UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Date: April 30, 2002

MEMORANDUM

SUBJECT: REVISED OCCUPATIONAL AND RESIDENTIAL EXPOSURE ASSESSMENT AND RECOMMENDATIONS FOR THE RE REGISTRATION ELIGIBILITY DECISION DOCUMENT FOR LINDANE

FROM David Jaquith
Reregistration Action Branch 4
Health Effect Division (7509C)

TO: Becky Daiss
Reregistration Branch 4
Health Effect Division (7509C)

THRU Susan Hummel, Senior Scientist
Reregistration Branch 4
Health Effects Division (7509C)

Please find attached the occupational and residential exposure assessment for lindane

DP BARCODE D282648

Pesticide Chemical Codes: 009001

EPA Reg Nos:

EPA MRID Nos.: 452000-02, 444058-02, 422519-01

PHED: No

CONTENTS

Executive Summary

This document presents the occupational exposure assessment for use of lindane. Lindane is the gamma isomer of 1,2,3,4,5,6-hexachlorocyclohexane, an insecticide previously used in many situations but now restricted to seed treatment only. There are no current registered uses for recreational, residential or other public (non-occupational) settings. All uses other than seed treatment have been cancelled. Lice and scabies treatment is considered in the risk assessment document.

Acute Toxicity Categories

Acute toxicity categories for technical grade lindane are in Toxicity Category II for oral, Toxicity Category II for dermal, and Toxicity Category II for inhalation. It is in Toxicity Category III for primary eye irritation.

The endpoints used in this document to assess lindane hazards include short-term and intermediate-term dermal and inhalation endpoints. The exposure duration for short-term assessments is 1 to30 days or up to 1 month. Intermediate-term duration is greater than 1 month to six months. Although there is little information to determine what percentage of workers apply for more than one month, it is reasonable to believe that typical uses of lindane by commercial seed treatment facilities may encompass an intermediate-term duration. On farm treatments are more likely to be of short-term duration. An oral developmental neurotoxicity study (MRID 45073501) in rats was selected for both dermal assessments. A 90-day inhalation toxicity study (MRID 00255003) was selected for inhalation assessment for all time periods.

In the developmental neurotoxicity study the maternal toxicity NOAEL is 50 ppm (5.6 mg/kg/day) based on reduced pup survival, decreased body weights and body weight gains during lactation, increased motor activity, and decreased motor activity habituation. The offspring toxicity NOAEL was 10 ppm (1.2 mg/kg/day).

In the subchronic inhalation toxicity study (Accession No. 255003) Tte systemic toxicity NOAELs for short term exposure was 0.5 mg/m^3 (0.13 mg/kg/day), based on lesions in the kidney and increased kidney weights.(1).

Exposure data on lindane are available but limited. An exposure study addressing on farm seed treatment has been conducted (MRID 444058-02). A detailed description along with the exposure calculations are presented in Appendix A. Another study addressing commercial seed treatment with another chemical has been reviewed by the Agency. The an excerpt of the review of that study (MRID 452000-02), along with the calculations for lindane exposure are presented in Appendix B.

The results of the handler assessments indicate that the on farm seed treatment provide dermal MOEs less than 100 with the attire worn during the study (long pants, long sleeved shirts, gloves). The assessments, both dermal and inhalation, yielded MOEs of less than 100 for

mixing/loading/application and bagging/sewing/stacking during commercial seed treatment of canola. All other exposure scenarios provide MOEs greater than or equal to 100 when wearing the clothing used in the study (coveralls over single layer of clothing, gloves for commercial other seed treatment workers) or at **baseline** attire (single layer of clothing, gloves for mixer/loaders) for loading seed for planting or for planting treated seed.

Due to the method of seed treatment, HED has determined that soil-incorporated, post-application agricultural exposure is considered to be negligible as long as the soil is not directly contacted. The exception is farmers handling treated seed. An estimate of the inherent risk from handling treated seed was conducted using relatively conservative assumptions. There are no study data available on exposure to lindane from handling treated seed and therefore the exposure was estimated using surrogate data. An excerpt of that review of that study (MRID 422519-01) and exposure calculations are presented in Appendix C.

1.0 BACKGROUND

Purpose

This document is for use in development of the Reregistration Eligibility Decision Document (RED) for the insecticide lindane and presents a review of the potential human health effects of occupational exposure to lindane.

Criteria for Conducting Exposure Assessments

An occupational and/or residential exposure assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (mixers, loaders, applicators, etc.) during use or to persons entering treated sites after application is complete. For lindane, both of these criteria are met.

1.1 Summary of Toxicity Concerns Relating To Occupational Exposures

Acute Toxicology Categories

Table 1 presents the acute toxicity categories as outlined in the Report of the Hazard Identification Assessment Review Committee (1).

Table 1: Acute Toxicity Categories for Lindane (Technical)

STUDY TYPE	MRID	CATEGORY	RESULT
81-1 Acute oral	00049330	II	LD_{50} 88 mg/kg - males 91 mg/kg - females
81-2 Acute dermal	00109141	II	LD_{50} 1000 mg/kg - males 900 mg/kg - females
81-3 Acute inhalation	Acc. 263946	III	LC_{50} 1.56 mg/L both sexes
81-4 Eye irritation	Acc. 263946	III	PIS = 0.6 no corneal involvement irritation cleared after 24 hours
81-5 Dermal irritation	Acc. 263946	IV	PIS = 0 not an irritant
81-6 Dermal sensitization	Acc. 263946	NA	not a sensitizer

Other Endpoints of Concern

The Report of the Hazard Identification Assessment Review Committee (HIARC) for lindane, (1) indicates that there are toxicological endpoints of concern for lindane. The endpoints used in assessing the risks for lindane are presented in Table 2.

