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MEMORANDUM

SUBJECT: EFED RED Science Chapter for Chlorothalonil

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The attached document contains the EFED science chapter for chlorothalonil. The RED chapter contains an Environmental Fate Assessment, Ecological Effects Assessment, Exposure and Risk Characterization and a Data Table.

EXECUTIVE SUMMARY

Use Summary:

Chlorothalonil (2,4,5,6-tetrachloroisophthalonitrile) is a broad spectrum fungicide registered for use on a variety of food and non-food use sites. The actual poundage used per year has reached over 17 million lbs. (1993 data). Most use sites are treated with very small percentages of the total that is applied annually. The exceptions are peanuts (>50% of the annual total), golf courses and lawns (about 14%), and cucurbits and tomatoes (>13%). It is registered on other turf sites, but the amount used is minimal. Application rates range from 0.75 lbs a.i./A for processed tomatoes to over 22 lbs a.i./A for turf, with multiple applications occurring at intervals of 2 to 21 days. EFED's risk assessment looked closely at the above crops, which the company maintains comprise over 80% of the chemical's use.

Toxicity Summary:

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The available acute toxicity data on the TGAI indicate that chlorothalonil is slightly to very practically non toxic to birds (LD50 = >4,000 mg/kg, mallard duck; LC50 = >10,000 ppm, bobwhite quail), practically non toxic to small mammals (LD50 = >10,000 mg/kg, rat), relatively non toxic to bees (LD50 = > 181.2 μg/bee), very highly toxic to freshwater organisms (LC50 = 23 - 84 ppb, fathead minnow and rainbow trout; EC50 = 68 ppb, daphnia), highly to very highly toxic to estuarine/marine organisms (LC50 or EC50 = 3.6 ppb, eastern oyster; 32 ppb, sheepshead minnow; 154 ppb, pink shrimp). Terrestrial plants were not significantly effected at >16 lb ai/A and aquatic algae had an EC50 = 190 ppb.
Chronic toxicity studies established the following NOEC values: birds 1000 ppm, bobwhite quail; small mammals 3,000, rat; freshwater fish 3.0 ppb, fish fathead minnow; aquatic invertebrates 39 ppb, daphnia; and estuarine invertebrates 0.83 ppb, mysid.

The available acute toxicity data on a major degradate, SDS-3701, indicates that it is moderately to slightly toxic to birds (LD50 = 158 mg/kg, mallard duck; 1746 ppm, bobwhite quail), moderately toxic to small mammals (LD50 = 332 mg/kg, rat), slightly toxic to aquatic organisms (LC50 = 15 ppm, bluegill sunfish; EC50 = 26 ppm, daphnia). Chronic toxicity studies established the following NOECs: birds 50 ppm, mallard duck; and small mammal 33 ppm, rabbit.

The available acute freshwater fish and aquatic invertebrate data on 3 formulations do not suggest any significant change in the toxicity on the basis of active ingredient.

Status of Data

EFED has adequate data to provide a qualitative assessment of the ecological toxicity of chlorothalonil to nontarget organisms. The following additional data would allow a more complete assessment of the ecological risk of chlorothalonil to nontarget organisms: Fish (estuarine & freshwater) fish early life stage (72-4(a)), Acute marine/estuarine fish, mollusk, and shrimp (72-3 (d-f)), Aquatic plant growth (123-2) and foliar dissipation. The first 2 guideline studies have a low value added and would be considered confirmatory data. The aquatic plant growth study is highly valued in that chlorothalonil has been seen to be toxic to one species of algae and there are no data on aquatic macrophytes. The foliar dissipation study is highly valued in order to improve the exposure and subsequently the risk assessment for terrestrial vertebrates.

With all data taken as a whole, EFED is reasonably confident in its environmental fate assessment of parent chlorothalonil. The nearly completed prospective small-scale ground water monitoring study which was precipitated by the presence of chlorothalonil and/or degradates (metabolites) in ground water will provide a more quantitative measure of ground water contamination potential. Spray drift and droplet size data are needed for estimates of exposure from drift. OPP would need the leaching rate of chlorothalonil from painted surfaces into the aquatic environment to evaluate an antifouling paint use.

