

**AUSTRALIAN PESTICIDES AND VETERINARY MEDICINE AUTHORITY
NATIONAL REGISTRATION SCHEME**

FOR AGRICULTURAL AND VETERINARY CHEMICALS

AUSTRALIA

CHEMICALS REVIEW PROGRAM

OCCUPATIONAL HEALTH AND SAFETY ASSESSMENT

OF

FENTHION

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GLOSSARY OF TERMS AND ABBREVIATIONS

bw	body weight
g	gram
h	hour
ha	hectare
Iv	intravenous
kg	kilogram
L	litre
m	metre
m ²	square metre
m ³	cubic metre
µg	microgram
mg	milligram
mg/kg bw/day	mg/kg bodyweight/day
mL	millilitre
min	minute
mo	month
ng	nanogram
ppb	parts per billion
ppm	parts per million
s	second
te	Tonne
wk	week

ACPH	Advisory Committee on Pesticides and Health
APVMA	Australian Pesticides and Veterinary Medicines Authority
CalEPA	California Environmental Protection Agency
ChE	Cholinesterase
CRP	Chemical Review Program
CV	Coefficient of Variation
DEFRA	UK Department for Environment, Food & Rural Affairs
DFR	Dislodgeable Foliar Residue
DMP	Dimethylphosphate
DoH	Department of Health
EC	Emulsifiable Concentrate
GC	Gas Chromatography
HG	Home Garden
IARC	International Agency for Research on Cancer
IPM	Integrated Pest Management
LD	Liquid
LOD	Limit of Detection
LOQ	Limit of Quantification
MOE	Margin of Exposure
MCL	Mononuclear cell leukaemia
NHMRC	National Health and Medical Research Council

NOEC	No Observed Effect Concentration
NOEL	No Observed Effect Level
NOHSC	National Occupational Health and Safety Commission
OCS	Office of Chemical Safety
OHS	Occupational Health and Safety
OP	Organophosphorus pesticide
PA	Paste
PCO	Pest Control Operator
PQs	Performance Questionnaires
PHED	Pesticide Handlers Exposure Database
POEM	Predictive Operator Exposure Model
PPE	Personal Protective Equipment
PVC	Polyvinyl chloride
R	Correlation Coefficient
R ²	Regression Coefficient
RBC	Red blood cell
REI	Re-entry interval
RHI	Re-handling interval
S	Poisons Schedule
SCBA	Self Contained Breathing Apparatus
SD	Standard Deviation
SEE	Standard Error
SO	Solid (formulation type)
SR	Slow Release Generators (formulation type)
STEL	Short Term Exposure Limit
TWA	Time Weighted Average
UK	United Kingdom
USEPA	United States Environment Protection Agency
WHP	Withholding period

1. EXECUTIVE SUMMARY

Fenthion is used for field and post-harvest treatment of various fruits, vegetables, and ornamentals, for mosquito control in water and septic tanks, for pest control in commercial and domestic areas and as an ectoparasiticide in cattle. Fenthion is also used for quarantine control of Queensland fruit fly and other fruit flies through post-harvest treatments (dipping, flood sprays and non-recirculating low volume sprays).

Workers may be occupationally exposed to fenthion during mixing, loading, and applying the pesticide, or to foliar residues during harvesting or pruning some days or weeks after application. For workers entering a treated site, a re-entry interval is usually calculated to determine the minimum length of time during which it is necessary to wear personal protective equipment when performing activities which may involve contact with treated foliage. The occupational risk during mixing/loading/application and post-application is measured by a Margin of Exposure (MOE), which is a measure of how close the occupational exposure comes to the No Observed Effect Level (NOEL) observed in an appropriate animal or human study. Since a suitable human study for fenthion was available, a MOE of 10 or greater is considered acceptable. Exposure was estimated through the use of a surrogate data model, the Pesticide Handler Exposure Database (PHED) (1998).

Acceptable MOE values could be achieved for mixing, loading and applying fenthion products while wearing a range of specified Personal Protective Equipment (PPE). Existing safety directions for EC 600 g/L or less in xylene 350 g/L or less have been amended to include the use of elbow-length chemical resistant gloves, cotton overalls over normal clothing, a washable hat, and if handling large volumes, a full face-piece respirator during mixing/loading. Due to differences in the amount of active constituent being prepared, mixing/loading for groundboom application did not require a respirator to adequately mitigate risks whereas mixing/loading for airblast application did. Given uncertainties regarding differences in work rates between airblast and groundboom spraying, and the problem of distinguishing mixing/loading for a particular application method in the Safety Directions, the requirement to wear a respirator for mixer/loaders preparing spray for groundboom application was considered reasonable. For applicators, MOE values were adequate when the products were applied using enclosed tractor cabs fitted with a charcoal filter (to filter incoming air). Based on this assessment during field applications by airblast, only closed cabs fitted with charcoal filters should be used. For groundboom, open cab application systems were acceptable.

Other modes of application, such as high pressure (motorised) hand-held apparatus, are not considered safe for use with fenthion products except for treatment of stagnant water (mosquito larvae only) and septic tanks when wearing cotton overalls over normal clothing, a washable hat, and elbow-length chemical resistant gloves. For commercial pest control operators applying the product for spider, ants and mosquito control in domestic and commercial situations, the required PPE are cotton overalls over normal clothing, a washable hat, elbow-length chemical resistant gloves and a full face piece respirator. For Spot-on treatments of lice in cattle, the use of gloves has been recommended based on the hazard and the risk assessment of exposure during use. The use of equipment carried on the back for all use patterns and hand held equipment for domestic users are not acceptable due to high levels of exposure and the requirement of domestic users to wear extensive PPE to mitigate the risk to human health.

Harvesting of agricultural crops may be either a mechanical or a manual activity. Mechanical harvesting is not of OHS concern as low worker exposure is anticipated. Manual harvesting and other pre-harvest activities such as weeding and pruning can result in exposure and will depend on the quantity of residues present at the time. The half-life of fenthion foliar residues is estimated to be 36 hours. This half-life and the US EPA re-entry calculator (v 1.0) were used to establish re-entry intervals for various activities and crops to protect the health of workers. Foliar half-life in greenhouses was considered likely to be significantly higher than in outdoor settings due to sheltering from wind, sunlight, and rain, and a re-entry period could not be determined for this use-pattern. On the basis of uncertainty regarding exposures to workers applying products, and to those undertaking re-entry activities, use of products containing fenthion in greenhouses was not supported.

It is uncommon for pest control operators to re-enter commercial areas post-treatment, except in certain circumstances such as removal of fenthion paints and gels after bird control uses (not supported due to high risk of exposure to fenthion). But depending on the use pattern, the public may re-enter such areas.

The use of 1% dust formulations for control of insect pests in domestic and commercial areas was supported for some uses. Dust formulations when applied to cracks and crevices are unlikely to lead to public exposure to dust residues when re-entry to the treated area occurs. However, the public may re-enter ceiling voids wall voids and crawl spaces and therefore these use patterns are not supported due to unacceptable re-entry risks. No post-application occupational exposure is anticipated in waterways and septic tanks. Previous advice to the APVMA has recommended “Following use of fenthion bird control products, roost areas must have fenthion product removed after use within seven days”; this use pattern is no longer supported by OCS as surrogate modelling indicated an unacceptable risk of exposure to fenthion by workers painting roost areas.

New Safety Directions and re-entry periods up to 11 days were established and PPE for early re-entry was specified. Certain high exposure re-entry activities such as harvesting were unacceptable up until day 6 after application even when wearing additional PPE; the withholding period (WHP) for crops is at least 7 days. Workers undertaking harvesting activities from day 7 onward were therefore considered to be protected if wearing additional re-entry PPE. However it is noted that workers undertaking re-entry activities in tropical fruit crops may encounter hot climatic conditions, and additional PPE for re-entry activities in these areas may be impractical.

OCS recommends that the APVMA should be satisfied that fenthion will not present an undue risk to human health via occupational exposure when used on:

- vegetables and fruits by boomspray and closed cab airblast;
- mosquito larvae in water when using high-pressure spray equipment and on adult mosquitoes and larvae in septic tanks and commercial areas for the control of control of spiders and ants;
- produce for quarantine treatment;
- treatment of cracks and crevices for crawling insects as a 1% dust formulation; and
- on cattle as a spot-on ectoparasiticide when applied with a Spot-On Gun or Dial-a-dose cup.

OCS recommends that the APVMA should not be satisfied that fenthion will not present an undue risk to human health when:

- applied by hand-held equipment for treating mealy bug in ornamental crops and adult mosquitoes in surface water
- treating plants in greenhouses
- it is for domestic use
- applying by backpack equipment except as a spot-on to cattle
- used in pest control in domestic areas except in the control of mosquito larvae
- used as a 1% dust for treatment of ceiling voids, wall voids and crawl spaces due to re-entry considerations.

2. INTRODUCTION

Fenthion is an organophosphate chemical used in crop protection as an insecticide/acaricide, in pest control, and as an ectoparasiticide in cattle. In conducting the occupational health and safety (OHS) review, the Office of the Chemical Safety (OCS) obtained information from the following sources: industry, overseas reviews, and published literature.

3. USE PATTERN AND FORMULATIONS

Several formulations of fenthion were registered in Australia at the commencement of the review. They include, emulsifiable concentrates (EC) containing 117 or 550 g a.i./L, pour-on containing 20 g a.i./L, paint containing 110 g a.i./kg, spray containing 117 g a.i./L, spot-on containing 100, 200 or 250 g a.i./L, flea liquidator 200 g a.i./L and a 1% (g a.i./kg) dust formulation. A summary of formulation and packaging types is provided in Table 1.

Table 1: Formulation types and packaging sizes and types for fenthion products registered for agricultural and veterinary use at the commencement of the review

<i>Formulation type (a.i./kg or a.i./L)</i>	<i>Packaging size and type</i>
EC 100 g/L, EC 550 g/L	100 mL, 1 L 5 L containers
Pour on 20 g/L	5 L container
Paint 110 g/kg	10 kg and 20 L containers
Spray 117 g/L, 550 g/L	200 mL and 500 mL containers
Spot-on (dogs) 100g/L, 200 g/L, 250 g/L	4 x 1 mL, 4 x 0.5 mL packs and 100 mL pump
Spot-on (cattle) 200 g/L	500 mL and 2.5 L containers
Flea liquidator 100 g/L, 200 g/L	4 x0.5 mL and 4 x 1.0 mL packs
Dust 10 g/kg	5 kg

Table 2: Formulation types and packaging sizes and types for fenthion products registered or under suspension for agricultural and veterinary use at the time of this revision

<i>Formulation type (a.i./kg or a.i./L)</i>	<i>Packaging size and type</i>
EC 117 g/L	200 mL containers
Spot-on (cattle) 200 g/L	500 mL, 2.5 L and 10 L containers
Paint/Paste 110 g/kg	10 kg and 20 L containers
Dust 10 g/kg	5 kg
<i>Suspended products not currently on PUBCRIS</i>	
EC 550 g/L	1 L and 5 L containers
EC 80 g/L	125ml, 200 ml and 500 ml containers

The following information is based on products registered or under suspension in Australia at the time of revising this review. Information on the Australian use pattern of fenthion was obtained from registered product label and industry information, State Chemical Co-ordinators, and the latest versions of labels available at the time of this revision. In all cases the maximum stated use rate for each crop type or use pattern is used. This information is summarised in Table 3.

Use pattern: Fenthion is registered in Australia for control of various insect pests in domestic and commercial areas, and as an ectoparasiticide in cattle. It has previously been registered for field and post harvest treatments of various fruits and vegetables, for control of various insect pests. It is also used as a public service, commercial, and domestic insecticide. The pests controlled include mosquitoes, fleas, lice and fruit flies. Fenthion is also used as a bird control agent in non-crop areas (buildings). These uses are summarised in Table 5.

Table 3: Agricultural use pattern of fenthion products 550g/L EC – crops/other situations (currently under suspension). Uses as stipulated under permit 13841 and 13840 (NSW only).

Crop	Pest	Product: application rate/dilution	Application method	Comments
Tropical and sub-tropical fruits (inedible peel)(avocado, banana breadfruit, custard apple, durian, feijoa, guava, jackfruit, kiwi fruit, lychee, longan, mango, mangosteen, pawpaw, passionfruit, persimmon, pineapple, pomegranate, rambutan, sapodilla, sapote, tamarind)	Fruit Fly	75 mL/100 L (0.4125 g a.i./L – 0.04%) 1200-2500 L/ha 15-20 ha/day	Airblast or misters	WA: Thorough spray coverage of fruit is essential. Apply at 6, 4, 3, 2 and 1 week (except guava and pawpaw apply at 6, 4, 3 and 2 weeks) before the expected start of harvest. QLD, NSW, Vic, NT: Spray when pest is present, thorough coverage of fruit is essential. Apply cover sprays, at a minimum 7 days interval. DO NOT apply more than 5 sprays per season
	Grapes	Mediterranean fruit fly Fruit fly	50–75 mL/100 L 15-20 ha/day	WA: Spray when pest is present. Thorough coverage of fruit is essential. Apply a maximum of 2 sprays per season, no less than 7 days apart if signs of fruit fly strike are seen, or monitoring numbers indicate that treatment is required. DO NOT apply more than 2 sprays per season QLD, NT: Spray when pest is present, thorough coverage of fruit is essential. Apply cover sprays, at a minimum 7 days interval. DO NOT apply more than 3 sprays per season.
Stone fruit (except cherries)	Mediterranean fruit fly Queensland fruit fly Oriental fruit moth Lightbrown apple moth Wingless grasshopper	75 mL/100 L (0.4125-0.5225 g a.i./L)		WA: Cover sprays provide additional protection over fruit fly baiting. Apply a maximum of 2 sprays per season, no less than 10 days apart if signs of fruit fly strike are seen, or monitoring numbers indicate that treatment is required. DO NOT apply more than 2 sprays per season QLD, NSW, Vic: Spray fruit thoroughly. Apply full cover sprays at a minimum 7 days interval, until 3 weeks before picking commences. DO NOT apply more than 3 sprays per season Apply every 2-3 weeks during the period of moth activity. Use higher rate for heavy infestation. Re-apply if necessary at a minimum 7 days interval until 3 weeks before picking commences. DO NOT apply more than 3 sprays per season

Citrus (WA only)	Mediterranean fruit fly	EC 75 mL/100 L (0.4125 g a.i./L–0.04%)		Apply no more than a single application per season of no more than 1000 L/ha. DO NOT apply more than 1 spray per season.
Pawpaws	Yellow peach moth	75 mL/ 100 L		Apply a thorough cover spray as insect populations indicate.
Persimmons (Inedible peel varieties only)	Queensland fruit fly, mealybug	75 mL/ 100 L		Spray when pest is present, thorough spray coverage of fruit is essential. with a maximum of 5 applications per season.
	Greenhouse thrips	90 mL/ 100 L (0.505 g a.i./L)		Apply as a cover spray as required with a maximum of 5 applications per season.
Persimmons (Edible peel varieties only)	Queensland fruit fly and mealybug Mediterranean fruit fly	75 mL/ 100 L		Apply a maximum of 2 sprays per season, at a minimum 10 days interval
Capsicums	Fruit fly	75 mL/100 L or 750 mL/ha		Apply when first fruit changes colour from dark green to light green. Repeat every 14 days.
Apples, pears, quince	Queensland fruit fly	150 mL/100 L (0.825 g a.i./L of water)		Apply full cover sprays until 4 weeks before picking commences.
Apples, pears	Fruit fly (QLD only)	75 mL/100 L		Apply full cover sprays until 4 weeks before picking commences.
Apples, pears	Codling moth Lightbrown moth	95 mL/100L (0.5225 g a.i./L)		Apply as a full cover spray every 2 – 3 weeks during the period of moth activity until 4 weeks before picking commences.
Apples, pears	Rutherglen bug	75 mL/100 L		Spray fruit trees when pests are first seen and repeat when they reinvade (at a minimum 7 days interval) until 4 weeks before picking commences. Also spray nearby weeds.
Apples, pears	Wingless grasshopper	75 mL/100L		Apply a full cover spray if hoppers infest fruit trees.
Ornamentals	Mealybug	0.55 g a.i./L (100 mL/100L)	Hand-held equipment - Motorised pumps with hand sprayers for large	Mealybugs may occur on all parts of the plants including roots. Thoroughly drench soil around plants. Also spray plants when pests are seen and repeat 14 days later.

			nurseries, knapsack for smaller applications	
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The current permits include the following restrictions:

DO NOT use fenthion on citrus (including oranges, lemons and grapefruit) (allowed in WA for Mediterranean fruit fly)

DO NOT use fenthion on any deciduous fruit trees or fruit trees other than as specified in the table below

DO NOT use fenthion on figs, loquats or quince

DO NOT use fenthion on any edible peel varieties of kiwifruit or guava

DO NOT use fenthion on eggplant (eggfruit) or pepinos

DO NOT use fenthion on tomatoes

DO NOT use fenthion as a post harvest treatment on any fruiting vegetables (including cucurbits) other than chillies, melons and watermelons.

