Proposed Special Review Decision PSRD2019-04

Special Review of Tetrachlorvinphos and Its Associated End-use Products

Consultation Document

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1.0 Introduction

Pursuant to subsection 17(1) of the *Pest Control Products Act*, Health Canada's Pest Management Regulatory Agency (PMRA) initiated a special review of tetrachlorvinphos (Canada, 2016) based on the toxicology information submitted under section 12 of the *Pest Control Products Act*, following the re-evaluation of tetrachlorvinphos (Canada, 2003; and Canada, 2004).

Pursuant to subsection 18(4) of the *Pest Control Products Act*, the PMRA has evaluated the aspects of concern that prompted the special review of pest control products containing tetrachlorvinphos. The aspects of concern for this special review are relevant to human health (potential occupational and residential risks).

2.0 Uses of Tetrachlorvinphos in Canada

Tetrachlorvinphos is a broad spectrum organophosphate insecticide registered for use on animals for food production (beef cattle, dairy cattle, poultry), companion animals (cats, dogs) and their bedding and living quarters, and in structures (for example, dairy barns, poultry houses, swine barns). All currently registered pest control products containing tetrachlorvinphos are considered in this special review (Appendix I).

3.0 Aspects of Concern that Prompted the Special Review

The PMRA reviewed toxicology information that was submitted under section 12 of the *Pest Control Products Act* (Appendix II) as well as re-examined the existing toxicological database for tetrachlorvinphos (Canada, 2004) in accordance with the current PMRA policies, including the application of the *Pest Control Products Act* factor (PCPA factor) (for more details refer to Appendix III). This resulted in revisions to the non-cancer reference values used in the human health risk assessment. The revised reference values may affect the existing occupational and residential assessments. Consequently, the following aspects of concern were identified for the special review under subsection 17(1) of the *Pest Control Products Act*:

- Potential occupational risk
- Potential residential risk

4.0 PMRA Evaluation of the Aspects of Concern that Prompted the Special Review

Following the initiation of the special review, the PMRA requested information related to the aspects of concern from provinces and other relevant federal government departments and agencies in accordance with subsection 18(2) of the *Pest Control Products Act*. No information was received.

In order to evaluate the aspects of concern for tetrachlorvinphos, the PMRA considered currently available relevant scientific information, which includes information submitted as part of the special review and under section 12 of the *Pest Control Products Act*, following re-evaluation of

tetrachlorvinphos (Appendix II), and information considered for its re-evaluation (Canada, 2003; and Canada, 2004). Information pertaining to the use pattern of commercial-class product received during the special review was considered in the assessment. The new exposure data for the pet collar use and other information received in the later phase of the special review will be considered along with other comments received during consultation of the proposed special review decision before making the final decision.

In addition, published information related to postapplication residential exposure was considered along with conducting the residential assessment as per current practices, which relies upon the 2012 United States Environmental Protection Agency (USEPA) Standard Operation Procedures (SOPs) for Residential Pesticide Exposure Assessments (USEPA, 2012).

4.1 Occupational Risks

Based on the current use pattern of tetrachlorvinphos, there is a potential for exposure for workers handling commercial and/or domestic-class pest control products containing tetrachlorvinphos and for workers entering treated sites or coming in contact with treated animals.

The PMRA estimates non-cancer risk by comparing an exposure estimate with the most relevant reference value from toxicology studies to calculate a margin of exposure (MOE). Route-specific and combined MOEs (for example, dermal and inhalation) were determined as applicable. This is compared to a target MOE incorporating uncertainty factors protective of the most sensitive subpopulation. If the calculated MOE is less than the target MOE, it does not necessarily mean that exposure will result in adverse effects, but mitigation measures to reduce risk would be required, if possible. If mitigation measures are not possible, the use can be proposed for cancellation.

For the cancer assessment, the lifetime average daily dose (LADD) was estimated and multiplied by the q_1^* (1.83×10^{-3} $(mg/kg/day)^{-1}$) (Appendix III) to obtain lifetime cancer risk estimates. For occupational workers, a lifetime cancer risk of less than 1×10^{-5} is considered acceptable by the PMRA.

Toxicological reference values for use in the human health risk assessment for tetrachlorvinphos are presented in Appendix III.

4.1.1 Dermal Absorption

The dermal absorption value for tetrachlorvinphos was re-assessed as part of the special review in accordance with current PMRA policies. The dermal absorption value of 22% was used for tetrachlorvinphos based on an in vivo rat dermal absorption study (for more details refer to Appendix IV).

4.1.2 Occupational Mixer/Loader and Applicator Exposure and Risk

Commercial applicators or workers can be exposed to tetrachlorvinphos while mixing, loading, and applying the commercial-class product formulated as a wettable powder to livestock housing (for example, dairy barns, poultry houses, and swine barns) and poultry, and while applying the commercial-class product formulated as an ear tag to cattle.

Typically, it is assumed that commercial applicators or workers would not be using domestic-class products. However, for tetrachlorvinphos, since there are no commercial-class products registered for application to pets or pet bedding, it was assumed that workers would be using domestic-class products (for example, in veterinary clinics).

Based on the current use pattern for tetrachlorvinphos, potential exposure scenarios include:

- Mixing/loading of wettable powders.
- Mixing/loading of wettable powder and applying with handheld sprayer equipment.
- Applying wettable powder with dusting equipment.
- Applying paint with paintbrush or airless sprayer.
- Applying ear tags to cattle.
- Applying domestic-class powder/dust product to pets and pet bedding.
- Applying domestic-class trigger spray product to pets.
- Applying domestic-class pet collars.

Commercial applicators or workers may use tetrachlorvinphos for short to extended periods of time from spring to fall to manage insect pressures. Therefore, mixer/loaders and applicators have the potential for short- to intermediate-term exposure (via dermal and inhalation routes) to tetrachlorvinphos.

For the following scenarios, exposure was assessed using chemical-specific mixer/loader and/or applicator exposure studies (for more details refer to Appendix IV):

- Mixing, loading, and applying wettable powder product with a mechanically pressurized handgun.
- Application of domestic-class powder/dust product to pets and pet bedding.
- Application of domestic-class pet collars.

For the remaining scenarios, dermal and inhalation exposures were estimated using data from the Pesticide Handlers Exposure Database (PHED). In addition, the USEPA 2012 Residential SOPs (sections 7 and 8) were used to assess scenarios including trigger spray applications to pets and dust/powder application on poultry and in livestock housing.

The PMRA derived exposure estimates for workers assuming the following personal protective equipment (PPE):

- Direct wettable powder application: Single layer and chemical-resistant gloves for mixers/loaders. Short-sleeved shirt and short pants for applicators.

- Spray applications with backpack and mechanically-pressurized handgun (MPHG): Coveralls over a single layer clothing, chemical-resistant gloves, and respirator for mixers/loaders and applicators.

- Paint applications with brush or sprayer: Single layer clothing and chemical-resistant gloves for mixers/loaders and applicators.

- Application of domestic-class products: Short-sleeved shirt and short pants for applicators.

A 90% protection factor was applied to inhalation exposure estimates when a respirator is specified on the label. A 75% protection factor was applied to PHED dermal exposure estimates for the body when coveralls over a single layer are specified on the label.

Dermal and inhalation exposures were combined because these exposures occur simultaneously and they have the same toxicology reference value.

Commercial-Class Products

Potential exposure of workers from ear tag application is expected to be relatively low in consideration of the low frequency of application, design of the product (as a slow release of tetrachlorvinphos), and the current label requirements to wear chemical-resistant gloves during application. Thus, mixer/loader and applicator risks are considered to be acceptable for ear tag use.

For workers mixing, loading, and applying the commercial wettable powder product, the risk assessment is presented in Appendix V, Table 1.

For the following uses on the commercial wettable powder label, potential non-cancer and cancer risks (MOEs greater than the target MOE of 300 and cancer risks less than $1x10^{-5}$) are considered to be acceptable:

- Handheld spray application to poultry.

- Roost paint application to treat lice, mites, and lesser meal-worms.

- Handheld spray application for poultry house floor management to treat lice, mites, and lesser meal-worms.

- Handheld spray application to poultry droppings, manure piles, garbage piles, and under feed troughs to treat maggots.

- Handheld spray application to livestock housing (1% and 2% dilution). The combined MOE for the 2% dilution was just below the target MOE of 300 at 267. This MOE is considered acceptable when considering conservatisms (that is, assumptions which may result in upper bound risk estimates) in the assessment, such as the use of maximum application rates.

In addition, revised PPE statements and additional precautionary statements are proposed for the current wettable powder end-use product label in order to ensure consistency, improve clarity, and to meet current labelling standards. For more details refer to Appendix VIII.

For the following uses, potential occupational risks are not considered to be acceptable:

- Direct wettable powder applications to poultry and poultry facilities - both non-cancer (MOEs 1-17, target MOE of 300) and cancer risks (exceeding 1×10^{-5}) are not considered to be acceptable. The registrant submitted additional information for commercial dust uses at the later phase of this special review. The information along with other comments received during consultation of this proposed special review decision will be considered before making the final decision.

- Handheld spray application to poultry housing walls, ceilings, floor cracks and crevices for fowl ticks - the cancer risk is considered to be acceptable but the non-cancer risk (MOE=107, target MOE of 300) is not considered to be acceptable.

Based on the above, the PMRA proposes cancellation of the following commercial uses of tetrachlorvinphos:

- Direct wettable powder (duster) applications to poultry and poultry facilities.

- Handheld spray application to treat fowl ticks in poultry housing.

Domestic-Class Products

The risk assessment for commercial applicators handling domestic-class products is presented in Appendix V, Table 2.

- **Applying ready-to-use powder/dust product to pets and pet bedding.** For commercial applicators handling ready-to-use powder/dust domestic-class products, the cancer risks are considered acceptable; however, the non-cancer risks (MOE=52–74, target MOE of 300) are not considered to be acceptable under current conditions of use.

- **Applying ready-to-use liquid (trigger spray) to pets.** For commercial applicators handling liquid (trigger spray) products, the cancer risk is considered to be acceptable; however, the non-cancer risk (MOE=88, target MOE of 300) is not considered acceptable under current conditions of use.

- **Applying ready-to-use pet collar products.** For commercial applicators handling pet collars, the cancer risk is considered to be acceptable; however, the non-cancer risk (MOE=58, target MOE of 300) is not considered to be acceptable under current conditions of use.

For trigger spray products, non-cancer risks could be mitigated with the use of lower application rates and implementation of additional spray instructions for different size dogs and cats. These rates and label directions would be similar to what is on the current American labels. For more details on the proposed mitigation measures for domestic-class products refer to Section 4.2.3.

Mitigation measures for powder/dust and pet collar products are limited, thus all domestic-class powder/dust products and pet collars are proposed for cancellation.

4.1.3 Occupational Postapplication Exposure and Risk

There is potential for exposure of workers entering livestock housing or coming in contact with animals treated with tetrachlorvinphos. Possible occupational postapplication exposure scenarios include:

- Commercial applicator or pest control operator returning to treated commercial or residential sites for scouting or to conduct other activities,
- Workers entering animal buildings to conduct typical activities (for example, milking, feeding),
- Workers handling treated pets or cleaning pet bedding areas.

Postapplication Risks Following Application of Commercial-class Products

For workers exposed to tetrachlorvinphos residues following application of commercial-class products (wettable powder and ear tag), the postapplication dermal and inhalation exposure from contact with treated surfaces or animals is expected to be low given the nature of activities that are performed in livestock facilities and the chemical properties of tetrachlorvinphos (for example, vapour pressure). Based on this, potential postapplication risks for these workers are considered to be acceptable under current conditions of use.

To further reduce the potential for exposure of postapplication workers, a precautionary label statement to not enter or allow entry into treated areas until sprays have dried, is also proposed to be included on the commercial-class wettable powder product label.

Postapplication Risks Following Application of Domestic-class Products

For workers exposed to tetrachlorvinphos residues following application of domestic-class products, potential postapplication exposure and risk are addressed in the assessment for the residential individuals (Section 4.2.2).

Based on results of the residential postapplication exposure and risk assessment (Section 4.2.2), postapplication dermal risks (non-cancer and cancer) to adults following application of domestic-class powder/dust, liquid, and pet collar products are not considered to be acceptable under current conditions of use.

For liquid (trigger spray) products, postapplication dermal risks (non-cancer and cancer) can be mitigated with the use of lower applications rates and additional spray instructions for different size dogs and cats. A precautionary statement, to avoid contact with the treated animal prior to residues drying, is also proposed on the liquid product label to further reduce the potential for exposure. The remaining domestic-class products (powder/dust and pet collar products) are proposed for cancellation.

For details on the proposed mitigation measures for domestic-class liquid products refer to Section 4.2.3.

4.1.4 Overall Occupational Risk Conclusions and Proposed Mitigation Measures

1) Potential occupational risk is considered to be acceptable for the following uses:

Commercial-class ear tag product:

- Cattle

Commercial-class wettable powder product:

- Roost paint application to treat lice, mites, and lesser mealworms.
- Handheld spray application to poultry.
- Handheld spray application to poultry house floor management to treat lice, mites, and lesser meal-worms.
- Handheld spray application to poultry droppings, manure piles, garbage piles, and under feed troughs to treat maggots.
- Handheld spray application to livestock housing (1% and 2% dilution).

In addition, revised PPE statements and additional precautionary statements are proposed for the current wettable powder end-use product label in order to ensure consistency, improve clarity, and to meet current labelling standards. For more details refer to Appendix VIII.

2) Potential occupational risk is considered acceptable with additional risk reduction measures (for example, additional application instructions) for the following tetrachlorvinphos uses:

Domestic-class liquid (trigger spray) products:

- Flea and tick spray for dogs and cats.

For details on the proposed mitigation measures for domestic-class liquid products refer to Section 4.2.3.

3) Potential occupational risk is not considered acceptable for the following tetrachlorvinphos uses and, therefore, these uses are proposed for cancellation:

Commercial-class wettable powder product

- Direct wettable powder/dust application to poultry and poultry facilities.
- Handheld spray application to poultry housing walls, ceilings, floor cracks and crevices to treat fowl ticks.

Domestic-class powder/dust product:

- Applications to pet bedding and to pets.

Domestic-class pet collar products

- Applications to pets.

The proposed label amendments are summarized in Appendix VIII.

Additional information was submitted by registrants at the later phase of the special review, and will be considered along with other comments received during consultation of this proposed special review decision before making the final decision.

4.2 Residential Risk

The general population can be exposed to tetrachlorvinphos while applying domestic-class products (residential applicators) and/or when coming in contact with residues on treated surfaces or pets (postapplication exposure of adults and children).

Commercial-class products containing tetrachlorvinphos are not expected to be used in residential areas. A standard precautionary label statement prohibiting the use of the commercial-class wettable powder in residential areas is proposed to be added to the product label.

