AUSTRALIAN PESTICIDES AND VETERINARY MEDICINES AUTHORITY

NATIONAL REGISTRATION SCHEME

FOR AGRICULTURAL AND VETERINARY CHEMICALS

AUSTRALIA

CHEMICAL REVIEW PROGRAM

OCCUPATIONAL HEALTH AND SAFETY ASSESSMENT

OF

FIPRONIL

Prepared by the

Office of Chemical Safety and Environmental Health
Office of Health Protection

of the

Department of Health and Ageing

Canberra

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GLOSSARY OF TERMS AND ABBREVIATIONS

ai	Active ingredient
bw	Bodyweight
cm^3	Cubic centimetre
g	Gram
ha	Hectare
h	Hour
kg	Kilogram
L	Litre
m^2	Square metre
m^3	Cubic metre
mg	Milligram
min	Minute
ml	Millilitre
μg	Microgram

AERP	Adverse Experience Reporting Program
APVMA	Australian Pesticides and Veterinary Medicines Authority
AOEL	Acceptable operator exposure level
BA	Bait
DoHA	Department of Health and Ageing
EUP	End-use product
EC	Emulsifiable concentrate
CRP	Chemical Review Program
GR	Granules
IPM	Integrated pest management
MOE	Margin of exposure
NOEL	No observable effect level
NOHSC	National Occupational Health and Safety Commission
OCSEH	Office of Chemical Safety and Environmental Health
OHS	Occupational health and safety
PHED	Pesticide Handlers Exposure Database
PCO	Pest control operators
PPE	Personal protective equipment
RBC	Red blood cell
SC	Suspension concentrate
US EPA	United States Environment Protection Agency
WG	Wettable granules
WHP	Withholding period

1 EXECUTIVE SUMMARY

Fipronil belongs to the phenylpyrazole family and acts by blocking the gamma-aminobutyric acid regulated chloride channels. It is a broad-spectrum insecticide and is used to control insect pests in a wide range of agricultural crops. Fipronil products are also used as insecticidal seed dressings and for the control of termites, cockroaches and ants in residential and commercial buildings. In veterinary situations, fipronil products are used as spray-on or concentrated spot-on formulations to control fleas and ticks on cats and dogs.

Following a number of reports of adverse experiences, such as skin reactions in humans, neurological signs and deaths in target animals, associated with the use of fipronil products, the APVMA has decided to review fipronil and reconsider the safety of people using products containing fipronil.

Risk assessment of fipronil products intended for commercial application indicated that safety directions on product labels needed to be revised. In particular, chemical resistant clothing; chemical resistant footwear and gloves are required when mixing/loading SC formulations by open mixing/loading system. Workers applying the diluted product by hand application method (including for termite treatment) will also need respiratory protection in addition to the above PPE. For all other application methods, one layer of clothing, with or without gloves, is considered to provide adequate protection. Risk to farmers treating peatmoss (mushroom cultivation) or treating seed (except by commercial treaters) could not be quantified due to lack of appropriate exposure data or exposure models. Exposure to fipronil is likely to occur when applying diluted product during these treatment methods. Workers would therefore need to wear cotton overalls or equivalent clothing and gloves.

All veterinary uses were assessed qualitatively. The following re-handling statement is recommended for fipronil animal spray product labels: *"Animals treated with fipronil spray formulations should not be handled till the spray has dried. If prior handling is required, workers should wear rubber gloves".*

Safe re-entry intervals were calculated for each crop, taking into account the amount of fipronil applied and the degradation of fipronil on foliage. The photolytic metabolite of fipronil, fipronil-desulfinyl (MB 46513), has repeat-dose toxicity similar to that of the parent compound, resulting in the same end-point for both compounds. A default 1% degradation rate for fipronil or its metabolite was assumed for risk assessment and re-entry interval calculations. Considering the type and duration of the post-application activities, a NOEL from a short-term dermal study was used. Results indicated a 0-day re-entry interval (ie. when the spray has dried) for all applications except brassica and turf. Exposure estimation during post-application activities in brassica (hand harvesting, irrigation, pruning, topping, tying mature plants) indicated an unacceptable risk to workers in the absence of PPE for up to 13 days after application. A re-entry interval of 13 days for hand harvesting, irrigation, pruning, topping, tying mature plants is recommended. Exposure estimation during post-application activities in turf (hand-weeding and transplanting) indicated an unacceptable risk to workers in the absence of PPE for up to 35 days after application. A re-entry interval of 35 days for hand-weeding and transplanting turf is recommended.

The air concentration of fipronil in dwellings treated for termite control was found to be very low and considered unlikely to pose an unacceptable risk to residents occupying the areas soon after treatment.

2 INTRODUCTION

Fipronil is a broad-spectrum insecticide and belongs to the phenylpyrazole family, which acts by blocking the gamma-aminobutyric acid regulated chloride channels, disrupting CNS activity.

In Australia, products containing fipronil are used to control insect pests in a wide range of agricultural and non-agricultural situations (termite control) and as insecticidal seed dressing in rice, canola, sorghum and cotton. Fipronil is also included in a number of household products and commercial building treatments such as cockroach baits and gels and in ant bait stations. It is also used in veterinary chemical products as a spray-on or concentrated spot-on formulation to control fleas and ticks on cats and dogs.

Fipronil is one of the agricultural and veterinary chemicals identified as candidates for priority review under the Australian Pesticides and Veterinary Medicine Authority Chemicals Review Program. This occupational health and safety (OHS) assessment considered only registered products and end uses which have potential for occupational exposure.

3 FIPRONIL PRODUCTS AND THEIR USE PATTERNS

Currently, 41 fipronil products are registered in Australia, of which four home garden (HG) products have been assessed in the OCSEH review of mammalian toxicology of fipronil. Twelve agricultural and 13 home veterinary (HV) products are within the scope of this OHS assessment (Table 1). The remaining products were registered after the data call-in period and are not part of this assessment.

Agricultural products containing fipronil are used to control a wide range of insect pests in bananas, brassica, cotton, potatoes, grapes, sugarcane and mushroom and as insecticidal seed dressing in rice, canola, sorghum and cotton. They are also used as ultra low volume (ULV) sprays to control locusts in pasture and sorghum. A granular formulation is registered for use in recreational domestic and commercial turf. In non-agricultural situations, fipronil products are used for the control of termites, cockroaches and ants in houses and commercial buildings.

Veterinary products containing fipronil are marketed for use on cats and dogs as ready-to-use spray or concentrated spot-on formulations. Four of the products also include the active constituent, (S)-methoprene and are intended for the control of fleas and biting lice as well as the treatment and control of allergy dermatitis. The products are mostly applied by pet owners monthly for flea control in cats and dogs, or every two weeks for tick control in dogs. Some products may also be occasionally used by veterinarians and pet groomers.

Although most of the gel formulations of fipronil indicated for the control of cockroach infestation are mainly HG products, they may be used by pest controllers as part of maintenance treatments. However, the pack sizes of these products are very small (35 grams, maximum) and the application volume is so small (applied as tiny spots in crevices and cracks) that large exposure to these products is unlikely. Safety directions arising from toxicological evaluation of these products were considered adequate for pest controllers, hence an OHS assessment of the gel and bait formulations of fipronil was not conducted (except for Goliath Cockroach Gel, which is indicated for use only by professional pest control operators).

Two entries in the FAISD have been added since the start of this review. These are DU 5 g/kg or less, and GB 0.2 g/kg or less. DU 5 g/kg or less has been assessed in respect to the necessity for the 180 statement only, and not evaluated further. GB 0.2 g/kg or less should be deleted, as there are no registered products in this category.

Fipronil products covered in this assessment are listed in Table 1. Appendix I lists the products assessed in the OCSEH review of mammalian toxicology of fipronil. Appendix II gives general information on regulatory actions on fipronil by overseas regulatory authorities.

Table 1: Summary of fipronil products assessed in this report

Agricultural use products

APVMA Product Code	Product Name	Fipronil Content	Description	Pack size
46793	REGENT 200SC INSECTICIDE	200 g/L	SC; insect control in bananas, brassicas, cotton, wine grapevines, mushrooms, pasture, potatoes, sorghum and sugarcane	2.5, 5, 10 and 20 L
47407	REGENT 800WG INSECTICIDE	800 g/kg	WG; insect control in bananas, brassicas, cotton, wine grapevines, mushrooms, pasture, potatoes, sorghum and sugarcane	0.5, 1 and 5 kg
48921*	CHIPCO CHOICE INSECTICIDE	1 g/kg	GR; For the control of a wide range of insect pests in recreational, domestic and commercial turf	0.3, 1, 2.5, 5, 10, 15, 22.8 kg
49434	COSMOS INSECTICIDAL SEED TREATMENT	500 g/L	SC; Insecticidal seed treatment for the control of insect pests in canola, rice, sorghum and sunflowers	0.5, 1, 5, 10, 20, 50, 100 and 200 L
49647	GOLIATH COCKROACH GEL	0.5 g/kg	BA; For the control of cockroaches in buildings	35 g
50285	ADONIS 8.5 UL INSECTICIDE	8.5 g/L	ULV; For the control of locusts and grasshoppers in pasture and sorghum	5, 10, 20, 50, 80, 90, 100, 200 and 1000 L
51371	SEMEVIN SUPER SEED DRESSING INSECTICIDE	80 g/L	SC; For the control of false wireworm and thrips in cotton (With 400 g/L thiodicarb)	1, 5, 10, 20, 50, 100, 200, 500 and 1000 L
53156	ADONIS 3UL INSECTICIDE	3 g/L	ULV; For the control of locusts in pasture and sorghum	50, 80, 90, 100, 110, 200 and 1000 L

APVMA Product Code	Product Name	Fipronil Content	Description	Pack size
53264*	PRESTO INSECTICIDE	200 g/L	SC; For the control of mushroom flies in mushroom houses	1, 2.5, 5, 10 and 20 L
53737*	PRESTO 100 INSECTICIDE	100 g/L	SC; For the control of mushroom flies in mushroom houses	1, 2.5, 5, 10 and 20 L
54624	TERMIDOR RESIDUAL TERMITICIDE	100 g/L	SC For the control of subterranean termites around domestic and commercial structures	2.5, 5, 10 and 20 L
57764	IMPEDE INSECTICIDE	1 g/kg	Granule; For the control of insect pests in recreational, domestic and commercial turf	300, 400, 450, 500, 550, 600, 650, 700, 750, 800, 900 g, and 1, 2.5, 5, 15 and 22.68 kg

SC= Suspension concentrate; WG= Wettable granule; ULV = Ultra low volume; *= no longer registered.

Table 1: Summary of fipronil products assessed in this report….continued

Veterinary products

APVMA Product Code	Product Name	Fipronil Content	Description	Pack size
46828	FRONTLINE SPRAY	2.5 g/L	Topical aerosol spray; for the treatment and prevention of flea infestations and control of flea allergy dermatitis, ticks and biting lice on dogs and cats	100 mL, 250 mL, 500 mL
48523	FRONTLINE TOP SPOT CAT	100 g/L	Topical solution/suspension; for the treatment and prevention of flea infestations and control of flea allergy dermatitis and biting lice on cats	3 x 0.5; 6 x 0.5 mL pipettes
48606	FRONTLINE TOP SPOT SMALL DOG		Topical cream, ointment, paste, gel, lotion: for the treatment and prevention of flea infestations and control of ticks on dogs up to 10 kg	3 x 0.67 mL; 6 x 0.67 mL pipettes
49825	FRONTLINE TOP SPOT MEDIUM DOG		Topical cream, ointment, paste, gel, lotion: for the treatment and prevention of flea infestations and control of ticks on dogs weighing 10 to 20 kg	3 x 1.34 mL; 6 x 1.34 mL pipettes
49826	FRONTLINE TOP SPOT LARGE DOG		Topical cream, ointment, paste, gel, lotion: for the treatment and prevention of flea infestations and control of ticks on dogs weighing 20 to 40 kg	3 x 2.68 mL; 6 x 2.68 mL pipettes

APVMA Product Code	Product Name	Fipronil Content	Description	Pack size
51304	STARTGARD FOR PUPPIES*	100 g/L	Oral chewable + topical cream, ointment, paste, gel: for initial treatment for fleas, ticks, ascarids and hookworms in puppies and to prevent heartworm disease. Also contains 68 µg ivermectin and 57 mg pyrantel per tablet	1 tablet + 1 x 0.67 mL pipette
51530	STARTGARD FOR KITTENS*		Oral chewable + topical cream, ointment, paste, gel: for initial treatment for fleas and hookworms in kittens, and to prevent heartworm disease. Also contains 55 µg ivermectin per tablet	1 tablet + 1 x 0.5 mL pipette
52043	FRONTLINE TOP SPOT EXTRA LARGE DOG		Topical cream, ointment, paste, gel, lotion: for the treatment and prevention of flea infestations and control of ticks on dogs weighing 40 to 60 kg	3 x 4.02 mL; 6 x 4.02 mL pipettes
52327	FRONTLINE TOP SPOT FOR DOGS		Topical solution/suspension; for the treatment and prevention of flea infestations, control of flea allergy dermatitis, control of ticks and biting lice on dogs	3 x 0.67 mL; 6 x 0.67 mL 3 x 1.34 mL; 6 x 1.34 mL 3 x 2.68 mL; 6 x 2.68 mL 3 x 4.02 mL; 6 x 4.02 mL pipettes

APVMA Product Code	Product Name	Fipronil Content	Description	Pack size
54523	FRONTLINE PLUS (FIPRONIL PLUS (S)-METHOPRENE) FOR DOGS	100 g/L	Topical solution/suspension; for the control of fleas, flea allergy dermatitis, paralysis, biting lice and ticks on dogs. Also contains 90 g/L (S)-methoprene	3 x 0.67 mL; 6 x 0.67 mL 3 x 1.34 mL; 6 x 1.34 mL 3 x 2.68 mL; 6 x 2.68 mL 3 x 4.02 mL; 6 x 4.02 mL pipettes
54524	FRONTLINE PLUS (FIPRONIL PLUS (S)-METHOPRENE) FOR CATS		Topical solution/suspension; for the control of fleas, flea allergy dermatitis and biting lice on cats. Also contains 120 g/L (S)-methoprene	3 x 0.5 mL; 6 x 0.5 mL pipettes
56123	STARTGARD PLUS FOR PUPPIES*		Oral bolus/chewable + topical solution/suspension; for initial treatment for fleas, ticks, biting lice, roundworms and hookworms and to prevent heartworm disease in puppies. Also contains 90 g/L (S)-methoprene (in pipette) and 68 µg ivermectin and 57 mg pyrantel per tablet	1 tablet + 1 x 0.67 mL pipette
56124	STARTGARD PLUS FOR KITTENS*		Oral bolus/chewable + topical solution/suspension; for initial treatment for fleas, flea allergy dermatitis, biting lice and hookworms and to prevent heartworm disease in kittens. Also contains 120 g/L (S)-methoprene (in pipette) and 55 µg ivermectin per tablet	1 tablet + 1 x 0.5 mL pipette

*These are combination products containing Frontline Top Spot and Heartgard in the one package. The Frontline Top Spot pipettes in these kits are the size equivalent of the pipettes for the ‘small dog’ and ‘small cat’ products.

3.1 Label information and current safety directions

Following is a brief description of the use pattern and existing safety directions (as listed in FAISD Handbook Edition 1/2009) for all fipronil products in this review.

Agriculture Products

HG BA 0.5 g/kg or less: Goliath Cockroach Gel (35 g pack size) is a gel formulation for crevice, crack or spot treatment for the control of cockroaches by professional pest control operators. The product is applied as a 0.03-0.06 g spot on the surface. About 1-3 spots per square meter are recommended. Due to the small amounts of the product applied, large-scale exposure of pest control operators to the product is not likely. The current safety directions for gel baits are as follows:

HG BA gel 0.5 g/kg or less	
160 162 164	May irritate the eyes and skin
210 211	Avoid contact with eyes and skin
351	Wash hands after use

GR 1 g/kg or less: Chipco Choice Insecticide (0.3, 1, 2.5, 5, 10, 15 and 22.8 kg pack sizes) and Impede Insecticide (300, 400, 450, 500, 550, 600, 650, 700, 750, 800, 900 g, and 1, 2.5, 5, 15 and 22.68 kg pack sizes) are granular formulations of fipronil, containing 1 g/kg fipronil. Chipco Choice Insecticide is no longer registered. Both products are indicated for the control of a wide range of insect pests in recreational, domestic and commercial turf. The products are applied by distributing granules evenly on turf surface using powered bait spreaders or mechanical fertilizer spreaders. Safety directions on the product labels comply with the current safety directions which are as follows:

GR 1 g/kg or less	
161 162	Will irritate the eyes
210 162	Avoid contact with eyes
351	Wash hands after use

UL 25 g/L or less: Adonis 3UL Insecticide (50, 80, 90, 100, 110, 200 and 1000 L container sizes) and Adonis 8.5UL Insecticide (5, 10, 20, 50, 80, 90, 100, 200 and 1000 L container sizes) are the ultra low volume (UVL) formulations containing 3 g/L, 8.5 g/L and 3 g/L fipronil, respectively. The products are for the control of locusts and grasshoppers in pastures and sorghum and are only available for use by the Australian Plague Locust Commission (APLC) or its approved applicators. The products are applied by aircraft through ULV spray units undiluted or diluted with compatible spraying oil.

The product labels comply with the current safety directions recommended for 25 g/L or less SC products, which are as follows:

UL 25 g/L or less	
161 162	Will irritate the eyes
210 162	Avoid contact with eyes
279 280 281 290 294	When opening the container and preparing spray wear elbow-length PVC gloves
351	Wash hands after use
360 361	After each day's use wash gloves

SC 100 g/L or less: Presto 100 Insecticide (1, 2.5, 5, 10 and 20 L pack sizes) and Termidor Residual Termiticide (2.5, 5, 10 and 20 L pack sizes) are SC formulations containing 100 g/L or less fipronil. Presto 100 Insecticide is no longer registered. It was used for the control of mushroom flies in mushroom houses. It was diluted with water and applied to peatmoss during preparation of casing by hand-held equipment or spray boom fixed to the top of peat moss turning machine.

Termidor Residual Termiticide is indicated for the control of subterranean termites around domestic and commercial structures. It is applied using hand-held equipment including soil injection (rodding) and trenching.

The product labels of the two products provided by the registrants do not comply with the current safety directions recommended for products containing fipronil at 100 g/L or less as SC formulation. The currently registered safety directions for SC 100 g/L or less fipronil are as follows:

SC 100 g/L or less	
161 162 164	Will irritate the eyes and skin
180	Repeated exposure may cause allergic disorders
210 211	Avoid contact with eyes and skin
351	Wash hands after use
279 280 281 282 290 291b 300 303 295	When opening the container, preparing spray and using the prepared spray wear chemical resistant clothing buttoned to the neck and wrist and a washable hat, half face piece respirator with combined dust and gas cartridge and elbow-length PVC or nitrile gloves
360 361 366 364	After each day's use, wash gloves, contaminated clothing and respirator, and if rubber wash with detergent and warm water

SC 200 g/L or less, more than 100 g/L: Regent 200SC Insecticide and Presto Insecticide are formulations containing 200 g/L fipronil. Regent 200SC is available in 2.5, 5, 10 and 20 L pack sizes and is indicated for insect control in bananas, brassicas, cotton, wine grapevines, mushrooms, pasture potatoes sorghum and sugarcane. It is diluted before application either by ground (boom spray or hand-held equipment) or by aerial application. Presto Insecticide is no longer registered. It was for the control of mushroom flies in mushroom houses and is available in 1, 2.5, 5, 10 and 20 L pack sizes. It was applied only as ground application by hand-held equipment.

The product labels (Regent and Presto) provided by the registrant do not comply with the current safety directions recommended for SC formulations containing fipronil at 200 g/L or less, which are as follows:

SC 200 g/L or less, more than 100 g/L	
129 132 133	Harmful if inhaled or swallowed
161 162 164	Will irritate the eyes and skin
180	Repeated exposure may cause allergic disorders
210 211	Avoid contact with eyes and skin
279 280 285 290 292b 294 297	When opening the container and preparing product for use, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and elbow-length PVC gloves and goggles
279 282 290 292b 294	When using the prepared spray, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and elbow-length PVC gloves
351	Wash hands after use
360 361 363 366	After each day's use, wash gloves, goggles and contaminated clothing

SC 500 g/L or less, more than 200 g/L: Cosmos Insecticidal Seed Treatment contains 500 g/L fipronil and is available in 0.5, 1, 5, 10, 20, 50, 100 and 200 L pack sizes. The product is used to treat seed and grain stored for sowing to control various insect pests and to protect seedlings from attack by insect pests.

The application rates for sorghum/sunflowers and canola are 150 and 400 mL per 100 kg seed, respectively. For rice treatment, 20 ml product per 100 kg seed is recommended. Seed is treated as a coarse shielded spray as it comes on a conveyor belt. Alternatively, seed is poured into a closable mixing vat and the diluted product is added to the seed followed by vigorous shaking. The product label for Cosmos complies with the current safety directions for SC formulations containing 200 to 500 g/L fipronil, which are as follows:

SC 500 g/L or less, more than 200 g/L	
130 132 133	Poisonous if inhaled or swallowed
210 164	Avoid contact with skin
279 280 285 282 290 292b 294	When opening the container, preparing product for use and using the prepared spray, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and elbow-length PVC gloves
351	Wash hands after use
360 361 366	After each day's use, wash gloves and contaminated clothing

WG 800 g/kg or less: Regent 800WG Insecticide is a wettable granule formulation containing 800 g/kg fipronil. It is available in 0.5, 1 and 5 kg pack sizes and is indicated for insect control in bananas, brassicas, cotton, wine grapevines, mushrooms, pasture, potatoes, sorghum and sugarcane. Regent 800WG Insecticide is applied by ground (boom spray or hand-held equipment) as well as by aerial application. The product is diluted with water before application.

The label for Regent 800WG Insecticide complies with the current safety directions for WG 800 g/kg or less products, which are as follows:

WG 800 g/kg or less	
130 131 132 133	Poisonous if absorbed by skin contact, inhaled or swallowed
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
220 221	Do not inhale dust
279 280 285 282 290 292b 294 299	When opening the container, preparing product for use, and using the prepared spray, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing), elbow length PVC gloves, and face shield or goggles
340 343	If product in eyes, wash it out immediately with water
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 365 366	After each day's, wash gloves, face shield or goggles and contaminated clothing

SC 80 g/L or less with thiodicarb 400 g/L or less: Semevin Super Seed Dressing Insecticide (1, 5, 10, 20, 50, 100, 200, 500 and 1000 L pack sizes) contains 400 g/L thiodicarb and 80 g/L fipronil and is indicated for the control of false wireworm and thrips in cotton seed. It is used as a seed coating using commercial seed coating equipment.

The label for Semevin Super Seed Dressing Insecticide complies with the current safety directions for 'Thiodicarb SC 400 g/L or less with fipronil 80 g/L or less' products, which are as follows:

Thiodicarb SC 400 g/L or less with fipronil 80 g/L or less	
130 132 133	Poisonous if inhaled or swallowed
161 162	Will irritate the eyes
190	Repeated minor exposure may have a cumulative poisoning effect
210 211	Avoid contact with eyes and skin
220 222	Do not inhale vapour
279 280 281 282 290 292 294 296 298 300 303	When opening the container, preparing spray and using the prepared spray wear cotton overalls buttoned to the neck and wrist and a washable hat, elbow-length PVC gloves, face shield, impervious footwear and half facepiece respirator with combined dust and gas cartridge
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 362 364 366	After each day's use wash gloves, face shield, respirator and if rubber wash with detergent and warm water and contaminated clothing

Veterinary Products

HV LD 2.5 g/L or less

Frontline Spray (100 mL, 250 mL and 500 mL) contains 2.5 g/L fipronil and is indicated for the treatment and prevention of flea infestations, control of flea allergy dermatitis, control of ticks (including paralysis ticks) and biting lice on dogs and cats.

The product labels for the 100, 250 and 500 mL Frontline Spray (APVMA approved labels) do not comply with the following existing safety directions for HV LD 2.5 g/L or less:

HV LD 2.5 g/L or less	
161 162	Will irritate the eyes
180	Repeated exposure may cause allergic disorders
210 162	Avoid contact with eyes
279 283 290 312	When using the product wear rubber gloves
340 343	If product in eyes, wash it out immediately with water
351	Wash hands after use
360 361	After each day's use, wash gloves

HV SA 100 g/L or less: The Frontline Top Spot, Frontline Plus and Startgard ranges of spot-on products (SA, 100 g/L fipronil). Frontline Top Spot for small dogs up to 10 kg, medium dogs 10-20 kg, large dogs 20-40 kg and extra large dogs 40-60 kg, is supplied in unit sizes of 0.67 mL, 1.34 mL, 2.68 mL and 4.02 mL respectively, in packs of 3 or 6 foil-backed trays of single-use pipettes. The unit size for Frontline Top Spot for cats is a 0.5 mL pipette, also available in packs of 3 or 6. Frontline Plus is identical to the Frontline Top Spot range of products, except that it contains the additional active constituent (S)-methoprene, at 90 g/L or 120 g/L for dogs and cats respectively. The Startgard range comprises kits of one tablet from the Heartgard range (active constituents ivermectin, or ivermectin and pyrantel) and one pipette from the Frontline Top Spot or Frontline Plus range. As these kits are intended for the treatment of puppies and kittens, the pipettes are the smallest sizes in the Frontline ranges (0.5 mL for kittens and 0.67 mL for puppies).

The product labels for the spot-on products do not comply with the following existing safety directions for HV SV 100 g/L or less:

HV SA 100 g/L or less	
161 162 164	Will irritate the eyes and skin
180	Repeated exposure may cause allergic disorders
210 211	Avoid contact with eyes and skin
340 343	If product in eyes, wash it out immediately with water
351	Wash hands after use

3.2 Use pattern of fipronil products

The following table details the application rates, dilution and application methods of fipronil products on various crops and other non-agricultural situations.

Table 2: Use pattern of fipronil products

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Bananas	Banana rust thrips	Butt application: **200 SC:** 150 mL/100 L water (0.03%) (0.75 mL/stool) **800 WG:** 37.5 g/100 L water (0.03%) (0.19 g/stool) Band application: **200 SC:** 40 mL/100 m^2 (or 4 L product in 1300 L water/ha; 0.062%) **800 WG:** 10 g/100 m^2 (or 1 kg product in 1300 L water/ha; 0.062%)	One application two months prior to bunch emergence.	Butt application: Applied as a coarse spray covering the stem to a height of 30 cm and the soil in a 30 cm radius from the stem base. A total volume of 500 mL solution is applied per stool (Hand spraying either as knapsack or handgun connected to spray tank). In Australia, the Cavendish variety is grown at a density of 1800 plants per hectare and the Lady's finger variety is grown at a density of 800 plants per hectare (Information provided by NSW DPI). Band application: Applied as a 30 cm wide band on each side of the butt. Applied with a side delivery boom and nozzles are adjusted to spray at least 30 cm of soil on either side of the butt and to a height of 30 cm up the stem. Applied at a minimum water volume of 13 L/100 m^2 (trash removed) or 26 L/100 m^2 (trash retained).
	Banana weevil borer			Apply by butt application as described for banana rust thrip. Applications should be made in Spring and/or Autumn when weevil numbers reach or exceed acceptable threshold levels. This use is subject to an Avcare Resistance Management Strategy.
Brassicas (head cabbage, cauliflower, broccoli, Brussels sprout, kohlrabi	Diamondback moth, cabbage white butterfly, cabbage cluster caterpillar	**200 SC**: 250 mL/ha (0.005-0.0125%) **800 WG:** 60 g/ha (0.0048-0.012%)	No more than four applications per year, preferably applied within an 8 week period.	Spray volume of between 400 and 1000 L/ha according to crop size are recommended. Aerial application not recommended. This use is subject to an Avcare Resistance Management Strategy.