<i>Fenthion quarantine treatment</i>				
Crop	Pest	Product: application rate/dilution	Application method	Comments
Tropical and sub-tropical fruits (inedible peel), Melons and watermelons	Fruit flies (Quarantine treatment only)	75 mL/100L (0.4125 g a.i./L) High volume application of at least 16 L/min/m ²	Dips, flood spray, low volume non-recirculated sprays	DO NOT use fenthion on any cucurbits other than melons and watermelons Post-harvest treatment – no withholding period. Dips: Dip fruit and completely submerge for 1 minute. Flood spray: Fruit should be sprayed in a single layer at 16 L/min/m ² . Spraying provides coverage of the fruit for a minimum of 10 seconds. Low volume non-recirculated sprays: Constant mixing is necessary to avoid settling or separation of the concentrate. Complete coverage is achieved by rotating the fruit which should be under the spray for a minimum of 15 seconds.
Hollow fruited chillies only			Flood spray	Post-harvesting treatment – no withholding period. DO NOT dip or flood spray capsicums Do not dip hollow chillies as dip may enter cavity. Apply as a flood spray of 16 L spray mixture/minute/m ² over fruit for a minimum of 10 seconds, then ensure fruit remains wet for at least 1 minute.

Table 4: Veterinary uses of fenthion products

Animal	Pest	Product: application rate/dilution	Application method	Comments
Cattle	Biting and sucking lice	Spot-On formulation 200 g a.i./L	Spot-On formulation is supplied in a backpack and applied with the special Spot-On Gun or Dial-a-dose cup	Apply once per season when lice become evident. Apply onto back of animal, preferably in one spot on rump or loins.

Table 5: Fenthion: Other situations (117 g/L EC with 722 g/L Hydrocarbon solvent)

Situation	Pest	Product: application rate/dilution	Application method	Comments
Water • Adults • Larvae Septic tanks	Mosquitoes	7.02 – 8.25 g a.i./L	Hand-held equipment	Apply 1 L/8 m ² as a coarse spray, approx 1250 L/ha, to all surfaces where mosquitoes congregate.
		146 – 165 g a.i./10000 m ² 4.68 – 5.75 g a.i./septic tank		Apply in a convenient amount of water, approx 1250 L/ha, to areas where mosquitoes are breeding. Flush into septic tank through pedestal pan every four weeks.
Outdoors and subfloor areas of: Dairies, Stables, Meatworks (non product areas), Commercial and Industrial areas (e.g. processing plants, warehouses, building tops, pipeyards, loading docks, bridges, farm buildings),	Spiders and ants	7.02 – 8.25 g a.i./L		Apply as a coarse spray. Thoroughly spray spiders, their webs and crevices in which they hide. Do not remove webs for a few days.
	Flies	11 g a.i./L water/8 m ²		Apply as a coarse spray to walls and other areas where flies alight or congregate.
Domestic (Cracks, crevices and skirting boards)	Fleas	11 – 16.7 g a.i./3 L/10 m ²	Hand-held equipment	Use a wetting agent and the higher rate on non-wetting soils. Pre-wetting the soil with a garden hose may be required on very dry soils. Thoroughly spray all infested areas and ensure pets present are treated with a suitable flea control product to avoid re-infestation.
<i>Paint/grease formulation</i>				
Commercial and industrial buildings	Unwanted Birds eg: Pigeons, Starlings, Sparrows, Indian mynah	Supplied as a 110 g a.i./kg paint	No equipment required	Paint strip 5 cm wide to 10 % of favoured roost areas.
<i>1% Dust Formulation</i>				
Commercial application to domestic cracks and crevices, wall voids, crawl spaces and ceiling voids	cockroaches, ants, silverfish and crickets, and in ceiling voids for spiders	1% Dust	Puffer	Used only by licensed pesticide operators (PCOs)

According to the APVMA Report, the most important use of fenthion is for fruit fly control, with three major use patterns outlined for this purpose.

- (1) A field spraying program which involves spraying at defined intervals before harvest. This ensures freedom from fruit fly irrespective of whether the pest is present in damaging numbers. For example, field spraying of *tropical and sub-tropical fruit (inedible peel) involves spraying at 6, 4, 3, 2 and 1 week before the expected start of harvest. By comparison, apples, pears, should be sprayed up to 4 weeks before picking commences.
- (2) A combination of field spraying and baiting, e.g. in apples and pears, cover sprays should be applied until 4 weeks before harvest if signs of fruit fly strike are seen.
- (3) The use pattern which applies only to tropical and sub-tropical fruits (inedible peel) and fruiting vegetables, involves post-harvest treatments using dips, flood sprays or non-recirculating low volume sprays.

(*tropical and sub-tropical fruits include avocado, banana, breadfruit, custard apple, durian, feijoa, guava, jackfruit, kiwi fruit, lychee, longan, mango, mangosteen, papaw, passionfruit, pineapple, pomegranate, persimmons, rambutan, sapodilla, sapote, tamarind)

Label restrictions:

The withholding periods (WHP) specified on fenthion product labels are summarised in Table 6.

Table 6: Withholding periods for fenthion products specified on the permits/product labels

Crop/Animal/Situation	WHP
Stone fruit except cherries	Do not harvest for 21 days after application
Paw paws, guavas	Do not harvest for 14 days after application
Apples, pears	Do not harvest for 28 days after application
Grapes	Do not harvest for 21 days after application
All other edible crops	Do not harvest for 7 days after application
Cattle	Do not apply later than 10 days before slaughter for human consumption

There are no re-entry periods specified on any of the product labels.

4. HAZARD OVERVIEW

4.1 Acute toxicity

Fenthion is moderately toxic by the oral, dermal and intraperitoneal routes for both rats and mice, with males being slightly more sensitive than females in some tests. Fenthion has a low to moderate toxicity when administered inhalationally as a mist. Fenthion was not an irritant to rabbit eye or skin. It is not a skin sensitiser in guinea pigs. A summary of the acute toxicity of technical fenthion is provided in Table 7:

Table 7: Summary of the acute toxicity of technical fenthion

Species	Sex	LD ₅₀ (mg/kg bw) or LC ₅₀ (mg/m ³)
Oral		
Mice	M	200 - 290
	F	225 - 280
Rats	M	140 - 474
	F	150 - 566
Dermal		
Mice	M	2000
	F	500 - >2000
Rats	M	325 - >5000
	F	271 - 5000
Inhalational		
Mice	M	2400
	F	2000
Rats	M	507 - 3450
	F	454 - 3000

4.2 Repeat dose toxicity

A number of repeat dose animal studies were considered suitable for regulatory purposes by OCS. In all studies, inhibition of cholinesterase in plasma, RBC and brain was the most critical effect. The OCS considers that a NOEL of 0.02 mg/kg bw/day in a 4-week human study (Coulston, 1979) is appropriate for OHS risk assessment purposes based on the following argument, with an acceptable MOE level considered to be ≥ 10 because of the use of a human study:

- the statistical significance of plasma ChE inhibition at 0.02 mg/kg bw/day in humans was equivocal;
- 0.02 mg/kg bw/day was also a NOEL for acute clinical signs in the human study; and
- a 2-year monkey study (Rosenblum, 1980) had recorded an identical NOEL of 0.02 mg/kg bw/day for plasma ChE inhibition.

4.3 Dermal absorption

In vitro and *in vivo* dermal absorption data have been submitted and assessed in the Toxicology Assessment report. Based on the *in vivo* absorption rate for fenthion 500 EC concentrate (17%) in a rat study (Weber, 2000), and the *in vitro* ratio of percutaneous penetration for human : rat (1: 2) (van de Sandt, 2000), the *in vivo* human dermal absorption factor will be calculated as $17\% \times 1/2 = 9\%$. This dermal absorption factor will be used in the risk assessment.

4.4 Health effects relating to occupational exposure

Workers exposed to aerial application of fenthion dust over 5 days complained of generalised chills, headache, vomiting, diarrhoea and irregular pulse. One of the workers needed hospitalisation, but had an uneventful recovery (Jung, 1963).

Workers exposed to a 20% solution of fenthion on a regular basis in a veterinary hospital developed neurological symptoms such as multiple shooting pains, muscle weakness, back pain, numbness and tingling of the hands and feet, ocular muscle weakness and paralysis. Results of tests of plasma and red blood cell cholinesterase activity were within the normal range for all workers (Metcalf et al, 1985).

A 21 year old abattoir-shed worker who was a known asthmatic developed an exacerbation of his symptoms following exposure to 3% fenthion in talc dust. His duties included supervising the long-term storage of animal skins, which were sprayed monthly with 3% fenthion in talc dust. Bronchial provocation tests with powder components of the insecticide did not demonstrate any response to the inhalation of talc or lactose dust for ten minutes after use. There was a delayed response which began after two hours and was maximal at six hours when the patient inhaled 3% fenthion in lactose powder for six minutes. Plasma and red blood cell cholinesterase activity was measured before, at 30 minutes, two hours and five hours after exposure. No alterations in plasma and erythrocyte cholinesterase levels were noted (Bryant, 1985).

Workers exposed to fenthion presented with symptoms and signs of Intermediate Syndrome (IMS). The clinical signs of IMS were weakness of several motor cranial nerves (diplopia, dysphagia, and facial diplegia), sudden respiratory weakness, neck and proximal limb muscle weakness and depression of the deep tendon reflexes. Muscle fasciculations were also present in certain cases. The duration of symptoms varied from a few days to several weeks. Severe acetylcholinesterase inhibition was noted in all patients during the entire duration of IMS (De Bleeker, 1995).

Public health workers exposed to fenthion for one week complained of headache, sweating, eye problems such as pain and watering, impaired vision, muscle cramps, chest tightness, dermatitis, excess salivation, and excessive secretions as compared to workers who were not exposed. Estimated concentrations of fenthion used ranged from 0.03 to 0.78 g/100 mLs. Analysis of blood cholinesterase concentrations of workers exposed to fenthion showed no depression during the working day over the period of the study (Jeyaratanam and Ponnambalam, 1980)

The health effects of 22 workers who regularly sprayed fenthion were investigated using clinical and biochemical parameters. The workers were subjected to detail history-taking, noting their

working conditions, dietary history and addictions. In addition, symptoms associated with spraying were noted for each worker. The mean age of the workers was 31 years, and the mean duration of fenthion exposure was 8.2 years. Headache, giddiness, ocular symptoms and paraesthesia were the commonest symptoms. Serum acetylcholinesterase and butyrylcholinesterase levels were significantly lower than in controls. After withdrawing the workers from organophosphate exposure for 3 weeks, the follow-up study revealed absence of transient symptoms. There was no change in their neurological status, but serum acetylcholinesterase and butyrylcholinesterase levels returned to normal pre-exposure levels (Misra et al, 1985).

A clinical and neurophysiological examination was carried out on thirty one workers engaged in spraying fenthion for about 1-14 years. The workers reported mild transient symptoms after spraying. There was no clinical evidence suggestive of excessive cholinergic activity. Results of clinical psychometry suggested subclinical effect of chronic fenthion exposure on the cognitive functions of the workers (Misra et al, 1994).

A telephone survey of health symptoms of pet handlers with occupational exposure to fenthion was conducted in California following several reports of ill workers. Work practices, PPE used and details of products were documented. Symptoms associated with exposure to fenthion were convulsions, muscle twitching, unusual tiredness, asthma, burning sensation in eyes and headache. Spraying and dusting were associated with increased symptom frequency for more adverse acute health symptoms than dipping. Spraying was associated with increased frequency of skin and eye irritation symptoms, whereas dusting was associated with increased frequency of gastrointestinal and respiratory symptoms, headaches and joint swelling or pain (Ames et al, 1989).

Retinal changes in 79 workers occupationally exposed to fenthion were studied. Fifteen workers (19%) had macular changes characterised by perifoveal irregularity of pigmentation and areas of hypopigmentation. Fluorescein angiography suggested pigment epithelium defects (Misra et al, 1985).

Potential dermal and respiratory exposures to fenthion were determined for mosquito-control workers during application by hand gun power spray equipment, backpack hand pressure sprayer (0.06% spray), and hand granular dispersal (1% granular formulation). A total of 33 work periods were studied over two seasons. Exposure pad and hand-rinse techniques were used to estimate exposure. The amount of pesticide entering the body via the respiratory route was estimated from the contamination of special filter pads in single-unit respirators worn by the volunteers. Mean dermal and respiratory exposure values during operation of power sprayers were 3.6 and <0.016 mg/hr of work, respectively, and for hand pressure sprayer operators the values were 3.6 and <0.021 mg/hr, respectively. Mean dermal and respiratory exposure values for hand granular dispersal were 12.3 and 0.088 mg/hr of work, respectively. Thus, potential dermal exposure was greater than potential respiratory exposure, and exposure was greatest during hand granular dispersal. Highest total dermal-respiratory exposure for any individual was only 0.03% of a toxic dose /hour of work activity. Tests to determine hazard from smoking during application operations indicated greater contamination of cigarettes as a result of contact with unwashed hands following hand granular application than following spray application operations. There was no important change in erythrocyte cholinesterase activity; however, there was some decrease in

plasma cholinesterase activity in certain workers. There were no toxic signs in any of the workers (Wolfe et al, 1974).

5. OCCUPATIONAL EXPOSURE ASSESSMENT

Fenthion products are currently registered or have permits (for suspended products) for agricultural and veterinary use in a range of crops/animals/use situations. To facilitate the exposure and risk assessment, exposure scenarios were developed and grouped where possible.

5.1 End use exposure

Agricultural uses

Fenthion is registered or has permits for agricultural use in a number of different formulations with varying concentrations of the active ingredient. The chemical is used as a foliar spray on outdoor crops, and is applied using airblast or misters, and boomsprayers. For application to ornamental plants motorised pumps with hand sprayers are used for large nurseries, and knapsack for smaller applications. Treatments are only carried out when a problem has been identified. The only use on ornamental plants is for control of root mealybug. Ornamentals, especially in nurseries are usually treated for mealybug infestation at the rate of 0.55 g a.i./L with hand-held equipment. Label recommendations indicate drenching of the soil around plants as well as direct application to the plants, using similar methods. Dips, floodspray and low-volume non-recirculated sprays are used as post-harvest and quarantine treatment for tropical and sub-tropical fruits and vegetables. Other uses include spray control of mosquitoes in water and septic tanks. Fenthion is also used as paint or paste in buildings for the control of pigeons, starlings, sparrows and the Indian mynah.

The main route of occupational exposure to fenthion is expected to be by skin contamination during mixing/loading/spraying. Inhalation of spray mist may occur during spray application, particularly when using hand-held equipment. Workers handling undiluted solvent-based product can be potentially exposed to solvent vapour during spraying. Dermal exposure to paint may occur during treatment of commercial and domestic buildings, and subsequent removal of the product. Accidental ocular exposure could also occur during application.

Occupational exposure for the following agricultural scenarios was estimated using the Pesticide Handler Exposure Database (PHED) Surrogate Exposure Guide (1998). Scenario details of each estimate are presented in Section 5.3.