The USEPA has generated standard default assumptions for developing residential exposure assessments for both applicator and postapplication exposures when chemical- and/or site-specific field data are limited. The assumptions and algorithms may be used in the absence of, or as a supplement to, chemical- and/or site-specific data and generally result in high-end estimates of exposure. The assumptions and algorithms relevant to the tetrachlorvinphos re-evaluation are outlined in the USEPA Residential SOPs (USEPA, 2012) in the following sections:

- Section 7: Indoor Environments
- Section 8: Treated Pets

4.2.1 Residential Applicator Exposure and Risk

A residential applicator is an individual (≥16 years old) who applies a domestic-class tetrachlorvinphos product in and around the home or directly to pets. Residential applicators are assumed to be wearing shorts, short-sleeved shirts, shoes, and socks during application. The residential applicator has the potential for short to intermediate term exposure (1–180 days) when applying products containing tetrachlorvinphos.

Based on typical use patterns, the representative exposure scenarios identified were:

- Applying ready-to-use powder/dust products to pet bedding.
- Applying ready-to-use powder/dust, trigger spray, and pet collar products to pets.

Potential exposure was estimated using a combination of chemical-specific studies (for more details refer to Appendix IV) and the USEPA 2012 Residential SOPs. The potential risks were estimated using toxicology reference values summarized in Appendix III. For the non-cancer assessment, the route-specific and combined dermal and inhalation MOEs greater than 300 are considered acceptable. For the general population, a lifetime cancer risk below 1×10^{-6} is considered by the PMRA as an acceptable risk.

The risk assessment for residential applicators is summarized in Appendix VI, Table 1.

- **Applying ready-to-use powder/dust products to pets and pet bedding:** For residential applicators handling dust/powder products, the cancer risks are considered to be acceptable for both pet and pet bedding uses. The non-cancer risk is considered to be acceptable under current conditions of use for the pet use but not for the pet bedding use (MOE = 209, target MOE of 300).
- **Applying ready-to-use liquid (trigger spray) to pets.** For the residential applicators applying liquid (trigger spray) products to pets, both cancer and non-cancer risks are considered to be acceptable under current conditions of use.
- **Applying ready-to-use pet collar products.** For residential applicator handling pet collars, the cancer risk is considered acceptable; however, the non-cancer risk (MOE = 232, target MOE of 300) is not considered to be acceptable under current conditions of use.

Based on the currently considered information, no additional risk reduction measures were identified to mitigate potential non-cancer risks for residential applicators of domestic-class powder/dust (pet bedding treatment) and pet collar products. Consequently, the PMRA proposes to cancel these two uses.

4.2.2 Residential Postapplication Exposure and Risk Assessment

Postapplication exposure can occur when an individual is exposed through dermal and/or incidental oral (non-dietary ingestion) routes as a result of being in a residential environment or contacting a pet that has been treated with a pesticide. The area or animal could have been treated by a residential or commercial applicator using a domestic-class tetrachlorvinphos product.

The following residential postapplication scenarios were assessed for domestic-class products containing tetrachlorvinphos:

- Adults, youth, and children (1<2 years old) dermal exposure from contact with treated pet bedding.
- Children (1<2 years old) incidental oral exposure from contact with treated pet bedding
- Adult, youth, and children (1<2 years old) dermal exposure from contact with treated pets.
- Children (1<2 years old) incidental oral exposure from contact with treated pets.

Short- to intermediate-term postapplication exposure is expected from powder/dust and trigger spray use scenarios. Intermediate- to long-term exposure may occur for pet collar use, as collars may be active and worn for several months at a time. For the non-cancer assessment, a single assessment was conducted to reflect all durations of exposure, as the toxicological reference value is the same for all exposure durations and routes.

The residential postapplication dermal exposure and risk assessment also addresses potential postapplication exposure of workers following application of domestic-class products.

Postapplication dermal exposure was calculated using activity-specific transfer coefficients, estimates for fur or surface residue, dislodgeable residue (residue transfer to skin) and exposure time. A transfer coefficient (TC) is a factor that relates exposure to dislodgeable residue and the amount of treated surface that a person contacts while performing activities in a given period (usually expressed in units of cm^2 per hour). It is specific to a particular population and activity (for example, children contacting treated pets).

Based on the information in the USEPA Assessment for tetrachlorvinphos (USEPA, 2016), both the solid and liquid TCs were used to assess postapplication exposure and risk for individuals handling pet collar products. It is unclear whether residues resulting from the flea collar use would be a fine powder or a liquid. The PMRA has requested additional information on the formulation type for pet collars. This information was submitted at the later phase of this special review and will be considered along with other comments received during the consultation of this proposed special review decision before making the final decision.

Incidental oral exposure occurs when pesticide residues are transferred to the hands of children playing on treated indoor surfaces or with treated pets, and are subsequently ingested as a result of hand-to-mouth (HtM) transfer. Residues can also be transferred to objects in treated areas (for example, a child's toy) and subsequently ingested as a result of object-to-mouth transfer.

In terms of inhalation risk, the USEPA Residential SOPs specify that inhalation risks be considered on a case-by-case basis, taking into consideration the vapour pressure and the use pattern. The combination of the low vapour pressure for tetrachlorvinphos, the type of domestic-class products registered (trigger spray, dust can, or pet collar), and the relatively small amount of pesticide applied is expected to result in negligible inhalation exposure.

Potential postapplication dermal and incidental oral exposure was assessed using chemical-specific exposure studies (for more details refer to Appendix IV) in combination with the USEPA Residential SOPs. The residential postapplication non-cancer and cancer exposure and risk estimates are presented in Appendix VI (Tables 2–9).

- **Powder/dust products:** The non-cancer and cancer dermal risks from contact with treated pets and pet bedding are not considered to be acceptable (Appendix VI, Tables 2–5). The non-cancer and cancer incidental oral risks are considered to be acceptable (Appendix VI, Tables 6–9) for all scenarios except for pet bedding use where the MOE was below the target of 300.

- **Pet collar products:** The non-cancer and cancer dermal risks from contact with treated pets are not considered to be acceptable (Appendix VI, Tables 4 and 5). In addition, the non-cancer and cancer incidental oral risks are not considered to be acceptable (Appendix VI, Tables 8 and 9).

- **Liquid (trigger spray) products:** With additional mitigation measures (additional application instructions for spray strokes to different size cats and dogs), non-cancer and cancer dermal risks from contact with treated pets are considered to be acceptable (Appendix VI, Tables 4 and 5). Under the revised conditions of use, the dermal MOEs for trigger spray products are greater than the target MOE of 300 for all scenarios, except for children contacting small cats (MOE=260). However, the MOE of 260 is considered to be acceptable given the conservatism in the assessment (for example, the use of the 22% dermal absorption factor). A precautionary statement, to avoid contact with the treated animal prior to residues drying, is also proposed on the liquid product label to further reduce exposure. The non-cancer and cancer incidental oral risks are also considered to be acceptable for liquid (trigger spray) under the revised conditions of use (Appendix VI, Tables 8 and 9).

Based on the results of the postapplication residential risk assessment, the PMRA proposes:

- Cancellation of all domestic-class powder/dust products.

- Cancellation of all domestic-class pet collar products.

- Additional mitigation measures for liquid (trigger spray) products. Refer to Section 4.2.3 for the proposed mitigation measures.

4.2.3 Overall Residential Risk Conclusions and Proposed Mitigation Measures

1) With additional risk reduction measures, potential residential risk is considered to be acceptable for the following tetrachlorvinphos uses:

- Domestic-class flea and tick liquid (trigger spray) products.

The proposed mitigation measures for domestic-class liquid (trigger spray) products include additional instructions for spray strokes to different size cats and dogs. Additional details on the size of cats and dogs may be added to the label instructions following consultation:

- Cat Products: Spray 15–25 strokes for a small cat, spray 25–35 strokes for a medium or large cat.

- Dog Products: Spray 25–35 strokes for small dogs. Spray 30–40 strokes for a medium dog. Spray 40–70 strokes for a large dog.

A precautionary label statement to avoid contact with the treated animal prior to residues drying is also proposed to further reduce the potential for exposure.

2) Under the current conditions of use, potential residential risk is not considered acceptable for the following tetrachlorvinphos products and, therefore, these products are proposed for cancellation:

- Domestic-class flea and tick powder/dust products.

- Domestic-class flea and tick pet collar products.

The proposed label amendments are summarized in Appendix VIII.

Additional information submitted at the later phase of this special review for the pet collar use will be considered along with other comments received during consultation of this proposed special review decision before making the final decision.

4.3 Aggregate Risk

Aggregate exposure is the total exposure to a single pesticide that may occur from food, drinking water, residential, and other non-occupational sources, and from all known or plausible exposure routes (oral, dermal, and inhalation).

For tetrachlorvinphos, the aggregate exposure and risk assessment was conducted for domestic-class liquid (trigger-spray) products. This scenario is the only residential use where application and postapplication exposure risks to the general public were considered to be acceptable with the proposed risk mitigation measures.

The following activities for the trigger spray use have the potential for co-occurrence:

Adults:

- Residential applicator dermal and inhalation + postapplication pets dermal + chronic dietary.

Youth 6 to <11 years:

- Postapplication pets dermal + chronic dietary.

Children 1 to <2 years:

- Postapplication pets dermal + postapplication pets incidental oral + chronic dietary.

The results of the aggregate assessment are presented in Appendix VII (Tables 1 and 2).

For liquid (trigger-spray) products, aggregate cancer risks to adults and children are considered to be acceptable with the proposed mitigation measures specified above (Section 4.2.3). Aggregate non-cancer risks for spray trigger products were greater than the target MOE of 300 for most scenarios and therefore, risks are considered to be acceptable. There was one scenario where MOEs were less than 300 for children contacting small cats at the MOE of 260. The MOE of 260 is considered acceptable due to conservatisms in the assessment such as the use of the 22% dermal absorption factor.

4.4 Cumulative Assessment

Tetrachlorvinphos belongs to a group of chemicals classified as organophosphates. Organophosphates have a common mechanism of toxicity wherein they all possess the ability to interact with the cholinesterase enzyme ultimately leading to neurotoxicity. A cumulative assessment will be undertaken upon completion of the re-evaluation of the individual chemicals in the organophosphate group with all relevant chemicals and scenarios of the common mechanism group.

5.0 Incident Reports

The PMRA incident reporting database was searched for human incident reports related to the identified aspects of concern for tetrachlorvinphos.

As of 2 October 2018, the PMRA has received 14 incidents (12 in Canada and 2 in the United States) where individuals were exposed to the active ingredient tetrachlorvinphos in a residential setting, and the signs reported were considered to be at least possibly related to exposure. Individuals (9 adults and 5 children) were exposed either during application, through contact with the treated pet, or from product misuse. Most individuals reported minor signs, including headache, nausea, vomiting, skin irritation, and eye irritation. Overall, given the low severity and frequency of tetrachlorvinphos incidents, no additional mitigation measures specific to health are proposed as a result of the incident reports.

6.0 Proposed Special Review Decision for Tetrachlorvinphos

Evaluation of available scientific information related to the aspects of concern, indicated that the potential risk to human health is considered to be acceptable for the following registered products containing tetrachlorvinphos with the proposed additional mitigation measures (Appendix VIII). On this basis, the PMRA is proposing to confirm the current registration for the following products containing tetrachlorvinphos for sale and use in Canada with the proposed risk mitigation measures pursuant to subsection 21(1) of the *Pest Control Product Act*:

Commercial-Class

- Ear tag product
- Wettable power product
- Roost paint application to treat lice, mites, and lesser mealworms.
    - Handheld spray application to poultry.
    - Handheld spray application to poultry house floor management to treat lice, mites, and lesser meal-worms.
    - Handheld spray application to poultry droppings, manure piles, garbage piles, and under feed troughs to treat maggots.
    - Handheld spray application to livestock premises (1% and 2% dilution).

Domestic-Class

- Flea and tick liquid (trigger spray) products

Assessment indicated that the potential risk to human health for the following uses of tetrachlorvinphos is not considered to be acceptable, and they are proposed for cancellation:

Commercial-Class

- Wettable powder product.
    - Direct application as a wettable powder or dust to poultry and poultry facilities.
    - Handheld spray application to poultry housing walls, ceilings, floor cracks and crevices to treat fowl ticks.

Domestic-Class

- All flea and tick powder/dust products.
- All flea and tick pet collar products.

This proposed special review decision is a consultation document.[1] The PMRA will accept written comments on this proposal up to 45 days from the date of publication of this document. Please forward all comments to Publications (please see contact information on the cover page of this document).

7.0 Next Steps

Before making a special review decision on tetrachlorvinphos, the PMRA will consider all comments received from the public in response to this consultation document. A science-based approach will be applied in making a final decision on tetrachlorvinphos. The PMRA will then publish a special review decision document, which will include the decision, the reasons for it, a summary of the comments received on the proposed decision, and the PMRA's response to these comments.

[1] "Consultation statement" as required by subsection 28(2) of the *Pest Control Products Act*

Appendix I Registered Products Containing Tetrachlorvinphos as of 28 January 2018

Registration Number	Marketing Class	Registrant	Product Name	Formulation Type	Guarantee
23019	Technical active	Hartz Mountain Corporation	Hartz Rabon Technical Insecticide (Tetrachlorvinphos)	solid	98.7%
25338	Technical active	Bayer Inc.	Technical Rabon Insecticide	dust or powder	98.7%
17415	Commercial	Bayer Inc.	Debantic 50 WP Insecticide Poultry And Livestock Premises Spray	wettable powder	50%
22880	Commercial	Bayer Inc.	Ectogard Insecticide Cattle Ear Tag	solid	14%
13266	Domestic	Hartz Canada Inc.	Hartz Incontrol Flea & Tick Collar For Cats	slow-release generator	14.55%
16673	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea & Tick Powder For Dogs	dust or powder	3.3%
17959	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea & Tick Powder For Cats	dust or powder	3.3%
18108	Domestic	Hartz Canada Inc.	Hartz Incontrol Flea & Tick Collar For Dogs	slow-release generator	14.55%
25381	Domestic	Hartz Canada Inc.	Hartz Ultraguard Plus Flea & Tick Collar For Cats & Kittens	slow-release generator	14.55%
25382	Domestic	Hartz Canada Inc.	Hartz Ultraguard Plus Flea & Tick Collar For Dogs & Puppies	slow-release generator	14.55%
25499	Domestic	Hartz Canada Inc.	Hartz Control Pet Care System Ultimate Flea Collar For Puppies	slow-release generator	14.55%
25620	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea & Tick Collar For Dogs	slow-release generator	14.55%
25621	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea & Tick Collar For Cats & Kittens	slow-release generator	14.55%
25654	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea & Tick Spray For Dogs	solution	1.08%
25655	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea & Tick Spray For Cats	solution	1.08%
28355	Domestic	Hartz Canada Inc.	Hartz Ultraguard Reflective Flea & Tick Collar For Dogs & Puppies	slow-release generator	14.55%
28356	Domestic	Hartz Canada Inc.	Hartz Ultraguard Reflective Flea & Tick Collar For Cats & Kittens	slow-release generator	14.55%
29475	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea & Tick Collar For Large Dogs	slow-release generator	14.55%
29476	Domestic	Hartz Canada Inc.	Hartz Ultraguard Flea And Tick Collar For Puppies	slow-release generator	14.55%
29720	Domestic	Hartz Canada Inc.	Hartz Ultraguard Plus Flea & Tick Collar For Dogs And Puppies With Reflect-X Shield	slow-release generator	14.55%
29721	Domestic	Hartz Canada Inc.	Hartz Ultraguard Plus Flea & Tick Collar For Cats And Kittens With Reflect-X Shield	slow-release generator	14.55%
30181	Domestic	Hartz Canada Inc.	Hartz Ultraguard Plus Flea & Tick Spray For Dogs With Aloe	solution	1.08%

