Section 5

OCCUPATIONAL HEALTH AND SAFETY

1. INTRODUCTION

In conducting the occupational health and safety (OHS) review, the National Occupational Health and Safety Commission (NOHSC) obtained information from the following sources: the Department of Health and Aged Care (DHAC) Review of chlorfenvinphos, industry submissions, NRA performance questionnaires (PQs) initiated as part of the review of chlorfenvinphos, NRA Agriculture Report on chlorfenvinphos, overseas reviews and the published literature.

2. HAZARD OVERVIEW

The following information is derived from the DHAC Report "Review of the Mammalian Toxicology and Metabolism/Toxicokinetics of Chlorfenvinphos" (DHAC, 1999), unless otherwise noted.

2.1 Metabolism and excretion

Following oral administration, chlorfenvinphos was rapidly excreted in the urine with 86-89% of the administered dose excreted over 4 days in rats and dogs, and 94% in a human volunteer over 26 hours. Tissue residues were low in sheep, three days after dermal application of chlorfenvinphos.

2.2 Toxicology endpoints relevant to the occupational health and safety assessment

Ideally, the toxicology end point(s) used in the OHS risk assessment should be established in the relevant species (ie. humans) by the route most appropriate for occupational exposure (ie. dermal). In the absence of human data, animal data may be used as surrogate, however, the variability in sensitivity between species is accounted for in the risk assessment (Section 5). Where dermal toxicology studies are not available or are inappropriate, oral studies may be used. Correction is made in the risk assessment to account for the protection afforded by skin, ie dermal penetration factor (Section 2.3).

Acute toxicity

Technical chlorfenvinphos was of high oral, dermal and inhalation toxicity. The acute toxicity of chlorfenvinphos showed wide variation between species. The lowest oral LD_{50} was 9.7 mg/kg bw (rat, male), lowest dermal LD_{50} was 30 mg/kg bw (rat, female), and lowest inhalation LC_{50} 133 mg/m^3 (4 hr, rat, male). It was a slight skin and eye irritant but not a skin sensitiser in experimental species.

Compared with the toxicity of the active ingredient, chlorfenvinphos formulations were equivalent or in some cases more toxic. The formulations showed similar oral toxicity. However, the dermal toxicity varied according to the formulation type with granules or wettable powder (WP) having a lower dermal toxicity than emulsifiable concentrates (EC).

Repeat dose toxicity

As provided in DHAC, 1999 (discussion), following is a summary of No-Observable-Effect-Levels (NOELs) based on cholinesterase (ChE) inhibition, relevant for the OHS assessment.

Table 1: Chlorfenvinphos; **Summary of NOELs (mg/kg bw/d) for ChE inhibition relevant to the OHS assessment**

Species and route	Duration of study	Plasma ChE	Red cell ChE	Brain ChE
Mouse, oral	2 weeks	0.2	2	-
Rat, oral	4 weeks	0.15	0.15	0.15
Rat, oral	12 weeks	0.15	0.15	-
Rat, oral	12 weeks	0.15	0.5*	-
Human, dermal	Single dose	1.81	1.81	-

* The NOEL established in this study for RBC ChE inhibition in both sexes was 0.5 mg/kg/d, however, the NOEL for RBC ChE inhibition in females was 0.15 mg/kg/d.

Discussion

The acute toxicity of chlorfenvinphos is high, with wide inter-species variation, but no sex related differences in sensitivity. Depression of ChE activity appears to be the most sensitive toxicological endpoint for chlorfenvinphos, with both plasma and brain ChE having a similar level of sensitivity in the rat.

The single dose human dermal study (NOEL 1.81 mg/kg/d for plasma and RBC ChE inhibition) may be used to establish a reference dose for the OHS risk assessment. However, considering that occupational exposure to chlorfenvinphos is likely to occur more frequently, the use of a reference dose derived from a single dose study will underestimate the risk to workers.

No animal dermal studies were available for chlorfenvinphos. Shorter-term rodent oral studies established a NOEL of 0.15 mg/kg/d to 0.2 mg/kg/d for plasma ChE and/or RBC ChE inhibition. Given the uncertainty associated with extrapolation across species and correcting for dermal penetration of the chemical, the use of a NOEL from a rodent oral study will overestimate the risk to workers.

In the absence of a repeat dose human dermal study and considering all of the above, NOHSC used the NOEL of 0.15 mg/kg/d, established in repeat dose rodent dietary studies in the OHS risk assessment.

2.3 Dermal absorption

No animal studies directly measuring the skin absorption of chlorfenvinphos were available. Dogs, guinea pigs and humans (refer below) dermally exposed to chlorfenvinphos demonstrated ChE depression, indicating uptake of the chemical via the skin.

Chlorfenvinphos was applied as an 80% EC, a 24% EC and a 25% WP formulation respectively, to the forearm of 9 volunteers and covered with an occlusive dressing. Considerable variability was noted in the absorbed dose between volunteers for each formulation, with plasma ChE activity inhibited to varying degrees. No RBC ChE depression was noted (Hunter, 1969; also cited in DHAC, 1999).

A 24% EC formulation of chlorfenvinphos was applied to the forearm of a single volunteer at 5 mg/kg bw, and covered with an occlusive (foil) dressing. After 6 hours the occlusive dressing was removed and the skin washed with water. Of the total dose of 380 mg chlorfenvinphos applied, 260 mg was recovered from the foil dressing. The total absorbed dose was therefore not more than 120 mg or approximately 31% of the applied dose. Blood samples collected 3, 6, 24 and 96 hours, and 8 and 18 days after dosing revealed 45% inhibition of plasma ChE activity at 96 hours, with levels returning to normal at 18 days. No abnormal clinical signs were observed during this period. Erythrocyte ChE activity was not inhibited (Brown, 1966; also cited in DHAC, 1999).

Discussion

Based on the systemic effects (ChE inhibition) following dermal dosing, chlorfenvinphos has shown to be absorbed through the skin of experimental animals and humans.

In the absence of specific skin penetration data for chlorfenvinphos, a default of 10% absorption is assumed in the risk assessment. A similar default value was used in the UK Ministry of Agriculture, Fisheries and Food (MAFF), Evaluation of Chlorfenvinphos (UK MAFF, 1994).

Insufficient data exists to adequately describe the dermal penetration process in terms of percentage absorption. The amount penetrating will depend on the area of skin involved, the amount of pesticide present on the skin acting as a "driving force" for penetration, the duration of presence on the skin, as well as on many other aspects related to the worker (skin) and the work situation.

2.4 Health effects relating to occupational exposure

Insufficient information was available to quantify the extent of occupational health effects associated with the use of chlorfenvinphos in Australia. Following are summaries of some overseas reports (not comprehensive):

Early studies conducted on workers exposed to OP pesticides highlighted possible alterations in neuromuscular activity (Jager et al., 1970; and Drenth et al., 1972). In a follow-up study, Roberts (1976) reported on electromyographic (EMG) examinations conducted on chemical industry workers exposed to a range of pesticides, including chlorfenvinphos (8 workers with high probability of exposure and a control group of 9 workers with low probability of exposure). A correlation was noted between exposure to OP compounds and low EMG voltage, following supra-maximal ulnar nerve stimulation. After a 3 week break from exposure, normal results were recorded, therefore, this effect was considered to be reversible.

Further investigations on 102 chemical industry workers and 75 factory workers not involved in production of OP compounds (controls), demonstrated that low voltage EMG in workers exposed to OPs was associated with low conduction velocities in fast and slow motor nerve fibres. A comparison of the maximum conduction velocities of motor nerve fibres in workers exposed to pesticides (n=8) with unexposed workers (n=8), demonstrated that exposed workers had approximately a 10% decrease in conduction (Roberts, 1976).

An epidemiological study compared workers exposed to chlorfenvinphos for longer than 5 years with those exposed for 2 years and workers never exposed to the chemical. Analysis of ChE activity, haematological parameters and EMG volatages was done. There were no significant differences in ChE activity between groups. Lower EMG voltages (reversible) were noted in workers exposed for 5 years in comparison to those exposed for 2 years or controls. The effect was reversed by improvements in industrial hygiene or removing the worker from the source of exposure. These findings were supported by similar findings in another study involving 10 workers exposed to chlorfenvinphos over 8 years (Ottevanger, 1976; also cited in DHAC, 1999).

A small-scale survey conducted jointly by The UK MAFF and the National Poisons Unit (NPU) confirmed that acute health effects can follow from occupational exposure to OPs in sheep dips and that acute cholinergic inhibition correlates poorly with clinical effects. In the period from 1985 to March 1992, 232 reports of suspected adverse reactions to sheep dips involving 315 individuals were reported to the Veterinary Medicines Directorate of MAFF. During the three month period from September to November 1991, the NPU received 34 reports of suspected exposure to sheep dips containing diazinon, propetamphos or chlorfenvinphos. Of these, 29/34 workers were exposed while working with sheep, 3/34 were accidental exposures and the circumstances surrounding exposure in 2/34 cases were unknown. Influenza-like symptoms were reported by 23 of these patients. Fifteen of the 23 workers reporting symptoms indicated that they had not worn the PPE recommended by the Health and Safety Executive and had probably been contaminated while putting sheep into a dip or handling recently dipped sheep. Paired blood samples were obtained from nine of the occupationally exposed patients who reported influenza-like symptoms. In 3/9 patients a rise in RBC ChE activity of at least 25% four to six weeks after exposure indicated that ChE activity had been depressed. In 6/9 patients, measurements were either equivocal or did not show increased activity (Murray et al., 1992).

Stephens et al., 1995 (cited in Steenland, 1996), studied 146 sheep farmers and 143 controls, in order to assess the effects of exposure to OP pesticides on neurobehavioural function. The exposed group averaged 15 years of sheep dipping, with the main chemicals being diazinon, propetamphos and chlorfenvinphos. Significant neurobehavioural effects were noted, including alterations in sustained attention and speed of information processing. No effects were observed involving memory or learning. Insufficient information was presented to delineate whether the effects were linked to all chemicals concerned or chlorfenvoinphos alone. Stephens et al. concluded that long-term health effects may occur in persons exposed to OP sheep dips.

Discussion

Overseas reports highlight the poor correlation between clinical effects and acute cholinergic inhibition following exposure to chlorfenvinphos. Surveys conducted in the UK suggest that workers may suffer adverse health effects from occupational exposure to sheep dips, with primary effects being ChE depression and possible neurobehavioural effects.

Epidemiological studies provide evidence for reversible alteration in neuromuscular activity in workers exposed to OPs, including chlorfenvinphos, even though their plasma ChE activity was within normal population limits. The DHAC determine that the regulatory significance and validation of such studies is unclear. There was no evidence of "intermediate syndrome" associated with the limited reports of chlorfenvinphos poisoning received.

Neurobehavioural effects were observed in workers following long-term exposure to OPs, including chlorfenvinphos, although the proportion of adverse effects directly attributable to chlorfenvinphos was not documented.

3. USE PROFILE

3.1 Prior to end use

Nine chlorfenvinphos products are currently registered in Australia. These include veterinary products containing chlorfenvinphos alone or in combination with another chemical such as cypermethrin. The EC formulations registered for veterinary use contain 2.5 g/L, 138 g/L, 200 g/L and 1 kg/L chlorfenvinphos whilst the single aerosol formulation contains 0.64 g/kg chlorfenvinphos.

The only product registered for agricultural use, is a 500 g/L EC formulation.

Table 2: Formulation type and package sizes for chlorfenvinphos products

Formulation type	Registered Pack Sizes
EC	800 mL, 1 L, 5 L, 20 L, 22L
Aerosol	450 g

Some chlorfenvinphos products are imported fully formulated, whilst others are formulated in Australia. A considerable portion of the imported technical grade chlorfenvinphos is used in the manufacture of ectoparasiticide products.

This assessment does not address worker exposure and risk during product formulation. Individual premises, manufacturing/formulation processes and exposure control measures may vary within workplaces. However, they are expected to follow good manufacturing practices, and have adequate quality control and monitoring facilities.

3.2 End use

The following information is based on products registered in Australia up to the commencement of this review found in the Agricultural assessment.

3.2.1 Recommended PPE

All chlorfenvinphos products recommend the use of protective clothing during mixing/loading and spray/solution application. The personal protective equipment (PPE) specified varies depending on product and work activity (see section 6.2 Safety Directions).

Table 1: Use pattern of chlorfenvinphos product (EC 500 g/L) in agricultural situations

Crop/Situation	Application rate/dilution (concentration of ai in spray)	Work rate	Spray Volume	Application frequency
Pastures and lucerne	**Broadcast spray**: 550 mL/ha to 1 L/ha	50 ha/day	100 L/ha	usually only 1 application (occasionally 2 applications) is required
	Directed spray: 50 mL/100 L (0.05% ai)	Short duration	-	-
	Aerial spray: 550 mL/ha to 1 L/ha	200 ha/day	20L/ha	-
Mushroom casing	**Incorporation**: 100 mL/1000 L water per cubic metre of casing	Intermittent activity of short duration	-	Casing is generally applied weekly on commercial farms if pest pressure is high enough
Farm buildings (fly control)	**Directed spray**: 500 mL/10 L (2.5% ai)	Expected to be of short duration	400mL/10m^2	Seasonal and intermittent
Potatoes	**Broadcast spray**: 550 mL/ha	30 h/day	400L	Not regularly used
	Directed spray: 50 mL/100 L (0.05% ai)	Short duration	-	-

(1) The following Restricted Entry Statement is included on the product label: "workers should not handle sprayed crop for 5 days unless wearing protective clothing".

