Pest Management Regulatory Agency
Agence de réglementation de la lutte antiparasitaire

Proposed Acceptability for Continuing Registration

PACR2003-09

Re-evaluation of Tetrachlorvinphos

The organophosphate active ingredient tetrachlorvinphos and associated end-use products were proposed for re-evaluation under Section 19 of the Pest Control Products (PCP) Regulations in June 1999.

As a result of the re-evaluation, it is proposed that uses of tetrachlorvinphos on livestock (beef cattle, dairy cattle and poultry), domestic animals (cats and dogs) and their bedding and living quarters, and non-food uses (farm buildings, dairy barns, poultry houses, swine barns, livestock manure and refuse in barns) do not entail an unacceptable risk to human health and the environment pursuant to Section 20, provided that the proposed mitigation measures described in this document are implemented. For tick control in outdoor living areas (campgrounds, backyards, picnic areas, recreational areas, etc.), the registrant agreed to voluntarily remove this use from the label.

This Proposed Acceptability for Continuing Registration (PACR) document provides a summary of the data reviewed and the rationale for the proposed regulatory decision for tetrachlorvinphos. The Pest Management Regulatory Agency (PMRA) will accept written comments on the proposed regulatory decision up to 60 days from the date of publication of this document. Please forward all comments to the Publications Coordinator at the address below.

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Foreword

The re-evaluation of the active ingredient tetrachlorvinphos and the associated end-use products (EPs) registered for use on food and non-food areas, has been completed by the Pest Management Regulatory Agency (PMRA). Registrants of the technical active ingredient are Boehringer Ingelheim (Canada) Ltd. and The Hartz Mountain Corporation.

The PMRA announced in June 1999 that organophosphate active ingredients, including tetrachlorvinphos, were subject to re-evaluation under authority of Section 19 of the Pest Control Product (PCP) Regulations[1].

The PMRA has carried out an assessment of available information and has found it sufficient, in accordance with Section 20 of the PCP Regulations, to allow a determination of the safety, merit and value of tetrachlorvinphos and associated EPs. The PMRA has concluded that the use of tetrachlorvinphos and its EPs does not entail an unacceptable risk to human health and the environment in accordance with Section 20, provided that the proposed mitigation measures described in the document are implemented.

It is proposed that the Food and Drugs Regulations be amended so that, with the exception of poultry, beef, milk and eggs, food with quantifiable residues of tetrachlorvinphos can no longer be sold in Canada, unless additional data to support tetrachlorvinphos residues in imported food are provided.

The PMRA will accept written comments on this proposal up to 60 days from the publication date of this document to allow interested parties an opportunity to provide input into the proposed re-evaluation decision for these products.

[1] Re-evaluation Document REV00-01, *Re-evaluation of Organophosphate Pesticides*

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1.0 Purpose

This document describes the outcome of the Pest Management Regulatory Agency' s (PMRA) re-evaluation of the insecticide tetrachlorvinphos and its end-use products (EPs). It includes a human health assessment, an environmental assessment and information on the value of tetrachlorvinphos to pest management in Canada. By way of this document, the PMRA is soliciting comments from interested parties on the decisions and mitigation measures proposed.

2.0 General background on re-evaluation

The PMRA is re-evaluating, under Section 19 of the Regulations pursuant to the *Pest Control Products Act*, all pesticides, both active ingredients (a.i.s) and formulated EPs, that were registered prior to 1995. As outlined in Regulatory Directive DIR2001-03 *PMRA Re-evaluation Program*, a modern scientific approach is used to determine the continuing acceptability of older active ingredients in relation to human health and the environment. Tetrachlorvinphos is under reassessment in the U.S. (United States) as a result of the *Food Quality Protection Act* and is therefore being re-evaluated by the PMRA under Program 3. The following components are addressed and considered in this re-evaluation:

Risk to human health: The initial focus of the re-evaluation of a pest control product in Program 3 is the risk to human health. As indicated in Regulatory Directive DIR2001-03, the reassessment in Program 3 pays particular attention to:

- pest control products with a common mechanism of toxicity,
- aggregate exposure to a pesticide arising from its residues in food and drinking water, and from non-occupational exposure, such as from treatments in and around homes, and
- susceptibility and exposure of infants and children during critical developmental stages, which may be different from those of adults.

The re-evaluation of risks to human health also includes a re-examination of the acceptability of risks resulting from occupational exposure. Once the reassessments of all the individual organophosphates have been completed, a cumulative assessment of all the remaining uses of organophosphates will be conducted.

Risk to the environment: The environmental assessments will be tiered, with refined environmental risk assessments taking place only on those active ingredients, products or uses that pass the cumulative health risk assessment or, for unique mechanisms of toxicity, that are acceptable from a human health perspective. At the first tier, based on an identification of hazards to non-target organisms, measures to reduce environmental exposure will be implemented where warranted. These measures may include removing

obsolete uses, reducing the number of applications, requiring buffer zones to protect sensitive habitats, and taking regulatory action against uses that have been determined to be extremely high risk to organisms in the environment. In general, uses which remain after the first tier assessment will be revisited when the results of refined environmental assessments are available.

A tiered approach is necessary for several reasons. For some products, initial environmental assessments indicate a high hazard. However, there is considerable uncertainty with regard to the frequency and magnitude of exposure and effects. For some products there is also little data on field concentrations and(or) adverse effects. A tiered approach to environmental risk assessment allows time for development and implementation of refined ecological risk assessment methods, for additional data to be provided to refine the environmental exposure assessments, and for consideration of the preferability of existing alternatives and the development of new ones. In addition, a tiered approach makes the most efficient use of assessment resources.

Value: The PMRA seeks to understand, as early as possible in the re-evaluation process, the current uses of products under review and their importance for pest management in agriculture, the nursery trades, forestry and public health. The PMRA relies primarily on provincial and territorial government input. Registrants and users are also important sources of information. Environment Canada, the Department of Foreign Affairs and International Trade, the Canadian Food Inspection Agency and Agriculture and Agri-Food Canada are also contacted, as needed, in the re-evaluation process for information specific to their areas of expertise.

The outcome of the re-evaluation of each pesticide, including proposed risk mitigation measures, will be published in a consultation document at the end of the aggregate human health risk assessment and the first tier environmental assessment. In some cases the PMRA will implement changes in regulatory status of products prior to public consultation, especially where the PMRA considers risk mitigation ineffective or impractical, or where registrants have opted for voluntary discontinuation of the sale of products.

3.0 Re-evaluation of tetrachlorvinphos

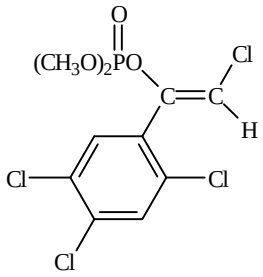
Tetrachlorvinphos is one of the 27 organophosphate pesticides subject to re-evaluation in Canada. The re-evaluation of tetrachlorvinphos was announced in Re-evaluation Document REV99-01 *Re-evaluation of Organophosphate Pesticides*. Tetrachlorvinphos is a broad spectrum organophosphate insecticide that inhibits the enzyme acetylcholinesterase, interrupting the transmission of nerve impulses. It works by contact, ingestion and vapour action. Tetrachlorvinphos has been used in registered pest control products in Canada since 1967 when the product “Gardona Insecticide 75% Wettable Powder” (Reg. No. 9910) was registered.

Currently two technical and 26 formulated EPs containing tetrachlorvinphos are registered in Canada, including 23 domestic and 3 commercial class products (Appendix I).

Much of the scientific information used by the PMRA in its assessment of tetrachlorvinphos came from reviews conducted by the U.S. Environmental Protection Agency (USEPA). The USEPA review for tetrachlorvinphos can be referenced for further details regarding the scientific studies used by the PMRA. This review, as well as other information on the regulatory status of tetrachlorvinphos in the U.S., can be found at the Web site for the USEPA: http://www.epa.gov/pesticides/reregistration/status.htm.

3.1 Identity of the active substance and end-use products containing it

Tetrachlorvinphos is an organophosphate insecticide consisting of the Z-isomer of 2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate. The chemical overview is shown below:

Active substance:	Tetrachlorvinphos
Function:	Insecticide
Chemical family:	Organophosphate
Chemical name:	(Z)-2-Chloro-1-(2,4,5-trichlorophenyl)ethenyl dimethyl phosphate
CAS[a] Registry number:	22248-79-9
Molecular formula:	$C_{10}H_9O_4Cl_4P$
Molecular weight:	366.0
Structural formula:	

(Z) - isomer

Basic Manufacturer(s):	DuPont Agricultural Products for Reg. No. 23019 Great Lakes Chemical Corporation for Reg. No. 25338

Purity of TGAI[b]:	98.7% nominal (97.0–100%) for Reg. No. 23019 98.7% nominal, (95.7–101.7%) for Reg. No. 25338

[a] CAS—Chemical Abstracts Service
[b] TGAI—Technical Grade Active Ingredient

Based on the raw materials used, the manufacturing process and the chemical structure of the active ingredient, the technical product is not expected to contain other impurities of toxicological concern.