Registration Number	Marketing Class	Registrant	Product Name	Formulation Type	Guarantee
31439	Domestic	Wellmark International	Vet-Kem Breakaway Flea & Tick Collar For Cats & Kittens	slow-release generator	14.55%
31440	Domestic	Wellmark International	Vet-Kem Flea & Tick Collar For Dogs	slow-release generator	14.55%
31441	Domestic	Wellmark International	Vet-Kem Ovitrol Breakaway Dual Action Flea & Tick Collar For Cats & Kittens	slow-release generator	14.55%
31443	Domestic	Wellmark International	Vet-Kem Ovitrol Dual Action Flea & Tick Collar For Dogs & Puppies	slow-release generator	14.55%
31444	Domestic	Wellmark International	Zodiac Breakaway Flea & Tick Collar For Cats & Kittens	slow-release generator	14.55%
31445	Domestic	Wellmark International	Zodiac Flea & Tick Collar For Dogs	slow-release generator	14.55%
31446	Domestic	Wellmark International	Zodiac Power Band Plus Breakaway Dual Action Flea & Tick Collar For Cats & Kittens	slow-release generator	14.55%
31473	Domestic	Wellmark International	Zodiac Power Band Plus II Dual Action Flea & Tick Collar For Dogs & Puppies	slow-release generator	14.55%

Appendix II Studies Submitted by the Registrant under Section 12 of the *Pest Control Products Act*

Applicant Supplied – Unpublished

PMRA No.	Reference
1444814	2005, Oral (Gavage) Development Neurotoxicity Study of Tetrachlorvinphos in Crl:CD (SD)IGS BR VAF/Plus Rats, DACO: 4.5.14 CBI
1921306	2005, 1608-003 PA Individual Tables, DACO: 4.5.14
1921307	2005, 1608-003 Watermaze Individual Tables, DACO: 4.5.14
1921308	2005, Adult Individual and Summary Historical Control Brain Weight Data, DACO: 4.5.14
1921309	2005, PND21 Individual and Summary Historical Control Brain Weight Data, DACO: 4.5.14
1985450	2005, Testing Laboratory Positive Control Data, DACO: 4.5.14
1986599	2009, Oral (Gavage) Maternal and Fetal Exposure Study of TVCP in Rats, DACO: 4.5.14
1986602	2009, Oral (Gavage) Acute Relative Sensitivity Study of TCVP in Neonatal and Adult Rats, DACO: 4.5.14

Appendix III Revised Toxicology Assessment for Tetrachlorvinphos

A detailed review of the toxicological database for tetrachlorvinphos was previously conducted (Canada, 2003). As a result of the re-evaluation decision (Canada, 2004), toxicological data were required to support continued registration of tetrachlorvinphos. A developmental neurotoxicity study and/or a comparative cholinesterase assay were required. The registrant submitted the required studies and this information was reviewed as set out below. Health Canada re-assessed the toxicological reference values taking into account the submitted information.

Summary of Section 12 Data

In a study comparing maternal and fetal cholinesterase activity following administration of tetrachlorvinphos via gavage to pregnant female rats there was no indication of fetal sensitivity.

Brain cholinesterase (BChE) activity was inhibited at all dose levels in the dams and fetuses with dams showing a higher level of inhibition. Plasma cholinesterase (PChE) activity was affected at all dose levels in dams and fetuses while erythrocyte cholinesterase (EChE) activity data was judged to be unreliable. Effects on maternal body weight and food consumption were noted at levels higher than that producing cholinesterase inhibition.

An acute oral comparative cholinesterase study assessing neonatal and adult rats was considered supplemental due to numerous limitations. Separate analyses for time to peak effect and dose response were not undertaken. High levels of variability in the measures of BChE and EChE precluded reliable determination of the time to peak effect in young animals. Other limitations included the use of animals from three different breeding sources, low sample sizes due to censoring of data for lack of reproducibility, differences in pre-dose values between control and treated groups and poor dose response in cholinesterase measures. While the magnitude of effect is consistently large enough to demonstrate a treatment-related effect on BChE at the lowest dose tested in all ages, the main goal of addressing age sensitivity was not achieved based on the quality of the data.

In a developmental neurotoxicity (DNT) study in rats conducted via gavage, maternal effects were limited to a non-adverse reduction in feed consumption values at the highest dose from days 7 to 11 of lactation. Mortality in the directly-dosed offspring occurred in a dosage-dependent manner and was considered treatment-related at the high dose; mortality at the mid-dose was considered to be equivocally-related to treatment. There was also an increase in pup mortality prior to the period of direct dosing (PND 0-4) in the high-dose group. Pup body weight was affected periodically during treatment with the high dose and resulted in decreased body weight gain over the period of treatment.

The learning and memory tests in the offspring produced different results; passive avoidance testing did not show any treatment-related effects whereas the M-water maze test showed effects at the mid- and high-doses. These effects were manifested as increases in errors and patterns of errors, trending to larger numbers of trials to criterion and increased variability.

Morphometric measurements of the brain were affected in the high-dose group in both the PND 22 and PND 70 offspring and the affected areas included the frontal cortex (females only), striatum, corpus callosum, hippocampus and cerebellum. These morphometric changes were

accompanied with decreases in brain weight in the high-dose offspring. In PND 70 offspring, morphometric changes were also observed in the corpus callosum and hippocampus at the mid-dose and were considered treatment-related as they progressed to a more pronounced state of regress at the high dose.

The new toxicological studies for tetrachlorvinphos are outlined in Table 1. The toxicological reference values for use in the human health risk assessment are summarized in Table 2.

Pest Control Products Act Hazard Characterization

For assessing risks from potential residues in food or from products used in or around homes or schools, the *Pest Control Products Act* requires the application of an additional 10-fold factor to take into account completeness of the data with respect to the exposure of, and toxicity to, infants and children, as well as potential pre- and post-natal toxicity. A different factor may be determined to be appropriate on the basis of reliable scientific data. The toxicology assessment in the original re-evaluation pre-dated the application of the PCPA factor; accordingly, the PCPA factor has now been incorporated in the current assessment to reflect modern standards.

With respect to the completeness of the toxicity database, the database contains the standard complement of required studies, including developmental toxicity studies in both the rat and rabbit, as well as a two-generation reproduction study in rats. A DNT study in rats examining brain morphometry and impacts on neurological behaviour, as well as a study measuring cholinesterase activity in maternal animals and fetuses were available. A comparative cholinesterase study was submitted but was deemed to be of little value as study limitations precluded an assessment of age-related sensitivity. A replacement comparative cholinesterase study will not be required at this time as it is not expected that such a study would impact the revised reference values outlined in this document.

Oral developmental and reproductive toxicity studies indicate no increased sensitivity of the developing young relative to maternal animals due to either pre- or post- natal exposure to tetrachlorvinphos. A gavage developmental toxicity study conducted in the rabbit did demonstrate effects in the form of increased resorptions, increased post-implantation loss, and a decrease in the number of live fetuses per dam; however, these effects occurred at a dose level which resulted in significant maternal toxicity.

The maternal/fetal cholinesterase study did not indicate that fetuses were more sensitive than their pregnant mothers to cholinesterase inhibition. In the DNT study, treatment-related changes in brain morphometry, decreases in brain weight and effects observed in learning and memory parameters study were considered serious endpoints of concern. These observations occurred at dose levels producing no evidence of maternal toxicity; however cholinesterase activity was not measured in this study. Effects on cholinesterase activity in the maternal animals can be inferred from the maternal and fetal cholinesterase study; the point of departure for cholinesterase inhibition in the maternal animal from this study occurred below the offspring LOAEL of the DNT study. As such it is believed that the studies do not demonstrate sensitivity of the younger population.

With regards to the PCPA factor, the toxicity data are considered complete however the developmental neurotoxicity is considered a serious endpoint. As this finding is tempered by the presence of maternal toxicity (inferred), the PCPA factor can be reduced to threefold.

Determination of Acute Reference Dose (ARfD)

To estimate acute dietary risk, the NOAEL of 10 mg/kg bw/day from the rat DNT study was selected. Changes in brain morphometrics as well as learning and memory parameters were noted at the LOAEL of 50 mg/kg bw/day. Standard uncertainty factors of 10-fold for inter-species extrapolation and 10-fold for intra-species variability were applied. The PCPA factor was reduced to threefold based on the rationale provided in the *Pest Control Products Act* Hazard Characterization Section. Thus, the composite assessment factor (CAF) is 300.

$$\text{ARfD} = \frac{\text{NOAEL}}{\text{CAF}} = \frac{10 \text{ mg/kg bw}}{300} = 0.03 \text{ mg/kg bw}$$

This replaces the previous ARfD of 0.067 mg/kg bw which was based on EChE inhibition, reduced weight gain, and effects on the liver, kidney, thyroid and adrenals in adult rats from a 90-day dietary toxicity study. The ARfD is considered protective of all populations including infants and children.

Determination of Acceptable Daily Intake (ADI)

To estimate risk from repeated dietary exposure the NOAEL of 10 mg/kg bw/day from the rat DNT study was selected. Changes in brain morphometrics as well as learning and memory parameters were noted at the LOAEL of 50 mg/kg bw/day. Standard uncertainty factors of 10-fold for inter-species extrapolation and 10-fold for intra-species variability were applied. The PCPA factor was reduced to threefold based on the rationale provided in the *Pest Control Products Act* Hazard Characterization section. Thus, the CAF is 300.

$$\text{ADI} = \frac{\text{NOAEL}}{\text{CAF}} = \frac{10 \text{ mg/kg bw/day}}{300} = 0.03 \text{ mg/kg bw/day}$$

This replaces the previous ADI of 0.042 mg/kg bw which was based on effects on the liver and adrenal gland in rats from a 104-week chronic study. The ADI is considered protective of all populations including infants and children.

Dermal and Inhalation Exposure (All Durations)

For exposure via the dermal or inhalation route (all durations), no adequate route-specific studies were available. The NOAEL of 10 mg/kg bw/day from the oral DNT study in the rat was selected for risk assessment. Changes in brain morphometrics as well as learning and memory were noted at the LOAEL of 50 mg/kg bw/day. For residential scenarios, a target margin of exposure (MOE) of 300 was derived which includes uncertainty factors of 10-fold for interspecies extrapolation, 10-fold for intraspecies variability and a threefold PCPA factor (as outlined in the *Pest Control Products Act* Hazard Characterization section).

For occupational exposure scenarios, the target MOE of 300 includes uncertainty factors of 10-fold for interspecies extrapolation, 10-fold for intraspecies variability and a threefold factor for the seriousness of the endpoint. This reference value is considered protective of all populations.

This replaces the previous value of 6.7 mg/kg bw/day, which was based on ↓EChE, ↓weight gain, effects on the liver, kidney, thyroid and adrenals in adult rats from a 90-day dietary toxicity study, and target MOE of 100.

Non-dietary Oral Exposure

For residential scenarios, the NOAEL of 10 mg/kg bw/day from the oral DNT study in the rat was selected for risk-assessment. Changes in brain morphometrics as well as learning and memory were noted at the LOAEL of 50 mg/kg bw/day. A target MOE of 300 was derived which includes uncertainty factors of 10-fold for interspecies extrapolation, 10-fold for intraspecies variability and a threefold PCPA factor (as outlined in the *Pest Control Products Act* Hazard Characterization Section).

This replaces the previous value of 6.7 mg/kg bw/day, which was based on ↓EChE, ↓weight gain, effects on the liver, kidney, thyroid and adrenals in adult rats from a 90-day dietary toxicity study, and target MOE of 100.

Short-term Aggregate Exposure

For short-term aggregate exposure, the endpoint from the oral DNT study in the rat was considered applicable to all routes of exposure. The NOAEL of 10 mg/kg bw/day was selected for aggregate risk assessment based on the changes in brain morphometrics as well as learning and memory at the LOAEL of 50 mg/kg bw/day. A target margin of exposure (MOE) of 300 was derived which includes uncertainty factors of 10-fold for interspecies extrapolation, 10-fold for intraspecies variability and a threefold PCPA factor (as outlined in the *Pest Control Products Act* Hazard Characterization section). This reference value is considered protective of all populations.

This replaces the previous value of 6.7 mg/kg bw/day, which was based on ↓EChE, ↓weight gain, effects on the liver, kidney, thyroid and adrenals in adult rats from a 90-day dietary toxicity study, and target MOE of 100.

Cancer Assessment

For the cancer risk assessment, a linear low dose extrapolation approach (q_1*of 1.83×10^{-3} $(mg/kg\ bw/day)^{-1}$) previously considered by PMRA as part of re-evaluation was used (Canada, 2003).

Table 1 New Toxicological Studies for Tetrachlorvinphos

Note: Effects noted below are known or assumed to occur in both sexes unless otherwise noted; in such cases, sex-specific effects are separated by semi-colons.