The below PHED scenarios were combined into the following exposure estimates:

Estimate 1a	PHED Scenarios 3 and 11	Fruits and vegetables
Estimate 1b	PHED Scenarios 3 and 12	
Estimate 2a	PHED Scenarios 3 and 13	
Estimate 2b	PHED Scenarios 3 and 14	
Estimate 3	PHED Scenarios 3	Post-harvest (quarantine treatment of fruit and vegetables)
Estimate 4a	PHED Scenarios 3 and 19	Water and septic tank
Estimate 4b	PHED Scenarios 3 and 20	
Estimate 5a	PHED Scenarios 3 and 19	Commercial and domestic areas
Estimate 5b	PHED Scenarios 3 and 20	
Estimate 6a	PHED Scenarios 3 and 18	Ornamentals
Estimate 6b	PHED Scenarios 3 and 20	
Estimate 7	PHED Scenarios 22	Roost area

<p>PHED Scenario 3 – All Liquids, Open Mixing/Loading. High confidence data for dermal exposure without gloves (AB grade): 75–122 dermal replicates; 53 hand replicates. High confidence data for dermal exposure with gloves (AB grade): 72–122 dermal replicates; 59 hand replicates. High confidence data for inhalational exposure (AB grade): 85 replicates total.</p>
<p>PHED Scenario 11 – Airblast Application, Open Cab. High confidence data for dermal exposure without gloves: 32–49 dermal replicates (AB grade); 22 hand replicates (AB grade). High confidence data for dermal exposure with gloves: 31–48 dermal replicates (AB grade); 18 hand replicates (All grade). High confidence data for inhalational exposure (AB grade): 47 replicates total.</p>
<p>PHED Scenario 12 – Airblast Application, Enclosed Cab. Low confidence data for dermal exposure without gloves: 20–30 dermal replicates (AB grade); 0 hand replicates. High confidence data for dermal exposure with gloves: 20–30 dermal replicates (AB grade); 20 hand replicates (AB grade). Low confidence data for inhalational exposure (ABC grade): 9 replicates total.</p>
<p>PHED Scenario 13 – Groundboom Application, Open Cab. High confidence data for dermal exposure without gloves: 23–42 dermal replicates (AB grade); 29 hand replicates (AB grade). Medium confidence data for dermal exposure with gloves: 23–42 dermal replicates (AB grade); 21 hand replicates (ABC grade). High confidence data for inhalational exposure (AB grade): 22 replicates total.</p>
<p>PHED Scenario 14 – Groundboom Application, Enclosed Cab. Medium confidence data for dermal exposure without gloves: 20–31 dermal replicates (ABC grade); 16 hand replicates (ABC grade). Low confidence data for dermal exposure with gloves: 20–31 dermal replicates (ABC grade); 12 hand replicates (All grade). High confidence data for inhalational exposure (AB grade): 16 replicates total.</p>
<p>PHED Scenario 18 – Low Pressure Handwand Application. Low confidence data for dermal exposure without gloves: 13 dermal replicates (C grade); 9 hand replicates (B,C grade). Low confidence data for dermal exposure with gloves: 13 dermal replicates (C grade); 4 hand replicates (B, C grade). Low confidence data for</p>

inhalational exposure (ABC grade): 13 replicates total.
PHED Scenario 19 – High Pressure Handwand Application. Low confidence data for dermal exposure without gloves: 9–11 dermal replicates (All grade); 2 hand replicates (All grade). Low confidence data for dermal exposure with gloves: 9–11 dermal replicates (All grade); 9 hand replicates (All grade). Low confidence data for inhalational exposure (All grade): 11 replicates total.
PHED Scenario 20 – Backpack Application. Low confidence data for dermal exposure without gloves: 69 dermal replicates (AB grade; head and neck data only); 60 hand replicates (AB grade). Low confidence data for dermal exposure with gloves: 69 dermal replicates (AB grade; head and neck data only); 0 hand replicates. High confidence data for inhalational exposure (AB grade): 40 replicates total.
PHED Scenario 22 – Paintbrush Application. Low confidence data for dermal exposure without gloves: 14–15 dermal replicates (C grade); 15 hand replicates (AB grade). Low confidence data for dermal exposure with gloves: 14–15 dermal replicates (C grade); 0 hand replicates. Medium confidence data for inhalational exposure (C grade); 15 replicates total.

A qualitative exposure assessment was conducted for the following agricultural scenarios:

Estimate (8) Application of 1% Dust formulation by PCOs. Due to the lack of an appropriate PHED scenario for this application type a semi-qualitative assessment was undertaken.

Veterinary uses

Fenthion products are registered for use as a Spot-On treatment for cattle lice. Workers involved in spot-on applications and using the flea liquidator may be exposed to fenthion products by skin contamination during accidental contact or rehandling treated animals.

Occupational exposure for the following veterinary scenarios was determined qualitatively as exposure studies were unavailable and POEM modelling and PHED surrogate data were not considered applicable. A worker exposure study, (Report no. FortDodge/0001a/1, Australia 2001) using chlorfenvinphos as a hand application on cattle was conducted by industry and provided to NOHSC by the NRA. As hand application for cattle is considered to be a “worst-case scenario”, the outcomes of the study were used as surrogate data to determine exposure for workers using fenthion for hand applications for cattle.

Estimate (9) Spot-on application for cattle

Agricultural use assumptions

The following assumptions are used in the agriculture exposure assessment:

- A normal work day of 8 hours, consistent with OCS policy on duration of working day was not used due to more specific data on work rates being available for various scenarios. Work rates/ hours worked are adjusted based on the use pattern.

- 100% absorption of inhaled dose (default; Thongsinthusak et al, 1993); and,
- 9% absorption of dermal dose based on *in vivo* and *in vitro* dermal absorption studies; and,
- average body weight: 70 kg, based on Australian data (enHealth 2012).
- 90% reduction in dermal exposure to the body afforded by wearing an additional layer of overalls (Thongsinthusak et al., 1993).
- 90% reduction in dermal exposure to the head and neck afforded by wearing a washable hat (Thongsinthusak et al., 1993).
- When a worker applying the product by hand-wand is wearing gloves, 99% of the dermal exposure is to the body and head/neck region (US EPA PHED Version 1.0).

5.2 Measured exposure studies

No measured exposure studies were submitted.

5.3 Predicted exposure

PHED

In the absence of relevant worker exposure data the Pesticide Handler's Exposure Database (PHED) was used to assess uses of fenthion wherever possible. PHED is based on the principle that most dermal and respiratory exposure are more dependent upon formulation type, conditions of use, environmental conditions and personal protective measures than the physical and chemical properties of the active ingredient. PHED contains measured exposure data collected from field workers and allocates these into three separate worker groups (mixer/loaders, applicators, and mixer/loader/applicators). Exposure scenarios were identified for airblast, ground-boom and hand held applications in various fruits. For applying sprays the worker is assumed to be wearing long pants, long sleeve shirt, but no gloves. Additional PPE included gloves and or a second layer of clothing as well as a respirator. For airblast and ground boom application, application equipment with open cabs and with closed cabs were both investigated.

The following parameters and assumptions were made for use of PHED surrogate data:

Inhalation absorption	100%
Dermal absorption	9%
Average body weight	70 kg
Formulation type	EC (550 g a.i./L)
Formulation type	EC (117 g a.i./L)
Formulation type	EC (80 g a.i./L)

The various end-use applications for fenthion are described under scenarios with designated numbers (Section 5.1). Use pattern parameters for each end use scenario considered in the agriculture exposure assessment using PHED are presented in Table 8.

Table 8: Use pattern parameters used in the agricultural exposure assessment

Crop/situation/Pest formulation	Scenario number and description	Dilution, product application rate/spray volume and concentration of ai in spray	Work rate
Vegetables/fruits EC 550 g/L	Estimate 1a,b Scenarios (3, 11a/12b) Open mixing /loading and application by airblast	75 –150 mL/100L 0.4125-0.825 g a.i./L 1200-2500 L/ha	3-6 hrs/day 15-20 ha/day
Vegetables/fruits EC 550 g/L	Estimate 2a,b Scenarios (3, 13a/14b) Open mixing/loading and application by boomspray	75 mL/100L 0.4125 g a.i./L 750 mL/ha	As above
Post-harvest treatment of fruits/vegetables (quarantine) EC 550 g/L	Estimate 3 Scenario (3) Open mixing/loading only	0.75 mL/L 0.4125 g a.i./L 1400 L spray volume	Varying work rates, estimated to be up to 3 hours
Water and septic tanks EC 550 g/L ----- EC 117 g/L ----- EC 80 g/L	Estimate 4 Scenarios (3, 19) Open mixing/loading and high pressure hand-wand spraying	<ul style="list-style-type: none"> • 15 mL/L of water/8 m2 8.25 g a.i./L [10 kg a.i. /ha] (adult mosquitoes) • 165 g a.i./10,000 m² (larvae) • 10 mL/septic tank 5.50 g a.i./septic tank <p>-----</p> <ul style="list-style-type: none"> • 80 mL/L of water/8 m2 7.02-8.25 g a.i./L [10 kg a.i. /ha] (adult mosquitoes) • 146 g a.i./10,000 m² (larvae) • 50 mL/septic tank 4.68-5.75 g a.i./septic tank <p>-----</p> <ul style="list-style-type: none"> • 100 mL/L of water/8 m2 8 g a.i./L [10 kg a.i. /ha] (adult mosquitoes) 	Varying work rates, estimated to be up to 3 hours
Commercial and domestic areas EC 80 g/L Spiders and ants (A) Fleas (B) Mosquitoes(C) EC 117 g/L	Estimate 5a,b Scenario (3, 19a/20b) Mixing/loading and hand-held spraying	<p>A: 100 mL/L of water 8 g a.i./L</p> <p>B: 65 mL/Lwater/3m2 15.6 g a.i./3L/10 m2</p> <p>C: 100 mL/L of water 8 g a.i./L water/8m2</p> <p>A: 70 mL/L of water 8.19 g a.i./L</p> <p>B: 120 mL/Lwater/3m2 42.12 g a.i./3L/10 m2</p>	Varying work rates, estimated to be up to 3 hours

		C: 70 mL/L of water 8.19 g a.i./L water/8m ²	
Ornamentals mealybug EC 550 g/L	Estimate 6a,b Scenario (3, 18a/20b) Mixing/loading and hand-held spraying	1 mL/L of water	Varying work rates, estimated to be up to 3 hours
EC 80 g/L		5 mL/L of water	

Agricultural applications

The maximum area sprayed was 20 ha/day, based on information provided by the APVMA, with a range of 15-20 ha/day for fruits and vegetables.

Estimate (1a,b) Open mixing/loading and application to fruits and vegetables by airblast (**Scenarios 3, 11a/12b**) using the *All liquid Formulations; Open mixing and open cab Airblast: Open mixing and enclosed cab Airblast*).

According to the APVMA report, most applications in orchards are by air-assisted sprayers – usually airblast or misters. The crops included in orchard spraying are tropical and sub-tropical fruits (inedible peel), pome fruit (apples, pears), citrus, stone fruit. The equipment used is either high volume applicators suitable for 1200-2500 L/ha or adjusted for concentrate or semi concentrate spraying at the rate of 0.5-2 ha/hr. An exception is for use on citrus crops, which may occasionally be sprayed at a diluted volume of 5000 L/ha. Advice provided by the APVMA also indicates that similar application equipment to that used in orchards are used in vineyards. The spraying equipment could also be modified so that nozzles are not directed upwards to penetrate a tree canopy.

Estimate (2a,b) Open mixing/loading and application to fruits and vegetables by boomspray (**Scenarios 3, 13a/14b**) using the *All liquid Formulations; Open mixing and open cab Ground-boom: Open mixing and Ground-boom: Enclosed cab*.

Boomsprayers are used for pre-harvest field treatments of capsicums. The product will be applied at the rate of 75 mL/100 L or 750 mL/ha.

Estimate (3) Open mixing/loading and post-harvest treatment of fruits and vegetables (**Scenario 3**) using the *All liquid Formulations; Open mixing* to estimate mixer/loader exposure only.

Scenario (4a,b) Open mixing/loading and hand-held spraying of water and septic tanks (**Scenarios 3, 19/20**) using the *All liquid Formulations, Open mixing and High Pressure Handwand or backpack*.

Mixer/loader and applicator exposure was estimated for workers exposed to fenthion when used in treating the larval stages of mosquitoes in water at the rates of 146 - 165 g a.i./ 10000 m² adult mosquitoes at rates of 7.02 - 8.25 g a.i./L/8 m² (10 kg a.i./ha), and treatment of septic tanks at the rate of 4.68-5.75 g a.i./septic tank. According to the APVMA Report, major mosquito breeding

grounds are usually relatively inaccessible, and treatment is mostly by high volume hand-held sprayers attached to motorised pumps mounted on vehicles (usually four wheel drive or All Terrain Vehicle [ATV]) or knapsack sprayers. Small pumps are used in some circumstances. Similar equipment mounted on aluminium dinghies and swamp boats are also used for this type of application where land-based vehicle access is limited. Information provided by the APVMA states that the product could be used from aircraft since per hectare rate was specified, but OCS did not assess aerial application as such use is not specified on labels. According to product labels, the EC products at concentrations of 117, and 550 g/L (currently only available under permit) are intended for control of larvae and treatment of septic tanks, while the 80 g/L EC product (currently only available under permit) is intended solely for the control of adult mosquitoes.

Estimate (5a,b) Open mixing/loading and hand-held spraying of commercial and domestic areas **Scenarios 3, 19a/20b)** using the *All liquid Formulations, Open mixing and High Pressure Handwand or Backpack*.

Spraying of commercial and domestic areas for the treatment of various pests is normally carried out by licensed PCOs with hand-held sprayers attached to motorised pumps, which are mounted on the backs of trucks or in vans. For the treatment of spiders and ants, fenthion is applied at the rate of 0.7-0.82%, whereas for the treatment of fleas in non-wetting soil a wetting agent and a rate of 0.4-0.6% is used. Exposure is expected to be seasonal and intermittent, and of short duration depending on the size of the buildings and outdoor areas that are to be sprayed. Pre-wetting the soil with a garden hose may be required on very dry soils. All infested areas and pets present are treated with a suitable flea control product to avoid re-infestation. Fenthion is also applied as a coarse spray on walls and other areas where flies alight or congregate.

Estimate (6a,b) Open mixing/loading and hand-held spraying of ornamental plants **Scenarios 3, 18a/20b)** using the *All liquid Formulations, Open mixing and Low Pressure Handwand or Backpack*.

Spraying of ornamental trees, flowers and shrubs for the treatment of various pests is normally carried out by trained horticultural workers in both external gardens and verges and in nursery settings. The more concentrated formulation (550 g/L) is currently only available under permit for the treatment of Mealybug at a rate of 100 mL/100 L of water as a soil drench and foliar spray. The lower concentration formulation (80 g/L) is currently only available under permit for the treatment of aphids, thrips, bugs, caterpillars, grasshoppers and crickets at a rate of 5 mL/L of water as a foliar spray when pest are seen.

In Tables 9 to 13, Daily total absorbed dose (mg/kg bw/d) = Daily absorbed dermal dose (mg/kg bw/d) + Daily absorbed inhalation dose (mg/kg bw/d).

Exposure scenarios, caveats, parameters and absorbed doses for airblast spraying of fruits and vegetables are outlined in Table 9.

Table 9: Agricultural uses (fruits and vegetables) of Fenthion (550 g a.i./L), exposure scenarios and absorbed doses (airblast spraying) (mg/kg bw/d)

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (1a) Open mixing/loading/application, airblast spraying, fruits and vegetables open cab (EC 550 g/L)	1.8 L product/ha	N	0.1603	0.0203	0.0007	0.0028	0.1842
	1200 L/ha or 2500 L spray /ha	Y	0.0013	0.0136	0.0007	0.0028	0.0184
	20 ha/day 19.8 kg ai/d	Y Plus second layer clothing + respirator during M/L/A ^b	0.0005	0.0015	0.0001	0.0003	0.0023
Estimate (1b) Open mixing/loading/application, airblast spraying, fruits and vegetables enclosed cab (EC 550 g/L)	1.8 L product/ha	N	0.1603	0.0076	0.0007	0.0003	0.1689
	1200 L/ha or 2500 L spray /ha	Y	0.0013	0.0011	0.0007	0.0003	0.0034
	20 ha/day 19.8 kg ai/d	Y Plus second layer clothing + respirator during M/L ^c	0.0005	0.0011	0.0001	0.0003	0.0019

^a - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and a washable hat during application.

^b - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during mixing and loading and application.

^c - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during mixing and loading. M/L – mixer/loader. M/L/A – mixer/loader/applicator. ⁽¹⁾ Label and APVMA recommended application rate and spray volume, considered to be representative for most crops.

Exposure scenarios and absorbed doses for boom spraying of fruits and vegetables are outlined in Table 10.