Table 2. Doses and Toxicological Endpoints Selected for Risk Assessment of Lindane			
EXPOSURE SCENARIO	DOSE (mg/kg/day)	ENDPOINT	STUDY TYPE/ MRID
Acute Dietary- general population	NOAEL= 6 mg/kg UF = 100	LOAEL is 20 mg/kg based on increased grip strength, increased motor activity	Acute Neurotoxicity in Rats/ 44769201
Acute RfD = 0.06 mg/kg/day		**aPAD = 0.02 mg/kg/day**	
Chronic Dietary	NOAEL= 0.47 mg/kg/day UF = 300	LOAEL is 100 ppm (4.81 mg/kg/day) periacinar hepatocyte hypertrophy, increased liver/spleen weight, decreased platelets	Chronic Feeding and Carcinogenicity in Rats 41094101, 41853701 42891201
Chronic RfD = 0.0047 mg/kg/day		**cPAD = 0.0016 mg/kg/day**	
Short-Term [1] (Dermal)	NOAEL= 1.2 mg/kg/day	LOAEL is 50 ppm based on reduced pup survival, decreased body weights and body weight gains during lactation, increased motor activity, and decreased motor activity habituation.	Developmental Neurotoxicity Study in Rats (oral) 45073501
Intermediate-Term [1] (Dermal)	NOAEL= 1.2 mg/kg/day	LOAEL is 50 ppm based on reduced pup survival, decreased body weights and body weight gains during lactation, increased motor activity, and decreased motor activity habituation.	Developmental Neurotoxicity Study in Rats (oral) 45073501
Long-Term [1] (Dermal)	NOAEL= 0.47 mg/kg/day	LOAEL is 100 ppm (4.81 mg/kg/day) periacinar hepatocyte hypertrophy, increased liver/spleen weight, decreased platelets	Chronic Feeding and Carcinogenicity in Rats 41094101, 41853701 42891201
Dermal Absorption Factor = 10%			
Short Term [1] (Inhalation)	0.13 mg/kg/day ($0.5\ mg/m^3$)	based on clinical signs (diarrhea, piloerection) seen at day 14 and continuing for 20 days	90-Day Inhalation Toxicity / 00255003
Intermediate Term [1] (Inhalation)	0.13 mg/kg/day ($0.5\ mg/m^3$)	LOAEL is 5.0 mg/m^3 based on increased kidney weights of female rats and bone marrow effects.	90-Day Inhalation Toxicity / 00255003
Long Term [2] (Inhalation)	N/A	N/A	N/A

[1] Since an oral NOAEL was selected, the dermal absorption factor (10%) should be used in route-to-route extrapolation.

[2] Exposure thru this route for this duration is not expected

1.2 Summary of Use Patterns and Formulations

The only use remaining for lindane is for seed treatment. The use closure memorandum (4) allows the seed treatment of the following crops: barley, broccoli, Brussels sprouts, cabbage, cauliflower, corn, lettuce, oats, radishes, rye, sorghum, spinach, and wheat. The crops and application rates are presented in Table 3. Wheat and canola were used as a representative crops for all other seeds treated with lindane because of the relatively large farm size, application rate, and nature of the product treated.

Table 3. Summary of Application Rates for Seed Treatment Using Lindane on Various Crops.

Commodity	Formulation/Reg. No.	Use Rate
barley		**0.0375** lb ai/100 pound seed
corn	dust (19713-262) EC (71096-2)	0.125 lb ai/bushel seed 0.125 lb ai/100 pound seed
oats	7501-38, 10107-121	0.03125 lb ai/100 pound seed
rye	19713-401 554-144 19713-387	0.032813 lb ai/100 pound seed
sorghum	**42056-15**	0.0628 lb ai/100 pound seed
spinach	dust (7501-38, 34704-653, 34704-658, 19713-262, 34704-658, 42056-14, 10107-121, 66330-19)	0.0625 lb ai/100 pound seed
wheat	dust, 2935-492	0.042578 lb ai/100 pound seed
canola	Not currently registered	1.5 lb ai/100 pounds seed (a rate of 0.75 lb/100 lbs seed has been proposed)

1.3 Method and Type of Equipment Used for Mixing/Loading/Applying

The flowable concentrate, and emulsifiable concentrate formulations for commercial application all require mixing with water to the label-specified dilution. This is usually performed by scooping or pouring the formulation into a mixing tank, often of 100 gallons or more in capacity, with mechanical agitation to keep the resulting emulsion homogenized and prevent variations in application strength. Smaller amounts may be handled using a tiller-planter (or seed drill)-mounted system. Large commercial operations, may have mechanical, automated,

metered pumps which require only connecting the formulation to the pump. Again, small seed treatment operations, such as seed box (or "hopper box") mixing, may be done by pouring small amounts in to a mixing device before planting the seeds in to the soil. Dry formulations may also be used, particularly for on farm treatment.