Table 2: Use pattern of chlorfenvinphos products (EC 138 g/L, 200 g/L and 2.5 g/L) in veterinary situations (cattle)

Application method/concentration of ai in product	Application rate/dilution	Work rate	Spray Volume	Frequency of application
Backrubber (200 g/L)	1 L/20 L sump oil		charged at a rate of 20 mL prepared mixture per animal	Every 3 weeks
Plunge dip (138 g/L)	1 part product to 250 parts of water (initial dilution) 4L/11000L water 1 part product to 185 parts of water (topping up) 8L/1500L water	500 cattle/day	standard size dip for a herd of 500 cattle is 11000 L (range 9000 L to 18000 L). Top up required when the level of the dip falls by 1000 L – 1500 L.	10-21 day intervals. Maximum of 10 treatments per year
Spray race (138 g/L)	1 part product to 250 parts of water (initial dilution) 1 part product to 185 parts of water (topping up)	500 cattle/day	Spray races operate at low pressure(140 kPa) and deliver 90000 L per hour. Pump and manuals paddles used to ensure thorough mixing	10-21 day intervals. Maximum of 10 treatments per year
Overspray (200 g/L)	20 mL /1 L water (0.4L/20L water)	100 cattle/day	Apply 200 mL per animal Ensure thorough coverage with 4 passes of the spray along the dorsal midline of each animal	Treatment interval is 21 days, minimum 10 days Maximum of 18 treatments per year
Hand spray and non-recirculating spray races (138 g/L)	1 part product to 250 parts of water (0.08L/20L water)	100 cattle/day	200mL/animal	Not available Assumed to be used as for overspray
Wound dressing (2.5 g/L)	Apply undiluted, 0.5-1 mL/5 kg liveweight (not to exceed 1 mL/5 kg)		As required	Apply when necessary. Do not reapply at less than 10 day intervals and not more than 5 times/year

Note: The WHP specified on chlorfenvinphos product labels range from "nil" to 8 days for cattle.
The product labels prohibit concurrent use with other OPs and application within 10 days of treatment with other OPs.

Table 2: Use pattern of chlorfenvinphos products (EC 1 kg/L, 2.5 g/L, and aerosol 0.64 g/kg) in veterinary situations (sheep)

Application method, formulation and concentration of ai	Application rate/dilution	Spray Volume	Frequency of application
Jetting (EC 1 kg/L)	100 mL product per 200 L water 500 sheeop/day	Allow up to 4 L of wash depending on length of wool when jetting against body strike Crutch jetting requires at least 1 L of wash per sheep. Up to 900 kPa pressure for dense-woolled sheep with 9-12 months wool growth; and 550-600 kPa for sheep with 6 months wool	When necessary
Hand dressing (EC 1 kg/L)	10 mL product/12 L water	-	When necessary
Lamb marking (EC 1 kg/L)	5 mL product/10 L water	-	When necessary
Wound dressing (EC 2.5 g/L)	2-5 mL/kg bw (depending on size of affected area)	Maximum 5 mL/kg bw Applied undiluted	Apply when necessary. Minimum re-treatment interval 10 day Maximum of 5 applications/year
Mulesing/marking wounds (EC 2.5 g/L)	5-8 mL/kg bw Applied undiluted	Minimum volume 55 mL/sheep	Apply at the time of marking or mulesing Minimum re-treatment interval 10 day Maximum of 5 applications/year
Wound dressing (Aerosol 0.64 g/kg)	As required	-	Apply and repeat as necessary Re-treatment interval and maximum applications not specified

3.2.2 Label restrictions:

Agricultural uses

The single chlorfenvinphos product registered for agricultural use carries the following Restricted Entry Statement on the label: "workers should not handle sprayed crop for 5 days unless wearing protective clothing".

Chlorfenvinphos products are prohibited for use in the home garden.

Veterinary uses - Cattle

The product labels prohibit concurrent use with other OPs and application within 10 days of treatment with other OPs.

Product labels do not contain recommendations concerning specific re-handling restrictions.

Veterinary uses - Sheep

Product labels do not contain recommendations concerning specific re-handling restrictions.

4. OCCUPATIONAL EXPOSURE ASSESSMENT

To facilitate the exposure assessment and risk assessment, rather than consider each individual exposure/use separately, exposure scenarios were developed, coded and grouped where possible. This allows maximisation of available data and simplifies the assessment.

4.1 End use exposure – agricultural uses

One chlorfenvinphos product, an EC containing 500 g/L active ingredient, is currently registered for agricultural use.

Under routine conditions of use, the main route of occupational exposure to chlorfenvinphos is expected to be by skin contamination. Chlorfenvinphos is of low volatility (vapour pressure 2.6 x 10^{-3} m Hg @ 80°C). However, workers handling undiluted solvent-based product can be potentially exposed to solvent vapour. Inhalation of spray mist may occur during spray application, particularly when using hand-held equipment.

The agricultural exposure scenarios identified for chlorfenvinphos are (Code: "a" denotes agricultural use):

(1a)	Mixing/loading to support ground broadcast spraying of pastures and lucerne.
(2a)	Mixing/loading to support directed spraying of pastures and lucerne.
(3a)	Mixing/loading to support aerial application of pastures and lucerne.
(4a)	Mixing/loading to support ground broadcast spraying of potatoes.
(5a)	Mixing/loading to support directed spraying of potatoes.

(6a)	Mixing/loading to support hand-held spraying in and around farm buildings
(7a)	Broadcast spraying of pastures and lucerne using boom sprayers.
(8a)	Directed spraying of pastures and lucerne, using hand-held equipment.
(9a)	Aerial application to pastures and lucerne.
(10a)	Broadcast spraying of potatoes, using boom sprayers.
(11a)	Directed spraying of potatoes, using hand-held equipment.
(12a)	Hand-held spraying (high level) in and around farm buildings
(13a)	Hand-held spraying (low level) in and around farm buildings
(14a)	Incorporation into mushroom casing.

4.1.1 Measured exposure studies

Only 1 study was submitted to the NRA in response to the data call-in for this review.

Blok AC, Mann AH, Robinson J (1977) Organophosphorus insecticide exposure of sprayers under field conditions on rice in India. I BIRLANE (chlorfenvinphos). The Hague, SIRM, Toxicol Div., Tox 77-005.

The study included three groups of workers who applied two different formulations of chlorfenvinphos to paddy-rice (crop height 30 cm) in India. One group applied a 24% EC formulation at a dilution of 0.06% (0.11% on the first day only). The second group applied a 10% granular formulation of chlorfenvinphos. The third group acted as controls. No personal protective clothing was used. Workers wore short-sleeved cotton shirts, cotton shorts and a cotton cloth covering the head. Their arms, legs and feet were uncovered. Workers applied the spray using 10 L knapsack sprayers and worked for 7 hours per day. The actual application lasted for a period of 6 days.

Blood samples were obtained before the trial, every morning during the trial and for 2 days post-application. Following analysis of the pre-trial samples it was determined that no inter-group comparison could be made. Plasma ChE activity was depressed in both groups exposed to chlorfenvinphos after the first day (81% inhibition in the first group and 51% in the second group). ChE depression was noted in the group spraying the liquid formulation until day 3. Workers applying the granular formulation did not demonstrate ChE depression after day 1. RBC ChE levels were unaffected throughout the trial. No adverse effects or clinical symptoms were observed in any of the study subjects during the spraying period.

Discussion

The study is not considered suitable to assess the agricultural use of chlorfenvinphos in Australia as the crop, study design, work practices, work clothing, PPE and application method are not comparable with Australian conditions. Therefore, the study results are not considered in the OHS risk assessment.

It is noted that although plasma ChE depression was significant in both groups (greater than permitted by Australian health surveillance guidelines), none of the study subjects demonstrated clinical signs of illness. The study authors provide no explanation. It is possible that these workers may have adapted to the effects of ChE depression from frequent exposure to anticholinesterase compounds. However, insufficient detail was available on the exposure history of each subject to enable a definite conclusion to be drawn.

No relevant measured worker exposure data were available for the agricultural uses of chlorfenvinphos.

4.1.2 Predicted exposure

The UK Predictive Operator Exposure Model (POEM) is a descriptive model based on databases of operator exposure field studies. POEM provides surrogate exposure values, which are derived from the levels determined in several field studies for each of several different scenarios. Exposure calculations are divided into two parts; contamination from handling the concentrated product and contamination during actual application of the dilute spray. The model assumes that the level and distribution of potential dermal contamination are mainly dependent on the handling techniques used during preparing the pesticide product for use, the type of application equipment employed and the work practices of the individual operator.

In this model, exposure during mixing/loading is assumed to be confined to the hands only, and no respiratory exposure is assumed to occur during mixing/loading. Dermal (hands, trunk and legs) and inhalation exposure is assumed during spray application.

In using POEM, it is necessary to make assumptions in order to estimate the actual exposure from potential exposure. These assumptions may be based on laboratory or field data, but in the absence of data conservative estimates have to be made.

The use of exposure values derived from predictive models (such as POEM), involve the use of conservative assumptions for unknowns and a range of values for a particular method of spraying. Such modelling is internationally accepted as the first step in a tiered risk assessment (Tier 1).

Predictive modelling was used to estimate worker exposure to chlorfenvinphos, where possible. The parameters and assumptions used for agricultural uses of chlorfenvinphos are provided in Table 6. Model default values were used for parameters not specified.

Table 3: **Use pattern parameters used in the agricultural exposure assessment**

Crop/situation	Application method	Representative application rate (g ai/ha or % ai)	Work rate (ha/6 hour spraying)	Representative spray volume (L/ha)	Application frequency
Pasture and lucerne	Broadcast ground spraying	550 mL/ha[(1)] (275 g ai/ha)	50 ha/d[(2)]	100 L/ha [(3)]	Once (maybe twice) per year
	Directed spraying	50 mL/100 L (0.05% ai)	Expected to be of short duration	-	Expected to be infrequent
	Aerial spraying	550 mL/ha[(1)] (275 g ai/ha)	200 ha/d[(2)]	20 L/ha[(4)]	Once (maybe twice) per year
Mushroom casing	Incorporation into casing	100 mL/1000 L (0.005% ai) per m^3 of casing	Intermittent activity of short duration	-	Used weekly, only if pests are present in significant numbers
Farm buildings	Hand-held directed spraying	500 mL/10 L (2.5% ai)	Expected to be of short duration depending on size of building[(5)]	400 mL/10 m^2	Inadequate information on use pattern, use may be seasonal and intermittent
Potatoes	Broadcast ground spraying	550 mL/ha (275 g ai/ha)	30 ha/d[(2)]	400 L [(4)]	Not a regular use (back-up chemical)
	Directed spraying	50 mL/100 L (0.05% ai)	Expected to be of short duration	-	Not a regular use

[(1)] the label recommended application rate ranges from 550 mL/ha to 1 L/ha, depending on State, however, a rate of 550 mL/ha is recommended for most States
[(2)] default value used in the absence of information on work rates and estimated to be the maximum area to be treated by this application method
[(3)] spray volume used in Tasmania (NRA Agriculture Report), note this is lower than the minimum spray volume recommended on the product label of 150 L/ha
[(4)] minimum spray volume recommended on product label
[(5)] an estimate of the area to be sprayed 100 m^2 and 2 hours spraying time (default values used in the absence of information on work rates)

The following assumptions are used:

* 10% penetration through PVC gloves (default) - Thongsinthusak et al. (1993);

* dermal penetration of 10% in humans (default) – as determined in Section 2.3;

* 100% absorption of inhaled dose (default) – Thongsinthusak et al. (1993); and

* average body weight 60 kg – consistent with the World Health Organisation.

Birlane 500 Insecticide is packaged in 5 L and 20 L containers. Worker exposure is estimated for 5 L containers for the following reasons:

(i) as a worst-case scenario; and

(ii) POEM estimates mixer/loader exposure for open pour operations only. The possibility of workers open mixing from 5 L containers is higher than from 20 L containers, where they are more likely to use closed filling/loading systems (if available).

Exposure estimates for mixing/loading and ground boom spraying of pastures, lucerne and potatoe, and mixing/loading to support aerial application in pasture and lucerne were estimated using the Vehicle Mounted (with cab) Hydraulic Nozzles (V-nozzle) model from POEM.

Exposure estimates for mixing/loading and low and high level hand-held spraying in and around farm buildings were estimated using the Hand-held Outdoor Rotary Disc Atomisers: high level application (H-RDA High) and Hand-held Outdoor Rotary Disc Atomisers: low level application (H-RDA Low).

It is noted that models H-RDA High and H-RDA Low are designed to estimate worker exposure during outdoor spraying of crops (high crops and low crops, respectively). These models were used in this report to provide a reasonable frame of reference, in order to obtain a rough estimate of potential mixer/loader and applicator exposure during hand-held spraying of chlorfenvinphos in and around farm buildings.

From modelling, estimates were derived for daily absorbed dermal dose for mixer/loaders and applicators, daily absorbed inhalation dose for applicators only and daily total absorbed dose for both worker categories. These values were used to estimate Margins of Exposure (MOE) for each of the exposure scenarios (or groups of scenarios) identified earlier.

4.1.3 End use exposure overview – Agricultural uses

No suitable measured exposure data were available to estimate worker exposure during the agricultural uses of chlorfenvinphos products. Under these circumstances, in accordance with internationally accepted practice, NOHSC was forced to use model data where possible, in an attempt to estimate potential worker exposure for the various scenarios identified in Section 4.1. However, it should be noted that the use of exposure data from predictive models using default assumptions, is likely to overestimate risk.

A qualitative risk assessment was conducted for scenarios where no suitable data or models were available.

Table 7 summarises the caveats and parameters specific for each scenario and presents dermal and inhalation doses.