<u>Special Study: Foliar dissipation of Residues on Vegetation</u>

Estimates of the concentrations of the toxic SDS-3701 metabolite on/in plants are based on selected residue chemistry studies reviewed by HED for residues on human food items or domesticated animal food or fodder. Such studies are generally not well-suited for environmental effects purposes. While we have concluded that SDS-3701 represents low acute and chronic risk to birds and mammals, there is uncertainty in using these data to make this conclusion. Therefore, we suggest additional testing be considered in the form of residue studies measuring the concentration of SDS-3701 on vegetation following application of parent chlorothalonil.

Environmental Fate Discussion

Chlorothalonil degrades principally by microbial processes. Ten to 50 day "half-lives" for field dissipation and/or biodegradation would be a nominal range for most uses (shorter and longer times have been observed). Degradation rates are very sensitive to the biogeochemical environment and ambient conditions, and may depart from first-order kinetics. Parent is generally less persistent under aquatic conditions, with apparent initial "half-lives" ranging from a few hours to around two weeks. SDS-3701, a major metabolite, is ever present and persistent. Other metabolites also exhibit a degree of persistence sufficient to allow their appearance in ground water. Parent and degradates have simple chemical structures with simple substituents (including multiple chlorine atoms) attached to a single benzene ring. Evolution of volatiles, including carbon dioxide, was never significant.

Parent chlorothalonil did not appreciably bioconcentrate in oysters or bluegill sunfish; recalcitrant metabolites did bioconcentrate somewhat in the biochemical (carbon) pool of the organisms and were slow to be eliminated.

Ecological Risk Discussion

The use sites that represent the greatest potential for ecological impact are peanuts, tomatoes, cucurbits, and turf. Peanuts, tomatoes and curcurbits are important because they comprise over 60% of the chlorothalonil usage. Turf comprises about 15% of chlorothalonil's usage.

Chlorothalonil is a chronic risk to terrestrial animals, and both an acute and chronic risk to aquatic animals. The risk quotients for turf uses are higher than for other uses primarily because of the higher use rates.

<u>Terrestrial Animals</u>

Chlorothalonil represents a chronic risk to birds for all sites- turf, orchards and non-orchard crops. There is chronic risk to mammals from turf and orchards. The chronic risks to birds and mammals for turf and orchards are greater than the other uses because: 1) the higher use rates 2) short grass is more abundant in turf and orchards than in the other uses sites and 3) estimated residues concentrations on short grass are higher than other food items (seeds, insects, leafy crops). No field data are available that corroborate or negate this risk conclusion. Parent chlorothalonil does not represent an acute risk to terrestrial animals.

<u>Aquatic Animals</u>

Chlorothalonil is highly toxic both acutely and chronically to aquatic (freshwater and estuarine) animals. For freshwater fish, most uses result in acute risk quotients that exceed the high risk LOC. Invertebrates are at risk, but other than mollusks, less so than fish. Oysters are the most acutely sensitive of all freshwater and estuarine organisms tested. All uses when located along estuaries represent a high acute risk to oysters. Freshwater mollusks, especially those inhabiting still or slow moving water, would be at high risk.

Since chronic risk quotients for crops including orchards are only slightly above the chronic LOC for fish the extent of risk from these uses is uncertain. However risk quotients are higher for turf -- especially the rates above 4 lb ai/A -- therefore chronic risk to fish is more likely. Mysids are the most chronically sensitive aquatic organism. Where ever chlorothalonil is used along estuaries there is potential for chronic effects to fish and invertebrates.

<u>Field Evidence Corroborating these Risk Conclusions</u>

The fish acute risk quotients would suggest chlorothalonil may result in fish kills. However, a test was conducted in which chlorothalonil was intentionally applied to a pond containing caged fish. Concentrations of 171 to 883 ppb did not result in fish mortality even though these concentrations exceed all LC50s by a sizeable margin. Because of their age (1-year old), the fish in this study may not have been as sensitive as the smaller fish used in toxicity tests. Therefore, this study does not prove conclusively that exposure to chlorothalonil at levels exceeding the LC50 would fail to kill fish.