Timing and Frequency of Application

Generally, seed will be treated on an as needed basis. However, it is industry practice only to treat enough seeds as are needed to be used that season.

1.4 Incident Data

No information regarding seed treatment incidents is available at this time.

2.0 OCCUPATIONAL EXPOSURES

2.1 Handler Exposures & Assumptions

HED has determined that there are potential exposures to mixers, loaders, applicators, or other handlers during usual use-patterns associated with lindane. Based on the use patterns and potential exposures described above, 5 major exposure scenarios were identified to represent the extent of lindane uses: (1) mixing/loading/application of formulations for on-farm seed treatment, (2) mixing/loading and applying liquid with commercial seed-treatment equipment, (3) bagging and otherwise handling treated seeds, (5) forklift operation, (6) cleaning seed treatment equipment, (7) mixing/loading/planting of treated seed for planting.

2.1.1 Submitted Studies

Mixer/loader/applicator exposure data for lindane were required since one or more toxicological criteria had been triggered. Requirements for applicator exposure studies are addressed by Series 875 Group A (formerly Subdivision U of the Pesticide Assessment Guidelines). Three exposure studies, one addressing on-farm treatment have been provided (Appendix A), another addressing commercial seed treatment (Appendix B), a third addressing planting of treated seed (Appendix C)

2.1.2 Summary of Occupational Handler Exposures

Table 5 presents the exposure scenarios, application rates, and amount potentially handled that have been used for the exposure calculations. These are restricted to canola and wheat for commercial seed treatment and wheat for on-farm treatments as representative of typical applications. Exposures for handling treated seed before planting and planting treated seed use parameters for wheat and canola as representative crops. Therefore, the rates/seed types presented in Table 5 are not all conclusive and no attempt has been made to assess a range of application rates to ensure that all use rates and exposure scenarios are represented.

2.1.3 Summary of Uncertainties

The assumptions and uncertainties are identified below to be used in risk management decisions:

- *Application Rates:* Based on wheat for on farm treatment and canola for commercial seed treatment. Other types of seed may have slightly different rates but these differences are unlikely to appreciably alter the exposure/risk assessment.

- *Amount Handled:* For commercial seed treatment the amounts handled are assumed to be equal to the amounts handled at the facilities used in the study described in the Appendices. On farm treatment exposures were estimated assuming that enough wheat seed could be treated and planted for 100 acres per day at a rate of 120 pounds of seed per acre.

- *Unit Exposures:* The unit exposure values for commercial seed treatment and planting of treated seed were derived from surrogate studies. The median exposure value was used for commercial seed treatment (Appendix B)and the arithmetic mean was used for the loading/planting task (Appendix C).

Table 4: Exposure Variables for Uses of Lindane					
Exposure Scenario (Scenario #)	Are Chemical Specific Monitoring Data [Available]	Are PHED Data Available?	Application Rates (lb ai/amt of seed)	Daily lb Seed Treated/Handled	Lb ai Handled/day
Applicator/Handler Exposure					
(1) mixing/loading/planting of dry formulations for on farm treatment	Yes MRID #44440585-02	No	0.023 lb ai/bushel (60 lbs seed) for wheat	12000 lbs seed, see Appendix A)	4.7[a]
(2) mixing/loading and applying liquid with a commercial seed-treatment equipment	No MRID #45200002	No	Wheat: 0.043lb ai/100 lb seed treated	176000	76
			Canola (low-end): 0.75 lb ai/100 lb seed treated	176000	1320
			Canola (high-end): 1.5 lb ai/100 lb seed treated	176000	2640
(3) handler for commercial seed-treatment equipment (i.e. bagging, sewing, stacking) with chemical resistant coveralls over long sleeve shirt long pants, chemical resistant gloves	No MRID #45200002	No	Wheat: 0.043lb ai/100 lb seed treated	176000	76
			Canola (low-end): 0.75 lb ai/100 lb seed treated	176000	1320
			Canola (high-end): 1.5 lb ai/100 lb seed treated	176000	2640
(4) handler for commercial seed-treatment equipment (i.e. bagging, sewing, stacking) with cotton/polyester coveralls over long sleeve shirt long pants, chemical resistant gloves	No MRID #45200002	No	Wheat: 0.043lb ai/100 lb seed treated	176000	76
			Canola (low-end): 0.75 lb ai/100 lb seed treated	176000	1320
			Canola (high-end): 1.5 lb ai/100 lb seed treated	176000	2640
(5) Forklift operator - chemical resistant coveralls over long sleeve shirt long pants, chemical resistant gloves	No MRID #45200002	No	Wheat: 0.043lb ai/100 lb seed treated	176000	76
			Canola (low-end): 0.75 lb ai/100 lb seed treated	176000	1320
			Canola (high-end): 1.5 lb ai/100 lb seed treated	176000	2640
(6) Worker Cleaning seed treatment equipment - chemical resistant coveralls over long sleeve shirt long pants, chemical resistant gloves	No MRID #45200002	No	Wheat: 0.043lb ai/100 lb seed treated	NA	NA
			Canola (low-end): 0.75 lb ai/100 lb seed treated	NA	NA