3.2 Description of current registered uses

The following information is based on the currently registered uses of tetrachlorvinphos.

Type of pesticide: insecticide (organophosphate; contact, stomach, vapour).

Summary of supported use sites:
In Canada tetrachlorvinphos is registered for use on livestock, domestic animals and their bedding and living quarters and non-food uses (Appendix I). The livestock that are supported are beef cattle, dairy cattle and poultry. The domestic animals supported are cats and dogs. The supported non-food uses are farm buildings, dairy barns, poultry houses, swine barns, livestock manure and refuse in barns. There is a registered use of tick control in outdoor living areas (campgrounds, backyards, picnic areas, recreational areas, etc.); however, this use is not supported by the registrant and will be phased out.

In the U.S., tetrachlorvinphos is registered for the same sites as in Canada except farm buildings and with the addition of hogs, horses, mink, sheep and garbage/refuse areas.

Target pests:
Tetrachlorvinphos is registered in Canada for the control of a broad spectrum of insect, tick and mite pests, including:

Coleoptera (beetles): lesser mealworm
Diptera: face fly, horn fly infesting cattle, flies infesting farm buildings and flies (maggots) infesting manure
Mallophaga: chewing lice
Siphonaptera: fleas
Acari: American dog tick, black legged (deer) tick, brown dog tick, fowl tick, mites infesting poultry, lice infesting poultry, Rocky Mountain tick, ticks infesting dogs and cats.

Formulation types registered: dusts, impregnated fabrics, solutions (delivered by pump sprayer), slow-release generators, wettable powders, aerosol sprays.

Method and rates of application:
Equipment—In agriculture: ear tags, power sprayers. Other applications: pet collars (slow-release generators and impregnated fabrics), dusts, ready to use aerosol and pump spray cans, low pressure backpack sprayers, power sprayers.

Application method and rate—
Commercial uses:
Cattle ear tags—2.3 g a.i./ear tag, 2 tags/animal per year.
Poultry wire cages containing poultry—20 g a.i./100 birds with low pressure sprayers, 14 days between sprays.
Poultry houses—dust box, 75 g a.i./100 birds.
Poultry houses—roost paint, 1.45–1.65 g a.i./10 m^2.
Poultry houses—litter management, 10–40 g a.i./100 m^2 with low pressure sprayers; 37.5g ai/10 m^2 with rotary or mechanical duster.
Poultry houses—in general, 30–40 g a.i./10 m^2 with power sprayers.
Farm buildings—40–160 g a.i./100 m^2 (adult flies) with low pressure sprayers.
Farm buildings—40 g a.i./100 m^2 (maggots) with low pressure sprayers, 7–10 days between sprays.
If no period between sprays is listed, none was stated on the product labels. The maximum number of applications and pre-slaughter intervals were not stated on the product labels.

Domestic uses:
Cat collars—1.6–2.8 g a.i./collar prior to trimming collar to size of animal, replace every three to seven months.
Dog collars—3.9–4.8 g a.i./collar prior to trimming collar to size of animal, replace every four to seven months.
Puppy collars—3.2 g a.i./collar prior to trimming to size of animal, replace every seven months.
Dust—amount per dog or cat not stated (3.8 g a.i./container), apply at weekly intervals as needed.
Aerosol—amount per dog or cat not stated (2.1 g a.i./container), apply at 3–7-day intervals as needed.
Pump spray—amount per dog or cat not stated (463 g a.i./container), apply at 7-day intervals as needed.

4.0 Effects having relevance to human health

4.1 Toxicology summary

Studies available from the registrant were the primary source for the toxicology database supporting tetrachlorvinphos. In laboratory animals, tetrachlorvinphos was moderately acutely toxic to rats via the oral route. Acute dermal and inhalation exposure resulted in a finding of low toxicity in rabbits and rats, respectively. Tetrachlorvinphos was found to be a slight dermal irritant and a dermal sensitizer. It was moderately irritating to the eyes.

Acute toxic signs induced by tetrachlorvinphos are consistent with signs of cholinesterase intoxication and include tremors, salivation, bloody tears, decreased motor activity, hyper-reactivity, depression and death. With oral exposure, tetrachlorvinphos was readily absorbed and rapidly eliminated with little tissue retention. Excretion occurred via the urine and feces. The major metabolite in feces was trichlorophenylethanol with lesser amounts identified as trichlorophenylethandiol. Trichloromandelic acid and desmethyl tetrachlorvinphos were urinary metabolites. Metabolite profiles differed quantitatively between genders.

In subchronic studies in the rat, cholinesterase inhibition was accompanied by effects on the liver, kidneys, thyroid, adrenals and body weight. In dogs, effects on hematological parameters were noted. The effects were typically dose-related with no apparent difference between sexes. In long-term studies in both the mouse and the rat, in addition to effects on body weight, the liver was the target organ with numerous degenerative changes. Other target organs with pathological changes in the mouse and rat included the kidney and testes. Additional effects at high dose levels were noted in the adrenal and uterus/ovaries (mouse) and thyroid and parathyroid (rat). Overall, the information from the subchronic and chronic studies indicate an effect on endocrine organs (e.g., adrenal, thyroid and reproductive organs) at high doses.

There was no evidence of delayed-type neurotoxicity in the hen study; however, neurotoxic esterase was not measured. There was no evidence of histopathological effects on the central nervous system in acute or subchronic neurotoxicity studies involving the rat or in the other subchronic/chronic studies.

For carcinogenicity, a National Cancer Institute (NCI) mouse study resulted in an increased incidence of hepatocellular carcinomas in males and an increased incidence of neoplastic liver nodules in females. Repetition of the study in mice yielded an increased incidence of hepatocellular adenomas/carcinomas in both sexes as well as an increased incidence of renal adenomas/carcinomas in males. In rats, a NCI study indicated an increased incidence of adrenal cortical adenomas and thyroid C-cell adenomas in females at dose levels that were likely excessive. In an additional long-term rat study, a non-statistically significant increase in thyroid C-cell adenomas and adrenal phaeochromocytomas was noted in males. In the assessment of genotoxicity, tetrachlorvinphos was negative in two in vitro mutation studies but was positive (without activation) in an in vitro chromosome aberration study. Tetrachlorvinphos yielded equivocal results in one unscheduled DNA synthesis assay but was negative in a second assay at comparable dose levels. No adequate in vivo genotoxicity data was available. Overall, tetrachlorvinphos is considered to be a possible human carcinogen based on statistically significant increases in combined hepatocellular adenomas/carcinomas in mice, and suggestive evidence of thyroid C-cell adenomas and adrenal adenomas in rats.

Developmental and reproductive toxicity studies in the rat did not indicate any increased sensitivity of the developing young, relative to maternal animals, due to either pre- or post-natal exposure to tetrachlorvinphos. A developmental study conducted in the rabbit

did demonstrate developmental effects in the form of increased resorptions, increased post-implantation loss, and decreased numbers of live fetuses per dam; however, these effects occurred at a dose level that resulted in significant maternal toxicity.

The toxicology database includes studies conducted with domestic animals using typical EPs containing tetrachlorvinphos. There was no evidence of adverse effects other than a decrease in plasma cholinesterase that would indicate exposure to a cholinesterase inhibitor.

Reference doses have been set based on no observed adverse effect levels (NOAELs) for the most sensitive indicators of toxicity. These reference doses incorporate various uncertainty factors to account for extrapolating between laboratory animals and humans, and for variability within the human population.

The toxicology endpoints used in the risk assessment of tetrachlorvinphos are summarized in Appendix II.

4.2 Non-cancer occupational and residential risk assessment

Non-cancer risk is estimated by comparing potential exposure to the most relevant endpoints from toxicology studies to generate a margin of exposure (MOE). This is compared to a target MOE incorporating safety factors protective of the most sensitive population. The risk exceeds the PMRA' s level of concern if the calculated MOE is less than the desired or target MOE.

4.2.1 Occupational

For short- and intermediate-term dermal and inhalation risk assessment (1–6 months) the oral NOAEL of 6.7 mg/kg bw/day from the 90-day rat study was selected. This NOAEL was based on erythrocyte cholinesterase inhibition, decreased weight gain, and additional effects on the liver, kidney, thyroid and adrenals at the Lowest Observable Adverse Effect Level (LOAEL) of 142 mg/kg bw/day. No adequate repeat-dose dermal study was available. The target MOE selected when using this study is 100; this accounts for standard uncertainty factors of 10× for interspecies extrapolation and 10× for intraspecies variability. The target MOEs are considered to be protective of all populations including pregnant women and their fetuses, infants and children.

For tetrachlorvinphos, the adverse toxicological endpoint of cholinesterase inhibition is the same regardless of exposure route and the short-term risk assessments have the same target MOE of 100; thus it is appropriate to combine the route-specific MOEs into a single risk estimate. MOEs greater than or equal to 100 do not require risk mitigation.