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Grapevines	Fig longicorn	**200 SC**: 100 mL/100 L (0.02%) **800 WG:** 3.1 g/100 L (0.0025%)	Apply as a single spray	Apply only as a high volume directed spray using hand-held equipment (500 mL per vine). Thorough coverage of vine trunks and cordons is essential for effective control (Suggested spray volume – 800 L/ha)[1].
Cotton	Cotton thrips Green mirid	**200 SC:** 62.5 – 125 mL/ha (0.07% maximum in ground spray and 0.125% maximum in aerial spray) **800 WG:** 15.5 – 30 g/ha (0.07% maximum in ground spray and 0.12% maximum in aerial spray)	Number of applications not specified on the labels[2]	Spray volume of 35 – 75 L/ha for ground spraying and 20 – 50 L/ha for aerial spraying (according to the size of the plants). Apply at first sign of pest. Use higher rates in situations of high thrips pressure. For the control of Green mirid, apply spray to achieve thorough coverage of foliage when pest first appears and repeat as required. Use the higher rate under sustained heavy Green mirid pressure. The product is compatible with early season IPM, with the lower rate having less impact on beneficials
Potatoes	Wireworm Mole cricket	**200 SC:** 250 mL/ha (0.018-0.025%) **800 WG:** 62.5 g/ha (0.018-0.025%)	Once before planting potatoes	Apply as a broadcast spray to the surface of the soil and incorporate to a depth of 15 cm prior to planting. 200-280 L spray/hectare (Information provided by the applicant at the time of registration of this use pattern). Aerial application not recommended
	Whitefringed weevil	**200 SC:** 500 mL/ha (0.036-0.05%) **800 WG:** 125 g/ha (0.036-0.05%)		

[1] Spray volume used by the registrant for risk assessment conducted

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Pasture, Sorghum	Australian Plague locust, Spur throated locust, Migratory locust Wingless grasshopper	**200 SC:** 6.25 mL/ha (0.0025% in ground spray and 0.00625% in aerial spray) **800 WG:** 1.5 g/ha (0.0024% in ground spray and 0.006% in aerial spray)	Number of applications not specified on the labels[2]	Apply diluted with water to a minimum of 20 L/ha by air or 50 L/ha by ground rig, directly onto locusts. Ensure thorough coverage of foliage. Where inaccessibility prevents direct spraying of locusts apply as a barrier treatment (minimum 25 m wide) ahead of advancing hopper bands.
	Plague locust, Spur throated locust, Migratory locust	**3 UL:** 420 mL/ha (1.26 g ai/ha)		Apply undiluted by aircraft through ULV spray units as a spray directly onto locusts.
		8.5 UL: 150 mL/ha (1.28 g ai/ha)		Apply by aircraft through ULV spray units undiluted or diluted with compatible spraying oil.
Turf, lawns and golf courses	Arg. Stem weevil, Funnel ant, Mole cricket	**GR:** 30 – 75 kg/ha (30-75 g ai/ha)	Number of applications not specified on the labels[2]	Distribute granules evenly on turf surface at the first signs of pest activity. Ensure incorporation with at least 6 mm of rainfall or overhead irrigation immediately after application.

[2] Number of applications on these crops is not specified on product labels. The OCSEH received advice from Nufarm Australia that a maximum of two applications per year are made in these crops

Table 2: Use pattern of fipronil products (continued)

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Sugarcane	Sugarcane weevil borer	**200 SC:** 2 to 5.7 mL/100 m row (0.01 – 0.03%) **800 WG:** 0.5 to 1.4 g/100 m row (0.01 – 0.03%)	Number of applications not specified on the labels[3]	Apply in a minimum water volume of 250 L/ha (approx. 3.8 L/100 m row). Use the higher rate when pest pressure is heavy. Apply during summer months when the crop has produced the first millable internode of cane. Use hollow cone nozzles as a directed spray to cover the base of the sugarcane stools and up to the stalk to a height of 40 cm. Treat both sides of the stool ensuring coverage of all stalks, soil and trash in an area to 10 cm either side of the stools.
	Sugarcane wireworm	<u>Single row plantings:</u> **200 SC:** 1.1 mL/100 m single row length **800 WG:** 0.3 g/100 m single row length <u>Double row plantings</u>: **200 SC:** 1.8 mL/100m double row length **800 WG:** 0.5 g/100 m double row length		Apply in the planting furrow over the top of the plant pieces (setts), in sufficient water to ensure coverage of the plant pieces and the surrounding soil. Total volume of water per double row length or per hectare not provided. Hence final concentration of fipronil in the spray solution could not be calculated.

[3] Number of applications on these crops is not specified on product labels. The OCSEH received advice from Nufarm Australia that a maximum of two applications per year are made in these crops.

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Mushrooms	Mushroom flies	**100 SC:** 32 mL/300 L bale of peatmoss (0.064%)	Apply mixture once during preparation of peatmoss (Once per crop, but several cycles of mushroom production per year).	Prepare solution by mixing the products with a small volume of water (5 L)[4] Apply mixture to peatmoss during preparation of casing. Ensure thorough mixing with peatmoss.
		200 SC: 16 mL/300 L bale of peatmoss (0.064%) **800 WG:** 4 g/300 L bale of peatmoss (0.064%)		

Seed treatment

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Canola	Red-legged earth mite	**500 SC:** 400 mL/100 kg seed (20%) for high volume spray	Where greater pest numbers are anticipated or where there are more than 8 mites per plant, alternative or additional treatments will be required	Ensure thorough coverage of seed. Add 400 mL product to 600 mL of water per 100 kg seed.
Sorghum, Sunflower	False wireworm Black field earwig	**500 SC:** 150 mL/100 kg seed (15%)	-	Thoroughly coat seed using commercial seed coating equipment. Add 150 mL of product to 350 mL of water/100 kg seed.
Rice	Bloodworm	**500 SC:** 20 mL/100 kg seed or 25 mL/ha	-	Use on seed through BASF approved equipment.

[4] Information obtained from mushroom growers.

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Cotton	False wireworm Cotton thrips	**80 SC** (with 400 g/L thiodicarb): 625 mL/100 kg seed (5%)	-	Thoroughly coat seed using commercial seed coating equipment. Allow to dry before handling.

Baits

Domestic, commercial and public service areas	Cockroach infestations	**Gel 0.5 g/kg:** 0.03-0.06 g spot size. (0.03 mg fipronil max). Apply 1-3 spots per m^2.	Reapply according to remaining level of infestation, when bait is no longer visibly present.	For heavy infestations, the number of spots is increased to 3/m^2.

Termite treatment

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Chemical soil barriers around existing buildings and structures	Subterranean termites	**100 SC:** Vertical barriers: 600 mL in 70 - 100 L water (0.06 – 0.086%) Horizontal barriers: 600 mL in 60 - 100 L water (0.06 – 0.1%)	As with all chemical termiticides, regular inspections (at least annually) is recommended as bridging and breaching of barriers can occur. The need for re-treatment should be determined as a result of these inspections.	Spray equipment should be calibrated to deliver a low-pressure high volume coarse spray. Apply to form a continuous chemical soil barrier (horizontal and vertical or as an external perimeter) around and under the structure to be protected as per AS3660.2. The barrier may be created using a combination of conventional spraying and trenching. Application of chemical barriers beneath the concrete slabs and paths will require drilling and injection of termiticide using rodding equipment. Rodding is to be used only where trenching and treating the backfill is not possible. Chemical barriers that have been disturbed will need to be re-applied to restore the complete barrier. <u>Spray volume</u> 100 L/m^3 for vertical barrier 5 L/m^2 of soil surface for horizontal barrier Note: In heavy soil, lower spray volumes may be used to prevent run-offs. In such cases, however, the concentration of ai should be increased in the spray solution so that the same amount of active is applied per given area or volume of soil (eg 0.086% ai if only 70 L/m^3 solution is used in vertical barrier and 0.1% ai if only 3 L/m^2 is used for horizontal barrier).
Protection of poles and fence posts		600 mL in 100 L water (0.06%)		Only poles and posts in contact with soil need to be treated. For existing posts and poles create a continuous barrier 450 mm deep and 150 mm wide around the post or pole trenching and puddle treating the backfill. Soil injection equipment must only be used where trenching or back-filling is not possible or rodding, or trench and puddle treat back-fill. Use 100 L of prepared spray per cubic meter of soil around the pole or post. If new poles are being installed then the bottom of the hole and the back-fill should be treated at installation.

Table 2: Use pattern of fipronil products (continued)

Veterinary products

Crop/ Situation	Pest	Product: application rate/dilution (Max. concentration of ai in spray)	Frequency of application (Work rate)	Comments/label instructions
Dogs and cats	Fleas, flea allergy dermatitis, ticks and biting lice on dogs and cats	**2.5 LD** (for spray treatment) (0.25% fipronil)	Applied fortnightly or monthly depending on the pest to be controlled	Spray treatment – product is packaged in spray bottles. Each trigger pump releases 0.5 mL product (1.5 mL from 250 and 500 mL bottles). A maximum of 6 mL/kg bw of the animal, equal to 12 trigger pumps/kg, (or 4 trigger pumps from 250 and 500 mL bottles) is sprayed. For example, for a 12-kg animal, 144 trigger pumps (or 48 trigger pumps from 250 and 500 mL bottles) delivering 72mL of product (7.5-15 mg fipronil/kg) are applied.
	Fleas, flea allergy dermatitis, ticks and biting lice in dogs And	**100 SA** (with 90 g/L methoprene), for spot treatment (10% fipronil + 9% methoprene)		Spot treatment – product containing 100 g fipronil/L is packaged in 0.5 mL pipettes for use on cats and in 0.67, 1.34, 2.68 or 4.02 mL pipettes for use on dogs (depending on the bodyweight of dogs). The tip of the pipette is broken and the entire amount is applied on the skin of the animal. For dogs, the dosage varies with the bodyweight of the animal and a minimum of 6.7 mg fipronil/kg bw of animal is applied. The Startgard range comprises kits of one tablet from the Heartgard range (active constituents ivermectin, or ivermectin and pyrantel) and one pipette from the Frontline Top Spot or Frontline Plus range. As these kits are intended for the treatment of puppies and kittens, the pipettes are the smallest sizes in the Frontline ranges (0.5 mL for kittens and 0.67 mL for puppies).
	Fleas, flea allergy dermatitis and biting lice in cats	**100 SA** (with 120 g/L methoprene) (for spot treatment) (10% fipronil + 12% methoprene		

3.3 Methods and types of equipment used for mixing/loading/application of fipronil products

Fipronil products are used for their insecticidal actions in agricultural as well as non-agricultural situations. In the agricultural situations, fipronil products are used in broadacre crops, bananas, grapevines, mushrooms and on turf. In non-agricultural situations, they are used for termite, ants and cockroach control and as insecticidal seed dressing.

Fipronil products are also used in veterinary situations as spray-on or concentrated spot-on formulations for the control of fleas, lice, flea allergy dermatitis and/or ticks in cats and dogs.

Broadacre crops, bananas, grapevines and turf

In broadacre crops, fipronil products are applied by ground or aerial application. Ground application is mostly by boom sprayers, although hand-held application is also used in some crops. Banana plants and grapevines are treated by hand-held application. Products are diluted with water according to label instructions and loaded in the spraying equipment. Workers mixing/loading for ground spraying (boomspray or hand-held) normally use the open-pour method.

Granular formulations of fipronil are used on turf. No dilution is required. The granules are evenly spread by mechanical spreaders. The label directs users to ensure that incorporation by rainfall or irrigation occurs.

ULV formulations are applied by aerial spraying for locust control. The product is used either undiluted or diluted with compatible spraying oil. The diluted or undiluted product is directly loaded into the aircraft or spray tanks from bulk containers by mechanical means.

Incorporation into mushroom casing

Mushrooms are grown on compost which is pasteurized and placed in large trays or beds. Mushroom spawn is worked into the compost and the growing takes place in specially constructed houses, where the farmers can regulate the crucial aspects of heat and humidity.

In two to three weeks, the compost becomes filled with the root structure of the mushroom, a network of lacy white filaments called mycelium. At that point, a layer of pasteurized peat moss (casing) is spread over the compost. The peat moss is treated with fipronil products just prior to layering over the compost. The process of mixing diluted product with peatmoss is usually mechanized; applied by spray boom fixed to the top of peat moss turning machine. The casing is applied evenly as a 4-5 cm thick layer over the compost. The quantity of product handled at any time will depend on the extent of the mushroom beds to be treated. Hand held space spray, though used sometimes, is the least preferred method of application as spawn run rooms and growing rooms are kept closed to personnel as much as possible to prevent cross contamination. In commercial enterprises, approximately 50 batches of mushrooms are grown per year, with new casing prepared for each batch.

Treating seed

In Australia, seeds are mostly treated by professional seed treaters in completely enclosed systems. Bulk containers of fipronil product are connected via an inlet pipe to the application equipment. The mechanical treaters measure the required amount of product and dilute it with water to the required volume. Seed to be treated is loaded into a hopper for treatment within the machine. Dry treated seed emerges from the machine through a funnel into sacks, which are sealed either mechanically or by hand.

At some seed-treating facilities, grain is treated as a coarse shielded spray (20% fipronil) as it comes on a conveyor belt for storage. A small minority of farmers may treat their own seed in an open system - generally as batch treatment in a cement mixer type arrangement or a semi-closed system (closed except for the final transfer to bins or bags.

Termite control

For termite control, fipronil product is applied by hand-held equipment including low-pressure hand wand and soil injection (rodding). The low-pressure hand wands used for applying termiticides are different from those used for foliar spray in that the hand wand for termiticide application delivers high volume, coarse ‘jet’, which is more like pouring the solution rather than spraying. The procedure is to dig a trench and pour in the diluted product with a watering nozzle on the end of a rod approximately 0.5-0.75 m long. This floods the soil below ground level and there is less likelihood of spray drift.

Bait treatment

A bait formulation of fipronil is used to control cockroaches in domestic, commercial and public service buildings. The product, available in 35 g tube, is applied as tiny spots (1-3 spots per m^2) in the infested area.

Application of veterinary products to cats and dogs

Veterinary products for use on dogs and cats are either spray-on treatment or spot treatment. Although the products are meant for use by the general public (pet owners), commercial pet groomers may also use the products to treat dogs and cats. Both types of formulations (spray and spot-on range) are ready-to-use products and do not require diluting or mixing before use. Label instructions for the Frontline Spray ready-to-use product require the user to spray the entire animal against the lay of the hair, using a pump nozzle applicator held 10-20 cm from the animal's coat. The coat is to be ruffled as the spray is applied, so the product penetrates down to the skin, and the coat is thoroughly wet. Occasionally workers may rub the product into the animal's skin and, to avoid spraying into the dog's eyes, nose, and mouth, workers spray one or more pumps into their hands and then rub the dog's face to cover the face.

The method of application of the Frontline spot-on range of products involves breaking the snap-off top from the pipette, then while holding the pipette tip against the skin of the animal, squeezing the pipette several times until it is emptied of its contents. Frontline Top Spot is applied monthly for the control of fleas, lice, flea allergy dermatitis in dogs and cats, and/or ticks in dogs.

3.4 Label restrictions

Withholding periods and other restrictions for fipronil products specified on the product labels are presented in Table 3 below:

Table 3: Withholding periods and other restrictions for fipronil products

Crop/Situation	WHP/other restrictions
Brassicas	Do not harvest for 7 days after application
Cotton	Do not harvest for 4 weeks after application. Do not graze or cut for stock food
Potatoes	Not required when used as directed. Do not graze or cut for stock food any part of failed crop (including tubers)
Bananas	Not required when used as directed
Mushrooms	Do not harvest for 14 days after application
Pastures	Do not graze or cut for stock food for 14 days after application or withhold stock from slaughter for 21 days, whichever is appropriate
Sorghum	Do not harvest, graze or cut for stock food for 14 days after application
Sugarcane	Do not harvest for 12 weeks after application. Do not graze or cut for stock food for 12 weeks after application
Wine grapevines	Not required when used as directed. Do not feed trash or by-products resulting from treated grapevines to livestock
Seed Treatment: Canola, sorghum, rice, sunflower and cotton	Harvest WHP not required when used as directed Grazing

Crop/Situation	WHP/other restrictions
Canola Sorghum Sunflower Rice	Do not graze plants grown from treated seed, or cut for stock food within 9 weeks of sowing Do not graze plants grown from treated seed, or cut for stock food within 5 weeks of sowing Do not graze plants grown from treated seed, or cut for stock food within 3 weeks of sowing. Do not feed treated seed to animals Not required when used as directed
Termite treatment	Residents and pets should not be allowed in a room being treated. Any spills should be cleaned up before leaving the room. Ensure all heating/air conditioning ducts, air vents, plumbing pipes, sewer lines, floor drains, heating pipes and electrical lines/conduits are known and identified before commencing any application of termiticide. Do not puncture or contaminate any of these. Avoid application around edible plants.
Turf	Do not allow birds or animals to feed on treated turf. Do not feed turf clippings from any treated area to any birds or animals.
Veterinary use	Treat pets outside or in well ventilated room away from surfaces likely to be affected by alcohol spray. Do not breathe spray when applying the spray – hold the applicator vertically 10-20 cm away from the coat.

Re-entry/re-handling intervals:

The following re-entry statement is stipulated on Regent 200SC Insecticide label provided by the registrant:

"Do not allow entry into treated areas until spray has dried. When prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing). Clothing must be laundered after each day's use. Human flaggers, if used in aerial spraying operations, must be protected by enclosed cabs".

The following re-entry statement is stipulated on Regent 800WG Insecticide label provided by the registrant:

"Do not allow entry into treated areas until spray has dried. When prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use. Human flaggers, if used in aerial spraying operations, must be protected by enclosed cabs".

The following re-entry statement is stipulated on Nufarm Adonis 3UL Insecticide label provided by the registrant:

"Do not allow entry into treated areas until spray has dried. When prior entry is necessary, wear personal protective equipment as specified in the Safety Directions. Clothing must be laundered after each day's use. Human flaggers, if used in aerial spraying operations, must be protected by enclosed cabs".

The following re-entry statement is stipulated on the Termidor Residual Termiticide label:

"Do not re-enter treated area until spray has dried".

The following re-handling interval is stipulated on Cosmos Insecticidal Seed Treatment label:

"Treated seed should be allowed to dry before re-handling".

No re-handling statements are stipulated on veterinary products.

4 TOXICOLOGICAL HAZARD OF FIPRONIL

4.1 Acute toxicity

4.1.1 Fipronil

When administered by the oral route, fipronil was moderately toxic in mice (LD_{50} ~91 mg/kg bw; Mondot and Dange 1995) and rats (LD_{50} = 97 mg/kg bw) (Gardner 1988a). Dermal toxicity was low in rats (LD_{50} >2000 mg/kg bw) (Gardner 1988b) and moderate in rabbits (LD_{50} = 354 mg/kg bw) (Myers and Christopher 1992). Inhalation toxicity was moderate in rats (LC_{50} = 682 mg/m^3; or 360/420 mg/m^3 in males/females) (Cracknell 1991). Toxicological signs were consistent with fipronil's known mode of action, which included hyperactivity, abnormalities of gait and posture, tremors and convulsions. Necropsy findings were limited to dermally exposed rabbits in which there were effects on the lungs, kidneys and spleen (e.g. discolouration/enlargement /blood in urine, kidneys).

Fipronil moistened with water was not a skin irritant in rabbits (Liggett 1988a), but it was a slight skin irritant when corn oil was used as the vehicle (Myers and Christopher 1993a). It was a slight eye irritant in rabbits (Liggett 1988b, Myers and Christopher 1993b). Fipronil was not a skin sensitiser by the Buehler method (Smith 1990), or the Magnusson and Kligman method (Johnson 1993). Therefore, fipronil is not a sensitiser in guinea pigs.

Toxicological signs were consistent with fipronil's known mode of action as a GABA antagonist, and included hyperactivity, abnormalities of gait and posture, tremors and convulsions. Necropsy findings were limited to dermally exposed rabbits in which there were effects on the lungs, kidneys and spleen (e.g. discolouration/ enlargement/blood in urine, kidneys).

4.1.2 Fipronil metabolites

Studies on the metabolism of fipronil following its application by foliar spray have shown that fipronil undergoes photodegradation to fipronil-desulfinyl (MB 46513) and RPA 104615 (JMPR, 2001). Other metabolites of fipronil, such as, fipronil-sulfone (MB 46136), fipronil-thioether (MB 45950) and fipronil-amide (RPA 200766) are formed by the oxidation, reduction and hydrolysis, respectively, of fipronil. The main residues found consistently on the foliage however, are the parent compound and MB 46513; lesser amounts of MB 45950 and MB 46136 are also detected (JMPR, 2001).

In rats, MB 46513 (fipronil desulfinyl) showed high acute oral toxicity (LD50 = 18/15 mg/kg bw, M/F) and low acute dermal toxicity (LD50 >2000 mg/kg bw) (Dange, 1993). Clinical signs were consistent with neurotoxic effects. The livers of decedents were enlarged, with various pathological changes including pale colour, foci of necrosis, and early fibrosis.

The acute oral toxicity of MB 45950 (fipronil sulfide) in rats was moderate to low (LD_{50} = 83 to 580) (Dange 1994 and Haynes 1988a). Toxicity was characterised by piloerection, red staining of the fur, hypoactivity and terminal convulsions. In both studies, males were more susceptible than females. When applied undiluted to rat skin, the dermal LD_{50} was >500 mg/kg bw (Haynes 1988 b). In rabbits, fipronil sulfide was a slight eye irritant, but was not a skin irritant (Haynes 1987 a,b).

Fipronil sulfone (MB 46136) had moderate acute oral toxicity when administered to rats in corn oil (LD_{50} = 218 mg/kg bw, Gardner 1988c). Clinical signs included abnormal gait, lethargy, pallor of the extremities, diarrhoea, increased respiratory rate, ataxia, increased salivation and terminal convulsions. In aqueous suspension, the dermal LD_{50} in rats was >2000 mg/kg bw (Gardner 1988d). When applied undiluted to rabbits, it was not a skin irritant, but it was a slight eye irritant (Liggett 1988 c,d).

The toxicity profiles of other fipronil metabolites and photodegradates are discussed in detail in the OCSEH review of mammalian toxicology.

4.1.3 Fipronil products

The acute oral toxicity of Regent 200SC Insecticide (suspension concentrate, 200 g/L) in aqueous vehicle was low in rats (LD_{50} = 1099 mg/kg bw) and moderate in mice (LD_{50} = 324 mg/kg bw) (Dreher 1990 a, b). The dermal toxicity was low (LD_{50} > 4192 mg/kg bw and LD_{50} = 2493 mg/kg bw in rats and rabbits respectively) (Dreher 1990 c, d). Inhalation toxicity in rats was moderate (LC_{50} = 1070 mg/m^3) (Blagden 1993a). The product was a slight skin irritant and a moderate eye irritant in rabbits, and did not cause skin sensitisation in guinea pigs using the modified Buehler method (Dreher 1993a; Glaza 1997; Dreher 1993b).

Acute studies were conducted with a 1 g/kg GR product, similar to the product marketed in Australia, Chipco Choice Insecticide (1 g/kg GR), but differing in the carrier. This product had low acute oral (LD_{50} > 5000 mg/kg bw), dermal (LD_{50} > 2000 mg/kg bw), and inhalation (LC_{50} >5160 mg/m^3) toxicity in rats (Myers 1994 a, b, Nachreiner 1994). No deaths were seen in any of these studies. The product was a slight eye irritant, but not a skin irritant in rabbits, and was not a skin sensitiser in guinea pigs using the Buehler method (Myers 1994 c, d; Myers & Nachreiner 1994).

Goliath^R Gel Cockroach Bait had low acute oral toxicity in male rats (LD_{50} = 4400 mg/kg bw), and low acute dermal toxicity in rats (LD_{50}> 5000 mg/kg bw). The formulation was not a skin or an eye irritant in rabbits, and was non-sensitising to the skin of guinea pigs using the Magnussen and Kligman test (Grunert 1996 a-e).

Regent 500 FS Seed Dressing Insecticide (500 g/L SC, equivalent to Cosmos Insecticidal Seed Treatment) had moderate oral toxicity (LD_{50} = 290 mg/kg bw), low dermal toxicity (LD_{50}>2000 mg/kg bw) and moderate inhalation toxicity (LC_{50} = 260 mg/m^3) in rats (Allen 1993a,b; Blagden 1993b). It was a slight skin irritant, but not an eye irritant in rabbits, and was not a skin sensitiser in guinea pigs (Allen 1993 c, d, e).

Regent 25 ULV Insecticide, a product of similar formulation and toxicity profile to currently registered fipronil UL products, had low acute oral toxicity (3208 mg/kg bw), low acute dermal toxicity (> 4000 mg/kg bw) and low acute inhalation toxicity (LC_{50} > 5000 mg/m^3) in rats (Warshawsky 1995a, b; Hilaski 1995). It was a slight eye irritant but not a skin irritant in rabbits, and was not a skin sensitiser in guinea pigs (Warshawsky 1995c, d, e).

Regent 800 WDG Insecticide (containing 800 g/kg fipronil) had moderate acute oral toxicity (LD_{50} = 177 mg/kg bw) and moderate acute inhalation toxicity (LC_{50} = 630 mg/m^3) in rats, and moderate dermal toxicity (LD_{50} = 569 mg/kg bw) in rabbits (Allen 1994a, Blagden 1994, Allen 1994b). It was a moderate eye irritant and a slight skin irritant in rabbits, and did not cause skin sensitisation in guinea pigs (Allen 1994 c, d, e).

Frontline Spray (suspension concentrate, 2.5 g/L) had low acute oral toxicity (LD_{50} > 5000 mg/kg bw) and low dermal toxicity (LD_{50} > 2000 mg/kg bw) in rats (Clouzeau 1993a,b). Inhalation toxicity in the rat was also low (LC_{50} > 5060 mg/m^3) (Robinson 1993). The formulation caused moderate eye irritation, but no skin irritation in rabbits (Clouzeau 1993d,c). It was not a skin sensitiser in guinea pigs (Clouzeau 1993 e).

Frontline Spot On for Cats and Frontline Spot On for Dogs containing 100g/L of fipronil, had low oral (LD_{50}=3000 mg/kg bw), dermal (LD_{50}>5000 mg/kg bw) and inhalation (LC_{50}>6320 mg/m^3) toxicity in rats (De Jouffrey 1994a & 1995, Kieran 1995). The formulation was a slight skin irritant and a moderate eye irritant in rabbits (De Jouffrey 1994b,c). It was not a skin sensitiser in guinea pigs using the Buehler test (De Jouffrey 1994 d).

Frontline Plus for Cats was a slight skin irritant and a slight eye irritant in rabbits (Findlay 1999a,b). It was not a skin sensitiser in guinea pigs using the Buehler method (Findlay 1999c).

4.2 Repeat-dose toxicity

Signs of neurological disturbance and changes in haematology were the most common manifestations of fipronil toxicity in short-term, subchronic and chronic studies in mice, rats and dogs. Reduced food consumption and decreased bodyweights were also noted in rats and dogs given fipronil by dietary route (Peters *et al*. 1990; Holmes 1991a; King 1992; Driscoll & Hurley, 1993; Mandella 1995). Rabbits exposed dermally to fipronil over a 21-day period exhibited decreased food intake and decreased bodyweight gain at 10 mg/kg bw/d. Also at this dose, two rabbits had an episode of extreme hyperactivity (Hermansky & Wagner 1993).

Longer term exposure (subchronic and chronic) to fipronil resulted in increase in liver and thyroid weights in rats with an associated increased incidence of follicular cell hypertrophy and hyperplasia of the thyroid (Aughton 1993; Holmes 1991b). Circulating thyroxine (T4) levels were consistently lower than control values in all treated groups, and this was reversible (Aughton 1993). Follicular cell tumours were also noted in rats treated for one year with fipronil and later assigned to the reversibility period (Aughton 1993). These tumours were however not considered relevant to humans as discussed in the OCSEH review of mammalian toxicology of fipronil. Rats and dogs also showed neurological signs after long term exposure to fipronil (Aughton 1993; Holmes 1992; Holmes 1993). In dogs, neurological effects consisted of exaggerated flexor reflexes, convulsions, head jerks or head nodding, disorientation and facial twitching (Holmes 1991a,c, d; 1992, 1993).