Table 4: Exposure Variables for Uses of Lindane					
Exposure Scenario (Scenario #)	Are Chemical Specific Monitoring Data [Available]	Are PHED Data Available?	Application Rates (lb ai/amt of seed)	Daily lb Seed Treated/Handled	Lb ai Handled/day
			Canola (high-end): 1.5 lb ai/100 lb seed treated	NA	NA
(7) Planting treated seed Enclosed cab	No MRID #42251901	No	Wheat: 0.043lb ai/100 lb seed treated	3000	12.9
			Canola (low-end): 0.75 lb ai/100 lb seed treated	1000	7.5
			Canola (high-end): 1.5 lb ai/100 lb seed treated	1000	15
[a] Data are available from on farm treatment study (Appendix A) [c] Daily amount treated based on HEDs estimates of acreage that would be reasonably expected to be planted in a day for commercially treated seed. The acres per day assumed 120 lbs. of wheat per acre, planting an average of 250 acres per day (2).					

2.2 Risk From Handler Exposures

EPA calculated the potential risk to persons from handler exposures and planting of treated seed using the daily dermal exposure scenarios identified in the exposure section.

Potential dermal and inhalation daily exposures for occupational handlers were calculated using the following formulas (10 percent dermal absorption was assumed):

$$\textit{Daily Inhalation Exposure}\left(\frac{mg\ ai}{day}\right) = \textit{Unit Exposure}\left(\frac{\mu g\ ai}{lb\ ai}\right) \times \textit{Conversion Factor}\left(\frac{1\ mg}{1{,}000\ \mu g}\right) \times \textit{Use Rate}\left(\frac{lb\ ai}{A}\right) \times \textit{Daily Acres Treated}\left(\frac{A}{day}\right)$$

$$\textit{Daily Dermal Exposure}\left(\frac{mg\ ai}{day}\right) = \textit{Unit Exposure}\left(\frac{mg\ ai}{lb\ ai}\right) \times \textit{Use Rate}\left(\frac{lb\ ai}{A}\right) \times \textit{Daily Acres Treated}\left(\frac{A}{day}\right)$$

The inhalation and dermal daily doses were calculated using the following formulas:

$$\textit{Daily Inhalation Dose}\left(\frac{mg\ ai}{kg/day}\right) = \textit{Daily Inhalation Exposure}\left(\frac{mg\ ai}{day}\right) \times \left(\frac{1}{\textit{Body Weight (kg)}}\right) * 1\ (100\%)$$

$$Daily\ Dermal\ Dose\left(\frac{mg\ ai}{kg/Day}\right) = Daily\ Dermal\ Exposure\left(\frac{mg\ ai}{Day}\right) x\left(\frac{1}{Body\ Weight\ (kg)}\right) * 0.1\ (10\%)$$

2.2.1 Risk From Handler Exposures

Margins of Exposure (MOEs) were calculated for handlers for short-term (one to seven days) and intermediate-term (one week to several months) durations for both dermal and inhalation exposures.

The MOEs were calculated using the following formulas:

$$MOE = \frac{NOAEL\left(\frac{mg}{kg/day}\right)}{Dermal\ Daily\ Dose\left(\frac{mg}{kg/day}\right)}$$

$$MOE = \frac{NOAEL\left(\frac{mg}{kg/day}\right)}{Inhlation\ Daily\ Dose\left(\frac{mg}{kg/day}\right)}$$

2.2.2 Summary of MOEs

The daily exposures, resulting short and intermediate term MOEs are presented in Table 7. The exposure scenario descriptions are presented in Table 8. The results of the **short-term** dermal exposure duration indicate that the MOEs range from 5.2 for on farm seed treatment to 34000 for the planting of treated seed . A total of 9 dermal and inhalation MOEs were calculated for the various scenarios. Based on the level of protection used in the studies, all of the MOEs for the application portion of seed treatment were less than 100. All other dermal MOEs were above 100. Inhalation MOEs for workers other than applicators for commercial treatment and seed handlers at large facilities are greater than 100.

2.2.3 Cancer Risks

The OPP/Cancer Assessment Review Committee (CARC) has completed the review of newly submitted carcinogenicity study in CD-1 mice along with other data. In accordance with the EPA Draft Guidelines for Carcinogen Risk Assessment (July, 1999), the CARC has classified lindane into the category **"Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential"** based on an increased incidence of benign lung tumors in female mice only. The Committee, therefore, recommended that the quantification of human cancer risk is not required.

2.2.4 Insufficient Data

Other studies are undergoing review by HED personnel at this time and may alter our estimate of exposure.

Table 5- Daily Exposures and MOEs for Commercial Seed Treatment Plant Worker Exposure