Table 4: **Agricultural uses of EC chlorfenvinphos (500 g/L), exposure scenarios, caveats, parameters and absorbed doses**

Exposure scenario	**Data source/model (Estimate No)**	**Equipment PPE/clothing[(1)]**	**Application rate (g ai/ha) Spray volume (L/ha) Work rate (ha/d) [(2)]**	**Daily absorbed dermal dose[(3)] (mg/kg/d)**	**Daily absorbed inhalation dose[(4)] (mg/kg/d)**	**Daily total absorbed dose (mg/kg/d) [(5)]**	**Comments**
Mixer/loaders							
Scenario (1a) Mixing/loading, to support boom spraying, pastures, lucerne	POEM Estimate 1a	Open mixing/loading from 5 L containers of non-specific design PPE - overalls (or long pants and long sleeved shirt), gloves	275 g ai/ha 100 L/ha 50 ha/d	0.10	NM	0.10	• representative application rate • minimum spray volume
Scenario (1a) Mixing/loading, to support boom spraying, pastures, lucerne	POEM Estimate 2a	Open mixing/loading from 5L wide neck containers PPE – as for Scenario (1a) above		0.005	NM	0.005	• hand exposure only estimated
Scenario (3a) Mixing/loading, to support aerial application, pastures and lucerne	POEM Estimate 5a	Open mixing/loading from 5 L containers of non-specific design PPE – as for Scenario (1a)	275 g ai/ha 20 L/ha 200 ha/d	0.367	NM	0.367	
Scenario (3a) Mixing/loading, to support aerial application, pastures and lucerne	POEM Estimate 6a	Open mixing/loading from 5 L wide neck containers PPE – as for Scenario (1a)		0.018	NM	0.018	
Scenario (4a) Mixing/loading, to support boom spraying, potatoes	POEM Estimate 3a	Open mixing/loading from 5 L containers of non-specific design PPE – as for Scenario (1a)	275 g ai/ha 400 L/ha 30 ha/d	0.067	NM	0.067	• maximum application rate • minimum spray volume • estimating worst-case exposure
Scenario (4a) Mixing/loading, to support boom spraying, potatoes	POEM Estimate 4a	Open mixing/loading from 5 Lwide neck containers PPE – as for Scenario (1a)		0.003	NM	0.003	• hand exposure only estimated

Table 4: Agricultural uses of EC chlorfenvinphos (500 g/L), exposure scenarios, caveats, parameters and absorbed doses (continued)

Exposure scenario	**Data source/model (Estimate No)**	**Equipment PPE/clothing[(1)]**	**Application rate (g ai/ha) Spray volume (L/ha) Work rate (ha/d) [(2)]**	**Daily absorbed dermal dose[(3)] (mg/kg/d)**	**Daily absorbed inhalation dose[(4)] (mg/kg/d)**	**Daily total absorbed dose (mg/kg/d) [(5)]**	**Comments**
Scenario (6a) Mixing/loading to support, hand-held spraying, farm buildings	POEM Estimate 7a Estimate 9a	Open mixing/loading from 5 L containers of non-specific design PPE – as for Scenario (1a)	10 kg ai/ha 400 L/h 0.01 ha/d	0.017	NM	0.017	• representative parameters • label dilution rate • hand exposure only estimated
Scenario (6a) Mixing/loading to support, hand-held spraying, farm buildings	POEM Estimate 8a Estimate 10a	Open mixing/loading from 5 L wide neck containers PPE – as for Scenario (1a)		0.001	NM	0.001	
Applicators							
Scenario (7a) Boom spraying, pastures and lucerne	POEM Estimate 1a Estimate 2a	Closed cab tractors PPE - Overalls (or long pants and long sleeved shirt), gloves	275 g ai/ha 100 L/ha 50 ha/d	0.03	0.003	0.033	• representative application rate • minimum spray volume • hand and body exposure estimated
Scenario (10a) Boom spraying, potatoes	POEM Estimate 3a Estimate 4a	Closed cab tractors PPE – as for Scenario (7a)	275 gai/ha 400 L/ha 30 ha/d	0.007	0.001	0.008	• maximum application rate • minimum spray volume • hand and body exposure estimated
Scenario (12a) High level hand – held spraying, farm buildings	POEM Estimate 7a Estimate 8a	Hand-held outdoor rotary disc atomiser PPE – as for Scenario (7a)	10 kg ai/ha 400 L/ha 100 m^2 area to be treated on average 2 hours spraying time	0.656	0.008	0.664	• representative parameters • label dilution • hand and body exposure estimated
Scenario (13a) Low level hand-held spraying, farm buildings	POEM Estimate 9a Estimate 10a	Hand-held outdoor rotary disc atomiser PPE – as for Scenario (7a)		0.304	0.008	0.312	

(1) Although product safety directions recommend the use of extensive PPE during mixing/loading (overalls, gloves, apron, water-proof footwear, respirator) only gloves were modelled as POEM only estimates hand exposure during mixing/loading. The protection afforded by the additional PPE cannot be quantified using POEM. The clothing scenario modelled is appropriate for applicators

(2) Internationally accepted, standard assumption of an 8 hour work day, comprising of a 6 hour application period, unless otherwise noted

(3) Daily absorbed dermal dose (mg/kg/d) = surface contamination (mL/operation or mL/hour) x number of operations or duration of exposure (hours) x concentration of ai in spray (mg/mL) x penetration through clothing/protective clothing (%) x dermal penetration (%)÷ average body weight (kg)

(4) Daily absorbed inhalation dose (mg/kg/d) = inhalation exposure (mL/hour) x concentration of active ingredient in spray (mg/mL) x duration of spraying (hours) x inhalation absorption (%)÷ average body weight (kg)

(5) Daily total absorbed dose (mg/kg/d) = Daily absorbed dermal dose (mg/kg/d) + Daily absorbed inhalation dose (mg/kg/d)

NM – not measured

4.2 End use exposure –veterinary uses

Cattle treatment

Three EC formulations containing 2.5 g/L, 138 g/L and 200 g/L of chlorfenvinphos are registered for use in cattle.

Cattle treatment is expected to occur mainly by plunge dipping and automatic spraying. Large volumes of chemical will be handled by workers involved in these application methods. Mixer/loader exposure will be mainly by skin contamination and inhalation of solvent vapour (chlorfenvinphos has low vapour pressure). Worker exposure during dipping and operation of spray races is expected to be by skin contamination as well as inhalation of spray mist, particularly as automatic spray races generate large amounts of spray mist.

Hand spraying involves smaller amounts of product. The main routes of exposure during this method of cattle treatment will be dermal contact and inhalation of spray mist, due to the close proximity of the operator to spray equipment.

During wound dressing, exposure will be mainly by the dermal route. Inhalation of spray mist may occur if coarse sprayers are used.

The veterinary exposure scenarios identified for uses of chlorfenvinphos in cattle are (Code: "c" denotes use in cattle):

(1c)	Backrubber preparation
(2c)	Mixing/loading to support plunge dip and spray race operations (charging)
(3c)	Mixing/loading to support plunge dip and spray race operations (topping up)
(4c)	Application by plunge dipping and spray race
(5c)	Mixing/loading to support overspray applications (200 g/L product)
(6c)	Application by overspray (200 g/L product)
(7c)	Mixing/loading to support hand spraying (138 g/L product)
(8c)	Application by hand-held equipment (138 g/L product)
(9c)	Wound dressing

Sheep treatment

Two EC formulations containing 2.5 g/L and 1000 g/L chlorfenvinphos and a single aerosol formulation containing 0.64 g/kg chlorfenvinphos are registered for use in sheep.

A large proportion of sheep treatment is expected to occur by automatic or hand jetting. Large numbers of animals are treated by jetting, therefore, workers will handle large quantities of jetting fluid. Mixer/loader exposure can occur mainly by skin contamination and to some extent by inhalation of solvent vapour. Worker exposure during actual jetting operations is likely to occur by skin contamination and inhalation of spray mist.

The main route of occupational exposure during wound dressing is expected to be through dermal contact. Inhalation of spray mist may occur, particularly when using pressure sprayers.

The veterinary exposure scenarios identified for use of chlorfenvinphos in sheep are (Code; "s" denotes use in sheep)

(1s)	Mixing/loading to support jetting
(2s)	Hand jetting
(3s)	Mixing/loading to support hand dressing/lamb marking
(4s)	Hand dressing/lamb marking using liquid formulations
(5s)	Wound dressing/lamb marking using aerosol formulation

4.2.1 Measured exposure studies

No measured worker exposure data were submitted for the veterinary uses of chlorfenvinphos.

4.2.2 Predicted exposure

A suitable model does not exist within the UK POEM to estimate worker exposure during animal treatments. However, applicable handler exposure estimates may be obtained using POEM for mixer/loaders for a range of application methods and applicators using hand-held spray equipment. Given the registered uses of chlorfenvinphos, it is assumed that these exposure estimates will provide a reasonable frame of reference to allow rough assessment of risk to workers mixing, loading, and applying chorfenvinphos. The approach is especially relevant for use patterns where there is potential for significant worker exposure.

Note, the assumptions specified in Section 4.1.2 of this report for agricultural use of chlorfenvinphos are also applicable for veterinary use of the chemical.

Cattle treatment

The parameters used in the exposure assessment for the use of chlorfenvinphos products in cattle are provided in Table 8.

Table 5: Use pattern parameters used in the exposure assessment for chlorfenvinphos cattle treatment

Application method	Product dilution	Application rate, number of animals treated, dip volume	Formulation type/concentration of active ingredient	Application frequency
Backrubber	1 L product/20 L sump oil	Not applicable	EC/200 g/L	Backrubbers are charged every 3 weeks
Plunge dip/spray race (charging)	44 L product per 11000L water (based on a dilution rate of 1:250 parts of water)	500 cattle [(a)] 11000 L [(b)]	EC/138 g/L	Not more than 10 treatments/year at 10-21 intervals
Plunge dip/spray race (topping up)	8 L product/1500 L water (based on dilution rates of 1:185 parts of water)	500 cattle 1500 L [(c)]		As required during dip/spray operations

Hand-held spraying	0.08 L product/20 L water (based on dilution rates of 1:250 parts)	200 mL/animal 100 cattle/day [(d)]		Expected to be as as for overspray
Overspray	0.4 L product/20 I water (based on dilution rates of 20 mL/1 L water)	200 mL/animal 100 cattle/day [(d)]	EC/200 g/L	At intervals of 10 - 21 days. Maximum of 18 applications/year Used during 5 month fly season
Wound dressing	Applied undiluted	0.5 mL-1 mL/5 kg	EC 2.5 g/L	When necessary – maximum 5 times/year. Minimum re-treatment interval 10 days

(a) 500 head of cattle taken to be representative of herd size in Australia (NRA Agriculture Report)
(b) dip vat size of 11000 L used to plunge dip an average herd of 500 cattle (NRA Agriculture Report)
(c) maximum volume assumed to be prepared per top-up operation (NRA Agriculture Report), note this is greater than the top up volume in the product labels of 1000 L and 300 L
(d) a representative number of 100 cattle assumed to be treated by hand spray/overspray per day. Note hobby farmers may treat smaller numbers, whilst large dairy operations may treat more animals by these methods

The EC formulations for use in cattle are packed in 1 L, 5 L, 20L and 22 L containers. Mixer/loader exposure to support dipping and spray race application was estimated for 20 L containers for the following reasons:

(i) considering the large number of animals treated by these methods, it is more likely that workers would use larger containers in order to minimise the number of mixing/loading operations; and
(ii) it is possible to conduct open-pour mixing from 20 L containers.

Mixer/loader exposure to support overspray (200 g/L product) and handspray (138 g/L product) was estimated for 5 L and 20 L containers respectively, based on the packaging information on registered product labels received through the NRA.

Exposure estimates for mixing/loading to support plunge dipping and spray race charging and topping up were estimated using the Vehicle Mounted (with cab) Hydraulic Nozzles (V-nozzle) model from POEM.

Exposure estimates for Mixing/loading and application as an overspray using hand-held equipment (200 g/L EC) and mixing/loading and application as a hand spray (138 g/L) were estimated using the Hand Held Outdoors Hydraulic Nozzle (H-Nozzle) model from POEM.

Sheep treatment

The use pattern parameters used in the exposure assessment for the use of chlorfenvinphos products in sheep are provided in Table 9.

Table 6: Use pattern parameters used in the exposure assessment for chlorfenvinphos sheep treatment

Application method	Product dilution	Application rate, number of animals	Formulation type/	Application frequency

		treated, spray volume	concentration of active ingredient	
Jetting	100 mL product/200 L water[1]	4 L jetting fluid/sheep[2] 500 sheep/day[3]	EC/1000 g/L	As required Mob treatment anticipated
Hand dressing	10 mL product/12 L water[1]	Not applicable		When required
Lamb marking	5 mL product/10 L water[1]	Not applicable		
Hand dressing of flystrike and superficial wounds	Applied undiluted	2-5 mL/kg bw	EC/2.5 g/L	Applied as necessary Minimum re-treatment interval 10 days
Mulesing and lamb marking		5-8 mL/kg bw		Maximum of 5 applications per year
Aerosol	-	-	Aerosol 0.64 g/kg	No restrictions on use specified on product label

(1) dilution recommended on product label
(2) volume of jetting fluid applied would depend on the age of the sheep, length of wool and area to be treated, range 3-5 L, average of 4 L used in the risk assessment
(3) treatment of 500 sheep per worker per day taken as representative of Australian work practices, spraying time of 6 hours assumed

Worker exposure during mixing/loading for hand jetting was estimated for 1 L containers based on the packaging information on registered product labels.

Exposure estimates for mixing/loading and hand jetting were estimated using the Hand Held Outdoors Hydraulic Nozzle (H-Nozzle) model from POEM.

4.2.3 End use exposure overview – veterinary uses

No suitable measured exposure data were available to estimate worker exposure during the veterinary uses of chlorfenvinphos products. A suitable model does not exist within the UK POEM to estimate worker exposure during animal treatments. However, model data were used, where possible, to obtain a rough estimate of potential worker exposure for the various scenarios identified for cattle treatment. It is noted that the use of exposure data from predictive models using default assumptions, is likely to overestimate risk.

A qualitative risk assessment was conducted for scenarios where predictive modelling was not used.

Tables 10 and 11 summarise the caveats and parameters specific for each scenario and present dermal and inhalation doses, for cattle and sheep treatment respectively.