Study/Species/ # of animals per group	Purity of Test Material / Dose Levels	Results/Effects
Comparative Cholinesterase Study (acute) gavage Sprague Dawley rat PMRA# 1986602	**Supplementary** ≥75 mg/kg bw: ↓BChE (PND 11, 21, adults); Time to peak for BChE: 3–4hrs (adults), 2–8 hrs (PND 21), not established (PND 11); poor dose response Note: EChE data of limited value	
Maternal Fetal Exposure Study (repeat dose) gavage Sprague Dawley rat PMRA# 1986599	**Fetal BChE BMD10/BMDL10 = 51.5/17.5 mg/kg bw/day** ≥75 mg/kg bw/day: PChE; ↓BChE ♀ ≥150 mg/kg bw/day: ↓BChE ♂ **Maternal BChE BMD10/BMDL10 = 28.8/22.76 mg/kg bw/day** ≥75 mg/kg bw/day: ↓BChE, PChE ≥150 mg/kg bw/day: ↓bwg, fc, fe 300 mg/kg bw/day: ↓bw Note: EChE data of limited value	
Developmental neurotoxicity (repeat dose) gavage Sprague Dawley rat PMRA# 1444814, 1921306, 1921307, 1921308, 1921309, 1985450	**Offspring** **NOAEL: 10 mg/kg bw/day** ≥ 50 mg/kg bw/day: ↑errors and trials to criterion in retention phase of learning and memory, ↓ length of corpus callosum **(PND 70)**; ↓ length of hippocampus (♀) **(PND 70)** 200 mg/kg bw/day: ↑errors and trials to criterion in retention phase of learning and memory **(PND22)**, ↓ length of hippocampus **(PND22/70),** ↓ length of corpus callosum **(PND22/PND70),** striatum **(**♂/♀ **- PND22**/♀ **PND70),** cerebellum **(**♂/♀ **- PND22**/♂ **- PND70),** frontal cortex **(**♀ **- PND22/70),** ↓ brain wt. **Maternal** **NOAEL: 200 mg/kg bw/day** – no treatment related effects observed (ChE not measured)	

Table 2 Revised Toxicological Reference Values for Use in Health Risk Assessment for Tetrachlorvinphos

Exposure Scenario	Endpoint	Study/NOAEL	MOE/CAF[1]
Acute dietary general population	Brain morphometry changes, effects on retention in learning and memory tests	Rat DNT NOAEL: 10 mg/kg bw/day	300
ARfD = 0.03 mg/kg bw			
Repeated dietary general population	Brain morphometry changes, effects on retention in learning and memory tests	Rat DNT NOAEL: 10 mg/kg bw/day	300
ADI = 0.03 mg/kg bw/day			
Short-term incidental oral	Brain morphometry changes, effects on retention in learning and memory tests	Rat DNT NOAEL: 10 mg/kg bw/day	300
Dermal[2] (all durations)	Brain morphometry changes, effects on retention in learning and memory tests	Rat DNT NOAEL: 10 mg/kg bw/day	300
Inhalation[3] (all durations)	Brain morphometry changes, effects on retention in learning and memory tests	Rat DNT NOAEL: 10 mg/kg bw/day	300
Short-term aggregate	Brain morphometry changes, effects on retention in learning and memory tests	Rat DNT NOAEL: 10 mg/kg bw/day	300
Cancer[4]	Based on statistically significant ↑combined hepatocellular adenomas/carcinomas in male mice. q_1* value $= 1.83 \times 10^{-3}$ (mg/kg bw/day)$^{-1}$		

1 CAF (composite assessment factor) refers to total of uncertainty and PCPA factors for dietary assessments; MOE (margin of exposure) refers to a target margin of exposure for occupational and residential assessments

2 Since an oral NOAEL was selected, a dermal absorption factor (22%) is used in route-to-route extrapolation

3 Since an oral NOAEL was selected, an inhalation absorption factor of 100% (default value) is used in route-to-route extrapolation

4 Canada, 2003

Appendix IV Information Considered for Exposure Assessment

1. Dermal Absorption Factor

The dermal absorption of (^{14}C) tetrachlorvinphos in the rat (PMRA #2722952).

Since the occupational and residential assessments were being updated as a result of this special review, the dermal absorption value for tetrachlorvinphos was also revisited in accordance with current PMRA policies. The dermal absorption value of 22% was used for tetrachlorvinphos in this assessment, based on this in vivo rat dermal absorption study. The dermal absorption value has been revised from the previous estimate of 9.57%. Although the revised value is derived from the same study using the same lowest dose group (0.01 mg/cm^2) and the same duration of exposure (10 hours), the revised value is now based on rats whose skin was washed with soap and water (rather than ethanol) and were sacrificed at 72 hours (rather than 10 hours). Skin washes, conducted with soap and water, are more appropriate to estimate risks for humans, since soap and water would typically be used in the field. In addition, as shown in the study, ethanol had higher residues in the skin wash as compared to the same treatment groups that had skin washed with soap and water, which would result in an underestimate of dermal absorption under typical conditions. The study results also showed atypical tissue residues in relation to residues in excreta over differing sacrifice times (immediately after skin wash at 10 hours versus 72 hours). Therefore, a dermal absorption value from animals sacrificed at 72 hours was selected, since there were significantly higher residues found in the excreta and overall absorbed dose.

2. Exposure Studies Used in the Occupational and Residential Mixer/Loader and Applicator Risk Assessment

- Monitoring exposure of mixer/loaders and applicators treating agricultural premises with tetrachlorvinphos (Rabon 50 WP Insecticide) in handheld wand-type sprayers (PMRA No. 2722951).

  A study was conducted to determine worker exposure while applying tetrachlorvinphos with a power handheld sprayer to the interior of a poultry house. A wettable powder product was used and the product was mixed with water before application. Four workers were monitored at two sites, with each worker monitored for four replicates of mixing/loading and four replicates of applying. The workers wore coveralls, chemical-resistant gloves, boots, and a hat with a visor. Most applicators also wore a dust mask during application. Dermal and inhalation unit exposures were determined for each monitoring unit. The average dermal and inhalation unit exposure estimates for mixer/loaders (dermal: 820 µg/kg a.i., inhalation: 65 µg/kg a.i.) and applicators (dermal: 1983 µg/kg a.i., inhalation: 15 µg/kg a.i.) were used to assess mixer/loader and applicator exposure for mechanically-pressurized handgun scenarios. An additional respirator protection factor of 90% was applied to the inhalation unit exposure estimates, as respirators are specified on the commercial label for handheld sprayers.

- Determination of dermal and inhalation exposures to tetrachlorvinphos (TCVP) during the application of an insecticide powder to a dog (PMRA No. 1987331).

  An applicator exposure study was available for the use of a domestic-class tetrachlorvinphos powder product on dogs. Five different people applied the powder to three dogs and were monitored for dermal and inhalation exposure. Applicators wore short pants and short-sleeved shirts. The average dermal (3800 mg/kg a.i.) and inhalation (6900 µg/kg a.i.) unit exposure estimates from the study were used to estimate exposure while applying the powder product to pets and pet bedding.

- Hartz Mountain in Use Risk Assessment of a Flea Collar, Dermal Exposure Test (PMRA No. 2178088).

  A study was available for the application of tetrachlorvinphos pet collar products. In the study, six dogs were treated with a tetrachlorvinphos pet collar. The applicators wore cotton gloves and applied the collar according to label directions. The application process involved taking the collar out of the packaging, stretching the collar to activate it, and adjusting and applying the collar around the dog's neck. Excess collar was trimmed off and discarded. The residue data were reported for each glove and the total residues from both gloves. The average residue estimate for both gloves (7.85 mg a.i.) was used to estimate applicator exposure for pet collars. The study lacked critical information for field and laboratory controls, which would typically make it unacceptable for use in a standard exposure and risk assessment. However, the study data were used in the assessment, as the results indicate approximately six-fold higher exposure estimates than based on the assessment using the USEPA 2012 Residential Standard Operating Procedures. Thus, using the study data would not be expected to underestimate exposure.

3. Exposure Studies Used in the Postapplication Residential Risk Assessment

- Determination of the Dislodgeability of Tetrachlorvinphos (TCVP) from the Fur of Dogs Following the Application of an Insecticide Powder, Pump Spray of Aerosol (PMRA #2725600).

  A study was conducted to determine dislodgeable tetrachlorvinphos residues from treated pets following powder, pump, and spray or aerosol applications. Only the trigger spray and powder products are registered for use in Canada. Five applicators applied each product to five different dogs. The application of each product was performed according to label directions and followed a standardized protocol. Postapplication exposures were measured at various times after application. Each of the five applicators stroked a treated dog five times from head to rump using one hand. The fraction of dislodgeable residues was determined by wiping the hand with a cotton gauze pad moistened in methanol. At the time of each stroking event, representative animal fur samples were removed and the residues of tetrachlorvinphos on the fur were determined. The fur clippings and petting handwipe samples were taken pre-treatment, at 4 hours, and 1, 2, 4, 8, 16, and 32 days after treatment. The test animals consisted of fifteen dogs.

The fraction of dislodgeable residues was calculated based on the residues found on the handwipes after petting compared to the application rate. This estimate can be incorporated into the residential postapplication algorithms for the parameter defined as the fraction of the application rate that is transferred or F_{AR}. The petting/rubbing method used in the study was limited in comparison to newer protocols that typically have more petting simulations or strokes and cover a larger area of dog fur. Thus, the maximum dislodgeable residue value on day 0 after the application was used to calculate the F_{AR} for the non-cancer assessment (0.81% for trigger spray, 0.048% for dust/powders). Typically, the mean dislodgeable residue on day 0 would be used. For the cancer assessment, the average dislodgeable residue value over the 32 day post-treatment period was used to calculate the F_{AR} (0.18% for trigger spray, 0.022% for dust/powders). The F_{AR} estimates were used to assess postapplication dermal exposure from pets treated with trigger spray or dust applications.

Treated fur data from the study was also used in the postapplication assessment. As there are no data for dust products in the Residential SOPs, the data for fur treated with the dust product in the study were used to estimate the deposited residue in pet bedding areas treated with a dust product. The translation of fur residue data to carpet and hard surface areas is an uncertainty in the risk assessment. For the non-cancer assessment, the day 0 average residue (72.8 µg/cm^2) was used. For the cancer assessment, the average residue from 0 to 32 days post-treatment (26.3 µg/cm^2) was used.

- Assessing intermittent pesticide exposure from flea control collars containing the organophosphorus insecticide tetrachlorvinphos - (PMRA #2862263).

  Two studies were conducted to determine postapplication dermal exposure to children and adults contacting dogs treated with a flea collar, which is composed of 14.55% tetrachlorvinphos. The studies were presented in a published report. Both studies were conducted in Mississippi with volunteer households that have dogs and use flea and tick control products regularly.

  Study 1:

  This study was conducted in 1998 over 112 days. Twenty-three dogs of different breeds and weights were tested. Tetrachlorvinphos residues were determined on the hands of samplers using a cotton glove to pet dogs. Dogs were petted in a marked 10 × 4 inch area with the gloved hand for a continuous 5 minute period. Students from a local veterinary college were recruited as samplers. Sampling times were at pre-treatment, 4 hours after treatment, and 3, 7, 14, 28, 56, 84, and 112 days after treatment. Glove samples were collected from three regions: 1) petting the neck region over the collar, 2) petting the neck region with the collar removed, and 3) along the back and tail regions. Blood samples were taken from the dogs concurrently with the glove samples to determine plasma cholinesterase (ChE) activity in treated dogs.

  Transferable residues in the neck region peaked at day 7 and steadily decreased for the duration of the study. Transferable residues in the tail region remained constant. No significant change in dog plasma ChE activities from pre-application levels were observed in most dogs.

Study 2:

This study was conducted in 2002 over 21 days on the basis that residues peaked at day 7 in the first study and decreased significantly within three weeks of application. Twenty-two dogs of different breeds and weights were tested. Study 2 sampled tetrachlorvinphos residues on gloves, residues on children's t-shirts, and the urinary metabolite 2,4,5-trichloromandelic acid (TCMA) in children and adults. Glove samples were taken pre-treatment, and at 5 and 12 days after application. The same petting protocol from Study 1 was followed. Participating children were supplied a new laundered t-shirt pre-treatment and on each of days 7–11 post-treatment. The same method was used to analyze tetrachlorvinphos residues in gloves and t-shirts as described in Study 1. Morning urine samples were collected from children wearing the t-shirt and from an adult in the same household. Urine sampling was done pre-treatment and on each day 8 to 12 days post-treatment.

Residues in the neck region were higher on day 7 and had declined 30% by day 12. Residues in the tail region remained constant. Average residues detected on the children's t-shirt were higher than pre-treatment samples. Urinary concentrations of TCMA in adults and children were higher in all post-treatment samples as compared to pre-treatment samples, indicating that some tetrachlorvinphos is absorbed through postapplication exposure. Concentrations in children were generally higher than adults, but not at statistically significant levels. The study authors could not determine correlations for urinary TCMA concentrations, amount of residues on the t-shirt, the time that the t-shirt was worn, or the amount of time spent with the treated dog. There was high variability in the TCMA concentrations found in the adult and children groups.

The data from the transferable residue portion of the studies (petting/rubbing with a gloved cotton hand) were used in the postapplication assessment for pet collars. The F_{AR} value was determined by dividing the total transferable residues with the application rate. The total transferable residues were calculated based on the sum of residues from the gloves used to pet the neck region (fur over the collar) and from the back in the tail region.

For the non-cancer postapplication dermal exposure and risk assessment to pet collars, the F_{AR} was calculated based on the average transferable residues from day 5 and day 12 samples in Study 2 (0.4%). For the cancer risk assessment, the F_{AR} was calculated based on the average transferable residues from 0 to 112 day samples in Study 1 (0.3%). The data from study 1 is more representative of long-term exposures.

Appendix V Occupational Exposure and Risk Assessment

Table 1 Short-, Intermediate-term M/L/A Occupational Non-Cancer and Cancer Exposure and Risk Assessment

Use	Form	Application Method	Application Rate	ATPD	Exposure (µg/kg bw/day)[a]		MOE (Target = 300)[b]			Cancer		
					Dermal	Inhalation	Dermal	Inhalation	Combined	WD/Yr	LADD[c]	Risk[d]
Single Layer, CR Gloves (ML). Short Pants, Short-sleeved shirt, CR Gloves (A).												
Poultry – Duster	WP	Shaker Can	0.75 g/bird	1000 bird	19554	373	1	27	1	30	840	$2x10^{-3}$
Poultry House Litter – Duster	WP	Plunger Duster	3.75 g/m^2	100 m^2	570	17.8	18	560	17	30	24.8	$5x10^{-5}$
		Shaker Can	3.75 g/m^2	100 m^2	9777	186	1	54	1	30	420	$8x10^{-4}$
Single Layer, CR Gloves (MLA).												
Roost – Paint	WP	Airless Sprayer	10 g/L	7.6 L	6.75	1.07	1480	9320	1280	30	0.33	$6x10^{-7}$
		Paintbrush	10 g/L	7.6 L	11.1	0.76	904	13200	846	30	0.50	$9x10^{-7}$
Coveralls, CR Gloves (MLA). Respirator (MLA).												
Livestock Premise – 1% Spray	WP	Backpack	0.8 g/m^2	1900 m^2	12.4	0.22	806	44500	792	30	0.53	$1x10^{-6}$
		MPHG	0.8 g/m^2	3000 m^2	18.5	0.24	541	41700	534	30	0.79	$1x10^{-6}$
Livestock Premise - 2% Spray	WP	Backpack	1.6 g/m^2	1900 m^2	24.8	0.45	403	22200	396	30	1.06	$2x10^{-6}$
		MPHG	1.6 g/m^2	3000 m^2	37.0	0.48	270	20800	267	30	1.58	$3x10^{-6}$
Poultry Droppings, Manure, Garbage Pile, Trough- Spray	WP	Backpack	4 g/m^2	100 m^2	3.27	0.06	3060	169000	3010	30	0.14	$3x10^{-7}$
		MPHG	4 g/m^2	100 m^2	3.08	0.04	3240	250000	3200	30	0.13	$2x10^{-7}$
Poultry – Spray	WP	Backpack	0.2 g/bird	20000 bird	32.7	0.59	306	16900	301	30	1.40	$3x10^{-6}$
		MPHG	0.2 g/bird	20000 bird	30.8	0.40	324	25000	320	30	1.32	$2x10^{-6}$
Poultry House - Fowl Tick Spray	WP	Backpack	4 g/m^2	500 m^2	16.3	0.30	613	33800	602	30	0.70	$1x10^{-6}$
		MPHG	4 g/m^2	3000 m^2	92.5	1.20	108	8330	107	30	3.95	$7x10^{-6}$
Poultry House Floor Management Litter – Spray	WP	Backpack	0.4 g/m^2	1900 m^2	6.20	0.11	1610	89000	1580	30	0.27	$5x10^{-7}$
		MPHG	0.4 g/m^2	3000 m^2	9.25	0.12	1080	83300	1070	30	0.39	$7x10^{-7}$

Form = Formulation, ATPD = Area/Amount/Animal Treated per Day, Exp = Exposure, MOE = Margin of Exposure, WD/Yr = Work Days/Year, LADD = Lifetime Average Daily Dose (µg/kg bw/day), MLA = Mixer/Loader/Applicator, CR = Chemical-resistant, MPHG = Mechanically Pressurized Handgun, WP=Wettable Powder

[a] Exposure (µg/kg bw/day) = Rate × ATPD ÷ 1000 g/kg × Unit Exposure ÷ Body Weight (80 kg). A 22% dermal absorption factor was applied to dermal exposure estimates.