There are some fish kills associated with chlorothalonil, however there are none that have occurred from labeled uses that are linked solely or strongly to chlorothalonil. The extensive fish kill on Prince Edward Island, Canada, in 1996 (see discussion of incidents in section (3) (a) concerning risk to fish) is associated with chlorothalonil concentrations in water (4 ppb) and sediment (up to 60 ppb), but the investigators did not identify chlorothalonil as the cause of the kill.

Subacute or chronic effects due to chlorothalonil would not be detected as incidents. This includes *acute* risk to oysters and *chronic* risk to both terrestrial and aquatic organisms. Therefore, failure to detect effects attributable to chlorothalonil does not mean they are not occurring.

<u>SDS-3701</u>

One of chlorothalonil's primary degradates, SDS-3701, is more toxic to birds and mammals than the parent. At this time, because residue studies suggest that residues do not occur on avian or mammalian food items at levels considered to be toxic, SDS-3701 is not considered to present a significant risk to birds or mammals. However there is high uncertainty associated with the residue data and therefore the risk assessment is tentative. SDS-3701 is less toxic to aquatic animals than parent chlorothalonil, and is not a risk to these organisms.

<u>Uses Not Assessed</u>

An assessment of the use of this chemical in antifoulant paint has **not been done.** OPP would need the leaching rate of chlorothalonil from painted surfaces into the aquatic environment to evaluate an antifouling paint use.

Risk Reduction:

For uses other than turf, *typical application rates* result in ecological risk quotients that exceed the LOC by relatively small margins. Reducing the label rates to those rates that are typically used is a recommended risk reduction. This would not eliminate LOC exceedances, but would be preferable, environmentally, to the higher rates now on the labels.

Because peanuts, tomatoes and curcurbits represent a large portion of chlorothalonil usage (@63%), lowering the application rates on these uses especially would be environmentally desirable. Even though turf is not a major usage for chlorothalonil based on percentage applied, the use rates are much higher than other sites. Therefore, reducing the application rates for turf would also be desirable, environmentally.

Water Resources Discussion

Parent and metabolites runoff with surface water and parent chlorothalonil has been detected in surface water. As was predictable from lab data, four identified metabolites have been found in ground water. Equally significantly and likewise predictably, parent chlorothalonil and another identified metabolite are much less mobile and less likely to appear in significant concentrations in ground water. Presence of parent and degradates in ground water precipitated the ground water monitoring study now being concluded.

EFED would like to make certain that HED and the Office of Water are aware of the presence and approximate concentrations of chlorothalonil and/or degradates which have been found in ground and surface water. Detailed assessments are given in the Water Resources Section of the RED document. Immunoassay test kits for parent, for certain degradates, and for manufacturing impurities are conveniently available commercially for field screening purposes.

Drinking Water

Chlorothalonil and prevalent degradates are not currently regulated under the Safe Drinking Water Act (SDWA). Therefore no MCLs have been established, and water supply systems are not required to sample and analyze for them.

The intermediate soil/water partitioning of chlorothalonil should make the primary treatment processes employed by most surface water source supply systems at least partially effective in removing it. Furthermore, the NAWQA data indicate that annual average concentrations of chlorothalonil in surface source drinking water are unlikely to exceed 1.5 ug/L. Ground water monitoring data also indicate that chlorothalonil in ground water is unlikely to reach average levels approaching the 10^{-6} lifetime cancer risk of 1.5 μg/L.

Label Language

MANUFACTURING USE (Incl. PR Notice 93-10)

"This pesticide is toxic to fish and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local treatment plant authority. For guidance contact your State Water Board or Regional office of the EPA."

END USE (Inc. PR Notice 93-3, 93-8)

AGRICULTURAL AND TURF USES

"This pesticide is toxic to fish and aquatic invertebrates. Do not apply directly to water or to areas where surface water is present or intertidal areas below the mean high water mark. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment washwaters or rinsate."

ANTIFOULANT PAINT USES

"This pesticide is toxic to fish and aquatic invertebrates. Do not contaminate water when disposing of wastes."