Exposure Scenario (Scenario #)	Application Rates (lb ai/100 lbs seed or Lb/A)	Amount Handled per Day (lbs a.i.)	Unit Exposure (mg/lb ai)[a]		Daily Exposure (mg/kg/day)		Short-Term MOEs & Intermediate Term MOES	
			Dermal	Inhalation	Dermal[b]	Inhalation[s]	Dermal[c]	Inhalation[e]
Mixing/loading /planting dry formulation for on farm seed treatment (1)	0.043	4.7	9.4	0.0016	0.074	0.00011	16	1200
Treater - Closed Transfer - chemical resistant coveralls over long-sleeved shirt, long pants, chemical resistant gloves (2)	1.5 (canola high-end)	76	0.00083	0.00012	0.036	0.0053	329	25
	0.75 (canola low-end)	1320	0.00083	0.00012	0.018	0.0026	657	49
	0.043 (wheat)	2640	0.00083	0.00012	0.0010	0.00015	11462	859
Bagger/Sewer /Stacker - chemical resistant coveralls over long-sleeved shirt, longpants, chemical resistant gloves - (3)	1.5 (canola high-end)	76	0.00026	0.00006	0.011	0.0026	1049	49
	0.75 (canola low-end)	1320	0.00026	0.00006	0.0057	0.0013	2098	98
	0.043 (wheat)	2640	0.00026	0.00006	0.00033	0.000076	36591	1718
Bagger/Sewer /Stacker cotten/polyester coveralls over long-sleeved shirt, longpants, chemical resistant gloves (4)	1.5 (canola high-end)	76	0.0003	0.00006	0.013	0.00264	909	49
	0.75 (canola low-end)	1320	0.0003	0.00006	0.0066	0.0013	1818	98
	0.043 (wheat)	2640	0.0003	0.00006	0.00038	0.000076	31712	1718
Forklift Operator - chemical resistant coveralls over long-sleeved shirt, longpants, chemical resistant gloves (5)	1.5 (canola high-end)	76	0.00008	7.7E-06	0.0035	0.00034	34091	384
	0.75 (canola low-end)	1320	0.00008	7.7E-06	0.0018	0.00017	6818	767
	0.043 (wheat)	2640	0.00008	7.7E-06	0.00010	9.7E-06	118922	13385
Cleaner - chemical resistant coveralls over long-sleeved shirt, longpants, chemical resistant gloves (6)	1.5 (canola high-end)	76	0.00669	0.00119	0.00011	1.98E-05	107623	6555
	0.75 (canola low-end)	1320	0.00669	0.00119	0.00011	1.98E-05	107623	6555
	0.043 (wheat)	2640	0.00669	0.00119	0.00011	1.98E-05	107623.3	6555

a Median unit dermal and arithmetic mean inhaltion unit exposures

b Dermal Exposure (mg/kg/day) = unit exposure (mg/lb ai) x amount handled per day (lbs a.i.) / bw (60 kg).

c Dermal MOE = Dermal NOAEL (1.2 mg/kg) / [daily exposure (mg/kg/day) x dermal absorption factor (10%)].

d Inhalation Exposure (mg/kg/day) = inhalation unit exposure (mg/lb ai) x amount handled per day (lbs a.i.) / body weight (70 kg).

e Inhalation MOE = NOAEL (0.13 mg/kg/day) / daily exposure (mg/kg/day).

Table 6. Exposure Scenario Descriptions for the Use of Lindane.			
Exposure Scenario (Scenario #)	Data Source	Standard Assumptions[a]	Comments[b]
Mixing/loading /planting dry formulation for on farm seed treatment (1)	Rhone-Poulenc Data MRID # 444058-02	Assumes enough seed treated and planted for 100 Acres per day	All data were for gloved hands; (see study, Appendix A.)
Mixing/loading/application of liquid formulation for commercial seed treatment (2)	Uniroyal Data MRID # 447305-01	176000 lbs of seed per day	See study review; based on geometric mean of data and amounts of seed from study data
Seed Handler for commercial seed treatment (3, 4,5,6)	Uniroyal Data MRID # 447305-01	176000 lbs of seed per day	See study review; based on geometric mean of data and amounts of seed from study data
Loading and planting treated seed for planting (7)	MRID 422519-01	Assumes 250 acres are planted per day at 120 lbs of seed per acre for wheat; 4 lbs per acre for canola, commercially treated seed	Appendix C
a All *Standard Assumptions* are based on an 8-hour work day as estimated by HED.			

REFERENCES

1) Lindane - Report of the Hazard Identification Assessment Review Committee, July 27, 2000.

2) Memorandum from S. Tadayon (CEB1) to A. Khasawinah (RRB4) titled "Occupational and Residential Exposure Assessment and Recommendations for the Registration Eligibility Decision Document for Imazalil", dated April 15, 2,000.

3) EPA (1998) Surrogate Exposure Guide, Estimates of Worker Exposure from the Pesticide Handler Exposure Database Version 1.1

4) Memorandum from M. Howard (SRRD) to Lindane RED Team Members titled "Final Lindane Use Closure Memo" dated May 17, 2000 (EMAIL).

cc: Lindane file (009001)
Correspondence file
R. Kent (RRB4/7509C)
D. Jaquith (RRB4/7509C)

APPENDIX A. MANUAL SEED TREATMENT (at farm):

CITATION: Fenske, R.A., A.M. Blacker, S.J. Hamburger, and G.S. Simon (1990) Worker Exposure and Protective Clothing Performance During Manual Seed Treatment with Lindane. Arch. Environ. Contam. Toxicol. 19, 190-196.

