Skin Notation (SK) Profile

Azinphos-methyl

[CAS No. 86-50-0]

Department of Health and Human Services
Centers for Disease Control and Prevention

National Institute for Occupational Safety and Health

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Foreword

As the largest organ of the body, the skin performs multiple critical functions, such as serving as the primary barrier to the external environment. For this reason, the skin is often exposed to potentially hazardous agents, including chemicals, which may contribute to the onset of a spectrum of adverse health effects ranging from localized damage (e.g., irritant contact dermatitis and corrosion) to induction of immune-mediated responses (e.g., allergic contact dermatitis and pulmonary responses), or systemic toxicity (e.g., neurotoxicity and hepatoxicity). Understanding the hazards related to skin contact with chemicals is a critical component of modern occupational safety and health programs.

In 2009, the National Institute for Occupational Safety and Health (NIOSH) published *Current Intelligence Bulletin (CIB) 61 – A Strategy for Assigning New NIOSH Skin Notations* [NIOSH 2009-147]. This document provides the scientific rationale and framework for the assignment of multiple hazard-specific skin notations (SK) that clearly distinguish between the systemic effects, direct (localized) effects, and immune-mediated responses caused by skin contact with chemicals. The key step within assignment of the hazard-specific SK is the determination of the hazard potential of the substance, or its potential for causing adverse health effects as a result of skin exposure. This determination entails a health hazard identification process that involves use of the following:

- Scientific data on the physicochemical properties of a chemical
- Data on human exposures and health effects
- Empirical data from in vivo and in vitro laboratory testing
- Computational techniques, including predictive algorithms and mathematical models that describe a selected process (e.g., skin permeation) by means of analytical or numerical methods.

This *Skin Notation Profile* provides the SK assignments and supportive data for azinphos-methyl. In particular, this document evaluates and summarizes the literature describing the hazard potential of the substance and its assessment according to the scientific rationale and framework outlined in CIB 61. In meeting this objective, this *Skin Notation Profile* intends to inform the audience—mostly occupational health practitioners, researchers, policy- and decision-makers, employers, and workers in potentially hazardous workplaces—so that improved risk-management practices may be developed to better protect workers from the risks of skin contact with the chemicals of interest.

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Contents

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
AChE	acetylcholinesterase
ATSDR	Agency for Toxic Substances and Disease Registry
CIB	Current Intelligence Bulletin
cm^2	squared centimeter(s)
cm/hr	centimeter(s) per hour
cm/s	centimeter(s) per second
DEREK	Deductive Estimation of Risk from Existing Knowledge
DIR	skin notation indicating the potential for direct effects to the skin following contact with a chemical
DMPT	dimethylphosphorothioate
EC	European Commission
ED_{50}	median effective dose
GHS	Globally Harmonized System for Labelling and Classification of Chemicals
GPMT	guinea pig maximization test
hr	hour(s)
IARC	International Agency for Research on Cancer
IPCS	International Program for Chemical Safety
(IRR)	subnotation of SK: DIR indicating the potential for a chemical to be a skin irritant following exposure to the skin
kaq	coefficient in the watery epidermal layer
k_p	skin permeation coefficient
kpol	coefficient in the protein fraction of the stratum corneum
k_{psc}	permeation coefficient in the lipid fraction of the stratum corneum
LD_{50}	dose resulting in 50% mortality in the exposed population
LD_{Lo}	dermal lethal dose
LLNA	local lymph node assay
LOAEL	lowest-observed-adverse-effect level
log K_{OW}	base-10 logarithm of a substance's octanol–water partition
M	molarity
m^3	cubic meter(s)
mg	milligram(s)
$mg/cm^2/hr$	milligram(s) per square centimeter per hour
mg/kg	milligram(s) per kilogram body weight
mg/m^3	milligram(s) per cubic meter
mL	milliliter(s)
mL/kg	milliliter(s) per kilogram body weight
MW	molecular weight
NIOSH	National Institute for Occupational Safety and Health
NOAEL	no-observed-adverse-effect level

NTP	National Toxicology Program
OEL	occupational exposure limit
OSHA	Occupational Safety and Health Administration
ppm	parts per million
RBC-AChE	erythrocyte acetylcholinesterase
REL	recommended exposure limit
RF	retention factor
SEN	skin notation indicating the potential for immune-mediated reactions following exposure of the skin
SI ratio	ratio of skin dose to inhalation dose
SK	skin notation
S_W	solubility
SYS	skin notation indicating the potential for systemic toxicity following exposure of the skin
USEPA	United States Environmental Protection Agency
µg	microgram(s)
µg/cm^2	microgram(s) per square centimeter
µg/cm^2/hr	microgram(s) per square centimeter per hour
µmol	micromole(s)

Glossary

Absorption—The transport of a chemical from the outer surface of the skin into both the skin and systemic circulation (including penetration, permeation, and resorption).