4.2.1.1 Mixer/loader/applicator

Occupational handlers of tetrachlorvinphos include individual farmers or ranchers who mix, load and(or) apply pesticides and professional or custom agricultural applicators. The major exposure scenarios identified were:

- mixing/loading wettable powder for high pressure handwand application on poultry and poultry premises
- mixing/loading wettable powder for groundboom application to broiler facilities
- mixing/loading wettable powder for paint-on fly control in farm buildings
- mixing/loading wettable powder for dusting applications in floor management of poultry premises
- applying using high pressure handwand on poultry and poultry premises
- applying with groundboom in broiler facilities
- mixing/loading/applying wettable powder with a low pressure handwand on poultry and poultry premises
- mixing/loading/applying wettable powder with a backpack on poultry and poultry premises
- mixing/loading/applying wettable powder for slurry paint-on for poultry premises
- applying ear tags to cattle.

This assessment is based on the USEPA assessment (EPA, 2002). The USEPA estimated risks addressing all elements of the poultry industry that included egg (layer) and broiler production, and risks associated with beef and dairy cattle production. Use patterns and application rates identified on Canadian product labels mirror those assessed by the USEPA. The USEPA, however, has assessed more scenarios than are likely in Canada because there are more formulations registered in the U.S. Data from a chemical-specific handler exposure study submitted to the USEPA were in the same range of exposures as those from the Pesticide Handlers' Exposure Database (PHED), the database routinely used for handler risk assessments when chemical-specific data are not available. The results based on PHED data were used because PHED is a more robust database. PHED is a compilation of generic mixer/loader/applicator passive dosimetry data with associated software that facilitates the generation of scenario-specific exposure estimates. To estimate exposure for each use scenario, appropriate subsets were created from the mixer/loader and applicator database files of PHED. All data were normalized for the amount, in kg, of active ingredient handled. Exposure estimates were calculated on the basis of the best-fit measure of central tendency, i.e., summing the measure of central tendency for each body part which is most appropriate to the distribution of data for that body part.

Exposure is calculated as the product of the unit exposure for a given scenario and the amount of active ingredient handled per day divided by the body weight. With appropriate personal protective equipment (PPE) and(or) other mitigative measures (see Section 4.7), all mixer/loader/applicator MOEs exceed the target MOE. This indicates potential exposures are below levels that would be of concern.

4.2.1.2 Occupational post-application

Given the nature of activities that people perform in a poultry house, such as visually checking the condition of the caged birds as well as feeding and watering, contact with treated surfaces should be minimal. Since the vapour pressure of tetrachlorvinphos is 2.6×10^{-7} mm Hg at 25°C, the post-application inhalation exposure is also assumed to be minimal. Thus, based on the use patterns for tetrachlorvinphos, the potential for post-application exposure is considered to be minimal and much lower than applicator exposure. Therefore, no quantitative occupational post-application exposure and risk assessment was conducted.

4.2.2 Residential

The same short- and intermediate-term toxicology endpoints and target MOEs as selected for the occupational risk assessment are relevant for adults and children in the residential risk assessment.

For short- and intermediate-term dermal and inhalation risk assessment (1–6 months) the oral NOAEL of 6.7 mg/kg bw/day from the 90-day rat study was selected. This NOAEL was based on erythrocyte cholinesterase inhibition, decreased weight gain and additional effects on the liver, kidney, thyroid and adrenals at the LOAEL of 142 mg/kg bw/day. No adequate repeat-dose dermal study was available. The target MOE selected when using this study is 100; this accounts for standard uncertainty factors of 10× for interspecies extrapolation and 10× for intraspecies variability. The target MOEs are considered to be protective of all populations including pregnant women and their fetuses, infants and children.

For assessment of short-term non-dietary oral ingestion, the oral NOAEL of 6.7 mg/kg bw/day from the 90-day rat study was selected for risk assessment. The target MOE selected when using this study is 100; this accounts for standard uncertainty factors of 10× for interspecies extrapolation and 10× for intraspecies variability.

4.2.2.1 Pet owner applicator

Products containing tetrachlorvinphos are registered for use on cats and dogs for control of ticks and fleas. The EPs with pet uses are available as impregnated collars, powders or dusts, aerosol spray (pressurized products) and pump sprays (solutions). Dermal and inhalation exposure for dusting a dog and dermal exposure for applying a flea collar were estimated from studies submitted by the registrant. The PHED was used for estimating dermal and inhalation exposures from aerosol and pump spray application of tetrachlorvinphos-containing solutions to pets.

Application rates for dust, pump spray and aerosol spray were estimated for an average sized dog weighing 14 kg. Exposure from applying a collar was based on the largest collar available. Dermal and inhalation exposures of adults applying a collar, dusting a dog, or spraying a dog with a pump spray or an aerosol result in MOEs that are above the target MOE of 100 and are not considered to be a health concern.

4.2.2.2 Post-application

Since residues must remain on pets for flea and tick control products to be effective, there is potential for post-application exposure of adults and children to tetrachlorvinphos residues transferable from contact with a treated pet.

A dislodgeable fur residue (DfR) study was also submitted to assist in assessing post-application exposure following application of powder, pump spray and aerosol spray formulations of tetrachlorvinphos-containing products to dogs.

Dermal exposure was estimated assuming the quantitative transfer from the dog to the owner of the total amount dislodgeable in the contact area equivalent to a toddler or a youth hugging an average-size dog (14 kg), or to an adult stroking the dog. Incidental oral ingestion by toddlers was estimated using the dislodgeable residue, the default values for frequency of hand-to-mouth transfers, total skin area per hand-to-mouth event, exposure duration and saliva extraction efficiency (USEPA Science Advisory Council for Exposure, Policy No. 12, “Recommended Revisions to the Standard Operating Procedures for Residential Exposure Assessments”, February 22, 2001).

The contribution from inhalation exposure in post-application scenarios is considered to be negligible because of the low volatility of tetrachlorvinphos. This assessment assumed negligible additional exposure from pet bedding. Post-application exposure estimates result in MOEs that are above the target of 100 and are not considered to represent a health concern.

4.3 Dietary risk assessment

In a dietary exposure assessment, the PMRA determines how much of a pesticide residue, including residues in milk and meat, may be ingested with the daily diet. These dietary assessments are age-specific and incorporate the different eating habits of the population at various stages of life. For example, assessments take into account differences in children’ s eating patterns, such as food preferences and the greater consumption of food relative to their body weight when compared to adults. Dietary risk is then determined by the combination of the exposure and the toxicity assessments. High toxicity may not indicate high risk if the exposure is low. Similarly, there may be risk from a pesticide with low toxicity if the exposure is high.

Acute dietary risk is calculated considering food consumption and residue values in food. A probabilistic statistical analysis allows all possible combinations of consumption and residue levels to be combined to estimate a distribution of the amount of tetrachlorvinphos residue that might be eaten in a day. A value representing the high end (99.9^{th} percentile) of this distribution is compared to the acute reference dose (ARfD), which is the dose at which an individual could be exposed on any given day and expect no adverse health effects. When the expected intake from residues is less than the ARfD, the expected intake is not considered to be of concern.

The chronic dietary risk is calculated by using the average consumption of different foods and average residue values on those foods, over a 70-year lifetime. This expected intake of residues is compared to the acceptable daily intake (ADI), which is the dose at which an individual could be exposed over the course of a lifetime and expect no adverse health effects. When the expected intake from residues is less than the ADI, the expected intake is not considered to be of concern.

To estimate acute dietary risk (1-day), the NOAEL of 6.7 mg/kg bw/day from a 90-day dietary toxicity study in rats was selected. This NOAEL was based on erythrocyte cholinesterase inhibition, decreased weight gain, and additional effects on the liver, kidney, thyroid and adrenals at the LOAEL of 142 mg/kg bw/day. The acute neurotoxicity study was not selected as cholinesterase measurements were not taken. Standard uncertainty factors of 10× for interspecies extrapolation and 10× for intraspecies variability were used. The ARfD was calculated to be 0.067 mg/kg bw (6.7 mg/kg bw ÷ 100). This value was considered to be protective of all populations including pregnant women and their fetuses, infants and children.

To estimate dietary risk from repeat dietary exposure, the NOAEL of 4.23 mg/kg bw/day from a 104-week chronic study in rats was selected for risk assessment. The NOAEL is based on liver histopathology noted (hepatocellular hypertrophy in males and females, hepatocytic degenerative changes in males) and adrenal histopathological changes observed in males and females at the LOAEL of 43 mg/kg bw/day. Standard uncertainty factors of 10× for interspecies extrapolation and 10× for intraspecies variability were used. The ADI was calculated to be 0.042 mg/kg bw/day (4.2 mg/kg bw/day ÷ 100). This value was considered to be protective of all populations including pregnant women and their fetuses, infants and children.