Fenske, R. A. Reregistration of Lindane Technical Case No. 0315, Chemical No. 9001. Worker Exposure to Lindane During Manual Seed Treatment. MRID No. 444058-02

Dermal and respiratory exposures of 4 male workers with prior experience were monitored during the manual treatment of winter wheat at a commercial wheat farm in South Dakota. The operations are considered to be representative of manual seed treatments in the midwest. A dust formulation containing 18.75 percent lindane, packaged in 10 lb bags was applied at the label rate of 2 ounces per bushel of seed. A total of 720 bushels of seed were treated. The treatment procedure involved the addition of grain to a 4 compartment, 12 bushel grain drill. The label instructions indicate the user is to fill the drill box half full of seed and add half of the formulation. The seed and formulation are then mixed with a stick. The rest of the grain is then added and the procedure repeated. After thorough mixing the seed was removed by a vacuum. Workers monitored in this study did not participate in the vacuuming procedure.

Each mixing consisted of the application of 24 oz (680 g) of the formulation to 12 bushels of grain. A plastic scoop, cut from a plastic bottle and determined to hold 12 oz of formulation, was used to remove the powder from the bag. The scoop was used to spread the formulation evenly over the seed.

Each replicate consisted of five mixings conducted by each of the four workers, the mixing activity lasting 4-6 minutes. The mixing periods averaged 24 minutes and were separated by 10-20 minute breaks. This was considered to be equal to one "work period". During this time a worker handled 120 oz of formulation or 1.4 lb of active ingredient. Each volunteer performed the tasks three times (total of 60 mixings), yielding a total of 12 work periods. During treatments the workers wore the label required long sleeve shirt, long pants, Nitrile gloves, a baseball cap, and a pesticide respirator. All clothing was new and/or prewashed to avoid confounding analytical problems. The workers did not remove their gloves during the procedure but did during breaks.

Dermal exposures were monitored using gauze dosimeters encased in an envelope with a 5.6 cm diameter circle exposed to the environment (25 cm^2 total area). Dosimeters were either attached to the clothing or taped to the skin on the chest, back, shoulders, forearms, upper legs, or lower legs. Two sets of dosimeters were used, one outside the clothing and the other inside the work garments. Care was taken to avoid overlap of the dosimeters, which could confound the results of the inner monitors. Surface areas were assumed to be those outlined in the Agency's Guidance (OPPTS 875 Group A test guidelines, formerly Subdivision U).

Dermal exposure of the hands was monitored by hand wash with 250 mL of 10 percent isopropanol in distilled water. A plastic bag was wrapped around the wrist and the bag shaken for about 30 seconds. This procedure was repeated 3 times, resulting in a pooled volume of 750 mL for each hand. Hand rinses were conducted for each hand immediately prior to the exposure period and again

immediately after. Approximately 75 mL was transferred to a glass jar for storage.

Respiratory exposure was monitored using calibrated battery powered pumps attached to the belt with a 37 mm fiberglass filter attached to the collar in the breathing zone. The flow rate was approximately 2 liters per minute.

Dermal dosimeters and air filter cassettes were removed immediately after the exposure period. Gauze pads were removed from their holders with solvent rinsed tweezers and placed in individual 4 ounce glass jars. Filter were sealed and replaced in their original packing containers. All samples were maintained at 4°C during shipment and storage. Samples arrived at the analytical laboratory within 6 days of collection and analyzed within the next 2 months.

Fifty mL of hexane/acetone (1/1, v/v) was added to the dermal dosimeters jars and the jars shaken for 1 hour. A 100 µL aliquot of the extract was added to a 10 mL volumetric flask and 2 µL of internal standard/surrogate chemical (aldrin and heptachlor, respectively). The resulting solution was brought to volume with hexane

The results of exposure monitoring are presented in Table A1.

Table A1. Exposures of Workers Applying Lindane as a Seed Treatment at a Rate of 1.4 lb ai) Pounds of Active Ingredient per 60 Bushels of Grain (3600 lbs of seed, total. Values used for exposure estimation are in boldface.

Body Region	Monitor Location	Exposure (mg)			Exposure (mg/lb ai)	
		Mean	Median	Range	Mean	Median
Chest	Outer	3.21	2.43	0.92-7.84	2.3	1.7
Back	Outer	2.48	2.48	0.85-4.58	1.8	1.8
Forearms	Outer	17.75	15.25	5.57-51.79	13.0	11.0
Upper arms	Outer	4.43	3.88	0.99-10.10	3.2	2.7
Upper legs	Outer	33.96	20.46	2.90-132.55	24.0	15
Lower legs	Outer	1.34	9.64	0.43-5.95	0.96	6.9
Chest	**Inner**	**0.45**	**0.44**	**0.07-0.71**	**0.32**	**0.31**
Back	**Inner**	**0.71**	**0.52**	**0.11-2.59**	**0.51**	**0.37**
Forearms	**Inner**	**5.43**	**3.46**	**1.31-16.70**	**3.9**	**2.5**
Upper arms	**Inner**	**1.12**	**0.79**	**0.12-2.91**	**0.80**	**0.56**
Upper legs	**Inner**	**2.88**	**2.18**	**0.08-9.32**	**2.1**	**1.6**
Lower legs	**Inner**	**0.16**	**0.12**	**0-0.33**	**0.11**	**0.086**
Hands		**0.74**	**0.71**	**0.4-1.27**	**0.53**	**0.51**
Head/Neck		**1.72**	**1.47**	**0.7-3.58**	**1.2**	**1.1**
Total Dermal		**13.21**	**9.69**		**9.4**	**7.1**
Respiratory		**0.0022**	**0**	**0-0.016**	**0.0016**	**0**

mg/lb ai = Exposure (mg) ÷ 1.4 lb ai

Calculation of Daily Exposures:

Assumptions:

1) An average worker weighs 60 kg for dermal risk assessment and 70 kg for inhalation exposure and has standard body surface areas and respiration rates as presented in the Pesticide Assessment Guidelines (OPPTS 875 Group A test guidelines).

