwand sprayer: 5 gallons of diluted solution per day.

Table 4 summarizes the inhalation risk estimates for residential handlers of tetramethrin products. All MOEs are well below the Agency’s LOC (MOEs \geq 1,000 are not of concern), with values ranging from 75,000 to 100,000.

Table 4. Residential Handler Risk Estimates from General Spray Applications				
Exposure Scenario	Application Rate	Amount Sprayed per Day	Pound a.i. handled per day	Inhalation MOE
M/L/A Liquids with LP Hand-wand or Backpack Sprayer	0.02 lb a.i./gallon solution	5 gallons	0.1	82,000
Aerosol Can Application	0.25% a.i.	1 can (16 oz ea)	0.0025	75,000
L/A RTU with a Trigger-pump Sprayer	0.02 lb a.i./gallon solution	1 gallon	0.02	100,000

M/L/A = Mix / load / apply
 LP = Low pressure
 L/A = Load / apply
 RTU = Ready-to-use

b. Residential Post-Application Risks

The Agency uses the term “post-application” to describe exposures to individuals that occur as a result of being in an area that has been previously treated with a pesticide. Unlike residential handler exposure, where the Agency assumed only adults will be handling and applying tetramethrin products, individuals of varying ages can potentially be exposed when reentering or performing activities in areas that have been previously treated. Tetramethrin can also be used on pets, which can lead to exposure by contact with the treated animals.

Tetramethrin post-application incidental oral exposures may occur after applications are made to residential areas resulting in residues on surfaces, such as carpets and vinyl flooring. Post-application inhalation exposures are possible from residue concentrations in air following applications such as space sprays and fogging applications. Post-application incidental oral exposures were assessed for children only, and inhalation exposures were assessed for both adults and children. Again, dermal exposures were not assessed, because no effects were observed at the limit dose in available acceptable dermal toxicity studies. The following scenarios were assessed.

- Inhalation exposure (adults and children) indoors:
 - Space spray and total release fogger;
- Inhalation exposure (adults and children) outdoors:
 - Handheld foggers and aerosols;
- Incidental oral ingestion (children only) of residues indoors:
 - Total release aerosol fogger treatment,
 - Aerosol and spray surface treatments,
 - Aerosol and spray treatments to pets; and,
- Incidental oral ingestion (children only) of residues outdoors:
 - Handheld fogger applications, and
 - Aerosol surface treatments.

The Agency assessed the post-application exposure to tetramethrin using two approaches: a deterministic approach and a probabilistic approach. A deterministic approach uses a point estimate from a data set, e.g., a single maximum value or an average value, as an input variable in the exposure model. This approach does not consider the range of potential exposures incurred by members of a population and does not describe the potential or probability of exposure to individuals within a population. Rather, the deterministic approach produces an output value that represents the potential exposure or risk of a group; depending on how the estimate was generated, the output value may reflect a “central tendency,” a “high-end,” or an “upper-bound.” In contrast, a probabilistic approach uses the full range of available data and produces a distribution of values as output, and is recognized as a refinement over the deterministic assessment. More detail is provided below regarding the probabilistic risk assessment.

i. Deterministic Risk Approach and Assessment

The February 5, 2008, *Tetramethrin: Phase I Revised Occupational and Residential Exposure Assessment and Recommendations for the Reregistration Eligibility Decision* presented results of the Agency’s deterministic post-application risk assessment. Risks of concern were identified for hand-to-mouth exposures following indoor aerosol can space spray treatments (MOEs of 290 and 430 for children on carpet and vinyl, respectively), inhalation exposure following indoor aerosol can treatments (MOE of 850 for children), and hand-to-mouth exposure following indoor ready-to-use liquid spray treatments (MOEs of 570 and 840 for children on carpet and vinyl, respectively).

ii. Probabilistic Risk Approach and Assessment

In the *Tetramethrin Risk Assessment for Registration Eligibility Decision*, dated June 18, 2008, the Agency presents the results of the probabilistic exposure assessment, using the Cumulative and Aggregate Risk Evaluation System (CARES[®] Version 3.0; <http://cares.ilsil.org/>), a publicly available software program. Probabilistic exposure assessment is recognized as a refinement over deterministic assessment because it allows users to identify percentiles of risk by using inputs in the form of distributions rather than point estimates.

a. Tetramethrin CARES Post-Application Risk Assessment

The Agency completed a CARES probabilistic residential exposure and risk assessment, which verified the CARES assessment that was submitted by tetramethrin registrants Valent BioSciences Corporation, Sumitomo Chemical Company, LTD, S. C. Johnson & Son, Inc., and McLaughlin Gormley King Company. CARES utilizes a reference population of 100,000 individuals selected from the 1990 U.S. Census. It is considered appropriate for use in exposure analysis due to its similarity with the U.S. Census Public Use Micro Data Sample (PUMS), a statistically representative dataset that contains data for statistical weights from sampled individuals of the general U.S. population, provided by the U.S. Department of Commerce, Bureau of the Census, Economics and Statistics Administration. Key sub-populations relevant to exposure analysis within CARES include different races (e.g., white, black, Hispanic, etc.) and different age groups (e.g., children 1-3 years old, male 20-54 years old, etc.) (Driver et al, 2008).

CARES simulates daily (24-hour) exposures over the course of one calendar year for each person in the specified sub-population based on user-specified routes of exposure (e.g., dietary, dermal, non-dietary ingestion), empirical data, and exposure algorithms. It can provide cumulative exposures for more than one chemical, aggregate across exposure routes, and provide results for different exposure patterns (e.g., acute or chronic exposures). Additionally, each input (e.g., chemical residue, exposure duration, and mouthing behavior) is described and used as a distribution in a Monte Carlo simulation to identify percentiles of risk and enable users to conduct analyses to identify major exposure contributors.

The calculations and algorithms used to estimate exposure for the various scenarios and routes are consistent with standard Agency practice for residential pesticide exposure assessment. Risks of concern were not identified for residential handler scenarios in the deterministic assessment; therefore, the CARES assessment considered only post-application exposure routes. The tetramethrin exposure scenarios were assessed using standard EPA algorithms for exposure estimation. Distributional inputs were included in the probabilistic assessment where possible. The probabilistic assessment assumes post-application exposure occurs on the “day of application,” which is the most conservative assumption.

The tetramethrin CARES assessment calculated risk for adults (defined as males and females 20 - 49 years old) and children (defined as males and females 1 - 2 years old). Though older or younger children may be exposed to tetramethrin, the selection of 1 - 2 year olds is appropriate since this age group exhibits the highest degree of mouthing behavior – a major route of exposure for this assessment (Tulve et al., 2002). Combined male/female populations are also appropriate since the toxicological endpoints used in the risk assessment are not gender specific. The risk percentages generated by the CARES model correspond only to those individuals who use tetramethrin as a pesticide (i.e., the population is “users only”) and those that reside within the home. The assessment does not characterize risk relative to the percentage of the population that does not use tetramethrin.

Exposure factors used in the CARES assessment were determined based on consultation between EPA and the tetramethrin registrants. Many of the non-tetramethrin-specific distributional inputs are based on EPA’s n-methyl Carbamate Revised Cumulative Risk Assessment (NMCCRA), the most recent EPA publication using probabilistic methods and

distributional inputs for residential exposure assessment. Refer to the *Tetramethrin: Phase IV Revised Occupational and Residential Exposure Assessment and Recommendations for the Reregistration Eligibility Decision*, dated June 13, 2008, for more information on the inputs and distributions considered for the CARES assessment.

Table 5. CARES Residential Post-Application Assessment – Tetramethrin MOEs for Adults (20 - 49 years)

Percentile	Exposure Scenario and Route		
	Outdoor Treatment	Indoor Treatment (Spray)	
	Inhalation	Inhalation (Applicator)	Inhalation (Post-application)
100	1,690	37,336	5,834
99.9	2,051	47,342	6,726
99.8	2,117	48,848	7,162
99.7	2,150	48,848	7,432
99.6	2,188	48,848	7,510
99.5	2,215	48,848	7,673

Table 6. CARES Residential Post-Application Assessment – Tetramethrin MOEs for Children (1 - 2 years)

Percentile	Exposure Scenario and Route					
	Outdoor Treatment		Indoor Treatment			Pet Care
	Ingestion	Inhalation	Fogger Ingestion	Spray Ingestion	Spray Inhalation	
100	1,808	1,034	3,351	492	3,007	3,725
99.9	2,123	1,040	5,347	942	3,113	5,135
99.88	2,188	1,042	5,487	947	3,130	5,207
99.8	2,387	1,045	6,085	1,092	3,160	5,770
99.7	2,603	1,045	6,952	1,144	3,221	6,131
99.6	2,771	1,046	7,951	1,249	3,246	6,482
99.5	2,870	1,048	8,475	1,333	3,285	6,719

For the tetramethrin CARES probabilistic residential exposure assessment, MOEs below 1,000 were identified only for indoor non-dietary ingestion at the 100, 99.9, and 99.88 percentiles for children 1-2 years old following a spray application. The MOE for this scenario is greater than 1,000 at the 99.8th percentile (MOE = 1,092). The Agency does not have a current policy on a “percentile of regulation” for probabilistic residential non-dietary exposure assessment; however, considering this assessment still reflects the standard, conservative practice of assessing “users only” on the “day of application,” risks do not exceed the Agency’s LOC.