No developmental abnormalities were reported for fipronil administered to rats and rabbits at oral doses up to 20 mg/kg bw/d and 1 mg/kg bw/d respectively (Brooker & John 1991; King 1990). One reproduction study showed reduced litter size and pup viability in the F0, and a slight reduction in mating performance and fertility index in the F1. Convulsions were recorded for both pups and dams in the reproduction study, but these occurred only at the relatively high dose of 27 mg/kg bw/d. Fipronil was not considered to cause reproductive toxicity at doses relevant to humans (King 1992).

Fipronil produced negative results in several genotoxicity tests in vitro (Clare 1988a; Marshall 1988a; Lloyd 1990; Wright 1995). Also taking into account the lack of evidence of carcinogenicity likely to have arisen via a genotoxic mechanism in chronic rodent studies (Aughton 1993), fipronil is not considered to be genotoxic.

5 TOXICOLOGICAL ENDPOINTS FOR OHS RISK ASSESSMENT

Considering the mode of action of fipronil, namely inhibition of the GABA-gated chloride channels in neurons, it seems appropriate that the endpoint most relevant for an OHS risk assessment will be associated with its pharmacological action, which in the case of fipronil, is neurotoxicity effect.

Fipronil products intended for professional use will be applied by farmers, spray contractors and pest control operators (PCO). The most likely route of exposure for farm workers and PCOs would be by dermal contact with the undiluted products, spray mixture and treated vegetation (re-entry workers). Inhalation of fipronil in spray aerosols may also occur. Dermal and inhalation studies are therefore appropriate for selection of NOELs for risk assessment.

Agricultural workers are likely to be exposed on a seasonal basis, as dictated by pest pressure and the growth cycle of plants under production, whereas PCOs may be exposed to the chemical throughout the year. Dermal and inhalation NOELs must therefore be set for assessment of occupational risk using data generated over timescales appropriate to the likely frequency and duration of exposure. It is therefore considered appropriate to use a NOEL from a short-term study for estimation of risk to farmers (or contract sprayers) and a NOEL from a chronic study to estimate occupational risk to PCOs.

A review of the existing toxicological database revealed that repeat dose inhalation studies for fipronil are not available. In the absence of a suitable inhalation study, NOEL from an oral dose study is used to assess risk from inhalation exposure.

5.1 Dose levels relevant to risk assessment

A summary of the no-observed-effect levels (NOEL) determined in studies deemed adequate for regulatory purposes is shown in Table 4 below (see OCSEH review of mammalian toxicology of fipronil for detailed assessment of these studies). NOELs suitable for OHS assessment have been determined from these studies.

Table 4: Summary of relevant NOELs from repeat-dose studies for fipronil

Species	Study Type	NOEL (mg/kg bw/d)	LOEL (mg/kg bw/d)	Effect	Reference
Rabbit	21-day dermal	5	10	Reduced bodyweight gain, hyperactivity	Hermansky & Wagner 1993
Dog	4 weeks dietary	1	10	Clinical signs of neurotoxicity signs, increased RBC and Hb	Holmes 1991a
Rat	13 weeks dietary	0.3	2	Increased liver and thyroid weights	Holmes 1991b
Rat	13 weeks neurotoxicity, dietary	0.3	7.5	Neurobehavioural changes	Driscoll & Hurley 1993
Dog	13 weeks capsules	0.5	2	Inappetence and reduced bodyweight gain (females)	Holmes 1991c
Mouse	78 weeks dietary	0.05	1.2	Increased liver weight and microscopic changes to the liver	Broadmeadow 1993
Rat	89-91 weeks dietary	0.02	0.06	Clinical signs of neurotoxicity; increased thyroid weight; decreased T4 levels; increased severity of progressive senile nephropathy	Aughton 1993
Dog	52 weeks capsules	0.2	2	Clinical signs of neurotoxicity, bodyweight loss	Holmes 1992
Dog	52 weeks, dietary	0.3	1	Clinical signs of neurotoxicity	Holmes 1993
Rat	2-generation reproduction, dietary	Parental: 0.25 Offspring: 2.5	Parental: 2.5 Offspring: 26	Parental: increased thyroid and liver weights; decreased pituitary weight; increased incidence of follicular epithelial hypertrophy of the thyroid Offspring: reduced survival; reduced bodyweight gain; developmental delays	King 1992
Rat	Developmental gavage	Maternal: 4 Foetal: 20	Maternal: 20 Foetal: -	Maternal: decreased bodyweight gain Foetal: no effects at the highest dose tested	Brooker & John 1991

Species	Study Type	NOEL (mg/kg bw/d)	LOEL (mg/kg bw/d)	Effect	Reference
Rat	Developmental neurotoxicity, dietary	Maternal: 0.9 Offspring: 0.05	Maternal: 8.7 Offspring: 0.9	Maternal: bodyweight loss Offspring: reduced pup weight during lactation, delay to preputial opening	Mandella 1995
Rabbit	Developmental gavage	Maternal: 0.2 Foetal: 1	Maternal: 0.5 Foetal: -	Maternal: decreased bodyweight gain Foetal: no effects at highest dose tested	King 1990

5.2 Short-term NOEL (for assessing risk to farmers and contract workers)

Fipronil products are generally applied twice per year per crop with a maximum of four applications in brassicas. Contract workers may use the products more often as they would apply these products in several farms. Farmers treat seeds with fipronil products once or twice per season at harvest time only. Commercial seed treaters use fipronil products intermittently and for only short durations during the year[5]. Based on the use pattern, a dermal NOEL of 5 mg/kg bw/day established in a 21-day dermal study in rabbits (Hermansky and Wagner 1993) is considered appropriate for occupational health and safety risk assessment of these workers.

Inhalational exposure to fipronil in an agricultural setting would mostly arise from inhalation of spray mist or dust generated from the granular product. The pattern and frequency of exposure would be the same as for dermal exposure. As user exposure to fipronil products is expected to be intermittent and of short durations, the NOEL of 1 mg/kg bw/day from a 4-week oral study in dogs (Holmes 1991a) will be used for the occupational risk assessment.

5.3 Long-term NOEL (for assessing risk to pest control operators (PCOs))

PCOs are likely to be exposed to fipronil products for a major proportion of year and throughout their working life. Based on the use pattern of Termidor, a NOEL from a long-term study in experimental animals is appropriate for risk assessment. The 89-91 week oral study in rats yielded a NOEL of 0.02 mg/kg bw/d, with neurological signs at the next higher dose level of 0.06 mg/kg bw/d (Aughton 1993). This NOEL was considered to be appropriate for the OHS risk assessment of PCOs. Route-to-route extrapolations usually involve a consideration of the internal dose. In the case of oral-to-dermal extrapolation this consideration takes account of the extent of absorption across the GI tract following oral administration. Absorption of fipronil across the GI tract was estimated to be 80-90% of the administered dose, taking its biliary excretion into account. Therefore, no correction to the NOEL used for OHS risk assessment is required. Since a long-term inhalation study is not available, this NOEL will also be used to assess risk from inhalation exposure.

5.4 NOEL for re-entry interval calculations

Workers may re-enter treated crops after the spray has dried for post-application activities, such as harvesting, pruning or to tend to crops. These ‘re-entry’ workers may be exposed to residues from fipronil and its photodegradation product which are deposited on foliage or fruit. Exposure would mostly occur via skin contact. Workers are likely to work for a total of 2 to 3 weeks performing post-application activities. Hence, the dermal NOEL chosen from the short-term repeat dose study to estimate occupational risk for mixer/loaders and applicators (5 mg/kg bw/day) is considered appropriate for establishment of safe re-entry intervals for various crops and post-application activities. The use of the fipronil dermal NOEL is considered to be appropriate for performing the risk assessment for the photodegradation product because there is sufficient evidence to indicate that desulfinyl fipronil is equitoxic to fipronil (see OCSEH review of mammalian toxicology of fipronil).

[5] Large quantities of rice, sorghum and sunflower seed are treated commercially with fipronil products for 2-3 months per year. However, seed treatment at these large-scale facilities are fully automated and enclosed (Information obtained from Pacific Seeds, QLD).

6 ASSESSMENT OF OCCUPATIONAL EXPOSURE DURING PRODUCTION

Technical grade fipronil is manufactured overseas. Most of the fipronil products are formulated in Australia from the imported active ingredient. The registrants have not provided any details of the sites formulating the products. Information submitted earlier for registration of products or extensions of their use have stated that Regent 200SC Insecticide, Regent 800WG Insecticide and Termidor Residual Termiticide are formulated at the registrant's Australian formulation plant. Description of the manufacturing/packaging process, the number of workers involved and personal protective equipment (PPE) used during formulation and packaging is not available. When involved in the manufacture of veterinary products, workers are expected to adhere to good manufacturing practice (GMP). Adequate quality control, exposure monitoring and risk control measures are under the jurisdiction of the States and Territories.

Formulators, laboratory staff and packers handle the active constituent and/or the products and can be exposed to fipronil during the process of formulation and packaging. Individual premises, manufacturing/formulation processes and exposure control measures may vary within workplaces. Transport workers, storemen retailers and warehouse workers can get exposed to the products if packaging is breached and spillage occurs.

7 ASSESSMENT OF OCCUPATIONAL EXPOSURE AND RISK WHEN HANDLING FIPRONIL PRODUCTS

7.1 Evaluation of exposure studies

The registrants provided a number of worker exposure studies and assessments in response to the data call-in by the APVMA. These are described in this subsection together with relevant comments by the OCSEH.

Pontal P.G. (1996) Fipronil: Worker exposure study during application of Regent 20GR in banana plantation. Study No. 94/136; Rhone Poulenc Agrochemie Centre De Recherche, France, June 1996

Study and observations: The study was designed to measure the potential dermal and inhalation exposure of workers during the loading and broadcast application of Regent 20GR on a banana plantation. The study was conducted in Cameroon.

Regent 20GR is a granular formulation of fipronil (20 g/kg fipronil) used on banana plantations for the control of banana weevil. The granules are spread around each plant at a rate of 7.5 g of product per plant. The common practice in Cameroon, at the time the study was conducted (1996), was to apply the product using calibrated spoons, although gravity-fed micro spreads were also used. Potential dermal and inhalation exposure was therefore estimated using both methods. A total of 18 loader/applicator events during micro spread (8 replicates) or spoon application (10 replicates) were monitored over three different days in June 1994 on the same banana plantation in Cameroon (6 spoon/hand applications on day 1; 4 spoon/hand applications on day 2; and 8 backpack events on day 3). Each worker was monitored throughout one typical task consisting of filling and refilling either their bucket or micro spread tank followed by application of the granules around the plants. Travelling to and from the field and cleaning and repairs of any breakdown of equipment were also monitored.

The product was applied either with a plastic spoon, roughly cut to contain approximately 7.5 g product (0.15 g fipronil), or with a Horstine Farmery micro spread calibrated to deliver 7.5 g formulation per operation. Regent 20GR, supplied in 10-kg boxes, was loaded directly into the backpack applicators or buckets for the spoon applicators.

As normal practice on the plantation, treatment was performed in teams. The duration of each operation, the area treated and the quantity of formulation handled was recorded for each team. On an average each worker treated 800 plants, covering an area of 0.5 hectares in one day. The quantity of formulation used per operator during a working day ranged between 5.6 kg and 8.3 kg. For calculations, it was assumed that each worker within a team treated the same number of plants and handled the same quantity of fipronil in a day.

On the first day, a team of six workers applied the product. All workers used plastic spoons. The total quantity applied on this day was 50 kg on 2.69 ha representing approximately 4994 plants. This represents an average application rate of 10 g/plant (0.2 g fipronil). During the second day a team of 17 workers applied the product. Only four workers were monitored and all these workers used plastic spoons. The total quantity applied on this day was 95 kg on 5.11 ha representing approximately 9465 plants. This represents an average application rate of 10 g product/plant. On the third day, a team of 15 workers applied the product using microspread method. Only eight were monitored. Eighty five kilograms of the product was applied over 6.56 hectares, representing approximately 12172 plants. The average application rate was calculated to be 7.7 g/plant.

Each applicator wore a jacket and long trouser (normal working clothes), that also served as the whole body dosimeter, and a cap. PVC gloves were worn over cotton gloves, which served as dosimeters. Due to high temperatures in the area, no underclothes were worn to measure penetration through the clothes. A standard 10% penetration factor was applied.

Exposure measurement: Dermal exposure was monitored using whole body dosimeters (cotton trouser and jacket), cotton gloves, cotton caps and personal sampling pumps equipped with filters. On completion of the task, workers' clothing was removed, turned inside out and segmented into arms, legs, and torso for analysis. The sections were wrapped in aluminium foil and packed in plastic bag with a label on it. The cap covers an estimated 50% of the total surface of the head and face. To obtain the total exposure to the head, the contamination measured on the cap was multiplied by two. Inhalation exposure was measured by Gilair personal air sampling pumps attached to the belt of the workers. A glass fire cassette, connected to the pump with polyethylene tubing was positioned in the breathing zone of the worker. The pump was calibrated at about 1 L/min.

Two blood samples (10 mL) were taken from each volunteer before beginning of fipronil application. Another sample was taken at the end of the week (two days after the last application). Blood samples were analysed for fipronil, its photo metabolite (M&B 46513) and animal metabolite (M&B 46136).

Fipronil residues were analysed by gas chromatography and electron capture detection. The limits of quantification (LOQ) were 9.7 µg per sample. Field and laboratory recovery data were generated for all media in a manner that addressed field sampling, field storage, transport, laboratory storage and analysis. Residues were corrected for the overall average field recovery for each residue/matrix combination. Generally, recovery was greater than 85% for all residue/matrix combinations.

Exposure calculations: The measured actual dermal exposure is the sum of the contamination measured on the coveralls, the calculated exposure for the underclothes (10% of the external exposure), exposure of head/face calculated from the cap and the cotton gloves.

The estimated potential dermal exposure is the sum of the calculated exposure for the underclothes/skin (10% of the external exposure), exposure of head/face calculated from the cap and the cotton gloves underneath the PVC gloves.

The inhalation exposure was calculated using a respiratory flow rate of 60 L/min corresponding to respiration during heavy work.

Results: Unit exposure values were calculated using the data from the study. The exposures were normalized by the amount of chemical used, the duration of the application interval, and by the bodyweight of the individual applicators. Table 5 presents exposure values for the two methods of applications. The values are based on a 50 percent clothing penetration factor.

Table 5: Worker exposure during application of Regent 20GR in banana plantation

Worker Number*	Appl. Method	No. of plants treated /day (mean)	Fipronil applied (g) (mean)	Dermal exposure (mg)				Inhal. exposure (mg)
				Actual exposure		Potential exposure**		
				Total	Per kg ai/kg bw	Total	Per kg ai/kg bw	
1	Spoon appl.	832	167	1.19	0.09	0.14	0.011	0.0002
2				3.26	0.03	0.42	0.035	0.002
3				6.11	0.60	0.58	0.059	0.037
4				1.97	0.18	0.21	0.019	0.020
5				0.74	0.07	0.11	0.010	0.001
6				4.0	0.38	0.57	0.055	0.003
8		557	112	1.07	0.15	0.12	0.016	0.005
9				0.52	0.07	0.06	0.007	0.002
10				0.25	0.04	0.03	0.004	0.002
11				0.40	0.05	0.05	0.006	0.004
Mean				**1.95**	**0.19**	**0.23**	**0.022**	**0.008**
12	Micro-spread appl.	811	113	0.29	0.04	0.03	0.004	0.004
13				0.26	0.04	0.03	0.005	0.002
14				0.27	0.04	0.03	0.004	0.003
15				0.40	0.06	0.05	0.007	0.008
16				0.24	0.04	0.03	0.004	0.004
17				0.38	0.06	0.04	0.007	0.004
18				0.18	0.02	0.03	0.003	0.002
19				0.41	0.05	0.06	0.007	0.002
Mean				**0.30**	**0.04**	**0.04**	**0.005**	**0.004**

*Worker No. 7 was a driver and did not participate directly in application procedures.

**10% of the total body exposure + head + hand exposure; assuming that normal working clothes allows only 10% penetration of fipronil.

Results and Conclusion: The results indicated very low exposures to fipronil with the spoon as well as the microspread application methods. Exposure values were expressed as mg/kg active ingredient handled/kg bw taking into consideration that 112-167 g of fipronil was applied by each worker per day.

Actual dermal exposure was 0.038-0.384 mg/kg ai/kg bw (mean 0.192 mg/kg ai/kg bw) for the spoon method and 0.024-0.062 mg/kg ai/kg bw (mean 0.44 mg/kg ai/kg bw) for the microspread method. Calculated potential exposure (underclothes + head + hands) ranged between 0.004 and 0.059 mg/kg ai/kg bw (mean 0.022 mg/kg ai/kg bw) for the spoon method and 0.004 and 0.007 mg/kg ai/kg bw (0.005 mg/kg ai/kg bw) for the microspread method. Mean inhalation exposure was 0.008 mg/kg ai/kg bw for the spoon method and 0.004 mg/kg ai/kg bw for the microspread method. Exposure was always less for the microspread method compared to the spoon method.

All blood samples before and one week after exposure were below the limit of quantification for fipronil, M&B 46136 and M&B 46513 (data not shown), which was consistent with the observed low external contamination.

Comment: The study measured exposure during application of a granular formulation of fipronil to banana plants. A maximum of 370 g of fipronil was applied per hectare by either a spoon or a microspreader. In Australia, banana plants are treated by spraying diluted products. The only granular application in Australia is to turf and lawns using a 1 g/kg fipronil formulation (eg Chipco Choice Insecticide). The application rate (15-75 g fipronil/ha) is almost a fifth of that used in the study and microspreader is the most common method used in Australia, often aided by tractor. The study is therefore of limited use for OH&S assessment. It does however indicate that exposure to fipronil is negligible when granular formulation is used.

Honeycutt RC and Kennedy S (2001) Determination of inhalation exposure to house occupants and pest control operators from fipronil during and after the application of Termidor 80 WG as a termiticide treatment to homes; Aventis CropScience Study Number RP99V16852. H.E.R.A.C., Inc., 220-1 Swing Road, Greensboro, North Carolina 27409, USA. 9 January 2001.

Study and observations: The study was conducted in North Carolina, USA, to estimate the inhalational exposure of pest control operators handling and applying Termidor 80 WG termiticide. Vapour concentrations of fipronil were measured in the crawl space, basement and slab construction type houses at different times after application.

Termidor 80 WG is a wettable granule formulation packaged in water-soluble bags. In the USA, it is registered for use at 0.06% - 0.125% final solution depending on the severity of termite infestation. Twenty-seven houses (16 crawl space, 6 basement and 5 slab type construction) were treated with the diluted spray at a rate of approximately 4 gallons/10 linear feet (15 L/3m) on outer and interior walls and approximately 2 gallons/10 linear feet (7.5 L/3m) injected into foundation walls.

At the highest mixing rate of 0.125% Termidor 80 WG, 500 L of spray solution contains 0.5 kg fipronil. However, only one site was treated with this maximum mixing rate of 0.125%. All other sites were treated with 0.07 - 0.08 % Termidor 80 WG (0.28 – 0.32 kg fipronil in 500 L). Spray applications were made using a variety of spray probes and injectors. The spray equipment or the application method was not described in detail in the study report.

Sixteen pest control operators (ranging in age from 21 to 53 and in bodyweight from 66 to 114 kg) applying Termidor 80WG in crawl space homes were monitored for inhalation exposure to fipronil using personal air monitoring pump during the application of the test substance. Each volunteer wore a personal air-monitoring pump on his belt. The air tubes, containing the Gelman filters, were pinned to the collar of the worker. The sampling pump was calibrated to 2 litres per minute. The pump was turned on when the mixing of the Termidor 80 WG began and was turned off when the worker completed Termidor treatment to the house. The sampling pump ran at approximately 2 L/min for the period of time that the PCO treated the house.

The presence of fipronil vapour was monitored in six basement houses, five crawl space houses and five slab houses (16 sites). Duplicate air sampling assemblies were set up in kitchen, family room, one bedroom and in the basement where appropriate. The air pumps were affixed at a height of approximately 2 feet above the floor and at 2 litre/min for 24 hours. Samples were then collected and frozen for analysis.

Field controls and field fortifications were set up outside most houses where fipronil was applied. Samples and standards were analysed by capillary gas liquid chromatography (GLC) using a mass selective detector.

Results: Air samples taken 24 hours before the application did not have detectable background vapour levels in any of the houses tested. Fipronil vapour in ambient air in rooms of houses treated with Termidor 80 WG were detectable generally only on the day of application. Measured vapour levels are presented in table 6.

Table 6: Fipronil vapour detected in indoor air on day of application

Construction type	Fipronil range detected (ng/L)	Mean and SD (ng/L)
Basement	0.005-0.042	0.019±0.013
Crawl space	0.004-0.011	0.008±0.002
Concrete slab	0.008-0.081	0.028±0.019

Respiratory exposure of PCOs applying the spray in crawl space houses was determined by having each volunteer wear a personal air-monitoring pump when applying the product. Analysis of the Gelman filters and air tubes from applicators showed the pest control operators would receive potential respiratory exposure of 2.23 to 385 µg/hour (0.03 to 5.50 µg/kg bw/hour; assuming 70 kg bw) (mean 0.95 µg/kg bw/hour) when applying Termidor to houses with crawl spaces. Table 7 summarises the PCO exposure (inhalation) to fipronil residues.

Table 7: Summary of respiratory exposure for PCO applying fipronil product

Site*	Fipronil handled/hr (kg)	Fipronil inhaled/hr (µg)	Fipronil inhaled (mg/kg ai)	Fipronil inhaled (mg/kg ai/kg bw)*
2	0.156	6.35	0.041	0.0006
3	0.25	10.70	0.042	0.0006
4	0.14	2.23	0.016	0.0002
5	0.22	19.59	0.090	0.0013
8	Not recorded	2.24	Cannot be calculated	Cannot be calculated
9	0.22	17.4	0.078	0.0011
10	0.27	12.88	0.048	0.0007
11	0.28	36.9	0.129	0.0018
12	0.23	2.47	0.011	0.0002
18	0.16	19.49	0.125	0.0018
19	0.30	16.56	0.055	0.0008
20	0.49	28.0	0.058	0.0008
21	0.15	274.6	1.790	0.0256
22	0.15	385.2	2.610	0.037
23	0.11	166.3	1.500	0.021
24	0.02	63.86	3.000	0.043
Arithmetic Mean		**66.5**	**0.640 (0.137)****	**0.0091**

*Respiratory exposure was monitored only in crawl space houses.

**Figures in brackets are geometric mean

Conclusions: Ambient air concentrations of fipronil in rooms of houses treated with Termidor 80 WG were extremely small ranging from 0.004 to 0.081 ng/litre and usually only occurred on the day of application. These trace amounts of fipronil dissipated rapidly and usually were below detection limits (0.009 ng/litre) by 24 hours from application.

Respiratory exposure to fipronil for PCOs treating houses for termites ranged between 0.0002 to 0.043 mg/kg ai/kg bw/h with a mean of 0.0091 mg/kg ai/kg bw/h. Considering that PCOs handle an average 0.6 kg fipronil per day (Section 7.3), workers are likely to inhale 0.026 mg/kg bw/d fipronil.

Comments: The spray equipment or the application method was not described in detail in the study report. In the absence of such information the use of the study data is restricted. However, for the purpose of post-application exposure assessment, this study is considered appropriate. The average amount of the active applied per house in this study (500 L of 0.056-0.064% fipronil) is similar to that recommended for Australian situation.

Meo NJ, Gonzalez CM and Mester TC (1997) Dermal and inhalation exposure of commercial pet groomers during application of Frontline Spray Treatment. Study No. SAFXT046, Merial Limited (formerly Rhone Merieux, Inc.), Georgia USA.

Merial Limited has conducted a study to determine dermal and inhalation exposure of commercial pet groomers to fipronil when applying Frontline Spray Treatment to dogs according to the label directions. Frontline Spray Treatment contains 2.5 mg/mL fipronil and is indicated for the treatment and prevention of flea and tick infestation and for the control of flea allergy dermatitis. The product is packed in ready-to-use trigger spray pump bottles containing 250 mL of the commercial product. The spray pump is capable of delivering approximately 1.5 mL of the product each time the pump trigger is depressed completely. The recommended application rate is two pumps depressions (3 mL) per pound bodyweight of the dog (approx. 6 ml/kg bw of dog). The product label advises users to spray the entire body of the dog and apply against the lay of the hair. The coat is to be ruffled as the spray is applied, especially in long-haired animals, so that the product penetrates down to the skin. One bottle of test substance could often be used for one or more dogs.

Exposure measurements were conducted in a grooming shop in Georgia USA, which generally bathes and grooms 20 to 40 dogs per day, six days a week. For the present study, the staff selected and scheduled the dogs to be bathed, groomed and treated. A variety of dogs with different hair lengths (0.25 to 5.0 inches) and bodyweights (6-122 pounds; approx. 2.7-55.3 kg) were used. The dogs were held in individual cages before they were bathed, while waiting to be groomed and while waiting to be treated with the fipronil product.

Sixteen workers (study subjects) took part in the study. A complete replicate consisted of treating eight dogs consecutively with Frontline Spray Treatment. Dogs were treated at the maximum label rate of two pumps per pound bodyweight. Each test subject was instructed to adjust the sprayer to the mist position and to prime the pump prior to counting the number of pumps for each dog. The test subjects would generally hold the dog with one hand and operate the pump with the other. The hand used to hold the dog was also used to rub the spray into the dog's coat. Occasionally the test subject would use the crook of the arm (partially closed elbow joint) to hold an active animal resulting in contact to a wet animal. The test subjects would often also spray one or more pumps into a hand and then rub the dog's face to cover the face to avoid spraying into the dog's eyes, nose, and mouth.

Duration of each treatment and the number of spray pumps applied during treatment were noted. Each bottle was weighed before and after use on each dog to obtain the actual amount of product applied to the dog.

Personal protection: All applicators wore short-sleeved cotton shirt, long-sleeved, ribbed-cuff smock (65% polyester/35% cotton), long cotton pants and shoes and socks covering the entire foot. In addition, all workers wore household latex gloves, which are the personal protective equipment listed on the product label.

Exposure monitoring: Exposure monitoring was accomplished with passive dosimetry. Work clothing was worn over a whole-body, one-piece, cotton union suit, termed the whole-body dosimeter suit. The dosimeter suit, along with the cotton gloves worn beneath the household latex gloves, functioned as the monitoring device for the possible dermal exposure to the test product. The collection media for potential dermal exposure of the face and neck consisted of facial swabs with ethanol-soaked 48 X 48 cotton gauze squares over the face and neck of each groomer, repeated three times, each time with a new ethanol-soaked gauze square.

Inhalation exposure was measured via passive dosimetry utilizing a SKC, Inc. Aircheck Sampler (model: 224-43XR), low volume battery-powered personal air-sampling pump attached to the test subject's belt and drawing approximately 1.5 liters of air per minute. Each air sampler was calibrated prior to use, for either a test subject or during the field fortification procedures, with a Kurtz Flow Calibrator, model: 54O-S and Kurtz Mass Flow Meter, model: 540-S. The duration of the monitored work function was measured from the time the air-sampling pump was turned on until it was turned off.

All samples from each groomer (dosimeter suits, facial swabs, cotton gloves, air-sampling pump and inhalation cassette) were packaged, sealed and placed in temperature-monitored chest freezers or in the small freezer in the field lab and logged into the freezer log maintained in the field notebook. Separate freezers were maintained for control fortification samples, field fortification solutions and field fortification samples, test subject samples and batch formulation samples.

Details of the methods of analysis of test samples or fortified sample were recorded in the appendices of the report. However, these appendices were not provided to the OCSEH.