Table 10: Agricultural uses (fruits and vegetables) of Fenthion (550 g/L), exposure scenarios and absorbed doses, boom spraying (mg/kg bw/d)

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (2a) Open mixing/loading/application, boomspray,, fruits and vegetables open cab (EC 550 g/L)	0.75 L product/ha	N	0.0668	0.0003	0.0003	0.0002	0.0676
	1000 L spray /ha	Y	0.0005	0.0003	0.0003	0.0002	0.0014
Estimate (2b) Open mixing/loading/application, boomspray,, fruits and vegetables enclosed cab (EC 550 g/L)	20 ha/day	N	0.0668	0.0001	0.0003	0.0000	0.0672
	8.25 kg ai/d	Y	0.0005	0.0001	0.0003	0.0000	0.0010

(1) Label and APVMA recommended application rate and spray volume, considered to be representative for boom spraying of most crops.

Exposure scenarios and absorbed doses for post-harvest – (quarantine) treatment of fruits and vegetables are outlined in Table 11.

Table 11: Agricultural uses, post-harvest (quarantine) treatment of fruits and vegetables of fenthion (550 g/L), exposure scenarios, mixer/loader exposure (mg/kg bw/d)

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE ^a	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (3) Open mixing/loading, to support quarantine treatment of fruits and vegetables (EC 550 g/L)	1400 L/day 1.05 L product/day 1 operation/day 0.5775 kg ai/d	N	0.0047	N/A	0.0000	N/A	0.0047
		Y	0.0000	N/A	0.0000	N/A	0.0001

⁽¹⁾ Information considered to be representative for quarantine treatment of fruits and vegetables (taken from the ICA documentation).

Exposure scenarios, caveats, parameters and absorbed doses for mosquito treatment of water (hand-held spraying) are outlined in Table 12. Formulations are grouped as the work rate for each is based on the amount of active ingredient used for each scenario.

Table 12: Pest control uses (mosquito treatment of water and septic tanks) of fenthion (550, 117 or 80 g/L), exposure scenarios, caveats, parameters and absorbed doses (high pressure hand wand/ backpack) (mg/kg bw/d)

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (4a) Open mixing/loading and application for septic tanks using high pressure hand wand (EC 550 g/L and EC 117 g/L)	5.75g ai / septic tank	N	0.0001	N/A	0.0000	N/A	0.0001
	3 tanks per day 17.5 g ai/d	Y	0.0000	N/A	0.0000	N/A	0.0000
Estimate (4a) Open mixing/loading and application for control of adult mosquitoes in water using high pressure hand wand. (EC 550, 117 or 80 g/L)	8.25g ai/L	N	0.0810	0.0508	0.0004	0.0249	0.1571
	10 kg ai/ha	Y	0.0007	0.0181	0.0004	0.0249	0.0440
	1 ha/day 10 kg ai/d	Y Plus second layer clothing + respirator during Application ^a	0.0001	0.0002	0.0000	0.0003	0.0006
Estimate (4a) Open Mixing/loading and application for control of larval mosquitoes in water using high pressure hand wand. (EC 550, 117 g/L)	165 g ai/ ha	N	0.0013	0.0008	0.0000	0.0004	0.0026
	1 ha/day 165 g ai/d	Y	0.0000	0.0003	0.0000	0.0004	0.0007
Estimate (4b) Open Mixing/loading and application for control of		N	0.0013	0.2258	0.0000	0.0017	0.2288
		Y	0.0000	0.1096	0.0000	0.0017	0.1113

Exposure scenario	Application and work rates⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
larval mosquitoes in water using backpack. (EC 550, 117 g/L)		Y Plus second layer clothing + respirator during M/L/A ^b	0.0000	0.0226	0.0000	0.0002	0.0228

^a - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during application.

^b - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during mixing and loading and application.

(1) Label and APVMA recommended application rate and spray volume, considered to be representative for boom spraying of most crops.

Exposure scenarios, caveats, parameters and absorbed doses for hand-held spraying of commercial and domestic areas are outlined in Table 13.

Table 13: Pest control uses (commercial and domestic areas) of fenthion (117, 80 g/L), exposure scenarios, caveats, parameters and absorbed doses (high pressure hand wand/ backpack) (mg/kg bw/d)

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (5a) Open mixing/loading and application for hand-held spraying of fleas, commercial and domestic areas using high pressure hand wand (EC 80 or 117 g/L)	42.12 g ai/10 m ² 0.1 ha/day	N	0.0033	0.0021	0.0000	0.0010	0.0065
	421.2 g ai/d	Y	0.0000	0.0007	0.0000	0.0010	0.0018
Estimate (5b) Open mixing/loading and application for hand-held spraying of fleas, commercial and domestic areas using backpack (EC 80 or 117 g/L)	42.12 g ai/10 m ² 0.1 ha/day	N	0.0034	0.5764	0.0000	0.0044	0.5842
	421.2 g ai/d	Y	0.0000	0.2798	0.0000	0.0044	0.2842
		Y Plus second layer clothing + respirator during M/L/A ^a	0.0000	0.0576	0.0000	0.0004	0.0581
Estimate (5a) Open Mixing/loading and application for hand-held spraying of spiders, ants and mosquitos, commercial and domestic areas using high pressure hand wand (EC 80 or 117 g/L)	8.19 g ai/ L/8 m ² 0.1 ha/day	N	0.0083	0.0052	0.0000	0.0025	0.0161
	1.024 kg ai/d	Y	0.0001	0.0019	0.0000	0.0025	0.0045
		Y Plus second layer clothing + respirator during Application ^b	0.0001	0.0002	0.0000	0.0003	0.0006
Estimate (5a) Open Mixing/loading and	8.19 g ai/ L/8 m ²	N	0.0083	0.0348	0.0000	0.0303	0.0734

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
application for hand-held spraying of spiders, ants and mosquitos, commercial and domestic areas using low pressure hand wand (EC 80 or 117 g/L)	0.1 ha/day	Y	0.0001	0.0205	0.0000	0.0303	0.0510
	1.024 kg ai/d	Y Plus second layer clothing + respirator during M/L/A ^a	0.0000	0.0021	0.0000	0.0030	0.0052
Estimate (5b) Open Mixing/loading and application for hand-held spraying of spiders, ants and mosquitos, commercial and domestic areas using backpack. (EC 550, 117 g/L)	8.19 g ai/ L/8 m ²	N	0.0083	1.4013	0.0000	0.0106	1.4202
	0.1 ha/day	Y	0.0001	0.6803	0.0000	0.0106	0.6910
	1.024 kg ai/d	Y Plus second layer clothing + respirator during M/L/A ^a	0.0000	0.1401	0.0000	0.0011	0.1412

^a - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during mixing and loading and application.

^b - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during application.

(1) Label and APVMA recommended application rate and spray volume, considered to be representative for mosquito treatment of water.

Estimate (6) Mixing/loading and application to ornamentals

Ornamentals, especially in nurseries are usually treated for mealybug infestation at the rate of 0.55 g a.i./L with hand-held equipment. In larger scale nursery applications, motorised pumps with hand sprayers attached are used, whereas knapsack sprayers are used for smaller applications. Label recommendations indicate drenching of the soil around plants as well as direct application to the plants, using similar methods.

Exposure scenarios, caveats, parameters and absorbed doses for hand-held spraying of ornamentals are outlined in Table 14.

Table 14: Ornamental plant uses of fenthion (550, 80 g/L), exposure scenarios, caveats, parameters and absorbed doses (low pressure hand wand/ backpack) (mg/kg bw/d)

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/ loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (6) Open mixing/loading and application for hand-held spraying of mealybug, in ornamentals using high pressure hand wand (EC 550 or 80 g/L)	0.55 g ai/L	N	0.0004	0.0019	0.0000	0.0016	0.0039
	1000 L/ha (for potted plants)	Y	0.0000	0.0011	0.0000	0.0016	0.0027
	0.1 ha/day 55 g ai/d	Y Plus second layer clothing M/L/A ^a	0.0000	0.0001	0.0000	0.0016	0.0017
Estimate (6) Open mixing/loading and application for hand-held spraying of mealybug, in ornamentals using backpack (EC 550 or 80 g/L)	0.55 g ai/L	N	0.0004	0.0753	0.0000	0.0006	0.0763
	1000 L/ha (for potted plants)	Y	0.0000	0.0365	0.0000	0.0006	0.0371
	0.1 ha/day 55 g ai/d	Y Plus second layer clothing + respirator during M/L/A ^a	0.0000	0.0075	0.0000	0.0001	0.0076

^a - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during mixing and loading and application.

(1) Label and APVMA recommended application rate and spray volume, considered to be representative for nursery treatment of potted plants.

Estimate (7) Application of paint to roost areas

Fenthion is used as paint for the control of unwanted birds in industrial and commercial premises. The product is to be used only by persons authorised by the relevant State or Territory as these are Restricted Chemical Products. Label directions must be observed during use of the product. It is applied as a paint strip 5 cm wide to 10% of favoured roost areas of pigeons, starlings, sparrows and the Indian mynah. Based on the label instruction and information from the APVMA a daily use pattern of up to 3 hours may be spent to paint roost areas. It is therefore possible that a worker may be exposed to up to 3 L of paint (1 L/h work rate). The paint product is ready to use so no mixing or loading is required. The PHED paintbrush scenario has been used to model the exposure of workers to fenthion (Table 15).

Table 15: Painting of roost areas with fenthion (110 g/L paint), exposure scenario, caveats, parameters and absorbed doses (paintbrush) (mg/kg bw/d)

Exposure scenario	Application and work rates ⁽¹⁾	Gloves and/or PPE	Mixer/loader dermal	Applicator dermal	Mixer/loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (7) Application of (110 g/L paint)	1 L/h	N	0.0000	0.1696	0.0000	0.0029	0.1725
	3 h/day	Y	0.0000	0.0222	0.0000	0.0029	0.0251
	330 g ai/d	Y Plus second layer clothing + respirator during Application ^a	0.0000	0.0170	0.0000	0.0003	0.0172

^a - Additional PPE for dermal exposure is a second layer of clothing over normal clothing and for inhalational exposure is a respirator during application.

(1) Label and APVMA recommended application rate, considered to be representative painting of roost areas plants.

Estimate (8) Application of 1% Dust Formulations

Fenthion 1% Dust Formulation is used by PCOs for the control of crawling insects in cracks and crevices, wall voids and crawl spaces for cockroaches, ants, silverfish and crickets, and in ceiling voids for spiders. As the product will be applied only by PCOs in limited quantities and the concentration of fenthion is quite low in the product, occupational exposure is likely to be low if the product is applied according to the label instructions, and safety directions observed.

Other agricultural application methods

Quarantine treatment

Post harvest exposure is expected during quarantine treatment for fruit fly control (tropical and sub-tropical fruits (inedible peel), fruiting vegetables (including cucurbits), mainly during

mixing/loading of the spray mixture. Post-harvest treatment is carried out using the following application methods; dipping, flood spraying and non-recirculating low volume sprays. Detailed quality assurance specifications for the three methods are contained in ICA*(Interstate Certification Assurance) - 01, ICA* - 02, and ICA* - 03. All operators undergo accredited training. The following is a summary of information relating to the actual application methods contained in these documents:

Flood Spray

Fruit is required to be sprayed in a single layer with a mixture containing 412.5 mg a.i./L in a high volume application of at least 16 L/minute per each square of the area being sprayed. This provides complete coverage of the fruit for a minimum of 10 seconds, after which the fruit must remain wet for not less than 60 seconds. Flood spraying should be the last treatment before packing. The spray mixture should be prepared at a minimum of every 48 hours or more frequently as required. The flood spraying facility should have a means of mixing the spray mixture in the spray tank throughout the spray operation to avoid settling or separation of the concentrate. This is achieved by mechanical mixing devices in the spray tank, or agitation from spray mixture returned via a by-pass from the spray pump. Unused spray mixture may be held overnight for use the next day, but should be thoroughly mixed for at least two minutes prior to further use. A spray 'Mixture Preparation Chart' and records of the addition of chemical to the mixture should be kept in close proximity to the flood spraying equipment to ensure the concentration of fenthion is being maintained in the spray tank. Exposure for the 'Treatment Operator' is possible during preparation of the mixture, (when the required amount of the concentrate is to be added to the spray tank using plastic or glass measuring cylinders or syringes), during top-up procedures, calibration of equipment, sampling of spray mixtures, and maintenance and cleaning of equipment.

Dips

Dipping may be carried out by manual fruit immersion or mechanical fruit feeding. It is required that fruit be fully immersed in a mixture containing 412.5 mg/L fenthion for a period of not less than 60 seconds. The dipping mixture should be prepared at a minimum of every 48 hours or more frequently as required. Periods longer than 48 hours may be considered where it can be demonstrated by analysis of the chemical mixture the ability to control and maintain concentration for a specified longer period. Certain fruits such as longan, lychee, passionfruit and rambutan may be dipped for a period of 10 seconds, after which they should remain wet for a period of not less than 60 seconds. In the treatment of paw paws, additional criteria are specified for control of philippinensis fruit fly. The papaws must be hard and must have more than 25% of their ripe coloration when assessed over their entire surface. As for flood spraying, accurate means of calibration should be provided and records of the addition of chemical to the mixture should be kept to ensure the concentration of fenthion is being maintained in the dip. Worker exposure is likely to occur during preparation of the dipping mixture (modelled in Table 11), during top-up procedures, calibration of equipment, sampling of spray mixtures, during manual immersion if there are splashes, and maintenance and cleaning of equipment.

Both types of fruit treatment are described below.

Manual Fruit Immersion

The 'Treatment Operator' should ensure that all fruit are placed in appropriate dipping containers, which may be plastic crates, wooden slatted or open metal bulk bins or perforated plastic buckets. The containers are placed in the dip ensuring that all fruit is fully immersed and that fruit does not float from containers. A mesh lid or other device may be required to ensure that all fruit remains fully immersed during dipping. After completion of the dipping process, the container is removed from the dip and the pesticide mixture allowed to drain.

Mechanical Fruit Feeding

The mechanical fruit feed equipment is designed such that the fruit remains completely immersed in the dip mixture for the required time period. Operation of equipment and volume of fruit feeding through the dip should be monitored by the Treatment Operator to ensure fruit is prevented from being pushed or carried through the dip in less than the required time period. During the dipping process it may be necessary for the Treatment Operator to top-up the dip mixture to maintain dip concentration and/or volume.

Low Volume Non-Recirculated Spraying

Low volume non-recirculated spraying with fenthion is approved for use on mangoes and avocados in some intrastate and interstate markets only. The spray and top-up mixtures are prepared according to label rates, and fruit sprayed in a single layer ensuring that the fruit is completely covered by the spray for a period of not less than ten seconds and fruit remains wet for at least another sixty seconds. The application rate is 0.6 L/minute for avocados and 1.2 L/minute for mangoes per each square metre of the area being sprayed. Low volume spraying with fenthion should be the last treatment before packing. Worker exposure is likely to occur during preparation of the mixture, during top-up procedures, calibration of equipment, sampling of spray mixtures, from possible splashes during spraying and during maintenance and cleaning of equipment.

Veterinary Application

Exposure (9) Spot-on application for cattle

No worker exposure studies were available for fenthion application to cattle and POEM modelling and PHED surrogate data are not considered applicable. A worker exposure study, (Report no. FortDodge/0001a/1, Australia 2001) using chlorfenvinphos as a hand application on cattle was conducted by industry and provided to NOHSC by the NRA. As hand application for cattle is considered to be a "worst-case scenario", the outcomes of the study are used as surrogate data to determine exposure for workers using fenthion for hand applications for cattle. The amount of active applied to cattle in the chlorfenvinphos study is similar to the fenthion label rates for spot-on application to cattle. The difference in use patterns with the chlorfenvinphos study being a backline spray verses a ready-made spot on would make the chlorfenvinphos study a conservative surrogate estimation of exposure for fenthion.

Fenthion is applied as a spot-on application for the treatment of lice in cattle. The product is supplied ready-to-use in a backpack and should only be applied with the special Spot-On Gun or Dial-a-Dose cup. The product is applied to the rump or loins of the animal in one spot, with the

amount applied based on the weight of the animal (Table 16). The product is only applied once per season when lice become evident, with further treatment depending on a re-infestation.