2) Examination of the Census of Agriculture data for Kansas yielded a median farm sizes of in the 100 to 249 acre range. Three other wheat producing states (North Dakota, Washington, and Montana) had median farm sizes in the 250 to 499 acre range. A farm size of 500 acres was assumed. Workers were assumed to treat and plant enough seed for 250 Acres per day, yielding a short term exposure scenario.

3) Workers are assumed to wear the same clothing as those participating in the study. Typical clothing consists of a long sleeved shirt, long pants, and chemical resistant gloves.

4) Wheat is planted at a rate of 120 pounds of seed per acre and each bushel of seed weighs 60 pounds (Hanson, A.A. (Ed) (1989) Practical Handbook of Agricultural Science. CRC Press, Inc., Boca Raton, FLA.) and BEAD report.

5) While the application rate varies somewhat for various types of seeds, the application rate/farm size is considered typical for lindane seed treatment products.

Amount of seed treated per 8 hour day:

Seed treated (lbs) = 100 A/day x 120 lbs seed/A l = 12000 lb seed/day

Amount of lindane handled per day:

Lbs ai handled per day = 2 oz/bushel x 0.1875 x 200 bushels seed/day x 1 lb/16 oz

= 4.7 lbs ai/day

Estimation of Exposure (manual seed treatment):

Dermal:

Dermal Exposure (mg/kg/day) = 9.4 mg/lb ai x 4.7 lbs ai/day ÷ 60 kg x 0.1

= 0.074 mg/kg/day

Respiratory:

Respiratory Exposure (mg/kg/day) = 0.0016 mg/lb ai x 12 lbs ai/day ÷ 70 kg

= 0.00011 mg/kg/day

The resulting Dermal MOE is:

MOE_D = 1.2 mg/kg/day ÷ 0.074 mg/kg/day = 16

The resulting Inhalation MOE is:

MOE_I = 0.13 mg/kg/day ÷ 0.00011 mg/kg/day = 1200

APPENDIX B

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Date: April 23, 2002

MEMORANDUM

SUBJECT: LINDANE: REVISION OF EXPOSURE ASSESSMENT FOR COMMERCIAL SEED TREATMENT PLANT WORKER (MRID 45200002, DP Barcode D282419) (Excerpt)

FROM David Jaquith
Reregistration Action Branch 4
Health Effect Division (7509C)

TO: Rebecca Daiss
Reregistration Branch 4
Health Effect Division (7509C)

2.2 Revised Exposure and Risk Estimates

HED has reevaluated the estimates of exposure and risk from treatment of wheat and canola seed with lindane using median unit dermal and inhalation exposures provided in the HELIX 289FS Study. Unit exposures used for this assessment are summarized in Table 2. Unit exposure data from the HELIX study are presented in detail in Appendix A.

Table 2. Unit Dermal and Inhalation Exposures of Workers During Seed Treatment and Handling of Treated Seed[1]

Median Unit Dermal and Inhalation Exposures	
Treater - Closed Transfer - Chemical-Resistant coveralls over long-sleeve shirt, long pants; chemical resistant gloves	
Dermal (n=17)	0.83 µg/lb/ai
Inhalation (n=17)	0.12 µg/lb/ai
Cleaner - Chemical-Resistant coveralls over long-sleeve shirt, long pants; chemical resistant gloves	
Dermal (n=7)	6.70 µg/kg bw
Inhalation (n=7)	1.20 µg/kg bw
Bagger/Sewer/Stacker - Chemical-Resistant coveralls over long-sleeve shirt, long pants; chemical resistant gloves	
Dermal - chemical resistant coveralls (n=34)	0.26 µg/lb/ai
Dermal - Cotton/polyester coveralls (n=19)	0.30 µg/lb/ai

Table 2. Unit Dermal and Inhalation Exposures of Workers During Seed Treatment and Handling of Treated Seed[1]	
Median Unit Dermal and Inhalation Exposures	
Inhalation (n=53)	0.06 µg/lb/ai
Forklift Operator - cotton/polyester coveralls over long-sleeve shirt, long pants; chemical resistant gloves	
Dermal (n=12)	0.08 µg/lb/ai
Inhalation (n=12)	0.008 µg/lb/ai

[1] Commercial Seed Treatment Plant Worker Exposure Study with Helix 289FS Seed Treatment on Canola (MRID 452000-02)

The application rate in the HELIX study was 400 gm thiamethoxam/100 kg seed (0.88 lb/220000 lb seed). The throughput of seed of 7000 kg/hr (15400 lb/hr), 6800 kg /hr(14960 lb/hr), 5000 kg/hr (11000 lb/hr), 5000 kg/hr (11000 lb/hr), 10000 kg/hr (22000 lb/hr) for sites 1 to 5, respectively. The following assumptions were used to estimate exposure:

6) The throughput of seed for both wheat and canola is 22000 lb/per hour or 176000 lbs per 8 hour day.