Results and discussion: Table 8 summarises the amount of product used by each worker to treat 8 dogs and total exposure (dermal and inhalation) resulting from the treatment. On an average, workers spent 56 minutes treating 8 dogs (range 38-72 minutes). The maximum application rate of two pumps per pound bodyweight of dog was used; for example, for a 122-pound dog, 244 pump triggers were used. The bodyweight of dogs ranged between 6 and 122 pounds. The actual amount of the product applied to each dog was determined by weighing the container before and after application. Total amount of product used by each worker in a session was determined as the sum of the product applied to eight dogs (Table 8). The mean amount of fipronil applied by workers in one session was 1,773 mg (range of 859 to 2,959 mg).

Spraying two pumps per pound bodyweight of dogs resulted in wet animals. Even long-haired animals appeared slightly wet with glistening coats. Short-haired dogs were soaked, occasionally to the point where the dogs would shake. Sometimes the grooming table would appear damp. After treatment, the dogs were caged in the treatment room to dry.

Table 8: Summary of applicator exposure following treatment of dogs with Frontline Spray Treatment

Replicate Number	Bodyweight (kg)	Total fipronil applied (mg)*	Total treatment time (min)**	Dermal exposure (ug)				Inhalation residue (ug)	Total Exposure (ug)	Exposure (mg/kg bw /day)
				Face and neck	Gloves	Body dosimeter	Total			
1	66	1505	52	1.47	5.58	332	339	0.64	339.6	0.005
2	65	1077	55	5.05	1.50	2838	2844	0.22	2845	0.044
3	86	1483	48	14.1	20.6	67.0	101	0.70	102	0.001
4	54	1581	49	8.09	3.60	692	704	0.97	705	0.013
5	58	2118	70	5.02	3.62	1107	1116	3.42	1119	0.019
6	76	2907	68	10.4	2.82	1688	1701	2.23	1704	0.022
7	77	1657	59	2.23	55.6	4345	4402	0.30	4403	0.057
8	74	1147	48	4.21	8.26	125	138	0.88	139	0.002
9	95	1643	60	16.6	4.53	983	1004	0.09	1004	0.011
10	85	2959	48	1.80	1.71	3735	3738	1.07	3739	0.044
11	75	1717	63	1.53	6.87	2243	2251	1.95	2253	0.030
12	60	1115	49	0.79	8.89	114	124	0.11	124	0.002
13	61	1484	49	13.2	50.9	621	685	0.94	686	0.011

Replicate Number	Bodyweight (kg)	Total fipronil applied (mg)*	Total treatment time (min)**	Dermal exposure (ug)				Inhalation residue (ug)	Total Exposure (ug)	Exposure (mg/kg bw /day)
				Face and neck	Gloves	Body dosimeter	Total			
14	70	2389	61	5.95	1.36	2830	2837	0.70	2838	0.040
15	66	859	38	5.18	8.84	713	727	0.94	728	0.011
16	67	2733	72	11.9	20.5	3956	3987	1.01	3989	0.059
Mean				**6.722**	**12.82**	**1649**	**1669**	**1.01**	**1670**	**0.024**

*Each worker treated 8 dogs; product containers were weighed before and after treatment to calculate the amount of product (gms) applied on each dog. The amount of fipronil applied was then computed using the sp. gravity of the product (0.852 g/mL) and the concentration of fipronil in the product (mg/mL).

**Time taken to treat 8 dogs.

Total exposure to fipronil of workers treating dogs with Frontline Spray Treatment was very low (0.024 mg/kg b wt/day). The treatment procedure included spraying the product and restraining the animals or lifting and carrying them to the grooming facility cages or kennels. In fact, a large portion of the residue detected on the forearms, upper arms and chest may be due to handling (lifting and transporting) treated dogs soon after treatment. Wet tables or floors resulting from spray application may also be contributing to the spread of the residue into some matrices.

Comment: Each worker in the present study treated eight dogs consecutively, while in most grooming facilities dogs would be treated on an as-needed basis as they arrive during the course of the day. In addition, groomers in the study were not allowed to change their outer clothing during the replicates, whereas in actual practice, due to sanitation concerns, the groomer would have the option of changing damp or soiled outer clothing frequently. The study also used the maximum label rate of two pumps per pound of bodyweight. Many professional groomers apparently judge the spray dosage for each dog depending upon the length and density of hair. In approximately two-thirds of the dogs treated in this study, the applicators stated that they would have completed treatment before the maximum label rate was achieved. The study is considered suitable for risk assessment.

Meo NJ, Gonzalez CM and Belcher TI (1997) Dermal exposure of commercial pet groomers during application of Frontline Top Spot. Study No. SAFXT047, Merial Limited (formerly Rhone Merieux, Inc.), Georgia USA.

Merial Limited has conducted a study to determine dermal exposure of commercial pet groomers to fipronil following treatment of eight dogs with Frontline Top Spot according to the label directions. Frontline Top Spot contains 100 mg/mL fipronil and is used to control fleas and ticks on dogs and cats. Although the product is used for treating both cats and dogs, for the purpose of this study, only dogs were chosen for treatment as they offered a greater variety of hair lengths and greater bodyweights than cats, thus utilizing a larger amount of active ingredient.

Exposure measurements were conducted as described in the previous study. The active ingredient was applied via commercially available supplies of the formulated product, which contained 100 mg/mL of fipronil. The application rate was dependent upon animal bodyweight and was categorized as four pre-measured application volumes. Dogs weighing up to 22 lbs (10 kg) received 0.67 mL (67 mg fipronil), 23 to 44 lbs (10-20 kg) received 1.34 mL (134 mg fipronil), 45 to 88 lbs (20-40) received 2.68 mL (268 mg fiproni1), and those weighing over 88 lbs (40 kg) received an appropriate combination of 2.68 mL plus an additional pre-measured applicator volume which delivered sufficient active ingredient suitable to their bodyweight. Application equipment consisted of ready-to-use, disposable, snap top, plastic foil-backed, pipettes which delivered the entire pre-measured unit dose to each dog. The pre-measured test substance was dispensed onto the dog by breaking open the scored tip and applying all contents of the pipette onto the dog.

The applicator test subjects were human volunteers who typically treat animals for flea control during the course of a typical work-day. The work function is commonly known as “groomer". A complete replicate consisted of treating eight dogs consecutively with Frontline Top Spot. The test subjects would generally hold the dog with one arm while opening the pipette with the other arm and then would insert the pipette tip through the dog’s hair coat near the neck area in order to dispense the contents onto the dog’s skin. Some test subjects then chose to rub the product into the skin using latex-gloved hands. After treatment the test subjects had to lift the dogs from the grooming and carry them to the holding cages. This resulted in direct contact with a treated dog to their sides of the lower arm, upper arm, chest, stomach and under arm areas. Larger dogs were generally led or gently pushed into their cages with less potential for exposure to the test subjects. This general process was repeated until the completion of the treatment applied to the eight dogs.

Personal protection: All applicators wore short-sleeved cotton shirt, long-sleeved, ribbed-cuff smock (65% polyester/35% cotton), long cotton pants and shoes and socks covering the entire foot. In addition, all workers wore household latex gloves, which are the personal protective equipment listed on the U.S. product label. It is important to note that whilst latex gloves were label PPE for the U.S. spot-on product, they are not a label requirement for the Australian spot-on product.

Exposure monitoring: Exposure monitoring was accomplished with passive dosimetry. Work clothing was worn over a whole-body, one-piece, cotton union suit, termed the whole-body dosimeter suit. The dosimeter suit, along with the cotton gloves worn beneath the household latex gloves, functioned as the monitoring device for the possible dermal exposure to the test product. The collection media for potential dermal exposure of the face and neck consisted of facial swabs with ethanol-soaked 48 X 48 cotton gauze squares over the face and neck of each groomer, repeated three times, each time with a new ethanol-soaked gauze square.

All samples from each groomer (dosimeter suits, facial swabs, cotton gloves, air-sampling pump and inhalation cassette) were packaged, sealed and placed in temperature-monitored chest freezers or in the small freezer in the field lab and logged into the freezer log maintained in the field notebook. Separate freezers were maintained for control fortification samples, field fortification solutions and field fortification samples, test subject samples and batch formulation samples. Details of the methods of analysis of test samples or fortified samples were recorded in the appendices of the report. However, these appendices were not provided to the OCSEH.

Results and discussion: Dermal exposure monitoring was accomplished with the use of passive dosimetry, which included the use of whole body dosimeter suits, cotton gloves for the hands, and cotton gauze was used for facial wipes of the face and neck. Table 9 summarises the amount of product used by each worker to treat 8 dogs and the total dermal exposure resulting from the treatment. On an average, workers spent 20 minutes treating 8 dogs (range 14-32 minutes). Total amount of fipronil used by each worker in a session was determined as the sum of the product applied to eight dogs. Workers applied an average 1047 mg fipronil (range of 670 to 1809 mg) in one session (8 dogs).

Table 9: Summary of applicator exposure following treatment of dogs with Frontline Top Spot

Replicate Number	Bodyweight (kg)	Total fipronil applied (mg)*	Total treatment time (min)**	Dermal exposure (ug)			Total Exposure (ug)	Exposure (mg/kg bw/day)
				Face and neck residue	Gloves total residue	Dosimeter suit total residue		
1	52	1072	26	0.233	2.618	3.913	6.764	0.00013
2	64	938	25	0.339	3.030	2.121	5.490	0.00009
3	86	1139	32	5.254	60.120	71.272	136.646	0.00160
4	84	737	14	2.221	7.499	8.773	18.493	0.00022
5	67	1474	26	20.536	0.211	3.071	23.818	0.00036
6	95	737	21	0.639	3.256	2.967	6.862	0.00007
7	74	1809	21	0.612	0.192	1.750	2.554	0.00003
8	64	804	17	0.265	0.205	194.152	194.622	0.00300
9	95	1139	17	1.886	0.070	5.206	7.162	0.00008
10	56	670	17	0.991	0.495	77.142	78.628	0.00140
11	61	938	22	17.956	39.911	272.396	330.263	0.00540
12	61	871	19	1.618	0.802	8.718	11.138	0.00180
13	73	871	17	0.113	0.596	2.251	2.960	0.00004

Replicate Number	Bodyweight (kg)	Total fipronil applied (mg)*	Total treatment time (min)**	Dermal exposure (ug)			Total Exposure (ug)	Exposure (mg/kg bw/day)
				Face and neck residue	Gloves total residue	Dosimeter suit total residue		
14	75	1206	17	210.402	4.652	14.608	229.662	0.00310
15	64	1139	18	1.050	1.953	6.111	9.114	0.00014
16	75	1206	15	2.562	4.874	549.179	556.615	0.00743
Mean				**16.677**	**8.155**	**76.477**	**101.299**	**0.00156**

*Each worker treated 8 dogs; **Time taken to treat 8 dogs

The assay method for detecting fipronil in each matrix was validated. Mean assay recoveries fell between 89 and 111 %. Data generated in the frozen stability phase of the study indicated that fipronil was stable in two dermal matrices after being frozen for up to three months. These data were corroborated by the range of mean recoveries from field fortification samples, which fell between 79 and 103 % of theoretical concentration.

The treatment procedure included inserting the pipette tip through the dog's hair coat near the neck area and dispense the contents onto the dog's skin. Some of the applicators used their latex gloved hand to 'rub in' the product to insure that the solution reached the skin of the dog. After treatment, the test subjects had to lift the dogs from the grooming table and safely and securely carry them to the holding cages. This resulted in direct contact with a treated dog to the inner sides of the lower arm, upper arm, chest, stomach, and under arm areas.

Generally, low levels of fipronil were detected in all 16 applicators and ranged from approximately 2.6 to 556.6 µg, with a mean of 101.3 µg. Mean total exposure to fipronil, expressed as mg/kg bodyweight of workers, was very low (0.0015 mg/kg bw/day).

Comment: The study is considered suitable for risk assessment.

7.2 Exposure assessments performed by registrants

Derzi, M (2001) Product safety and risk evaluation - Termidor SC100 containing the active ingredient fipronil: Evaluation of operator and post application exposure during post-construction application of Termidor SC100 for termite control in Australia, Aventis CropScience Pty Ltd.

This study estimates short-term and long-term exposure of and risk to PCO using Termidor SC 100 for treatment of houses for termite control. The authors have used exposure data from the Honeycutt and Kennedy study (Honeycutt and Kennedy, 2001) and surrogate exposure data from PHED to estimate risk to workers using Termidor SC100 for termite control.

Frequency of exposure: Termidor SC 100 is diluted 600 mL in 100 L water and applied at a rate of 100 L of diluted solution per cubic meter of soil. Information provided by Aventis indicated that a PCO could treat one or two houses per day. Not all houses that are treated would be crawlspace construction homes. The PCO is also expected to conduct inspections of houses and it is not unusual for the day to consist of one home treatment and inspection of other houses for termites. In prime termite areas, it is expected that a PCO would apply termiticides for 4 days a week and for 120 days per year.

For estimating risk from short-term exposure, the study assumed that a PCO will treat two crawlspace houses per day. A NOEL from a 90-day dog dietary study (0.5 mg/kg bw/day) was to estimate risk from short-term exposure. For the purpose of estimating risk from long-term exposure, it was assumed that on an average only one crawlspace construction home was treated with Termidor per day. A long-term NOEL of 0.025 mg/kg bw/day from a chronic/carcinogenicity rat study was selected for risk assessment. Based on in vitro (rat and human) and in vivo (rat) dermal absorption studies, a dermal absorption factor of 1% has been used for risk assessment.

Exposure data: Data from PHED and the Honeycutt and Kennedy study (Honeycutt and Kennedy, 2001) was used to evaluate the risk (short-term and long-term) from dermal and inhalation exposure.

Table 10: Surrogate exposure data (PHED) for termiticide injection method

Mixer, Loader and Applicator File **Scenario – long pants, long sleeved shirt and gloves**	**Exposure** **(mg/kg ai handled)**	**Exposure** **(mg/0.6 kg ai)**	**Exposure** **(mg/kg bw)**
Head & neck	0.068	0.040	
Upper arm & lower arm, chest, back thigh and lower leg	0.498	0.298	
Hand	0.227	0.136	
Total dermal	0.794	0.474	0.0068
Inhalation	0.00485	0.0029	0.0000415

Risk assessment

Risk assessment for short-term (repeated) exposure

Total dermal exposure	0.0068 mg/kg bw/day (PHED)
With 1% dermal absorption	0.000068 mg/kg bw/day
Inhalation exposure	0.0000415 mg/kg bw/day
Total exposure	0.000109 mg/kg bw/day
MOE (0.5 ÷ 0.000109)	**4587**

When inhalation exposure value from the Honeycutt and Kennedy study (0.137 mg/kg ai handled (geometric mean)) was used for calculation:

Inhalation exposure	0.137 mg/kg ai handled
Total inhalation exposure	0.0822 mg/0.6 kg ai handled
Total inhalation exposure	0.00117 mg/kg bw/day
Total exposure (dermal + inhalation)	0.00123 mg/kg bw/day
(0.000068 + 0.00117 mg/kg bw/day)	
MOE (0.5 ÷ 0.00123)	**406**

Risk assessment for long-term (repeated) exposure

Risk assessment for long-term exposure was based on surrogate (PHED) and Honeycutt and Kennedy study data and it was assumed that as a worst case a PCO will treat 1 house per day for a total of 120 days per year (amortisation of exposure - adjustment of daily exposure to account for the fact that it is usually discontinuous throughout the year and throughout the lifetime of the exposed individual).

Total dermal exposure	0.0034 mg/kg bw/day (treating one house/day; 0.3 kg ai used)
With 1% dermal absorption	0.000034 mg/kg bw/day
Inhalation exposure	0.0000207 mg/kg bw/day
Total exposure	0.0000548 mg/kg bw/day
MOE (0.025 ÷ 0.0000548)	**456**

When inhalation exposure value from the Honeycutt and Kennedy study (0.137 mg/kg ai handled (Table 10) was used for calculation:

Inhalation exposure	0.137 mg/kg ai handled
Total inhalation exposure	0.0411 mg/0.3 kg ai handled
Total inhalation exposure	0.00059 mg/kg bw/day
Total exposure (dermal + inhalation)	0.000624 mg/kg bw/day
(0.000034 + 0.00059 mg/kg bw/day)	
MOE (0.025 ÷ 0.000624)	**40**

Conclusion and discussion: Based on actual inhalation exposure data (Honeycutt & Kennedy, 2001) for crawl space applications and combined with dermal surrogate data, the MOE was 40, which is considered inadequate. However, this risk assessment assumes that the operator is not wearing any form of respiratory protection (only one layer of clothing and gloves). The use of a respirator eg. dust/mist respirator is expected to provide 80% reduction in inhalation exposure (PHED Guide, 1998). The MOE of 167 was obtained when 80% reduction in inhalation exposure was applied. Based on these calculations, the authors have recommended that PCOs need to wear coveralls, gloves and a dust/filter respirator for the application of Termidor in confined spaces (e.g. crawl space treatment).

Fipronil and Regent 80 WG Insecticide. Summary of Mammalian Toxicology (1997).

Rhone Poulenc conducted the following risk assessment in relation to the use of fipronil formulations in corn, potato, rice and cotton in the USA.

Normalised exposures for workers mixing/loading and applying an 80% fipronil formulation by ground and aerial application methods were estimated, based on data in Version 1.1 of the Pesticide Handlers Exposure database (PHED).

Mixer/Loader: PHED contains 23 records of high quality data (Grade A and B) for inhalation, hand and other dermal exposures for open mixing and loading of a water dispersible granule formulation. The best-fit inhalation, dermal (under long pants and long sleeved shirt), and hand (under gloves) exposures are 0.77, 72.33 and 10.57 µg/lb ai respectively (1.7, 159 and 23.3 µg/kg ai, respectively), constituting a daily total exposure of 83.67 µg/lb ai (184 µg/kg ai handled.

Applicator: PHED contains high quality data (Grades A and B) for inhalation, hand and other dermal exposures. All records in these subsets involve groundboom application with an open cab or closed cab with an open cockpit. The best-fit inhalation, dermal (under long pants and long sleeved shirt), and hand (without gloves) exposures are 0.71, 7.95 and 6.61 µg/lb ai respectively (1.6, 17.5 and 14.6 µg/kg ai, respectively), giving a daily total exposure of 15.27 µg/lb ai (33.6 µg/kg ai) handled. Although some product labels require the applicator to wear gloves, an insufficient number of observations were available in PHED for gloved hands. Therefore, records for hand exposure without gloves were used.

To estimate exposure during aerial application, applicator files for aerial applications between 1 and 5 gal/acre were searched. Further sub-setting to restrict the exposure data to an application rate similar to fipronil use-pattern (less than 1 lb ai/acre), resulted in too few replicates and did not give exposure values significantly different from the subset based on 1 to 5 gal/acre. Therefore, the subset containing the greater number of replicates was used. Hand exposure for aerial applicators is based on 'no gloves' scenario, as pilots are unlikely to wear gloves because of the difficulty in adjusting cockpit instruments when wearing chemical resistant gloves. The best-fit inhalation and dermal exposures (under long pants, long sleeved shirt and no gloves) are 7.0 and 0.087 µg/lb ai respectively (15.4 and 0.19 µg/kg ai, respectively); giving a daily total exposure of 7.1 µg/lb ai handled (15.6 µg/kg ai).

The MOE calculations are based on the following:

- Fipronil is used at the maximum application rate of 0.05 lb ai/acre (0.056 kg/ha).
- All aspects of the application will be performed by a single individual weighing 70 kg.
- In a single day, one person is unlikely to treat more than 500 acres (202 ha).
- The 21-day dermal toxicity study in rabbits provides the most appropriate NOEL because it is most representative of the exposure route in the field, i.e. dermal. This study provides a NOEL of 5 mg/kg bw/day.

Calculations:

Exposure (µg/kg/day) = lb ai/acre x acres treated/day x exposure µg/lb ai ÷ 70 kg

MOE = Dermal NOEL ÷ Exposure

Mixer/Loader:

83.67 µg/lb ai x 0.05 lb ai/acre x 500 acres/day ÷ 70 kg = 30 µg/kg/day

MOE = 5000 µg/kg/day ÷ 30 µg/kg/day = **167.**

Applicator – Ground spraying**:**

15.27 µg/lb ai x 0.05 lb ai/acre x 500 acres/day ÷ 70 kg = 5.5 µg/kg/day

MOE = 5000 µg/kg/day ÷ 5.5 µg/kg/day = **909.**

Applicator – Aerial spraying:

7.1 µg/lb ai x 0.05 lb ai/acre x 500 acres/day ÷ 70 kg = 2.5 µg/kg/day

MOS = 5000 µg/kg/day ÷ 2.5 µg/kg/day = **2000.**

Comments: These calculations demonstrate adequate MOEs for mixing/loading and application of fipronil formulations. Worker exposure associated with treatment of rice seeds with fipronil is not addressed in this submission.

Occupational and residential exposure and risk assessment characterisation for Fipronil. PC Code: 129121. DP Barcode: D254430, D254365.

The Occupational and Residential Exposure Branch (OREB) of the USEPA has conducted risk assessment of PCOs using Termidor 80 WG. Supporting data for the assessment were provided by Rhone Poulenc in support of registration of their product, Termidor 80 WG. The assessment has been reviewed by the Registration Analysis Branch 1 (RAB1) of the US EPA. Following is the summary of RAB1's review.

Termidor 80 WG is applied as a trench, rod or sub-slab injection or similar subterranean treatment application in or around the foundation or crawl space of the dwellings. The product is packaged in water-soluble bags and is available for use by professional PCOs only. As a minimum, eye protection, chemical resistant gloves, chemical resistant footwear with socks, a long sleeved shirt and long pants or coveralls are recommended. A chemical resistant apron is recommended when loading, mixing or cleaning equipment. If applying in confined areas a respirator must be worn. Using the gas saturation method (OECD 1-104), the RAB1 concluded that the vapour pressure of fipronil is very low (3.7×10^{-9} hPa at 25 ^{o}C), and since fipronil product is injected into the ground and sealed immediately, dermal or inhalation exposure to resident adults or children would be very low. The only anticipated exposure would be to the PCOs while mixing/loading and applying the chemical. In the absence of chemical specific data, PHED surrogate data was used to assess worker exposure. Since the proposed use of fipronil applies to commercial pest control applicators, short-, intermediate- and long-term exposures are expected.

Application method 16 (termiticide injection) of the PHED version 1.1 was selected from the mixer/loader/applicator file (MLAP) yielding a subset containing 17 records. The resultant exposure estimates for mixer/loader/applicators were 385 µg/lb ai by dermal route (total body exposure) and 2.0 µg/lb ai by inhalation route. Workers wore one layer of clothing and gloves. The data submitted by the registrant assumed that 200 gallons of a 0.125% termiticide emulsion would be applied per day. This is within the range of the application volumes recorded in the surrogate studies in the PHED and was used by OREB for its calculations. The amount handled therefore was calculated to be:

200 gal x 3.785 L/gal x 1.25 g/L x 1 lb ai/454 g = 2.1 lbs ai/day.

Using this application rate, the average daily dermal and inhalation exposures are calculated to be:

Dermal Exposure (mg/kg bw/day)	= 2.1 lb ai/day x 385 µg/lb ai x 1/70 kg
	= 12 µg/kg/day
	= 0.012 mg/kg bw/day
Inhalation exposure (mg/kg bw/day)	= 2.1 lb ai/day x 2.0 µg/lb ai x 1/70 kg
	= 0.060 µg/kg/day
	= 0.000060 mg/kg bw/day
The total daily exposure (mg/kg bw/day)	= 0.012 + 0.000060 mg/kg bw/day
	= 0.012 mg/kg bw/day

Table 11: Exposure and MOE values for PCO using Termidor WG

Exposure to fipronil in Termidor WG (80% fipronil)				
Person exposed	**Exposure (mg/kg bw/day)**	**Short-term & Intermediate MOE[1]**	**Long-term MOE[2]**	**Cancer Risk[3]**
Mixer/loader/applicator (single layer, gloves)	0.012 (dermal)	420 (dermal)	108	7.3E-07
	0.00006 (inhalation)	830 (inhalation)		

All PHED exposure values are of high confidence data.

[1]A NOAEL of 5 mg/kg bw/day for dermal and 0.05 mg/kg bw/day for inhalation was used.

[2]An oral NOAEL of 0.0195 mg/kg bw/day for long-term exposure was used. A dermal absorption of 1% for fipronil and an inhalation absorption of 100% were assumed.

[3]Cancer risk = (dermal + inhalation exposure) x 220 days (based on a handlers working 5 days per week with 2 weeks vacation per year)/365 days x 35 years/70 year lifetime) x RfD (0.0002 mg/kg bw/day).

Results and discussion: The results indicated that the risk to PCO is acceptable (MOE>100) with one layer of clothing and gloves (Table 9).

Comment: The above estimate has assumed that PCOs handle 2.1lbs (0.95 kg) of fipronil active per day. This is significantly higher than the amount expected to be used by PCOs in Australian situation when treating two houses per day. Moreover, exposure from termiticide injection method only has been estimated, whereas the hand spray for trenching is the more commonly used method. Exposure for this method is not discussed. This estimate is of limited value for risk assessment.

Tier 2 Summary of toxicological studies for plant protection product Regent TS; Code: EXP 80415A / AE F124964 00 FS41 A1 (2002) Aventis CropScience, Lyon France

Aventis CropScience has conducted exposure and risk assessment for workers treating maize seeds with the fipronil product, Regent TS (code EXP 80415A). EXP 80415A is a flowable concentrate (FS) containing 500 g/L fipronil and is used for seed dressing as an insecticide. It is presently used in many European countries and is applied in seed treatment plants at the maximum use rate of 10 L formulation/ton of seeds, equivalent to 5 kg fipronil/ton of seeds.

The assessment is based on extrapolation of generic exposure data for seed treatment workers, which was developed by an industry task force (Seed Treatment Exposure Group – TROPEX) formed in 1993. The Seed Tropex model describes the following stages in seed treatment where exposure to the chemical could occur:

1. Calibration phase

2. Mixing/loading phase

3. Bagging of treated seed

4. Cleaning

Exposure estimation: Worker exposure was estimated for two different dilutions of the product (as used in different countries). The level of dilution used in Italy leads to a spray applied at 357 g/L fipronil (500 ml + 200 ml water), while in France the formulation is more diluted at 143 g/L fipronil (500 ml + 1250 ml water). The calculations presented below were performed successively with both dilutions. EXP 80415A is delivered in 5 to 200 L containers or drums, which are equipped with a fast-coupling system in order to avoid any contact with the compound during mixing/loading. Since the fast-coupling system is expected to result in negligible exposure, the mixing loading phase has not been considered in the present assessment. The treated seeds are packed (bagged) in 25 kg and 50 kg bags. Exposure during bagging in different sized bags was also considered.

Estimation of operator exposure was carried out with workers wearing personal protective equipment (PPE) specified in the Seed Tropex model (gloves during mixing/loading and cleaning and bagging and ventilated helmets during cleaning). Effect of wearing dust mask and Tyvek coveralls during cleaning and/or bagging were also considered.

Tables 12 and 13 summarize the estimated exposure to fipronil by dermal and inhalation routes as calculated from the generic data obtained in Seed Tropex model. Exposure from two different dilutions of the product are presented.