7. Aggregate Exposure and Risk

For tetramethrin, short term aggregate risk potentially involves adding exposure estimates for incidental oral exposure and inhalation exposure pathways for young children. However, exposures from incidental oral and inhalation pathways may not be aggregated for tetramethrin because the toxicity endpoints for these exposure routes are not based on common toxic effects (i.e., body weight changes are considered to be non-specific, and there are no common specific target organ effects observed in the oral and inhalation toxicity studies.)

8. Occupational Exposure and Risk

The occupational risk assessment addresses risks to workers who may be exposed to tetramethrin when mixing, loading, or applying a pesticide (i.e., handlers), and when entering treated sites for routine tasks (post-application). Exposure for workers generally occurs via the dermal or inhalation route. However, for tetramethrin, only inhalation exposures were calculated since there were no treatment related systemic toxic effects at the highest dose tested in the 21 day dermal toxicity study. The target MOE is 1,000 for occupational exposures.

Occupational exposure to tetramethrin was assessed using data from the Pesticide Handler Exposure Database (PHED), and worker exposure and risk estimates are based on the best data currently available to the Agency. In addition, standard default assumptions pertaining to average body weight, work day, and area treated daily were used to calculate risk estimates. Application rates used in this assessment are derived directly from current tetramethrin labels. The occupational risk assessment is summarized here. For further detail, see the *Tetramethrin Risk Assessment for Registration Eligibility Decision*, dated June 18, 2008.

a. Occupational Handler Exposure and Risks

The term “handler” applies to individuals who mix, load, and apply the pesticide product. Because most tetramethrin products are packaged in aerosol cans, most of the uses will involve application only (i.e., there is no mixing or loading activities for aerosol cans). However, some products are packaged as ready-to-use liquids or liquid concentrates, which are applied with mechanical sprayers, compressed air sprayers or foggers (i.e., equipment and formulation that do require mixing and loading activities). Based upon the currently registered product labels, the Agency assessed the following occupational handler scenarios:

Pesticide Control Operator Scenarios

1. Mix/Load/Apply (M/L/A) liquids with a backpack sprayer or low pressure handwand
2. M/L/A liquids with handheld fogging equipment
3. Applying with an aerosol can
4. Load/Apply (L/A) liquids with a trigger-pump sprayer

Occupational handler exposure assessments are conducted by the Agency using different levels of protection. The Agency typically evaluates all exposures with minimal protection and then adds protective measures in a tiered approach to determine the level of protection necessary to obtain appropriate MOEs. Dermal exposures were not assessed because no systemic effects were observed at the limit dose in available acceptable dermal toxicity studies. Inhalation exposures were assessed at the minimum level of protection, which is no respirator. Risk estimates (i.e., MOEs) for the general surface and space sprays and handheld fogger handler scenarios are summarized in Tables 7 and 8. All MOEs are above the target MOE of 1,000 (ranging from 10,000 to 50,000), and therefore, are not of concern.

Table 7. Short / Intermediate-term Inhalation MOEs for Occupational Handlers Applying General Surface and Space Sprays						
Exposure Scenario	Unit Exposure ^A (µg/lb a.i.)	Application Rate ^B	Amount Sprayed per Day	lb a.i. handled per day	Inhalation Dose ^E (mg/kg/day)	Inhalation MOE ^F

Table 7. Short / Intermediate-term Inhalation MOEs for Occupational Handlers Applying General Surface and Space Sprays

Exposure Scenario	Unit Exposure ^A (µg/lb a.i.)	Application Rate ^B	Amount Sprayed per Day	lb a.i. handled per day	Inhalation Dose ^E (mg/kg/day)	Inhalation MOE ^F
M/L/A liquids with LP hand-wand or backpack sprayer	30	0.02 lb a.i./gallon solution	40 gallons ^C	0.8	0.00034	10,000
L/A liquids with Trigger-pump Sprayer	123		2 gallons ^D	0.04	0.00007	50,000
Aerosol can application	1300	0.25% a.i.	6 cans ^D	0.015	0.00028	13,000

- A. Unit Exposure values are from PHED (See Table A12)
- B. Application rates are from labels 769-939 (0.02 lb a.i./gallon solution) and 73049-165 (0.25%)
- C. Based upon ExpoSAC Policy 9.
- D. Screening level estimate based upon professional judgment.
- E. Inhalation dose (mg/kg/day) = [unit exposure (ug/lb a.i.) * 0.001 mg/ g * lb a.i. handled per day)] / Body weight (70 kg).
- F. MOE = NOAEL (3.5 mg/kg/day) / Dose

Table 8. Inhalation MOEs for Occupational Handlers Applying Sprays using Handheld Fogging Equipment

Application Rate		Inhalation Exposure ^C (mg/day)	Inhalation Dose ^D (mg/kg/day)	Inhalation MOE ^E
(lb a.i./ft ³) ^A	(mg/m ³) ^B			
0.00000001	0.218	0.0174	0.00025	14,000

- A. Based on EPA Reg. No. 73049-432: 1 fluid ounce of 0.10% RTU solution per 600 square feet at an approximate spray height of 8 feet. [1 fl.oz./600 ft²] * [1 gallon/128 fl.oz.] * [8.35 lb soln/gallon] * [0.1% a.i.] / 8 ft = 0.00000001 lb a.i./ft³
- B. Application rate (mg/m³) = 0.00000001 lb a.i./ft³ * [454000 mg/lb] * [35 ft³/m³] = 0.218 mg/m³
- C. Inhalation Exposure (mg/day) = [Application Rate (mg/m³) * Breathing Rate (1 m³/hr) * Exposure Time (8 hours/day)] / Outdoor Dilution Factor (100)
- D. Inhalation Dose (mg/kg/day) = Inhalation Exposure (mg/day) / Body Weight (70 kg)
- E. MOE = NOAEL/Dose where the NOAEL is 3.5 mg/kg/day.

b. Occupational Post-Application Exposure and Risk

The Agency uses the term “post-application” to describe exposures to individuals that occur as a result of being in an environment that has been previously treated with a pesticide (also referred to as re-entry exposure). The Agency did not conduct a post-application risk assessment for tetramethrin for occupational exposures. Although dermal exposure is possible and expected, no occupational post-application assessment was conducted because no systemic effects were observed at the limit dose in available acceptable dermal toxicity studies in animals. Additionally, inhalation post-application exposures were not assessed because tetramethrin is applied in areas where prolonged occupational presence in areas with low ventilation following application (e.g., following greenhouse applications) is not expected.

9. Cumulative Exposure and Risk

Section 408(b)(2)(D)(v) of FFDCA requires that, when considering whether to establish, modify, or revoke a tolerance, the Agency consider “available information” concerning the cumulative effects of a particular pesticide's residues and “other substances that have a common mechanism of toxicity.”

Tetramethrin is a member of the pyrethroid class of pesticides. Although all pyrethroids alter nerve function by modifying the normal biochemistry and physiology of nerve membrane sodium channels, EPA is not currently following a cumulative risk approach based on a common mechanism of toxicity for the pyrethroids. Although all pyrethroids interact with sodium channels, there are multiple types of sodium channels, and it is currently unknown whether the pyrethroids have similar effects on all channels. Nor do we have a clear understanding of effects on key downstream neuronal function e.g., nerve excitability, nor do we understand how these key events interact to produce their compound specific patterns of neurotoxicity. There is ongoing research by the EPA's Office of Research and Development and pyrethroid registrants to evaluate the differential biochemical and physiological actions of pyrethroids in mammals. When available, the Agency will consider this research and make a determination of common mechanism as a basis for assessing cumulative risk. For information regarding EPA's procedures for cumulating effects from substances found to have a common mechanism on EPA's website at <http://www.epa.gov/pesticides/cumulative/>.