Table 16: Use rates of fenthion spot-on

Live weight (kg)	Dose (mL)
< 110	2.5
110 – 220	5
220 – 550	10
> 550	20

One product (Tiguvon Spot-on Cattle Lice Insecticide (200 g/L)) is applied directly of cattle (20 mL of 200 g/L fenthion per beast (maximum rate as per Table 16)). Though the volume to be applied is lower than that used in the chlorfenvinphos worker exposure study (in which 200 mL of 4 g/L chlorfenvinphos spray was applied to the backline of 200 cattle), 50 times as much active constituent is applied per animal. Dermal exposure in the cattle study was ~44 µg chlorfenvinphos per person applying the dose to cattle. Scaling up this exposure to allow for the increase in fenthion used per beast is equivalent to $44 \mu\text{g} \times 50 = 2200 \mu\text{g}$. Based on an exposure of 2200 µg, the dermal dose would be equivalent to a systemic dose of $2.8 \times 10^{-3} \text{ mg/kg bw}$ ($2200 \mu\text{g} \div 70 \text{ kg bw} \times 9\% \text{ dermal absorption} \div 1000$).

5.4 Post-application exposure

Fenthion product labels do not carry specific re-handling restrictions.

Agriculture uses

Exposure may occur in agricultural crops when workers re-enter treated crops to irrigate, weed, prune, thin or harvest crops. The type of activity, timing and frequency of re-entry activities are dependent on crop type. Potential worker exposure will be determined by factors such as the amount of chemical applied; interval between spraying and re-entry; nature and duration of the particular re-entry activity; density of foliage and spacing of crops and environmental factors that affect the breakdown of residues.

No specific exposure data or dislodgeable foliar residue data were available for fenthion, but the half-life of fenthion residues on foliar surfaces is approximately 36 hours (Tomlin C, 2003). This foliar half-life (equivalent to 33% per day) and default foliar transfer co-efficient values from the US EPA Occupational Post-Application Risk Assessment Calculator Version 1 (2000, US EPA Policy 003.1), were used to estimate post-application exposure for workers.

Harvesting of agricultural crops may be either a mechanical or a manual activity. Mechanical harvesting is not of OHS concern as no worker exposure is anticipated. Manual harvesting can result in exposure, and will depend on the quantity of residues present at the time of harvest and work practices. Timing for harvesting is governed by the WHP for harvest. This ranged from 3-14 days for vegetables and fruits, (currently 7 to 28 days).

It is reasonable to assume that workers will be required to engage in post-application activities in greenhouses for the treatment of ornamentals. Potential worker exposure will be determined by factors listed for agricultural/horticultural crops (refer above). Of particular concern is the exposure in enclosed areas where there may be delayed drying of spray, in closely packed plants resulting in extensive contact with treated foliage and the lack of adequate ventilation. These factors were considered likely to substantially increase the foliar half-life of fenthion, and a half-life of 36 hours was not considered applicable for re-entry into greenhouses.

Low post-application occupational exposure is anticipated in waterways, septic tanks, and roost areas.

Detailed exposure estimates and descriptions of very low, low, medium, high, and very high exposure activities with and without PPE for each crop type are provided in Appendix 3. Workers undertaking re-entry activities in tropical fruit crops may experience hot climatic conditions, and were considered less likely to adhere to PPE requirements for early re-entry activities.

Certain crops and tropical fruit crops in particular, did not contain any datasets in the US EPA re-entry exposure calculator. In the absence of such data, estimates for these crops were calculated by grouping them with other crops on the basis of similarity in application rate and approximate total foliar surface area. Where used, such grouping was noted (Table 20).

Pest control operators

It is uncommon for pest control operators to re-enter commercial areas post-treatment, except in certain circumstances. Registered product labels do not include a restriction on re-entering enclosed areas after treatment with fenthion. Children re-entering treated areas in domestic settings may be exposed to residues of fenthion from dermal contact and hand-to-mouth behaviour, whilst adults may be exposed by dermal contact. The major use of the product is in cracks and crevices of domestic residences where accidental exposure of the public is not expected as there is little potential for exposure to applied/residual product. However there is a possible re-entry risk to the public after application of the dust product in ceiling- or wall-voids or crawl spaces within domestic residences; this risk cannot be mitigated without wearing extensive PPE and hence these latter use patterns are not supported.

Veterinary uses

Cattle

Post-application exposure is likely for persons who may come into contact with treated animals shortly after application. No exposure data were available to assess the risk from such contact. Considering normal animal husbandry practices, significant contact with treated cattle is not anticipated. Should exceptional circumstances require workers to handle treated animals, the risk from post application exposure is expected to be substantially lower than the risk to mixer/loaders and dip/spray operators. A withholding period of 10 days for cattle treated with the Spot-On formulations are recommended before slaughter for human consumption. OCS is not the appropriate agency for assessing the risks to public health and safety from exposure to treated commodities.

5.4.1 Measured post-application exposure studies

No measured exposure data or dislodgeable foliar residue data were provided.

6. OCCUPATIONAL RISK ASSESSMENT

The occupational risk assessment takes into consideration the hazard of the chemical as determined by toxicology testing (Section 2), its use pattern in Australia (Section 3) and worker exposure for each exposure scenario (Section 5). In order to adequately determine the risk associated with the use of fenthion, margins of exposure (MOE) were calculated by comparing the most appropriate NOEL with exposure values obtained from surrogate data (PHED). A qualitative risk assessment was conducted where suitable models or surrogate data was not identified.

The main adverse health effect of fenthion exposure is cholinesterase inhibition. The most appropriate NOEL to assess short and long-term occupational risk to workers was determined to be 0.02 mg/kg bw/d, established in a 4-week human dietary study (Section 4.2). A dermal absorption adjustment of 9% was used in the risk assessment (Section 4.3). No correction was made for inhalation absorption, as 100% absorption was assumed (Section 4). As the NOEL is from a human study a MOE of ≥ 10 to allow for diversity within human populations will be considered as acceptable.

Due to the presence of excipients, products containing fenthion were considered to be slight skin irritants. This topical effect may manifest in workers who come into contact with fenthion products. The potential for topical effects when in contact with the working strength solutions is likely to be governed by the concentration of the product in the spray/solution in each case. In estimating the risk to workers handling fenthion products, it is assumed that workers wear appropriate PPE, as specified on product labels.

6.1 Risk from end use exposure

Fruits/Vegetables

Fenthion is registered for control of fruit fly both as field and post-harvest treatments. Fruits and vegetables may be treated with fenthion at 14-day intervals if required, depending on the crop and level of infestation. It is anticipated that in most instances mixing/loading and spray application will be carried out by the farmers or farm employees.

Workers are required to open containers, measure the required quantity of product and mix it with the appropriate amount of water often within the spray tank of the application equipment. Fenthion application to crops is mainly by airblast or misters. These are either used as high volume applicators or adjusted for concentrate or semi-concentrate spraying. Boomsprayers are used for the treatment of various pests in capsicums and cucurbits. The amount of chemical applied as a foliar spray depends on plant size, with higher rates being used for advanced crops. In all crops, the concentration of the active constituent in the spray varies between 0.04-0.08%.

The risk associated with mixing/loading and application by airblast spraying (Estimate 1) is shown in Table 17.

Table 17: Risk associated with mixing/loading, and application by airblast spraying

Exposure scenario	Gloves and/or PPE ^a	MOE Mixer/loader dermal	MOE Applicator dermal	MOE Mixer/loader Inhalation	MOE Applicator Inhalation	Total MOE ¹
Estimate (1a) Open mixing/loading/application, airblast spraying, fruits and vegetables open cab (EC 550 g/L)	N	0	1	27	7	0
	Y	16	1	27	7	1
	Y Plus second layer clothing + respirator during M/L/A	43	14	267	71	9
Estimate (1b) Open mixing/loading/application, airblast spraying, fruits and vegetables enclosed cab (EC 550 g/L)	N	0	3	27	71	0
	Y	16	19	27	71	6
	Y Plus second layer clothing + respirator during M/L	43	19	267	71	11

^a - Additional PPE for dermal exposure is an additional pair of overalls and a washable hat, while PPE for inhalational exposure is a respirator. M/L – mixer/loader. M/L/A – mixer/loader/applicator.

⁽¹⁾ MOE = NOEL (0.02 mg/kg bw/d) ÷ daily total absorbed dose (mg/kg bw/d).

Surrogate data modelling revealed unacceptable MOE values for open mixing and loading and airblast application for all scenarios with an open cab when applying the spray (550 g/L formulation). The addition of significant PPE including a second layer of clothing over normal clothes, a washable hat and a full face piece respirator, during mixing and loading and application was unable to mitigate this exposure to levels that result in an acceptable MOE. When applying the 550 g/L formulation with an enclosed cab and open mixing and loading an acceptable MOE was only achieved when the mixer and loader wore a second layer of clothing over normal clothes, a washable hat and a full face piece respirator. The OCS does not recommend the continued support of open cab airblast application to fruit and vegetables through registration or permits.

The risk associated with mixing/loading and application by boom spraying (Estimate 2) is found in Table 18.

Table 18: Risk associated with mixing/loading, and application by boom spraying

Exposure scenario	Gloves and/or PPE ^a	MOE Mixer/loader dermal	MOE Applicator dermal	MOE Mixer/loader Inhalation	MOE Applicator Inhalation	Total MOE ¹
Estimate (2a) Open mixing/loading/application, boomspray,, fruits and vegetables open cab (EC 550 g/L)	N	0	60	64	104	0
	Y	37	61	64	104	15
Estimate (2b) Open mixing/loading/application, boomspray,, fruits and vegetables enclosed cab (EC 550 g/L)	N	0	170	64	1790	0
	Y	37	168	64	1790	20

^a - Additional PPE for dermal exposure is an additional pair of overalls and a washable hat, while PPE for inhalational exposure is a respirator. M/L – mixer/loader. M/L/A – mixer/loader/applicator.

⁽¹⁾ MOE = NOEL (0.02 mg/kg bw/d) ÷ daily total absorbed dose (mg/kg bw/d).

Surrogate data modelling revealed acceptable MOE values for open mixing and loading and ground-boom application for all scenarios with an open or enclosed cab when applying the spray (550 g/L formulation) with the addition of gloves while mixing and loading and application.

The risk associated with mixing/loading for post-harvest (quarantine) treatment of fruits and vegetables is found in Table 19.

Table 19: Risk associated with mixing/loading, for post-harvest (quarantine) treatment of fruits and vegetables (Open mixing and loading only)

Exposure scenario	Gloves and/or PPE ^a	MOE Mixer/loader dermal	MOE Applicator dermal	MOE Mixer/loader Inhalation	MOE Applicator Inhalation	Total MOE ¹
Estimate (3) Open mixing/loading, to support quarantine treatment of fruits and vegetables (EC 550 g/L)	N	4	N/A	916	N/A	4
	Y	532	N/A	916	N/A	336

⁽¹⁾ MOE = NOEL (0.02 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d). N/A not applicable.

Surrogate data modelling found an acceptable MOE values for mixing/loading when open pouring from the 550 g/L formulation when the worker is wearing gloves.

Water and Septic tanks

Treatment of stagnant water with fenthion is carried out using high volume hand-held sprayers attached to motorised pumps mounted on either four wheel drives or ATVs and knapsack sprayers. Exposure is anticipated when workers open containers, measure the required quantity of product, and mix it with the appropriate amount of water, often within the spray tank of the application equipment. For hand-held spraying, it is assumed that fenthion will be mixed in a 400 L spray tank. based on advice from the APVMA, the work rate was 1 ha/day and the diluted spray rates were 1250 L/ha. Surrogate data modelling was used to estimate worker exposure.

For the treatment of septic tanks worker exposure is anticipated when the workers open the container, measure the required quantity (4.68 – 5.75 g a.i./tank), and dispense the product. No dilution is carried out. Surrogate data modelling was used to estimate exposure during the opening and pouring the product only as there was no model for direct ‘flushing’ into septic tanks. The risk associated with mixing/loading and treatment of water using hand-held equipment (Exposure 4) is found in Table 20.

Table 20: Risk associated with mixing/loading and treatment of water by hand-held equipment (high pressure hand wand and backpack)

Exposure scenario	Gloves and/or PPE ^a	MOE Mixer/loader dermal	MOE Applicator dermal	MOE Mixer/loader Inhalation	MOE Applicator Inhalation	Total MOE ¹
Estimate (4a) Open mixing/loading and application for septic tanks (EC 550 g/L and EC 117 g/L)	N	141	N/A	30240	N/A	141
	Y	17546	N/A	30240	N/A	11103
Estimate (4a) Open mixing/loading and application for control of adult mosquitoes in water using high pressure hand wand. (EC 550, 117 or 80 g/L)	N	0	0	53	1	0
	Y	31	1	53	1	0
	Y Plus second layer clothing + respirator during M/L/A	85	10	529	8	4
Estimate (4a) Open Mixing/loading and application for control of larval mosquitoes in water using high pressure hand wand. (EC 550, 117 g/L)	N	15	24	3207	49	8
	Y	1861	67	3207	49	28
Estimate (4b) Open Mixing/loading and application for control of larval mosquitoes in water using backpack. (EC 550, 117 g/L)	N	15	0	3207	12	0
	Y	1861	0	3207	12	0
	Y Plus second layer clothing + respirator during M/L/A	5129	1	32073	117	1

⁽¹⁾ MOE = NOEL (0.02 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d). N/A = not applicable. PPE: Mixers, loaders, and applicators wearing gloves, an additional layer of overalls over normal clothing, and a washable hat.

Unacceptable MOEs were obtained for mixer/loaders and application of fenthion for control of adult mosquitoes using a high pressure handwand; the addition of significant PPE including a second layer of clothing over normal clothes, a washable hat and a full face piece respirator, during mixing and loading and application was unable to mitigate the risk posed via this method. Exposure was acceptable for mixing/loading and application for control of mosquito larvae when using high pressure hand wand equipment, provided that workers wore gloves. The use of backpack for both adult (data not shown) and larval mosquito control were unacceptable despite the

addition of significant PPE including a second layer of clothing over normal clothes, a washable hat and a full face piece respirator, during mixing and loading and application. The OCS does not support the use of fenthion for control of adult mosquitos and the use of equipment carried on the back for water treatment.

Commercial and domestic areas

Workers treating various commercial and domestic areas for fleas, spiders, ants and mosquitos are likely to be exposed when opening containers, measuring the required amount, diluting the product and loading the spray tank. Treatment is carried out using hand-held equipment, which is usually, hand-held sprayers attached to motorised pumps mounted on the backs of trucks or vans or carried on the back of the operator.

The risk associated with mixing/loading and treatment of commercial and domestic areas using hand-held equipment including high pressure hand wand and backpack (Estimate 5) is shown in Table 21.

Table 21: Risk associated with mixing/loading and treatment of commercial and domestic areas by hand-held equipment (High and low pressure hand wand and backpack)

Exposure scenario	Gloves and/or PPE ^a	MOE Mixer/loader dermal	MOE Applicator dermal	MOE Mixer/loader Inhalation	MOE Applicator Inhalation	Total MOE ¹
Estimate (5a) Open mixing/loading and application for hand-held spraying of fleas, commercial and domestic areas using high pressure hand wand (EC 80 or 117 g/L)	N	6	10	1284	20	3
	Y	745	27	1284	20	11
Estimate (5b) Open mixing/loading and application for hand-held spraying of fleas, commercial and domestic areas using backpack (EC 80 or 117 g/L)	N	6	0	1256	5	0
	Y	729	0	1256	5	0
	Y Plus second layer clothing + respirator during M/L/A	2009	0	12564	46	0
Estimate (5a) Open Mixing/loading and application for hand-held spraying of spiders, ants and mosquitos, commercial and domestic areas using high pressure hand wand (EC 80 or 117 g/L)	N	2	4	517	8	1
	Y	300	11	517	8	4
	Y Plus second layer clothing + respirator during Application	300	99	517	79	36
Estimate (5a) Open Mixing/loading and application for hand-held spraying of spiders, ants and mosquitos, commercial and domestic areas using low pressure hand wand (EC 80 or 117 g/L)	N	2	1	517	1	0
	Y	300	1	517	1	0
	Y Plus second layer clothing + respirator during M/L/A	827	10	5168	7	4
Estimate (5b) Open Mixing/loading and application for hand-held spraying of spiders, ants and mosquitos, commercial and domestic areas using backpack. (EC 550, 117 g/L)	N	2	0	517	2	0
	Y	300	0	517	2	0
	Y Plus second layer clothing + respirator during M/L/AI	827	0	5168	19	0

⁽¹⁾ MOE = NOEL (0.02 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d). PPE: Mixers, loaders, and applicators wearing gloves, an additional layer of overalls over normal clothing, and a washable hat.