Table 12: Estimated exposure to fipronil by dermal and inhalation routes for each task. Spray concentration: 357 g/L (Italy)

Task	Generic exposure (Tropex model) (mL/operation)		Estimated exposure to fipronil (mg/operation)		No. of operations per day	Estimated exposure to fipronil (mg/day)	
	Dermal exposure	Inhalation exposure	Dermal exposure	Inhalation exposure		Dermal exposure	Inhalation exposure
Calibration	0.014	0.001	5	0.357	1	5	0.357
Bagging (50 kg bags)	0.472	0.015	0.157	0.005	8	1.26	0.04
Bagging (25 kg bags)	0.862	0.131	0.287	0.044	8	2.3	0.35
Cleaning	0.083	0.016	29.63	5.71	1	29.63	5.71
Total (Bagging- 50 kg)						**35.89**	**6.11**
Total (Bagging- 25 kg)						**36.93**	**6.42**

Table 13: Estimated exposure to fipronil by dermal and inhalation routes per task and per day. Spray concentration: 143 g/L (France)

Task	Generic exposure (Tropex model) (mL/operation)		Estimated exposure to fipronil (mg/operation)		No. of operations per day	Estimated exposure to fipronil (mg/day)	
	Dermal exposure	Inhalation exposure	Dermal exposure	Inhalation exposure		Dermal exposure	Inhalation exposure
Calibration	0.014	0.001	2.00	0.143	1	2.00	0.143
Bagging (50 kg bags)	0.472 (mg/op)	0.015 (mg/op)	0.157	0.005	8	1.259	0.040
Bagging (25 kg bags)	0.862 (mg/op)	0.131 (mg/op)	0.287	0.044	8	2.30	0.35
Cleaning	0.083	0.016	11.87	2.288	1	11.87	2.288
Total (Bagging- 50 kg)						**15.13**	**2.471**
Total (Bagging- 25 kg)						**1.171**	**2.781**

The total dermal exposure is the sum of contamination of underclothes, hands (hand rinsing or undergloves) and head (cap). The distribution of dermal exposure for each task as given in the Tropex model is presented in Table 14.

Table 14: Distribution of dermal exposure for each task

	Bagging (%)	Cleaning (%)
Underclothing	16.7	38.5
Hands	78.5	0
Head (cap)	4.8	61.5

Calculation of exposure during various tasks

1. Mixing/loading

As mixing/loading is done through fast-coupling system, which is expected to result in negligible exposure, the mixing loading phase was not considered in the present assessment.

2. Exposure during bagging

In Seed Tropex studies, workers wore coveralls and gloves for all tasks, except for bagging where only coveralls were worn.

Hand contamination when bagging represents 78.5% of actual dermal contamination. Wearing gloves during this phase would reduce the contamination by a factor of at least 10. The exposures during bagging, for both Italian and French use pattern, could then be adjusted as follows:

- dermal contamination (50 kg bags): (1.26 x 0.215) + (1.26 x 0.785/10) = 0.37 mg/day

- dermal contamination (25 kg bags): (2.3 x 0.215) + (2.3 x 0.785/10) = 0.675 mg/day

Use of dust mask provides 90% inhalation protection. Inhalation exposure during bagging could therefore be adjusted as follows:

- Inhalation exposure (50 kg bags): (0.04 x 0.1) = 0.004 mg/day

- Inhalation exposure (25 kg bags): (0.35 x 0.1) = 0.035 mg/day

3. Exposure during cleaning

Aventis strongly recommends the wearing of a ventilated helmet. This helmet is expected to completely block head contamination, which represents 61.5% of total dermal contamination during cleaning. Therefore only 38.5% of the total contamination (11.408 mg/day for Italian use pattern and 4.57 mg/day for French use pattern) can be expected, which is further reduced by 90% if workers wear Tyvek type coverall, as shown below. The ventilated helmet also provides 95% protection from inhalation exposure.

For Italian use pattern:

- Dermal contamination (29.3 x 0.615 x 0) + (29.3 x 0.385) = 11.41 mg/day

" " with Tyvek suit (29.3 x 0.615 x 0) + (29.3 x 0.385 x 0.1) = 1.141 mg/day

- Inhalation contamination (5.71 x 0.05) = 0.2855 mg/day

For French use pattern:

- Dermal contamination (11.87 x 0.615 x 0) + (11.87 x 0.385) = 4.57 mg/day
- " " with Tyvek suit (11.87 x 0.615 x 0) + (11.87 x 0.385 x 0.1) = 0.457 mg/day
- Inhalation contamination (2.29 x 0.05) = 0.114 mg/day

Total expected exposure for fipronil by dermal and inhalation routes when all mitigation factors are used will be as follows (Tables 15 and 16):

Table 15: Summary of estimated exposure during various seed treatment tasks (Italian use pattern)

	Estimated dermal exposure (mg/op)	**Inhalation exposure (mg/op)**	**No. of operations**	**Expected dermal exposure (mg/day)**	**Inhalation exposure (mg/day)**
Calibration	5	0.357	1	5	0.357
Bagging (50 kg) + gloves&mask	0.0463	0.0005	8	0.37	0.004
Bagging (25 kg) + gloves&mask	0.0844	0.0044	8	0.675	0.035
Cleaning with helmet	11.41	0.2855	1	11.41	0.286
Cleaning with helmet and Tyvek coveralls	1.141	0.2855	1	1.141	0.286
Total (bagging – 50 kg bags; gloves & mask/bagging				35.00	6.07
Total (bagging – 50 kg bags; gloves & mask/bagging + helmet/cleaning)				16.78	0.646
Total (bagging – 50 kg bags; gloves & mask/bagging + helmet & Tyvek coverall/cleaning)				6.51	
Total (bagging – 25 kg bags; gloves & mask/bagging				35.31	6.10
Total (bagging – 25 kg bags; gloves & mask/bagging + helmet/cleaning)				17.08	0.678
Total (bagging – 25 kg bags; gloves & mask/bagging + helmet & Tyvek coverall/cleaning)				6.82	

Table 16: Summary of estimated exposure during various seed treatment tasks (French use pattern)

	Estimated dermal exposure (mg/op)	Inhalation exposure (mg/op)	No. of operations	Expected dermal exposure (mg/day)	Inhalation exposure (mg/day)
Calibration	2.002	0.143	1	2.002	0.143
Bagging (50 kg) + gloves&mask	0.0463	0.0005	8	0.37	0.004
Bagging (25 kg) + gloves&mask	0.0844	0.0044	8	0.676	0.035
Cleaning with helmet	4.5696	0.1144	1	4.57	0.114
Cleaning with helmet and Tyvek coveralls	2.98	0.1144	1	0.457	0.114
Total (bagging – 50 kg bags; gloves & mask/bagging)				14.24	2.43
Total (bagging – 50 kg bags; gloves & mask/bagging + helmet/cleaning)				6.94	0.26
Total (bagging – 50 kg bags; gloves & mask/bagging + helmet & Tyvek coverall/cleaning)				2.83	
Total (bagging – 25 kg bags; gloves & mask/bagging				14.55	2.47
Total (bagging – 25 kg bags; gloves & mask/bagging + helmet/cleaning)				7.25	0.292
Total (bagging – 25 kg bags; gloves & mask/bagging + helmet & Tyvek coverall/cleaning)				3.13	

Risk Assessment: Total absorbed dose from dermal and inhalation routes for each task, with and without additional protection, was calculated using dermal and inhalation exposures and skin penetration factors (Tables 17 and 18). To calculate dermal absorbed dose, a dermal absorption factor of 1% was used based on the comparative *in vitro* studies in rat and human epidermis and an in vivo dermal absorption study in rats. A 100% absorption was assumed for inhalation exposure. The total absorbed dose was compared with the acceptable operator exposure level (AOEL) to characterise the risk to workers carrying out different tasks with different level of protection (Tables 17 and 18).

Table 17: Total absorbed dose and risk characterisation (% AOEL) of workers using fipronil product to treat maize seeds (including exposure during calibration)

PPE	Italian use pattern						French use pattern					
	50 kg bag			25 kg bag			50 kg bag			25 kg bag		
	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL
No additional protection	42.0	6.47	**1845**	43.4	6.79	**1939**	17.6	2.62	**749**	18.9	2.94	**841**
Gloves & dust mask at bagging	41.1	6.42	**1835**	41.4	6.46	**1844**	16.7	2.58	**736**	17.0	2.61	**746**
Gloves & dust mask (bagging) + ventilated helmet (cleaning)	17.4	0.81	**233**	17.8	0.85	**242**	7.20	0.33	**95**	7.54	0.36	**104**
Gloves & dust mask (bagging) + ventilated helmet & Tyvek coveralls (cleaning)	7.16	0.71	**203**	7.49	0.75	**213**	3.09	0.29	**83**	3.43	0.32	**92**

Table 18: Total absorbed dose and risk characterisation (% AOEL) of workers using fipronil product to treat maize seeds (exposure during calibration not included)

PPE	Italian use pattern						French use pattern					
	50 kg bag			25 kg bag			50 kg bag			25 kg bag		
	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL	Exposure (mg/day)	Absorbed dose (mg/day)	% of AOEL
No additional protection	36.6	6.06	1730	38.0	6.38	1823	15.5	2.46	703	16.8	2.78	794
Gloves & dust mask at bagging	35.7	6.01	1718	36.1	6.05	1728	14.5	2.41	690	14.9	2.45	700
Gloves & dust mask (bagging) + ventilated helmet (cleaning)	12.1	0.41	116	12.4	0.44	126	5.06	0.17	48	5.40	0.20	58
Gloves & dust mask (bagging) + ventilated helmet & Tyvek coveralls (cleaning)	1.80	0.30	**87**	2.13	0.34	**97**	0.95	0.13	**36**	1.28	0.16	**46**

The study authors' considered the NOEL from the 21-day dermal study to be most appropriate to derive the AOEL. This NOEL, in the authors opinion, corresponded to an estimated human dermal NOEL of 50 mg/kg/day, based upon data from *in vitro* comparative dermal penetration studies, which, show that animal skin is at least 10 times more permeable to fipronil than human skin. This represents an internal dose of 0.5 mg/kg bw/day if 1% dermal penetration of fipronil is assumed. This is consistent with the NOEL from the dog 90-day oral study (0.5 mg/kg/day). Using a 100-fold safety factor, the AOEL was calculated as follows,

$$\text{Short-term systemic AOEL} = \frac{0.5 \text{ mg/kg bw/day}}{100} = 0.005 \text{ mg/kg/day}$$

Assuming an average bodyweight of 70 kg for workers, the AOEL of 0.35 mg/day was obtained.

Discussion: The results show that, for the Italian use-pattern the estimated exposure was higher than the acceptable occupational exposure level (Table 17; column 3 and 6). However, when exposure from the calibration phase was not included, assuming that, this treatment phase is now completely automated and no exposure occurs during calibration, the total exposures were acceptable for both bag sizes (87% and 97% of the AOEL for 50 kg and 25 kg bags, respectively) (Table 18).

For the French use-pattern, where a more dilute spray is used (500 mL EXP B0415A + 1250 mL water), exposures were acceptable with or without calibration (Table 17 and 18).

All exposures were estimated with workers wearing a dust mask during bagging and a ventilated helmet during cleaning in addition to the classical PPE as assumed by the model Seed Tropex. Analysis of the results indicates that reduction of exposure is mainly provided by gloves worn during bagging and by the respiratory protective equipment worn during the cleaning phase. The use of a dust mask during bagging or the use of a coverall during cleaning did not provide any extra protection as evident from the exposure calculations (Tables 17 and 18).

Comments: The assessment is based on extrapolation of exposure data for seed treatment workers developed by an industry task force (TROPEX model). The OCSEH did not have access to this exposure data or to the studies that produced the data. The OCSEH is therefore unable to verify the data or consider it for risk assessment.

The use of an extrapolated human dermal NOEL of 50 mg/kg/day, based upon data from *in vitro* comparative dermal penetration studies is not accepted by the OCSEH. The use of this approach effectively abolishes the usual interspecies safety factor of 10, and in doing so disregards other pharmacokinetic or pharmacodynamic differences that may occur between species. In addition the dermal absorption in the *in vitro* study exhibits a variability of 4- to 27-fold difference, and hence does not enable a robust value to be drawn. Thus, in the absence of reliable data comparing and critically fully evaluating the comparative pharmacokinetic and pharmacodynamic profiles of fipronil in rabbits and humans, the OCSEH does not consider it appropriate to modify the NOEL as above.

Polakoff BM, Youngren SH and Walls CL (1998) Frontline Top Spot and Frontline Spray Treatment: Definitive pet groomer exposure analysis and risk assessment. Novigen Sciences Inc. Project Number Fipronil 98-07 (Merial-445-LPERA), Sponsored by Merial Limited, New Jersey USA.

Novigen completed a pet groomer exposure analysis and risk assessment that utilized contemporary monitoring data derived from 1) veterinarian and commercial groomer exposure studies (Meo, *et al*. 1997a,b), 2) veterinary and commercial pet groomer surveys (Irwin, 1997a,b) and 3) toxicology data for fipronil. The groomer surveys were utilized to provide insight into typical groomer practices with regard to application of flea and tick treatments both in general and specifically pertaining to the use of Frontline brand products. This assessment was conducted in order to estimate potential short-term and chronic exposure and risk to pet groomers.

In order to determine the median number of dogs treated by veterinary pet groomers, a veterinary groomer survey was conducted for 3,099 veterinary clinics (Irwin, 1997a). Of the 3,099 veterinary clinics surveyed, 337 (10.9%) had groomers and 125 (37.1%) of those clinics with groomers used Frontline products. During the peak flea and tick season, a maximum of 39 (median of 2.3) dogs could be treated per day with any product by veterinary groomers, and a maximum of 7.4 (median of 0.9) and 5 (median of 1.2) dogs could have been treated per day with the spot-on and spray products, respectively.

Of the 1,132 commercial groomer facilities surveyed, 84 (7.4%) used Frontline brand products (Irwin, 1997b). During the peak flea and tick season, a maximum of 25 (median of 7.0) dogs could be treated per day with *any* product by commercial pet groomers, and a maximum of 5 dogs (median 1-2 dogs) could be treated per day with either the spot-on or the spray product.

Based on the survey results, the authors of this assessment concluded that the treatment of eight dogs by each worker in the groomer exposure studies represented the high end use and not the average or "typical" use, i.e., 1-2 dogs per day. The authors considered median value as the best predictor of the "typical" number of animals treated per day and used the median values in the exposure analysis and risk assessment “to represent the appropriate number of pets treated per day”. Data from the two surveys were combined and the median value was used in this assessment. The median number of dogs treated per day was determined to be 1 and 1.7 for the spot-on and spray products, respectively.

Exposure values for each worker obtained from treating eight dogs in the groomer exposure studies were standardised for median number of dogs (1 dog for spot-on and 1.7 dogs for spray formulations). Standardised exposure values from the treatment of the median number of dogs in these two studies are presented in Tables 19 and 20 for the spray and spot-on, respectively.

Table 19: Exposure from treatment of median number of dogs during peak infection season* (Frontline Spray Treatment)

Replicate Number	Bodyweight (kg)	Dermal exposure (µg)	Dermal exposure (mg/kg bw)	Inhalation exposure (µg)	Inhalation exposure (mg/kg bw)
1	66	72.0	0.0011	0.14	0.0000021
2	65	604	0.0093	0.05	0.0000007
3	86	21.6	0.00025	0.15	0.0000017
4	54	150	0.0028	0.21	0.0000038
5	58	237	0.0041	0.73	0.0000130
6	76	362	0.0047	0.47	0.0000062
7	77	936	0.012	0.06	0.0000008
8	74	29.3	0.00040	0.19	0.0000025
9	95	213	0.0022	0.02	0.0000002
10	85	794	0.0094	0.23	0.0000027
11	75	478	0.0064	0.41	0.0000055
12	60	26.4	0.00044	0.02	0.0000004
13	61	146	0.0024	0.20	0.0000033
14	70	603	0.0086	0.15	0.0000021
15	66	155	0.0023	0.20	0.0000030
16	67	847	0.013	0.21	0.0000032
Median	**68**	**225**	**0.0034**	**0.19**	**0.0000026**

*Exposure values (from treating 8 dogs) were standardised to median number of dogs treated per day (1.7 dogs/day).

Table 20: Exposure from treatment of median number of dogs during peak infection season* (Frontline Top Spot)

Replicate Number	Bodyweight (kg)	Dermal exposure (µg)	Dermal exposure (mg/kg bw)
1	52.2	0.86	0.000017
2	64.4	0.64	0.0000099
3	86.2	17.08	0.00020
4	83.9	2.33	0.000028
5	66.7	2.90	0.000043
6	95.3	0.85	0.0000089
7	74.4	0.34	0.0000046
8	63.5	24.22	0.00038
9	95.3	0.90	0.0000095
10	56.2	9.79	0.00017
11	61.2	41.28	0.00067
12	61.2	1.39	0.000023
13	72.6	0.38	0.0000052
14	75.3	28.7	0.00038
15	64.0	1.14	0.000018
16	74.8	69.69	0.00093
Median	**69.6**	**1.86**	**0.000025**

*Exposure values (from treating 8 dogs) were standardised to median number of dogs treated per day (1 dog/day).

The median dermal exposures from the treatment of the median number of dogs were 0.00003 and 0.0034 mg/kg/day, for the spray and spot-on treatment, respectively (Tables 19 and 20). The median inhalation exposure for the spray was 0.0000026 mg/kg/day (Table 19).

Risk Assessment: For assessing risk from short-term exposure, a NOEL of 5 mg/kg bw/day (21-day dermal toxicity in rabbits, Hennansky and Wagner, 1993) was selected. Groomers were considered to have median exposure from treating median number of animals each day of the short-term period.

Risk from long-term exposure was estimated using the chronic oral NOEL of 0.02 mg/kg/day (chronic toxicity/carcinogenicity study in rats, Aughton, 1993) and 1% dermal absorption factor. Considering that groomers work 5 days a week and 26 weeks of the year appropriate time adjustment factors were applied. The basic algorithm was modified to reflect this time adjustment as follows:

MOE = (NOEL) ÷ [(Exposure) x (5/7) x (26/52)]

Pet Groomer MOE summary

Duration	MOE	
	Dermal	**Inhalation**
Frontline Spray Treatment		
Short-term	1454	344,924
Chronic	1547	20,389
Frontline Top Spot		
Short-term	197,898	Not measured
Chronic	210,563	Not measured

Conclusion: The study authors concluded that risk to pet groomers using fipronil products was acceptable provided workers wore the PPE specified on the product labels.

Comments: The present study used median exposure values (from treating 1-2 dogs) for estimating risk to pet groomers. This may be valid for long-term exposure, however for short-term risk assessment, exposures during peak flea and tick season (from treating a maximum of 25 dogs, as revealed by the survey) should be used to reflect real life scenario. This assessment was not considered for the present risk assessment.

7.3 Estimation of occupational exposure and risk

Very limited chemical specific exposure data are available for fipronil. Some registrants have estimated worker exposure using surrogate data as described earlier. However these estimates do not cover all use patterns and in some cases the parameters used in the estimations do not correspond to Australian use pattern (for example, number of hectares treated per day by boomspray). The OCSEH has therefore estimated occupational exposure to fipronil using surrogate exposure data from the Pesticide Handlers Exposure Database (PHED, US EPA, 1999). The following assumptions have been applied:

List of assumptions used in exposure and risk assessment

Bodyweight	70 kg	US EPA (1997)
Body surface area (adult)	1.94 m^2	Derelanko (2000)
Ventilation rate (light activities)	1.0 m^3/h	US EPA (1997)
Normal workday	8 h with an application period of 6 h	
Average size of house	Area 170 m^2 Volume 430 m^3	
Average industrial building	Area 2500 m^2 Volume 12 500 m^3	

Average office building	Area 7500 m^2 Volume 18 000 m^3	
Penetration through overalls	10%	Stamper *et al*. (1989)
Penetration through chemical-resistant full body clothing	5%	Thongsinthusak *et al*. (1993)
Penetration through chemical-resistant gloves	10%	Thongsinthusak *et al*.. (1993)
Protection afforded by half face-piece respirator with gas/dust cartridges	90%	Thongsinthusak *et al*. (1993)
Protection afforded by full face-piece respirator with gas/dust cartridges	98%	Thongsinthusak *et al*. (1993)
Protection afforded by supplied air respirator (air-hose respirator or SCBA)	100%	
Container neck width	Narrow	

Agricultural use

Fipronil is registered for agricultural use in a number of different formulations with varying concentrations of the active ingredient. The chemical is used as a foliar spray on outdoor crops and is applied by using boomspray, hand-held equipment or aircraft. The SC products are applied at various dilutions in water ranging from a relatively concentrated 400 mL/L for seed treatment (500 g/L fipronil product), to a very dilute 6.25 mL/50 L for spraying on pasture and sorghum. The ULV products (3 g/L and 8.5 g/L fipronil) are applied by aircraft either undiluted (420 mL/ha and 150 mL/ha, respectively) or diluted (8.5 g/L fipronil product only) to 3.0 L with a compatible spraying oil.

The main route of occupational exposure to fipronil is expected to be by skin contamination during mixing/loading and spraying. Fipronil has very low vapour pressure (3.7×10^{-9} hPa at 25^{o}C). Inhalation exposure to fipronil during mixing/loading is therefore not expected. Inhalation of spray mist may occur during ground spray application (boomspray or hand-held equipment).

Dermal or inhalation exposure of flaggers to fipronil spray is possible during aerial spraying. There are no chemical specific studies on exposure of flaggers or bystanders. Neither are there any appropriate exposure models to estimate exposure during flagging. It is therefore not possible to estimate risk to these workers.

Occupational exposure for the following agricultural scenarios was assessed using the Pesticide Handlers Exposure Database (PHED, US EPA, 1999).

Scenario (1) Open Mixing and loading SC formulations

Scenario (2) Closed mixing loading SC formulations

Scenario (3) Mixing and loading WG formulations

Scenario (4) Application by boomspray

Scenario (5) Application by hand-held equipment (knapsack/tank)

Scenario (6) Application by aircraft

Scenario (7) Application of granular formulation

Scenario (8) Incorporation into mushroom casing

Scenario (9) Application of diluted SC formulation for termite control

Scenario (1): Open mixing and loading of SC formulations

There are six SC formulation products containing 80-500 g/L fipronil. The products are applied as dilute sprays to crops or in the case of termite control, around domestic and commercial structures. Two of the products, Cosmos Insecticidal Seed Treatment and Semevin Super Seed Dressing Insecticide are used in dilute form for seed treatment. The quantity of fipronil active that is handled per day varies with the application method. Maximum quantities of fipronil active used are:

Boomspray	5 kg (50 ha treated/day @ the maximum rate of 100 g ai/ha)
Hand-held	0.8 kg/day (40 mL EUP/100 m^2; 4 L EUP/ha; 800g ai/ha)
Seed treatment	80 kg/day (40 tonnes seed treated/day @ 200 g ai/100 kg seed)*
	2 kg/day (1 tonne seed treated/day @ 200 g ai/100 kg seed)
Termite control	0.6 kg/day (0.6 g a.i/L; 500 L/house; 2 houses/day)

*Approximate figure provided by Pacific Seeds, QLD.

Scenario (2): Closed mixing and loading of SC formulations

Regent products (200SC and 800 WG) are also applied by aerial spraying to cotton crops and pasture and sorghum. Large volumes of spray are prepared for aerial application, since this method of application can cover about 200 ha per day. Normally, the mixing/loading for aerial application is an automated and closed system.

Aircraft	5 kg (200 ha treated/day @ the highest rate of 25 g ai/ha in cotton)

Scenario (3): Mixing and loading of WG formulation

There is only one product, Regent 800WG Insecticide (800 g/kg fipronil), with the wettable granule formulation. It is used for the control of a wide range of insect pests in a variety of crops, including mushrooms and is applied as dilute sprays by ground as well as aerial spraying. Repeat applications of the product are indicated for some crops. The quantities of fipronil active handled per day varies with the application method. Maximum quantities of fipronil active used are:

Boomspray	5 kg (50 ha treated/day @ the maximum rate of 100 g ai/ha)
Hand-held	0.8 kg (10 g EUP/100 m^2; 1kg EUP/ha; 0.8 kg/ha)
Aircraft	5 kg (200 ha treated/day @ the highest rate of 25 g ai/ha in cotton)*

*Regent products are used for aerial application also, however there are no exposure studies in the PHED for closed mixing/loading of wettable granule formulation. Exposure for closed mixing/loading of Regent 800WG Insecticide could not be quantitated.

Scenario (4): Application of diluted products by boomspray

Fipronil products are applied by boomspray for the control of a range of insect pests in brassicas, potatoes, pastures, sugar cane and cotton. Maximum quantity of fipronil active applied by this method is:

Boomspray	5 kg (50 ha treated/day @ the maximum rate of 500 mL EUP (100 g ai per hectare)

Scenario (5) Application of diluted products by hand-held equipment (knapsack/tank)

Regent 200SC and Regent 800WG are applied by hand-held equipment for the control of a range of insect pests in bananas, mushroom and grapevine. The highest application rate is indicated for bananas: 40 mL (200SC) or 10 g (800WG) per 100 m row, equivalent to 800 g fipronil/ha.

Hand-held application:	800 g/ha (60 mL product per 1.5 m x 100 m row; total spray volume 40 L/ha) (1 hectare treated/day).

Scenario (6) Application by aircraft

ULV products (Adonis 3 and 8.5 UL) are applied by aerial spraying either undiluted at the rate of 420 mL and 150 mL, respectively (1.275 g fipronil/ha) or diluted (8.5 g/L fipronil product only) to 3.0 L with a compatible spraying oil (APLC, 2004). Regent 200SC and 800WG are also applied by aerial spraying on pastures, sorghum and cotton crops. For aerial spraying Regent products are diluted to give a final concentration of 0.125 % fipronil (maximum).

Aircraft: 5 kg/day (200 ha treated/day @ the highest rate of 25 g ai/ha in cotton).

Human flaggers may be used during aerial application. However, there are no exposure studies or exposure models to estimate exposure during this task.

Scenario (7) Application of granular formulation

Fipronil in granular formulation is applied to turf and lawns for the control of Argentine stem weevil, Funnel ants, and Mole crickets. Application of granules is normally made using mechanical spreaders. The granules are watered in immediately after application. The application rate is 30-75 g fipronil per hectare. The maximum application rate (75 g/ha) is used for risk assessment.

Mechanical spreader: 0.75 kg (10 ha/day @ 0.075 kg/ha).

Scenario (8) Incorporation into mushroom casing

Fipronil products are applied to peatmoss just prior to layering it over the compost in which mushrooms are growing (This process is called 'casing'). The process of mixing diluted product with peatmoss is usually mechanized; applied by spray boom fixed to the top of peat moss turning machine. Hand held spray, though used sometimes, is the least preferred method of application.

Information on the amount of fipronil used per day for treating peatmoss is not available. The quantity of product handled at any time will depend on the extent of the mushroom beds to be treated. However, mixing/loading and spray application methods are covered under scenarios 1 and 4.

Scenario (9) Application of diluted SC formulation for termite control

The Termidor label recommends the use of a combination of conventional spraying and trenching for termite control. Soil injection (rodding) is recommended only when trenching and backfill is not possible. Hand spraying (to puddle treat backfill for chemical barriers) is therefore considered as the main use pattern for termite treatment.

Hand-held: 0.6 kg (0.6 g a.i/L; 500 L/house; 2 houses/day)

7.3.1 Determination of Occupational Exposure

PHED was used to estimate dermal and inhalation exposure for workers using fipronil products for scenarios 1 to 9 described above. The following table gives the standard (default) number of hectares treated per day that have been used to estimate daily exposure levels in each occupational handler scenario. Spray volumes for hand-held spraying have been modified according to the use patterns of fipronil products (crop spraying and termite control). Hand held applications (knapsack or motorised hand held sprayer) are carried out for treatment of banana plants. As an approximation, 500 L for hand held application is used for exposure assessment. There are no appropriate PHED scenarios or other exposure model to estimate exposure during seed treatment or placing of baits. An estimated 40 tonnes of grain is treated per day at any one site.

Occupational handler standard (default) areas treated per day

Exposure Scenario and Equipment / Usage Value Units

Mixer/Loader

Estimate 1; Mixing/loading for:

a) Boomspray	50 ha/day (5 kg fipronil)
b) Hand-held application	1 ha/day (0.8 kg fipronil/day)
c) Aerial application	200 ha/day (5 kg fipronil/day)
d) Grain treatment	40 tonnes/day (80 kg fipronil/day)
	1 tonne/day (2 kg fipronil/day)

e) Granule spreader	10 ha/day (0.75 kg fipronil/day)
f) Termite control	2 houses per day (0.6 kg fipronil/day)

Applicators

Estimate 2; Applying sprays:

a) Boomspray	50 ha/day (5 kg fipronil/day)
b) Hand-held	1 ha/day (0.8 kg fipronil/day)
c) Aerial spray	200 ha/day (5 kg/fipronil/day)
d) Granule spreading	10 ha/day (0.75 kg/day)

Mixer/Loader/Applicator

Estimate 3; Mixing/loading/applying:

a) Boomspray	50 ha and 5 kg fipronil per day
b) Hand-held	1 ha and 0.8 kg fipronil per day
c) Aerial spray	200 ha and 5 kg fipronil per day
d) Granule spreader	10 ha and 0.75 kg/day
e) Grain treatment	80 kg fipronil per day (loading only)
f) Termite control	0.6 kg fipronil/day (treating 2 houses per day)

The following parameters and assumptions were used:

Mixing/loading:

Open and closed mixing/loading for ground and aerial spraying, respectively.