Acute exposure—Contact with a chemical that occurs once or for only a short period of time.

Cancer—Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Contaminant—A chemical that is (1) unintentionally present within a neat substance or mixture at a concentration less than 1.0% or (2) recognized as a potential carcinogen and present within a neat substance or mixture at a concentration less than 0.1%.

Cutaneous (or percutaneous)—Referring to the skin (or through the skin).

Dermal—Referring to the skin.

Dermal contact—Contact with (touching) the skin.

Direct effects—Localized, non-immune-mediated adverse health effects on the skin, including corrosion, primary irritation, changes in skin pigmentation, and reduction/disruption of the skin barrier integrity, occurring at or near the point of contact with chemicals.

Immune-mediated responses—Responses mediated by the immune system, including allergic responses.

Sensitization—A specific immune-mediated response that develops following exposure to a chemical, which, upon re-exposure, can lead to allergic contact dermatitis (ACD) or other immune-mediated diseases such as asthma, depending on the site and route of re-exposure.

Substance—A chemical.

Systemic effects—Systemic toxicity associated with skin absorption of chemicals after exposure of the skin.

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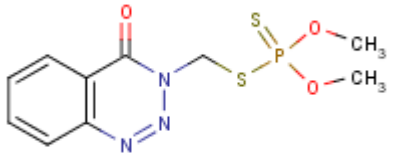
1.0 Introduction

1.1 General Substance Information

Chemical: Azinphos-methyl
CAS No: 86-50-0
Molecular weight (*MW*): 317.3
Molecular formula: $C_{10}H_{12}O_3PS_2N_3[(CH_30)_2P(S)SCH_2(N_3C_7H_4O)]$
Structural formula:



Synonyms: O,O-Dimethyl-S-4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl phosphorodithioate; Methyl azinphos; azinfos-methyl; methyl guthion; gluthion; gusathion; gusathion methyl

Uses: Azinphos-methyl is a broad spectrum organophosphate pesticide; an estimated 3 million pounds (~1.3 million kilograms) of the pesticide was produced in 1982 [HSDB 2009].

1.2 Purpose

This skin notation profile presents (1) a brief summary of epidemiological and toxicological data associated with skin contact with azinphos-methyl and (2) the rationale behind the hazard-specific skin notation (SK) assignment for azinphos-methyl. The SK assignment is based on the scientific rationale and logic outlined in the *Current Intelligence Bulletin (CIB) #61: A Strategy for Assigning New NIOSH Skin Notations* [NIOSH 2009]. The summarized information and health hazard assessment are limited to an evaluation of the potential health effects of dermal exposure to azinphos-methyl. A literature search was conducted through October 2012 to identify information on azinphos-methyl, including but not limited to data relating to its toxicokinetics, acute toxicity, repeated-dose systemic toxicity, carcinogenicity, biological system/function–specific effects (including reproductive and developmental effects and immunotoxicity), irritation, and sensitization. Information was considered from studies of humans, animals, or appropriate modeling systems that are relevant to assessing the effects of dermal exposure to azinphos-methyl.

1.3 Overview of SK Assignment

Azinphos-methyl is potentially capable of causing numerous adverse health effects following skin contact. A critical review of available data has resulted in the following SK assignment for azinphos-methyl: **SK: SYS (FATAL)-SE**N. Table 1 provides an overview of the critical effects and data used to develop the SK assignment for azinphos-methyl.