[b] MOE = NOAEL ÷ Exposure × 1000 × µg/mg. NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300. Shaded values indicate MOEs that did not reach the target.

[c] LADD (µg/kg bw/day) = (Dermal Exposure + Inhalation Exposure) × WD/Yr ÷ 365 days/year × Work Duration (40 years) ÷ Life Expectancy (78 years)

[d] Cancer Risk = LADD ÷ 1000 µg/mg × q_1*. q_1* = 1.83×10^{-3} (mg/kg bw/day)$^{-1}$. Shaded values indicate cancer risks above $1x10^{-5}$.

Table 2 Short-Intermediate-term Occupational Applicator Non-cancer and Cancer Exposure and Risk Assessment for Domestic-Class Products

Use	Form	Application	Application Rate[a]	ATPD	Exp (µg/kg bw/day)[b]		MOE[c]			Cancer			
					Dermal	Inhalation	Dermal	Inhalation	Combined	TF/Yr	Exp Yrs	LADD[d]	Risk[e]
Pet Bedding	Powder	Shaker Can	0.0091 kg a.i./can	2 Cans	190	1.57	53	6400	52	30	35	7.05	$1x10^{-5}$
Pet	Powder	Shaker Can	0.0016 kg a.i./pet	8 Pets	135	1.12	74	9000	74	30	35	5.03	$7x10^{-6}$
	Liquid	Trigger Spray	0.0028 kg a.i./pet	8 Pets	112	2.04	90	4900	88	30	35	4.19	$6x10^{-6}$
	SR	Pet Collar	0.0046 kg a.i./pet	8 Pets	173	0	58	-	58	30	35	6.37	$9x10^{-6}$
Trigger Spray – Lower Application Rates (For mitigation)													
Small Dog	Liquid	Trigger Spray	0.00035 kg a.i./pet	8 Pets	13.9	0.25	720	39000	710	30	35	0.52	$7x10^{-7}$
Medium Dog	Liquid	Trigger Spray	0.00040 kg a.i/.pet	8 Pets	15.9	0.29	630	34000	620	30	35	0.60	$8x10^{-7}$
Large Dog	Liquid	Trigger Spray	0.00070 kg a.i./pet	8 Pets	27.8	0.51	360	20000	350	30	35	1.05	$1x10^{-6}$
Small Cat	Liquid	Trigger Spray	0.00025 kg a.i./pet	8 Pets	9.9	0.18	1000	55000	980	30	35	0.37	$5x10^{-7}$
Medium Cat	Liquid	Trigger Spray	0.00035 kg a.i./pet	8 Pets	13.9	0.25	720	39000	710	30	35	0.52	$7x10^{-7}$
Large Cat	Liquid	Trigger Spray	0.00035 kg a.i./pet	8 Pets	13.9	0.25	720	39000	710	30	35	0.52	$7x10^{-7}$

Form = Formulation, ATPD = Amount or Animal Treated per Day, Exp = Exposure, MOE = Margin of Exposure, TF/Yr = Treatment Frequency/Year, LADD = Lifetime Average Daily Dose (µg/kg bw/day), SR = Slow Release

[a] Shaker can rate/can = guarantee × typical can size = 3.3% × 275 grams = 0.0091 kg a.i./can.
Shaker can rate/pet = rate/kg pet × pet weight = 0.07 g a.i./kg pet × 23.1 kg (large dog) = 0.0016 kg a.i./pet.
Default Trigger spray rate/pet = guarantee × 0.5 bottle/pet × typical bottle size × density = 1.08% × 0.5 × 525 ml × 0.99 g/ml = 0.0028 kg a.i./pet.
Lower Trigger spray rate/pet = 700 mg a.i. for large dogs, 400 mg a.i. for medium dogs, 350 mg a.i. for small dogs, 350 mg a.i. for large and medium cats, and 250 mg a.i. for small cats. All rates were converted to kg a.i./pet for the risk assessment.
Pet collar rate/pet = guarantee × typical collar size = 14.55% × 32.5 grams = 0.0046 kg a.i./pet.

[b] Exposure (µg/kg bw/day) = Rate × ATPD × Unit Exposure x1000 µg/mg ÷ BW (80 kg). A dermal absorption value of 22% was applied to dermal exposure.

[c] MOE = NOAEL ÷ Exposure × 1000 × µg/mg. NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300. Shaded cells indicate MOEs that did not reach the target.

[d] LADD (µg/kg bw/day) = (Dermal Exposure + Inhalation Exposure) × TF/Yr ÷ 365 days/year × Exposure Years ÷ Life Expectancy (78 years).

e Cancer Risk = LADD ÷ 1000 µg/mg × q_1*. q_1* = 1.83×10^{-3} $(mg/kg\ bw/day)^{-1}$.

Appendix VI Residential Exposure and Risk Assessment

Table 1 Short-Intermediate Term Applicator Non-cancer and Cancer Exposure and Risk Assessment for Residential Applicators

Use	Form	Application	Application Rate[a]	ATPD	Exp (µg/kg bw/day)[b]		MOE[c]			Cancer			
					Dermal	Inhalation	Dermal	Inhalation	Combined	TF/Yr	Exp Yrs	LADD[d]	Risk[e]
Pet Bedding	Powder	Shaker Can	0.0091 kg a.i./can	0.5 Cans	47.4	0.391	211	26000	209	4	35	0.24	$3x10^{-7}$
Pet	Powder	Shaker Can	0.0016 kg a.i./pet	2 Pets	33.8	0.279	296	36000	296	4	35	0.17	$2x10^{-7}$
	Liquid	Trigger Spray	0.0028 kg a.i./pet	2 Pets	27.9	0.511	358	20000	352	6	35	0.21	$3x10^{-7}$
	SR	Pet Collar	0.0046 kg a.i./pet	2 Pets	43.2	-	232	-	232	4	35	0.21	$3x10^{-7}$
Trigger Spray – Lower Application Rates (Mitigation)													
Small Dog	Liquid	Trigger Spray	0.00035 kg a.i./pet	2 Pets	3.5	0.064	2900	160000	2800	6	35	0.03	$4x10^{-8}$
Medium Dog	Liquid	Trigger Spray	0.00040 kg a.i./pet	2 Pets	4.0	0.073	2500	140000	2500	6	35	0.03	$4x10^{-8}$
Large Dog	Liquid	Trigger Spray	0.00070 kg a.i./pet	2 Pets	7.0	0.127	1400	80000	1400	6	35	0.05	$7x10^{-8}$
Small Cat	Liquid	Trigger Spray	0.00025 kg a.i./pet	2 Pets	2.5	0.046	4000	220000	3900	6	35	0.02	$3x10^{-8}$
Medium Cat	Liquid	Trigger Spray	0.00035 kg a.i./pet	2 Pets	3.5	0.064	2900	160000	2800	6	35	0.03	$4x10^{-8}$
Large Cat	Liquid	Trigger Spray	0.00035 kg a.i./pet	2 Pets	3.5	0.064	2900	160000	2800	6	35	0.03	$4x10^{-8}$

Form = Formulation, ATPD = Amount or Animal Treated per Day, Exp = Exposure, MOE = Margin of Exposure, TF/Yr = Treatment Frequency/Year, LADD = Lifetime Average Daily Dose (µg/kg bw/day), SR = Slow Release

[a] Shaker can rate/can = guarantee × typical can size = 3.3% × 275 grams = 0.0091 kg a.i./can.
Shaker can rate/pet = rate/kg pet × pet weight = 0.07 g a.i./kg pet × 23.1 kg (large dog) = 0.0016 kg a.i./pet.
Default Trigger spray rate/pet = guarantee × 0.5 bottle/pet × typical bottle size × density = 1.08% × 0.5 × 525 ml × 0.99 g/ml = 0.0028 kg a.i./pet
Lower Trigger spray rate/pet = 700 mg a.i. for large dogs, 400 mg a.i. for medium dogs, 350 mg a.i. for small dogs, 350 mg a.i. for large and medium cats, and 250 mg a.i. for small cats. All application rates were converted to kg a.i./pet for the risk assessment.
Pet collar rate/pet = guarantee × typical collar size = 14.55% × 32.5 grams = 0.0046 kg a.i./pet.

[b] Exposure (µg/kg bw/day) = Rate × ATPD × Unit Exposure x1000 µg/mg ÷ BW (80 kg). A dermal absorption value of 22% was applied to dermal exposure.

[c] MOE = NOAEL ÷ Exposure × 1000 × µg/mg. NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300. Shaded cells indicate MOEs that did not reach the target.

[d] LADD (µg/kg bw/day) = (Dermal Exposure + Inhalation Exposure) × TF/Yr ÷ 365 days/year × Exposure Years ÷ Life Expectancy (78 years).

[e] Cancer Risk = LADD ÷ 1000 µg/mg × q_1*. q_1* = 1.83×10^{-3} $(mg/kg\ bw/day)^{-1}$.

Table 2 Treated Pet Bedding – Postapplication Non-cancer Dermal Risk Assessment

Exposure Scenario	Surface	Lifestage	DR[a] (µg/cm^2)	Fraction Transferred	TR[b] (µg/cm^2)	TC (cm^2/hr)	ET (hrs/day)	Dermal Exposure[c] (mg/kg bw/day)	MOE[d]
Perimeter (Coarse) – Pet Bedding	Carpet	Adults	72.80	0.06	4.37	6800	2[e]	0.16	61
		Children 1 <2 yrs	72.80	0.06	4.37	1800	2[e]	0.31	32
	Hard Surfaces	Adults	72.80	0.08	5.82	6800	2	0.22	46
		Children 1 <2 yrs	72.80	0.08	5.82	1800	2	0.42	24

DR = Deposited Residue, TR = Transferrable Residue, TC = Transfer coefficient, ET = Exposure Time, MOE = Marge of Exposure

[a] DR value is based on chemical-specific data.

[b] TR (µg/cm^2) = DR × Fraction Transferred.

[c] Dermal exposure (mg/kg bw/day) = TR ÷ 1000 µg/mg × TC × ET × Dermal Absorption (22%) ÷ BW (80 kg for Adults, 11 kg for Children).

[d] MOE = NOAEL ÷ Exposure. NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300.

[e] Two hours of exposure time was used for carpet instead of the default of 8 hours for adults and 4 hours for children as the application is limited to pet bedding areas and less exposure time is expected.

Table 3 Treated Pet Bedding – Postapplication Cancer Dermal Risk Assessment

Exposure Scenario	Surface	Lifestage	DR[a] (µg/cm^2)	Fraction Transferred	TR[b] (µg/cm^2)	TC (cm^2/hr)	ET (hrs/day)	EF (days/year)	Exposure Years	LADD[c] (mg/kg bw/day)	Cancer Risk[d]
Pet Bedding	Carpet	Adults	26.3	0.02	0.526	4,700	2[e]	90	35	0.00150	$3x10^{-6}$
		Youth 11 <16 yrs	26.3	0.02	0.526	3,900	2[e]	90	5	0.00025	
		Children 1 <2 yrs	26.3	0.02	0.526	1,300	2[e]	90	5	0.00043	
	Hard Surface	Adults	26.3	0.03	0.789	4,700	2	90	35	0.00226	$4x10^{-6}$
		Youth 11 <16 yrs	26.3	0.03	0.789	3,900	1	90	5	0.00019	
		Children 1 <2 yrs	26.3	0.03	0.789	1,300	2	90	5	0.00065	

DR = Deposited Residue, TR = Transferrable Residue, TC = Transfer coefficient, ET = Exposure Time, EF = Exposure Frequency, LADD = Lifetime Average Daily Dose

[a] DR based on chemical-specific data.

[b] TR (µg/cm^2) = DR × Fraction Transferred.

[c] Dermal LADD (mg/kg bw/day) = TR (µg/cm^2) ÷ 1000 µg/mg × TC (cm^2/hr) × ET (hrs/day) × Dermal Absorption (22%) ÷ BW (Adults: 80 kg, 32 kg: Youth, 11 kg: Children) × EF (days/year) ÷ 365 days/year × Exposure years ÷ Life Expectancy (78 years).

[d] Cancer Risk = LADD × q_1*; q_1* = 1.83 × 10^{-3} (mg/kg bw/day)$^{-1}$. Shaded cells indicate cancer risks above $1x10^{-6}$.

[e] Two hours of exposure time was used for carpet instead of the default of 8 hours for adults, 5 hours for youth, and 4 hours for children as the application is limited to pet bedding areas and less exposure time is expected.