SURFACE WATER LABEL ADVISORY

Based on the detailed assessment, the following surface water label advisory is recommended for chlorothalonil:

"Chlorothalonil can contaminate surface water through spray drift. Under some conditions, chlorothalonil may also have a high potential for runoff into surface water (via both dissolution in runoff water and adsorption to eroding soil) for several weeks to months post-application. These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters, frequently flooded areas, areas over-laying extremely shallow ground water, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and highly erodible soils."

GROUND WATER LABEL ADVISORY

Likewise, the following ground water label advisory is recommended for chlorothalonil:

"At least one chlorothalonil degradate is known to leach through soil into ground water under certain conditions as a result of label use. Chlorothalonil parent and several other degradates generally have low leaching potentials but have been found in ground water. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground water contamination."

Aerial Spray Drift Management

Standard spray drift labeling languange applies to all aerial, mist blowers and/or spray blast uses of chlorothalonil.

Classification

All uses of chlorothalonil exceed the restricted use criteria for aquatic animals (fish are more sensitive than freshwater invertebrates with the possible exception of freshwater mollusks). It is recommended that restricted use be considered as a risk mitigation measure to reduce the likelihood of higher risk because of misapplication.

ENVIRONMENTAL ASSESSMENT

Ecological Toxicity Data

The Agency has adequate data to provide a qualitative assessment of the ecological toxicity of chlorothalonil to nontarget organisms. The following additional data would allow a more complete assessment of the ecological risk of chlorothalonil to nontarget organisms: Fish early life stage (72-4(a)), Acute marine/estuarine fish, mollusk, and shrimp (72-3 (d-f)), Aquatic plant growth (123-2), and residue on foliage (70-1).

Toxicity to Terrestrial Animals

Birds, Acute and Subacute

Toxicity of Chlorothalonil: In order to establish the toxicity of chlorothalonil to birds, the following tests were required using the technical grade material: one avian single-dose oral (LD_{50}) study on one species (preferably mallard or bobwhite quail); two subacute dietary studies (LC_{50}) on one species of waterfowl (preferably the mallard duck) and one species of upland game bird (preferably bobwhite quail). The following two tables summarize the avian acute oral toxicity findings and the avian subacute dietary toxicity findings:

Avian Acute Oral Toxicity Findings

Test Species	% a.i.	LD_{50} mg/kg	Citation (MRID #)	Toxicity Category	Fulfills Guideline?
Mallard	96%	> 4640	00068753	Practically non-toxic	Yes
Japanese quail	Tech.	> approx. 2000	40964105	Practically non-toxic	Supplemental

Avian Subacute Dietary Toxicity Findings

Test Species	% a.i.	LC_{50} ppm	Citation (MRID #)	Toxicity Category	Fulfills Guideline?
Northern Bobwhite	96%	> 10,000	00030388	Practically non-toxic	Yes
Mallard	93.6%	> 21,500	00039146	Practically non-toxic	Yes
Mallard	96%	> 10,000	00030389	Practically non-toxic	Yes

These results indicate that chlorothalonil is "practically non-toxic" to avian species on an acute oral and subacute dietary basis. The avian acute and subacute guideline requirements for parent chlorothalonil are fulfilled.

Toxicity of SDS-3701: Additional studies on a degradate, SDS-3701, have been submitted. These studies are summarized in the following table:

Avian Acute Oral and Subacute Dietary Toxicity Findings					
Test Species	**% a.i.**	**Results**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Mallard	SDS-3701 (87%)	LD_{50} = 158 mg/kg	00030395	Moderately toxic	Yes
Northern Bobwhite	SDS-3701 (87%)	LC_{50} = 1746 ppm	00115109	Slightly toxic	Yes
Mallard	SDS-3701 (87%)	LC_{50} = 2000 ppm	00115108	Slightly toxic	Yes

These studies show that SDS-3701 is "moderately toxic" on an acute oral basis and "slightly toxic" on a dietary basis to the test birds, based on a mortality response.