Table 1. Summary of the SK Assignment for azinphos-methyl

Skin Notation	Critical Effect	Available Data
SK: SYS (FATAL)	Acetylcholinesterase (AChE) inhibition	Sufficient human and animal data
SK: SEN	Skin allergy	Limited animal data

2.0 Systemic Toxicity from Skin Exposure (SK: SYS)

Toxicokinetic data following dermal exposure to azinphos-methyl were identified in humans and animals. In human volunteers, 4 micrograms per square centimeter ($\mu g/cm^2$) azinphos-methyl, dissolved in a small amount of acetone, was applied to the forearm under non-occlusive conditions for 24 hours (hr) and resulted in 15.9% of the dose being absorbed, measured by total excretion in the urine after 120 hr [Feldman and Maibach 1974]. When the same amount of azinphos-methyl was applied to the undamaged forearm skin of humans but under occlusive conditions, the *in vivo* percutaneous absorption was reported as 56.1% of the applied dose [Wester and Maibach 1985]. Franklin et al. [1989] reported percutaneous absorption of azinphos-methyl in humans, monkeys and rats. Percutaneous absorption in humans was 36% of the applied dose when the test material was applied to the forehead, in monkeys percutaneous absorption was 47% (forehead) and 32% (forearm), and percutaneous absorption was 93% in rats [Franklin et al. 19889]. Urinary excretion of the major metabolite – dimethylphosphorothioate (DMPT) – has also been used as an index of dermal absorption of azinphos-methyl in humans because it indicates actual absorption from all sources [McCurdy 1994]. The author noted that urinary metabolites were the most sensitive indicator of recent exposure since it correlated with dermal and clothing levels, in addition to erythrocyte acetylcholinesterase (RBC-AChE) levels among 20 northern California peach harvesters. McCurdy [1994] found that RBC-AChE levels decreased 7% over the initial 3 day period post application of azinphos-methyl, and continued to decrease up to 19% over the 6 week season. Thongsinthusack [1999] estimated absorption of 44.2 to 59.0% of the applied dose following application of 0.93 $\mu g/cm^2$ azinphos-methyl to the skin of rats for 10 hr. Miles Inc. [1992] investigated the dermal absorption of azinphos-methyl by rat from a guthion (35%) wettable powder formulation using ^{14}C-azinphos-methyl. Animals were treated with 0 2.6 to 267 µg of the formulation/cm^2 [corresponding to 0.93 to 93 µg azinphos-methyl/cm^2]. The absorption

of the highest dosage level was calculated as 20% (direct) or 26% (indirect)when calculated directly or indirectly, respectively.

The potential of azinphos-methyl to pose a skin absorption hazard was also evaluated, with use of a predictive algorithm for estimating and evaluating the health hazards of dermal exposure to substances [NIOSH 2009]. The evaluation method compares an estimated dose accumulated in the body from skin absorption and an estimated dose from respiratory absorption associated with a reference occupational exposure limit. On the basis of this algorithm, a ratio of the skin dose to the inhalation dose (SI ratio) of 0.059 was calculated for azinphos-methyl. An SI ratio of ≥0.1 indicates that skin absorption may significantly contribute to the overall body burden of a substance[NIOSH 2009]; therefore, azinophos-methyl is not considered to be absorbed through the skin following dermal exposure. Additional information on the SI ratio and the variables used in its calculation are included in the appendix.

No estimated dermal lethal doses (LD_{Lo}) for humans were identified. A dermal LD_{50} value (lethal doses in 50% of exposed animals) of 65.03 milligrams per kilograms body weight (mg/kg) was reported for a 20% azinphos-methyl formulation in mice [Sato 1959] and LD_{50} values of 90 to 220 mg/kg were reported for rats [Gaines 1960; Pasquet et al. 1976]. Sato [1959] reported that the acute symptoms in percutaneous application of organic phosphorus, including azinphos-methyl, were similar to those in oral poisoning, including stillness, loss of coordination, dyspnea, muscle cramp, fibrillation, indicating the potential of azinphos-methyl to cause acetylcholinesterase (AChE) inhibition. Skinner [1982a] reported a dermal LD_{50} of 6000 mg/kg for mice when the rodent's feet were immersed in azinphos-methyl. Because the reported acute dermal LD_{50} values for mice and rats are less than the critical dermal LD_{50} value of 200 mg/kg body weight that identifies chemical substances with the potential for fatality following acute dermal exposure [NIOSH 2009], azinphos-methyl is considered fatal after acute dermal exposure.

No case reports or epidemiological studies were identified that evaluated the potential of azinphos-methyl to cause systemic effects following dermal exposure. In animals, ED_{50} values (levels of a compound that caused 50% depression) for response of blood cholinesterase inhibition of mice exposed to foliar residue of azinphos-methyl (that is, the amount of azinphos-methyl that might be available shortly after application) were studied [Skinner and Kilgore 1982b]. In this study, mice were exposed to foliar doses of 5.4, 7.6, or 16.9 $\mu g/cm^2$ of dislodgeable active ingredient [corresponding to 0.135, 0.19, and 0.423 mg/kg-day] for 10 hr per day for 6 days, but there were no measurable responses in the mice at maximal foliar concentrations. Lack of effects on cholinesterase in this study may be attributed to the low dose levels used.