Table 4 Treated pets – Postapplication Non-cancer Dermal Risk Assessment

Exposure Scenario	Animal	Lifestage	AR[a] (mg a.i./pet)	F_{AR}[b]	SA (cm^2/pet)	TR[c] (µg/cm^2)	TC (cm^2/hr)	ET (hrs/day)	Dermal Exposure[d] (mg/kg bw/day)	MOE[e]
Trigger Spray	Dog – Small	Adult	2832	0.81%	3000	7.65	5200	0.77	0.08	120
		Child 1 <2 yrs	2832	0.81%	3000	7.65	1400	1	0.21	47
	Dog – Medium	Adult	2832	0.81%	7000	3.28	5200	0.77	0.04	280
		Child 1 <2 yrs	2832	0.81%	7000	3.28	1400	1	0.09	110
	Dog – Big	Adult	2832	0.81%	11000	2.09	5200	0.77	0.02	440
		Child 1 <2 yrs	2832	0.81%	11000	2.09	1400	1	0.06	170
	Cat – Small	Adult	1273	0.81%	1500	6.87	5200	0.77	0.08	130
		Child 1 <2 yrs	1273	0.81%	1500	6.87	1400	1	0.19	52
	Cat – Medium	Adult	1273	0.81%	2500	4.12	5200	0.77	0.05	220
		Child 1 <2 yrs	1273	0.81%	2500	4.12	1400	1	0.12	87
	Cat – Big	Adult	1273	0.81%	4000	2.58	5200	0.77	0.03	350
		Child 1 <2 yrs	1273	0.81%	4000	2.58	1400	1	0.07	140
Trigger Spray (Lower Mitigation Rate)	Dog – Small	Adult	350	0.81%	3000	0.95	5200	0.77	0.01	960
		Child 1 <2 yrs	350	0.81%	3000	0.95	1400	1	0.03	380
	Dog – Medium	Adult	400	0.81%	7000	0.46	5200	0.77	0.01	2000
		Child 1 <2 yrs	400	0.81%	7000	0.46	1400	1	0.01	770
	Dog – Big	Adult	700	0.81%	11000	0.52	5200	0.77	0.01	1800
		Child 1 <2 yrs	700	0.81%	11000	0.52	1400	1	0.01	690
	Cat – Small	Adult	250	0.81%	1500	1.35	5200	0.77	0.01	670
		Child 1 <2 yrs	250	0.81%	1500	1.35	1400	1	0.04	260
	Cat – Medium	Adult	350	0.81%	2500	1.13	5200	0.77	0.01	800
		Child 1 <2 yrs	350	0.81%	2500	1.13	1400	1	0.03	310
	Cat – Big	Adult	350	0.81%	4000	0.71	5200	0.77	0.01	1300
		Child 1 <2 yrs	350	0.81%	4000	0.71	1400	1	0.02	500
Powder	Dog – Small	Adult	637	0.048%	3000	0.10	140000	0.77	0.03	330
		Child 1 <2 yrs	637	0.048%	3000	0.10	38000	1	0.08	130
	Dog – Medium	Adult	1106	0.048%	7000	0.08	140000	0.77	0.02	440
		Child 1 <2 yrs	1106	0.048%	7000	0.08	38000	1	0.06	170
	Dog – Big	Adult	1617	0.048%	11000	0.07	140000	0.77	0.02	480
		Child 1 <2 yrs	1617	0.048%	11000	0.07	38000	1	0.05	190
	Cat – Small	Adult	161	0.048%	1500	0.05	140000	0.77	0.02	650
		Child 1 <2 yrs	161	0.048%	1500	0.05	38000	1	0.04	260
	Cat – Medium	Adult	287	0.048%	2500	0.06	140000	0.77	0.02	610
		Child 1 <2 yrs	287	0.048%	2500	0.06	38000	1	0.04	240
	Cat – Big	Adult	413	0.048%	4000	0.05	140000	0.77	0.01	680
		Child 1 <2 yrs	413	0.048%	4000	0.05	38000	1	0.04	270

Exposure Scenario	Animal	Lifestage	AR[a] (mg a.i./pet)	F_{AR}[b]	SA (cm^2/pet)	TR[c] (µg/cm^2)	TC (cm^2/hr)	ET (hrs/day)	Dermal Exposure[d] (mg/kg bw/day)	MOE[e]
Pet Collars (Liquid)	Dog – Small	Adult	3201	0.4%	3000	4.27	5200	0.77	0.05	210
		Child 1 <2 yrs	3201	0.4%	3000	4.27	1400	1	0.12	84
	Dog – Medium	Adult	4583	0.4%	7000	2.62	5200	0.77	0.03	350
		Child 1 <2 yrs	4583	0.4%	7000	2.62	1400	1	0.07	140
	Dog – Big	Adult	5296	0.4%	11000	1.93	5200	0.77	0.02	470
		Child 1 <2 yrs	5296	0.4%	11000	1.93	1400	1	0.05	190
	Cat – Small	Adult	2037	0.4%	1500	5.43	5200	0.77	0.06	170
		Child 1 <2 yrs	2037	0.4%	1500	5.43	1400	1	0.15	66
	Cat – Medium	Adult	2663	0.4%	2500	4.26	5200	0.77	0.05	210
		Child 1 <2 yrs	2663	0.4%	2500	4.26	1400	1	0.12	84
	Cat – Big	Adult	3143	0.4%	4000	3.14	5200	0.77	0.03	290
		Child 1 <2 yrs	3143	0.4%	4000	3.14	1400	1	0.09	110
Pet Collar (Solid)	Dog – Small	Adult	3201	0.4%	3000	4.27	140000	0.77	1.27	8
		Child 1 <2 yrs	3201	0.4%	3000	4.27	38000	1	3.24	3
	Dog – Medium	Adult	4583	0.4%	7000	2.62	140000	0.77	0.78	13
		Child 1 <2 yrs	4583	0.4%	7000	2.62	38000	1	1.99	5
	Dog – Big	Adult	5296	0.4%	11000	1.93	140000	0.77	0.57	18
		Child 1 <2 yrs	5296	0.4%	11000	1.93	38000	1	1.46	7
	Cat – Small	Adult	2037	0.4%	1500	5.43	140000	0.77	1.61	6
		Child 1 <2 yrs	2037	0.4%	1500	5.43	38000	1	4.13	2
	Cat – Medium	Adult	2663	0.4%	2500	4.26	140000	0.77	1.26	8
		Child 1 <2 yrs	2663	0.4%	2500	4.26	38000	1	3.24	3
	Cat – Big	Adult	3143	0.4%	4000	3.14	140000	0.77	0.93	11
		Child 1 <2 yrs	3143	0.4%	4000	3.14	38000	1	2.39	4

AR = Application Rate, F_{AR} = Fraction of Application Rate Transferred, SA = Surface Area, TR = Transferrable Residue, TC = Transfer coefficient, ET = Exposure Time, MOE = Marge of Exposure

[a] Label instructions and product information were used to calculate application rates.

[b] F_{AR} estimates were based on chemical-specific data.

[c] TR (µg/cm^2) = AR × F_{AR} ÷ SA × 1000 µg/mg.

[d] Dermal Exposure (mg/kg bw/day) = TR ÷ 1000 µg/mg × TC × ET × Dermal Absorption (22%) ÷ BW (80 kg for Adults, 11 kg for Children)

[e] MOE = NOAEL (mg/kg bw/day) ÷ Exposure (mg/kg bw/day). NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300. Shaded values indicate MOEs that did not reach the target.

Table 5 Treated pets – Postapplication Cancer Risk Assessment

Exposure Scenario	Animal	Lifestage	AR[a] (mg a.i./pet)	F_{AR}[b]	SA (cm^2/pet)	TR[c] (µg/cm^2)	TC (cm^2/hr)	ET (hrs/day)	EF (days/year)	Exposure Years	LADD[d] (mg/kg bw/day)	Cancer Risk[e]
Trigger Spray	Dog – Small	Adults	2832	0.18%	3000	1.70	3600	0.5	90	35	0.00093	$2x10^{-6}$
		Youth 11 <16 yrs	2832	0.18%	3000	1.70	3000	0.42	90	5	0.00013	
		Children 1 <2 yrs	2832	0.18%	3000	1.70	980	1	90	5	0.00053	
	Dog – Medium	Adults	2832	0.18%	7000	0.73	3600	0.5	90	35	0.00040	$9x10^{-7}$
		Youth 11 <16 yrs	2832	0.18%	7000	0.73	3000	0.42	90	5	0.00006	
		Children 1 <2 yrs	2832	0.18%	7000	0.73	980	1	90	5	0.00023	
	Dog –Large	Adults	2832	0.18%	11000	0.46	3600	0.5	90	35	0.00025	$6x10^{-7}$
		Youth 11 <16 yrs	2832	0.18%	11000	0.46	3000	0.42	90	5	0.00004	
		Children 1 <2 yrs	2832	0.18%	11000	0.46	980	1	90	5	0.00014	
	Cat – Small	Adults	1273	0.18%	1500	1.53	3600	0.5	90	35	0.00084	$2x10^{-6}$
		Youth 11 <16 yrs	1273	0.18%	1500	1.53	3000	0.42	90	5	0.00012	
		Children 1 <2 yrs	1273	0.18%	1500	1.53	980	1	90	5	0.00047	
	Cat – Medium	Adults	1273	0.18%	2500	0.92	3600	0.5	90	35	0.00050	$1x10^{-6}$
		Youth 11 <16 yrs	1273	0.18%	2500	0.92	3000	0.42	90	5	0.00007	
		Children 1 <2 yrs	1273	0.18%	2500	0.92	980	1	90	5	0.00028	
	Cat – Large	Adults	1273	0.18%	4000	0.57	3600	0.5	90	35	0.00031	$7x10^{-7}$
		Youth 11 <16 yrs	1273	0.18%	4000	0.57	3000	0.42	90	5	0.00004	
		Children 1 <2 yrs	1273	0.18%	4000	0.57	980	1	90	5	0.00018	
Trigger Spray (Lower Application Rate)	Dog – Small	Adults	350	0.18%	3000	0.21	3600	0.5	90	35	0.00012	$3x10^{-7}$
		Youth 11 <16 yrs	350	0.18%	3000	0.21	3000	0.42	90	5	0.00002	
		Children 1 <2 yrs	350	0.18%	3000	0.21	980	1	90	5	0.00007	
	Dog – Medium	Adults	400	0.18%	7000	0.10	3600	0.5	90	35	0.00006	$1x10^{-7}$
		Youth 11 <16 yrs	400	0.18%	7000	0.10	3000	0.42	90	5	0.00001	
		Children 1 <2 yrs	400	0.18%	7000	0.10	980	1	90	5	0.00003	
	Dog –Large	Adults	700	0.18%	11000	0.11	3600	0.5	90	35	0.00006	$1x10^{-7}$
		Youth 11 <16 yrs	700	0.18%	11000	0.11	3000	0.42	90	5	0.00001	
		Children 1 <2 yrs	700	0.18%	11000	0.11	980	1	90	5	0.00004	
	Cat – Small	Adults	250	0.18%	1500	0.30	3600	0.5	90	35	0.00016	$4x10^{-7}$
		Youth 11 <16 yrs	250	0.18%	1500	0.30	3000	0.42	90	5	0.00002	
		Children 1 <2 yrs	250	0.18%	1500	0.30	980	1	90	5	0.00009	
	Cat – Medium	Adults	350	0.18%	2500	0.25	3600	0.5	90	35	0.00014	$3x10^{-7}$
		Youth 11 <16 yrs	350	0.18%	2500	0.25	3000	0.42	90	5	0.00002	
		Children 1 <2 yrs	350	0.18%	2500	0.25	980	1	90	5	0.00008	
	Cat – Large	Adults	350	0.18%	4000	0.16	3600	0.5	90	35	0.00009	$2x10^{-7}$
		Youth 11 <16 yrs	350	0.18%	4000	0.16	3000	0.42	90	5	0.00001	
		Children 1 <2 yrs	350	0.18%	4000	0.16	980	1	90	5	0.00005	

Exposure Scenario	Animal	Lifestage	AR[a] (mg a.i./pet)	F_{AR}[b]	SA (cm^2/pet)	TR[c] (µg/cm^2)	TC (cm^2/hr)	ET (hrs/day)	EF (days/year)	Exposure Years	LADD[d] (mg/kg bw/day)	Cancer Risk[e]
Powder/Dust	Dog – Small	Adults	637	0.022%	3000	0.05	120000	0.5	90	35	0.00085	$2x10^{-6}$
		Youth 11 <16 yrs	637	0.022%	3000	0.05	98000	0.42	90	5	0.00012	
		Children 1 <2 yrs	637	0.022%	3000	0.05	31000	1	90	5	0.00046	
	Dog – Medium	Adults	1106	0.022%	7000	0.03	120000	0.5	90	35	0.00063	$1x10^{-6}$
		Youth 11 <16 yrs	1106	0.022%	7000	0.03	98000	0.42	90	5	0.00009	
		Children 1 <2 yrs	1106	0.022%	7000	0.03	31000	1	90	5	0.00034	
	Dog –Large	Adults	1617	0.022%	11000	0.03	120000	0.5	90	35	0.00059	$1x10^{-6}$
		Youth 11 <16 yrs	1617	0.022%	11000	0.03	98000	0.42	90	5	0.00008	
		Children 1 <2 yrs	1617	0.022%	11000	0.03	31000	1	90	5	0.00032	
	Cat – Small	Adults	161	0.022%	1500	0.02	120000	0.5	90	35	0.00043	$1x10^{-6}$
		Youth 11 <16 yrs	161	0.022%	1500	0.02	98000	0.42	90	5	0.00006	
		Children 1 <2 yrs	161	0.022%	1500	0.02	31000	1	90	5	0.00023	
	Cat – Medium	Adults	287	0.022%	2500	0.03	120000	0.5	90	35	0.00046	$1x10^{-6}$
		Youth 11 <16 yrs	287	0.022%	2500	0.03	98000	0.42	90	5	0.00006	
		Children 1 <2 yrs	287	0.022%	2500	0.03	31000	1	90	5	0.00025	
	Cat – Large	Adults	413	0.022%	4000	0.02	120000	0.5	90	35	0.00041	$1x10^{-6}$
		Youth 11 <16 yrs	413	0.022%	4000	0.02	98000	0.42	90	5	0.00006	
		Children 1 <2 yrs	413	0.022%	4000	0.02	31000	1	90	5	0.00022	
Pet Collar (Liquid)	Dog – Small	Adults	3201	0.3%	3000	3.20	3600	0.5	90	35	0.00175	$4x10^{-6}$
		Youth 11 <16 yrs	3201	0.3%	3000	3.20	3000	0.42	90	5	0.00025	
		Children 1 <2 yrs	3201	0.3%	3000	3.20	980	1	90	5	0.00099	
	Dog – Medium	Adults	4583	0.3%	7000	1.96	3600	0.5	90	35	0.00108	$3x10^{-6}$
		Youth 11 <16 yrs	4583	0.3%	7000	1.96	3000	0.42	90	5	0.00015	
		Children 1 <2 yrs	4583	0.3%	7000	1.96	980	1	90	5	0.00061	
	Dog –Large	Adults	5296	0.3%	11000	1.44	3600	0.5	90	35	0.00079	$2x10^{-6}$
		Youth 11 <16 yrs	5296	0.3%	11000	1.44	3000	0.42	90	5	0.00011	
		Children 1 <2 yrs	5296	0.3%	11000	1.44	980	1	90	5	0.00045	
	Cat – Small	Adults	2037	0.3%	1500	4.07	3600	0.5	90	35	0.00223	$5x10^{-6}$
		Youth 11 <16 yrs	2037	0.3%	1500	4.07	3000	0.42	90	5	0.00031	
		Children 1 <2 yrs	2037	0.3%	1500	4.07	980	1	90	5	0.00126	
	Cat – Medium	Adults	2663	0.3%	2500	3.20	3600	0.5	90	35	0.00175	$4x10^{-6}$
		Youth 11 <16 yrs	2663	0.3%	2500	3.20	3000	0.42	90	5	0.00025	
		Children 1 <2 yrs	2663	0.3%	2500	3.20	980	1	90	5	0.00099	
	Cat – Large	Adults	3143	0.3%	4000	2.36	3600	0.5	90	35	0.00129	$3x10^{-6}$
		Youth 11 <16 yrs	3143	0.3%	4000	2.36	3000	0.42	90	5	0.00018	
		Children 1 <2 yrs	3143	0.3%	4000	2.36	980	1	90	5	0.00073	