Spray application:

Ground application = Groundboom and Hand-held application

Aerial application = Fixed winged carrier aerial application.

PHED does not take into consideration the container size or spray volume. Exposure to the chemical is estimated based on the amount of chemical handled per day.

Amount of ai used per day for boom application = 5 kg
[0.1 kg ai per ha (max label rate); 50 ha/day]

Amount of ai used per day for aerial spray = 5 kg
(0.025 kg ai per ha, 200 ha/d)

Amount of ai used per day for hand-held application = 0.8 kg
[40 mL/100 m^2; 1 ha/day)

Amount of ai used per day for grain treatment = 80 kg
(0.2 kg ai per 100 kg seed (max label rate); 40 tonnes grain treated per day)

Amount of ai used per day for termite treatment = 0.6 kg
(0.6 g a.i/L; 500 L/house; 2 houses/day)

Amount of ai used per day for turf application = 0.75 kg
(0.075 g a.i/ha; 10 ha/day)

PHED estimates for dermal and inhalation exposure for various application methods are presented in the Table 21. Values are arithmetic means of replicates, the number of which is shown in the table.

Table 21: Dermal and inhalation exposure estimates (using PHED database)

Exposure Scenario Equipment	Dermal Unit Exposure (body+hands) (mg/kg ai)	Dermal Replicates	Hand Replicates	Inhalation Unit Exposure (mg/kg ai)	Inhalation Replicates
Mixer/Loader					
All Liquids					
Open mixing/loading (no gloves)	64.07	16-68	3	0.008	51
Open mixing/loading (gloves)	2.72	11-38	35	0.008	38
Closed mixing/loading (no gloves)	(10.03)	16-21	0	0.006	21
Closed mixing/loading (gloves)	0.05	16-21	21	0.006	21
Dry flowable					
Open mixing/loading (no gloves)	0.488	7-23	7	0.002	23
Open mixing/loading (gloves)	0.477	16-23	16	0.002	23
Granules					
Open mixing/loading (no gloves)	(0.019)	3-43	0	0.004	43
Open mixing/loading (gloves)	0.021	3-43	41	0.004	43

Table 21: Dermal and inhalation exposure estimates (using PHED database) (Continued)

Applicator					
Boom application					
Applicator, open cab (no gloves)	0.177	11-19	17	0.004	19
Applicator, open cab (gloves)	(0.043)	11-19	0	0.004	19
Applicator, closed cab (no gloves)	0.023	4-6	6	0.00004	6
Applicator, closed cab, (gloves)	(0.008)	4-6	0	0.00004	6
Hand-held application					
Low pressure hand wand (no gloves)	110.0	13	9	5.64	13
Low pressure hand wand (gloves)	50.0	13	4	5.64	13
High pressure hand wand (no gloves)	(19.95)	9	0	0.17	9
High pressure hand wand (gloves)	20.19	9	9	0.17	9
Aerial (Fixed wing)					
Aerial fixed wing (no gloves)	0.023	12-25	21	0.0005	20
Aerial fixed wing (gloves)	0.031	11-25	11	0.0005	20

Table 21: Dermal and inhalation exposure estimates (using PHED database) (Continued)

Granule application					
Granule spread; tractor open cab (no gloves)	0.034	1-5	5	0.003	5
Granule spread; tractor open cab (gloves)	(0.021)	1-5	0	0.003	5
Granule spread tractor closed cab (no gloves)	0.024	1-5	3	0.0002	5
Granule spread tractor closed cab (gloves)	0.007	1-5	2	0.0002	5
Mixing/loading/application					
Mixing/loading/Groundboom application					
Open mixing/loading Open cab (no gloves)	7.81	13-44	23	0.005	43
Open mixing/loading Open cab (gloves)	0.52	13-44	18	0.005	43
Closed mixing/loading /Closed cab (no gloves)	0.172	7-11	7	0.006	11
Closed mixing/loading /Closed cab (gloves)	0.263	4-11	4	0.006	11

Table 21: Dermal and inhalation exposure estimates (using PHED database) (Continued)

Mixing/loading/Hand held application					
Open mixing/loading Low pressure hand wand (no gloves)	(18.33)	26	0	2.34	26
Open mixing/loading Low pressure Hand wand (gloves)	23.4	26	25	2.34	26
Open mixing/loading High pressure Hand wand (no gloves)	(14.10)	7-13	0	0.50	13
Open mixing/loading High pressure Hand wand (gloves)	14.82	7-13	13	0.50	13
Mixing/loading/Termiticide application					
Open mixing/loading Termiticide injection (no gloves)	(2.75)	17	0	0.006	17
Open mixing/loading Termiticide injection (gloves)	3.28	17	17	0.006	17

*Each study in PHED has been graded from “A” to “E” according to the quality of the study. PHED runs having any combination of A and B grade or A, B and C grade data are listed as ‘Grade AB’ or Grade ABC, respectively. Studies for mixing/loading and boomspray application were of AB Grade and of medium to high confidence. Studies for handheld application and combined mixing/loading/application (all application methods) were of ABC Grade and low confidence.

Values in parentheses represent estimates where observations on hand contamination were not available.

For mixing/loading estimates, subsets for all types of liquids were used, as this provided large number of hand replicates.

For all exposure measurements, workers wore long pants and long sleeve shirt.

Measured exposure data is available only for termite treatment (inhalation exposure). In the absence of exposure data for other uses of fipronil, the PHED was used to estimate worker exposure, using suitable exposure scenarios. The use of exposure values derived from predictive models or databases, using conservative assumptions for unknowns and a range of values for a particular method of spraying, is internationally accepted as the first step in a tiered risk assessment (Tier 1).

The PHED exposure data for mixing/loading and boomspray application were generally from high quality studies (AB grade and 15 or more replicates for each body part). However, for hand-held applications and for combined mixing/loading and application (for all application methods), PHED studies were of either medium or low quality grade and low confidence (ABC grade and/or less than 15 replicates per body part).

7.3.2 Risk estimates from combined dermal and inhalation exposure

The same toxicity endpoint (i.e. neurotoxicity) is applicable to both inhalation and dermal risk assessments; and because dermal and inhalation exposures may occur simultaneously, risks from the two routes were combined to obtain a total risk estimate for occupational exposure.

7.4 Occupational risk characterization

7.4.1 Dermal and Inhalation Margins of Exposure (MOEs)

Potential daily exposure is calculated using the following formula:

Daily Exp. (mg ai/day) = Unit Exp. (mg ai/kg ai) x Max. Appl. Rate (kg ai/ha) x Max. Area Treated (ha/day)

The daily dose is calculated using the following formula:

Daily Dose (mg ai/kg bw/day) = Daily Exp. (mg ai/day)/bodyweight (kg)

When NOELs from oral studies are used to estimate risk, a dermal absorption factor is applied to account for the internal (systemic) dose. Risk to PCOs was estimated using a long-term NOEL from a dietary study (Section 5.3). A 1% dermal absorption for fipronil, derived from comparative in vitro dermal studies with human, rat and rabbit epidermis (Walters and Brain 1990 and Ward RJ 1997a, b, c) and an in vivo rat study (Cheng, 1995) (see OCSEH review of mammalian toxicology of fipronil) was used for risk assessment.

The MOE is calculated using the following formula:

MOE = NOEL (mg/kg bw/day)/Daily dose (mg/kg bw/day)

7.4.2 Combined Dermal and Inhalation MOEs

Considering that the NOEL used in the risk assessment was established in laboratory animals, a MOE of 100 or more is normally considered acceptable. This MOE takes into account inter- (10x) and intra-species (10x) variability. The following tables (Tables 22–27) summarise the MOEs calculated from combined dermal and inhalation exposures to fipronil during mixing/loading and application of fipronil products by various application methods.

Table 22: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for ground boom applications

Scenarios	Exposure (mg/kg bw/day)		Dermal MOE	Inhalation MOE	Total MOE
	Dermal	Inhalation			
Mixer/loader					
All liquids open mixing, no gloves	4.58	0.0006	1.1	1667	1.1
All liquids open mixing, gloves	0.194	0.0006	25.8	1667	26
All liquids open mixing, gloves, chemical resistant clothing*	0.009	0.0006	539	1667	416
All liquids closed mixing, no gloves	(0.720)	0.0004	(7.0)	2500	7
All liquids closed mixing, gloves	0.004	0.0004	1428	2500	1000
Dry flowable open mixing, no gloves	0.035	0.0001	143	10000	141
Dry flowable open mixing, gloves	0.034	0.0001	147	10000	145
Applicator					
Open cab, no gloves	0.013	0.0003	385	3333	345
Open cab, gloves	(0.003)	0.0003	(1667)	3333	1111
Closed cab, no gloves	0.002	0.000003	2500	333333	2325
Closed cab, gloves	(0.0006)	0.000003	(8333)	333333	6667

Table 22: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for ground boom applications (Continued)

Mixer/loader/applicator					
Open mixing, open cabs; no gloves	0.56	0.0004	8.9	2500	9
Open mixing, open cabs; gloves	0.037	0.0004	135	2500	128
Open mixing, closed cabs; no gloves	0.012	0.0004	417	2500	357
Open mixing, closed cabs; gloves	0.019	0.0004	263	2500	238

Dermal and inhalation exposures are adjusted for total active ingredient handled per day (5 kg).

Values in parentheses represent estimates where observations on hand contamination were not available.

Daily dermal or inhalation exposure (mg ai/kg bw/day) =arithmetic mean exposure obtained from PHED (mg/kg ai handled/day) x 5 kg ai÷70 kg (bw). As the NOEL is selected from a dermal study, the dermal absorption factor was not applied. A 100% absorption through inhalation route was considered.

Dermal MOE = (Dermal NOEL/total dermal dose) and Inhalation MOE = (oral NOEL/inhalation dose)

A NOEL of 5 mg/kg bw/day from a rabbit dermal study was used for assessing risk from dermal exposure and a NOEL of 1 mg/kg bw/day from a dog dietary study was used for assessing risk from inhalation exposure.

Total MOE were calculated by using formula 1/Total MOE = 1/Dermal MOE + 1/Inhalation MOE.

Exposure for the combined task (mixing/loading/application) was obtained by adding exposures during mixing/loading and applications.

*A 95% reduction in dermal exposure was assumed with chemical resistant coveralls (Thongsinthusak *et al* (1993).

Table 23: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for hand-held applications

Scenarios	Exposure (mg/kg bw/day)		Dermal MOE	Inhalation MOE	Total MOE
	Dermal	Inhalation			
Mixer/loader					
All liquids open mixing, no gloves	0.730	0.0001	6.8	10000	7
All liquids open mixing, gloves	0.030	0.0001	167	10000	167
Dry flowable open mixing, no gloves	0.006	0.00002	833	50000	820
Dry flowable open mixing, gloves	0.005	0.00002	1000	50000	980
Applicator					
Low press, no gloves	1.260	0.064	4.0	16	3
Low press, gloves	0.570	0.064	9.0	16	6
*Low press, gloves, chemical resistant clothing, half face respirator	0.028	0.006	179	167	86
High press, no gloves	(0.228)	0.002	(22.0)	500	21
High press, gloves	0.230	0.002	22.0	500	21
*High press, gloves, chemical resistant clothing	0.014	0.002	357	500	208

Table 23: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for hand-held applications (Continued)

Mixer/loader/applicator					
Open mixing, low press; no gloves	(0.21)	0.027	(24)	37	15
Open mixing, low press; gloves	0.270	0.027	19	37	13
*Open mixing, low press, gloves, chemical resistant clothing, half face respirator	0.014	0.003	370	370	185
Open mixing, high press; no gloves	(0.160)	0.006	(31)	167	26
Open mixing, high press; gloves	0.175	0.006	29	167	25
*Open mixing, high press, gloves, chemical resistant clothing	0.008	0.006	625	167	132
Mixer/loader/applicator (Termiticide application)					
Low press, no gloves	0.157	0.020	12.7	1	0.9
Low press, gloves	0.200	0.020	10	1	0.9
*Low press, gloves, chemical resistant clothing, half face respirator	0.010	0.002	200	10	9.5

Dermal and inhalation exposures are adjusted for total active ingredient handled per day (0.8 kg).

Values in parentheses represent estimates where observations on hand contamination were not available.

See legends of Table 22 for exposure and MOE calculation details.

*A 95% reduction in dermal exposure was assumed with chemical resistant coveralls and 90% reduction in inhalation exposure was assumed with half facepiece respirator (Thongsinthusak *et al* (1993).

A NOEL of 5 mg/kg bw/day from a rabbit dermal study was used for assessing risk from dermal exposure and a NOEL of 1 mg/kg bw/day from a dog dietary study was used for assessing risk from inhalation exposure. For termiticide application a NOEL of 0.02 mg/kg bw/d and a dermal absorption factor of 1% for fipronil were used for calculating MOE. Amount of ai applied by this method was 0.6 kg fipronil per day.

Table 24: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for aerial application

Scenarios	Exposure (mg/kg bw/day)		Dermal MOE	Inhalation MOE	Total MOE
	Dermal	Inhalation			
Mixer/loader					
All liquids closed mix/loading, no gloves	(0.720)	0.0004	(6.9)	2500	(7)
All liquids closed mix/loading, gloves	0.003	0.0004	1428	2500	910
Dry flowable closed mix/loading, no gloves	No data available		-	-	-
Dry flowable closed mix/loading, gloves	No data available		-	-	-
Applicator					
Fixed wing aerial application; no gloves	0.002	0.00004	3043	25000	806
Fixed wing aerial application, gloves	0.002	0.00004	2258	25000	806
Mixer/loader/Applicator					
Closed mixing/loading; fixed wing aerial application; no gloves	(0.722)	0.00044	(7)	2270	(7)
Closed mixing/loading; fixed wing aerial application; gloves	0.006	0.00044	864	2270	617

Dermal and inhalation exposures are adjusted for total active ingredient handled per day (5 kg).

Values in parentheses represent estimates where observations on hand contamination were not available.

Scenarios for mixer/loader/applicator are not available. Exposures during mixing/loading and application were added to give mixer/loader/applicator exposure.

See legends of Table 22 for exposure and MOE calculation details.

Table 25: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for granule application

Scenarios	Exposure (mg/kg bw/day)		Dermal MOE	Inhalation MOE	Total MOE
	Dermal	Inhalation			
Mixer/loader					
Granules, open loading; no gloves	(0.0002)	0.00004	(25000)	25000	12500
Granules, open loading; gloves	0.0002	0.00004	25000	25000	12500
Applicator					
Granule spreader tractor mounted; open cab; no gloves	0.0004	0.00003	12500	33333	9090
Granule spreader tractor mounted; open cab; gloves	(0.0002)	0.00003	(25000)	33333	14286
Granule spreader tractor mounted; closed cab; no gloves	0.0002	0.000002	25000	500000	23810
Granule spreader tractor mounted; closed cab; gloves	0.00008	0.000002	62500	500000	55555
Mixer/loader/Applicator					
Open loading; tractor mounted; open cab; no gloves	0.0006	0.00007	8333	14286	5263
Open loading; tractor mounted; open cab; gloves	0.0004	0.00007	12500	14286	6667
Open loading; tractor mounted; closed cab; no gloves	0.0004	0.00004	12500	25000	8333
Open loading; tractor mounted; closed cab; gloves	0.0003	0.00004	16667	25000	10000

Dermal and inhalation exposures are adjusted for total active ingredient handled per day (0.75 kg).

Values in parentheses represent estimates where observations on hand contamination were not available.

Scenarios for mixer/loader/applicator are not available. Exposures during mixing/loading and application were added to give mixer/loader/applicator exposure.

See legends of Table 22 for exposure and MOE calculation details.

Table 26: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for mixing/loading for seed treatment

Scenarios	Exposure (mg/kg bw/day)		Dermal MOE	Inhalation MOE	Total MOE
	Dermal	Inhalation			
Mixer/loader					
*All liquids open mixing, no gloves	1.83	0.0002	2.7	5000	3
*All liquids open mixing, gloves	0.078	0.0002	64	5000	63
*All liquids open mixing, gloves; chemical resistant clothing**	0.004	0.0002	1250	5000	1000
All liquids closed mixing, no gloves	(11.46)	0.007	(0.44)	146	0.44
All liquids closed mixing, gloves	0.055	0.007	91	146	56
All liquids closed mixing, gloves; chemical resistant clothing**	0.0027	0.007	1852	146	135
Applicator					
	Data not available			-	
Mixer/loader/applicator					
	Data not available			-	

Dermal and inhalation exposures for closed mixing/loading are adjusted for total active ingredient handled per day (80 kg).

Values in parentheses represent estimates where observations on hand contamination were not available.

*Farmers treating seed manually will use open mixing/loading system and treat approximately 1 tonne seed per day using 2 kg fipronil/day.

See legends of Table 22 for exposure and MOE calculation details.

**A 95% reduction in dermal exposure was assumed with chemical resistant coveralls (Thongsinthusak *et al.* (1993).

Table 27: Occupational exposure estimated from PHED data-subsets and dermal, inhalation and total MOE for termiticide injections

Scenarios	Exposure (mg/kg bw/day)		Dermal MOE	Inhalation MOE	Total MOE
	Dermal	Inhalation			
Mixer/loader					
All liquids open mixing, no gloves	0.549	0.00007	4	286	4
All liquids open mixing, gloves	0.023	0.00007	87	286	67
All liquids open mixing, gloves, chemical resistant clothing*	0.001	0.00007	1740	286	250
Applicator					
	Data not available				
Mixer/loader/applicator					
Open mixing/loading termiticide injection, no gloves	(0.023)	0.00005	(85)	400	70
Open mixing/loading termiticide injection, gloves	0.028	0.00005	71	400	60
Open mixing/loading termiticide injection, gloves, chemical resistant clothing	0.0014	0.00005	1428	400	312

Dermal and inhalation exposures are adjusted for total active ingredient handled per day (0.6 kg).

Values in parentheses represent estimates where observations on hand contamination were not available.

Daily dermal or inhalation exposure (mg ai/kg bw/day) = arithmetic mean exposure obtained from PHED (mg/kg ai handled/day) x 0.6 kg ai÷70 kg (bw).

A dermal absorption factor of 1% was applied to calculate the internal dose via dermal route. A NOEL of 0.02 mg/kg bw/day from a chronic oral study was used (see Section 5.2).

See legends of Table 22 for exposure and MOE calculation details.

*A 95% reduction in dermal exposure was assumed with chemical resistant coveralls (Thongsinthusak *et al*., 1993).

7.4.3 Evaluation of worker risk estimates

Mixer/loaders (Scenarios 1, 2 and 3)

Exposure to fipronil was estimated for workers mixing/loading the product for ground (boom and hand-held spraying) and aerial application and for non-agricultural uses such as termiticide treatment and seed dressing (Tables 22-27). The amount of product handled per day for the different application methods varies depending on the number of hectares treated by that particular method or the amount of grain treated per day. The MOEs calculated using exposure estimates from PHED indicated unacceptable risks to workers mixing/loading SC formulations for boomspray application, seed treatment (manual treatment) and termite treatment (Tables 22, 26 and 27, respectively). Although chemical resistant gloves reduced exposures considerably, MOEs were still unacceptable. Chemical resistant clothing is expected to provide 95% protection against contamination (Thongsinthusak *et al*, 1993). When exposures for mixer/loader wearing chemical resistant clothing were calculated, MOEs were acceptable (Tables 22, 26 and 27).

MOEs were acceptable for mixing/loading SC formulations for hand-held application when workers wore just gloves and one layer of clothing (Table 23). Similarly, for closed mixing/loading, MOEs higher than 100 were obtained only for workers wearing chemical resistant gloves. However, exposure data for workers not wearing gloves were unreliable due to lack of any hand-exposure data (Tables 22 and 24).

In the case of seed treatment, where large quantities of product are required to be mixed per day, risk estimates indicated that workers need to wear gloves and chemical resistant clothing even when using closed mixing/loading system (Table 26).

For mixing/loading dry flowable formulation exposure was low even when gloves were not worn (Table 22 and 23).

The granule formulation of fipronil is applied to turf for insect control. Mixing of the product is not required, however the product needs to be loaded in the granule spreader. PHED estimates indicated that risk during loading was low even when workers did not wear gloves (Table 25).

Applicators (Scenarios 4-7)

Exposure to fipronil when applying the diluted product by boomspray application method was low and did not pose undue risk to workers irrespective of the type of cab used during application, i.e. open or closed cab (Table 22).

Hand-held application (Scenario 5, Estimate 2), either with low or high-pressure hand wand, resulted in unacceptable MOEs. MOE were low even with gloves on (Table 23). Gloves, chemical resistant clothing (95% protection) and a half face respirator (90% protection) worn during low-pressure application resulted in a total MOE of 86 which was just below the acceptable margin of safety (100). The same PHED scenario based on mixer/loader/applicator estimates is also applicable to this particular assessment (Scenario 5, Estimate 3). Use of gloves, chemical resistant clothing and half face respirator in this scenario (low pressure), lowered the risks to within acceptable levels (total MOE=185; Table 23). Taken together, and considering the conservative margin of safety (MOE=100), the risks to users when using low pressure hand-held application equipment are within acceptable levels provided that gloves, chemical resistant clothing and half face respirator are worn during application. Chemical resistant clothing (95% protection) and gloves worn during high-pressure hand-held application resulted in an acceptable margin of safety (MOE=132; Table 23).

Fipronil products are also applied aerially either in diluted form or undiluted. PHED estimates for spray application in a fixed winged, enclosed cockpit craft indicated acceptable risk to applicators (Table 24). Application of granules with the spreader also did not pose any risk to workers even without any PPE, as indicated by the high MOE values (Table 25).

Mixer/loader/applicators (Scenarios 1-7)

Risk to workers performing both activities ie. mixing/loading as well as application, was high for boomspray application method when open mixing/loading and open cabs were used. Risk to these workers was acceptable when they wore gloves or used closed cabs (Table 22).

For hand-held application, exposures and therefore risk for the combined tasks were high for low-pressure as well as high-pressure applications (Table 23). Use of chemical resistant clothing (for high-pressure) and chemical resistant clothing and half face respirator (low pressure), lowered the risks to within acceptable levels (Table 23).

Risk to workers performing closed mixing/loading and aerial application was high without gloves as indicated by the low MOEs (MOE=7 without gloves, Table 24). Use of gloves lowered the risks to within acceptable levels (MOE=617, Table 24). Loading and application of granule formulation to turf was considered safe based on the exposure values (Table 25).

Flaggers

The OHS risk for flaggers cannot be quantified from any surrogate exposure data. Therefore, human flaggers should be protected by engineering controls such as enclosed cabs.

Other application methods for fipronil products

Incorporation of fipronil products into mushroom casing (Scenario 8)

No measured exposure data were available for this use of fipronil. A suitable study does not exist within PHED to estimate operator exposure for this use. A qualitative risk assessment was carried out for this use-pattern. Splashing and spray drift could occur when applying the diluted product to peat moss while it is being turned in the turning machine. Considering the method of mushroom cultivation, preparation of large volumes of spray may not be required. One layer of clothing and chemical resistant gloves should therefore be able to provide adequate protection during mixing/loading fipronil products. Similar PPE should be sufficient during application of diluted products by the fixed spray boom. However, if the spray is applied by hand equipment, chemical resistant clothing and half face respirator should be worn as indicated by PHED estimation for hand-held low pressure application. Also, since the product is an eye irritant, workers are also required to wear face shield or goggles to prevent eye contamination from any spills or splashes.

Application of diluted SC formulation for termite control (Scenario 9)

A single product, Termidor Residual Termiticide, is under consideration in this review for termite control. Chemical barriers (horizontal and vertical) are installed by PCOs in Australia using a combination of conventional spraying and trenching. Fipronil is applied by hand-held equipment including low-pressure hand wand and soil injection (rodding). Soil injection (rodding) is recommended only when trenching and backfill is not possible. Hand spraying (to puddle treat backfill for chemical barriers) is therefore considered as the main use pattern for termite treatment.

As mentioned earlier (Section 3.3), the low-pressure hand wands used for applying termiticides are different from those used for foliar spray in that the hand wand for termiticide application delivers high volume, coarse 'jet', which is more like pouring the solution rather than spraying. The procedure is to dig a trench and pour in the diluted product with a watering nozzle on the end of a rod approximately 0.5-0.75 m long. This floods the soil below ground level and there is less likelihood of spray drift. There is no specific exposure data in the PHED for this particular type of application. The closest is the 'garden hose end sprayer' scenario; however, the PHED Exposure Guide (PHED 1998) states that the data for this scenario is of extremely low confidence and should be treated as a data gap. Therefore, this scenario was not considered further. Low-pressure hand-held spray application scenarios in PHED indicate very low dermal and inhalation MOEs without PPE (Table 23). Dermal MOEs reached acceptable limits (MOE≥100) with PPE (gloves and chemical resistant clothing), but inhalation MOEs did not. However, as discussed above, this application technique does not represent the actual trenching method and was therefore not considered further.

Due to a limited amount of method-specific exposure information, the PHED 'liquid/open pour/termiticide injection' scenario was considered the most appropriate. This scenario contains exposure data for mixing/loading and application under slab foundation (rodding) and crawl spaces. A limitation is that it does not have exposures for the trenching method, which is more commonly used to create chemical soil barriers (horizontal, vertical or external perimeter) around or under the structure of existing buildings. Dermal MOE estimates indicate the need for chemical resistant clothing when applying fipronil products by the injection/rodding technique (Table 27). Using the same scenario, inhalation MOE estimates indicated an acceptable level of risk to workers without respiratory protection (Table 27). However, a worker inhalation exposure study indicates that the exposure is unacceptable (MOE=4) during crawl space termiticide injection. A product containing 80 g/kg fipronil was applied in the study using a variety of spray probes and injectors resulting in a mean worker inhalation dose of 0.0091 mg/kg ai/kg bw (Honeycutt & Kennedy, 2001). Considering that Australian PCOs handle an average 0.6 kg fipronil per working day, inhalation exposure was estimated to be 0.026 mg/kg bw/d (Section 7.1). When applying a NOEL of 0.02 mg/kg bw/day from a chronic oral study (Section 5.3) an inhalation MOE of 77 ((0.02/0.026x100)) results, indicating the need for respiratory protection when applying the termiticide. Based on study results, the exposure may be further reduced with the use of a half-face piece respirator with combined dust and gas cartridge, which affords 90% protection. The resultant MOE (770) indicates that there is no unacceptable risk (MOE>100) to the worker provided that a PCO uses a half-face piece respirator with combined dust and gas cartridge when applying termiticides.

Both PHED (Table 27) and worker study estimates are for injectors used in crawl space houses. However, the worker study indicated exposure via inhalation to be some 100 times greater than PHED estimate. Considering this difference in exposure, it is possible that the use of spray probes may contribute to high inhalation exposure compared to injection. Given that the vapour pressure of fipronil is very low (3.7×10^{-9} hPa), the method of application in Australia is more like pouring than spraying (a low pressure, high volume coarse spray), and the surrogate PHED scenario indicated a higher MOE, inhalation exposure is expected to be much lower than that measured in the worker study. However, on the conservative basis that worker study data for spray probe and injector application do indicate a requirement for respiratory protection, the use of a half-face piece respirator with combined dust and gas cartridge has been recommended during spray preparation and application.

Application of diluted product for seed treatment

Bulk treatment of seed is largely by mechanical process, wherein fipronil product containers are connected via an inlet pipe to the application equipment. The mechanical treaters measure the required amount of product and dilute it with water to the required volume. Seed to be treated is loaded into a hopper for treatment within the machine. Dry treated seed emerges from the machine through a funnel into sacks, which are sealed either mechanically or by hand.