Unacceptable MOE estimates were obtained using PHED modelling data for all back pack applications. An acceptable MOE for flea treatment with fenthion was reached for open mixing and loading and application using a high pressure handwand when gloves were worn. For the higher use rate treatment of spider, ants and mosquitos in commercial and domestic areas with open mixing and loading and use of high pressure handwand equipment an acceptable MOE could only be achieved with the addition of significant PPE including a second layer of clothing over normal clothes, a washable hat and a full face piece respirator, during application. The use of low pressure hand wand equipment was not acceptable even with the use of extensive PPE. The OCS does not support the use of fenthion via equipment carried on the back of the user for any commercial or domestic area. The use of fenthion via hand wand for commercial and/or domestic areas for the control of fleas and spider, ants and mosquitos is only supported with the use of high pressure equipment and PPE as outlined above. The use of extensive PPE precludes the use of fenthion EC formulations for the control of spider, ants and mosquitos by domestic users.

Ornamentals

Workers treating ornamentals in nursery settings for mealybug are likely to be exposed when opening containers, measuring the required amount, diluting the product and loading the spray tank. Treatment is carried out using hand-held equipment, which is usually, hand-held sprayers attached to motorised pumps mounted on the backs of trucks or vans or carried on the back of the operator.

The risk associated with mixing/loading and treatment of commercial and domestic areas using hand-held equipment including high pressure hand wand and backpack (Estimate 6) is shown in Table 22.

Table 22: Risk associated with mixing/loading and treatment of ornamentals by hand-held equipment (high pressure hand wand and backpack)

Exposure scenario	Gloves and/or PPE ^a	MOE Mixer/loader dermal	MOE Applicator dermal	MOE Mixer/loader Inhalation	MOE Applicator Inhalation	Total MOE ¹
Estimate (6a) Open mixing/loading and application for hand-held spraying of mealybug, in ornamentals using low pressure hand wand (EC 550 or 80 g/L)	N	45	11	9622	12	5
	Y	5583	18	9622	12	7
	Y Plus second layer clothing M/L/A	15388	178	9622	12	11
Estimate (6b) Open mixing/loading and application for hand-held spraying	N	45	0	9622	35	0
	Y	5583	1	9622	35	1

Exposure scenario	Gloves and/or PPE ^a	MOE Mixer/loader dermal	MOE Applicator dermal	MOE Mixer/loader Inhalation	MOE Applicator Inhalation	Total MOE ¹
of mealybug, in ornamentals using backpack (EC 550 or 80 g/L)	Y Plus second layer clothing + respirator during M/L/A	15388	3	96218	350	3

⁽¹⁾ MOE = NOEL (0.02 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d). PPE: Mixers, loaders, and applicators wearing gloves, an additional layer of overalls over normal clothing, and a washable hat.

Unacceptable MOE estimates were obtained using PHED modelling data for back pack application. An acceptable MOE was obtained for mealybug treatment in ornamentals with fenthion for open mixing and loading and application using a high pressure handwand when a second layer of clothing over normal clothes, a washable hat and gloves were worn during mixing and loading and application. The OCS does not support the use of fenthion *via* equipment carried on the back of the user for treatment of ornamentals. The use of fenthion *via* hand wand for ornamentals for the control of mealybug is only supported with the use of PPE as outlined above.

Paint to roost areas

Workers treating roost areas of pest avian species pigeons, starlings, sparrows and the Indian mynah are likely to be exposed when opening containers, and applying the paint. Treatment is carried out using hand-held paint brushes or rollers.

The risk associated with mixing/loading and treatment of commercial and domestic areas using hand-held equipment including high pressure hand wand and backpack (Estimate 7) is shown in Table 23.

Table 23: Painting of roost areas with fenthion (110 g/L), exposure scenario, caveats, parameters and absorbed doses (paintbrush) (mg/kg bw/d)

Exposure scenario	Gloves and/or PPE ^a	Mixer/loader dermal	Applicator dermal	Mixer/loader Inhalation	Applicator Inhalation	Total Exposure
Estimate (7) Application of paint (110 g/L)	N	N/A	0	N/A	7	0
	Y	N/A	1	N/A	7	1
	Y Plus second layer clothing + respirator during Appl	N/A	1	N/A	69	1

⁽¹⁾ MOE = NOEL (0.02 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d). N/A = not applicable. PPE: Mixers, loaders, and applicators wearing gloves, an additional layer of overalls over normal clothing, and a washable hat.

Unacceptable MOE estimates were obtained using PHED modelling data for painting application. The addition of a second layer of clothing over normal clothes, a washable hat, gloves and respirator were worn during application was unable to mitigate the risk posed through dermal exposure to fenthion. The OCS does not support the use of fenthion *via* paint brush/roller for roost areas of pigeons, starlings, sparrows and Indian mynahs.

Spot-on application for cattle

From the surrogate exposure estimate (Estimate 9) where a direct substitution of fenthion for chlorfenvinphos was performed, a 44 µg dermal dose would be equivalent to a systemic dose of 2.8×10^{-3} mg/kg bw ($2200 \mu\text{g} \div 70 \text{ kg bw} \times 9\% \text{ dermal absorption} \div 1000$). Using the NOEL for fenthion in a human oral repeat dose study of 0.02 mg/kg bw/d, a MOE of 7 ($0.02 \div 2.8 \times 10^{-3}$) is obtained. No mixing and loading is necessary due to the product being sold in the end use form.. A MOE of 10 is considered acceptable, based on the use of a human study. On the basis of the unacceptable MOE, there is a requirement to wear chemical resistant gloves when applying the product. This condition on the use pattern, which is already on the label, would lead to the continued OCS conclusion of no objection to the continued use of this product in cattle when applied as a spot-on according to label instructions.

6.2 Risk from post-application exposure

Margins of exposure and re-entry intervals for various crops with-and-without personal protective equipment is shown in Table 24. Detailed tables of the exposure estimates are provided in Appendix 3.

Table 24: Re-entry intervals and Margins of Exposure (MOE \geq 10 required)

Crop	VL	L	M	H
<i>Grapefruit, lemons, mangoes, oranges, papaya, avocado, sapote¹, guava¹, breadfruit¹, jackfruit¹, durian¹, tamarind¹, longan¹, lychee¹, persimmon¹, feijoa¹, loquats¹, mangosteen¹, sapodilla¹, rambutan¹: 1.03 kg a.i./ha</i>				
Day	1	6	9	11
MOE	10	10	11	10
<i>Grapefruit, lemons, mangoes, oranges, papaya, avocado, sapote¹, guava¹, breadfruit¹, jackfruit¹, durian¹, tamarind¹, longan¹, lychee¹, persimmon¹, feijoa¹, loquats¹, mangosteen¹, sapodilla¹, quince¹, rambutan¹: 1.03 kg a.i./ha.,</i>				
Day	0	1	3	6
MOE	94	14	10	13
<i>Bananas: 1.03 kg a.i./ha</i>				
Day	-	1	7	8
MOE	-	14	12	11
<i>Bananas: 1.03 kg a.i./ha, with PPE*</i>				
Day	-	0	1	2
MOE	-	94	10	10
<i>Apples, apricots, figs, nectarines, peaches, pears, plums/prunes, pomegranates: 1.306 kg a.i./ha</i>				
Day	1	7	-	10
MOE	11	12	-	13
<i>Apples, apricots, figs, nectarines, peaches, pears, plums/prunes, pomegranates 1.306 kg a.i./ha, with PPE</i>				
Day	0	1	-	4
MOE	74	11	-	12
<i>Capsicums & chilli peppers: 1.03 kg a.i./ha</i>				
Day	-	5	5	6
MOE	-	14	14	10
<i>Capsicums & chilli peppers: 1.03 kg a.i./ha, with PPE</i>				
Day	-	0	0	1
MOE	-	19	13	14
<i>Pineapple: 1.03 kg a.i./ha</i>				
Day	-	3	5	6
MOE	-	10	13	10
<i>Pineapple: 1.03 kg a.i./ha, with PPE</i>				
Day	-	0	0	1
MOE	-	29	17	13
<i>Grapes, passionfruit: 1.03 kg a.i./ha</i>				
Day	-	-	6	10
MOE	-	-	10	10
<i>Grapes, passionfruit: 1.03 kg a.i./ha, with PPE</i>				
Day	-	0	1	5
MOE	-	18	14	14

*Cotton overalls and gloves, 90% reduction in exposure. VL, L, M, and H denote 'very low', 'low', 'medium', and 'high' exposure re-entry activities, respectively (see Appendix 3 for more information). ¹ denotes crops that did not contain datasets in the US EPA re-entry exposure calculator, and were instead grouped with other crops on the basis of similarity in application rate and approximate total foliar surface area. Due to a relatively high dissipation rate of 33% per day, there was no significant impact on exposures from repeat applications to crops on e.g. weeks 6, 4, 3, 2, and 1 prior to harvest (data not shown).

Foliar half life in greenhouses was considered likely to be significantly higher than in outdoors settings due to sheltering from wind, sunlight, and rain. There was also insufficient information on foliar half-life and application rates for use on ornamental crops. Thus, a re-entry period could not be determined for workers undertaking re-entry activities in greenhouses. Re-entry periods for ornamentals were therefore not calculated.

Cattle

Product labels do not include a re-handling restriction.

Significant contact with treated cattle is not anticipated. Should circumstances require workers to handle treated animals, the risk from post-application exposure is expected to be substantially lower than the risk to mixer/loaders. Therefore, it is determined that post-application exposures do not appear to pose an unreasonable risk to workers handling treated animals, as long as contact is not permitted for one day after application of fenthion.

Risk management

Re-entry into treated crops

To minimise risk to re-entry workers it is recommended that re-entry workers should enter only after days specified in Table 24. MOE values were estimated to be unacceptable in certain high exposure activities for up to 11 days in certain crops. Although high exposure re-entry activities such as harvesting were unacceptable up until day 6 after application even when wearing additional PPE, the WHP for all crops is at least 7 days. Workers undertaking harvesting activities from day 7 onward were therefore considered to be protected if wearing additional re-entry PPE.

The following re-entry statement is recommended:

Restricted-entry statement: For capsicums & chilli peppers, and pineapple crops, do not allow entry into treated areas prior to 6 days. For banana crops, do not allow entry into treated areas prior to 8 days. For apples, stonefruit, cherries, pears, pomegranate, grapes, kiwi, and passionfruit crops, do not allow entry into treated areas prior to 10 days. For citrus, mangoes, papaya, avocado, sapote, guava, breadfruit, jackfruit, durian, tamarind, longan, lychee, persimmon, feijoa, loquats, mangosteen, sapodilla, quince, and rambutan crops, do not allow entry into treated areas prior to 11 days. If early re-entry is required wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

6.3 First AID Instructions and Safety directions

The existing First Aid Instructions and Safety Directions for Australian products containing fenthion are shown below. No amendments were considered necessary.

Fenthion in home garden preparations

<i>Code</i>	<i>First Aid Instruction</i>
a	If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126, New Zealand 0800 764 766.

Fenthion in other preparations when included in Schedule 5

<i>Code</i>	<i>First Aid Instruction</i>
a	If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126, New Zealand 0800 764 766.

Fenthion in other preparations when included in Schedule 6

<i>Code</i>	<i>First Aid Instruction</i>
m	If swallowed, splashed on skin or in eyes, or inhaled, contact a Poisons Information Centre (Phone eg Australia 131126; New Zealand 0800 764 766) or a doctor at once. Remove any contaminated clothing and wash skin thoroughly. If swallowed, activated charcoal may be advised. Give atropine if instructed.

Emulsifiable Concentrates (ECs)

There are currently three EC products available for professional or domestic use, which contain either 80, 117, or 550 g a.i./L fenthion as the active constituent, the 550 and 80 g/L formulations are only available under permit conditions. They are currently in Schedule 6 for preparations containing 60 percent or less of fenthion, with a cut-off to Schedule 5 for preparations containing 10 percent or less. All but the 80 g/L home garden product contain xylene as an excipient. For commercial agricultural applications, they can be used as a concentrated spray at no greater than 2-4%. For outdoor or subfloor insect control, they are used at approximately 4-8%. Directions for the HG EC 125 g/L or less in xylene 750 g/L or less entry are based on qualitative risk assessment and hazard only, and require updating based on the OHS assessment above. While the hazard profile of the HG EC 125 g/L or less in xylene 750 g/L product would not preclude its use by domestic users, the risk assessment above placed unrealistic PPE requirements for these users, therefore the OCS does not support the continued registration of this product for home/garden use. Based on a consideration of hazard and from OHS assessment for risks from systemic exposures, the following Safety Directions were considered to be appropriate:

Amended entry

EC 600 g/L or less in xylene 350 g/L or less	
130 133	Poisonous if swallowed
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
190	Repeated minor exposure may have a cumulative poisoning effect
220 223	Do not inhale spray mist
279 281 290 292d 294c	When preparing spray wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and elbow-length chemical resistant gloves
279 280 286, 290 292d 294c 301 307	When opening the container and pouring large quantities, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, elbow-length chemical resistant gloves and a full facepiece respirator with organic vapour cartridge
289 290 292d 294c	If applying by hand, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and elbow-length chemical resistant gloves
340 342	If product on skin, immediately wash area with soap and water
340 343	If product in eyes, wash it out immediately with water
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 362 366	After each day's use, wash gloves, face shield and contaminated clothing

Delete entry

Delete entry from the FAISD as Home/Garden use is no longer supported.

HG EC 125 g/L or less in xylene 750 g/L or less	
129 132 133	Harmful if inhaled or swallowed
160 162 164	May irritate the eyes and skin
210 211	Avoid contact with the eyes and skin
220 223	Do not inhale spray mist
279 283 290 292d 312	When using the product, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and rubber gloves
340 342	If product on skin, immediately wash area with soap and water
340 343	If product in eyes, wash it out immediately with water

350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 366	after each day's use, wash gloves and contaminated clothing

Delete entry

Delete entry from the FAISD as no products of this type are currently registered

HG EC 125 g/L for aqueous formulations with surfactant 50 g/L or less	
129 132 133	Harmful if inhaled or swallowed
220 223	Do not inhale spray mist
279 283 290 292d 312	When using the product, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and rubber gloves
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water

Liquid Concentrates (LCs)

There is currently one LC containing 200 g/L fenthion as the active constituent and it is in Schedule 6 of the SUSDP. The product is a veterinary spot-on ectoparasiticide for treating beef and dairy cattle (Tiguvon® SPOTTON® Cattle Lice Insecticide), which is supplied in a backpack and is applied with a Spot-on Gun or Dial-a-Dose cup, which is also supplied. The product label specifies a withholding period of 10 days for meat and states that the product should not be used on lactating cows where the milk or milk products are intended for human consumption.

With regard to this product, there is a potential for hand exposure to occur. Based on the OHS risk assessment for fenthion, no PPE would be required (Section 6.1, Applications, Exposure 9, Spot-on for Cattle). However, considering that the hazard statements for the product are based on a consideration of the toxicity of the non-active constituents and the mode of application, elbow-length chemical resistant gloves were considered appropriate.

Amended entry

LC SA 270 g/L or less	
129 131 133	Harmful if absorbed by skin contact or swallowed
160 162 164	May irritate the eyes and skin
210 211	Avoid contact with eyes and skin
190	Repeated minor exposure may have a cumulative poisoning effect
279 283 290 294c	When using the product, wear elbow-length chemical resistant gloves
340 343	If product in eyes, wash it out immediately with water
340 342	If product on skin, immediately wash area with soap and water
351	Wash hands after use
360 361	After each day's use, wash gloves

Pastes (PA)

There are two PA products containing 110 g/kg fenthion as the active constituent (Avigel Pest Bird Control Agent and Avigrease Pest Bird Eradication Compound). These products are in schedule 6 of the SUSDP and are available only to authorised persons for bird control in industrial and commercial premises. Based on a consideration of the hazard of the product, and the occupation risk assessment the use of these products is not supported by the OCS.

Delete: Existing entry

Delete entry from the FAISD as use pattern is no longer supported

PA 120 g/kg or less in grease	
129 133	Harmful if swallowed
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
290 312	Wear rubber gloves
351	Wash hands after use
360 361	After each day's use, wash gloves

Dusts (DUs)

There is a single DU formulation available to licensed pesticide operators to control crawling insects in cracks and crevices. (Amalgamated Pest Control Fenthion 1% Dust Insecticide).