Birds, Chronic

Toxicity of Chlorothalonil: Avian reproduction studies have been required in the past for pesticides when birds may be exposed repeatedly or continuously through persistence, bioaccumulation, or multiple applications, or if mammalian reproduction tests indicate reproductive hazard. Present product labeling of chlorothalonil in many cases allows repeat applications of the end-use product during a single growing season. Approved changes to 40CFR Part 158 will generally require avian reproduction studies for all outdoor uses, regardless of repeat applications. The following table summarizes the avian reproduction findings:

Avian Reproduction Findings						
Test Species	**% a.i.**	**NOEL PPM**	**LOEL PPM**	**Endpoints affected**	**Citation (MRID #)**	**Fulfills Guideline?**
Mallard	Tech.	>10,000 (reprod.)	>10,000 (reprod.)	No reproductive effects cited at any test level (1000, 5000, 10,000 ppm)	40964102	Yes

Avian Reproduction Findings						
Test Species	**% a.i.**	**NOEL PPM**	**LOEL PPM**	**Endpoints affected**	**Citation (MRID #)**	**Fulfills Guideline?**
Bobwhite	Tech.	1000 (reprod.)	5000 (reprod.)	"Overt signs of toxicity and reduced reproduction" cited at 5000 ppm; "overt signs of toxicity, mortalities, and profound effects upon several reproductive parameters related to egg production, hatching success, and survival of hatchlings" cited at 10,000 ppm.	40964104	Yes
Mallard	99.6		Not established. Highest level of 50 ppm did not cause impairment.	Not applicable.	00041441	Supplemental
Bobwhite	99.6		Not established. Highest level of 50 ppm did not cause impairment.	Not applicable.	00041440	Supplemental

The avian reproduction studies indicate that parent chlorothalonil does not affect avian reproduction at 1000 ppm and below; effects were seen at 5000 ppm and above (based on bobwhite study). The guideline requirements for testing with parental chlorothalonil are fulfilled.

Toxicity of SDS-3701: Because of the high persistence of SDS-3701 degradate, avian reproduction studies have also been required for this material. These studies are summarized in the following table:

Avian Reproduction Findings						
Test Species	**% SDS-3701**	**NOEL PPM**	**LOEL PPM**	**Endpoints affected**	**Citation (MRID #)**	**Fulfills Guideline?**
Mallard	99.6	50	100	Reduction in eggshell thickness seen at 100 ppm; at 250 ppm adult body weight, food consumption, and gonad development affected, as well as effects on numbers of eggs laid, embryonic development, eggshell thickness, hatchability, and hatching survival.	40729402	Yes
Bobwhite	99.6	100	250	Reduction in numbers of eggs laid (but not statistically significant)	40729404	Yes

These results indicate that avian reproduction in birds could be affected at levels of SDS-3701 above 50 ppm.

Mammals

Wild mammal testing is required on a case-by-case basis, depending on the results of the lower tier studies such as acute and subacute testing, intended use pattern, and pertinent environmental fate characteristics. In most cases, however, data from the Agency's Health Effects Division (HED) are used to determine toxicity to mammals. These data are reported below:

Mammalian Toxicity Findings--Chlorothalonil

Test Species	LD_{50} mg/kg	NOEL PPM	LOEL PPM	Citation (MRID #)	Toxicity Category
Rat (small mammal surrogate)	>10,000			00094940	practically non-toxic
Rabbit (developmental)[1]		330	660 decrease in maternal body weight gain	41250503	n/a
Rat (developmental)		2,000	8,000 increased resorptions of fetuses	00130733 41679301	"
Rat (2 generation reproduction)[1]		1500	3,000 decrease in pup body weight gain	41706201	"

[1] No developmental toxicity was seen at any dose level.

The available mammalian data indicate that chlorothalonil is "practically non-toxic" to small mammals on an acute oral basis, based on the rat LD_{50}. However, a number of non-lethal effects were reported, including, "diarrhea, lacrimation, reduced muscle tone and erythema. The only definitive NOEL for a developmental parameter was 2,000 ppm based on resorption of fetus at 8,000 ppm. A decrease in body weight gain is not considered to be a significant parameter to be used in assessing ecological risk to reproduction.