7) The application rate for wheat is 0.043 lb ai per hundred weight of seed. The application rate for canola is 1.5 lb (high-end) and 0.75 lb (low-end) ai per hundredweight of seed.

3) Pounds handled per day for wheat:

lbs handled per day wheat = 176000 lbs/day x 0.043 ÷ 100 lbs = 76 lbs/day
lbs handled per day canola (high-end) = 176000 lbs/day x 1.5 ÷ 100 lbs = 2640 lbs/day
lbs handled per day canola (low-end) = 176000 lbs/day x 0.75 ÷ 100 lbs = 1320 lbs/day

4) Median unit dermal and inhalation exposures were used based on data distribution.

5) Worker body weight for dermal exposure = 60 kg (female body weight used for developmental endpoint)
Worker body weight for inhalation exposure = 70 kg

APPENDIX C
Date: April 24, 2002

MEMORANDUM

SUBJECT: REVISION OF EXPOSURE ASSESSMENT FOR PLANTING OF SEED TREATED WITH LINDANE DP BARCODE D282418, MRID 42251901 (Excerpt)

FROM David Jaquith
Reregistration Action Branch 4
Health Effect Division (7509C)

TO: Becky Daiss
Reregistration Branch 4
Health Effect Division (7509C)

THRU Susan Hummel, Senior Scientist
Reregistration Branch 4
Health Effects Division (7509C)

2.0 CONCLUSIONS

HED has reevaluated the estimates of exposure and risk from planting of wheat and canola seed with lindane using a study specifically addressing this scenario rather than using PHED as a model for planting seeds. Using an oral NOAEL of 1.2 mg/kg/day to assess dermal risk and an inhalation NOAEL of 0.13 mg/kg/day the MOEs are :

Estimation of Dermal and Respiratory Exposures or Risksof Workers Planting Wheat and Canola Seed Treated with Lindane				
	Dermal Exposure (mg/kg/day)	Respiratory Exposure (mg/kg/day)	MOE	
			Dermal	Respiratory
Wheat	0.0013	0.00011	920	1200
Canola	0.0015	0.00013	800	1000

Examination of the data from the revised assessment, derived from a planting study (not included in PHED) and the previous assessment from PHED indicates that there are a large number of non detect samples in both of the data sets. Since the original PHED-derived estimates, which separated loading from planting showed large numbers of non detects for the planting function, it is evident that the loading contributes the majority of the exposure and that the actual planting task contributes relatively little to the total exposure.

3.0 CALCULATION OF EXPOSURES

In order to estimate the exposures of workers planting seed treated with lindane a number of assumptions regarding amount of seed planted and other parameters were required.

6) It is assumed that 250 acres of wheat or canola can be planted in a day (2).

7) An average worker has a body weight of 60 kg (a change from the previous assessment due to changes in the toxicological parameters) for dermal assessment. A weight of 70 kg is used for inhalation assessments.

8) Wheat is planted at a rate of 120 lbs of seed per acre. Canola is planted at a rate of 4 lbs seed per acre.

9) The application rate of lindane on wheat seed is 0.68 oz/cwt (0.043 lb/cwt). For canola the rate is 23.3 oz/cwt (1.5 lb ai/cwt). See Appendix B.

10) The dermal absorption of lindane is 10 percent (1).

3.1 Exposure Assessment for Wheat

Amount of lindane handled per day:

Lbs ai/day = 250 A/day x 120 lb seed/A x 0.043 lb ai/100 lbs seed = 12.9 lb ai/day

The resulting dermal exposure using arithmetic mean values from Appendix A is:

Dermal Exposure (mg/kg/day) = 0.0597 mg/lb ai x 12.9 lb ai/day x 0.1 (abs) ÷ 60 kg bw

= 0.0013 mg/kg/day

The resulting dermal MOE using a NOAEL of 1.2 mg/kg/day is:

MOE = 1.2 mg/kg/day/0.0013 mg/kg/day = 920

The respiratory exposure is:

Respiratory Exposure (mg/kg/day) = 12.9 lb ai/day x 0.0006 mg/lb ai ÷ 70 kg

= 0.00011 mg/kg/day

The resulting respiratory MOE using a NOAEL of 0.13 mg/kg/day is:

MOE = 0.13 mg/kg/day/0.00011 mg/kg/day = 1200

3.1 Exposure Assessment for Canola

Amount of lindane handled per day:

Lbs ai/day = 250 A/day x 4 lb seed/A x 1.5 lb ai/100 lbs seed = 15 lb ai/day

The resulting dermal exposure using arithmetic mean values from Appendix A is:

Dermal Exposure (mg/kg/day) = 0.0597 mg/lb ai x 15 lb ai/day x 0.1 (abs) ÷ 60 kg bw

= 0.0015 mg/kg/day

The resulting dermal MOE using a NOAEL of 1.2 mg/kg/day is:

MOE = 1.2 mg/kg/day/0.0015 mg/kg/day = 800

The respiratory exposure is:

Respiratory Exposure (mg/kg/day) = 15 lb ai/day x 0.0006 mg/lb ai ÷ 70 kg

= 0.00013 mg/kg/day

The resulting respiratory MOE using a NOAEL of 0.13 mg/kg/day is:

MOE = 0.13 mg/kg/day/0.00013 mg/kg/day = 1000