Table 7: Veterinary uses of EC chlorfenvinphos in cattle (138 g/L and 200 g/L), exposure scenarios, caveats, parameters and absorbed doses

Exposure scenario/ Concentration of active ingredient in product	Data source/model (Estimate No)	Equipment PPE/clothing[(1)]	No of animals treated application dose and dip/spray volume	Daily absorbed dermal dose[(3)] (mg/kg/d)	Daily absorbed inhalation dose[(4)] (mg/kg/d)	Daily total absorbed dose (mg/kg/d) [(5)]	Comments
Mixer/loaders							
Scenario (2c) Mixing/loading to support plunge dip and spray race application (charging), 138 g/L product	POEM Estimate 1c	Open mixing/loading from 20 L non-specific design container PPE - Cotton overalls (or equivalent clothing) and gloves	500 head of cattle/day 44 L product/day 11000 L dip size	0.035	NM	0.035	• average number of animals and dip size • exposure estimates considered representative • hand exposure only estimated
Scenario (2c) Mixing/loading to support plunge dip and spray race application (charging), 138 g/L product	POEM Estimate 2c	Open-mixing/loading from 20 L wide neck container PPE – as for Scenario (2c) above		0.003	NM	0.003	
Scenario (3c) Mixing/loading to support plunge dip and spray race application (topping up), 138 g/L product	POEM Estimate 3c	Open mixing/loading from 20 L non-specific design container PPE – as for Scenario (2c)	Topping up is done when level falls below 1500 L 8 L product/operation	0.012	NM	0.012	• maximum volume prepared during one top up operation for average dip vat • worst case exposure estimated • hand exposure only estimated
Scenario (3c) Mixing/loading to support plunge dip and spray race application (topping up), 138 g/L product	POEM Estimate 4c	Open mixing/loading from 20 L wide neck container PPE – as for Scenario (2c)		0.001	NM	0.001	

Table 7: Veterinary uses of EC chlorfenvinphos in cattle (138 g/L and 200 g/L), exposure scenarios, caveats, parameters and absorbed doses (continued)

Exposure scenario/ Concentration of active ingredient in product	Data source/model (Estimate No)	Equipment PPE/clothing[1]	No of animals treated application dose and dip/spray volume	Daily absorbed dermal dose[3] (mg/kg/d)	Daily absorbed inhalation dose[4] (mg/kg/d)	Daily total absorbed dose (mg/kg/d) [5]	Comments
Scenarios (5c) and (6c) Mixing/loading to support application by overspray, 200 g/L product	POEM Estimate 5c	Open mixing/loading from 5 L non-specific design container PPE – as for Scenario (2c)	100 head of cattle/day 200 mLper animal 0.4 L product/day 20 L spray/day	0.013	NM	0.013	• maximum spray concentration • assuming 100 animals/day/worker • small container size • worst case exposures estimated • hand exposure only estimated
Scenarios (5c) and (6c) Mixing/loading to support application by overspray, 200 g/L product	POEM Estimate 6c	Open mixing/loading from 5 L wide neck container PPE – as for Scenario (2c)		0.001	NM	0.001	
Scenarios (7c) and (8c) Mixing/loading to support application by handspray, 138 g/L product	POEM Estimate 7c	Open mixing/loading from 20 L non-specific design container PPE – as for Scenario (2c)	100 head of cattle/day 200 mLper animal 0.08 L product/day 20 L spray/day	0.023	NM	0.023	
Scenarios (7c) and (8c) Mixing/loading to support application by handspray, 138 g/L product	POEM Estimate 8c	Open mixing/loading from 20 L wide neck container PPE – as for Scenario (2c)		0.002	NM	0.002	

Table 7: Veterinary uses of EC chlorfenvinphos in cattle (138 g/L and 200 g/L), exposure scenarios, caveats, parameters and absorbed doses (continued)

Exposure scenario/ Concentration of active ingredient in product	Data source/model (Estimate No)	Equipment PPE/clothing[1]	No of animals treated application dose and dip/spray volume	Daily absorbed dermal dose[3] (mg/kg/d)	Daily absorbed inhalation dose[4] (mg/kg/d)	Daily total absorbed dose (mg/kg/d) [5]	Comments
Applicators							
Scenario (6c) Application as an overspray (200 g/L product)	POEM Estimate 5c	Hand-held hydraulic nozzle sprayers PPE - Cotton overalls (or equivalent clothing) and gloves	0.4 L product 20 L water 200 mL spray per animal 100 animals per day	0.330	0.008	0.338	• maximum spray concentration • assuming 100 animals/day/worker
Scenario (6c) Application as an overspray (200 g/L product)	POEM Estimate 6c	Hand-held hydraulic nozzle sprayers PPE - Gloves, cotton overalls (or equivalent clothing) and waterproof clothing		0.078	0.008	0.086	• small container size • worst case exposures estimated
Scenario (8c) Application as a hand spray (138 g/L product)	POEM Estimate 7c	Hand-held hydraulic nozzle sprayers PPE - Cotton overalls (or equivalent clothing) and gloves	0.08L product 20 L water 200 mL spray per animal	0.046	0.001	0.047	• hand and body exposures estimated
Scenario (8c) Application as a hand spray (138 g/L product)	POEM Estimate 8c	Hand-held hydraulic nozzle sprayers PPE - Gloves, cotton overalls (or equivalent clothing) and waterproof clothing	100 animals per day	0.011	0.001	0.012	

[1] Although product safety directions recommend the use of extensive PPE during mixing/loading (overalls, gloves, apron, water-proof footwear, goggles) only gloves were modelled as POEM only estimates hand exposure during mixing/loading. The protection afforded by the additional PPE cannot be quantified using POEM. For applicators, two clothing scenarios were modelled, namely (a) gloves and cotton overalls or equivalent clothing and gloves, and (b) cotton overalls (or equivalent clothing), waterproof clothing and gloves. The protection afforded by water resistant footwear could not be quantified.

[2] Internationally accepted, standard assumption of an 8 hour work day, comprising of a 6 hour application period, unless otherwise noted

[3] Daily absorbed dermal dose (mg/kg/d) = surface contamination (mL/operation or mL/hour) x number of operations or duration of exposure (hours) x concentration of ai in spray (mg/mL) x penetration through clothing/protective clothing (%) x dermal penetration (%)÷ average body weight (kg)
[4] Daily absorbed inhalation dose (mg/kg/d) = inhalation exposure (mL/hour) x concentration of active ingredient in spray (mg/mL) x duration of spraying (hours) x inhalation absorption (%)÷ average body weight (kg)
[5] Daily total absorbed dose (mg/kg/d) = Daily absorbed dermal dose (mg/kg/d) + Daily absorbed inhalation dose (mg/kg/d)
NM – not measured

Table 8: Veterinary uses of EC chlorfenvinphos in sheep (1 kg/L), exposure scenarios, caveats, parameters and absorbed doses

Exposure scenario, concentration of active ingredient in product	Data source/model (Estimate No)	Equipment PPE/clothing[(1)]	No of animals treated application dose and spray volume	Daily absorbed dermal dose[(3)] (mg/kg/d)	Daily absorbed inhalation dose[(4)] (mg/kg/d)	Daily total absorbed dose (mg/kg/d) [(5)]	Comments
Mixer/loaders							
Scenario (1s) Mixing/loading to support hand jetting, 1 kg/L product	POEM Estimate 1s	Open mixing/loading from 1 L non-specific design container and wide neck containers PPE - Cotton overalls (or equivalent clothing) and gloves	500 sheep/day 4 L spray/animal 800 L spray tank 1L product/day 2000 L spray/day	0.005	NM	0.005	• average number of animals and spray tank size • exposure estimates considered representative • hand exposure only estimated • hand contamination for 1 L containers not expected to be influenced by container design (POEM assumption)
Applicators							
Scenario (2s) Application by hand jetting, 1 kg/L product	POEM Estimate 2s	Hand-held hydraulic nozzle sprayers PPE - Cotton overalls (or equivalent clothing) and gloves	500 sheep/day 4 L spray/animal 800 L spray tank 1L product/day 2000 L spray/day	0.041	0.001	0.042	• maximum spray concentration • assuming 500 sheep/day/worker
Scenario (2s) Application by hand jetting, 1 kg/L product	POEM Estimate 2s	Hand-held hydraulic nozzle sprayers PPE - Gloves, cotton overalls (or equivalent clothing) and waterproof clothing		0.010	0.001	0.011	• small container size • worst case exposures estimated • hand and body exposure estimated

[(1)] Although product safety directions recommend the use of extensive PPE during mixing/loading (overalls, gloves, apron, water-proof footwear, goggles) only gloves were modelled as POEM only estimates hand exposure during mixing/loading. The protection afforded by the additional PPE cannot be quantified using POEM. For applicators, two clothing scenarios were modelled,

namely (a) gloves and cotton overalls or equivalent clothing and gloves, and (b) cotton overalls (or equivalent clothing), waterproof clothing and gloves. The protection afforded by water resistant footwear could not be quantified.

(2) Internationally accepted, standard assumption of an 8 hour work day, comprising a 6 hour application period, unless otherwise noted

(3) Daily absorbed dermal dose (mg/kg/d) = surface contamination (mL/operation or mL/hour) x number of operations or duration of exposure (hours) x concentration of ai in spray (mg/mL) x penetration through clothing/protective clothing (%) x dermal penetration (%)÷ average body weight (kg)

(4) Daily absorbed inhalation dose (mg/kg/d) = inhalation exposure (mL/hour) x concentration of active ingredient in spray (mg/mL) x duration of spraying (hours) x inhalation absorption (%)÷ average body weight (kg)

(5) Daily total absorbed dose (mg/kg/d) = Daily absorbed dermal dose (mg/kg/d) + Daily absorbed inhalation dose (mg/kg/d)

NM – not measured

4.3 Post-application exposure

Agricultural uses

There is a potential for post-application exposure for persons entering treated areas after application is complete, particularly following aerial and ground broadcast spraying. No post-application exposure data or dislodgeable residue data were available for chlorfenvinphos.

The current chlorfenvinphos label carries the following re-entry/re-handling statement: "workers should not handle sprayed crop for five days unless wearing protective clothing".

In pastures and lucerne, significant post-application activity (harvesting, scouting, irrigation etc) is not expected shortly after spraying. The WHP in these crops is 7 days for cutting for stock food, which is expected to be a mechanical activity.

Chlorfenvinphos is not applied to potatoes on a regular basis. Should it be used to control potato moth, the label specifies a WHP of 1 day for harvest. It is feasible to assume that in some instances, chlorfenvinphos may be applied to potatoes up to one day prior to harvest. Considering the 5 day REP specified on the product label, workers are required to wear protective clothing during manual harvesting of potatoes up to 5 days after spraying. Therefore, worker exposure during manual harvesting of potatoes or other post-application activity is not of OHS concern.

Chlorfenvinphos is mixed into the peatmoss in mushrooms. Label safety directions require workers to wear elbow-length rubber gloves when handling treated casing. Therefore, post application dermal exposure to mushroom house workers is not expected to be of concern. Considering the low volatility of chlorfenvinphos and the high dilution of the solution applied to casing (0.005% ai), inhalation exposure of workers within mushroom housing is not expected to be significant.

Treatment of farm buildings and surrounds with chlorfenvinphos is not expected to result in significant re-entry exposure. Workers are not likely to re-enter animal housing soon after spray application and extensive contact with treated surfaces is not likely. In general, animal housing is adequately ventilated and the chemical is relatively non volatile. Therefore, re-entry exposure by the inhalation route is not likely to be of concern.

Considering all of the above, an extensive (quantitative) occupational exposure assessment for post-application workers is not required, provided workers follow good agricultural practice and adhere to the REP specified on the product label.

Veterinary uses - Cattle

Post-application exposure is likely for persons who may come in contact with treated animals immediately after application of chlorfenvinphos. No exposure data were available to assess the risk from such contact.

Considering normal practice amongst cattle farmers, it is not likely that significant contact with treated animals will be required shortly after treatment. In addition, the degree of post-

application exposure is likely to be substantially lower than the exposure mixers and loaders receive in handling chlorfenvinphos while preparing spray and dip solutions and applicators/operators during dip/spray race operations and hand spraying of chlorfenvinphos to cattle.

Considering the WHP for slaughter and work practices within abattoirs, exposure of workers during slaughter and subsequent handling of carcasses is not expected to be significant.

Considering all of the above, an extensive (quantitative) occupational exposure assessment for workers handling treated animals/ carcasses is not required following cattle treatment.

Veterinary uses - Sheep

Post application exposure is likely for persons handling treated sheep, particularly following jetting of long woolled sheep, due to retention of chemical in the wool staple. Animal husbandry practices such as wound dressing require workers to handle treated sheep. Workers are expected to adhere to safe work practices and not handle treated animals shortly after jetting. Therefore, overall exposure during such activities is expected to be less than worker exposure during mixing/loading and jetting of sheep.

Chlorfenvinphos products are registered in Australia as long wool treatments. Product labels do not recommend a re-handling period for shearing. Therefore, it is reasonable to assume that sheep may be shorn within days/weeks of treatment with the chemical. Refer to Section 5.3 for assessment of risk to shearers and other wool handlers from chlorfenvinphos residues in wool.

5. OCCUPATIONAL RISK ASSESSMENT

The occupational risk assessment takes into consideration the hazard of the chemical as determined by toxicology testing, its use pattern in Australia and worker exposure for each exposure scenario.

No suitable measured exposure data were available for the agricultural or veterinary uses of chlorfenvinphos. In order to determine the risks associated with the use of the chemical, margins of exposure (MOE) were calculated by comparing the most appropriate NOEL with exposure data obtained from predicted modelling, where possible. A qualitative risk assessment was conducted where a suitable model was not identified.

The main adverse health effect of chlorfenvinphos exposure is ChE inhibition. The most appropriate NOEL to assess the occupational risk to workers was determined to be 0.15 mg/kg/d, established in repeat-dose dietary studies in rats, for plasma and RBC ChE depression (Section 2.2). A dermal absorption adjustment of 10% was used in the risk assessment (Section 2.3). No correction was made for inhalation absorption, as 100% absorption was assumed (Section 4.1).