Cancer risk from dietary exposure is calculated on the same 70-year lifetime exposure as for the chronic dietary risk. The product of expected intake of residues and the cancer potency factor (Q_1*) estimates the lifetime cancer risk as a probability. A lifetime cancer risk in the most exposed subpopulation of less than 1×10^{-6} is not of concern.

Tetrachlorvinphos is considered to be a possible human carcinogen based on statistically significant increases in combined hepatocellular adenomas/carcinomas in female mice, and suggestive evidence of thyroid cell adenomas and adrenal phaeochromocytomas in rats. A cancer potency factor (Q_1*) of 1.83×10^{-3} (mg/kg bw/day)$^{-1}$ was estimated using the time-to-tumour model.

Acute, chronic, and cancer dietary exposure and risk estimates were generated using the Dietary Exposure Evaluation Model (DEEM®) software and updated consumption data from the United States Department of Agriculture' s (USDA) Continuing Survey of Food Intakes by Individuals (CSFII; 1994–1998). Although exposure through drinking water is normally included in the dietary risk assessment, the registered uses of tetrachlorvinphos (ear tags, poultry spray, animal premise spray, domestic pets) are not likely to impact drinking water sources. Therefore the potential exposure to tetrachlorvinphos through drinking water was considered to be negligible.

The acute dietary exposure was assessed in a mixed tier probabilistic assessment, using anticipated residue data from metabolism studies, available monitoring data and percentage of livestock treated as refinements for all commodities on which tetrachlorvinphos is registered in the U.S. and in Canada. The acute potential daily intake (PDI) accounted for <20% (99.9^{th} percentile) of the ARfD for all subpopulations.

The chronic dietary exposure and dietary cancer risk were assessed using anticipated residue data from metabolism studies and the percentage of livestock treated as refinements for all commodities on which tetrachlorvinphos is registered in the U.S. and in Canada. The chronic PDI accounted for <1% of the ADI for all population subgroups. Lifetime cancer risk was 0.15×10^{-6}, which is below the agency' s level of concern. For the most exposed subpopulation, children aged 1–6 years, cancer risk was acceptable even with lifetime exposure amortised over only that six-year period (cancer risk was 0.37×10^{-6}).

These cancer, chronic and acute dietary risk assessments demonstrated that there were no dietary health concerns for any population subgroup in Canada, including infants, children, teenagers, adults and seniors. In addition, no dietary health concerns were evident for nursing or pregnant females, or based on gender in general.

4.4 Aggregate non-cancer risk assessment

Short-term aggregate exposure to tetrachlorvinphos is comprised of food, drinking water and residential (incidental oral, dermal and inhalation) exposure. The relevant duration of exposure to assess toxicological endpoints for this assessment would be a period of 1–30 days. As there is no study of this duration within the toxicology database for tetrachlorvinphos, the most relevant studies have been selected.

For assessment of the oral, dermal and inhalation route of exposure, an oral 90-day rat study was selected (an adequate dermal and inhalation study was not available). The NOAEL of 6.7 mg/kg bw/day was based on erythrocyte cholinesterase inhibition, decreased weight gain, and additional effects on the liver, kidney, thyroid and adrenals at the LOAEL of 142 mg/kg bw/day. For the 1- to 30-day aggregate assessment the target MOE is 100; this accounts for standard uncertainty factors of 10× for interspecies extrapolation and 10× for intraspecies variability. This target MOE is considered protective of all populations.

For short-term aggregate risk, exposure to tetrachlorvinphos in food and short-term residential exposures (handler and post-application) are combined. The chronic dietary exposure was considered representative of a typical short-term exposure, since it represents the average daily exposure over an individual' s lifetime.

All aggregate non-cancer risks are greater than the target MOE of 100 and do not represent a health concern to the PMRA. For adults, the highest exposure scenario was application of collars with a MOE of 230. MOEs for all other application scenarios ranged from 2200 to 7400. Aggregate risk estimates for post-application exposures of toddlers were not a health concern for all scenarios. The lowest MOE was for aerosol spray (130). The other risk estimates ranged between MOEs of 180 and 540.

4.5 Aggregate cancer risk assessment

In aggregate cancer risk assessment, exposure from all sources is combined and amortised over a 70-year lifetime to estimate a lifetime average daily dose (LADD). Dietary exposure of the general population is considered over a 70-year lifetime. Pet ownership for 50 years is assumed. Residential exposures are considered over the different life stages. Child dermal and incidental oral ingestion exposures arising from contact with a treated pet are considered for 6 of the 50 years of pet ownership, youth dermal exposure for another 6 years and adult application and post-application exposures are considered for the remaining 38 years of pet ownership.

Aggregate cancer risks from exposure to pets treated with powders (dusts), pump or aerosol sprays, and collars were calculated using a Q_1* value of 1.83×10^{-3} $(mg/kg\ bw/day)^{-1}$. Aggregate cancer risks less than 1×10^{-6} or one in 1 million, are not considered to represent a health concern. Aggregate cancer risks for all scenarios were not considered a health concern as risk estimates ranged from 1.6×10^{-7} to 3.6×10^{-7}.

5.0 Environmental assessment

The environmental risk assessment has been largely based on the information contained in the USEPA Reregistration Eligibility Decision (RED) for Tetrachlorvinphos. Information has also been obtained from the Agricultural Research Service (ARS) of the USDA Pesticide Properties Database and the USEPA Pesticide Ecotoxicity Database.

5.1 Environmental fate

Tetrachlorvinphos has a reported solubility in water of 15 mg/L at 24°C, which would classify it as soluble. The vapour pressure of 5.6×10^{-6} Pa at 20°C (4.2×10^{-8} mm Hg) indicates that tetrachlorvinphos is relatively non-volatile under field conditions. The calculated Henry' s Law constant of 1.35×10^{-9} atm.m^3/mole and the calculated 1/H of 1.7×10^{7} indicates that tetrachlorvinphos is unlikely to volatilize from water or moist soil surfaces. The octanol/water partition coefficient (log K_{ow} = 3.53) indicates that tetrachlorvinphos has a potential for bioaccumulation in biota. Based on the chemical structure, tetrachlorvinphos will not dissociate under acidic or basic conditions. The UV/visible absorption spectrum was not reported.

Tetrachlorvinphos was transformed via hydrolysis with the most rapid transformation occurring under alkaline conditions. No information was available addressing the phototransformation of tetrachlorvinphos in soil, water and air. Aerobic soil biotransformation is an important route of biotic transformation of tetrachlorvinphos. No information was provided addressing anaerobic soil biotransformation or aquatic aerobic and anaerobic transformation of tetrachlorvinphos.

Tetrachlorvinphos was observed to have a low mobility in sand, sandy loam, loam and silty clay soils tested in the laboratory. Soil field dissipation studies were not conducted in Canada or in relevant northern U.S. states.

No information was provided addressing the bioaccumulation of tetrachlorvinphos in biota. Tetrachlorvinphos was, however, almost completely metabolized and most of the radiolabel was excreted in urine (46–60%) and feces (38–56%) within 48 hours of dosing in laboratory studies conducted with rats.

5.2 Environmental toxicology

Technical tetrachlorvinphos was highly toxic to the honeybee (*Apis mellifera)* in a laboratory acute contact toxicity test. The LD_{50} was determined to be 1.37 µg/bee. Tetrachlorvinphos foliar residues remained toxic to honeybees (*Apis mellifera)* for less than 3 hours in a foliar residue toxicity study. No information on the toxicity of tetrachlorvinphos to earthworms was available.

The acute oral LD_{50} for mallard duck, ring-necked pheasant and chukar partridge was >2000 mg TGAI/kg bw and classifies technical tetrachlorvinphos as practically non-toxic to these species. The subacute dietary toxicity of 96% technical tetrachlorvinphos to bobwhite quail (*Colinus virginianus*), mallard duck (*Anas platyrhynchos*), Japanese quail (*Coturnix japonica*) and ring-necked pheasant (*Phasianus colchicus*) was >5000mg/kg diet, which classifies it as practically nontoxic to these species. The subacute dietary toxicity of technical tetrachlorvinphos to the cardinal (*Richmonden cardinalis*) was 2835 mg a.i./kg diet, which classifies it as slightly toxic. The subacute dietary toxicity of technical tetrachlorvinphos to the blue jay (*Cyanocitta cristata*) and the house sparrow (*Passer domesticus*) was 995 mg a.i./kg diet and 1000 mg a.i./kg diet respectively, classifying it as moderately toxic to these species. Tetrachlorvinphos is moderately toxic (rat LD_{50} 465 mg a.i./kg bw) to mammals on an acute oral basis.

Tetrachlorvinphos is very highly acutely toxic to freshwater aquatic invertebrates (48-h LC_{50} for *Daphnia magna* 1.9 µg a.i./L), highly acutely toxic to cold fresh water fish, e.g., rainbow trout (96-h LC_{50} 320 µg a.i./L), highly acutely toxic to warm fresh water fish, e.g., bluegill sunfish (96-h LC_{50} 500 µg a.i./L) and highly acutely toxic to estuarine and marine invertebrates (48-h LC_{50} 260 µg a.i./L). No information was available for algae or aquatic vascular plants.