10. Tetramethrin Human Incident Reports

The OPP Incident Data System (IDS) and Poison Control Centers (PCC) databases were consulted for poisoning incident data on the active ingredient tetramethrin. Reports submitted to the IDS and PCC typically represent anecdotal reports or allegations only; therefore, no conclusions can be drawn implicating tetramethrin as a cause of any of the reported health effects unless supported by results from other data sources or unless the individual incidents are well documented.

There are approximately 98 reported incidents in the IDS database over the last five years (2002 to the present) for products containing tetramethrin. Since there are no pesticide products for which tetramethrin is the sole active ingredient, reported incidents cannot be solely attributed to exposure to tetramethrin. The incidents are classified as mild to moderate human incidents (less than 1% involved major effects). The majority (approximately 85%) of incidents with documented health effects reported either no effects or mild effects resulting from tetramethrin-related exposures. The majority of the symptoms included respiratory irritation, shortness of breath, blisters, welts, hives, dizziness, rashes, coughing, and eye irritation, which are similar to that of other pyrethroid compounds. The PCC incidents involved a wide range of effects including cardiovascular, gastrointestinal, respiratory, dermal, and ocular effects.

The Agency believes the number of reported incidents is small in relation to the estimated usage of tetramethrin, which is approximately 15,000 to 30,000 pounds per year. Tetramethrin applications are primarily residential localized or spot treatments via aerosol or RTU sprays on an "as needed" basis (residential exposures accounted for 98% of the reported cases involving tetramethrin); therefore, given this broad spectrum residential use pattern, the Agency estimates the number of applications per year could range in the hundreds of thousands or greater.

While the incident report does inform the Agency further regarding possible dermal and respiratory irritations attributed to pyrethroids, it does not garner greater concern for the active

ingredient tetramethrin solely. The Agency is currently investigating the pyrethroid class of chemicals and aggravated dermal and asthmatic reactions.

B. Environmental Risk Assessment

Tetramethrin is used in residential and industrial/commercial areas in relatively small quantities through aerosols, foggers, and space sprays. On a nationwide basis, tetramethrin use is relatively limited. It is not used on a wide scale, such as agriculture or in mosquito abatement by public authorities. The use pattern is therefore in individual, isolated areas, and again, in small amounts. Tetramethrin also decomposes rapidly by photolysis and hydrolysis. The localized use pattern of tetramethrin, combined with the low total pounds used on a national basis, and rapid degradation due to photolysis and hydrolysis, make it highly unlikely that non-target organisms will be exposed at harmful levels. Non-target organism exposure is most likely to result from outdoor uses, such as spraying wasp or hornet nests under the eaves of houses, and backyard foggers for flying insects. Further, because of the very rapid photolytic decomposition of tetramethrin, only those organisms present at the time of spraying are likely to be exposed and are at risk of acute effects.

The standard models (GENEEC, PRZM-EXAMS, T-REX, Terrplant) used to calculate and quantify risks to terrestrial and aquatic organisms do not fit with the localized use patterns of tetramethrin. As a result, tetramethrin's ecological risk assessment did not follow the standard methodology and the acute risks will be characterized qualitatively rather than quantitatively. A summary of the Agency's environmental fate and effects risk assessment is presented below. For detailed discussion of all aspects of the environmental risk assessment, please see the February 5, 2008 *Revised Environmental Fate and Ecological Risk Assessment Chapter in Support of Phase I of the Re-registration Eligibility Decision on Tetramethrin*, which is available under docket number EPA-HQ-OPP-2008-0014.

1. Environmental Fate and Transport

Tetramethrin is not a persistent pyrethroid in the environment. It may be co-formulated with synergists, other active ingredients such as pyrethrins and pyrethroids, and growth inhibitors. These other ingredients are more persistent than tetramethrin and provide residual activity against insects not initially exposed. Tetramethrin decomposes rapidly by photolysis and hydrolysis in shallow, non-turbid water. Photolysis in air is expected to be rapid (half-life 30 minutes) based on reaction with ozone. Tetramethrin is more susceptible to hydrolysis at pH 7 and 9 than pH 5. The half-lives were 15.9 – 19.7 days (pH 5), 0.89 – 1.06 days (pH 7), and 0.009 – 0.014 days (pH 9). Tetramethrin is slightly mobile in soil (Koc value range from 1,249-2,939), has a vapor pressure of 7.1×10^{-6} mm Hg, water solubility of 1.83 mg/L, and an estimated Henry's law constant of 1.7×10^{-6} atm-m³/mol-l.

At least nine degradates were detected in a column leaching study, and in an aerobic soil metabolism study, seven degradates were identified including one (acid-NPY) that retains the entire ester structure and possibly the mode of action of the parent tetramethrin. However, it too is subject to rapid hydrolysis, and therefore, exposure to acid-NPY is unlikely. In two acceptable

field dissipation studies, tetramethrin dissipated from the upper 15 cm of soil with a DT50 (time to 50% degradation) of 3 hours in a California study, and less than one hour in a Florida study. No toxicity data are available for tetramethrin degradates.

Indoor uses of tetramethrin are not expected to result in significant exposure pathways to terrestrial and aquatic ecosystem as they are confined indoors, and tetramethrin rapidly degrades in hours. While there are numerous outdoor uses, these applications are limited to spot treatments in localized areas and, again, the degradation of tetramethrin to non-toxic degradates is rapid. There is potential for tetramethrin residues to be transported to aquatic systems from use in drainage systems, but only in acidic water where hydrolysis is slower. However, the Agency believes exposure is unlikely because product labels prohibit direct application to water.

2. Ecological Exposure and Risk

The possible exposure mechanisms considered following tetramethrin applications were runoff, spray drift, and direct spray. Only direct spray is considered to be a completed exposure pathway, since tetramethrin is too non-persistent to be transported via runoff, and it is not used in sufficient quantities for spray drift to be of concern. As stated above, neither indoor nor outdoor uses of tetramethrin are expected to result in significant exposure pathways to terrestrial and aquatic ecosystems since they are limited and tetramethrin degrades rapidly. Given that degradation of tetramethrin to non-toxic degradates is rapid, the primary risk will be acute exposure to tetramethrin at the time of application and a brief period thereafter.

Acute toxicity data from studies submitted by pesticide registrants along with the available open literature were used to evaluate the potential direct effects of tetramethrin aquatic and terrestrial organisms. This includes toxicity data on the technical grade active ingredient, degradates, and formulated products when available. The open literature studies are identified through EPA's ECOTOX database (<https://cfpub.epa.gov/ecotox/>), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. The evaluation of both sources of data can also provide insight into the direct and indirect effects of tetramethrin on biotic communities from loss of species that are sensitive to the chemical and from changes in structure and functional characteristics of affected communities.

a. Terrestrial Organisms

No terrestrial modeling was conducted for tetramethrin because exposure of non-target organisms to harmful levels is unlikely based on the localized use patterns, low total pounds used on a national basis, and rapid degradation due to photolysis and hydrolysis. Instead, the Agency conducted a qualitative assessment using submitted studies and review of the literature.

The Agency developed an effects characterization, which describes the potential effects a pesticide can produce in a terrestrial organism, and is based on registrant-submitted studies that describe acute effects toxicity information for various terrestrial animals. Table 9 summarizes the specific measurement endpoint value selected to evaluate risks for tetramethrin to mammals and birds.

Table 9. Summary of Specific Measurement Endpoint Values Selected to Evaluate Risk for the Associated Terrestrial Animal Assessment Endpoints

Assessment Ends	Acute Measurement Endpoint (most sensitive)	Selected Measurement Endpoint Values and Source				
		Species	Study Duration	Toxicity Value	Most Sensitive Endpoint (MRID)	Acute Toxicity Classification
Survival and Reproduction of Birds, Reptiles and Amphibians	Acute oral toxicity	Bobwhite quail	Single oral dose	LD ₅₀ >2250 mg/kg-bw	Mortality* (416096-04/ Acceptable)	Practically non-toxic
	Acute dietary toxicity	Bobwhite quail and Mallard duck	8 days	LC ₅₀ >5620 mg/kg/-diet	Mortality* (416096-05, 416096-06/ Acceptable)	
Survival and Reproduction of Terrestrial Mammals	Acute oral toxicity, LD ₅₀	Rat	Single oral dose	LD ₅₀ >5000 mg/kg-bw	Mortality* (00063574/ Acceptable)	Practically non-toxic
	Dermal toxicity, LD ₅₀	Rat	Not available	LD ₅₀ >5000 mg/kg-bw	Mortality* (00063574/ Acceptable)	
	Inhalation toxicity, LC ₅₀	Rat	Not available	LC ₅₀ >1.18 mg/L	Mortality* (421464-01/ Acceptable)	
	Reproduction NOAEL	Rat	Two – generation	25 mg/kg/day	Mortality* (161842/ Acceptable)	
Survival of Terrestrial Invertebrates and Beneficial Insects	Contact LD ₅₀ (µg/bee)	Honey bee (<i>Apis mellifera</i>)	48 hours	LD ₅₀ 0.155 µg/bee	Mortality (416096-13/ Acceptable)	Highly Toxic
	Foliar residue toxicity (honey bee)	Honey bee (<i>Apis mellifera</i>)	24 hours post treatment	< 3 hours post treatment	Mortality (419408-01/ Acceptable)	

*None observed at the highest dose

Birds and Mammals

Non-target terrestrial animals are not likely to be subject to mortality from the use of tetramethrin because it is practically non-toxic to birds and mammals on an acute exposure basis.