Considering that the NOEL used in the OHS risk assessment was established in experimental species, MOE of approximately 100 or more were considered acceptable, to account for possible intra- (10x) and inter-species (10x) variability.

Chlorfenvinphos is a slight skin and eye irritant in experimental animals. These topical effects may be manifest in workers who come in contact with chlorfenvinphos 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 chlorfenvinphos products, it is assumed that workers wear appropriate PPE, as specified on product labels.

5.1 Risk from end use exposure – agricultural uses

Pastures and lucerne

It is anticipated that in most instances, mixing/loading and spray application will be carried out by the farmer or farm employee. Occasionally, contract spraying may occur in broadacre crops, particularly aerial spraying.

Information available from users indicated that spraying of chlorfenvinphos in pastures and lucerne usually takes place once per season. Very occasionally, a second application may be required. Directed spraying of broadacre crops such as pastures is anticipated when small areas of infestation are identified. Therefore, infrequent worker exposure is expected when chlorfenvinphos is used in the scenarios noted below.

Table 9: Risk associated with open mixing/loading and broadcast spraying of pastures and lucerne

Scenario and description of container/equipment	Daily absorbed dermal dose (mg/kg/d)	Daily absorbed inhalation dose (mg/kg/d)	Daily total absorbed dose (mg/kg/d)	MOE[(1)]
Scenario (1a) Mixing/loading, to support boom spraying, pastures, lucerne, non specific containers	0.10	NM	0.10	1.5
Scenario (1a) Mixing/loading, to support boom spraying, pastures, lucerne, wide neck containers	0.005	NM	0.005	30
Scenario (3a) Mixing/loading, to support aerial application, pastures and lucerne, non specific containers	0.367	NM	0.367	<1
Scenario (3a) Mixing/loading, to support aerial application, pastures and lucerne, wide neck containers	0.018	NM	0.018	8
Scenario (7a) Boom spraying, closed cabs, pastures and lucerne	0.03	0.003	0.033	5

[(1)] MOE = NOEL (0.15 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d)

MOE obtained for open mixing/loading to support ground and aerial spraying of pastures and lucerne were of concern.

MOE for boom sprayers were also of concern, despite the fact that a closed cab scenario was modelled. Worker exposure during spray application in open cabs was not quantified. However, the risk to workers in open cabs is expected to be greater (particularly in environmental conditions conducive to the generation of spray drift) than the risk to workers in closed cabs.

A suitable model does not exist within POEM to estimate aerial applicator exposure. It is not anticipated that aerial applicators will be significantly exposed to spray mist given that they are most often in closed cabins and operate against the direction of spray drift. In addition, aerial operators are adequately trained and accredited to conduct chemical spray applications. Flaggers will only be used during night spraying, when Geographic Positioning Systems (GPS) can not be utilised. Flaggers are expected to follow established best practice guidelines, such as in 4A's Manual.

Directed spraying of pastures and lucerne is expected to be an infrequent activity, using a diluted spray (0.05% ai compared with 0.275 % ai for broadcast spraying) and cover small areas as required. It is not possible to establish the frequency or extent of this use, based on information available. Workers are expected to handle smaller quantities of product and apply a more dilute spray to smaller areas, when compared to broadcast spraying of pastures and lucerne.

Discussion

Although MOE calculated for this use pattern were inadequate, it is noted that the NOEL used in the risk assessment was from repeat-dose studies. Therefore, these MOE are likely to overestimate risk due to the following reasons:

- *chlorfenvinphos will generally be used once (occasionally twice) per season;*
- *worst case mixer/loader exposure was estimated, ie. for 5 L container;.*
- *ground applicators in broadacre crops generally use closed cabin tractors with air-conditioning and pesticide filters. The additional protection afforded by pesticide filters could not be quantified; and*
- *aerial operators are trained and accredited in the application of agricultural chemicals. Mixing/loading for large aerial spraying operations is most likely to utilise closed systems such as dry coupling or closed filling/loading systems.*

Potential exposure and risk to aerial applicators is not expected to be significant.

The risk to workers during directed spraying could not be quantified. Overall, the risk to these workers is not expected to exceed the risk to workers involved in ground broadcast application of chlorfenvinphos.

Potatoes

As in broadacre crops, it is expected that farmers or farm employees will treat potato crops with chlorfenvinphos. No contract spraying is anticipated.

Information available through the NRA Agriculture Report indicated that the use of chlorfenvinphos in potato crops is declining, with users favouring other chemicals over chlorfenvinphos. It is now considered as a backup chemical for the control of potato moth, to be used only when pest pressure is high or when other control techniques fail. Directed spraying of potatoes is expected to take place when small areas of infestation are identified. Therefore, the following exposure scenarios will result in infrequent worker exposure

Table 10: Risk associated with open mixing/loading and ground broadcast spraying of potatoes

Scenario and description of container/equipment	Daily absorbed dermal dose (mg/kg/d)	Daily absorbed inhalation dose (mg/kg/d)	Daily total absorbed dose (mg/kg/d)	MOE[(1)]
Scenario (4a) Mixing/loading, to support boom spraying, potatoes, non specific containers	0.067	NM	0.067	2
Scenario (4a) Mixing/loading, to support boom spraying, potatoes, wide neck containers	0.003	NM	0.003	50
Scenario (10a) Boom spraying, closed cabs, potatoes	0.007	0.001	0.008	19

[(1)] MOE = NOEL (0.15 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d)

The use pattern parameters used for predictive modelling, ie. maximum application rate, minimum spray volume and 5L container, result in worst-case exposure estimates.

MOE for open mixing/loading to support broadcast spraying of potatoes were of concern, however, they are substantially higher (yet of concern) for workers handling wide neck containers. MOE were also of concern for boom spray applicators in closed cabs. Although the risk to applicators in open tractors was not quantified, it is reasonable to assume that it will be greater than the risk to workers in closed cabs.

Directed spraying of potatoes is expected to be infrequent, utilise a more dilute spray than broadcast spraying and cover small areas as required. It is not possible to establish the frequency or extent of this use, based on information available to this agency. Workers are expected to handle smaller quantities of product and apply a more dilute spray to smaller areas, in comparison with broadcast spraying.

Discussion

MOE determined using exposure estimates from predicted modelling were of concern for broadcast spraying of potatoes. The NOEL used to calculate these MOE was from repeat-dose dietary studies, however, frequent and extensive use of the chemical is not anticipated in potato crops. In addition, worst—case exposures were estimated and the protection afforded by engineering controls such as pesticide filters could not be quantified. Therefore, these MOE are considered to overestimate the risk to mixer/loaders and ground boom applicators in potato crops.

The unquantifiable risk to workers involved in directed spraying of potatoes is not expected to exceed the risk to workers involved in broadcast application.

Fly control in and around farm buildings

Chlorfenvinphos is currently registered for the control of flies in and around farm buildings. It is reasonable to assume that spray application will be conducted using hand-held equipment, an application method that has the potential to result in significant operator exposure. Information obtained through the NRA performance questionnaires does not highlight this as being a major use of the chemical. However, it is possible that chlorfenvinphos may be applied to farm buildings regularly, particularly in warm weather when pest pressure is high.

Therefore, mixing/loading and high level and low level hand-held spraying in and around farm buildings may be regular and possibly seasonal:

Information available to this agency on the frequency and extent of use, farm building sizes and work practices was inadequate to accurately assess this use pattern. Representative values were used to estimate worker exposure, in the absence of data.

Table 11: Risk associated with open mixing/loading and hand-spraying of chlorfenvinphos in and around farm buildings

Scenario and description of container/equipment	Daily absorbed dermal dose (mg/kg/d)	Daily absorbed inhalation dose (mg/kg/d)	Daily total absorbed dose (mg/kg/d)	MOE[(1)]
Scenario (6a) Mixing/loading to support, hand-held spraying, farm buildings, non specific containers	0.017	NM	0.017	9
Scenario (6a) Mixing/loading to support, hand-held spraying, farm buildings, wide neck containers	0.001	NM	0.001	150
Scenario (12a) High level hand –held spraying, farm buildings	0.656	0.008	0.664	<1
Scenario (13a) Low level hand-held spraying, farm buildings	0.304	0.008	0.312	<1

[(1)] MOE = NOEL (0.15 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d)

MOE for open mixing to support hand spraying were of concern when handling containers of non-specific design. The risk is determined to be acceptable (MOE = 150) for workers open-pouring from wide neck containers.

Label safety directions require workers to wear cotton overalls and PVC gloves during spraying (the clothing scenario modelled). MOE were low, for high and low level hand spraying of chlorfenvinphos.

It is likely that the same worker will mix/load and apply chlorfenvinphos using hand-held equipment on farms. Based on exposure estimates obtained from POEM, the risk to workers performing combined tasks is likely to be unacceptable.

Discussion

Insufficient information was available to adequately assess this use of chlorfenvinphos. In the absence of a totally appropriate model to estimate worker exposure for this use pattern, predictive models designed to estimate worker exposure during high and low level hand-spraying of crops were used, to obtain a rough estimate of potential exposure.

Hand-held spray application has the potential to cause significant operator exposure, with high level applications often resulting in greater exposure than low-level applications. In the absence of information to the contrary, it is possible that chlorfenvinphos may be used regularly for fly control on farms, particularly during the warmer months of the year.

Based on available information and using exposure estimates from predictive models, the risk to workers mixing/loading and spraying chlorfenvinphos using hand-held equipment in and around farm buildings is likely to be unacceptable.

Fly control in mushrooms

Information obtained through the NRA Agriculture Report indicates that currently, the mushroom industry has access to several chemicals, including chlorfenvinphos, for use in growing rooms. In addition, the duration of protection afforded by chlorfenvinphos has decreased over time due to enhanced microbial degradation. It is estimated that chlorfenvinphos provides approximately 2 weeks protection against phorid infestation when applied to casing. The chemical is not registered for application to mushroom beds.

Current practice in the mushroom industry is to periodically monitor the farm for the presence of flies and incorporate chlorfenvinphos into the next batch of casing, when pest pressure indicates the need for chemical control. Treatment of casing will continue until the phorid infestation is under control. On large commercial mushroom farms casing is applied weekly, however, it is not anticipated that chlorfenvinphos will be required for more than a few consecutive batches of casing. Therefore, considering potential use over a full season, exposure is expected to be intermittent.

Mushroom house workers are required to mix the product with the required quantity of water and incorporate the dilute solution (0.005% ai) into dry peat moss. In order to comply with label instructions, they are required to wear cotton overalls, PVC or rubber apron, elbow-length PVC gloves, goggles, impervious footwear and a half-face respirator, when opening containers, pouring large quantities and preparing the solution. Workers are also required to wear elbow-length rubber gloves when handling treated casing. Therefore, the likelihood of skin contamination is not expected to be significant.

It is possible that peat moss will be treated within mushroom housing. Given that workers are required to wear a respirator when opening containers and pouring large volumes of product, exposure to solvent vapour is not likely to be of concern.

Discussion

No measured exposure data were available for this use of chlorfenvinphos. A suitable model does not exist within POEM to estimate operator exposure for this use. However, the risk to workers involved in this activity is not expected to be significant over a full season because:

- *chlorfenvinphos is one of many chemicals available to the mushroom industry;*
- *it is applied to mushroom casing only when economically damaging levels of phorid infestations are observed and will take place at weekly intervals until pest pressure is reduced;*
- *the high dilution of the product in the working strength solution (0.005% ai); and*
- *work practices, namely diluting the product with water and incorporating into peat moss, are not expected to result in extensive worker exposure, provided appropriate PPE is worn.*

5.2 Risk from end use exposure – veterinary uses

Cattle treatment - *Backrubber*

Available information did not indicate the extent of use of chlorfenvinphos as back rubber treatment in Australia. Cattle farmers are expected to prepare backrubbers at approximately 3-week intervals during the buffalo fly season (November to April). Workers are required to prepare a solution containing 1 L product per 20 L sump oil (1% ai) and charge each backrubber at a rate of 20 mL prepared mixture per animal. It is not anticipated that workers will handle the product on a regular basis all year round. Therefore, backrubber preparation is expected to result in intermittent exposure, over the fly season.

Label safety directions require workers to wear cotton overalls buttoned to the neck and wrist (or equivalent clothing), a washable hat, gloves, PVC or rubber apron, goggles and water resistant footwear when opening containers, pouring large quantities and preparing working strength solution. Therefore, skin contamination is not expected to be significant. Backrubber preparation is most often carried out outdoors, hence inhalation of product vapour is not expected to result in adverse health effects.

Discussion

No measured exposure data were available for this use of chlorfenvinphos. A suitable model does not exist to provide surrogate exposure data. However, worker exposure during backrubber preparation is expected to be neither frequent nor extensive for the following reasons:

- *the product will be used on a regular basis only during the buffalo fly season (approximately 5 months), at 3 weekly intervals;*
- *the high dilution of active ingredient in the working strength solution (1% ai);*
- *work practices within the industry; and*
- *the extensive protective equipment specified on product labels.*

Cattle - Plunge dip and spray race operations

Plunge dipping is the preferred method for controlling cattle tick in Australia. Mechanical spraying of cattle by means of power operated spray races is used as an alternative to plunge dipping. Large numbers of cattle are treated by these methods, therefore, farmers are expected to handle large volumes of chemical during plunge dip and spray race operations.

In addition to initial charging of the dip/spray race, periodic topping up is carried out in order to maintain an adequate concentration of the chemical in the dip solution/spray. Top-up is carried out as required, depending on level of working strength solution in the dip/sump. Therefore, worker exposure is anticipated during initial charging as well as top up operations. It is expected that a dip will be prepared at the beginning of the working day and topped up as required, ie. several top-up operations are likely, however, number of operations cannot be quantified.