5.3 Concentrations in drinking water

The potential for contamination of drinking water with tetrachlorvinphos is expected to be minimal because the current registered use patterns in Canada are not expected to result in any appreciable runoff into surface waters or exposure to soil and hence leaching to groundwater.

The commercial class registrations of tetrachlorvinphos, including use in ear tags to control face flies and horn flies on beef and dairy cattle, use in farm buildings (dairy barns, poultry houses, swine barns) for the control of flies and maggots, use in poultry houses for the control of lice, mites, lesser mealworms and the fowl tick and the domestic class registrations for the control of fleas and ticks on dogs and cats will not result in any runoff to surface waters or exposure to soil and hence leaching to groundwater.

The commercial class registration for the control of flies in manure around agricultural premises could potentially result in runoff to surface waters if rainfall ever occurred immediately following application or leaching to groundwater if the manure was spread on agricultural fields. Laboratory aerobic soil biotransformation studies, however, showed that tetrachlorvinphos was non-persistent in soil (DT_{50} 4.4–<8 days). It is expected that the high microbial populations in manure should result in an even more rapid biotransformation and hence lower persistence. Tetrachlorvinphos was also observed to have a low mobility on sand, sandy loam, loam and silty clay soils tested in the laboratory. The high organic content of manure should increase the adsorption of tetrachlorvinphos and reduce its mobility even more, thus reducing the potential for high concentrations in runoff or leaching to soil.

5.4 Terrestrial risk assessment

A terrestrial risk assessment for tetrachlorvinphos was not conducted because the registered uses are expected to result in minimal exposures to non-target terrestrial organisms and, therefore, negligible risk.

5.5 Aquatic risk assessment

An aquatic risk assessment for tetrachlorvinphos was not conducted because the registered uses are expected to result in minimal exposures to non-target aquatic organisms and, therefore, negligible risk.

5.6 Toxic Substances Management Policy

The PMRA has taken into account the federal Toxic Substances Management Policy (TSMP) during the review of tetrachlorvinphos. Insufficient data are available to determine whether tetrachlorvinphos meets the TSMP Track-1 criteria for persistence because the persistence in water, sediment and air were not reported. However, the reported half-life in soil (4.4 days) is below the TSMP Track-1 cut-off criterion for persistence ($\geq$6 months). Also, the Log K_{ow} of 3.53 is below the TSMP Track-1 cut-off criterion ($\geq$5.0). The toxicity of tetrachlorvinphos is described in sections 4.0 and 5.0. Tetrachlorvinphos, therefore, does not meet the TSMP Track-1 criteria because the reported Log K_{ow} falls below the TSMP Track-1 cut-off criterion for bioaccumulation.

As a part of the re-evaluation, the PMRA has reviewed all of the tetrachlorvinphos EP formulations for the USEPA List 1 formulants and has not identified any of these formulants.

5.7 Environmental assessment conclusions

The current registered uses of tetrachlorvinphos are not expected to result in any appreciable exposure to non-target terrestrial or aquatic organisms, therefore the risk is expected to be negligible.

6.0 Value

6.1 Evaluation method

Commercial class products

The importance of tetrachlorvinphos EPs for managing specific pests on livestock or in livestock buildings in Canada was evaluated based on:

- the availability of registered alternative pesticides that are potential substitutes
- current field use of tetrachlorvinphos in agriculture in Canada as measured by a survey of organophosphate (OP) use conducted in 1998 (the “1998 OP Survey”)

with the cooperation of provincial governments and from consultations with crop production specialists
- expert opinion of provincial agricultural officials, grower groups and other stakeholders.

Uses of tetrachlorvinphos were classified into two value classes as follows:

Key uses:
Some uses of tetrachlorvinphos were considered "key uses" because they matched one or more of the following criteria:
- there was reported use of at least 10% and there are no registered alternatives
- there was reported use of at least 10% and alternative active ingredients are registered, but tetrachlorvinphos is the preferred active ingredient (e.g., due to more favourable performance characteristics compared with alternatives)
- maintaining registration was considered key for resistance management and/or plays an important role in integrated pest management (IPM) programs
- the site of use is of large importance to the economy of Canada.

Non-key uses:
Uses of tetrachlorvinphos were considered to be "non-key uses" either because they did not match the "key use" criteria, or because the information available to the PMRA indicated little or no use in Canada.

6.2 Evaluation results

Commercial class products
Sites with key uses of tetrachlorvinphos
The following sites were identified as having "key uses" of tetrachlorvinphos: cattle (beef and dairy).

Although there are registered alternatives to tetrachlorvinphos for the control of face and horn flies on cattle, tetrachlorvinphos is important in insecticide resistance management. Also, the most used alternatives to tetrachlorvinphos for these pests are synthetic pyrethroids which become less effective at temperatures above 25°C.

Sites with non-key uses of tetrachlorvinphos
The following sites were identified as not having "key uses" of tetrachlorvinphos: poultry, poultry houses, farm buildings, swine barns, livestock manure piles and refuse in barns.

Domestic class products
The PMRA has no information about the extent of use of the tetrachlorvinphos domestic class products. However, there are alternative active ingredients registered for the domestic uses of tetrachlorvinphos.

7.0 Proposed regulatory action

The PMRA has determined that the aggregate risks for tetrachlorvinphos are acceptable provided that the mitigation measures proposed below are adopted. As indicated earlier in the document (Section 2.0), these proposed actions represent an interim decision until a full reassessment of the cumulative risk from all organophosphate pesticides is completed. The acceptable uses for tetrachlorvinphos products, together with proposed mitigation measures and use limitations, are presented in Appendices IV and V.

7.1 Proposed regulatory action relating to human health

1. Labels of pesticide products carry statements regarding symptoms of poisoning and treatment, which are especially important for those who may be overexposed when working with the product in a commercial or industrial setting, for example, mixers/loaders who handle more concentrated forms. Based on the toxicological assessments, the label text of all commercial class tetrachlorvinphos-containing products should be expanded and(or) standardized, as follows:

   Toxicology information (**Commercial class products**):

   "Tetrachlorvinphos is a cholinesterase inhibitor. Typical symptoms of overexposure to cholinesterase inhibitors include headache, nausea, dizziness, sweating, salivation, runny nose and eyes. This may progress to muscle twitching, weakness, tremor, incoordination, vomiting, abdominal cramps and diarrhea in more serious poisonings. A life-threatening poisoning is signified by loss of consciousness, incontinence, convulsions and respiratory depression with a secondary cardiovascular component. Treat symptomatically. If exposed, plasma and red blood cell cholinesterase tests may indicate degree of exposure (baseline data are useful). Atropine, only by injection, is the preferable antidote. Oximes, such as Pralidoxime Chloride, may be therapeutic if used early; however, use only in conjunction with atropine. In cases of severe acute poisoning, use antidotes immediately after establishing an open airway and respiration. With oral exposure, the decision of whether to induce vomiting or not should be made by an attending physician."

   Labels of all domestic class tetrachlorvinphos products should comply with Regulatory Directive DIR2002-01 (*Canadian Label Improvement Program for Pesticides Used on Companion Animals*), including addition of the following:

   Toxicology information (**Domestic class products**):

   "This product contains a pesticide that is a cholinesterase inhibitor (anti-cholinesterase compound). Symptoms of human poisoning may include headache, weakness, sweating, blurred vision, nausea and diarrhea. Obtain medical attention or call a poison control centre at once. Atropine is antidotal.

Acute symptoms of overdosages in dogs and cats include diarrhea, salivation, vomiting, muscular tremors and weakness. Contact a veterinarian immediately."

In addition, spray products should have the following addition at the end of the Toxicology information section:

"Contains a petroleum distillate."

2. Mitigation measures (Occupational and residential exposure):
Several measures are required to mitigate exposure in occupational and residential settings. The following label modifications are needed:

Workers (**Commercial class products**)

- Restrict the use of low pressure handwands for wettable powder (WP) applications to spot treatments in poultry facilities.

- Coveralls over long sleeves and long pants, gloves and dust/mist respirator for mixers, loaders and applicators using dusting equipment to apply WP formulation as dusts; single layer and gloves for loaders and others handling dust bags.

- Coveralls over long sleeves and long pants, gloves and dust/mist respirator for mixers, loaders and applicators engaging in low pressure handwand activities using the WP formulations in egg and broiler facilities.

- Single layer clothing, i.e., long sleeves and long pants and gloves for mixers, loaders and applicators engaging in backpack spraying activities.

- Coveralls over long sleeves and long pants, gloves and dust/mist respirator for mixers, loaders and applicators engaging in paint-on activities using WP formulations.

- Single layer clothing and chemical-resistant gloves for workers when handling ear tags.

Residential (**Domestic class products**)

Dust formulations only

- Use no more than 2 grams of powder per kilogram of body weight for cats or dogs.