The limitation of outdoor applications to spot treatments and the non-persistent nature of tetramethrin make it unlikely that exposure sufficient to cause the chronic effects seen in laboratory studies would occur in the field. The Agency's conceptual model for assessing risk to terrestrial animals assumes that the animals derive the entirety of their diet from treated feed items. The use of tetramethrin as a spot treatment in residential and/or commercial settings is unlikely to result in extensive treatment of potential feed items. In addition, although chronic toxicity studies are not designed to determine how long an exposure is necessary to cause adverse chronic effects, the quick degradation of tetramethrin would reduce the amount of time that toxic residues are available for potential dietary exposure.

Given that tetramethrin is an insecticide, it is considered highly toxic to invertebrates, including beneficial insects, such as honey bees, on an acute contact exposure basis. Non-target

invertebrates present at the time of spraying and shortly thereafter are considered to be at risk of acute effects.

Terrestrial Plants

Toxicity data are not available for terrestrial plants. Therefore, the potential for risk to terrestrial plants from exposure to tetramethrin cannot be assessed, and remains an uncertainty. However, any toxicity to plants would occur for reasons other than tetramethrin's insecticidal mode of action, because tetramethrin works in insects as a neural toxin. Unlike insects, plants do not have neural networks that could be affected. In addition, the Agency also believes there is a low likelihood of exposure to non-target terrestrial plants because outdoor applications are limited to spot treatments.

b. Aquatic Organisms

No aquatic exposure modeling was conducted for tetramethrin because exposure of non-target organisms to harmful levels is unlikely based on the localized use patterns, low total pounds used on a national basis, and rapid degradation due to photolysis and hydrolysis. Also, the aquatic exposure models assume that the chemical is applied to a ten-acre watershed draining to a one-acre pond, which is unlikely for current use scenarios for tetramethrin. Instead, the Agency conducted a qualitative assessment using submitted studies and review of the literature.

The Agency developed an effects characterization, which describes the potential effects a pesticide can produce in an aquatic organism, and is based on registrant-submitted studies that describe acute effects for various aquatic animals. Table 10 summarizes the toxic effects and reference values used to assess risks for tetramethrin to aquatic organisms.

Table 10. Summary of Specific Measurement Endpoint Values Selected to Evaluate Risk for the Associated Terrestrial Animal Assessment Endpoints						
Assessment Ends	Acute Measurement Endpoint (most sensitive)	Selected Measurement Endpoint Values and Source				
		Species	Study Duration	Toxicity Value	Most Sensitive Endpoint (MRID)	Acute Toxicity Classification
Survival and Reproduction of Freshwater Vertebrates (fishes, etc.)	Freshwater fish or amphibian LC ₅₀	Rainbow trout (<i>Oncorhynchus mykiss</i>)	96 hr LC ₅₀	3.7 ppb	Mortality (416096-08/ Acceptable)	Very Highly Toxic
Survival and Reproduction of Freshwater Invertebrates	Freshwater invertebrates	Water flea (<i>Daphnia magna</i>)	48 hr EC ₅₀ flow-through	45 ppb	Immobilization and mortality (416096-09/ Supplemental)	Very Highly Toxic

Freshwater and Estuarine/Marine Fish and Invertebrates

The acute toxicity of tetramethrin was tested in two species of freshwater fish (rainbow trout and bluegill sunfish) and one freshwater invertebrate. Based on submitted studies, tetramethrin is classified as very highly toxic to fish and invertebrates on an acute exposure

basis. No chronic toxicity data were available for freshwater fish or invertebrates. However, the limitation of outdoor applications to spot treatments and the non-persistent nature of tetramethrin make it unlikely that exposure sufficient to cause the chronic effects would occur. The use of tetramethrin as a spot treatment in residential and/or commercial settings is unlikely to result in spray drift or run-off activities that would lead to exposure to non-target aquatic organisms. In addition, although chronic toxicity studies are not designed to determine how long an exposure is necessary to cause adverse chronic effects, the quick degradation of tetramethrin would reduce the amount of time that toxic residues are available for potential dietary exposure.

Additionally, no acute or chronic toxicity data were available for estuarine/marine fish or invertebrates. The Agency is not requesting this toxicity data for estuarine/marine fish or invertebrates because the outdoor uses of tetramethrin should not pose an acute risk to aquatic animals (fish, aquatic-phase amphibians, and invertebrates) since exposure levels are not expected to reach thresholds where adverse effects would be likely for such uses. Additionally, based on the rapid photolytic and hydrolytic degradation of tetramethrin, and its demonstrated rapid dissipation in field studies, the exposure duration is not expected to be sufficient to cause reproductive effects. There are potential acute risks to non-target aquatic organisms from direct application to drainage systems, but only in acidic waters where hydrolysis is slower. This remains an uncertainty in the risk assessment; however, the Agency believes exposure is unlikely because product labels prohibit direct application to water.

Aquatic Plants

Toxicity data are lacking for vascular and nonvascular aquatic plants. However, tetramethrin is not expected to reach water bodies in sufficient concentrations to induce phytotoxic effects in aquatic plants. Runoff exposure is not expected due to very short photolysis, hydrolysis, and field dissipation half-lives. Spray drift exposure is expected to be minimal based on use patterns and label restrictions. Additionally, similar to terrestrial plants, any toxicity to plants would occur for reasons other than tetramethrin's insecticidal mode of action, because tetramethrin works in insects as a neural toxin. Unlike insects, plants do not have neural networks that could be affected.

c. Data Gaps

As stated above, the Agency does not have chronic toxicity data for either terrestrial or aquatic organisms, acute or chronic toxicity data for terrestrial or aquatic plants, nor acute toxicity data for are estuarine/marine animals. Although these data are guideline requirements, the available effects data, non-persistent nature of tetramethrin, and low potential for environmental exposure indicate this data would not affect the outcome of the risk assessment. No additional environmental fate studies are needed to complete this assessment.

3. Adverse Ecological Incidents

A search of the EIIIS (Environmental Incident Information System) database for ecological incidents (run on Dec. 2, 2005) identified no ecological incidents involving

tetramethrin. The number of documented incidents in EIIS is believed to be a very small fraction of total mortality caused by pesticides for a variety of reasons. An absence of reports does not necessarily equate to an absence of incidents given the nature of the incident reporting.

4. Endangered Species Considerations

Table 11 provides a matrix that depicts the potential for direct and indirect effects to listed species resulting from the use of tetramethrin. No direct or indirect effects to endangered species are expected, except the potential for direct effects for Listed insects or indirect effects to plants if they have an obligate relationship with a Listed insect pollinator.

Listed Taxon	Direct Effects	Indirect Effects
Terrestrial and semi-aquatic plants – monocots	None (1)	Possible (2)
Terrestrial and semi-aquatic plants - dicots	None (1)	Possible (2)
Insects	Yes (acute)	None
Birds	None (3)	None (4)
Terrestrial phase amphibians	None (3)	None (4)
Reptiles	None (3)	None (4)
Mammals	None (5)	None (4)
Aquatic vascular plants	None (1)	None
Freshwater fish	None (6)	None (4)
Aquatic phase amphibians	None (6)	None (4)
Freshwater crustaceans	None (6)	None (4)
Mollusks	None (6)	None (4)
Marine/estuarine fish	None (6)	None (4)
Marine/estuarine crustaceans	None (6)	None (4)

- (1) Direct effects to plants are not anticipated based on lack of incident reports, registration on ornamental plants, and no identified mechanism of toxicity.
- (2) Indirect Effects on plants are possible if they have an obligate relationship with a Listed insect pollinator.
- (3) Direct Effects are considered unlikely due to low toxicity to birds and low exposure.
- (4) Indirect effects via loss of prey base (insects and invertebrates) not likely due to low magnitude of effect.
- (5) Direct effects are considered unlikely due to low toxicity to mammals and low exposure.
- (6) Direct Effects are not anticipated due to low exposure, despite high toxicity to freshwater fish and invertebrates.