The label recommends that chlorfenvinphos be applied by these methods at 10 –21 day intervals, with a maximum of 10 treatments per year. It is reasonable to assume that farmers would treat the whole herd to control ticks and prevent spread of the infestation. Therefore, Mixing/loading, plunge dipping and spray race operations (charging and topping up) would results in intermittent worker exposure.

Table 12: Risk associated with open mixing/loading for plunge dip and spray race applications

Scenario, application method and container type	Daily absorbed dermal dose (mg/kg/d)	Daily absorbed inhalation dose (mg/kg/d)	Daily total absorbed dose (mg/kg/d)	MOE[(1)]
Scenario (2c) Mixing/loading to support plunge dip and spray race application, non specific container (charging)	0.035	NM	0.035	4
Scenario (2c) Mixing/loading to support plunge dip and spray race application, wide neck container (charging)	0.003	NM	0.003	50
Scenario (3c) Mixing/loading to support plunge dip and spray race application, non specific container (topping up)	0.012	NM	0.012	13
Scenario (3c) Mixing/loading to support plunge dip and spray race application, wide neck container (topping up)	0.001	NM	0.001	150

(1) MOE = NOEL (0.15 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d)

MOE obtained for open mixing/loading to support plunge dip and spray race for charging and topping-up were of concern for workers handling containers of non-specific design. MOE were higher when handling wide neck containers. It should be noted that worker exposure was estimated for a single top up operation, however, multiple operations are anticipated within a working day. Therefore, the MOE for topping up will be lower when exposure over a full working day is considered.

Current industry practice is to use mechanical agitation of dips, hence worker exposure is not anticipated during this activity. A suitable model was not available for estimating worker exposure during plunge dipping or spray race operation. Splashing is quite common during plunge dipping of cattle, whilst the large quantity of spray mist generated during automatic spray race operations may result in significant worker exposure. Potential exposure during these activities could only be estimated theoretically. A NOEL of 0.15 mg/kg/d is equivalent to skin contamination with 160 mL of the working strength solution (assuming 138 g ai/L of product, 1:250 dilution of product, 10% dermal absorption of chlorfenvinphos and 60 kg body weight). However, it is not possible to estimate the distribution of contamination (therefore penetration through PPE).

Workers using prepared dip or spray are required to wear waterproof clothing, a washable hat, elbow-length gloves and water resistant footwear (alternatively cotton overalls, and PVC or rubber apron, a washable hat, elbow-length gloves and water resistant footwear).

Discussion

No measured exposure data were available. Predictive modelling was used in order to obtain a frame of reference for mixer/loader exposure. POEM could not be used to estimate dip/spray race operator exposure.

Although MOE calculated for mixing/loading for plunge and spray race operations were inadequate, it is noted that the NOEL used in the risk assessment was from repeat dose studies. These MOE may overestimate risk due to:

- *the intermittent use of the chemical, ie. applied at 10-21 day intervals and the maximum of 10 applications per year;*
- *farmers are more likely to treat the whole herd at any one time and have periods between treatments free of exposure to chlorfenvinphos; and*
- *that the likelihood of spillage, therefore hand contamination, when open-pouring into a large dip vat is expected to be less than when open pouring into a spray tank for agricultural uses (as POEM is designed to estimate).*

It is established that potential worker exposure during plunge dipping and spray race operations is high. The risk to these workers could not be adequately quantified. However, it is likely that workers may be potentially exposed to substantial quantities of the dip/spray solution during actual operation of plunge dips and spray races.

Cattle - *Hand spraying*

The use of chlorfenvinphos as an overspray for buffalo fly control is recommended by several State Agricultural Authorities. Workers are required to mix the required quantities of product

and water, and apply the spray along the dorsal midline of each animal (4 passes each) using hand-held spray equipment. Information available from users indicated that farmers use trigger packs, knapsack sprayers or engine powered equipment connected to a hose and hand wand.

Two chlorfenvinphos products are registered for hand spraying of cattle (ie. formulations containing 138 g/L and 200 g/L active ingredient). They are both used during the buffalo fly season, from November to April, at intervals of 10 –21 days, with a maximum of 18 treatments per year. Therefore, mixing/loading and hand spraying (200 g/L and 138 g/L product) would be intermittent and seasonal:

Table 13: Risk associated with open mixing/loading and overspray application

Scenario, equipment design and concentration of ai in product	Daily absorbed dermal dose (mg/kg/d)	Daily absorbed inhalation dose (mg/kg/d)	Daily total absorbed dose (mg/kg/d)	MOE[(1)]
Scenario (5c) Mixing/loading to support overspray using hand-held equipment, non specific containers, 200 g/L product	0.013	NM	0.013	12
Scenario (5c) Mixing/loading to support overspray using hand-held equipment, wide neck containers, 200 g/L product	0.001	NM	0.001	150
Scenario (7c) Mixing/loading to support hand spray using hand-held equipment, non specific containers, 138 g/L product	0.023	NM	0.023	7
Scenario (7c) Mixing/loading to support hand spray using hand-held equipment, wide neck containers, 138 g/L product	0.002	NM	0.002	75
Scenario (6c) Application by overspray wearing cotton overalls and gloves, 200 g/L product	0.330	0.008	0.338	<1
Scenario (6c) Application by overspray wearing waterproof clothing, cotton overalls and gloves, 200 g/L product	0.078	0.008	0.086	2
Scenario (8c) Application by hand spray wearing cotton overalls and gloves, 138 g/L product	0.046	0.008	0.054	3
Scenario (8c) Application by hand spray wearing waterproof clothing, cotton overalls and gloves, 138 g/L product	0.011	0.001	0.012	13

(1) MOE = NOEL (0.15 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d)

MOE were low and of concern for mixer/loaders of both formulations handling current containers (design). The risk to mixer/loaders was acceptable when handling wide neck containers.

Product safety directions recommend the use of water-proof clothing (or cotton overalls buttoned to the neck and wrist and PVC or rubber apron), gloves, hat and water resistant footwear, during spray application. MOE for applicators using hand-held spray equipment were inadequate when wearing cotton overalls and gloves. The risk was marginally lower, yet unacceptable, for workers wearing cotton overall, gloves and waterproof clothing. The protection afforded by water-resistant footwear and apron could not be quantified.

The exposure assessment used a work rate of 100 cattle per day, as a worst-case scenario. Information obtained during the review indicated that hand-spraying of cattle is common amongst small time "hobby farmers" who are likely to treat smaller numbers of animals. Large dairy farmers may treat more than 100 head per day, using more sophisticated equipment.

Discussion

In the absence of measured data, exposure estimates were obtained using predictive modelling for mixer/loaders and spray applicators.

The risk to workers during mixing/loading from currently registered containers and spray application was determined to be unacceptable. It is possible that these MOE may overestimate risk for the following reasons:

- *the chemical is used at intervals of 10 – 21 days (maximum 18 treatments) over the fly season;*
- *farmers are likely to treat the whole herd at the one time, therefore have an exposure free period between treatments; and*
- *many Australian farmers are likely to treat a smaller number of animals (<100) per day by hand-spraying.*

However, potential dermal and inhalation exposure (and risk) during hand spraying of cattle may be significant due to:

- *the close proximity of the operator to the animal and application equipment;*
- *the possibility of splashing and generation of spray mist; and*
- *the relatively large volumes of solution handled.*

The MOE for applicators from predictive modelling were very low (<1 to 13, for varying products and clothing scenarios). Therefore, operator exposure and risk during hand spraying is of OHS concern.

Cattle - *Wound dressing*

A chlorfenvinphos product containing 25 g/L active ingredient, is registered as a wound dressing in cattle. The product is available in 5 L containers. It is applied undiluted, at a maximum rate of 1 mL/5 kg bw, using a stencil brush or pressure sprayer.

Wound treatment is carried out as required, and herd treatment is not anticipated by this method. A minimum re-application interval of 10 days and a maximum of 5 applications per animal are specified on the product label.

Worker exposure during application using a brush is not expected to be significant. Exposure during pressure spraying of wounds is likely to be higher. Label instructions recommend that workers wear overalls, gloves, apron, goggles and water resistant footwear. Wound dressing is generally conducted outdoors. Therefore, dermal and inhalation exposure is not expected to be significant, provided label safety directions are followed.

Discussion

Considering the frequency of use, number of animals likely to be treated and work practices, worker exposure during wound dressing of cattle is not expected to be of OHS concern.

Sheep treatment - *Jetting*

Jetting is the preferred method of fly control on Australian sheep farms. Jetting may be carried out using automatic jetting races or hand-held spray equipment.

Hand jetting is more labour intensive yet more effective against fly strike. This is the preferred method of treatment where fly populations are large and/or sheep are struck (to ensure the whole wound is treated).

Available information indicated that a single operator can effectively hand-jet 500 - 800 sheep per day. Hand jetting is conducted using a "jetting gun" or wand, with a "comb-like" end. The gun/wand is connected to a motorised pressure tank (usually of 500 L - 800 L capacity). Workers are required to add the required volume of product and water into the pressure tank. Agitation is conducted mechanically. A few mixing/loading operations may be required depending on the number of animals to be treated and capacity of spray tank.

The applicator is required to stand in close proximity to the animal being treated and thoroughly saturate the wool with jetting fluid by running the comb along the wool. The volume of jetting fluid applied is dependent on the age of the animal, area(s) to be treated and length of wool. Adult sheep with more than 6 months growth require 4-5 L of jetting fluid to cover body and breech. The pressure at which the fluid is applied is also dependent on the length of wool, with lower pressures used for longer wooled animals.

Large numbers of animals can be treated daily by hand jetting, requiring workers to handle large volumes of jetting fluid. However, the concentration of active ingredient in the working strength solution is low (0.05%).

Automatic jetting results in uneven penetration and distribution of chemical. Therefore, it is relatively ineffective and provides only half the period of protection afforded by hand jetting for fly control. Automatic jetters are often used to apply a preventative treatment and protect

sheep against impending flystrike. Automatic jetting races allow rapid treatment of sheep (up to 1000 per hour) and are used to treat large mobs.

As for hand jetting, mixer/loaders are required to prepare the jetting fluid in large pressure tanks. Application of jetting fluid is an automated process. However, workers are required to remain in the vicinity of the application equipment, in order to manoeuvre animals through the spray race. It is recognised that automatic jetting equipment has the potential to generate significant quantities of spray mist. Therefore, worker exposure by the dermal and inhalation routes may be significant.

The product label does not limit the number of applications neither does it specify a re-treatment interval. However, farmers are not expected to jet long woolled sheep more than a few times per year. Therefore mixing/loading and hand jetting are expected to result in intermittent worker exposure:

Table 14: Risk associated with open mixing/loading/application for hand jetting

Scenario/application method	Daily absorbed dermal dose (mg/kg/d)	Daily absorbed inhalation dose (mg/kg/d)	Daily total absorbed dose (mg/kg/d)	MOE[1]
Scenario (1s) Mixing/loading to support hand jetting, non specific containers or wide neck containers[2]	0.005	NM	0.005	30
Scenario (2s) Application by jetting gun wearing cotton overalls and gloves	0.041	0.001	0.042	4
Scenario (2s) Application by jetting gun wearing cotton overalls, waterproof clothing and gloves	0.010	0.001	0.011	14

(1) MOE = NOEL (0.15 mg/kg/d) ÷ daily total absorbed dose (mg/kg/d)

(2) Both containers have similar hand contamination (0.01 mL per operation) and are therefore included in the same scenario

NM – not measured

MOE were low for mixer/loaders although they are only required to conduct a few open-pour operations per day and handle small (1L) containers. This reflects the high concentration of active ingredient in the product (approximately 100%). Hand contamination when handling wide neck 1 L containers is not expected to differ from the degree of contamination when pouring from containers of non-specific design (POEM assumption).

Two applicator clothing scenarios were modelled based on the options available to workers in product safety directions. The risk to workers was of concern when wearing cotton overalls and gloves as well as water-proof clothing, cotton overalls and gloves. The protection afforded by PVC or rubber apron and water resistant footwear could not be quantified.

Predictive modelling was used to obtain a rough estimate of worker exposure during hand-jetting. Worker exposure during mixing/loading for automatic jetting may be higher due to

the fact that larger numbers of animals are treated and larger volumes of product handled. However, it is recognised that automatic jetting is likely to be less common and less frequent on Australian farms than hand jetting. It is determined that applicator exposure during hand-jetting is likely to exceed applicator exposure during operation of automatic jetting races.

Discussion

Overall, when comparing the frequency of use and work practices during automatic jetting and hand jetting of sheep, potential worker exposure during hand jetting is expected to exceed worker exposure during automatic jetting.

In the absence of measured worker exposure data, exposure estimates were obtained from the POEM for mixer/loaders and hand jetters of chlorfenvinphos products.

The risk to workers during mixing/loading and hand jetting was determined to be unacceptable. It is possible that these MOE, calculated using a repeat-dose NOEL, may overestimate risk due to:

- *the probability of only a few jetting operations being carried out in any one year;*
- *farmer likely to treat mobs of sheep at any one time, with intervening periods free from exposure; and*
- *the likelihood of spillage (therefore hand exposure), when open-pouring into large pressure tanks is expected to be less than when open-pouring into a knapsack sprayer (as POEM hand-held models are designed to estimate).*

However, worker exposure during sheep jetting may be significant due to:

- *the high concentration of the chemical in the products;*
- *the large numbers of animals treated and large volumes of jetting fluid handled;*
- *the likelihood of the same worker mix/loading and hand-jetting; and*
- *the close proximity of the worker to the animal resulting in dermal and inhalation exposure.*

The MOE for workers, particularly hand-jetters from predictive modelling were very low (4 and 14, for varying clothing scenarios). Operator exposure during jetting is likely to be significant, therefore, potential worker exposure during sheep jetting is of occupational health and safety concern.

Sheep - Wound dressing/lamb marking

Three chlorfenvinphos products are registered for wound dressing/lamb marking, namely EC 1000 g/L (used diluted), EC 2.5 g/L (used undiluted) and aerosol 0.64 g/kg.