- Apply to bedding used by pets only. Do not apply to flooring, carpets, furniture, or other areas that may come into contact with humans.

7.2 Proposed regulatory action relating to the dietary risk assessment

The residue of concern (ROC) for acute dietary exposure is the parent compound, (Z)-2-Chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate. The residue of concern for chronic and cancer dietary exposure is the parent compound, (Z)-2-Chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate and the following metabolites containing the trichlorophenyl moieties: des-O-methyl tetrachlorvinphos, 1-(2,4,5-trichlorophenyl) ethanol (free and conjugated forms), 2,4,5-trichloroacetophenone and 1-(2,4,5-trichlorophenyl) ethanediol.

7.2.1 Maximum residue limits of tetrachlorvinphos in food

Maximum residue limits (MRLs) of tetrachlorvinphos in food are currently established at 10 ppm for apples and grapes, 1.5 ppm (calculated on the fat content) for meat, meat by-products and fat of cattle and hogs and 0.75 ppm (calculated on the fat content) for meat, meat by-products and fat of poultry. Residues on all other imported or domestic commodities must not exceed 0.1 ppm, a default value specified by the Food and Drugs Regulations subsection B.15.002(1).

This document proposes continued registration for products containing tetrachlorvinphos to be used on cattle and poultry. Based on the available information, it is recommended that the MRL for beef meat, meat by-products and fat be reduced from 1.5 ppm to 0.1 ppm (based on fat content), and that MRLs be established at 0.01 for milk and 0.2 ppm for eggs (Appendix III). There are insufficient data to reassess the MRLs for poultry meat, meat by-products and fat; therefore, no change is currently recommended to the existing MRL for these commodities at this time. Data in accordance with the Residue Chemistry Guidelines are required.

In general, when the re-evaluation of a pesticide has been completed, the PMRA intends to prevent unauthorized use of the pesticide by recommending new MRLs at the limit of quantification (LOQ) for any agricultural commodities not approved for continued treatment in Canada. Additional MRLs for import purposes will be considered if sufficient data are provided by interested parties to allow a reassessment of those residues. The USEPA undertakes similar action in such circumstances. Proposed amendments to the Food and Drugs Regulations reflecting these MRLs will be published in the Canada Gazette.

In the case of tetrachlorvinphos, continued registration of food uses is proposed only for products used to treat poultry and cattle. As all other food uses of tetrachlorvinphos are not supported in Canada, the PMRA will recommend that an MRL be established at the LOQ of tetrachlorvinphos residues for all other agricultural commodities (i.e., 0.013 ppm for vegetable produce including apples and grapes and 0.025 ppm for animal produce), unless additional data are provided to support additional import MRLs. The proposed MRL revisions for tetrachlorvinphos are summarized in Appendix III.

Parties interested in supporting an MRL to allow additional imports of specific commodities treated with tetrachlorvinphos should contact the PMRA during the consultation period to discuss the submission of appropriate data. The PMRA will accept written comments on the proposed changes up to 60 days from the date of publication of this document to allow interested parties an opportunity to provide input into the proposed re-evaluation decision for these products.

7.3 Proposed regulatory action relating to the environment

Additional environmental risk mitigation measures are not required because the risk from the current registered uses of tetrachlorvinphos is expected to be negligible.

7.4 Proposed regulatory action relating to value

There is no regulatory action for tetrachlorvinphos relating to value.

8.0 Additional data requirements

Scientifically based rationales for data waivers may also be acceptable for some of the following data requirements.

8.1 Chemistry

End-use products (EPs):

- SPSFs for all registered EPs in accordance with Table 1 in Section 3.3 of Regulatory Directive DIR98-03, following conversion of TGAI to nominal guarantee.

- Historical Quality Control (QC) data of active from 10 batches of EPs to support the nominal active value, if the nominal guarantee of pure active ingredient in the EP is the same as the original minimum guarantee.

- The guarantee of the EPs will be revised to the nominal value after submission of these data.

8.2 Toxicology

The following confirmatory data would be required to support the continued registration of tetrachlorvinphos and to support any expansion of tetrachlorvinphos use:

- a developmental neurotoxicity study (Data Code (DACO) 4.5.12)

Although not critical to the current tetrachlorvinphos re-evaluation, the following data gaps were also identified and may be required to support any expansion of tetrachlorvinphos use:

- an assessment of neurotoxic esterase (NTE) activity in a delayed neurotoxicity study in hens (DACO 4.5.10)
- a short-term dermal study (DACO 4.3.4 or 4.3.5)
- a short-term inhalation study (DACO 4.3.6 or 4.3.7)

8.3 Residue chemistry

There is conservatism in the dietary risk assessments, which use potential residues derived from metabolism studies. However, there are data gaps in the available residue data to establish the MRLs that are used in compliance and enforcement activities. These activities ensure that commodities are being treated according to registered rates and that residues on treated animal commodities do not exceed this compliance standard.

Analytical methodology is required to measure the full ROC (parent and metabolites). The method must be able to quantify residues of the parent compound alone, and the sum of the full ROC, consisting of the parent compound and the metabolites of toxicological concern containing the trichlorophenyl moieties: des-O-methyl tetrachlorvinphos, 1-(2,4,5-trichlorophenyl) ethanol (free and conjugated forms), 2,4,5-trichloroacetophenone and 1-(2,4,5-trichlorophenyl) ethanediol (DACO 7.2 and 7.3).

While not critical to the safety assessment in the current re-evaluation of tetrachlorvinphos, acceptable magnitude of residue studies are required for poultry (meat, meat by-products, fat). Although sufficient data are available to recommend changes to MRLs for other registered food commodities (cattle, eggs, milk), additional data are required to meet current standards as identified in the Residue Chemistry Guidelines (RCG).

As indicated in Section 7.2.1, additional data would also be required to support the establishment of MRLs for imported food commodities.

8.4 Occupational exposure

Although risks were acceptable for mixing and loading powder for dusting applications, the PMRA does not have data to assess what the actual exposure would be for applicators. Therefore, a mixer/loader/applicator study is needed to confirm that PPE will adequately protect workers using dusting equipment.

8.5 Environment

Additional environmental data are not required to support the continued registrations of existing uses for tetrachlorvinphos.

The following data may be required to support any expansion of tetrachlorvinphos use:

- UV/visible absorption spectrum
- Phototransformation in water, soil and air
- Aerobic and anaerobic aquatic biotransformation
- Canadian or equivalent soil field dissipation study
- Earthworm acute toxicity study

9.0 Proposed re-evaluation decision

The PMRA has carried out an assessment of available information and has found it sufficient in accordance with Section 20 of the PCP Regulations to allow a determination of the safety, merit and value of tetrachlorvinphos and its associated EPs. Tetrachlorvinphos does not entail an unacceptable risk of harm to human health or the environment in accordance with Section 20, provided that the proposed mitigation measures described in this document are implemented (Appendix IV). Further measures may be necessary/proposed pending the outcome of the cumulative risk assessment for the organophosphates, which share a common mechanism of toxicity.

It is proposed that the Food and Drugs Regulations be amended so that, with the exception of poultry, beef, milk and eggs, food with quantifiable residues of tetrachlorvinphos can no longer be sold in Canada, unless additional data to support tetrachlorvinphos residues in imported food are provided.

The PMRA will accept written comments on this proposal up to 60 days from the date of publication of this document, to allow interested parties an opportunity to provide input into the proposed re-evaluation decision for these products.

List of abbreviations

ADI	acceptable daily intake
a.i.	active ingredient
ARfD	acute reference dose
ARS	Agricultural Research Services
atm	atmospheres
bw	body weight
CAS	Chemical Abstracts Service
CSFII	Continuing Survey of Food Intakes by Individuals
DACO	data code
DEEM	Dietary Exposure Evaluation Model
DfR	Dislodgeable fur Residues
DRA	dietary risk assessment
DT_{50}	dissipation time to 50%
DU	dust
EP	end-use product
g	gram(s)
IF	impregnated fabric
IPM	integrated pest management
kg	kilogram(s)
K_{ow}	octanol-water partition coefficient
LADD	lifetime average daily dose
LC_{50}	median lethal concentration to 50%
LD_{50}	median lethal dose to 50%
LOAEL	lowest observable adverse effect level [mg a.i./kg bw]
LOQ	limit of quantification
m	metre(s)
mg	milligram(s)
mg/kg bw/day	milligrams per kilogram of body weight per day
MOE	margin of exposure
MRL	maximum residue limit
NCI	National Cancer Institute
NOAEL	no observed adverse effect concentration
NTE	neurotoxic esterase
op	organophosphate pesticide
PACR	Proposed Acceptability for Continuing Registration
PCP	pest control product
PDI	potential daily intake
PHED	Pesticide Handlers' Exposure Database
PMRA	Pest Management Regulatory Agency
PP	pressurized product
PPE	personal protective equipment
Q*	cancer potency factor
RED	Reregistration Eligibility Document
Reg. No.	Registration Number (*Pest Control Products Act*)