Exposure Scenario	Animal	Lifestage	AR[a] (mg a.i./pet)	F_{AR}[b]	SA (cm^2/pet)	TR[c] (µg/cm^2)	TC (cm^2/hr)	ET (hrs/day)	EF (days/year)	Exposure Years	LADD[d] (mg/kg bw/day)	Cancer Risk[e]
Pet Collar (Solid)	Dog – Small	Adults	3201	0.3%	3000	3.20	120000	0.5	90	35	0.058	$1x10^{-4}$
		Youth 11 <16 yrs	3201	0.3%	3000	3.20	98000	0.42	90	5	0.008	
		Children 1 <2 yrs	3201	0.3%	3000	3.20	31000	1	90	5	0.031	
	Dog – Medium	Adults	4583	0.3%	7000	1.96	120000	0.5	90	35	0.036	$8x10^{-5}$
		Youth 11 <16 yrs	4583	0.3%	7000	1.96	98000	0.42	90	5	0.005	
		Children 1 <2 yrs	4583	0.3%	7000	1.96	31000	1	90	5	0.019	
	Dog –Large	Adults	5296	0.3%	11000	1.44	120000	0.5	90	35	0.026	$6x10^{-5}$
		Youth 11 <16 yrs	5296	0.3%	11000	1.44	98000	0.42	90	5	0.004	
		Children 1 <2 yrs	5296	0.3%	11000	1.44	31000	1	90	5	0.014	
	Cat – Small	Adults	2037	0.3%	1500	4.07	120000	0.5	90	35	0.074	$2x10^{-4}$
		Youth 11 <16 yrs	2037	0.3%	1500	4.07	98000	0.42	90	5	0.010	
		Children 1 <2 yrs	2037	0.3%	1500	4.07	31000	1	90	5	0.040	
	Cat – Medium	Adults	2663	0.3%	2500	3.20	120000	0.5	90	35	0.058	$1x10^{-4}$
		Youth 11 <16 yrs	2663	0.3%	2500	3.20	98000	0.42	90	5	0.008	
		Children 1 <2 yrs	2663	0.3%	2500	3.20	31000	1	90	5	0.031	
	Cat – Large	Adults	3143	0.3%	4000	2.36	120000	0.5	90	35	0.043	$1x10^{-4}$
		Youth 11 <16 yrs	3143	0.3%	4000	2.36	98000	0.42	90	5	0.006	
		Children 1 <2 yrs	3143	0.3%	4000	2.36	31000	1	90	5	0.023	

AR = Application Rate, F_{AR} = Fraction of Application Rate Transferred, SA = Surface Area, TR = Transferrable Residue, TC = Transfer Coefficient, ET = Exposure Time, EF = Exposure Frequency, LADD = Lifetime Average Daily Dose

[a] Label instructions and product information were used to calculate application rates.

[b] F_{AR} estimates were based on chemical-specific data.

[c] TR (µg/cm^2) = AR × F_{AR} ÷ SA × 1000 µg/mg.

[d] Dermal LADD (mg/kg bw/day) = TR (µg/cm^2) ÷ 1000 µg/mg × TC (cm^2/hr) × ET (hrs/day) × Dermal Absorption (22%) ÷ BW (Adults: 80 kg Youth: 32 kg, Children: 11 kg) × EF (days/year) ÷ 365 days/year × Exposure Years ÷ Life Expectancy (78 years)

[e] Cancer Risk = LADD × q_1*; q_1* = 1.83 × 10^{-3} (mg/kg bw/day)$^{-1}$. Shaded values indicate cancer risks above 1 × 10^{-6}.

Table 6 Treated Pet Bedding – Postapplication Non-cancer Incidental Oral (Object-to-Mouth) Risk Assessment

Exposure Scenario	Surface	DR[a] (µg/cm^2)	F_O	OR[b] (µg/cm^2)	SAM (cm^2/event)	ET (hr/day)	N_Replen (interval/hr)	SE	Freq_OtM (events/hr)	Oral Exposure[c] (mg/kg bw/day)	MOE[d]
Pet Bedding	Carpet	72.8	0.06	4.37	10	2[e]	4	0.48	14	0.029	350
	Hard Surfaces	72.8	0.08	5.82	10	2	4	0.48	14	0.038	260

DR = Deposited Residue, F_O = Fraction transferred to object, OR = Object Residue, SAM = Surface Area Mouthed/Event, ET = Exposure Time, N_Replen = # of Replenish Intervals/hr, SE = Saliva Extraction Factor, Freq_OTM = Object-to-Mouth Events/hr, MOE = margin of exposure

[a] DR value is based on chemical-specific data.

[b] OR (µg/cm^2) = DR × F_O.

[c] Object-to-Mouth Exposure (mg/kg bw/day) = OR ÷ 1000 µg /mg × SAM × ET × N_Replen × [(1-(1-SE)^{FreqHtM}] ÷ BW(11 kg)

[d] MOE = NOAEL (mg/kg bw/day) ÷ Exposure (mg/kg bw/day). NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300. Shaded values indicate MOEs that did not reach the target.

[e] 2 hours of exposure time was assumed for carpet instead of the default at 4 hours as the application is limited to pet bedding areas and less exposure time is expected.

Table 7 Treated Pet Bedding – Postapplication Cancer Incidental Oral (Object-to-Mouth) Risk Assessment

Exposure Scenario	Surface	DR[a] (µg/cm^2)	F_O	OR[b] (µg/cm^2)	SAM (events/hr)	ET (hrs/day)	N_Replen (Interval/hr)	SE	Freq_OTM (events/hr)	EF (days/yr)	Exposure Years	LADD[c] (mg/kg bw/day)	Cancer Risk[d]
Pet Bedding	Carpet	26.3	0.02	0.526	10	2[e]	4	0.48	12	90	5	0.000052	$7x10^{-8}$
	Hard Surfaces	26.3	0.03	0.789	10	2[e]	4	0.48	12	90	5	0.000078	$1x10^{-7}$

DR = Deposited Residue, F_O = Fraction transferred to object, OR = Object Residue, SAM = Surface Area Mouthed/Event, Exposure Time, N_Replen = # of Replenish Intervals/hr, SE = Saliva Extraction Factor, Freq_OTM = Object-to-Mouth Events/hr, EF = Exposure Frequency, LADD = Lifetime Average Daily Dose

[a] DR value is based on chemical-specific data.

[b] OR (µg/cm^2) = DR × F_O.

[c] Object-to-Mouth LADD (mg/kg bw/day) = OR (µg/cm^2) ÷ 1000 µg /mg × SAM (events/hr) × ET (hrs/day) × N_Replen × $[(1-(1-SE)^{FreqHtM}]$ ÷ BW(11 kg) × EF (days/year) ÷ 365 days/year × Exposure Years ÷ Life Expectancy (78 years).

[d] Cancer Risk = LADD × q_1*; q_1* = 1.83×10^{-3} (mg/kg bw/day)$^{-1}$.

[e] 2 hours of exposure time was assumed for carpet instead of the default at 4 hours as the application is limited to pet bedding areas.

Table 8 Treated pets and pet bedding – Postapplication Non-cancer Incidental Oral (Hand-to-Mouth) Risk Assessment

Exposure Scenario	Surface or Animal	F_{ai}	DE[a] (mg/hr)	HR[a] (mg/hr)	F_M	ET (hr/day)	N_Replen (interval/hr)	SE	Freq_HtM (events/hr)	Oral Exposure[b] (mg/kg bw/day)	MOE[c]
Pet Bedding	Carpet	0.15	7.9	0.590	0.13	2[d]	4	0.48	20	0.0134	750
	Hard Surfaces	0.15	10.5	0.786	0.13	2	4	0.48	20	0.0179	560
Trigger Spray	Dog – Small	0.04	10.71	0.214	0.13	1	4	0.48	20	0.0024	4100
	Dog – Medium	0.04	4.59	0.092	0.13	1	4	0.48	20	0.0010	9600
	Dog – Large	0.04	2.92	0.058	0.13	1	4	0.48	20	0.0007	15000
	Cat – Small	0.04	9.62	0.192	0.13	1	4	0.48	20	0.0022	4600
	Cat – Medium	0.04	5.77	0.115	0.13	1	4	0.48	20	0.0013	7600
	Cat - Large	0.04	3.61	0.072	0.13	1	4	0.48	20	0.0008	12000
Trigger Spray (Lower Application Rates)	Dog – Small	0.04	1.32	0.026	0.13	1	4	0.48	20	0.0003	33000
	Dog – Medium	0.04	0.65	0.013	0.13	1	4	0.48	20	0.0001	68000
	Dog – Large	0.04	0.72	0.014	0.13	1	4	0.48	20	0.0002	61000
	Cat – Small	0.04	1.89	0.038	0.13	1	4	0.48	20	0.0004	23000
	Cat – Medium	0.04	1.59	0.032	0.13	1	4	0.48	20	0.0004	28000
	Cat - Large	0.04	0.99	0.020	0.13	1	4	0.48	20	0.0002	44000
Powder	Dog – Small	0.37	3.87	0.716	0.13	1	4	0.48	20	0.0081	1200
	Dog – Medium	0.37	2.88	0.533	0.13	1	4	0.48	20	0.0061	1600
	Dog – Large	0.37	2.68	0.496	0.13	1	4	0.48	20	0.0056	1800
	Cat – Small	0.37	1.96	0.362	0.13	1	4	0.48	20	0.0041	2400
	Cat – Medium	0.37	2.09	0.387	0.13	1	4	0.48	20	0.0044	2300
	Cat - Large	0.37	1.88	0.348	0.13	1	4	0.48	20	0.0040	2500

Exposure Scenario	Surface or Animal	F_{ai}	DE[a] (mg/hr)	HR[a] (mg/hr)	F_M	ET (hr/day)	N_Replen (interval/hr)	SE	Freq_HtM (events/hr)	Oral Exposure[b] (mg/kg bw/day)	MOE[c]
Pet Collar (Liquid)	Dog – Small	0.04	5.98	0.120	0.13	1	4	0.48	20	0.0014	7400
	Dog – Medium	0.04	3.67	0.073	0.13	1	4	0.48	20	0.0008	12000
	Dog – Large	0.04	2.70	0.054	0.13	1	4	0.48	20	0.0006	16000
	Cat – Small	0.04	7.60	0.152	0.13	1	4	0.48	20	0.0017	5800
	Cat – Medium	0.04	5.96	0.119	0.13	1	4	0.48	20	0.0014	7400
	Cat - Large	0.04	4.40	0.088	0.13	1	4	0.48	20	0.0010	10000
Pet Collar (Solid)	Dog – Small	0.37	162	30.0	0.13	1	4	0.48	20	0.3411	29
	Dog – Medium	0.37	100	18.4	0.13	1	4	0.48	20	0.2093	48
	Dog – Large	0.37	73	13.5	0.13	1	4	0.48	20	0.1539	65
	Cat – Small	0.37	206	38.2	0.13	1	4	0.48	20	0.4341	23
	Cat – Medium	0.37	162	29.9	0.13	1	4	0.48	20	0.3405	29
	Cat - Large	0.37	119	22.1	0.13	1	4	0.48	20	0.2512	40

F_{ai} = Fraction of a.i. on one hand, DE = Dermal Exposure/hr, HR = Hand Residue Loading/hr, F_M = Fraction of Hand Surface Area Mouthed, ET = Exposure Time, N_Replen = # of Replenish Intervals/hr, SE = Saliva Extraction Factor, Freq_HTM = Hand-to-Mouth Events/hr, MOE = margin of exposure

[a] DE (mg/hr) = Dermal Exposure (mg/kg bw/day) × BW (11 kg) ÷ ET. HR = F_{ai} × DE ÷ 2 hands. Refer to Table 2 and 3 for details on the dermal exposure estimates.

[b] Hand-to-Mouth Exposure (mg/kg bw/day) = HR × F_M × ET × N_Replen × $[(1-(1-SE)^{FreqHtM}]$ ÷ BW(11 kg).

[c] MOE = NOAEL (mg/kg bw/day) ÷ Exposure (mg/kg bw/day). NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300. Shaded values indicate MOEs that did not reach the target.

[d] 2 hours of exposure time was assumed for carpet instead of the default at 4 hours as the application is limited to pet bedding areas and less exposure time is expected.

Table 9 Treated Pets and Pet Bedding – Postapplication Cancer Incidental Oral (Hand-to-Mouth) Risk Assessment

Exposure	Surface or Animal	F_{ai}	DE[a] (mg/hr)	HR[a] (mg/hr)	FM	ET (hr/day)	N_Replen (interval/hr)	SE	Freq_HTM (events/hr)	EF (days/year)	Exposure Years	LADD (mg/kg bw/day)	Cancer Risk[c]
Pet Bedding	Carpet	0.15	0.7	0.051	0.12	2[d]	4	0.48	14	90	5	0.000016	$2x10^{-8}$
	Hard Surfaces	0.15	1.0	0.077	0.12	2	4	0.48	14	90	5	0.000024	$3x10^{-8}$
Trigger Spray	Dog – Small	0.04	3.33	0.067	0.12	1	4	0.48	14	90	5	0.000010	$1x10^{-8}$
	Dog – Medium	0.04	0.71	0.014	0.12	1	4	0.48	14	90	5	0.000002	$3x10^{-9}$
	Dog – Large	0.04	0.45	0.009	0.12	1	4	0.48	14	90	5	0.000001	$2x10^{-9}$
	Cat – Small	0.04	1.50	0.030	0.12	1	4	0.48	14	90	5	0.000005	$6x10^{-9}$
	Cat – Medium	0.04	0.90	0.018	0.12	1	4	0.48	14	90	5	0.000003	$4x10^{-9}$
	Cat – Large	0.04	0.56	0.011	0.12	1	4	0.48	14	90	5	0.000002	$2x10^{-9}$
Trigger Spray (US Rates)	Dog – Small	0.04	0.21	0.004	0.12	1	4	0.48	14	90	5	0.000001	$9x10^{-10}$
	Dog – Medium	0.04	0.10	0.002	0.12	1	4	0.48	14	90	5	0.000000	$4x10^{-10}$
	Dog – Large	0.04	0.11	0.002	0.12	1	4	0.48	14	90	5	0.000000	$5x10^{-10}$
	Cat – Small	0.04	0.29	0.006	0.12	1	4	0.48	14	90	5	0.000001	$1x10^{-9}$
	Cat – Medium	0.04	0.25	0.005	0.12	1	4	0.48	14	90	5	0.000001	$1x10^{-9}$
	Cat – Large	0.04	0.15	0.003	0.12	1	4	0.48	14	90	5	0.000000	$7x10^{-10}$