Normal husbandry practices require farmers to carry out wound dressing following docking of tails, mulesing, castrating, ear marking, vaccination and drenching (occasionally). In addition, wound dressing is also used to treat fly strike. The solution/aerosol is applied/sprayed directly to the wound and surrounding area of skin, using either a stencil brush or pressurised sprayer (for EC formulations).

Information available to this agency indicated that often, two workers form a team, treating approximately 800 - 1400 sheep per day. Whilst some products for wound dressing recommend a minimum re-treatment interval of 10 days and a maximum of 5 applications per year, other product labels do not carry such restrictions.

Workers are likely to treat a varying number of animals, depending on the extent of flystrike or husbandry practice requiring protective wound dressing. Considering the circumstances under which wound dressing would be required, it is reasonable to assume that Mixing/loading and hand dressing/lamb marking using liquid formulations and wound dressing /lamb marking using aerosol formulation may result in either regular exposure (for short periods of time) or intermittent worker exposure.

The concentration of chlorfenvinphos in the solution/aerosol is low, 0.06% in aerosol, 0.25% when used undiluted and 0.08% when used diluted.

Label safety directions require workers to wear cotton overalls, gloves, PVC or rubber apron (alternatively water-proof clothing and gloves) and water resistant footwear.

It is possible that pressurised spraying of product onto wounds may generate some spray mist. Considering that wound dressing is an outdoor activity and the concentration of active ingredient in the spray is low, inhalation exposure during wound dressing is not of concern.

Discussion

The risk to workers during wound dressing could not be quantified. However, the risk for these workers is likely to be acceptable because:

- *the concentration of chlorfenvinphos in solution/aerosol is low;*
- *the areas requiring dressing are not expected to be extensive, therefore the quantities of product/spray handled by workers will not be large;*
- *work practices and PPE recommended on product labels will minimise skin contamination;*
- *outdoor application will provide a dilution effect and mitigate inhalation of spray/aerosol;*
- *it is anticipated that farmers will have periods between treatments with no exposure to chlorfenvinphos;*
- *potential worker exposure and risk for workers involved in wound dressing is expected to be lower than workers involved in sheep jetting.*

5.3 Risk from post-application exposure

Agricultural uses

There were no chlorfenvinphos-specific post-application exposure data available. The product label indicates a restriction on re-entry/re-handling of 5 days.

As indicated in Section 4.3, agricultural use of the chemical will be in crops and situations where frequent or routine prolonged entry by persons who come in contact with treated foliage/surfaces is unlikely.

The risk to re-entry workers is likely to be acceptable, provided the product is used in accordance with good agricultural practice and label instructions.

The following REP should be included on the product label:

> Do not enter sprayed area for 5 days unless protective clothing is worn. Clothing must be laundered after each day's use.

Veterinary uses - Cattle treatment

The product labels do not include a re-handling restriction.

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 likely to be substantially lower than the risk for mixer/loaders and dip/spray applicators.

Based on this rough estimate of risk, it is determined that post-application exposures do not appear to pose an unreasonable risk to workers contacting treated animals, as long as contact is not permitted immediately after application.

Veterinary uses - Sheep treatment

Jetting applications result in higher chemical residues at shearing due to the larger quantities of jetting fluid retained in long wool and the short interval between application and shearing.

Wound dressings are generally applied at higher concentrations than jetting. Although wound dressing may be conducted relatively close to shearing, it is usually on fly-blown sheep and only to the affected area after clipping the affected wool. Although wound dressing of individually struck sheep is unlikely to result in high residue levels on a whole flock basis, it may pose an occupational hazard to workers shearing large numbers of those sheep.

There were no chlorfenvinphos-specific dissipation data available for this review.

A protocol to evaluate occupational hazard to shearers and other wool handlers was developed jointly by industry and government (NRA, 1997a).

Stage 1 of the protocol enables use of the assumptions where specific data are not available.

Weight of sheep	50 kg
Maximum amount of fluid retained in the fleece	3 L[(a)]
Amount of wool grease per animal	1 kg
Amount of wool grease adsorbed by the shearer/day	23 g[(b)]

Weight of shearer	70 kg[(c)]
Dermal absorption rate	100%[(d)]

The parameters used in the initial evaluation are as follows:

Concentration of chlorfenvinphos in product	1000 g/L
Minimum dilution	100 mL product/200 L water
Maximum application rate	5 L jetting fluid/sheep
NOEL	0.15 mg/kg/day[(e)]

(a) volume assumed when more than this amount is applied per animal

(b) assumption – a 70 kg shearer accumulated a heavy coating of wool wax (2-3 mg/cm^2) on the entire front half of his body (approximately 9000 cm^2) in the course of a day's shearing. This amounts to 23 g wool wax per day. This value is currently under review. Data are being generated in an attempt to revise this aspect of the protocol.

(c) Note this value is different to the average body weight used in the end use risk assessment

(d) The protocol assumes total absorption (100%). Based on available information, the OHS risk assessment utilised a default value of 10% for dermal absorption of chlorfenvinphos.

(e) The protocol recommends the use of the lowest NOEL. However, considering the probable duration of shearer exposure over a year, the NOEL from a 12 week dietary study in rats was considered more appropriate.

Based on the above assumptions and parameters, the amount of chlorfenvinphos absorbed by a shearer was calculated.

. Amount of chlorfenvinphos retained in the fleece will be 1500 mg

. Amount of chlorfenvinphos in 1 kg wool grease will be 1500 mg

. Amount of chlorfenvinphos in 23 g of wool grease will be 34.5 mg

. Amount of chlorfenvinphos absorbed by shearers 0.49 mg/kg bw (assuming 100% dermal absorption) or 0.049 mg/kg bw (assuming 10% dermal absorption)

On the basis of a Stage 1 evaluation, the amount of chlorfenvinphos absorbed by a shearer per day exceeds 1/100[*] of the NOEL.

[*] Consistent with current international practice, a MOE (safety factor) of 100 is more appropriate for chlorfenvinphos, given that the NOEL is derived from animal data.

Discussion

The following factors influence the amount of pesticide retained in the fleece:

- *the initial deposit of pesticide left on the sheep after treatment;*
- *the treatment regime; and*
- *subsequent distribution and dissipation of the pesticide.*

The main exposure to residues in wool for shearers and other wool handlers is through dermal absorption. It is assumed that all residues in wool are contained in the wool wax, therefore available for transfer to the handlers' skin. Factors which influence the extent of worker exposure include:

- *amount and distribution of pesticide residues in the fleece;*
- *area of skin exposed; and*
- *the rate of percutaneous absorption.*

Given that the amount of chemical absorbed by a shearer is greater than 1/100 of the NOEL, dissipation data alone (to enable a Stage II evaluation), or in combination with percutaneous absorption data (to enable a Stage III evaluation) will be required for chlorfenvinphos.

It is noted that this evaluation is conducted assuming a single application of chlorfenvinphos. Information available to this agency indicates that many farmers apply ectoparasiticides more than once per season. It is reasonable to expect that repeat applications are likely to leave higher residues in the fleece at shearing than a single application.

A safe re-handling period for shearing could not be determined for chlorfeninphos based on available data.

6. OCCUPATIONAL CONTROLS

6.1 Hazard classification

Chlorfenvinphos is listed in the National Occupational Health and Safety Commission (NOHSC) List of Designated Hazardous Substances (NOHSC, 1994a). Substances containing chlorfenvinphos are classified as harmful at concentrations greater than or equal to 0.1%, as toxic at concentrations greater than or equal to 1%, and very toxic at concentrations greater than or equal to 7%.

The risk and safety phrases assigned to chlorfenvinphos at concentrations greater than or equal to 0.1% are as follows:

Risk phrases

R24	Toxic in contact with skin
R28	Very toxic if swallowed

Safety phrases

S36/37	Wear suitable protective clothing and gloves
S45	In case of accident or if you feel unwell, contact a doctor or Poisons Information Center immediately (show the label where possible)

The revised European Commission classification has included the following additional risk and safety phrases (European Commission Directive 96/54/EC, 1996). These revisions have been picked up in the NOHSC List of Designated Hazardous Substances (NOHSC, 1997, draft).

R50	Very toxic to aquatic organisms
R53	May cause long term effects in the aquatic environment
S1/2	Keep locked up and out of reach of children
S28	After contact with skin, wash immediately with plenty of …..(material to be specified by the manufacturer)
S60	This material and its container must be disposed of as hazardous waste
S61	Avoid release to the environment. Refer to special instructions/safety data sheets

All formulations of chlorfenvinphos registered in Australia are determined to be hazardous substances based on the concentration of the active constituent they contain ie. 2.5 g/L to 1000 g/L, except the aerosol product for sheep treatment containing 0.64 g/kg.

The National Model Regulations [NOHSC:1005(1994b)] and National Code of Practice [NOHSC:2007(1994b)] for the Control of Workplace Hazardous Substances apply to all hazardous substances, as defined in the national model regulations, and extend to all workplaces in which hazardous substances are used or produced and to all persons (consistent with the relevant Commonwealth/State/Territory occupational health and safety legislation) with potential for exposure to hazardous substances in those workplaces.

6.2 Safety directions

The safety directions for chlorfenvinphos in the Handbook of First Aid Instructions and Safety Directions (1998) are as follows:

AL 3 g/L or less, with hydrocarbons 755 g/L or less	
Product is very dangerous, particularly the concentrate	120, 100, 101
Poisonous if absorbed by skin contact inhaled or swallowed.	130, 131, 132, 133
Will irritate the eyes and skin.	161, 162, 164
Repeated minor exposure may have a cumulative poisoning effect.	190
Obtain an emergency supply of atropine tablets 0.6 mg.	373
Avoid contact with eyes and skin.	210, 211
Do not inhale vapour.	220, 222
When opening the container and pouring large quantities, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat, PVC or rubber apron, elbow-length PVC gloves, goggles and water resistant footwear.	279, 280, 286, 290, 292a, 293, 294, 297, 298b.

When using the product wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat and elbow length butyl rubber gloves (if excessive splashing or contamination is likely when using the prepared dip wear protective waterproof clothing, elbow length butyl rubber gloves and water resistant footwear).	279, 283, 290, 292a, 294a (if excessive splashing or contamination is likely 279, 282, 290, 291, 294a, 298b)
If clothing becomes contaminated with product remove clothing immediately	330, 332
If product on skin, immediately wash area with soap and water.	340, 342
If product in eyes, wash it out immediately with water.	340, 343
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water	350
After each day's use, wash gloves, goggles and contaminated clothing.	360, 361, 363, 366
EC all strengths except as separately specified	
Very dangerous, particularly the concentrate	100, 101
Product is poisonous if absorbed by skin contact inhales or swallowed	120, 130, 131, 132, 133
Will irritate the eyes, nose throat and skin.	161, 162, 163, 164
Avoid contact with eyes and skin.	210, 211
Do not inhale vapour or spray mist.	220, 222, 223
Repeated minor exposure may have a cumulative poisoning effect.	190
Obtain an emergency supply of atropine tablets 0.6 mg.	373
When preparing spray and pouring large quantities wear cotton overalls buttoned to the neck and wrist and a washable hat, PVC or rubber apron, elbow-length PVC gloves, goggles, impervious footwear and a half facepiece respirator.	279, 281, 286, 290, 292, 293, 294, 297, 298, 300
When using the prepared spray wear cotton overalls buttoned to the neck and wrist and a washable hat and elbow-length PVC gloves.	279, 282, 290, 292, 294
If clothing becomes contaminated with product or wet with spray remove clothing immediately	330, 331, 332
If product on skin, immediately wash area with soap and water.	340, 342
If product in eyes, wash it out immediately with water.	340, 343
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water	350
After each day's use, wash gloves, goggles, respirator and if rubber wash with detergent and warm water and contaminated clothing.	360, 361, 363, 364, 366

EC 215 g/L or less with liquid hydrocarbons 650 g/L or less, with surfactants	
Product is very dangerous, particularly the concentrate	120, 100, 101
Poisonous if absorbed by skin contact inhaled or swallowed.	130, 131, 132, 133
May irritate the eyes and skin.	160, 162, 164
Repeated minor exposure may have a cumulative poisoning effect.	190
Obtain an emergency supply of atropine tablets 0.6 mg.	373
Avoid contact with eyes and skin.	210, 211

Do not inhale vapour or spray mist.	220, 222, 223
When opening the container, preparing the spray and pouring large quantities, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat, PVC or rubber apron, elbow-length PVC gloves, goggles and water resistant footwear.	279, 280, 281, 286, 290, 292a, 293, 294, 297, 298b.
When using the prepared spray wear protective waterproof clothing (or cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat and PVC or rubber apron) (if excessive splashing or contamination is likely when using the prepared dip wear protective waterproof clothing, (or cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat and PVC or rubber apron) elbow length butyl rubber gloves and water resistant footwear).	279, 282, 290, 291 [or 292a, 293] (if excessive splashing or contamination is likely 279, 282, 290, 291, [or 292a, 293] 294a, 298b)
If clothing becomes contaminated with product or spray remove clothing immediately	330, 341, 332
If product or spray on skin, immediately wash area with soap and water.	340, 341, 342
If product or spray in eyes, wash it out immediately with water.	340, 341, 343
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water	350
After each day's use, wash gloves, goggles and contaminated clothing.	360, 361, 363, 366

EC 1000 g/L, or less, with liquid hydrocarbons 20 g/L or less	
Product is very dangerous, particularly the concentrate	120, 100, 101
Poisonous if absorbed by skin contact inhaled or swallowed.	130, 131, 132, 133
May irritate the eyes and skin.	160, 162, 164
Repeated minor exposure may have a cumulative poisoning effect.	190
Obtain an emergency supply of atropine tablets 0.6 mg.	373
Avoid contact with eyes and skin.	210, 211
Do not inhale vapour or spray mist.	220, 222, 223
When opening the container, preparing the spray and pouring large quantities, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat, PVC or rubber apron, elbow-length PVC gloves, goggles and water resistant footwear.	279, 280, 281, 286, 290, 292a, 293, 294, 297, 298b.
When using the prepared spray wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat and elbow-length PVC gloves (if excessive splashing or contamination is likely when using the prepared dip wear protective waterproof clothing, (or cotton overalls buttoned to the neck and wrist (or equivalent clothing) and a washable hat and PVC or rubber apron) elbow length PVC gloves and water resistant footwear).	279, 282, 290, 292a, 294 (if excessive splashing or contamination is likely 279, 282, 290, 291, [or 292a, 293] 294, 298b)
If clothing becomes contaminated with product or spray remove clothing immediately	330, 341, 332
If product or spray on skin, immediately wash area with soap and water.	340, 341, 342
If product or spray in eyes, wash it out immediately with water.	340, 341, 343
After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water	350
After each day's use, wash gloves, goggles and contaminated clothing.	360, 361, 363, 366

These directions are considered acceptable.