RCG	Residue Chemistry Guidelines
ROC	residue of concern
SPSF	Statement of Product Specification Form
SR	slow-release
TBD	to be determined
TGAI	technical grade active ingredient
TSMP	Toxic Substances Management Policy
TWA	time-weighted average
µg	microgram(s)
U.S.	United States of America
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
WP	wettable powder

Appendix I Tetrachlorvinphos products currently registered

Registrant	Registration Number	Guarantee	Product Name	Class
Technical				
HARTZ	23019	98.7%	Hartz Rabon Technical Insecticide (Tetrachlorvinphos)	Technical
BOEHRINGER INGELHEIM	25338	98.7%	Boehringer Ingelheim Technical Rabon Insecticide	Technical
Commercial				
BOEHRINGER INGELHEIM	17415	50%	Debantic 50WP Insecticide	Commercial
DISPAR	18792	13.7%	Disvap Insecticide Cattle Ear Tag	Commercial
BOEHRINGER INGELHEIM	22880	14%	Ectogard Insecticide Cattle Ear Tag	Commercial
Domestic				
HARTZ	13266	14.55%	Longlife 9-day Collar for Cats	Domestic
HARTZ	16673	3.3%	Hartz 2-in-1 Flea and Tick Powder for Dogs	Domestic
HARTZ	17959	3.3%	Hartz 2-in-1 Flea and Tick Powder for Cats	Domestic
HARTZ	18108	14.55%	Hartz 2-in-1 Long Lasting Collar for Dogs	Domestic
HARTZ	18109	14.55%	Hartz 2-in-1 Long Lasting Collar for Cats	Domestic
BEAPHAR	21359	15%	Beaphar Flea and Tick Collar for Dogs	Domestic
BEAPHAR	21360	15%	Beaphar Flea and Tick Collar for Cats	Domestic
HARTZ	25189	1.08%	Hartz 2-in-1 Flea and Tick Aerosol for Dogs	Domestic
HARTZ	25190	1.08%	Hartz 2-in-1 Flea and Tick Aerosol for Cats	Domestic
HARTZ	25381	14.55%	Hartz Control Pet Care System Ultimate Flea Collar for Cats (also contains 1.02% (S)-methoprene)	Domestic
HARTZ	25382	14.55%	Hartz Control Pet Care System Ultimate Flea Collar for Dogs (also contains 1.02% (S)-methoprene)	Domestic
HARTZ	25499	14.55%	Hartz Control Pet Care System Ultimate Flea Collar for Puppies (also contains 1.02% (S)-methoprene)	Domestic
HARTZ	25500	14.55%	Hartz Control Pet Care System Ultimate Flea Collar for Cats (also contains 1.02% (S)-methoprene)	Domestic
WELLMARK	25568	14.55%	Zodiac Power Band Dual Action Flea and Tick Collar for Cats (also contains 1.02% (S)-methoprene)	Domestic

Registrant	Registration Number	Guarantee	Product Name	Class
WELLMARK	25569	14.55%	Zodiac Power Band Dual Action Flea and Tick Collar for Dogs (also contains 1.02% (S)-methoprene)	Domestic
HARTZ	25620	14.55%	Hartz 2-in-1 Flea and Tick Collar for Dogs	Domestic
HARTZ	25621	14.55%	Hartz 2-in-1 Flea and Tick Collar for Cats	Domestic
HARTZ	25622	14.55%	Hartz 2-in-1 Flea and Tick Collar with Deodorant for Dogs	Domestic
HARTZ	25623	14.55%	Hartz 2-in-1 Flea and Tick Collar with Deodorant for Cats	Domestic
HARTZ	25654	1.08%	Hartz Control Pet Care System Flea and Tick Guard for Dogs	Domestic
HARTZ	25655	1.08%	Hartz Control Pet Care System Flea and Tick Guard for Cats	Domestic
WELLMARK	25667	14.55%	Vet-kem Ovitrol plus Dual Action Flea and Tick Collar for Dogs (also contains 1.02% (S)-methoprene)	Domestic
WELLMARK	25668	14.55%	Vet-kem Ovitrol plus Dual Action Flea and Tick Collar for Cats (also contains 1.02% (S)-methoprene)	Domestic

Appendix II Toxicology endpoints for risk assessment

Exposure Scenario	Endpoint	Study	Dose (mg/kg bw/day)	UF/SF or MOE[a]
Acute Dietary	Erythrocyte cholinesterase inhibition, reduced weight gain and effects on liver, kidney, thyroid and adrenals	90-day dietary rat	6.7	100
	ARfD = 0.067 mg/kg bw			
Chronic Dietary	Erythrocyte cholinesterase inhibition, reduced weight gain and effects on liver and adrenals	2-year dietary rat	4.23	100
	ADI = 0.042 mg/kg bw/day			
Short-Term[b] Incidental Oral	Erythrocyte cholinesterase inhibition, reduced weight gain and effects on liver, kidney, thyroid and adrenals	90-day dietary rat	6.7	100
Short- and Intermediate-Term[b] Dermal[c]	Erythrocyte cholinesterase inhibition, reduced weight gain and effects on liver, kidney, thyroid and adrenals	90-day dietary rat	6.7	100
Short- and Intermediate-Term[b] Inhalation[d]	Erythrocyte cholinesterase inhibition, reduced weight gain and effects on liver, kidney, thyroid and adrenals	90-day dietary rat	6.7	100
Cancer (if applicable)[e]	Liver adenomas and carcinomas in ♀ mice	2-year dietary mouse	$Q_1^* = 1.83 \times 10^{-3}$ (mg/kg bw/day)$^{-1}$	

[a] UF/SF refers to total of uncertainty and(or) safety factors for dietary assessments, MOE refers to desired margin of exposure for occupational or residential assessments

[b] Duration of exposure is up to 6 months

[c] Since an oral NOAEL was selected, a dermal absorption factor of 10% should be used in route-to-route extrapolation

[d] Since an oral NOAEL was selected, an inhalation absorption factor of 100% (default value) should be used in route-to-route extrapolation

[e] Cancer risk is adjusted for cross-species scaling (body weight scaled to the 0.75 power)

Appendix III Recommended maximum residue limit (MRL) revisions for tetrachlorvinphos in food

Summary of recommended MRL revisions for tetrachlorvinphos		
Commodity	**Existing MRL (ppm)**	**Recommended MRL (ppm)**
Commodities registered in Canada		
Cattle: meat, meat by-products, fat	1.5	0.1
Eggs	0.1 (default)	0.2
Milk	0.1 (default)	0.01 (LOQ)†
Poultry: meat, meat by-products, fat	0.75	TBD*
Commodities not registered in Canada		
All other raw plant commodities	10 apples and grapes 0.1 (default) all other commodities	0.013 (LOQ)†
All other raw animal commodities	1.5 hog meat, meat by-products, fat	0.025 (LOQ)†

*TBD To be determined (No change proposed at this time)
† LOQ Limit of quantification

Appendix IV Use standards for commercial class products containing tetrachlorvinphos

NOTE: The information in this appendix summarizes the acceptable uses, limitations, and precautions for the commercial class products containing tetrachlorvinphos, but does not identify all label requirements for such products. Registrants are referred to the PMRA Registration Handbook for further guidance on label requirements for pest control products.)

Common name: Tetrachlorvinphos

Chemical name: (Z)-2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate

Formulation types:

SR	slow-release generator
WP	wettable powder

Site categories:

8	Livestock for Food
20	Structural wood

General limitations:

Store in a cool place, apart from food and feed.
Wash hands after use.

Toxicology information:

Tetrachlorvinphos is a cholinesterase inhibitor. Typical symptoms of overexposure to cholinesterase inhibitors include headache, nausea, dizziness, sweating, salivation, and runny nose and eyes. This may progress to muscle twitching, weakness, tremor, incoordination, vomiting, abdominal cramps and diarrhea in more serious poisonings. A life-threatening poisoning is signified by loss of consciousness, incontinence, convulsions and respiratory depression with a secondary cardiovascular component. Treat symptomatically. If exposed, plasma and red blood cell cholinesterase tests may indicate degree of exposure (baseline data are useful). Atropine, only by injection, is the preferable antidote. Oximes, such as Pralidoxime Chloride, may be therapeutic if used early; however, use only in conjunction with atropine. In cases of severe acute poisoning, use antidotes immediately after establishing an open airway and respiration. With oral exposure, the decision of whether to induce vomiting or not should be made by an attending physician.

Protective clothing and equipment:

Application of WP Formulations:	
Dusting equipment	
Low pressure handwands (egg and broiler facilities)	
Mixers, loaders and applicators	Wear coveralls over long sleeves and long pants, chemical-resistant gloves and a dust/mist respirator.
Loaders and others handling dust bags	Wear single layer clothing and chemical-resistant gloves.
Backpack spraying	
Mixers, loaders and applicators	Wear single layer clothing, i.e., long sleeves and long pants and chemical-resistant gloves.
Painting	
Mixers, loaders and applicators	Wear coveralls over long sleeves and long pants, chemical-resistant gloves and a dust/mist respirator.
Application of SR Formulations:	
Workers handling ear tags	Wear single layer clothing and chemical-resistant gloves.