Amended entry

DU 15 g/kg or less	
120 129 133	Product harmful if swallowed
210 211	Avoid contact with eyes and skin
220 221	Do not inhale dust
279 283 290 294c 315 302	When using the product wear elbow-length chemical resistant gloves and a disposable respirator with dust cartridge or canister
351	Wash hands after use
360 361	After each day's use, wash gloves

Existing Safety Directions as they appear in the FAISD handbook contain an entry for AL 110 g/L in xylene 70 g/L or less (AL = other liquid formulations). As there are no longer any of this type of product registered for use in Australia, this entry is no longer considered appropriate and should be deleted from the FAISD handbook.

Delete entry

Delete entry from the FAISD as there are no currently registered products of this formulation type.

AL 110 g/L in xylene 70 g/L or less	
129 133	Harmful if swallowed
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
279 280 283 290 292b 294	When opening the container and using the product wear cotton overalls buttoned to the neck and wrist and PVC gloves
351	Wash hands after use
360 361 366	After each day's use, wash gloves and contaminated clothing

7. OHS ASSESSMENT FINDINGS

7.1 Overview

All registered uses of fenthion in Australia were considered, and exposures estimated where possible.

Australian use pattern information was insufficient to conduct a quantitative risk assessment for some exposure scenarios. Given the lack of measured exposure data for a majority of uses, surrogate data (PHED) was used where possible. It is generally accepted that surrogate data are adequate for estimating occupational exposure and establishing risk-mitigation measures to protect health and safety.

Detailed outcomes for each use are presented below.

7.2 Worker exposure during mixing/loading and application

For all emulsifiable concentrate formulations containing fenthion, it is recommended that products are packaged only in wide neck containers and that workers not apply EC products by backpack equipment.

Fruits and Vegetables (EC formulations)

No exposure data were available for this use and exposure estimates used surrogate data from PHED for professional users; unacceptable MOE values ($MOE < 10$) were obtained for mixing/loading, and applying fenthion by open cab airblast at work rates of 20 hectares per day and personal protective equipment could not reduce risks to workers to acceptable levels ($MOE > 10$) for open-cab airblast application for the 550 g/L formulation. Use of cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, a half facepiece respirator and elbow-length chemical resistant gloves

In the case of estimating exposure from groundboom applications, PHED surrogate data provided options to select an open or closed cab system, and the datasets in which the data were based contained an acceptable number and quality of replicates. Based on PHED surrogate data, open mixing/loading and application by open-cab groundboom systems are supported on the condition that the Safety Directions are adhered to.

Due to differences in the amount of active constituent being prepared, mixing/loading for groundboom application did not require a respirator to adequately mitigate risks whereas mixing/loading for airblast application with the 550 g/L formulation did. Given uncertainties regarding differences in work rates between airblast and groundboom spraying, and the problem of distinguishing mixing/loading for a particular application method in the Safety Directions, the requirement to wear a respirator for mixer/loaders preparing spray for groundboom application was considered reasonable.

It is recommended that the use of emulsifiable concentrate formulations containing fenthion for the control of insect pests on fruits and vegetables is supported, on the condition that:

When preparing spray, users wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and elbow-length chemical resistant gloves.

When opening the container and pouring large quantities, users wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, elbow-length chemical resistant gloves and a full facepiece respirator with organic vapour cartridge.

Closed cab systems fitted with appropriate pesticide filters are used when applying the product by airblast.

Ornamentals (EC 550 and 80 g/L formulations)

Adequate information was available to determine the use pattern of fenthion in the nursery industry and potential worker exposure during this use. PHED surrogate data indicated that open mixing/loading and application by low pressure handwand systems are acceptable with the addition of an additional layer of overalls during mixing /loading and application. Based on the PHED surrogate data the use of equipment carried on the back of the user was not supported.

Of concern is the hand spraying of plants in enclosed spaces such as greenhouses. Further information on use and work practices is required in order to determine the risk to workers involved in treating nursery plants and ornamentals and in re-entry to greenhouses. At this stage application to ornamental plants is not supported.

It is recommended that:

- Use of products containing fenthion for control of mealybugs on ornamental plants is no longer supported.

Water, septic tanks for mosquito control (EC formulations)

Exposure estimates obtained from surrogate data models were used to obtain an estimate of worker exposure for mixer/loaders and applicators when using products for the control of mosquito larvae by high pressure hand wand. These were found to be acceptable, provided that mixer/loaders and applicators wore gloves. In contrast, the level of risk to workers using the products to control adult mosquitoes was unacceptable (≤ 10), and additional PPE could not adequately mitigate this risk by hand application methods. Based on the PHED surrogate data the use of equipment carried on the back of the user was not supported

It is recommended that:

- When using products for the control of mosquito larvae, mixer/loaders and applicators wear gloves and apply the product by high-pressure spray equipment if applying by handspray.
- Use of EC products by handspray for the control of adult mosquitoes is no longer supported, based on an acceptable level of risk to the health of workers.

- Use of EC products for the control of adult mosquitoes and larvae in septic tanks is acceptable, based on qualitative risk assessment.
- Do Not use equipment carried on the back of the user.

Commercial and domestic areas (EC and dust formulations)

Surrogate data modelling was used to estimate worker exposure during mixing/loading and application by hand spray. Unacceptable MOEs were obtained for workers using hand held equipment for the treatment of fleas, spiders, ants and mosquitos in commercial and domestic areas using backpack equipment with the EC products and the use of commonly available PPE could not satisfactorily mitigate this risk. Use of high pressure hand wand was acceptable for treatment of fleas when gloves were worn, however, for the higher use rate for spiders, ants mosquitos an additional layer of overalls and a respirator were required during application to achieve adequate MOEs.

Therefore, the risk to workers is considered to be unacceptable and applications by equipment carried on the back of the worker for commercial and domestic pest-control uses is not supported. On the basis of risk assessment, the use of EC products by domestic users for insect and pest control is not supported based on the need to use high pressure hand wand equipment and extensive PPE not generally available in the domestic situation.

However, Fenthion 1% Dust Formulation for the control of crawling insects in cracks and crevices will be applied only by commercial operators in limited quantities and the concentration of fenthion is very low in the product; this use of dust formulation is acceptable based on qualitative OHS risk assessment.

The use of 1% dust formulation by commercial operators in domestic residence ceiling voids, wall voids and crawl spaces is not supported due to an unacceptable risk to members of the public from re-entry to these treated spaces.

It is recommended that:

- Use of emulsifiable concentrate products containing fenthion for control of fleas, flies, spiders, and ants in commercial and domestic areas be restricted to professional pest operators, on the basis of unacceptable risks to the health of domestic users. The use by professional operators should be restricted to the use with high pressure handwand.
- Do Not use of equipment carried on the back of the user
- Use of dust formulation products containing fenthion for control of crawling insects in cracks and crevices is supported, provided that pest control officers wear elbow-length chemical resistant gloves and a disposable respirator.
- Use of dust formulation products containing fenthion for control of crawling insects in wall voids and crawl spaces and spiders in ceiling voids is not supported due to an unacceptable risk to members of the public from re-entry to these treated spaces.

Post harvest treatment – Quarantine (EC 550 formulations)

When mixers/loaders were wearing gloves, acceptable MOEs were obtained for workers mixing/loading fenthion (550 g a.i./L) for treatment of fruits and vegetables using surrogate data modelling. On the basis of a qualitative risk assessment, applicators are required to wear gloves and overalls during dipping or spray activities.

It is recommended that:

- Use of products containing fenthion for post harvest treatment of fruits and vegetables is supported, provided that mixers/loaders and applicators wear gloves, and applicators also wear overalls.

Bird repellent (paint formulations)

On the basis of surrogate data modelling the application of fenthion as a ready to use paint formulation to roosting areas of pest bird species are unacceptable ($MOE \leq 10$), and additional PPE could not adequately mitigate this risk to workers.

It is recommended that:

- Use of products containing fenthion for control of pest avian species in roosting areas is no longer supported.

Ectoparasiticide use (LC formulations)

Cattle

Fenthion is supplied as ready to use spot-on formulation for use in cattle. Surrogate data modelling using a worker exposure study to chlorfenvinphos was used to determine the extent of exposure to fenthion via this use pattern. An unacceptable MOE (7) was obtained using surrogate data modelling however this would be expected to be increased due to:

- (i) the packaging of the chemical will result in intermittent and negligible worker exposure;
- (ii) normal work practices, including the use of special Spot-On Gun or Dial-a-dose cup when applying the product from a backpack; and
- (ii) PPE specified on product labels (chemical resistant gloves),

It is recommended that:

- The risk to workers during use of spot-on application is acceptable, provided elbow length chemical resistant gloves are worn.

7.2.1 Exposure mitigation methods

Further risk-mitigation measures discussed in Section 7.2 are specified in Safety Directions provided in Section 8 below.

7.3 Post-application exposure

The following re-entry statements are recommended based on the risk assessment:

Restricted-entry statement: For capsicums & chilli peppers and pineapple crops, do not allow entry into treated areas prior to 6 days. For banana crops, do not allow entry into treated areas prior to 8 days. For apples, stonefruit, pears, pomegranate, grapes, kiwi, and passionfruit crops, do not allow entry into treated areas prior to 10 days. For grapefruit, citrus, mangoes, oranges, papaya, avocado, sapote, breadfruit, jackfruit, durian, tamarind, longan, lychee, persimmon, feijoa, loquats, mangosteen, sapodilla and rambutan crops, do not allow entry into treated areas prior to 11 days. If early re-entry is required wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

8. RECOMMENDATIONS TO THE APVMA

Following an OHS risk assessment the following recommendations are made for fenthion-containing products currently registered/under permit in Australia.

1. The OCS recommends that the APVMA should NOT be satisfied that the likely occupational exposure to fenthion when using hand-held applications is acceptable, including for the control of adult mosquitoes. The only exceptions being when the fenthion product is used in accordance with the amended label instructions in the treatment of stagnant water for the control of mosquito larvae using high pressure hand-held spray equipment provided that mixers, loaders, and applicators wear gloves, an additional layer of overalls, and a washable hat, and in the control of adult mosquitoes and larvae in septic tanks based on a qualitative assessment. In particular, OCS recommends that APVMA should NOT be satisfied that the application of products containing fenthion by backpack equipment is acceptable, except when applied with a Spot-On Gun or Dial-a-dose cup for the treatment of cattle.
2. The OCS recommends that the APVMA can be satisfied that all fenthion products will not cause adverse effects to the health and safety of persons preparing and applying these products when used in accordance with the amended label instructions regarding safety directions, precautionary statements and re-entry statements.
3. The following Safety Directions and engineering controls for fenthion products are recommended. The Hazard and PPE codes will be included in the FAISD Handbook and the plain English text should be included on the product label.

Amended entry

EC 600 g/L or less in xylene 350 g/L or less

Hazard and PPE codes	
130 133 161 162 164 210 211 190 220 223 279 281 290 292d 294c 279 280 286, 290 292d 294c 301 307 289 290 292d 294c 340 342 340 343 350 360 361 362 366	Poisonous if swallowed Will irritate the eyes and skin Avoid contact with eyes and skin Repeated minor exposure may have a cumulative poisoning effect Do not inhale spray mist When preparing spray wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and elbow-length chemical resistant gloves When opening the container and pouring large quantities, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, elbow-length chemical resistant gloves and a full facepiece respirator with organic vapour cartridge If applying by hand, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and elbow-length chemical resistant gloves If product on skin, immediately wash area with soap and water If product in eyes, wash it out immediately with water After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water After each day's use, wash gloves and contaminated clothing

Amend entry

LC SA 270 g/L or less

Hazard and PPE codes	
129 131 133 160 162 164 210 211 190 279 283 290 294c 340 343 340 342 351 360 361	Harmful if absorbed by skin contact or swallowed May irritate the eyes and skin Avoid contact with eyes and skin Repeated minor exposure may have a cumulative poisoning effect When using the product, wear elbow-length chemical resistant gloves If product in eyes, wash it out immediately with water If product on skin, immediately wash area with soap and water Wash hands after use After each day's use, wash gloves

Amend entry

DU 15 g/kg or less

Hazard and PPE codes	
120 129 133 210 211 220 221 279 283 290 294c 315 302 351 360 361	Product harmful if swallowed. Avoid contact with eyes and skin. Do not inhale dust. When using the product wear elbow-length chemical resistant gloves and a disposable respirator with dust cartridge or canister. Wash hands after use. After each day's use, wash gloves.

Delete entry

HG EC 125 g/L or less in xylene 750 g/L or less

Hazard and PPE codes	
129 132 133 160 162 164 210 211 220 223 279 283 290 292d 312 340 342 340 343 350 360 361 366	Harmful if inhaled or swallowed May irritate the eyes and skin Avoid contact with the eyes and skin Do not inhale spray mist When using the product, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and rubber gloves If product on skin, immediately wash area with soap and water If product in eyes, wash it out immediately with water After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water after each day's use, wash gloves and contaminated clothing

Delete entry

HG EC 125 g/L for aqueous formulations with surfactant 50 g/L or less

Hazard and PPE codes	
129 132 133 220 223 279 283 290 292d 312 350	Harmful if inhaled or swallowed Do not inhale spray mist When using the product, wear cotton overalls, over normal clothing, buttoned to the neck and wrist and a washable hat, and rubber gloves After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water

Based on the risk quantitative assessment in this report OSC recommends that the use of fenthion in ready to use paint/grease not be supported. Therefore the following entry should be deleted from the FAISD handbook.

Delete existing entry

PA 120 g/kg or less in grease

Hazard and PPE codes	
129 133 161 162 164 210 211 290 312 351 360 361	Harmful if swallowed. Will irritate the eyes and skin. Avoid contact with eyes and skin. Wear rubber gloves. Wash hands after use. After each day's use, wash gloves.

Existing safety directions as they appear in the FAISD handbook contain an entry for AL 110 g/L in xylene 70 g/L or less (AL = other liquid formulations). As there are no longer any of this type of product registered for use in Australia, the adequacy of the SD cannot be confirmed and therefore should be deleted from the FAISD handbook.

Delete entries

AL 110 g/L in xylene 70 g/L or less
 EC all strengths
 LD 25 g/L or less in paraffin, light liquid

Engineering controls

If applying to fruit and vegetable crops, DO NOT apply by open cab airblast systems.
 If treating stagnant water, DO NOT apply by low-pressure handspray.
 DO NOT apply using spray equipment carried on the back of the user, except when applying with a Spot-On Gun or Dial-a-dose cup for the treatment of cattle.

4. Re-entry statements

The following re-entry statements are recommended:

Restricted-entry statement: For capsicums & chilli peppers and pineapple crops, do not allow entry into treated areas prior to 6 days. For banana crops, do not allow entry into treated areas prior to 8 days. For apples, stonefruit, pears, pomegranate, grapes, kiwi, and passionfruit crops, do not allow entry into treated areas prior to 10 days. For citrus, mangoes, papaya, avocado, sapote, breadfruit, jackfruit, durian, tamarind, longan, lychee, persimmon, feijoa, loquats, mangosteen, sapodilla and rambutan crops, do not allow entry into treated areas prior to 11 days. If early re-entry is required wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

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OCS OCCUPATIONAL HEALTH AND SAFETY ASSESSMENT

ACTIVE INGREDIENT: Fenthion

ATTACHMENTS:

Appendix 1 Risk control measures

Appendix 2 Detailed Margin of Exposure estimates

Appendix 1 – Risk control measures

Labels

The product labels should include the safety directions and re-entry statements recommended.

The product labels should include a reference to the Material Safety Data Sheet (MSDS).

Material Safety Data Sheet

The active ingredient and all registered fenthion products require MSDS in accordance with the NOHSC Code of Practice for the Preparation of Material Safety Data Sheets (NOHSC, 1994c).

The product MSDS should contain a statement of hazardous nature.

The product MSDS should be available to all workers using fenthion products. The product MSDS should contain a statement of hazardous nature and reflect the hazard classification.

Occupational exposure monitoring

Atmospheric monitoring

A NOHSC Exposure Standard of 0.2 mg/m³, Time-Weighted-Average (TWA) has been assigned for fenthion (NOHSC, 1995a).