Exposure	Surface or Animal	F_{ai}	DE[a] (mg/hr)	HR[a] (mg/hr)	FM	ET (hr/day)	N_Replen (interval/hr)	SE	Freq_HTM (events/hr)	EF (days/year)	Exposure Years	LADD (mg/kg bw/day)	Cancer Risk[c]
Powder/ Dust	Dog – Small	0.37	1.45	0.268	0.12	1	4	0.48	14	90	5	0.000042	$6x10^{-8}$
	Dog – Medium	0.37	1.08	0.199	0.12	1	4	0.48	14	90	5	0.000031	$4x10^{-8}$
	Dog – Large	0.37	1.00	0.185	0.12	1	4	0.48	14	90	5	0.000029	$4x10^{-8}$
	Cat – Small	0.37	0.73	0.135	0.12	1	4	0.48	14	90	5	0.000021	$3x10^{-8}$
	Cat – Medium	0.37	0.78	0.145	0.12	1	4	0.48	14	90	5	0.000022	$3x10^{-8}$
	Cat – Large	0.37	0.70	0.130	0.12	1	4	0.48	14	90	5	0.000020	$3x10^{-8}$
Pet Collar (Liquid)	Dog – Small	0.04	3.14	0.063	0.12	1	4	0.48	14	90	5	0.000010	$1x10^{-8}$
	Dog – Medium	0.04	1.92	0.038	0.12	1	4	0.48	14	90	5	0.000006	$8x10^{-9}$
	Dog – Large	0.04	1.42	0.028	0.12	1	4	0.48	14	90	5	0.000004	$6x10^{-9}$
	Cat – Small	0.04	3.99	0.080	0.12	1	4	0.48	14	90	5	0.000012	$2x10^{-8}$
	Cat – Medium	0.04	3.13	0.063	0.12	1	4	0.48	14	90	5	0.000010	$1x10^{-8}$
	Cat – Large	0.04	2.31	0.046	0.12	1	4	0.48	14	90	5	0.000007	$1x10^{-8}$
Pet Collar (Solid)	Dog – Small	0.37	99	18.4	0.12	1	4	0.48	14	90	5	0.002844	$4x10^{-6}$
	Dog – Medium	0.37	61	11.3	0.12	1	4	0.48	14	90	5	0.001745	$2x10^{-6}$
	Dog – Large	0.37	45	8.3	0.12	1	4	0.48	14	90	5	0.001284	$2x10^{-6}$
	Cat – Small	0.37	126	23.4	0.12	1	4	0.48	14	90	5	0.003620	$5x10^{-6}$
	Cat – Medium	0.37	99	18.3	0.12	1	4	0.48	14	90	5	0.002839	$4x10^{-6}$
	Cat – Large	0.37	73	13.5	0.12	1	4	0.48	14	90	5	0.002095	$3x10^{-6}$

Fai = Fraction of a.i. on one hand, DE = Dermal Exposure/hr, HR = Hand Residue Loading/hr, FM = Fraction of Hand Surface Area Mouthed, Exposure Time, N_Replen = # of Replenish Intervals/hr, SE = Saliva Extraction Factor, Freq_HTM = Hand-to-Mouth Events/hr, EF = Exposure Frequency, LADD = Lifetime Average Daily Dose

[a] DE (mg/hr) = Dermal Exposure (mg/kg bw/day) × BW (11 kg) ÷ ET. HR = F_{ai} × DE ÷ 2 hands.

[b] Hand-to-Mouth LADD (mg/kg bw/day) = HR (mg/hr) × FM × ET (hr/day) × N_Replen × [(1-(1-SE)FreqHtM] ÷ BW(11 kg)) × EF ÷ 365 days/yr × Exposure Years ÷ Life Expectancy (78 years).

[c] Cancer Risk = LADD × q_1*; q_1* = 1.83×10^{-3} (mg/kg bw/day)$^{-1}$. Shaded values indicate cancer risks above 1×10^{-6}.

2 hours of exposure time was assumed for carpet instead of the default at 4 hours as the application is limited to pet bedding areas and less exposure time is expected.

Appendix VII Aggregate Exposure and Risk Assessment

Table 1 Aggregate Non-Cancer Exposure and Risk Assessment for Domestic-Class Trigger Spray Products Assuming Lower Application Rates

Animal	Lifestage	Residential Applicator Exposure (µg/kg bw/day)[a]		Residential PA Exposure (µg/kg bw/day)[b]		Dietary Exposure[c] (µg/kg bw/day)	Aggregate Exposure[d] (µg/kg bw/day)	Aggregate MOE[e]
		Dermal	Inhalation	Dermal	Hand-to-Mouth			
Dog – Small	Adult	3.48	0.06	10.41	-	0.015	13.96	720
	Child 1 <2 yrs	-	-	26.46	0.30	0.019	26.78	370
Dog – Medium	Adult	3.98	0.07	5.10	-	0.015	9.16	1090
	Child 1 <2 yrs	-	-	12.96	0.15	0.019	13.13	760
Dog – Large	Adult	6.96	0.13	5.68	-	0.015	12.78	780
	Child 1 <2 yrs	-	-	14.43	0.16	0.019	14.62	680
Cat – Small	Adult	2.49	0.05	14.86	-	0.015	17.41	570
	Child 1 <2 yrs	-	-	37.80	0.43	0.019	38.25	260
Cat – Medium	Adult	3.48	0.06	12.49	-	0.015	16.05	620
	Child 1 <2 yrs	-	-	31.75	0.36	0.019	32.13	310
Cat – Large	Adult	3.48	0.06	7.80	-	0.015	11.36	880
	Child 1 <2 yrs	-	-	19.85	0.23	0.019	20.09	500

PA = Postapplication, MOE = Margin of Exposure

[a] Refer to Appendix V for details on the residential applicator exposure estimates. Lower application rates were used to calculate the residential applicator exposure estimates.

[b] Refer to Appendix V for details on the residential postapplication exposure estimates. Lower application rates were used to calculate the residential postapplication exposure estimates.

[c] Chronic dietary exposure estimates are based on the past dietary exposure and risk assessment.

[d] Aggregate Exposure = Residential Applicator Exposure (adults) + Residential Postapplication Exposure + Dietary Exposure.

[e] Aggregate MOE = NOAEL (mg/kg bw/day) ÷ Exposure (µg/kg bw/day) × 1000 × µg/mg. NOAEL = 10 mg/kg bw/day based on an oral study. Target MOE = 300. Shaded cells indicate MOEs that are approaching the target.

Table 2 Aggregate Cancer LADD and Risk Assessment for Domestic-Class Trigger Spray Products Assuming Lower Application Rates

Animal	Lifestage	Residential Applicator LADD (µg/kg bw/day)[a]		Residential PA LADD (µg/kg bw/day)[b]		Dietary Exposure[c]	Aggregate LADD[d] (µg/kg bw/day)	Aggregate Cancer Risk[e]
		Dermal	Inhalation	Dermal	Hand-to-Mouth	(µg/kg bw/day)		
Dog – Small	Adult	0.026	0.0005	0.115	-	0.019	0.242	$4x10^{-7}$
	Youth 11 <16 yrs	-	-	0.016	-			
	Child 1 <2 yrs	-	-	0.065	0.0006			
Dog - Medium	Adult	0.029	0.0005	0.056	-	0.019	0.145	$3x10^{-7}$
	Youth 11 <16 yrs	-	-	0.008	-			
	Child 1 <2 yrs	-	-	0.032	0.0003			

Animal	Lifestage	Residential Applicator LADD (µg/kg bw/day)[a]		Residential PA LADD (µg/kg bw/day)[b]		Dietary Exposure[c]	Aggregate LADD[d] (µg/kg bw/day)	Aggregate Cancer Risk[e]
		Dermal	Inhalation	Dermal	Hand-to-Mouth	(µg/kg bw/day)		
Dog – Large	Adult	0.051	0.0009	0.063	-	0.019	0.179	$3x10^{-7}$
	Youth 11 <16 yrs	-	-	0.009	-			
	Child 1 <2 yrs	-	-	0.035	0.0003			
Cat – Small	Adult	0.018	0.0003	0.164	-	0.019	0.319	$6x10^{-7}$
	Youth 11 <16 yrs	-	-	0.023	-			
	Child 1 <2 yrs	-	-	0.093	0.0009			
Cat – Medium	Adult	0.026	0.0005	0.138	-	0.019	0.281	$5x10^{-7}$
	Youth 11 <16 yr	-	-	0.019	-			
	Child 1 <2 yrs	-	-	0.078	0.0008			
Cat – Large	Adult	0.026	0.0005	0.086	-	0.019	0.193	$4x10^{-7}$
	Youth 11 <16 yr	-	-	0.012	-			
	Child 1 <2 yrs	-	-	0.049	0.0005			

PA = Postapplication, LADD = Lifetime Average Daily Dose

[a] Refer to Appendix V for details on the residential applicator LADD estimates. Lower application rates were used to calculate residential applicator LADD estimates.

[b] Refer to Appendix V for details on the residential postapplication LADD estimates. Lower application rates were used to calculate residential postapplication LADD estimates.

[c] The chronic exposure estimate for the general population was used and is representative of the dietary LADD.

[d] Aggregate LADD = Residential Applicator LADD (Adults) + Residential Postapplication LADD (All Life stages) + Dietary Exposure (General Population).

e Aggregate Cancer Risk = Aggregate LADD ÷ 1000 µg/mg × q_1*; q_1* = 1.83×10^{-3} $(mg/kg\ bw/day)^{-1}$

Appendix VIII Label Amendments for Products Containing Tetrachlorvinphos

The label amendments proposed below do not include all label requirements for individual products, such as disposal statements, and precautionary statements. Information on labels of currently registered products should not be removed unless it contradicts the following label statements.

Commercial-Class Products

I. The following uses are proposed for removal on the commercial-class wettable powder label:

- Directions for direct application as a wettable powder.
- Handheld spray application to poultry housing walls, ceilings, floor cracks and crevices to treat fowl ticks.

II. The following changes are proposed for the commercial-class wettable powder label:

Replace the following:

Operator Function by Use Pattern Required Protective Equipment	Required Protective Equipment
Applying WP formulation as a dust. Mixers, loaders and applicators using dusting equipment. Loaders and others handling dust bags.	Coveralls over long-sleeved shirt and long pants, chemical–resistant gloves and dust/mist respirator. Single layer clothing and chemical-resistant gloves.
Applying WP formulation in egg and broiler facilities. Mixers, loaders and applicators using low pressure hand-wand activities.	Coveralls over long-sleeved shirt and long pants, chemical-resistant gloves and dust/mist respirator.
Applying WP formulation with backpack spraying. Mixers, loaders and applicators.	Single layer clothing (i.e. long-sleeve shirt and long pants, chemical-resistant gloves and dust/mist respirator.

With:

Operator Function by Use Pattern Required Protective Equipment	Required Protective Equipment
Applying WP mixed with water using a backpack sprayer or mechanically pressurized handgun. Mixers, loaders and applicators	Coveralls over long-sleeved shirt and long pants, chemical-resistant gloves, socks and shoes, and a respirator with a NIOSH-approved organic-vapour-removing cartridge with a prefilter approved for pesticides or a NIOSH approved canister approved for pesticides.
Applying WP mixed with paint using a brush or a sprayer. Mixers, loaders and applicators.	Long-sleeved shirt, long pants, socks and shoes, and chemical-resistant gloves.

III. For clarity and to meet the current labelling standard, the following are proposed to be included a section entitled **PRECAUTIONS**:

- "DO NOT enter or allow entry into treated areas until sprays have dried."
- "DO NOT apply by handheld mist blower/sprayer or fogger."
- "DO NOT use in residential areas. Residential areas are defined as any use site where bystanders including children could be exposed during or after application. This includes homes, schools, parks, playgrounds, playing fields, public buildings, or any other areas where the general public including children could be exposed."

Domestic-Class Products

I. The following domestic-class products are proposed for cancellation:

- All flea and tick powder/dust products.
- All flea and tick pet collar products.

II. The following changes are proposed to be added to flea and tick liquid (trigger spray) product labels:

- Cats: Spray 15–25 strokes for a small cat, spray 25–35 strokes for a medium or large cat.
- Dogs: Spray 25-35 strokes for a small dog, spray 30–40 strokes for a medium dog, spray 40-70 strokes for a large dog.

III. For clarity and to meet the current labelling standard, the following are proposed to be included a section entitled **PRECAUTIONS**:

- Avoid contact with treated animal prior to drying.

References

Value Assessment

PMRA No.	Reference
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2878779	Check List for Fly Control in Poultry Facilities http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/all/epw12257/$FILE/poultry.pdf
2878774	Insecticide-Impregnated Cattle Ear Tags. ENTFACT-505 https://entomology.ca.uky.edu/files/efpdf3/ef505.pdf

Occupational Assessment

Applicant Supplied – Unpublished

PMRA No.	Reference
1987331	2001, Determination of Dermal and Inhalation Exposures to Tetrachlorvinphos (TCVP) During the Application of an Insecticide Powder to a Dog, DACO: 5.4
2178088	1999, Hartz Mountain In Use Risk Assessment of a Flea Collar, Dermal Exposure Test No. 1475 - Protocol 99-1, Test Sample No. 11345, DACO: 5.4
2178090	1999, Revised Hartz Mountain In Use Risk Assessment of a Flea Collar, Dermal Exposure Test No. 1475, Protocol No. 99-1, Sample No. 11345, DACO: 5.4
2722951	1992, Monitoring Exposure Of Mixer/Loaders and Applicators Treating Agricultural Premises with Tetrachlorvinphos (Rabon 50 WP Insecticide) in Handheld Wand-Type Sprayers, DACO: 5.4
2722952	1991, The Dermal Absorption of (^{14}C)Tetrachlorvinphos In The Rat, DACO: 5.8
2725600	2001, Determination of the Dislodgeability of Tetrachlorvinphos (TCVP) from the Fur of Dogs Following the Application of an Insecticide Powder, Pump Spray of Aerosol, DACO: 5.6
2895402	2018, Cover letter-TCVP Technical Special Review, DACO: 5.14
2895403	2018, TCVP Exposure and Use Information Comments to PMRA, DACO: 5.14
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Additional Information - Published

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2862263	Davis, K.; Boone, S.; Moran, K.; Tyler, J. 2008. Assessing Intermittent Pesticide Exposure from Flea Control Collars Containing the Organophosphorus Insecticide Tetrachlorvinphos. Journal of Exposure Science and Environmental Epidemiology (2008) 18, 564–570. DACO: 5.6
2931432	USEPA. 2016. Tetrachlorvinphos: Final Occupational and Residential Exposure Assessment for Registration Review. DACO: 12.5.5
2931433	USEPA. 2015. Occupational and Residential Exposure Assessment for Registration Review. DACO: 12.5 .5
2931434	USEPA. 2014. Residential Exposure Assessment in Response to the Natural Resources Defense Council Petition to Cancel All Pet Uses for Tetrachlorvinphos. DACO: 12.5
2931435	USEPA. 2015. Science Review of “Davis et al., 2008. Assessing Intermittent Pesticide Exposure from Free Control Collars Containing the Organophosphorus Insecticide Tetrachlorvinphos” for HSRB Consideration. DACO: 12.5.5