Specific levels of concern could not be evaluated for the supported use of tetramethrin because RQs were not calculated in this assessment. However, acute risks from tetramethrin’s outdoor uses to listed aquatic species are not expected due to low application rates, the localized and spatially fragmented use patterns, and rapid dissipation of the chemical stressor due to photolysis and hydrolysis.

In terrestrial environments, vertebrates such as mammals, birds, reptiles and amphibians are not expected to be at risk because tetramethrin is practically non-toxic to birds and mammals, and because of the localized and fragmented use patterns. Insects, if directly exposed, are at risk of mortality.

The potential for chronic risk to any listed animal cannot be dismissed at this time because of a lack of available data. However, tetramethrin is not expected to persist long enough to lead to chronic exposure.

IV. Risk Management, Reregistration, and Tolerance Reassessment Decision

A. Determination of Reregistration Eligibility

Section 4(g)(2)(A) of FIFRA calls for the Agency to determine, after submission of relevant data concerning an active ingredient, whether or not products containing the active ingredient are eligible for reregistration. The Agency has previously identified and required the submission of the generic (i.e., active ingredient-specific) data required to support reregistration of products containing the active ingredient tetramethrin. The Agency has completed its review of these generic data, and has determined that the data are sufficient to support reregistration of all products containing tetramethrin.

The Agency has completed its assessment of the human health and ecological risks associated with the use of pesticide products containing the tetramethrin. The Agency has determined that tetramethrin-containing products are eligible for reregistration provided that label amendments are made as outlined in Chapter V. Appendix A summarizes the uses of the tetramethrin that are eligible for reregistration. Appendix B identifies the generic data requirements that the Agency reviewed as part of its determination of reregistration eligibility of tetramethrin, and lists the submitted studies that the Agency found acceptable.

Based on its evaluation of tetramethrin, the Agency has determined that products containing tetramethrin, unless labeled and used as specified in this document, would present risks inconsistent with FIFRA. Accordingly, should a registrant fail to implement any of the label changes identified in this document, the Agency may take regulatory action to address the risk concerns from the use of tetramethrin. If all changes outlined in this document are incorporated into the product labels, then all current risks for tetramethrin will be adequately mitigated for the purposes of this determination under FIFRA.

B. Public Participation

Through the Agency's public participation process, EPA worked with stakeholders and the public to reach the regulatory decisions for tetramethrin. EPA released the tetramethrin preliminary risk assessments for public comment on February 27, 2008, for a 60-day public comment period (Phase 3 of the public participation process). During the public comment period on the risk assessments, which closed on April 28, 2008, the Agency received comments from: the registrant McLaughlin, Gormley, King Company; the California Regional Water Quality Control Board, S.F. Bay Region; the California Stormwater Quality Association (CASQA); California Tri-TAC; as well as from private citizens. These comments in their entirety, responses to the comments, as well as the preliminary and revised risk assessments, are available in the public docket (OPP-2008-0014) at <http://www.regulations.gov>.

C. Regulatory Position

1. Regulatory Rationale

The Agency has determined that products containing tetramethrin are eligible for reregistration provided that specified label amendments are made. The following is a summary of the rationale for managing risks associated with the use of tetramethrin. Where labelling revisions are warranted, specific language is set forth in the summary table of Section V.

a. Human Health Risk Management

There are no human health risks of concern for tetramethrin, and therefore, no risk mitigation is necessary. The personal protective equipment (PPE) for all occupational handlers is baseline (long-sleeve shirt, long pants, and shoes plus socks), and the re-entry interval (REI) is 12 hours.

b. Ecological Risk Management

The Agency evaluated potential ecological risk from both indoor and outdoor uses of tetramethrin. Although the Agency believes exposure to non-target organisms is unlikely, tetramethrin is considered highly toxic to aquatic organisms. Therefore, the Agency is requiring the following label statements to reduce the potential exposure of tetramethrin to aquatic organisms.

- Limit all outdoor applications to spot and crack-and-crevice applications only, except for the following barrier, perimeter, band or broadcast spray applications, which are permitted:

(1) Barrier, perimeter or band applications to soil or vegetation around structures up to a maximum of 10 feet away from the building;

(2) Band applications to building foundations, up to a maximum of 3 feet up the walls of the building.

- The following statement will be required for liquid and ready-to-use products labeled or intended for outdoor residential uses:

“Do not apply directly to or near water, storm drains, gutters, sewers, or drainage ditches. Do not apply when windy. Do not water the treated area(s) to the point of run-off or apply when raining or when rain is expected that day. Rinse application equipment over treated area only.”

Because outdoor uses will be limited to localized spot treatments, no additional mitigation measures for these uses are required.

2. Endocrine Disruptor Effects

Following recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was a scientific basis for including, as part of the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC’s recommendation that EPA include evaluations of

potential effects in wildlife. For pesticides, EPA will use FIFRA, and to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP).

When the appropriate screening and/or testing protocols being considered under the EDSP have been developed, individual pesticides may be subject to additional screening and/or testing. However, in the available toxicity studies for tetramethrin, there was no evidence of endocrine disruption.

3. Endangered Species

The Endangered Species Act required federal agencies to ensure that their actions are not likely to jeopardize listed species or adversely modify designated critical habitat. The Agency has developed the Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on federally listed endangered and threatened species, and to implement mitigation measures that address these impacts. To assess the potential of registered pesticide uses that may affect any particular species, EPA puts basic toxicity and exposure data developed for the REDs into context for individual listed species and considers ecological parameters, pesticide use information, the geographic relationship between specific pesticide uses and species locations and biological requirements and behavioral aspects of the particular species. When conducted, these analyses take into consideration any regulatory changes recommended in this RED being implemented at that time. A determination that there is a likelihood of potential effects to a listed species may result in limitations on the use of the pesticide, other measures to mitigate any potential effects, and/or consultations with the Fish and Wildlife Service or National Marine Fisheries Service, as necessary. If the Agency determines use of tetramethrin “may affect” listed species or their designated critical habitat, EPA will employ the provisions in the Services regulations (50 CFR Part 402).

No direct or indirect effects to endangered species are expected due to tetramethrin applications, except the potential for direct effects for Listed insects or indirect effects to plants if they have an obligate relationship with a Listed insect pollinator. The ecological assessment that EPA conducted for this RED does not, in itself, constitute a determination as to whether specific species or critical habitat may be harmed by the pesticide. Rather, this assessment serves as a screen to determine the need for any species specific assessment that will evaluate whether exposure may be at levels that could cause harm to specific listed species and their critical habitat. That assessment refines the screening-level assessment to take into account the geographic area of pesticide use in relation to the listed species, the habits and habitat requirements of the listed species, etc. If the Agency’s specific assessments for tetramethrin result in the need to modify use of the pesticide, any geographically specific changes to the pesticide’s registration will be implemented through the process described in the Agency’s Federal Register Notice (54 FR 27984) regarding implementation of the Endangered Species Protection Program.

D. Labeling Requirements

In order to be eligible for reregistration, various use and safety information will be included in the labeling of all end-use products containing tetramethrin. For the specific labeling statements, refer to Section V of this RED document.

V. What Registrants Need to Do

The Agency has determined that products containing tetramethrin are eligible for reregistration provided that the required label amendments are made. The Agency intends to issue Data Call-In Notices (DCIs) requiring product-specific data. Generally, registrants will have 90 days from receipt of a DCI to complete and submit response forms or request time extension and/or waiver requests with a full written justification. For product-specific data, the registrant will have eight months to submit data. Additionally, below are the label amendments that the Agency intends to require for tetramethrin to be eligible for reregistration.

A. Manufacturing Use Products

1. Additional Generic Data Requirements

The generic data base supporting the reregistration of tetramethrin for currently registered uses has been reviewed and determined to be substantially complete. However, a few data gaps remain, and these are listed below.

Product Chemistry

All product chemistry data requirements will be required for the technical grade active ingredient (see Appendix B).

Toxicology

870.1300	Acute Inhalation
870.2400	Primary Eye Irritation
870.2500	Primary Dermal Irritation
870.2600	Skin Sensitization
870.3700a	Developmental Toxicity (rodent)
870.6200a	Acute Neurotoxicity
870.6200b	Subchronic Neurotoxicity study
870.6300	Developmental Neurotoxicity study

2. Labeling for Manufacturing-Use Products

To ensure compliance with FIFRA, manufacturing-use product (MUP) labeling should be revised to comply with all current EPA regulations, PR Notices, and applicable policies. The MUP labeling should bear the labeling contained in Tables 11 and 12.