No standard toxicity or specialty studies were identified that evaluated biological systemic/function were identified (including reproductive/developmental toxicity or immunotoxicity) following dermal exposure to azinphos-methyl. No studies were identified that evaluated the potential of azinphos-methyl to be a carcinogen following

dermal exposure. Table 2 summarizes carcinogenic designations of multiple governmental and nongovernmental organizations for azinphos-methyl.

Table 2. Summary of the carcinogenic designations for azinphos-methyl by numerous governmental and nongovernmental organizations

Organization	Carcinogenic designation
NIOSH [2005]	No designation
NTP [2011]	No designation
USEPA [2013]	No designation
GHS [European Parliament 2008]	No designation
IARC [2012]	No designation
EC [2012]*	No designation
ACGIH [2001]	A4: Not classifiable as a human carcinogen

ACGIH = American Conference of Governmental Industrial Hygienists; EC = European Commission, Joint Research, Institute for Health and Consumer Protection; GHS = Globally Harmonized System for Labelling and Classification of Chemicals; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; USEPA = United States Environmental Protection Agency.
*Date accessed.

Although the mathematical model indicates that azinphos-methyl is not absorped by the skin after dermal exposure, sufficient toxicokinetic data in humans **[Feldman and Maibach 1974; Wester and Maibach 1985; Franklin et al. 1989; McCurdy et al. 1994]**[1] and animals **[Thongsinthusack 1999; Franklin et al. 1989]** as well as acute dermal toxicity data **[Gains 1960; Pasquet et al. 1976; Sato 1959]** indicate that azinphos-methyl can be absorbed through the skin, be systemically available, and be fatal at low doses following exposure. Although adequate prolonged, repeat-dose dermal toxicity studies were not identified, azinphos-methyl acts via inhibition of acetylcholinesterase (AChE) as its primary mode of action for inducing systemic toxicity [Sheets 1994]. Therefore, on the basis of the data for this assessment, azinphos-methyl is assigned the SK: SYS(FATAL) notation.

3.0 Direct Effects on Skin (SK: DIR)

No human or animal *in vivo* studies for corrosivity of azinphos-methyl or *in vitro* for corrosivity using human or animal skin models or *in vitro* tests of skin integrity using cadaver skin were identified. No case reports or standard skin irritation tests in animals were identified that evaluated the potential of azinphos-methyl to cause direct skin effects. The structure-activity relationship model, Deductive Estimation of Risk from Existing Knowledge (*DEREK*) for Windows, predicted azinphos-methyl to be negative for skin irritation.

[1]References in **bold** text indicate studies that serve as the basis of the SK assignments.

Therefore, on the basis of the data for this assessment, azinphos-methyl is not assigned the SK: DIR (IRR) notation.

4.0 Immune-mediated Responses (SK: SEN)

Evidence of skin sensitization following dermal exposure to azinphos-methyl is limited. While no diagnostic tests evaluating skin sensitization in humans were identified, one predictive test (Buehler patch test) was conducted in guinea pigs [Bayer AG 1987]. A dermal application of the test compound at a concentration of 12.5%, [Bayer AG 1987] induced sensitization in approximately 50% of the experimental animals using a 6% active ingredient concentration (1st challenge), but one-tenth of the concentration (0.6%) failed to elicit any relevant skin reactions (2nd challenge). Bayer AG [1987] concluded that the test compound had skin-sensitizing properties that were elicited only after application of relatively high concentrations. No other predictive tests were identified that evaluated the potential of azinphos-methyl to cause skin sensitization in animals. The structure activity relationship model, *DEREK* for Windows, predicted azinphos-methyl to be positive for skin sensitization, indicating that azinphos-methyl has structural alerts for skin sensitization.

Although no diagnostic tests in humans or human case reports were identified that evaluated the potential for azinphos-methyl to be a skin sensitizer, one study using a standardized protocol, the Buehler patch test, indicates that azinphos-methyl is a sensitizer in guinea pigs **[Bayer AG 1987]**. Therefore, on the basis of the data for this assessment, azinphos-methyl is assigned the SK: SEN notation.