Under normal operating conditions, workers are not likely to come in contact with the spray, unless attaching hoses from the tank to the sprayers or when checking any nozzle blockages. Estimation of exposure during these tasks is not possible. As the seed treatment products are skin irritants, workers will need to wear cotton overalls buttoned to the neck and wrist and elbow-length PVC gloves when carrying out these tasks.

A small minority of farmers may treat their own seed in an open system - generally as batch treatment in a cement mixer type arrangement or a semi-closed systems (closed except for the final transfer to bins or bags). Exposure to fipronil is possible when loading the prepared slurry and when bagging treated seed. There is no appropriate model to estimate exposure during these processes. As the seed treatment products are skin irritants, farmers will need to wear cotton overalls buttoned to the neck and wrist, elbow-length PVC gloves and a disposable mask when preparing the slurry, using the prepared slurry and bagging treated seeds.

Application of ULV products

Ultra low volume (ULV) products are generally applied undiluted by aerial application. In some instances, the products may be diluted with small volumes of water or oil; however this is achieved by closed mixing/loading. Exposure is therefore expected to be minimal; only when connecting transfer hoses to the product containers. A qualitative risk assessment indicates that chemical resistant gloves are expected to provide adequate protection during this process.

Application of fipronil products as baits

A gel formulation of fipronil is used by profession pest control operators to control cockroaches in domestic, commercial or public service areas. The product, available in 35 g tubes, is applied as tiny spots (1-3 spots per m^2) by lightly squeezing the tube or depressing the plunger to dispense the product. An appropriate model/scenario to estimate exposure for this use pattern is not available. However, because of the tiny amount of the product applied and the method of application, exposure to workers using this product is expected to be minimal.

Veterinary Use

Veterinary products for use on dogs and cats are either spray-on treatment or spot treatment. The products are mainly used by pet owners once or twice a month. However, veterinarians and pet groomers may also use the products more frequently. For spray-on treatment, workers normally hold the dog or cat with one hand and operate the spray pump with the other. Occasionally workers also rub the product into the animal's skin and spray one or more pumps into a hand and then rub the dog's face to cover the face to avoid spraying into the dog's eyes, nose, and mouth. The most likely route of user exposure is dermal, although inhalation exposure is also possible. Taking into account that fipronil is present in the product at a low concentration (0.25%); and the vapour pressure of fipronil is low, the level of user exposure is not expected to be of toxicological concern.

With the spot treatment, workers hold the animal with one arm while opening the pipette with the other hand and insert the pipette tip through the animal's hair coat near the neck area in order to dispense the contents onto the skin. This procedure is unlikely to lead to the user being dermally exposed to the product, but given the unpredictable behaviour of pets, accidental exposure cannot be ruled out. If the safety direction 'wash hands after use' is followed, any exposure should be transitory and not of toxicological concern. As fipronil is not volatile, exposure by inhalation is not expected.

Studies provided by the applicant (Meo *et al*. 1997a,b) indicated low exposure to fipronil residues when dogs were treated with fipronil products as directed by the product label. Pet groomers or veterinarians may use the product throughout the year. Using a chronic NOEL (0.02 mg/kg bw/day) and a 1% dermal factor, MOEs of approximately 83 and 1280 were calculated from the exposure data for Frontline Spray and Frontline Top Spot, respectively. Although the MOE for Frontline Spray is slightly below the acceptable mark [MOE=100], consideration should be given to the fact that volunteers in the study treated 8 dogs in each session. It is unlikely that pet groomers will treat 8 dogs every day all year round).

Workers in both the studies were wearing disposable latex gloves. Although, exposure data 'without gloves' is not available, it can be calculated (assuming that gloves provide 90% reduction in hand exposure) that exposure to fipronil when using Frontline Top Spot is acceptable even when gloves are not worn. Workers using Frontline Spray will however need to wear gloves when treating the animals.

The addition of (S)-methoprene to the Frontline Top Spot formulation does not alter the product hazard profile, so no additional consideration is required for exposure to the Frontline Plus product range. These products are packaged similarly and have the same method of application as for Frontline Top Spot.

8 ASSESSMENT OF POST-APPLICATION EXPOSURE

8.1 Post application exposure

Agricultural uses

Exposure to fipronil residues may also occur when workers enter crops treated with fipronil products for irrigation, weeding, pruning, thinning or harvesting. The type of activity, timing and frequency of re-entry activities is dependent on crop type. Potential worker exposure is determined by factors such as the amount of chemical applied, interval between spraying and re-entry, nature and duration of the particular re-entry activity, density of foliage and spacing of crops and environmental factors that affect the breakdown of residues. Exposure can also occur while sampling treated grain.

Measured post-application exposure studies

Measured exposure data for post-application workers or dislodgeable foliar residue data for fipronil are not available. Exposure to workers entering crops treated with fipronil products was estimated using the default values included in the US EPA Occupational Post-Application Risk Assessment Calculator Version 1 (8/9/00)-US EPA Policy 003.1.

8.2 Exposure assessment of re-entry workers

In agricultural situations, fipronil is used in field/row crops (cotton), root vegetables (potatoes), brassica, bananas, grapevines, sugarcane, sorghum, mushrooms, pasture and turf. As mentioned earlier, workers engaged in post-treatment activities such as, irrigation, scouting, thinning and harvesting and sampling treated grains may be exposed to fipronil and its degradates, most likely from dermal contact with the treated foliage. Safe re-entry intervals for post-application activities can be determined if dislodgeable foliar residue (DFR) for the chemical and transfer coefficient (TC) for post-application activities are known. These parameters can be used to estimate the dermal exposure using the following formula:

$$\text{Dermal exposure (mg/kg bw/day)} = \frac{\text{DFR } (\mu g/cm^2) \times \text{TC } (cm^2/hr) \times \text{T (hr)} / \text{BW (kg)}}{1000}$$

The Transfer Coefficient (TC) is a “residue transfer index” and indicates the amount of DFR that can be transferred to workers as a function of “field work activity”. An appropriate TC is used in order to estimate worker exposure from DFR.

8.3 Estimation of dermal exposure and safe re-entry periods

In the absence of actual exposure data, the following assumptions were used to estimate worker exposure during post-application activities:

- Initial dislodgeable foliar residues (DFR): 20% of the ai applied amount, as used in the Occupational Post-application Risk Assessment Calculator Version 1 (8/9/00) – US EPA policy 003.1.

- Turf Transferable Residue (TTR): 5% of the ai applied amount, as used in the Occupational Post-application Risk Assessment Calculator Version 1 (8/9/00) – US EPA policy 003.1.

- Dissipation rate/day: Information on DFR for fipronil is not available. The US EPA Occupational Post-Application Risk Assessment Calculator assumes a daily dissipation rate of 10%. However, considering fipronil’s half-life (3-7 months) on treated vegetation (Belayneh, 1998), a daily dissipation rate of 1% is assumed for fipronil and its degradates.

- Adult bodyweight 70 kg (Section 7.3)

- 8 h work day (Section 7.3)

- Transfer coefficients established by the US EPA Agricultural Re-entry Task Force (ARTF). TC values (cm^2/hr) vary with crop and agronomic activities, as follows:

Bananas		*100 (hand harvesting, stripping, irrigation, weeding mature plants)
Brassicas	(low exposure)	2000 (irrigation, scouting, thinning, weeding immature)
	(medium exposure)	4000 (scouting mature plants)
	(high exposure)	5000 (irrigation, pruning, topping and hand harvesting)

Cotton		1500 (Irrigation and scouting mature plants)
		2500 (hand harvesting, pruning, skating)
Grapevines		1000 (scouting, training, irrigation)
		10000 (grape girdling)
Mushrooms		Not available
Potato		2500 (hand harvesting)
Sorghum		1000 (scouting, irrigation, weeding mature/full foliage plants)
Sugarcane		2000 (scouting mature plants)
Turf	(low exposure)	500 (mowing)
	(high exposure)	16500 (hand weeding, transplanting)

*In bananas, the product is to be applied to the base of each stool and the soil around it. Therefore, transfer of residues from foliage is expected to be minimal. Hence a low TC of 100 is used.

These TC values are established by the USEPA Agricultural Re-entry Task Force (ARTF) for use in post application exposure assessments and are based on exposure data generated by member companies of the Task Force. The Task Force has grouped potential post-application exposure into 18 groups based on crop type. Within each crop type there are activity patterns based on agricultural practices expected for the different crop groupings. TC values have been established for each of these post-application agricultural practices.

Since BASF Australia Ltd and Bayer CropSciences are members of the ARTF, the TC values developed by the ARTF and incorporated in the Occupational Post-application Risk Assessment Calculator Version 1 (8/9/00)-US EPA Policy 003.1, were used to estimate exposure for workers re-entering treated areas for various agricultural activities for a number of days after application and to derive safe re-entry intervals for carrying out those activities. Workers entering treated crops for post-application activities may be exposed to fipronil residues and its photodegradation products deposited on foliage or fruit. Workers are likely to work for a total of 2 to 3 weeks performing post-application activities and exposure would mostly be via skin contact. Hence, the dermal NOEL chosen from the short-term repeat dose study to estimate occupational risk for mixer/loaders and applicators (5 mg/kg bw/day) is considered appropriate for establishment of safe re-entry intervals for various crops and post-application activities. There is sufficient evidence to indicate that the major metabolite of fipronil, desulfinyl fipronil, is equitoxic to fipronil (see OCSEH review of mammalian toxicology of fipronil). Consequently, a separate assessment of risk from the photodegradation product was not considered necessary.

8.4 Calculated Risk from Occupational Post-application Exposure

The results indicated the following re-entry periods for various crops and agricultural activities:

Table 28: Risk for re-entry workers entering areas treated with fipronil products

Re-entry situation		**Fipronil application rate** (kg/ha)**	**TC***	**Risk calculator results*** **			
				Absorbed dose (mg/kg/day)		**MOE**** **	
Crop	**Re-entry activities**			**Day 0**	**Day 5**	**Day 0**	**Day 5**
Bananas	Irrigation, stripping, hand harvesting	0.27	100	0.0062	0.0059	810	852
Brassica	Irrigation, scouting, thinning, weeding immature plants	0.05	2000	0.0229	0.0217	219	230
	Scouting mature plants		4000	0.0457	0.0435	109	115

	Hand harvesting, irrigation, pruning, topping, tying mature plants		5000	0.0571	0.0543	88	92[#]

Table 28: Risk for re-entry workers entering areas treated with fipronil products (Continued)

Re-entry situation		Fipronil application rate** (kg/ha)	TC*	Risk calculator results***			
				Absorbed dose (mg/kg/day)		MOE****	
Crop	Re-entry activities			Day 0	Day 5	Day 0	Day 5
Cotton	Irrigation and scouting mature plants	0.025	1500	0.0086	0.0082	583	613
	Hand harvesting, pruning, skating		2500	0.0143	0.0136	350	368
Grapevines	Scouting, training, irrigation	0.16	1000	0.0366	0.0348	137	144
	Girdling		10000	0.3657	0.3478	14	14
Potatoes	Irrigation, scouting, thinning, weeding immature plants	0.05	2500	0.0286	0.0272	175	184
Sorghum	Scouting, irrigation, weeding mature/full foliage plants	0.00125	1000	0.0003	0.0003	17500	18402
Sugar cane	Irrigation, scouting, thinning, weeding immature plants	0.075	2000	0.0343	0.0326	146	153
Turf	Mowing	0.075	500	0.0021	0.002	2333	2454
	Transplanting, hand-weeding		16500	0.0707	0.067	71	74##

* Transfer coefficients as described in the US EPA Occupational Post-Application Risk Assessment Calculator Version 1 (8/9/00)-US EPA Policy 003.1

** Maximum product label rates

*** Based on data generated in the US EPA Occupational Post-Application Risk Assessment Calculator Version 1 (8/9/00)-US EPA Policy 003.1.

**** Based on short-term NOEL of 5 mg/kg bw/day

Acceptable limits (MOE=100) achieved by Day 13

Acceptable limits (MOE=100) achieved by Day 35

The results indicated that MOEs for most of the activities were acceptable (MOE≥100) on Day 0 (day of application) (Table 28). It should be noted however that these calculations assume workers enter the field only after the spray has dried. Since no TC values for mushrooms were available, a qualitative risk for workers entering mushroom growing areas was conducted. The re-entry intervals for various crops and agricultural activities derived from the above calculations are:

Bananas 0 day (hand-harvesting, stripping, irrigation, weeding mature plants)

Brassicas 0 day (Irrigation, scouting, thinning, weeding immature plants)

0 day (Scouting mature plants)

13 days (Hand harvesting, irrigation, pruning, topping, tying mature plants)

Cotton 0 day (Irrigation and scouting mature plants

hand-harvesting, pruning, skating)

Grapevines	0 day (scouting, training, irrigation) (see text for REI for girdling activity)
Mushrooms	(see text below)
Potato	0 day (hand-harvesting)
Sorghum	0 day (irrigation, weeding mature/full foliage plants)
Sugarcane	0 day (scouting mature plants)
Turf	0 day (mowing)
	35 days (hand weeding, transplanting)

It is noted that, with the exception of brassica crops, all re-entry periods are shorter than their respective withholding periods stipulated on the product labels.

Brassica

The re-entry risk calculation for brassicas was performed assuming the maximum concentration of fipronil applied as a worst-case scenario (50 g ai/ha for Regent 200SC). Using this approach, the risk to re-entry workers was determined to be minimal from 'day 0', for low (MOE=219) and medium (MOE=109) exposure activities (irrigation, scouting, thinning, weeding immature plants, scouting mature plants). However, for high exposure activities (hand harvesting, irrigation, pruning, topping, tying mature plants) the risk to re-entry workers did not reach an acceptable limit until 13 days post-application (MOE=100).

The following re-entry statements have been established: Do not allow entry into treated areas until the spray has dried, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use. Do not perform high exposure activities including hand-harvesting, irrigation, pruning, topping and/or tying mature plants in brassica for 13 days, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

The WHP for brassicas on associated product labels (Regent 200 SC and Regent 800WG) is 7 days for harvest. In the absence of specific information, the re-entry risk assessment has assumed that Australian workers are engaged in high exposure activities for 8 h per day when handling treated brassicas. A reduction in the handling duration will allow for a shorter re-entry interval. If only a 6 h duration per day is assumed for workers involved in high exposure activities (hand harvesting, irrigation, pruning, topping, tying mature plants) post-application, the risk becomes minimal from 'day 0' (MOE≥100).

Grapevines

In grapevines, the product will be applied to dormant vines following pruning and prior to budburst; crop management activities are therefore likely to be minimal during this period, except for weeding and irrigation. The risk to re-entry workers was determined to be low from 'day 0', for irrigation and scouting activities. For girdling the risk was unacceptable even 30 days after application. It should however be noted that the risk calculator assumes foliar contact with workers, consequently if the product is applied to pruned, dormant vines (without leaves), exposure is likely to be low even for girdling activities. Moreover, girdling is done at bloom time or within two or three weeks of ripening which is significantly more than thirty days after spraying.

Mushrooms

Normally re-entry into mushroom houses is expected to be limited to harvesting operations only. Although mushrooms are harvested manually, picking is usually conducted a few weeks after treatment (normally during spawning) and workers wear gloves to protect the produce (Australian Mushroom Growers Response to Review of Fipronil). Since fipronil is applied at the time of preparation of peatmoss (a few weeks before harvesting) and since there is then no mushroom tissue on which fipronil residues could be deposited, under normal use situations, there should be minimal dermal or inhalation exposure during mushroom harvesting.

Turf

The risk to re-entry workers was determined to be low from 'day 0' (MOE=2333), for the low exposure activity of mowing. When undertaking high exposure activities (handweeding and transplanting), the risk to workers when re-entering treated turf areas was unacceptable (MOE<100) from 'day 0' (MOE=74). An acceptable risk for workers undertaking high exposure activities was not achieved until 35 days post-application. The risk assessment assumed a worst-case scenario where workers were involved in high exposure activities 8 h per day on a daily basis. The following re-entry statements are recommended: Do not allow entry into treated areas until the spray has dried, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use. Do not perform high exposure activities including handweeding and transplanting for 35 days, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

Re-handling treated seed

Treated seed is rehandled by farmers in the cropping process. Seed is transferred from bags or bulk containers to sowing (planting) equipment. Inhalational exposure is possible from the product dust coming off the dried seed. There are no data to estimate inhalation exposure during this process. However, since fipronil has moderate inhalation toxicity, workers should wear a dust mask when handling treated seed.

Re-entering termiticide treated areas

As described in the Honeycutt and Kennedy study anyone entering areas/buildings treated with a fipronil-based termiticide are likely to be exposed to fipronil vapour (Honeycutt and Kennedy, 2001). Dermal exposure is unlikely in the habitable areas of the building because the site of application is usually in areas that are not frequented (ie. under the concrete slab through drill holes or in the under-house crawl spaces). While it is unlikely that a PCO will be required to re-enter the crawl space under a treated house for at least a year, the building occupants and other occupational groups (eg. plumbers, electricians etc.) who may use the crawl space are likely to be exposed to some fipronil vapours. For the latter group inhalation exposure is likely to be appreciable during drying of the product. The occupational risk assessment for applicators suggests that a re-entry statement advising of this unacceptable risk should be included on the product label. The following statement is considered appropriate for re-entering crawl space areas following termiticide treatment:

"Do not enter treated areas until the spray has dried."

For the residents of a treated dwelling the study by Honeycutt and Kennedy showed that the ambient air concentrations of fipronil following Termidor 80WG treatment was very low, ranging from 0.004 – 0.08 µg/m^3 and present only on the day of application (Honeycutt and Kennedy, 2001). At this air concentration (0.00008 mg/ m^3), the amount of fipronil inhaled per day will lead to an estimated systemic exposure of 0.00005 mg/kg bw, assuming 100% absorption from the lungs. The acute reference dose established for fipronil is 0.02 mg/kg bw (see OCSEH review of mammalian toxicology of fipronil). Therefore this exposure is unlikely to have any adverse effect on the residents occupying treated houses even immediately after treatment. Dermal exposure to fipronil after the spray has dried is likely to be minimal.

Veterinary situations

Exposure to fipronil residues may occur when handling animals soon after product application. Although, veterinary "spot-on" products containing fipronil may cause skin irritation, gloves are not required during application due to the limited dermal exposure afforded by the packaging. Likewise, due to the small area treated on the animal, gloves are not required for rehandling.

Veterinary spray products are applied by thoroughly wetting the animals coat and hence the exposure to persons applying the product and handling treated animals is much greater. Therefore, when applying the product gloves should be worn and treated animals should not be handled until the spray has dried. If prior handling is required, workers should wear rubber gloves.

9 DISCUSSION

Following receipt of a number of reports of adverse experiences involving products containing fipronil, the APVMA has decided to consider whether fipronil and products containing fipronil in the context of both agricultural and veterinary uses:

- may be an undue hazard to the safety of people exposed to it during their handling;
- may have an effect that is harmful to human beings;
- may have an unintended effect that is harmful to animals; and whether
- product labels contain adequate instructions with regard to the safe handling of the

product or other warning and precautionary instructions.

In Australia, products containing fipronil are used to control insect pests in a wide range of agricultural and non-agricultural situations (eg. termite control) and as insecticidal seed dressing in rice, canola, sorghum and cotton. It is also used in veterinary chemical products as a spray-on or concentrated spot-on formulation to control fleas and ticks on cats and dogs.

There is very limited information on occupational exposure to fipronil during mixing/loading and applying fipronil products in a wide variety of crops. A single study measured worker exposure during application of a granular formulation to banana plantation (Pontal, 1996). Another study looked at inhalation exposure of PCOs treating houses with fipronil termiticide (Honeycutt and Kennedy, 2001). Exposure assessments, using surrogate data, have been submitted, however, they cover very few use patterns of fipronil products. The OCSEH has therefore used PHED to estimate exposure for most uses of fipronil in order to quantify the risk to workers using fipronil products. Where appropriate surrogate data or exposure models were not available, a qualitative estimation of the risk was conducted taking into account the use pattern and the toxicity hazard profile of the product.

The activities which resulted in an unacceptable risk (ie. MOE<100) to workers were mixing/loading SC products for boomspray application, grain treatment (open mixing/loading for treating smaller quantities of seed) and termite treatment, even when wearing gloves. The use of chemical resistant clothing, which is reported to provide up to 95% protection (Thongsinthusak *et al.*, 1993), was considered acceptable to sufficiently mitigate exposure during open mixing/loading of SC formulations of fipronil (Table 22, 26 and 27). A single layer of clothing and chemical resistant gloves provided adequate protection to workers mixing/loading SC formulations for hand-held application (smaller volumes as compared to boomspray application) and dry flowable formulations for all methods of application. Workers mixing/loading dry flowable formulations did not need extra clothing or gloves.

Exposure to fipronil was within acceptable levels (low risk) for workers applying the diluted products by boomspray (open or closed cabs) and aerially. For hand-held application however, exposure was very high with low- as well as high-pressure spray equipment (MOE <100). The risk appeared to be acceptable if workers wore chemical resistant clothing, gloves and a half-face piece respirator with combined dust and gas cartridge. With high pressure hand equipment, respirators were not required.

Exposure during incorporation of diluted fipronil product into peatmoss (mushroom casing) could not be estimated due to the absence of an appropriate model. A qualitative assessment of the risk to peatmoss workers indicated the need to wear cotton overalls or equivalent clothing and gloves for occupational protection. If however the spray is applied using hand-held equipment, workers will need to wear chemical resistant clothing, elbow-length gloves and a half face respirator.

Seed treatment is mostly carried out by professional seed treaters in closed systems. Application activities are usually mechanised and do not result in much worker exposure. Seed baggers may be exposed to fipronil dust when handling treated seed. A qualitative risk assessment for farmers who may treat seed on their farms indicated the need to wear cotton overalls buttoned to the neck and wrist, elbow-length PVC gloves and a disposable dust mask when using the prepared slurry and bagging treated seeds. This conclusion is in agreement with the outcome of the risk assessment performed by Aventis CropSciences (see section 7.2).

For termite control, fipronil is applied by hand-held equipment including low-pressure hand wand and soil injection (rodding). There is no exposure data in the PHED for the type of low-pressure hand wands that are used in trenching to create chemical soil barriers (horizontal, vertical or external perimeter) around or under existing building structures. The 'liquid/open pour/termiticide injection' scenario from the PHED was found to be the most suitable surrogate for exposure modelling and contains exposure data only for mixing/loading and application under slab foundation (rodding) and crawl spaces. PHED data suggest that during injection, trenching and rodding methods, chemical resistant clothing and gloves are sufficient to protect pest control operators during application to post-construction soil barriers. The U.S. worker exposure study data for spray probe and injector application indicate a requirement for respiratory protection (a half-face piece respirator with combined dust and gas cartridge) during spray preparation and application.

Calculating the likely risk to residents occupying houses treated for termite control immediately after treatment indicated that it was acceptable because the air concentrations of fipronil were extremely low.

Pet groomer exposure studies indicated acceptable risk to workers using Frontline products to treat dogs. Exposure data from these studies indicated the need for gloves when using the spray formulation. Risk from using spot formulation was found to be acceptable even if workers did not wear gloves.

Workers entering treated areas for harvesting or other activities or re-handling treated seed may be exposed to fipronil residues or its degradation products. Safe re-entry/re-handling intervals were calculated for each crop taking into account the amount of fipronil applied and the degradation of fipronil on foliage. The major photolytic metabolite, fipronil-desulfinyl (MB 46513), has repeat-dose toxicity similar to that of the parent compound, resulting in the same end-point for both compounds (see Section 5.4). Results indicated that for most post-application activities no PPE would be required to be worn once the spray has dried, with a few notable exceptions. For treated brassica, high exposure activities including hand harvesting, irrigation, pruning, topping, tying mature plants were considered to pose unacceptable risks for up to 13 days after application. Hence, a 13-day re-entry interval is proposed. If these activities are required within the 13-day interval then PPE should be worn so that there is no unacceptable risk posed to the worker. For hand-weeding and transplanting turf the magnitude of the MOE was considered to be unacceptable for up to 35 days after application. Hence, a 35-day re-entry interval is proposed. If handweeding and transplanting activities need to be performed during the 35-day re-entry interval, PPE should be worn so that there is no unacceptable risk posed to the worker.

Girdling activities in grapevines is not expected to result in appreciable exposure as fipronil is applied to dormant vines (without leaves) following pruning and prior to budburst and girdling is carried out at bloom time or within two or three weeks of fruit ripening. Similarly, in the case of mushrooms, fipronil is applied at the time of preparation of peatmoss and since there is no foliage on which fipronil residues could be deposited, there is likely to be minimal dermal or inhalation exposure during mushroom harvesting. Moreover, although mushrooms are harvested manually, picking is usually conducted a few weeks after treatment (normally during spawning) and workers wear gloves to protect the produce (Australian Mushroom Growers Response to Review of Fipronil).

10 SAFETY DIRECTIONS AND RE-ENTRY INTERVALS

10.1 Safety directions

The OCSEH review of mammalian toxicology of fipronil has recommended revisions to the hazard-based label Safety Directions for a number of currently registered products, and has also recommended hazard-based statements applicable to other products that are not covered by a FAISD Handbook entry. Based on the exposure and risk assessments performed in Section 7, this Occupational Health and Safety assessment has identified a need to revise the currently-recommended PPE for use by persons handling and applying fipronil products, and to recommend appropriate PPE for persons applying the diluted products. The amended and new Safety Directions from the Toxicology and OHS assessments are combined and given below.

SC products

SC 100 g/L or less

Presto 100 Insecticide (100 g/L or less fipronil)

Presto 100 Insecticide is for the control of mushroom flies in mushroom houses. It is diluted with water and applied to peatmoss during preparation of casing by hand-held equipment or spray boom fixed to the top of peat moss turning machine.

Termidor Residual Termiticide (100 g/L or less fipronil)

Termidor Residual Termiticide is an SC formulation of fipronil indicated for the control of subterranean termites around domestic and commercial structures. It is applied using hand-held equipment, including soil injection (rodding) and trenching.

SC 100 g/L or less	
129 133	Harmful if swallowed
160 162	May irritate the eyes
210 162	Avoid contact with eyes
351	Wash hands after use
279 280 281 290 291b 298a 295	When opening the container and preparing spray wear chemical resistant clothing buttoned to the neck and wrist and a washable hat, chemical resistant footwear, and elbow-length PVC or nitrile gloves
279 282 290 292b 295	When using the prepared spray wear cotton overall buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves
289 290 291b 295, 298a, 300 303	If applying by hand wear chemical resistant clothing buttoned to the neck and wrist and washable hat, elbow-length PVC or nitrile gloves, chemical resistant footwear and half face piece respirator with combined dust and gas cartridge
360 361 364 365 366	After each day's use, wash gloves, respirator, and if rubber wash with detergent and warm water, and contaminated clothing

SC 200 g/L or less, more than 100 g/L

Regent 200SC Insecticide

Regent 200SC is indicated for insect control in banana, brassicas, potatoes, sorghum, mushrooms, pasture and sugarcane. It is diluted before application either by ground application (boom spray or hand-held equipment) or by aerial application.

Presto Insecticide

Presto Insecticide is for the control of mushroom flies in mushroom houses. It is applied only as ground application by hand-held equipment. PPE has been recommended on the basis of acute (moderate eye and slight skin irritancy) and repeat-dose risks (Section 7.4.3).