Health surveillance

NOHSC has placed OP pesticides, which include fenthion on the Schedule (Schedule 3 Hazardous Substances for which Health Surveillance is Required) for Health Surveillance (NOHSC 1994a). Guidelines are available for monitoring OP pesticides (NOHSC, 1998). The employer is responsible for providing health surveillance where a requirement has been established as a result of the workplace assessment process (Regulation 14(1) of the Model regulations).

The NOHSC guidelines recommend one, or preferably two pre-exposure tests at least 3 days apart, to establish baseline ChE activity (an average is used when two samples are obtained). It is also recommended that a period of 4 weeks elapse between last exposure to OP pesticides and testing to establish baseline levels.

The NOHSC guidelines require estimation of RBC and plasma ChE levels. It is preferable if testing is carried out in the latter half of the working day when OP pesticides are used. If a 20% depression in ChE activity is seen, the worker should be re-tested. If ChE levels fall by 40% or more, the worker should be removed from exposure to OP pesticides until such time as the level returns to baseline level.

Induction and training

Appropriate induction and on-going training should be provided to all workers with the potential for exposure to fenthion products, in relation to those substances in the workplace and commensurate with the risk identified by the workplace assessment process.

Hazard classification

Fenthion is listed in the Safe Work Australia (SWA, 2013) List of Designated Hazardous Substances. The List has been revised according to the EU Annex of the EEC Council Directive 67/548/EEC (as updated by EC Council Directive 96/54/EC) to include the following risk and safety phrases with Concentration Cut Offs:

Classification

Mutagen. Cat.3

R68 Possible risk or irreversible effects

Toxic (T)

R23 Toxic by inhalation

R48/25 Toxic; danger of serious damage to health by prolonged exposure if swallowed

Harmful (Xn)

R21/22 Harmful in contact with skin if swallowed

Environmental (N)

R50 Very toxic to aquatic organisms

R53 May cause long term adverse effects in the aquatic environment

Concentration Cut Offs

At concentrations greater than or equal to 25%

Toxic (T)

R68 Possible risk or irreversible effects

R23 Toxic by inhalation

R48/25 Toxic; danger of serious damage to health by prolonged exposure if swallowed

R21/22 harmful in contact with skin if swallowed

At concentrations greater than or equal to 10% and less than 25%

Toxic

R68 Possible risk or irreversible effects

R48/25 Toxic: danger of serious damage to health by prolonged exposure if swallowed

R20 harmful by inhalation

At concentrations greater than or equal to 3% and less than 10%

Harmful (Xn)

R68 Possible risk or irreversible effects

R48/22 Harmful: danger of serious damage to health by prolonged exposure if swallowed

R20 harmful by inhalation

At concentrations greater than or equal to 3% and less than 10%
Harmful (Xn)

R68 Possible risk or irreversible effects

R48/22 Harmful: danger of serious damage to health by prolonged exposure if swallowed

Appendix 2 – Detailed Margin of Exposure estimates

DAT:	Day after treatment
DFR	Dislodgeable foliar residue
Nadj:	Not adjusted
Adj:	Adjusted For Rate
VL:	Very Low Exposure
L:	Low Exposure
M:	Medium Exposure
H:	High Exposure
MOE:	Margin of exposure (unitless, ≥ 10 needed). Calculated using an NOEL of 0.02 mg/kg bw/d.

Assumptions used in risk assessment for re-entry activities:

- A normal work day of 8 hours, consistent with OCS policy on duration of working day.
- 33% foliar dissipation rate per day (Tomlin C, 2003).
- 100% absorption of inhaled dose (default) -Thongsinthusak et al. (1993); and,
- 9% absorption of dermal dose based on in vivo and in vitro dermal absorption studies; and,
- 70 kg average body weight, consistent with the World Health Organisation.
- 80% of total dermal exposure is to the body, and the remaining 20% is to the head/neck (OCS default values).
- 90% reduction in dermal exposure to the body afforded by wearing an additional layer of overalls Thongsinthusak et al. (1993).
- 90% reduction in dermal exposure to the head and neck afforded by wearing a washable hat - Thongsinthusak et al. (1993).
- When a worker applying the product by hand-wand is wearing gloves, 99% of the dermal exposure is to the body and head/neck region (US EPA PHED Version 1.0).

Due to the relatively high foliar dissipation rate of 33% per day (Tomlin C, 2003), there was no significant impact from repeat applications to crops on *e.g.* weeks 6, 4, 3, 2, and 1 prior to harvest (data not shown).

Grapefruit, lemons, mangoes, oranges, papaya, avocado, sapote¹, guava¹, breadfruit¹, jackfruit¹, durian¹, tamarind¹, longan¹, lychee¹, persimmon¹, feijoa¹, loquats¹, mangosteen¹, sapodilla¹, rambutan¹: 1.03 kg a.i./ha

DAT	DFR level (µg/cm ²)		Dose (mg/kg/day)				MOE			
	Nadj	Adj	VL	L	M	H	VL	L	M	H
0	2.062	2.062	0.0021	0.021	0.064	0.170	9.4	0.9	0.3	0.1
1	1.381	1.381	0.0014	0.014	0.043	0.114	14.1	1.4	0.5	0.2
2	0.925	0.925	0.0010	0.010	0.029	0.076	21.0	2.1	0.7	0.3
3	0.620	0.620	0.0006	0.006	0.019	0.051	31.4	3.1	1.0	0.4
4	0.415	0.415	0.0004	0.004	0.013	0.034	46.8	4.7	1.6	0.6
5	0.278	0.278	0.0003	0.003	0.009	0.023	69.9	7.0	2.3	0.9
6	0.186	0.186	0.0002	0.002	0.006	0.015	104.3	10.4	3.5	1.3
7	0.125	0.125	0.0001	0.001	0.004	0.010	155.6	15.6	5.2	1.9
8	0.084	0.084	0.0001	0.001	0.003	0.007	232.3	23.2	7.7	2.9
9	0.056	0.056	0.0001	0.001	0.002	0.005	346.7	34.7	11.6	4.3
10	0.038	0.038	0.0000	0.000	0.001	0.003	517.4	51.7	17.2	6.5
11	0.025	0.025	0.0000	0.000	0.001	0.002	772.3	77.2	25.7	9.7

VL: Propping. L: Irrigation, scouting, hand weeding, thinning Christmas trees. M: Harvesting, pruning, training, tying, thinning, cone pruning. H: Harvesting, thinning, pollination, bagging, tying, miscellaneous hand labour, staking, topping, training. ‘1’ denotes crops that did not contain datasets in the US EPA re-entry exposure calculator, and were instead grouped with other crops on the basis of similarity in application rate and approximate foliar surface area

Grapefruit, lemons, mangoes, oranges, papaya, avocado, sapote¹, guava¹, breadfruit¹, jackfruit¹, durian¹, tamarind¹, longan¹, lychee¹, persimmon¹, feijoa¹, loquats¹, mangosteen¹, sapodilla¹, rambutan¹: 1.03 kg a.i./ha, with PPE.

DAT	DFR level (µg/cm ²)		Dose (mg/kg/day)				MOE			
	Nadj	Adj	VL	L	M	H	VL	L	M	H
0	2.062	2.062	0.00021	0.00212	0.00636	0.01696	94	9	3	1
1	1.381	1.381	0.00014	0.00142	0.00426	0.01137	141	14	5	2
2	0.925	0.925	0.00010	0.00095	0.00286	0.00761	210	21	7	3
3	0.620	0.620	0.00006	0.00064	0.00191	0.00510	314	31	10	4
4	0.415	0.415	0.00004	0.00043	0.00128	0.00342	468	47	16	6
5	0.278	0.278	0.00003	0.00029	0.00086	0.00229	699	70	23	9
6	0.186	0.186	0.00002	0.00019	0.00058	0.00153	1043	104	35	13

VL: Propping. L: Irrigation, scouting, hand weeding, thinning Christmas trees. M: Harvesting, pruning, training, tying, thinning, cone pruning. H: Harvesting, thinning, pollination, bagging, tying, miscellaneous hand labour, staking, topping, training. ‘1’ denotes crops that did not contain datasets in the US EPA re-entry exposure calculator, and were instead grouped with other crops on the basis of similarity in application rate and approximate foliar surface area

Bananas: 1.03 kg a.i./ha

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	L	M	H	L	M	H
0	2.062	2.062	0.0021	0.0276	0.0424	9.4	0.7	0.5
1	1.381	1.381	0.0014	0.0185	0.0284	14.1	1.1	0.7
2	0.925	0.925	0.0010	0.0124	0.0190	21.0	1.6	1.1
3	0.620	0.620	0.0006	0.0083	0.0128	31.4	2.4	1.6
4	0.415	0.415	0.0004	0.0056	0.0085	46.8	3.6	2.3
5	0.278	0.278	0.0003	0.0037	0.0057	69.9	5.4	3.5
6	0.186	0.186	0.0002	0.0025	0.0038	104.3	8.0	5.2
7	0.125	0.125	0.0001	0.0017	0.0026	155.6	12.0	7.8
8	0.084	0.084	0.0001	0.0011	0.0017	232.3	17.9	11.6

L: Irrigation, handweeding and scouting immature/low foliage plants. M: Irrigation and scouting mature plants. H: Hand harvesting, stripping, training, thinning, topping, mechanical hop harvest.

Bananas: 1.03 kg a.i./ha, with PPE

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	L	M	H	L	M	H
0	2.062	2.062	0.0002	0.0028	0.0042	94.3	7.3	4.7
1	1.381	1.381	0.0001	0.0018	0.0028	140.8	10.8	7.0
2	0.925	0.925	0.0001	0.0012	0.0019	210.1	16.2	10.5

L: Irrigation, handweeding and scouting immature/low foliage plants. M: Irrigation and scouting mature plants. H: Hand harvesting, stripping, training, thinning, topping, mechanical hop harvest.

Apples, pears, pomegranates: 1.306 kg a.i./ha

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	VL	L	H	VL	L	H
0	2.614	2.614	0.0027	0.027	0.081	7.4	0.7	0.2
1	1.751	1.751	0.0018	0.018	0.054	11.1	1.1	0.4
2	1.173	1.173	0.0012	0.012	0.036	16.6	1.7	0.6
3	0.786	0.786	0.0008	0.008	0.024	24.7	2.5	0.8
4	0.527	0.527	0.0005	0.005	0.016	36.9	3.7	1.2
5	0.353	0.353	0.0004	0.004	0.011	55.1	5.5	1.8
6	0.236	0.236	0.0002	0.002	0.007	82.2	8.2	2.7
7	0.158	0.158	0.0002	0.002	0.005	122.7	12.3	4.1
8	0.106	0.106	0.0001	0.001	0.003	183.2	18.3	6.1
9	0.071	0.071	0.0001	0.001	0.002	273.4	27.3	9.1
10	0.048	0.048	0.0000	0.000	0.001	408.1	40.8	13.6
11	0.032	0.032	0.0000	0.000	0.001	609.1	60.9	20.3
12	0.021	0.021	0.0000	0.000	0.001	909.1	90.9	30.3

VL: Propping. L: Irrigation, scouting, weeding. H: Harvesting, pruning, training, tying.

Apples, pears, pomegranites: 1.306 kg a.i./ha, with PPE

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	VL	L	H	VL	L	H
0	2.614	2.614	0.00027	0.00269	0.00807	74	7	2
1	1.751	1.751	0.00018	0.00180	0.00540	111	11	4
2	1.173	1.173	0.00012	0.00121	0.00362	166	17	6
3	0.786	0.786	0.00008	0.00081	0.00243	247	25	8
4	0.527	0.527	0.00005	0.00054	0.00163	369	37	12
5	0.353	0.353	0.00004	0.00036	0.00109	551	55	18
6	0.236	0.236	0.00002	0.00024	0.00073	822	82	27

VL: Propping. L: Irrigation, scouting, weeding. H: Harvesting, pruning, training, tying.

Capsicums & chilli peppers: 1.03 kg a.i./ha

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	L	M	H	L	M	H
0	2.062	2.061	0.0106	0.0148	0.0212	1.9	1.3	0.9
1	1.381	1.381	0.0071	0.0099	0.0142	2.8	2.0	1.4
2	0.925	0.925	0.0048	0.0067	0.0095	4.2	3.0	2.1
3	0.620	0.620	0.0032	0.0045	0.0064	6.3	4.5	3.1
4	0.415	0.415	0.0021	0.0030	0.0043	9.4	6.7	4.7
5	0.278	0.278	0.0014	0.0020	0.0029	14.0	10.0	7.0
6	0.186	0.186	0.0010	0.0013	0.0019	20.9	14.9	10.4

L: Irrigation, scouting, thinning, weeding immature plants. M: Irrigation and scouting mature plants. H: Hand harvesting, pruning, staking, tying.

Capsicums & chilli peppers: 1.03 kg a.i./ha, with PPE

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	L	M	H	L	M	H
0	2.062	2.061	0.0011	0.0015	0.0021	19	13	9
1	1.381	1.381	0.0007	0.0010	0.0014	28	20	14

L: Irrigation, scouting, thinning, weeding immature plants. M: Irrigation and scouting mature plants. H: Hand harvesting, pruning, staking, tying.

Pineapple: 1.03 kg a.i./ha

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	L	M	H	L	M	H
0	2.168	2.168	0.0067	0.0111	0.0223	3.0	1.8	0.9
1	1.452	1.452	0.0045	0.0075	0.0149	4.5	2.7	1.3
2	0.973	0.973	0.0030	0.0050	0.0100	6.7	4.0	2.0
3	0.652	0.652	0.0020	0.0034	0.0067	9.9	6.0	3.0
4	0.437	0.437	0.0013	0.0022	0.0045	14.8	8.9	4.5
5	0.293	0.293	0.0009	0.0015	0.0030	22.1	13.3	6.6
6	0.196	0.196	0.0006	0.0010	0.0020	33.1	19.8	9.9

L: Irrigation, scouting, thinning, weeding immature plants. M: Irrigation and scouting mature plants. H: Hand harvesting and pruning artichokes.

Pineapple: 1.03 kg a.i./ha, with PPE

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	L	M	H	L	M	H
0	2.168	2.168	0.0007	0.0011	0.0022	29.9	17.9	9.0
1	1.452	1.452	0.0004	0.0007	0.0015	44.6	26.8	13.4

L: Irrigation, scouting, thinning, weeding immature plants. M: Irrigation and scouting mature plants. H: Hand harvesting and pruning artichokes.

Grapes, kiwi, passionfruit: 1.03 kg a.i./ha

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)		MOE	
	Nadj	Adj	M	H	M	H
0	2.062	2.062	0.0212	0.1060	0.9	0.2
1	1.381	1.381	0.0142	0.0710	1.4	0.3
2	0.925	0.925	0.0095	0.0476	2.1	0.4
3	0.620	0.620	0.0064	0.0319	3.1	0.6
4	0.415	0.415	0.0043	0.0214	4.7	0.9
5	0.278	0.278	0.0029	0.0143	7.0	1.4
6	0.186	0.186	0.0019	0.0096	10.4	2.1
7	0.125	0.125	0.0013	0.0064	15.6	3.1
8	0.084	0.084	0.0009	0.0043	23.2	4.6
9	0.056	0.056	0.0006	0.0029	34.7	6.9
10	0.038	0.038	0.0004	0.0019	51.7	10.3
11	0.025	0.025	0.0003	0.0013	77.2	15.4
12	0.017	0.017	0.0002	0.0009	115.3	23.1

M: Scouting, training, tying. H: Hand harvest, leaf pulling, thinning, pruning, training/tying grape.

Grapes, kiwi, passionfruit: 1.03 kg a.i./ha, with PPE

DAT	DFR level ($\mu\text{g}/\text{cm}^2$)		Dose (mg/kg/day)			MOE		
	Nadj	Adj	L	M	H	L	M	H
0	2.062	2.062	0.0011	0.0021	0.0106	18.9	9.4	1.9
1	1.381	1.381	0.0007	0.0014	0.0071	28.2	14.1	2.8
2	0.925	0.925	0.0005	0.0010	0.0048	42.0	21.0	4.2
3	0.620	0.620	0.0003	0.0006	0.0032	62.7	31.4	6.3
4	0.415	0.415	0.0002	0.0004	0.0021	93.6	46.8	9.4
5	0.278	0.278	0.0001	0.0003	0.0014	139.7	69.9	14.0
6	0.186	0.186	0.0001	0.0002	0.0010	208.5	104.3	20.9

M: Scouting, training, tying. H: Hand harvest, leaf pulling, thinning, pruning, training/tying grape.