5.0 Summary

There is sufficient data from toxicokinetic studies in humans **[Feldman and Maibach 1974; Wester et al. 1985; Franklin et al. 1989; McCurdy et al. 1994]** and animals **[Franklin et al. 1989; Thongsinthusack 1999]** as well as acute dermal toxicity data in animals **[Gains 1960; Sato 1959; Pasquet et al. 1976]** that indicate that azinphos-methyl can be absorbed through the skin, be systemically available, and be fatal following exposure at low doses. No prolonged, repeat-dose dermal toxicity studies were identified, but azinphos-methyl inhibits AChE in the central and peripheral nervous systems, as is observed in oral toxicity studies in rats [Sheets 1994]. No case reports or standard skin irritation tests in animals were identified upon which the potential of azinphos-methyl to cause direct skin effects can be determined. No diagnostic tests in humans or case reports of sensitization were identified but a well-conducted Buehler patch test using guinea pigs indicates that azinphos-methyl has the potential to cause skin sensitization **[Bayer AG 1987]**. Therefore, on the basis of these assessments, azinphos-methyl is assigned a composite skin notation of **SK: SYS (FATAL)-SEN**.

Table 3 summarizes the skin hazard designations for azinphos-methyl previously issued by NIOSH and other organizations. The equivalent dermal designations for azinphos-methyl, according to the Global Harmonization System (GHS) of Classification and Labelling of Chemicals, are Acute Toxicity Category 3 (Hazard statement: Toxic in contact with the skin), and Skin Sensitization Category 1 (Hazard statement: May cause an allergic skin reaction) [European Parliament 2008].

Table 3. Summary of previous skin hazard designations for azinphos-methyl

Organization	Skin hazard designation
NIOSH [2005]	[skin]: Potential for dermal absorption. Prevent skin contact.
OSHA [2012]*	[skin]: Potential for dermal absorption. Prevent skin contact.
ACGIH [2001]	[skin]: Based on the relatively low doses applied to rabbit skin that produced lethality and the reports of cholinergic inhibition in agricultural workers dermally exposed.
EC [2012]*	R24: Toxic in contact with skin R43: May cause sensitization by skin contact

ACGIH = American Conference of Governmental Industrial Hygienists; EC = European Commission, Joint Research, Institute for Health and Consumer Protection; NIOSH = National Institute for Occupational Safety and Health; OSHA = Occupational Safety and Health Administration.
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Note: Asterisks (*) denote sources cited in text; daggers (†) denote additional resources.

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Appendix: Calculation of the SI Ratio for Azinphos-methyl

This appendix presents an overview of the SI ratio and a summary of the calculation of the SI ratio for azinphos-methyl. Although the SI ratio is considered in the determination of a substance's hazard potential following skin contact, it is intended only to serve as supportive data during the assignment of the NIOSH SK. An in-depth discussion on the rationale and calculation of the SI ratio can be found in Appendix B of the *Current Intelligence Bulletin (CIB) #61: A Strategy for Assigning New NIOSH Skin Notations* [NIOSH 2009].

Overview

The SI ratio is a predictive algorithm for estimating and evaluating the health hazards of skin exposure to substances. The algorithm is designed to evaluate the potential for a substance to penetrate the skin and induce systemic toxicity [NIOSH 2009]. The goals for incorporating this algorithm into the proposed strategy for assigning SYS notation are as follows:

(1) Provide an alternative method to evaluate substances for which no clinical reports or animal toxicity studies exist or for which empirical data are insufficient to determine systemic effects.
(2) Use the algorithm evaluation results to determine whether a substance poses a skin absorption hazard and should be labeled with the SYS notation.

The algorithm evaluation includes three steps:
(1) determining a skin permeation coefficient (k_p) for the substance of interest,
(2) estimating substance uptake by the skin and respiratory absorption routes, and
(3) evaluating whether the substance poses a skin exposure hazard.

The algorithm is flexible in the data requirement and can operate entirely on the basis of the physicochemical properties of a substance and the relevant exposure parameters. Thus, the algorithm is independent of the need for biologic data. Alternatively, it can function with both the physicochemical properties and the experimentally determined permeation coefficient when such data are available and appropriate for use.

The first step in the evaluation is to determine the *kp* for the substance to describe the transdermal penetration rate of the substance [NIOSH 2009]. The k_p, which represents the overall diffusion of the substance through the stratum corneum and into the blood capillaries of the dermis, is estimated from the compound's molecular weight (*MW*) and base-10 logarithm of its octanol–water partition coefficient (log K_{ow}). In this example, k_p is determined for a substance with use of Equation 1. A self-consistent set of units must

be used, such as centimeters per hour (cm/hr), outlined in Table A1. Other model-based estimates of k_p may also be used [NIOSH 2009].