6.3 Information provision

6.3.1 Labels

Active constituent label

Technical grade chlorfenvinphos is determined to be a hazardous substance. Therefore, it must be labelled in accordance with the NOHSC Code of Practice for the Labelling of Workplace Substances (NOHSC, 1994c)

Product labels

All chlorfenvinphos product labels, except the aerosol formulation containing 0.64 g/kg, must include a reference to the MSDS for further information.

6.3.2 MSDS

The active ingredient and products (except the aerosol formulation containing 0.64 g/L) require MSDS in accordance with the NOHSC Code of Practice for the preparation of Material Safety Data Sheets (NOHSC, 1994d).

It is noted that it is the responsibility of manufacturers and importers of chlorfenvinphos, active ingredient and products, to produce MSDS where required, and review/revise these MSDS in accordance with Commonwealth/State/Territory hazardous substances legislation.

6.4 Occupational exposure monitoring

6.4.1 Atmospheric monitoring

NOHSC has not established an exposure standard for chlorfenvinphos..

6.4.2 Health surveillance

NOHSC has placed OP pesticides (including chlorfenvinphos) on the Schedule for Health Surveillance (Schedule 3 Hazardous Substances for which Health Surveillance is Required). Guidelines are available for monitoring OP pesticides (NOHSC, 1995). The employer is responsible for providing health surveillance where estimates of workplace risk indicate surveillance.

Where health surveillance is required, 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.

7. REVIEW OUTCOMES

7.1 End use

7.1.1 Agricultural uses of chlorfenvinphos

Pastures and lucerne

The use of chlorfenvinphos in pastures is identified as being the most important agricultural use of the chemical. The use pattern parameters used in the exposure assessment are considered to be representative for the respective application method (ie. ground application and aerial application).

No suitable exposure data were available for this use pattern. Therefore, predictive modelling was used as a first tier approach, to provide a reasonable frame of reference for potential exposure of mixer/loaders and applicators, where a suitable model exists. For reasons specified in Section 5.1, the MOE obtained using model data were considered to be conservative and will overestimate risk.

Noting: (i) the infrequent use of the chemical over the growing season;
(ii) the likely overestimation of risk during broadcast spraying, from use of predictive exposure models, and
(iii) the use pattern, frequency and potential for directed spraying of pastures and lucerne,

it is concluded that the risk to workers involved in broadcast application (ground and aerial) and directed spraying of chlorfenvinphos in pastures and lucerne is likely to be acceptable under the following conditions:

(a) that exposure mitigation methods specified in Section 7.1.3 are instituted, where applicable; and
(b) the product is used in accordance with good agricultural practice and label instructions.

Potatoes

Chlorfenvinphos is currently used only as a back up chemical for the control of potato moth, hence its use is expected to be infrequent. The use pattern parameters used in the exposure assessment estimate worst-case exposures.

No exposure data were available for this use pattern. Therefore, predictive modelling was used to provide a rough estimate of potential worker exposure during broadcast spraying. As indicated in Section 5.1, MOE calculated for mixer/loaders and applicators are considered to overestimate risk.

Noting: (i) the infrequent and relatively minor use of the chemical;
(ii) the likely overestimation of risk during broadcast spraying, from use of predictive models; and
(iii) the use pattern, frequency and potential for directed spraying of potatoes,
it is concluded that the risk to workers during broadcast application and directed spraying of chlorfenvinphos in potatoes is likely to be acceptable under the following conditions:

(a) that exposure mitigation methods specified in Section 7.1.3 are instituted, where applicable; and
(b) the product is used in accordance with good agricultural practice and label instructions.

Fly control in and around farm buildings

Chlorfenvinphos is registered for the control of flies in and around farm buildings. The NRA Agricultural Assessment does not highlight this as a major agricultural use of the chemical. Inadequate information was available to accurately determine parameters for the exposure assessment. Representative values were used in the absence of data.

Hand-held spray application can result in significant worker exposure. No exposure data were available for this use pattern. Therefore, predictive modelling was used to obtain a rough estimate of potential worker exposure.

In a first tier (modelled) risk assessment, the risk to mixer/loaders was unacceptable when handling currently registered containers (size and design). The risk to applicators wearing label specified PPE, was unacceptable during low- and high-level spray application. The risk to workers performing combined tasks is also determined to be unacceptable.

Noting:
(i) the potential for significant operator exposure during hand-spraying;
(ii) the lack of adequate Australian use pattern information;
(iii) possible regular (seasonal) use of the chemical; and
(iv) the lack of measured exposure data,
it is concluded that the risk to workers during hand-held application of chlorfenvinphos for fly control in farm buildings is unacceptable on occupational health and safety grounds. Additional worker exposure data and use pattern information are required. Refer to Section 7.3 for data requirements.

Whilst continued use is supported pending data generation, exposure mitigation methods specified in Section 7.1.3 should be instituted, where applicable, during any agreed interim data collection period.

Fly control in mushrooms

Chlorfenvinphos is registered only for incorporation into mushroom casing. Information available on this use of chlorfenvinphos indicates it is one of several chemicals available to the industry for fly control. In addition, the duration of control has decreased over time and

is presently estimated to be round 2 weeks following incorporation into casing. Agricultural practices within the industry, ie. chemical control instituted only when pest pressure exceeds economic threshold, minimises the frequency of use.

No measured exposure data were available for this use pattern. A suitable model does not exist within POEM to estimate potential worker exposure.

Noting: (i) the short-duration of control afforded by chlorfenvinphos;
(ii) the availability of several chemicals for fly control in mushrooms; and
(iii) agricultural practices within the industry,
it is concluded that the risk to workers during incorporation of chlorfenvinphos to mushroom casing is likely to be acceptable under the following conditions:

(a) that exposure mitigation methods specified in Section 7.1.3 are instituted, where applicable; and
(b) the product is used in accordance with good agricultural practice and label instructions.

7.1.2 Veterinary uses of chlorfenvinphos

Cattle treatment - Backrubber preparation

Chlorfenvinphos is registered for incorporation in cattle backrubbers for buffalo fly control. Inadequate information was available to accurately determine the extent of use of chlorfenvinphos for this use pattern.

No exposure data were available and a suitable model was not identified to estimate worker exposure.

Noting: (i) the frequency of use of chlorfenvinphos which is likely to result in intermittent worker exposure rather than regular (daily) exposure;
(i) the work practices when preparing cattle backrubbers; and
(ii) the PPE specified on the product label,
it is concluded that the risk to workers during preparation of cattle backrubbers is likely to be acceptable under the following conditions:

(a) that exposure mitigation methods specified in Section 7.1.3 are instituted, where applicable; and
(b) the product is used in accordance with label instructions.

Cattle - Plunge dip and spray race operations

The use of chlorfenvinphos in plunge dips and spray races is identified as a major use of the chemical. Large numbers of animals are treated, requiring workers to handle large quantities of product. The use pattern parameters used in the exposure assessment are considered to be representative of cattle farms in Australia.

No measured worker exposure data were available. Predictive modelling was used to roughly estimate worker exposure during mixing and loading only. As noted, MOE obtained using the POEM may over-estimate risk as conservative default values are used.

Potential worker exposure during actual dipping and spraying could not be quantified. It is recognised that these are potentially high exposure scenarios.

Noting: (i) the large numbers of animals treated and the quantity of chemical handled by these workers;
(ii) the potential for high operator exposure, particularly during dip/spray operations; and
(iii) the lack of measured exposure data,

it is concluded that the risk to workers involved in cattle dipping and automatic spraying could not be adequately quantified. Additional worker exposure data are required in order to assess this use of chlorfenvinphos with any degree of confidence. Refer to Section 7.3 for data requirements.

Whilst continued use is supported pending data generation, exposure mitigation methods specified in Section 7.1.3 should be instituted, where applicable, during any agreed interim data collection period.

It is noted that label safety directions permit a choice of either protective water-proof clothing or cotton overalls buttoned to the neck and wrist (or equivalent clothing) and PVC or rubber apron, when using the prepared spray/dip solution. During this interim data collection period, it is preferable that workers involved in plunge dipping and spray race operations wear water proof clothing over normal work clothing, instead of a PVC or rubber apron over cotton overalls buttoned to the neck and wrist, in order to provide maximum protection to torso and limbs. In either case, workers are also required to wear gloves, a hat and water-resistant footwear.

Cattle - Hand spraying

Hand spraying is a common method of chlorfenvinphos use for buffalo fly control. The use pattern parameters used in the exposure assessment, estimate worker exposure for a worst-case scenario.

No measured worker exposure data were available. In a first tier risk assessment, predictive modelling was used to obtain a frame of reference for potential worker exposure. MOE obtained using the POEM may over-estimate the risk to these workers, nevertheless, it is noted that MOE for spray applicators were very low.

Noting: (i) work practices within the industry;
(ii) the potential for high operator exposure during hand spraying of cattle; and
(iii) the lack of measured exposure data,

it is concluded that the risk to workers involved in hand spraying of cattle could not be adequately quantified. Therefore, additional worker exposure data are required. Refer to Section 7.3 for data requirements.

Whilst continued use is supported pending data generation, exposure mitigation methods specified in Section 7.1.3 should be instituted, where applicable, during any agreed interim data collection period.

Cattle - Wound dressing

Chlorfenvinphos is used undiluted, as a wound dressing in cattle. Individual animal treatment rather than herd treatment is anticipated. Label specifications recommend a minimum re-application interval (10 days) and maximum number of applications (5) per animal.

No measured worker exposure data were available for this use pattern of chlorfenvinphos. As indicated in Section 5.2, worker exposure and risk are not expected to be of occupational health and safety concern, under the following conditions:

(a) that exposure mitigation methods specified in Section 7.1.3 are instituted, where applicable; and
(b) the product is used in accordance with label instructions.

Sheep treatment - Jetting

Sheep jetting is the favoured method of chlorfenvinphos use for the control and treatment of fly strike in Australia. The product registered for sheep jetting contains approximately 100% active constituent. Large numbers of sheep are jetted at any given time, therefore large quantities of jetting fluid are handled by workers. A quantitative risk assessment was carried out for hand jetting (determined to be the worst-case scenario) using representative use pattern parameters.

No measured exposure data were available. In a first tier risk assessment, exposure estimates from predictive modelling were used as a reference for hand-jetting operations. It is possible that MOE obtained using POEM may overestimate risk in this case, however, it is noted that the MOE were very low particularly for hand-jetters.

Noting: (i) the high concentration of active constituent in the product;
(ii) the large numbers of animals treated and large quantities of jetting fluid handled;
(iii) the potential for high operator exposure during hand jetting; and
(iv) the lack of measured exposure data,

it is concluded that the risk to workers involved in sheep jetting could not be adequately quantified. Given the potential for significant use of the chemical, it is concluded that additional worker exposure data are required. Refer to Section 7.3 for data requirements.

Whilst continued use is supported pending data generation, exposure mitigation methods specified in Section 7.1.3 should be instituted, where applicable, during any agreed interim data collection period.

It is noted that label safety directions permit a choice of either protective water-proof clothing or cotton overalls buttoned to the neck and wrist (or equivalent clothing) and PVC or rubber

apron, when using the prepared spray/dip solution. During this interim data collection period, it is preferable that workers involved in plunge dipping and spray race operations wear water proof clothing over normal work clothing, instead of a PVC or rubber apron over cotton overalls buttoned to the neck and wrist, in order to provide maximum protection to torso and limbs. In either case, workers are also required to wear gloves, a hat and water-resistant footwear.

Sheep treatment - Wound dressing/lamb marking

Chlorfenvinphos is used as an aerosol and liquid for wound dressing of sheep and lambs. Although mob treatment may be undertaken, such activity is expected to be intermittent or regular over short periods of time only.

No measured exposure data were available for this use pattern. Worker exposure and risk could not be quantified. However, as indicated in Section 5.2, the risk to workers wound dressing sheep and lambs is not expected to be significant under the following conditions:

(a) that exposure mitigation methods specified in Section 7.1.3 are instituted, where applicable; and
(b) the product is used in accordance with label instructions.

7.2 Post-application

Agricultural uses

The review indicated that the risk to re-entry workers is likely to be acceptable, provided the chemical is used in accordance with good agricultural practices and label instructions.

The current REP of 5 days is adequate for chlorfenvinphos products.

Veterinary uses - Cattle

The risk to workers re-handling treated cattle is not likely to be significant when good animal husbandry practices are observed.

A re-handling restriction is not required for chlorfenvinphos use in cattle at this stage.

Veterinary uses - Sheep

The review indicated that the risk to workers re-handling sheep is likely to be acceptable provided workers do not come in direct contact with sheep soon after treatment and good animal husbandry practices are followed.

The risk to shearers and other wool handlers was determined to be unacceptable, based on a first tier assessment. A safe wool re-handling period could not be determined for chlofenvinphos.

7.3 Recommendations/Conclusions

In light of the recent report from the NRA Expert Panel the occupational health and safety recommendations have been changed substantially. Please refer to the Review Summary for further detail.

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