Environmental hazards

This product is toxic to fish. Do not contaminate water by disposal of this product.

Acceptable commercial uses for tetrachlorvinphos

Sites, pests	Guarantees, rates and directions
Cattle	**DO NOT APPLY TO RESIDENCES**
Face Fly (reduction), Horn Fly	SR Formulation: 13.7–14.0% tetrachlorvinphos **Ear Tag,** 2.3 g a.i./ear tag: Apply ear tag with the Allflex Tagging System when pests first appear in the spring. For optimum control use 2 tags per animal. Replace as necessary. No waiting period necessary between treatment and slaughter. Calves less than 6 months old should not be tagged. Remove tags at end of summer before slaughter.
Poultry	**DO NOT APPLY TO RESIDENCES**
Lice, Mites	WP Formulation: 50% w/w tetrachlorvinphos **Wire Cages,** 20 g a.i./100 birds (0.5% solution; 4 L/100 birds): Apply directly to the birds, spraying vent and fluff areas from below. Repeat when necessary. For maximum lasting control of the northern fowl mite, penetration of the feathers around the vent area is absolutely essential. Use power sprayer at 7–9 kg/cm^2 at NO LESS THAN RECOMMENDED PRESSURE. More attention must be given to each individual bird when using low pressure equipment. Treat roosters carefully and thoroughly to avoid re-infestation of breeding flocks. Do not repeat more often than every 14 days
Lice, Mites, Lesser Mealworm (larvae of darkling beetle, Alphitobius spp.)	**Floor Management—Dust Box**, 75 g a.i./100birds/dust box (150g of 50% solution/100 birds/dust box): Mix evenly throughout top layer of box contents. **Floor Management—Roost Paint,** 1.45–1.65 g a.i./10 m^2 (145–156 mL of 1% solution/10 m^2): Brush or spray roosts thoroughly, particularly cracks and crevices. **Floor Management—Litter,** 10–40 g a.i./100 m^2 (1–4 L of 1% solution/100 m^2): Apply evenly for penetration to litter surface. Also apply thoroughly to walls, roost cracks, crevices and interiors. Spray birds lightly **Floor Management—Litter,** 37.5 g a.i./10 m^2 (75g of 50% solution/10 m^2): Treat evenly and thoroughly, using a rotary or mechanical duster. (Wear dust mask during this operation.)
Fowl Tick	**All Management Types,** 30–40 g a.i./10 m^2 (3–4 L of 1% solution/10 sq m): Apply to walls, ceilings, floor cracks and crevices with a power sprayer.
Dairy Barns, Poultry Houses, Swine Barns	**DO NOT APPLY TO RESIDENCES**
Flies	WP Formulation: 50% w/w tetrachlorvinphos **Whitewashed Wood and Concrete,** 160 g a.i./100 m^2 (8 L of 2% solution/100 m^2): Apply to surfaces after whitewash is dry. **Unpainted Wood or Painted Concrete Block** , 80 g a.i./100 m^2 (8 L of 1% solution/100 m^2) **Masonite or Galvanized Sheet Metal**, 40 g a.i./100 m^2 (4 L of 1% solution/100 m^2)
Maggots	**Poultry Droppings, Manure Piles, Garbage Piles, Under Feed Troughs,** 40 g a.i./100 m^2 (4 L of 1% solution/100 m^2): Penetrate problem area the first time; repeat every 7–10 days thereafter.

Appendix V Use standards for domestic class products containing tetrachlorvinphos

NOTE: The information in this appendix summarizes the acceptable uses, limitations, and precautions for the domestic class products containing tetrachlorvinphos, but does not identify all label requirements for such products. Registrants are referred to the PMRA Registration Handbook for further guidance on label requirements for pest control products. In addition, consult Regulatory Directorate DIR2002-01 for label requirements specific to pesticides used on companion animals.)

Common name: Tetrachlorvinphos

Chemical name: (Z)-2-chloro-1-(2,4,5-trichlorophenyl)vinyl dimethyl phosphate

1. Domestic class products: Detailed

Formulation types:	SR	slow-release generator
	DU	dust
	PP	pressurized product
	IF	impregnated fabric
Site categories:	24	Companion Animals

General limitations:

All formulations:
After handling or applying, wash hands (and any other skin that came in contact with the product) with soap and water.
KEEP OUT OF REACH OF CHILDREN.
Store in a cool place, apart from food and feed.
Do NOT use on dogs or cats under 12 weeks of age. (With the exception of the one product for use on puppies which should state: “Do NOT use on puppies under 8 weeks of age.” on the primary and secondary panels.)
FOR USE ONLY ON DOGS **OR** CATS (specify).

IF and SR Formulations:
DO NOT ALLOW CHILDREN TO HANDLE THIS COLLAR.

PP Formulation:
Avoid contact with pets until dry.

Toxicology information:

All Formulations:
This product contains a pesticide that is a cholinesterase inhibitor (anti-cholinesterase compound). Symptoms of human poisoning may include headache, weakness, sweating, blurred vision, nausea and diarrhea. Obtain medical attention or call a poison control centre at once. Atropine is antidotal. Acute symptoms of overdosages in dogs and cats include diarrhea, salivation, vomiting, muscular tremors and weakness. Contact a veterinarian immediately.

PP Formulation:
Contains a petroleum distillate.

Protective clothing and equipment:

PP Formulation:
Wear rubber gloves during application of this product.

Environmental hazards:

Toxic to fish and other aquatic life. Cover aquaria in vicinity of treatment area. Toxic to birds. Do not contaminate water by disposal of this product.

Acceptable domestic uses for tetrachlorvinphos

Sites, pests	Guarantees, rates and directions
Cats and Dogs	**All Formulations** For effective flea and tick control, treatment of the pet should be combined with the sanitation of any area used by the pet. Vacuum floors, carpets and furniture (discard vacuum bag after use) and wash the pet' s bedding, living quarters and surrounding areas. If pest problem persists, an insecticidal premise treatment may be required. Do NOT use on dogs/cats under 12 weeks of age. (Except the one product for use on puppies which should state: "Do NOT use on puppies under 8 weeks of age.") Consult a veterinarian before using on sick, aged, pregnant, or nursing animals or animals receiving drug or other pesticide treatment. Do not use this product on dogs/cats at the same time or within 30 days before or after treatment with, or exposure to, cholinesterase-inhibiting drugs, pesticides, or chemicals. **Collars** (SR and IF Formulations): Do not allow children to play with collar. Do not unroll collar until ready to use. This collar is intended for use as an insecticide generator dog/cat collar.
Fleas, Ticks (may include Deer Ticks, Black Legged Tick and(or) Rocky Mountain Ticks, as stated on current label)	**Collar:** SR Formulation: **14.5–15.0% tetrachlorvinphos** (1.6– 4.8 g a.i./collar) IF Formulation: **14.6% tetrachlorvinphos** (2.19 g a.i./collar) Remove the collar from the package, unroll and stretch to activate. This releases the active ingredient at time of use and assures full activity. Place the flea collar around the dog' s/cat' s neck, allowing a spacing of 2 fingers between collar and neck and buckle in place. Leave 5 to 8 cm on the collar for extra adjustment. Cut off any excess length and dispose of it in the garbage. Wash hands with soap and water after handling collar. **Spray:** PP Formulation: **1.08% tetrachlorvinphos** SHAKE WELL BEFORE USE. Hold bottle upright 15 cm (6 inches) from pet. Direct spray toward pet and spray entire coat, pressing dispenser with quick short strokes. Do not spray in pet' s eyes or on face. Move bottle to get even coverage of coat (until tips of hair are moist). Apply lightly and rub into animal' s coat. For best penetration, spray against the natural lay of the hair to cause fluffing of the coat. Attached ticks should be sprayed directly. For long-haired dogs/cats, ruffle hair for spray to reach skin. Attached ticks should be sprayed directly. After 10 minutes, dry animal with towel. (Wash towel separately from other household laundry.) Comb and brush coat. Repeat as required—no more than once a week. Do not apply to pet bedding, flooring, carpets, furniture, or other areas that may be touched by humans.

	Dust: DU Formulation: **3.3% tetrachlorvinphos** To kill fleas and ticks, including deer ticks, which may carry the organism which causes Lyme Disease, and to reduce itching and scratching due to insect bites, dust entire cat beginning at head and working back. Use no more than 2 grams of powder per kilogram of body weight for dogs/cats. Avoid getting powder in pet' s eyes or genital area. Make sure that the powder gets down to the skin. Take care to treat feet and legs. Dust pet' s bedding and living quarters. Repeat at weekly intervals if necessary. Wash hands after use. Apply to bedding used by pets only. Do not apply to flooring, carpets, furniture, or other areas that may come into contact with humans.