Equation 1: Calculation of Skin Permeation Coefficient (k_p)

$$k_p = \frac{1}{\frac{1}{k_{psc} + k_{pol}} + \frac{1}{k_{aq}}}$$

where k_{psc} is the permeation coefficient in the lipid fraction of the stratum corneum, k_{pol} is the coefficient in the protein fraction of the stratum corneum, and k_{aq} is the coefficient in the watery epidermal layer. These components are individually estimated by

$\log k_{psc} = -1.326 + 0.6097 \times \log K_{ow} - 0.1786 \times MW^{0.5}$
$k_{pol} = 0.0001519 \times MW^{-0.5}$
$k_{aq} = 2.5 \times MW^{-0.5}$

The second step is to calculate the biologic mass uptake of the substance from skin absorption (skin dose) and inhalation (inhalation dose) during the same period of exposure. The skin dose is calculated as a mathematical product of the k_p, the water solubility (S_w) of the substance, the exposed skin surface area, and the duration of exposure. Its units are milligrams (mg). Assume that the skin exposure continues for 8 hr to unprotected skin on the palms of both hands (a surface area of 360 squared centimeters [cm^2]).

Equation 2: Determination of Skin Dose

Skin dose = $k_p \times S_w \times$ Exposed skin surface area $\times$ Exposure time
= k_p(cm/hr) $\times$ S_w (mg/cm^3) $\times$ 360 cm^2 $\times$ 8 hr

The inhalation dose (in mg) is derived on the basis of the occupational exposure limit (OEL) of the substance—if the OEL is developed to prevent the occurrence of systemic effects rather than sensory/irritant effects or direct effects on the respiratory tract. Assume a continuous exposure of 8 hr, an inhalation volume of 10 cubic meters (m^3) inhaled air in 8 hr, and a factor of 75% for retention of the airborne substance in the lungs during respiration (retention factor, or RF).

Equation 3: Determination of Inhalation Dose

Inhalation dose = OEL × Inhalation volume × RF
= OEL (mg/m^3) × 10 m^3 × 0.75

The final step is to compare the calculated skin and inhalation doses and to present the result as a ratio of skin dose to inhalation dose (the SI ratio). This ratio quantitatively indicates (1) the significance of dermal absorption as a route of occupational exposure to the substance and (2) the contribution of dermal uptake to systemic toxicity. If a substance has an SI ratio greater than or equal to 0.1, it is considered a skin absorption hazard.

Calculation

Table A1 summarizes the data applied in the previously described equations to determine the SI ratio for azinphos-methyl. The calculated SI ratio was 0.059. On the basis of these results, azinphos-methyl is predicted to represent a skin absorption hazard.

Table A1. Summary of Data used to Calculate the SI Ratio for Azinphos-methyl

Variables Used in Calculation	Units	Value
Skin permeation coefficient		
Permeation coefficient of stratum corneum lipid path(k_{psc})	cm/hr	0.0015
Permeation coefficient of the protein fraction of the stratum corneum (k_{pol})	cm/hr	8.527×10^{-6}
Permeation coefficient of the watery epidermal layer (k_{aq})	cm/hr	0.1403
Molecular weight (MW)[a]	amu	317.33
Base-10 logarithm of its octanol–water partition coefficient (Log K_{ow})[a]	None	2.75
Calculated skin permeation coefficient (k_p)	cm/hr	0.0015
Skin dose		
Water solubility (S_w)[a]	mg/cm^3	0.0209
Calculated skin permeation coefficient (k_p)	cm/hr	0.0015
Estimated skin surface area (palms of hand)	cm^2	360
Exposure time	hr	8
Calculated skin dose	mg	0.0884
Inhalation Dose		
Occupational exposure limit (OEL)[b]	mg/m^3	0.2
Inhalation volume	m^3	10
Retention factor (RF)	None	0.75
Inhalation dose	mg	1.5
Skin dose–to–inhalation dose (SI) ratio	None	0.059

[a]Variables identified from SRC [2009].
[b]The OEL used in calculation of the SI ratio for azinphos-methyl was the NIOSH recommended exposure limit (REL) [NIOSH 2005].

Appendix References

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