SC 200 g/L or less, more than 100 g/L	
129 132 133	Harmful if inhaled or swallowed
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
340 343	If product in eyes, wash it out immediately with water
279 280 281 290 291b 299 298a 295	When opening the container and preparing spray wear chemical resistant clothing buttoned to the neck and wrist and a washable hat, face shield or goggles, chemical resistant footwear, and elbow-length PVC or nitrile gloves
279 282 290 292b 295	When using the prepared spray wear cotton overall buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves
289 290 291b 295, 298a, 300 303	If applying by hand wear chemical resistant clothing buttoned to the neck and wrist and washable hat, elbow-length PVC or nitrile gloves, chemical resistant footwear and half face piece respirator with combined dust and gas cartridge
351	Wash hands after use
360 361 364 365 366	After each day's use, wash gloves, respirator, and if rubber wash with detergent and warm water, face shield or goggles and contaminated clothing

SC 500 g/L or less, more than 200 g/L

Cosmos Insecticidal Seed Treatment

Cosmos Insecticidal Seed Treatment contains 500 g/L fipronil. The product is used to treat seed and grain stored for sowing to control various insect pests and to protect seedlings from attack by insect pests.

The application rates for sorghum/sunflowers and canola are 150 and 400 mL per 100 kg seed for, respectively. For rice treatment, 20 ml product per 100 kg seed is recommended. Seed is treated as a coarse shielded spray as it comes on a conveyor belt. Alternatively, seed is poured into a closable mixing vat and the diluted product is added to the seed followed by vigorous shaking. Re-application is not normally required.

SC 500 g/L or less, more than 200 g/L	
130 132 133	Poisonous if inhaled or swallowed
161 164	Will irritate the skin
210 164	Avoid contact with the skin
279 280 281 290 291b 300 303 295	When opening the container and preparing slurry wear chemical resistant clothing buttoned to the neck and wrist and a washable hat, chemical resistant footwear and elbow-length PVC or nitrile gloves
279 282 290 292b 295 306	When using the prepared slurry wear cotton overalls buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves and a disposable dust mask
351	Wash hands after use
360 361 366	After each day's use, wash gloves and contaminated clothing

Wettable granule products

WG 800 g/kg or less

Regent 800WG Insecticide

Regent 800WG Insecticide is a wettable granule formulation containing 800 g/kg fipronil. It is indicated for insect control in banana, brassicas, potatoes, sorghum, mushrooms, pasture and sugarcane. Regent 800WG Insecticide is applied by ground (boom spray or hand-held equipment) as well as aerial application. The product is diluted with water before application. PPE requirements for the preparation of wettable granules have been established to protect against the acute toxicological effects associated with this formulation (moderate oral, inhalation and dermal toxicity and; moderate eye and slight skin irritation). PPE requirements when applying diluted spray have been established in order to avoid any adverse health effects associated with repeat-dose exposure. Following are the amended safety directions for Regent 800WG Insecticide:

WG 800 g/kg or less	
130 131 132 133	Poisonous if absorbed by skin contact, inhaled or swallowed
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
220 221	Do not inhale dust
279 280 281 290 292b 295 299	When opening the container and preparing spray, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing), elbow length PVC or nitrile gloves and face shield or goggles
279 282 290 292b 295	When using the prepared spray wear cotton overall buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves
289 290 291b 295, 298a, 300 303	If applying by hand wear chemical resistant clothing buttoned to the neck and wrist and washable hat, elbow-length PVC or nitrile gloves, chemical resistant footwear and half face piece respirator with combined dust and gas cartridge
340 343	If product in eyes, wash it out immediately with water
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 364 365 366	After each day's use, wash gloves, respirator, and if rubber wash with detergent and warm water, face shield or goggles and contaminated clothing

ULV Products

UL 25 g/L or less

Adonis 3UL Insecticide

Adonis 8.5UL Insecticide

Adonis 3UL Insecticide and Adonis 8.5UL Insecticide are ultra low volume (UVL) formulations containing 3 g/L and 8.5 g/L fipronil, respectively. The products are for the control of locusts and grasshoppers in pastures and sorghum and are only available for use by the Australian Plague Locust Commission (APLC) or it's approved applicators. The products are applied by aircraft through ULV spray units undiluted or diluted with a compatible spraying oil.

UL 25 g/L or less	
161 162	Will irritate the eyes
210 162	Avoid contact with eyes
279 280 281 290 295	When opening the container and preparing spray wear elbow-length PVC or nitrile gloves
351	Wash hands after use
360 361	After each day's use wash gloves

Gel products

BA 0.5 g/kg or less

Goliath Cockroach Gel

New entry to replace HG BA gel 0.5 g/kg or less

BA Gel 0.5 g/kg or less	
351	Wash hands after use

Veterinary Products

HV LD 2.5 g/L or less

Frontline Spray

HV LD 2.5 g/L or less	
161 162	Will irritate the eyes
210 162	Avoid contact with eyes
279 283 290 312	When using the product wear rubber gloves
340 343	If product in eyes, wash it out immediately with water
351	Wash hands after use
360 361	After each day's use, wash gloves

HV SA 100 g/L or less

The Frontline Top Spot, Frontline Plus and Startgard ranges of spot-on products

HV SA 100 g/L or less	
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
340 343	If product in eyes, wash it out immediately with water
351	Wash hands after use

Thiodicarb product containing fipronil (80 g/L)

Semevin Super Seed Dressing Insecticide (80 g/L fipronil and 400 g/L thiodicarb)

Semevin Super Seed Dressing Insecticide is indicated for the control of false wireworm and thrips in cotton seed. It is used as a seed coating using commercial seed coating equipment. This product also contains 400 g/L thiodicarb. Thiodicarb is a cholinesterase inhibitor. It has high oral toxicity in the rat (66 mg/kg in aqueous CMC, 120 mg/kg in corn oil), low dermal toxicity in rats (>640 mg/kg) and rabbits and LC_{50} values for inhalation studies ranging from 115 to 6230 mg/m^3. It is a moderate, but reversible eye irritant in rabbits. The following safety directions are based on the toxicity of the product estimated from the toxicities of individual product constituents (OCSEH review of mammalian toxicology of fipronil).

SC 400 g/L or less, with fipronil 80 g/L or less	
130 132 133	Poisonous if inhaled or swallowed
161 162	Will irritate the eyes
210 162	Avoid contact with eyes
340 343	If product in eyes, wash it out immediately with water
220 222	Do not inhale vapour
190	Repeated minor exposure may have a cumulative poisoning effect
279 280 281 282 290 292 294 296 298 300 303	When opening the container, preparing the spray and using the prepared spray, wear cotton overalls buttoned to the neck and wrists and a washable hat, elbow-length PVC gloves, face shield, impervious footwear and a half facepiece respirator with combined dust and gas cartridge
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 362 364 366	After each day's use, wash gloves, face shield, respirator and if rubber wash with detergent and warm water and contaminated clothing

10.2 Re-entry intervals

The results indicated the following re-entry intervals for various crops and agricultural activities:

Bananas	0 day (hand harvesting, stripping, irrigation, weeding mature plants)
Brassicas	0 day (irrigation, scouting, thinning, weeding immature plants)
	0 day (scouting mature plants)
	13 days (hand harvesting, irrigation, pruning, topping, tying mature plants)
Cotton	0 day (Irrigation and scouting mature plants)
	0 day (hand harvesting, pruning, skating)
Grapevines	0 day ((scouting, training, irrigation)
Potato	0 day (hand harvesting)
Sorghum	0 day (irrigation, weeding mature/full foliage plants)
Sugarcane	0 day (scouting mature plants)
Turf	0 day (mowing)
	35 days (hand weeding, transplanting)

10.3 Re-entry/re-handling statements

The following re-entry statement is stipulated for bananas, cotton, mushrooms, pasture, potato, sorghum and sugarcane:

"Do not allow entry into treated areas until spray has dried. If prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and gloves. Clothing must be laundered after each day's use.

The following re-entry statements are stipulated for brassica:

"Do not allow entry into treated areas until the spray has dried, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

Do not perform high exposure activities including hand-harvesting, irrigation, pruning, topping and/or tying mature plants in brassica for 13 days, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves."

The following re-entry statement is stipulated for turf:

"Do not allow entry into treated areas until the spray has dried, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

Do not perform high exposure activities including handweeding and transplanting for 35 days, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves."

The following re-entry statement is stipulated for fipronil termiticide treated areas:

"Do not enter treated areas until the spray has dried."

The following re-handling statement is stipulated for seed treated with fipronil products:

"Treated seed should be allowed to dry before re-handling. Wear dust mask when handling treated seed".

Re-handling statement for animals treated with fipronil spray formulations:

"Animals treated with fipronil spray formulations should not be handled till the spray has dried. If prior handling is required, workers should wear rubber gloves".

Precautionary statements

"Human flaggers, if used in aerial spraying operations, must be protected by enclosed cabs".

10.4 Exposure mitigation methods

Hazardous substances legislation

Fipronil and many of its products currently registered in Australia are determined to be hazardous substances (refer to Appendix II). In accordance with Commonwealth/State /Territory Hazardous Substances legislation, the control measures listed in Appendix II must be instituted, where applicable (NOHSC, 1994a).

11 RECOMMENDATIONS TO THE APVMA

1. The OCSEH recommends that the APVMA can be satisfied that fipronil will not cause adverse effects on the health and safety of persons preparing and applying fipronil-based products when used in accordance with the revised label instructions.
2. The following amended and existing Safety Directions, which will be included in the FAISD Handbook, should be included on the product label.

Safety Directions

The recommended safety directions for the reviewed **fipronil** products are summarised in the following Table. The current entries for fipronil EC 300 g/L, WP 10 g/kg or less, HG WP 10 g/kg or less and GB 0.2 g/kg or less should be deleted as there are no registered products in these categories. The current entry for HG BA gel 0.5 g/kg or less should be deleted as it is included under the new entry BA gel 0.5 g/kg or less. The current entry for DU 5 g/kg or less has been amended in terms of deletion of the 180 statement only, as the product was registered after the data-call in for the review.

No change	**HG BA 0.5 g/kg or less in plastic labyrinth**
No change	**BA 0.03 g/station or less in propylene glycol impregnated in cardboard**
No change	**GR 1 g/kg or less**

Amended entry	**WG 800 g/L or less**
Amended entry	**UL 25 g/L or less**
Amended entry	**HV SA 100 g/L or less**
Amended entry	**HV LD 2.5 g/L or less**
Amended entry[#]	**DU 5 g/kg or less**
Amended entry	**SC 500 g/L or less, more than 200 g/L**
Amended entry	**SC 200 g/L or less, more than 100 g/L**
Amended entry	**SC 100 g/L or less**

New entry	**BA gel 0.5 g/kg or less**

Deleted entry	**EC 300 g/L**
Deleted entry	**WP 10 g/kg or less**
Deleted entry	**HG WP 10 g/kg or less**
Deleted entry	**GB 0.2 g/kg or less**
Deleted entry	**HG BA gel 0.5 g/kg or less**

Note: [#] This entry has only been evaluated in terms of sensitisation and the necessity of the 180 statement. The remaining safety directions were not reviewed in either the toxicology or OHS reports as the entry occurred after the data-call in period.

The recommended safety directions for the reviewed **thiodicarb** product containing fipronil are summarised in the following table:

Amended entry	**SC 400 g/L or less, with fipronil 80 g/L or less**

Details of Amended Entries

Note: Amendments/modification shown in italics, deleted SDs are struck-through.

SC 100 g/L or less	
129 133	*Harmful if swallowed*
~~*180*~~	~~Repeated exposure may cause allergic disorders~~
160 162	*May irritate the eyes*
210 162	*Avoid contact with eyes*
351	Wash hands after use
279 280 281 290 291b 298a 295	When opening the container and preparing spray wear chemical resistant clothing buttoned to the neck and wrist and a washable hat, chemical resistant footwear, and elbow-length PVC or nitrile gloves
279 282 290 292b 295	*When using the prepared spray wear cotton overall buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves*
289 290 291b 295, 298a, 300 303	*If applying by hand wear chemical resistant clothing buttoned to the neck and wrist and washable hat, elbow-length PVC or nitrile gloves, chemical resistant footwear and half face piece respirator with combined dust and gas cartridge*
360 361 364 365 366	After each day's use, wash gloves, respirator, and if rubber wash with detergent and warm water, and contaminated clothing

SC 200 g/L or less, more than 100 g/L	
129 132 133	Harmful if inhaled or swallowed
161 162 164	Will irritate the eyes and skin
~~180~~	~~Repeated exposure may cause allergic disorders~~
210 211	Avoid contact with eyes and skin
340 343	*If product in eyes, wash it out immediately with water*
279 280 281 290 291b 299 298a 295	When opening the container and preparing spray wear chemical resistant clothing buttoned to the neck and wrist and a washable hat, face shield or goggles, chemical resistant footwear, and elbow-length PVC or nitrile gloves
279 282 290 292b 295	When using the prepared spray wear cotton overall buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves
289 290 291b 295, 298a, 300 303	*If applying by hand wear chemical resistant clothing buttoned to the neck and wrist and washable hat, elbow-length PVC or nitrile gloves, chemical resistant footwear and half face piece respirator with combined dust and gas cartridge*
351	Wash hands after use
360 361 364 365 366	After each day's use, wash gloves, respirator, and if rubber wash with detergent and warm water, face shield or goggles and

	contaminated clothing

SC 500 g/L or less, more than 200 g/L	
130 132 133	Poisonous if inhaled or swallowed
161 164	*Will irritate the skin*
210 164	Avoid contact with the skin
279 280 281 290 291b 300 303 295	When opening the container and preparing *slurry* wear chemical resistant clothing buttoned to the neck and wrist and a washable hat, chemical resistant footwear and elbow-length PVC or nitrile gloves
279 282 290 292b 295 306	*When using the prepared slurry wear cotton overall buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves and a disposable dust mask*
351	Wash hands after use
360 361 366	After each day's use, wash gloves and contaminated clothing

WG 800 g/kg or less	
130 131 132 133	Poisonous if absorbed by skin contact, inhaled or swallowed
161 162 164	Will irritate the eyes and skin
210 211	Avoid contact with eyes and skin
220 221	Do not inhale dust
279 280 281 290 292b 295 299	When opening the container and preparing spray, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing), elbow length PVC or nitrile gloves and face shield or goggles
279 282 290 292b 295	*When using the prepared spray wear cotton overall buttoned to the neck and wrist or equivalent clothing and elbow-length PVC or nitrile gloves*
289 290 291b 295, 298a, 300 303	*If applying by hand wear chemical resistant clothing buttoned to the neck and wrist and washable hat, elbow-length PVC or nitrile gloves, chemical resistant footwear and half face piece respirator with combined dust and gas cartridge*
340 343	If product in eyes, wash it out immediately with water
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 364 365 366	After each day's use, wash gloves, respirator, and if rubber wash with detergent and warm water, face shield or goggles and contaminated clothing

UL 25 g/L or less	
161 162	Will irritate the eyes
210 162	Avoid contact with eyes
279 280 281 290 295	When opening the container and preparing spray wear elbow-length *PVC or nitrile gloves*
351	Wash hands after use
360 361	After each day's use wash gloves

BA Gel 0.5 g/kg or less [New entry]	
351	*Wash hands after use*

HV LD 2.5 g/L or less	
161 162	Will irritate the eyes
~~180~~	~~Repeated exposure may cause allergic disorders~~
210 162	Avoid contact with eyes
279 283 290 312	When using the product wear rubber gloves
340 343	If product in eyes, wash it out immediately with water
351	Wash hands after use
360 361	After each day's use, wash gloves

HV SA 100 g/L or less	
161 162 164	Will irritate the eyes and skin
~~180~~	~~Repeated exposure may cause allergic disorders~~
210 211	Avoid contact with eyes and skin
340 343	If product in eyes, wash it out immediately with water
351	Wash hands after use

Revised Safety Directions for thiodicarb product containing fipronil

SC 400 g/L or less, with fipronil 80 g/L or less	
130 132 133	Poisonous if inhaled or swallowed
161 162	Will irritate the eyes
210 162	Avoid contact with eyes
340 343	*If product in eyes, wash it out immediately with water*
220 222	Do not inhale vapour
190	Repeated minor exposure may have a cumulative poisoning effect
279 280 281 282 290 292 294 296 298 300 303	When opening the container, preparing the spray and using the prepared spray, wear cotton overalls buttoned to the neck and wrists and a washable hat, elbow-length PVC gloves, face shield, impervious footwear and a half facepiece respirator with combined dust and gas cartridge
350	After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water
360 361 362 364 366	After each day's use, wash gloves, face shield, respirator and if rubber wash with detergent and warm water and contaminated

	clothing

Re-entry/re-handling statements

Re-entry statement for bananas, cotton, mushrooms, pasture, potato, sorghum and sugarcane:

"Do not allow entry into treated areas until spray has dried. If prior entry is necessary, wear cotton overalls buttoned to the neck and wrist (or equivalent clothing) and gloves. Clothing must be laundered after each day's use.

The following re-entry statements are stipulated for brassica:

"Do not allow entry into treated areas until the spray has dried, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

Do not perform high exposure activities including hand-harvesting, irrigation, pruning, topping and/or tying mature plants in brassica for 13 days, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use."

The following re-entry statement is stipulated for turf:

"Do not allow entry into treated areas until the spray has dried, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use.

Do not perform high exposure activities including handweeding and transplanting for 35 days, unless wearing cotton overalls buttoned to the neck and wrist (or equivalent clothing) and chemical resistant gloves. Clothing must be laundered after each day's use."

Re-entry statement for fipronil termiticide treated areas:

"Do not enter treated areas until the spray has dried."

Re-handling statement for seed treated with fipronil products:

"Treated seed should be allowed to dry before re-handling. Wear dust mask when handling treated seed".

Re-handling statement for animals treated with fipronil spray formulations:

"Animals treated with fipronil spray formulations should not be handled till the spray has dried. If prior handling is required, workers should wear rubber gloves".

Precautionary statement

"Human flaggers, if used in aerial spraying operations, must be protected by enclosed cabs".

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13 APPENDIX I – Fipronil products assessed in the toxicology review

(Adapted from APVMA PUBCRIS. Only products that are included in the Review are listed.)

Veterinary products

APVMA Product Code	Product Description	Product Name
46828	HV LD, 2.5 g/L fipronil	Frontline Spray
48523	HV SA, 100 g/L fipronil	Frontline Top Spot Cat
48606	HV SA, 100 g/L fipronil	Frontline Top Spot Small Dog
49825	HV SA, 100 g/L fipronil	Frontline Top Spot Medium Dog
49826	HV SA, 100 g/L fipronil	Frontline Top Spot Large Dog
51304	HV SA, 100 g/L fipronil	Startgard For Puppies *
51530	HV SA, 100 g/L fipronil	Startgard For Kittens *
52043	HV SA, 100 g/L fipronil	Frontline Top Spot Extra Large Dog
52327	HV SA, 100 g/L fipronil	Frontline Top Spot For Dogs
54523	HV SA, 100 g/L fipronil, 90 g/L (S)-methoprene	Frontline Plus (Fipronil Plus (S)-Methoprene) For Dogs
54524	HV SA, 100 g/L fipronil, 120 g/L (S)-methoprene	Frontline Plus (Fipronil Plus (S)-Methoprene) For Cats
56123	HV SA, 100 g/L fipronil, 90 g/L (S)-methoprene	Startgard Plus for Puppies
56124	HV SA, 100 g/L fipronil, 120 g/L (S)-methoprene	Startgard Plus for Kittens

*These are combination products containing Frontline Top Spot and Heartgard in the one package. The Frontline Top Spot pipettes in these kits are the size equivalent of the pipettes for the ‘small dog’ and ‘small cat’ products.

Agricultural products

APVMA Product Code	Product Description	Product Name
46793	SC, 200 g/L fipronil	Regent 200SC Insecticide
47407	WG, 800 g/L fipronil	Regent 800WG Insecticide
48921*	GR, 1 g/kg fipronil	Chipco Choice Insecticide

APVMA Product Code	Product Description	Product Name
49434	SC, 500 g/L fipronil	Cosmos Insecticidal Seed Treatment
49646	HG BA, 0.5 g/kg fipronil	Goliath Cockroach Bait
49647	BA gel, 0.5 g/kg fipronil	Goliath Cockroach Gel
50285	UL, 8.5 g/L fipronil	Adonis 8.5ul Insecticide
51371	SC, 400 g/L thiodicarb, 80 g/L fipronil	Semevin Super Seed Dressing Insecticide
51720	HG BA 0.1 g/kg fipronil	Combat Ant-Rid Relief From Tough Ant Problems 4 Ant Baits
53156	UL 3.0 g/L fipronil	Adonis 3ul Insecticide
53264*	SC, 200 g/L fipronil	Presto Insecticide
53737*	SC, 100 g/L	Presto 100 Insecticide
54587	HG BA gel, 0.3 g/kg	Goliath Gold Gel Insecticide
54624	SC, 100 g/L fipronil	Termidor Residual Termiticide
55553	HG BA gel, 0.3 g/kg	Maxforce Gold Gel Insecticide
57764	GR, 1 g/kg fipronil	Impede Insecticide

*= No longer registered

14 APPENDIX II - Overseas Regulatory Assessments/Actions

US EPA

In July 2004, the US EPA approved requests submitted by Bayer CropScience to voluntarily cancel the registrations of certain pesticide products containing fipronil for use on rice or rice seed. Any distribution, sale or use of the products subject to this cancellation order was only permitted in accordance with the terms of the existing stocks provision of this cancellation order.

The US EPA has approved fipronil products for agricultural and domestic (veterinary and home garden) uses. Registered domestic fipronil products are approved for use on cats and dogs for flea control and on turf to control fire ants. The US EPA conducted an aggregate dietary exposure estimate for fipronil and concluded that chronic dietary exposure to fipronil residues from both primary and secondary sources, as a result of its use on field corn, potatoes, rice and cotton does not represent a significant risk to any segment of the population[6]. The US EPA also approved agricultural fipronil products for use on potato and sweet potato in August 2007 and for use on pine seedling in June 2007[7].

European Union

The European Food Safety Authority (EFSA), the lead agency in the EU's pesticide review process completed a re-evaluation of fipronil and its products in 2006[8]. In 2007 the European Commission Health and Consumer Protection Directorate-General reviewed the EFSA report and additional data in order to ascertain if fipronil should be included in Annex I of Directive 91/414/EEC. The Directive provides for the establishment of a positive list of active substances (Annex I), that have been shown to be without unacceptable risk to people or the environment. The positive list of active substances are authorised for use in plant protection products within the community. The 2007 review[9] concluded that the available data supported use of fipronil as a seed dressing on sunflower and maize. The overall conclusion was that fipronil be included in Annex I of Directive 91/414/EEC for use as a seed dressing.

In 2007, the United Kingdom (UK) published a revocation notice for fipronil agricultural products that did not comply with the specific condition for fipronil's inclusion in Annex I of of Directive 91/414/EEC: 'only uses as insecticide for use as seed treatment may be authorised.'.

[6] US EPA (2007) Fipronil; Pesticide Tolerances. 40 CFR Part 180 [EPA-HQ-OPP-2005-0206; FRL-8142-6] Federal Register).
[7] US EPA (2007)Multi-Year Workplan for Reregistration of Conventional Pesticides – Completions for Fiscal Year 2007. Office of Pesticide Programs.
[8] EFSA (2006) Summary of the *EFSA Scientific Report* (2006) 65, 1-110, Conclusion on the peer review of fipronil.

[9] EC (2007) Review report for the active substance of fipronil finalised in the Standing Committee on the Food Chain and Animal Health at its meeting on 16 March 2007 in view of the inclusion of fipronil in Annex I of Directive 91/414/EEC. European Commission.

AFSSA/AFSSE: Agence Française de Sécurité Sanitaire des Aliments (French Food Health Safety Agency) / Agence Française de Sécurité Sanitaire Environmentale (French Environmental Health Safety Agency)

In 2005 AFSSA/AFSSE conducted a human health risk assessment of fipronil[10]. The report concluded on the basis of modelling results for exposure scenarios compared to the most relevant toxicological reference values (i.e. acute, subacute and chronic NOEL's), and on the basis of other available data, that:

- The theoretical dietary exposure of the adult population to fipronil residues remains within the set safety limits, however, for young children there are cases where exposure scenarios exceed the ADI. The report emphasised that very few analyses of fipronil residues in food stuffs were available and analyses were mainly limited to uses requested within the framework of the European re-evaluation (maize and sunflower).
- The use of domestic biocidal products and plant protection products bearing the note "approved for use in gardens" presents an acceptable risk for an adult applier (with the exception of the "Special wasp and hornet Nests" product which should be reserved for professional use).
- Exposures linked to contact with animals treated with veterinary medicinal products containing fipronil present an acceptable risk. The report noted that safety margins were lowest for young children and therefore attention should be drawn to precautionary statements on domestic products addressing a possible risk to young children.
- Due to lack of available exposure data for farmers and pest control professionals, potential risk could not be evaluated.

[10] AFSSA/AFSSE (2005) Assessment of the risks to human health from exposure to fipronil. March 2005.

15 APPENDIX III – EXPOSURE MITIGATION MEASURES

ACTIVE INGREDIENT: Fipronil

Hazard classification

Fipronil is listed on the ASCC Hazardous Substances Information System *HSIS* (ASCC, 2005) with the following health effects risk phrases:

R23/24/25 Toxic by inhalation, in contact with skin and if swallowed

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

R20/21/22 Harmful by inhalation, in contact with skin and if swallowed.

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

The following cut-offs apply:

Conc>=25%: T; R23/24/25; R48/25

>=10% Conc <25%: T; R48/25; R20/21/22

>=3% Conc <10%: Xn; R20/21/22; R48/22

>=1% Conc <3%: Xn; R48/22

where T= toxic; Xn =harmful.

All SC, ULV, dry flowable (WG) and SA formulations of fipronil are determined to be hazardous substances based on the concentration of active ingredient.

The National Model Regulations and National Code of Practice (NOHSC, 1994a) 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.

Information provision

Labels

Active constituent label:

Technical grade fipronil 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, 1994b)

Product labels:

Labels of all fipronil products that have been determined hazardous must include a reference to the MSDS for further information.

Atmospheric monitoring

A NOHSC exposure standard has not been assigned to fipronil.

Material Safety Data Sheet

Manufacturers and importers should produce a Material Safety Data Sheet for fipronil products that have been determined to be hazardous. These should contain information relevant to Australian workers, as outlined in the NOHSC *National Code of Practice for the Preparation of Material Safety Data Sheets* (NOHSC, 1994c). Employers should obtain the Material Safety Data Sheets from the supplier and ensure that their employees have ready access to it.

NOHSC Exposure Standards

Not assigned

Health Surveillance Requirements

NOHSC has not placed the active constituent on the Schedule for Health Surveillance (Schedule 3; Hazardous Substances for which Health Surveillance is Required; NOHSC, 1994a).

Hazardous substances legislation

Fipronil and most of its products currently registered in Australia are determined to be hazardous substances. In accordance with Commonwealth/State/Territory Hazardous Substances legislation, the following control measures must be instituted, where applicable.

1. Induction and training - Appropriate induction and on-going training of all workers with the potential for exposure to fipronil products, in relation to those substances in the workplace and commensurate with the risk identified by the workplace assessment process.

It is recommended that appropriate training courses (eg. Farm Chemical User Course or recognised equivalent) be identified for all workers involved in the use of fipronil products.

2. Workplace assessment – A suitable and sufficient assessment of the risks to health created by work involving potential exposure to fipronil.

3. Control - As far as practicable, the prevention or adequate control of exposure of workers to hazardous substances should be secured by measures other than the provision of PPE. Control measures should be implemented in accordance with the hierarchy of controls.

It is preferable that the following engineering controls be adopted where possible:

(a) mixer/loaders:

Containers designed to minimise spillage, eg wide-neck or no-glug containers;

closed mixing/loading (mechanical transfer) systems, eg. closed filling/loading systems or dry coupling.

(b) applicators:

Use of closed cab tractors – inclusion of air-conditioning and pesticide filters will provide added protection as well as worker comfort.

(c) flaggers in aerial operations:

Use of closed cab vehicles.

It is recommended that industry-based standard operating procedures (including safe work practices) be developed, where appropriate.

Where PPE is used, it should be selected and used in accordance with the relevant Australian Standards. Protective equipment should be properly selected for the individual and task, be readily available, clean and functional, correctly used and maintained.

4. Record keeping – Records should be maintained in accordance with the NOHSC Control of Workplace Hazardous Substances (NOHSC, 1994a).