B. End-Use Products

1. Additional Product-Specific Data Requirements

Section 4(g)(2)(B) of FIFRA calls for the Agency to obtain any needed product-specific data regarding the pesticide after a determination of eligibility has been made. The Registrant must review previous data submissions to ensure that they meet current EPA acceptance criteria

and if not, commit to conduct new studies. If a registrant believes that previously submitted data meet current testing standards, then the study MRID numbers should be cited according to the instructions in the Requirement Status and Registrants Response Form provided for each product. The Agency intends to issue a separate product-specific data call-in (PDCI), outlining specific data requirements.

2. Labeling for End-Use Products

To be eligible for reregistration, labeling changes are necessary to implement measures outlined in Section IV above. Specific language to incorporate these changes is specified in Table 12. Generally, conditions for the distribution and sale of products bearing old labels/labeling will be established when the label changes are approved. However, specific existing stocks time frames will be established case-by-case, depending on the number of products involved, the number of label changes, and other factors.

C. Labeling Changes Summary Table

In order to be eligible for reregistration, amend all product labels to comply with the following table. Table 12 describes how language on the labels should be amended.

Table 12. Summary of Labeling Changes for Tetramethrin		
Description	Amended Labeling Language	Placement on Label
Manufacturing Use Products		
For Manufacturing Use Products that will be formulated into total release fogger end-use products that contain directions for use indoors	If information is available that justifies a duration longer than 2 hours for the waiting period before beginning ventilation following an application or a duration longer than 2 hours as the length of the ventilation period, submit that information to the Agency.	Directions for use
For all Manufacturing Use Products	“Only for formulation into an <i>insecticide</i> for the following use(s) [fill blank only with those uses that are being supported by MP registrant].”	Directions for use
One of these statements may be added to a label to allow reformulation of the product for a specific use or all additional uses supported by a formulator or user group	<p>“This product may be used to formulate products for specific use(s) not listed on the MP label if the formulator, user group, or grower has complied with U.S. EPA submission requirements regarding support of such use(s).”</p> <p>“This product may be used to formulate products for any additional use(s) not listed on the MP label if the formulator, user group, or grower has complied with U.S. EPA submission requirements regarding support of such use(s).”</p>	Directions for Use
Environmental Hazards Statements	<p>“ENVIRONMENTAL HAZARDS”</p> <p>“This pesticide is highly toxic to fish and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Eliminations System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance, contact your State Water Board or Regional</p>	Precautionary Statements: Environmental Hazards

Table 12. Summary of Labeling Changes for Tetramethrin		
Description	Amended Labeling Language	Placement on Label
	Office of the Environmental Protection Agency.”	
End-Use Products Intended for Occupational Use (WPS and Non-WPS)		
PPE Requirements ¹ for Ready To Use (RTU) Formulations (RTU Liquids and Pressurized Liquids)	<p>“Personal Protective Equipment (PPE)”</p> <p>“Some materials that are chemical-resistant to this product are [registrant inserts correct material(s)].” For more options, follow the instructions for category [insert A, B, C, D, E, F, G or H] on the chemical-resistance category selection chart.</p> <p>“Applicators and other handlers must wear: > Long-sleeve shirt and long pants, and > Shoes plus socks.”</p>	Immediately following/below Precautionary Statements: Hazards to Humans and Domestic Animals
PPE Requirements for Liquid Concentrates including Emulsifiable Concentrates	<p>“Personal Protective Equipment (PPE)”</p> <p>“Some materials that are chemical-resistant to this product are [registrant inserts correct material(s)].” For more options, follow the instructions for category [insert A, B, C, D, E, F, G or H] on the chemical-resistance category selection chart.</p> <p>“Mixers, Loaders, Applicators and other handlers must wear: > Long-sleeve shirt and long pants, and > Shoes plus socks.”</p>	Immediately following/below Precautionary Statements: Hazards to Humans and Domestic Animals
User Safety Requirements	“Follow manufacturer’s instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.”	Precautionary Statements: Hazards to Humans and Domestic Animals immediately following the PPE requirements
User Safety Recommendations	<p>“User Safety Recommendations”</p> <p>“Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.”</p> <p>“Users should remove clothing/ PPE immediately if pesticide gets inside, then wash thoroughly and put on clean clothing.”</p>	Precautionary Statements under: Hazards to Humans and Domestic Animals (Must be placed in a box.)

Table 12. Summary of Labeling Changes for Tetramethrin

Description	Amended Labeling Language	Placement on Label
	<p>“Users should remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.”</p>	
<p>Environmental Hazards Statements for Products Labeled for Outdoor Uses</p>	<p>“ENVIRONMENTAL HAZARDS”</p> <p>“This pesticide is toxic to fish and aquatic invertebrates. Do not apply directly to water, or to areas where surface water is present, or to inter-tidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwater or rinsate.”</p> <p>“This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the area.”</p>	<p>Precautionary Statements: Hazards to Humans and Domestic Animals</p>
<p>Environmental Hazards Statements for Products Labeled for Indoor Uses Only</p>	<p>“ENVIRONMENTAL HAZARDS”</p> <p>“This product is highly toxic to fish and aquatic invertebrates. Do not contaminate water when disposing of equipment, washwater, or rinsate. See Directions for Use for additional precautions and requirements.”</p> <p>For indoor commercial, industrial or institutional products packaged in containers equal to or greater than 5 gallons or 50 lbs add the following statement:</p> <p>“Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollution Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.”</p>	<p>Precautionary Statements: Hazards to Humans and Domestic Animals</p>
<p>Restricted-Entry Interval for Products with Directions for use within the scope of the Worker Protection Standard for Agricultural Pesticides</p>	<p>“Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 12 hours.”</p>	<p>Directions for Use, in the Agricultural Use Requirements Box</p>

Table 12. Summary of Labeling Changes for Tetramethrin

Description	Amended Labeling Language	Placement on Label
<p>(WPS)</p> <p><i>For Products Subject to WPS as required by Supplement 3 of PR Notice 93-7</i></p>		
<p>Early Entry Personal Protective Equipment</p> <p><i>For Products Subject to WPS as required by Supplement 3 of PR Notice 93-7</i></p>	<p>“PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is coveralls, shoes and socks, and waterproof gloves.”</p>	<p>Directions for Use, in Agricultural Use Requirements Box</p>
<p>General Application Restrictions</p>	<p>“Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.”</p>	<p>Place in the Directions for Use directly above the Agricultural Use Box</p>
<p>Entry Restrictions for NonWPS Uses</p>	<p>For products that do not contain directions for use that allow people to be present during application:</p> <p>“Do not enter or allow others to enter treated area until sprays have dried.”</p> <p>For products that contain directions for use that allow people to be present during application AND are labeled for use as a directed spray (does not apply to products applied directly to domestic animals):</p> <p>“Except when (insert application method or site that allows people to be present during application), do not enter or allow others to enter treated area until sprays have dried.”</p> <p>For products that contain directions for use that allow people to be present during application AND are labeled for use as a space spray:</p> <p>“Except when (insert application method or site that allows people to be present during application), do not enter or allow others to enter until vapors, mists, and aerosols have dispersed, and the treated area has been thoroughly ventilated.”</p>	<p>If no WPS uses on the product label, place the appropriate statement in the Directions for Use Under General Precautions and Restrictions. If the product also contains WPS uses, then create a Non-Agricultural Use Requirements box as directed in PR Notice 93-7 and place the appropriate statement inside that box.</p>

Table 12. Summary of Labeling Changes for Tetramethrin

Description	Amended Labeling Language	Placement on Label
	<p>For total release foggers labeled for indoor use: “Wait at least two (2) hours after application, then open windows, vents and doors for two more hours. If an odor is still detected additional ventilation is required.”</p>	
<p>Application Restrictions for End Use Products containing directions for use to food/feed handling and service areas</p>	<p>For applications to food/feed handling and service areas: “Do not apply when food is present.”</p> <p>“Do not use in food areas of food handling establishments, restaurants, or other areas where food is commercially prepared or processed. Do not use in serving areas while food is exposed or facility is in operation. Serving areas are areas where prepared foods are served, such as dining rooms, but excluding areas where foods may be prepared or held. In the home, all food processing surfaces and utensils should be covered during treatment or thoroughly washed before use. Exposed food should be covered or removed.”</p>	<p>In the directions for use for to food/feed handling and service areas</p>
<p>General Application Restrictions for all products that do not contain directions for use in drains or sewers</p>	<p>Products labeled for use around or near floor drains must contain the following statement. “Do not apply directly into sewers or drains, or to any area like a gutter where drainage to storm sewers, water bodies, or aquatic habitat can occur. Do not allow the product to enter any drain during or after application.”</p>	<p>Directions for Use</p>
<p>General Application Restrictions for all products that contain directions for use in drains or sewers</p>	<p>“Except when applying to sewers or drains as directed on this label, do not apply directly into sewers or drains, or to any area like a gutter where drainage to storm sewers, water bodies, or aquatic habitat can occur. Do not allow the product to enter any drain during or after application.”</p>	<p>Directions for Use</p>
<p>Additional Application Restrictions For Outdoor Use</p>	<p>“Applications outdoors are limited to spot treatments or crack and crevice treatments, except for: (1) Barrier, perimeter or band applications to soil or vegetation around structures up to a maximum of 10 feet away from the building; (2) Band applications to building foundations, up to a maximum of 3 feet up the walls of the building.”</p>	<p>Directions for Use</p>
<p>Application Restrictions for Liquid Concentrate and Ready to Use End Use products that contain directions for use in outdoor residential areas</p>	<p>“Do not apply directly to or near water, storm drains, gutters, sewers, or drainage ditches. Do not apply when windy. Do not water the treated area(s) to the point of run-off or apply when raining or when rain is expected that day. Rinse application equipment over treated area only.”</p>	<p>Directions for Use</p>

Table 12. Summary of Labeling Changes for Tetramethrin

Description	Amended Labeling Language	Placement on Label
End Use Products Primarily Used by Consumers/Homeowners		
Environmental Hazards Statement	<p>“ENVIRONMENTAL HAZARDS”</p> <p>“This product is highly toxic to fish and aquatic invertebrates. Do not apply directly to water. Do not contaminate water when cleaning equipment or disposing of equipment washwaters or rinsate. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas.”</p> <p>“This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the area.”</p>	Precautionary Statements under Environmental Hazards
General Application Restrictions for all products that do not contain directions for use in drains or sewers	<p>Products labeled for use around or near floor drains must contain the following statement.</p> <p>“Do not apply directly into sewers or drains, or to any area like a gutter where drainage to storm sewers, water bodies, or aquatic habitat can occur. Do not allow the product to enter any drain during or after application.”</p>	Directions for Use
General Application Restrictions for all products that contain directions for use in drains or sewers	<p>“Except when applying to sewers or drains as directed on this label, do not apply directly into sewers or drains, or to any area like a gutter where drainage to storm sewers, water bodies, or aquatic habitat can occur. Do not allow the product to enter any drain during or after application.”</p>	Directions for Use
General Application Restrictions	<p>“Do not apply this product in a way that will contact adults, children, or pets, either directly or through drift.”</p>	Place at the beginning of the Direction for Use
Additional Application Restrictions For Outdoor Use	<p>“Applications outdoors are limited to spot treatments or crack and crevice treatments, except for:</p> <p>(1) Barrier, perimeter or band applications to soil or vegetation around structures up to a maximum of 10 feet away from the building;</p> <p>(2) Band applications to building foundations, up to a maximum of 3 feet up the walls of the building.”</p>	Directions for Use
Application Restrictions for Liquid Concentrate and Ready to Use End Use products that contain directions for use in outdoor residential areas	<p>“Do not apply directly to or near water, storm drains, gutters, sewers, or drainage ditches. Do not apply when windy. Do not water the treated area(s) to the point of run-off or apply when raining or when rain is expected that day. Rinse application equipment over treated area only.”</p>	Directions for Use

Table 12. Summary of Labeling Changes for Tetramethrin

Description	Amended Labeling Language	Placement on Label
Application Restrictions for End Use Products containing directions for use around residential food or feed handling or service areas	For applications to food or feed handling or service areas: “Do not apply when food is present. Exposed food should be covered or removed. All food preparation surfaces and utensils should be covered during treatment or thoroughly washed before use.”	In the directions for use for to food/feed handling and service areas

Appendix A. Non-Food and Non-Feed Use Patterns Subject to the Reregistration of Tetramethrin

Product Type	Use Profile	Maximum Application Rate			
		% Active Ingredient (% a.i.)	Volume-based	Area-based	Space-based
RTU ^A	General indoor spray ^D	0.10	0.01 lb a.i./gal solution	0.00001 lb ai/ft ²	n/a
	General outdoor spray (spot treatment only) ^E				
	Handheld fogger (PCO use only)	0.10	n/a	0.0000001 lb ai/ft ²	n/a
Aerosol can	General indoor spray	0.25	n/a	0.000003 lb ai/ft ²	n/a
	General outdoor spray (spot treatment only)	0.20	n/a	0.00002 lb ai/ft ²	n/a
	Pets	0.063	n/a	n/a	n/a
EC ^B	General indoor spray	2.5	0.02 lb a.i./gal solution	0.0000002 lb ai/ft ²	n/a
	General outdoor spray (spot treatment only)				
TRF ^C	Indoor fogger	0.54	n/a	n/a	6oz can / 4,600 ft ³

^A RTU – Ready to use (product can be poured directly into a sprayer without mixing with water).

^B EC – Emulsifiable concentrate.

^C TRF – Total release fogger (aerosol can).

^D Use sites include but are not limited to: commercial, industrial, institutional, and residential locations; agricultural structures and equipment; eating establishments; animal kennels and sleeping quarters; empty greenhouses; hospitals.

^E Use sites include but are not limited to: commercial, industrial, institutional, and residential locations; compost piles; ornamental plants; patios; paths.

Appendix B. Data Supporting Guideline Requirements for Tetramethrin

Data Supporting Guideline Requirements for the Reregistration of Tetramethrin		
Guideline Number	Study Description	Citation(s)
PRODUCT CHEMISTRY		
830.1550	Product Identity and Composition	Required
830.1600	Description of Materials Used	Required
830.1620	Description of Production Process	Required
830.1670	Discussion of Formation of Impurities	Required
830.1700	Preliminary Analysis	Required
830.1750	Certified Limits	Required
830.1800	Enforcement Analytical Method	Required
830.6302	Color	Required
830.6303	Physical State	Required
830.6304	Odor	Required
830.6313	Stability	Required
830.7000	pH	Required
830.7050	UV/Visible Absorption	Required
830.7200	Melting Point	Required
830.7220	Boiling Point	Required
830.7300	Density	Required
830.7370	Dissociation Constant	Required
830.7550 830.7570	Octanol / Water Partition Coefficient	Required
830.7840 830.7860	Solubility	Required
830.7950	Vapor Pressure	Required
ECOLOGICAL EFFECTS		
850.1010	Aquatic Invertebrate Acute	41609609
850.1025	Oyster Acute Toxicity Test	Data gap
850.1035	Mysid Acute Toxicity Test	Data gap
850.1045	Penaeid Acute Toxicity Test	Data gap
850.1055	Bivalve Acute Toxicity Test	Data gap
850.1075	Fish Acute Toxicity	
	Freshwater	41609608, 41609607
	Estuarine / Marine	Data gap
850.1300	Aquatic Invertebrate Life Cycle (Freshwater)	Data gap
850.1350	Aquatic Invertebrate Life Cycle (Marine)	Data gap
850.1400	Fish Early Life-Stage (Freshwater and Marine)	Data gap
850.1500	Fish Full Life-Cycle (Freshwater and Marine)	Data gap
850.1710	Oyster BCF	Data gap

Data Supporting Guideline Requirements for the Reregistration of Tetramethrin		
Guideline Number	Study Description	Citation(s)
850.1730	Fish BCF	Data gap
850.1850	Aquatic Food Chain Transfer	Data gap
850.2100	Avian Acute Oral Toxicity	41609604
850.2200	Avian Subacute Dietary Toxicity	41609605, 41609606
850.2300	Avian Reproduction Toxicity	Data gap
850.2400	Wild Mammal Toxicity	00063574, 00161842
850.3020	Honey Bee Acute Contact Toxicity	41609613
850.3030	Residues on Foliage Honeybee Toxicity	41940801
850.3040	Honeybee Feeding Toxicity Test	Data gap
850.4100	Seedling Emergence and Growth	Data gap
850.4150	Vegetative Vigor	Data gap
850.4400	Aquatic Plant Growth	Data gap
850.4500	Algal Plant Toxicity	Data gap
850.4550	Algal Plant Toxicity	Data gap
TOXICOLOGY		
870.1100	Acute Oral Toxicity	42146405
870.1200	Acute Dermal Toxicity	00063574, 40276101
870.1300	Acute Inhalation Toxicity	Required
870.2400	Acute Eye Irritation	Required
870.2500	Acute Dermal Irritation	Required
870.2600	Skin Sensitization	Required
870.3100	90-Day Oral Toxicity in Rodents	42146404
870.3150	90-Day Oral Toxicity in Non-rodents	42146403, 41698902
870.3200	21/28 -Day Dermal Toxicity	41995004
870.3465	90-Day Inhalation Toxicity	42012101, 41995003
870.3700	Prenatal Developmental Toxicity	Required 42189202, 41995005, 00114369, 00114370
870.3800	Reproduction and Fertility Effects, 2-Generation Reproduction	00114371, 00137656, 00137658, 00161842
870.4100	Chronic Toxicity	41723301, 40009401, 40280401, 00156488, 40007501, 41723302, 42189301, 44083501
870.4200	Carcinogenicity	41723301, 40009401, 40280401, 00156488, 40007501, 41723302
870.4300	Combined Chronic Toxicity/Carcinogenicity	00158951, 40276301, 44096001
870.5265	Gene Mutation (Ames assay)	40276001, 40275801
870.5385	Bone Marrow Chromosomal Aberration Test	40275901, 42414401, 42414402, 42414403
870.5550	Unscheduled DNA Synthesis in mammalian cells in culture	40778401, 40275801
870.6200	Neurotoxicity Screening battery	
(a)	Acute Neurotoxicity	Required 42601501, 42601502, 43152701
(b)	Subchronic Neurotoxicity	Required

Data Supporting Guideline Requirements for the Reregistration of Tetramethrin		
Guideline Number	Study Description	Citation(s)
870.6300	Developmental Neurotoxicity Study	Required
870.7485	Metabolism and Pharmacokinetics	42448901, 42448902
	Special Study – motor activity in male and female mice post-natally exposed by inhalation	44222801
ENVIRONMENTAL FATE		
835.1230	Leaching and Adsorption / Desorption	41995007, 42212901
835.1410	Laboratory Volatility	Data gap
835.2120	Hydrolysis	41995006
835.2240	Photodegradation in Water	00164634, 43773401
835.2370	Photodegradation in Air	Data gap
835.2410	Photodegradation on Soil	Data gap
835.4100	Aerobic Soil Metabolism	42563301
835.4200	Anaerobic Soil Metabolism	Data gap
835.4300	Aerobic Aquatic Metabolism	Data gap
835.4400	Anaerobic Aquatic Metabolism	Data gap
835.6100	Terrestrial Field Dissipation	42622401, 42622402
835.6200	Aquatic (Sediment) Dissipation	Data gap
835.6400	Combination and Tank Mixes Dissipation	Data gap
835.7100	Ground Water Monitoring	Data gap
835.8100	Field Volatility	Data gap

Appendix C. Technical Support Documents

Additional documentation in support of the Tetramethrin RED is maintained in the OPP Regulatory Public Docket, located in Room S-4400 One Potomac Yard (South Building), 2777 S. Crystal Drive, Arlington, VA. It is open Monday through Friday, excluding legal holidays, from 8:30 a.m. to 4:00 p.m. All documents may be viewed in the OPP Docket room or viewed and/or downloaded via the Internet at <http://www.regulations.gov>. The Agency's documents in support of this RED include the following:

1. Daiss, B. Tetramethrin Health Effects Division's Risk Assessment for Reregistration Eligibility Decision. June 18, 2008.
2. Crowley, M. Tetramethrin: Phase IV Revised Occupational and Residential Exposure Assessment and Recommendations for the Reregistration Eligibility Decision. June 13, 2008.
3. Eckel, W. et al. Revised Environmental Fate and Ecological Risk Assessment for the Reregistration Eligibility Decision on Tetramethrin. February 5, 2008.
4. Abdel-Saheb, I. Revised Drinking Water Assessment for Tetramethrin Use as a Rapid Knockdown Agent Against Flying and Crawling Insects. February 5, 2008.

Appendix D. Bibliography

In addition to the studies listed in Appendix B, this bibliography contains additional citations considered to be part of the database supporting the reregistration decision for Tetramethrin.

In addition to the MRID study references listed in Appendix B, this bibliography contains the expanded study citations as well as additional literature considered to be part of the database supporting the reregistration decision for Tetramethrin.

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114369	Sato, T.; Narama, K. (1982) Reproduction Test of Neopynamin: Part 2. Teratology Study in Rats: Doc. Code IT-01-0076. (Translation; unpublished study received Sep 20, 1982 under 10308-1; prepared by Sumitomo Chemical Co., Ltd., Japan, submitted by Sumitomo Chemical Co., Ltd., Baltimore, MD; CDL:248342-B)
114370	Sato, T.; Narama, K. (1982) Reproduction Test of Neopynamin: Part 3. Teratology Study in Rabbits: Doc. Code IT-01-0077. (Translation; unpublished study received Sep 20, 1982 under 10308-1; prepared by Sumitomo Chemical Co., Ltd., Japan, submitted by Sumitomo Chemical Co., Ltd., Baltimore, MD; CDL:248342-C)
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137658	Rutter, H. (1974) One-generation Reproduction Study--Rats: Neo-Pynamin: Project No. 343-106; IT-41-0042. Final rept. (Unpublished study received Apr 30, 1982 under 10308-1; prepared by Hazleton Laboratories, Inc., submitted by Sumitomo Chemical Co., Ltd., Baltimore, MD; CDL:247530-C)
156488	Pence, D. (1986) Chronic Toxicity Study in Rats: Neopynamin Technical: Addendum to Final Report: Project No. 343-117. Unpublished study prepared by Hazleton Laboratories America, Inc. 575 p.
158951	Cox, R. (1986) Combined Chronic Toxicity and Oncogenicity Study in Mice: Neopynamin: Final Report: Project No. 343-136. Unpublished study prepared by Hazleton Laboratories America, Inc. 4980 p.

MRID	Citation Reference
161842	Pence, D.; Wolfe, G.; Kulwich, B. (1986) Two-generation Reproduction Study in Rats: Neopynamin Forte: Final Report: Project No. 343-147. Unpublished study prepared by Hazleton Laboratories America, Inc. 418 p.
164634	Chen, Y.; Casida, J. (1970) Photodecomposition of pyrethrin I, allethrin, phthalthrin, and dimethrin modifications in the acid moiety. <i>Pyrethum Post</i> 10(3):7-16.
40007501	Cox, R. (1986) Chronic Toxicity Study in Rats, Neopynamin Technical: Addendum III to Final Report: Hazleton Project No. 343-117. Unpublished study prepared by Hazleton Laboratories America, Inc. 7 p.
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40275801	Ding, C.; Yu, Y.; Zhang, J.; et al. (1985) Genotoxicity of tetramethrin in mammalian cells and salmonella typhimurium. <i>Journal of the Zhejiang Univ. of Medicine</i> 14(1):1-4.
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40280401	Cox, R.; Jones, S. (1987) Historical Control Data for Liver Adenoma Incidence among Mice, and Supporting Information: Hazleton Product No. 343-107. Unpublished study prepared by Hazleton Laboratories America, Inc. 53 p.
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41609608	Bowman, J. ; Gormley, M. (1990) Acute Flow-Through Toxicity of Neo- Pynamin to Rainbow Trout (Oncorhynchus mykiss): Lab Project Number: IW/01/0011. Unpublished study prepared by Analytical Bio-Chemistry Laboratories, Inc., 189 p.
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42622402	Ver Hey, M. (1992) A Terrestrial Field Dissipation Study with Tetramethrin (Neo-Pynamin) Applied for Control of Insects in Plants (Florida Field Study): Lab Project Number: SUMITOMO-1150. Unpublished study prepared by Colorado Analytical Research & Development Corp. 450 p.
43152701	Robinson, K.; Benjamin, W.; Noveroske, J. (1993) An Acute Study of the Potential Effects of Orally Administered Neopynamin on Behavior and Neuromorphology in Rats: Supplemental Volume: Lab Project Number: 97137: IT/21/0258. Unpublished study prepared by Bio-Research Lab., Ltd. 6 p.
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46188613	NDETF Volume 13. Measurement of Transfer of Pyrethrin and Piperonyl Butoxide Residues from Vinyl and Carpet Flooring Treated with a Fogger Formulation to DSS Wetted Hands Following a Single Hand Press.
46188618	NDETF Volume 18. Measurement of Air Concentration, Dermal Exposure, and Deposition of Pyrethrin and Piperonyl Butoxide Following the Use of an Aerosol Spray.
46188623	NDETF Volume 23. Post-Application Deposition Measurements for Permethrin & Piperonyl Butoxide Following Use of a Total Release Indoor Fogger.
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