Toxicity of SDS-3701: Data on the toxicity of the SDS-3701 degradate to mammals are tabulated below:

Mammalian Toxicity Findings--SDS-3701					
Test Species	**LD_{50} mg/kg**	**NOEL PPM**	**LOEL PPM**	**Citation (MRID #)**	**Toxicity Category**
Rat (small mammal surrogate)	242 (fem.)			001098	moderately toxic
Rabbit (developmental)		33	82.5 maternal death and abortion	00047944	n/a
Rat (3 generation reproduction)		10	reduced pup body weight gain at 60 ppm	00127844	"
Rat (1 generation reproduction)		10	reduced pup body weight gain at 60 ppm	00127845	"

The data indicate that SDS-3701 is moderately toxic to small mammals on an acute oral basis. In a 3-generation rat reproductive study, a modest reduction in the rate of body weight for pups was observed at 60 ppm. However this measurement end point is not considered a significant parameter used in assessing ecological risk to reproduction. Although a definitive reproductive or developmental NOEL was not established in any of the above studies, chlorothalonil demonstrated an impact on pregnant rabbits at concentrations between 33 and 82.5 ppm.

Insects

A honey bee acute contact LD_{50} study is required if the proposed use will result in exposure to honey bees. The available insect acute contact toxicity findings for chlorothalonil are summarized in the following table:

Nontarget Insect Acute Contact Toxicity Findings					
Test Species	**% a.i.**	**Results**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Honey bee	Tech.	at 181 ug/bee, 14.28% mortality	00036935	Relatively non-toxic	Yes
Honey bee	Tech.	non-toxic at 181 ug/bee	00077759	non-toxic at 181 ug/bee	Yes

There is sufficient information to characterize chlorothalonil as "relatively non-toxic" to honey bees. The guideline requirement is fulfilled.

Toxicity to Aquatic Animals

Freshwater Fish

Toxicity of Technical Chlorothalonil: In order to establish the toxicity of a pesticide to freshwater fish, the minimum data required on the technical grade of the active ingredient are two freshwater fish toxicity studies. One study should use a coldwater species (preferably the rainbow trout), and the other should use a warmwater species (preferably the bluegill sunfish). The freshwater fish acute toxicity findings for the technical grade of the active ingredient are summarized in the following table:

Freshwater Fish Acute Toxicity Findings					
Test Species	**% a.i.**	**LC_{50} ppb a.i.**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Rainbow trout	96	42.3	00056486	very highly toxic	Supplemental
Bluegill	96	59.5	00041439	very highly toxic	Yes
Bluegill	99	84	00029410	very highly toxic	Yes
Bluegill	98	51	00127862	very highly toxic	Yes
Channel catfish	96	48	00030390	very highly toxic	Yes
Fathead minnow	96	23	00030391	very highly toxic	Yes

The results of the 96-hour acute toxicity studies indicate that chlorothalonil is "very highly toxic" to fish. The guideline requirements are fulfilled.

Toxicity of Formulated Product: Formulated product testing is specified for products with direct application to aquatic habitats and for typical end-use products where the EEC for the active ingredient is $\geq LC_{50}$. The previous Phase IV Review (1/12/93) specified further testing of a 54% ai flowable concentrate due to a cranberry use. The freshwater fish acute toxicity findings for the 54%, 75%, and Bravo W-75 formulations are summarized in the following table:

Freshwater Fish Acute Toxicity Findings					
Test Species	**% a.i.**	**LC_{50} ppb formulation**	**Citation (MRID #)**	**Toxicity Category (FP)**	**Fulfills Guideline? (for Formulated Product tested)**
Rainbow trout	54 (Bravo 720)	61 (33.2; ai)	43302101	very highly toxic	Yes
Bluegill	54 (Bravo 720)	49 (26.3; ai)	42433804	very highly toxic	Yes
Rainbow trout	75	152 (48-hr.)	00087304	highly toxic	Supplemental
Rainbow trout	75	103	00087303	highly toxic	Yes
Bluegill	Bravo W-75	167	00087258	highly toxic	P

These studies show that Bravo 720 is "very highly toxic" to both rainbow trout and bluegill. The 75% ai formulation tested is "highly toxic" to these species.

Toxicity of SDS-3701: Testing using the degradate SDS-3701 was required due to its persistence in water. Freshwater fish acute toxicity findings for the degradate SDS-3701 are summarized in the following table:

Freshwater Fish Acute Toxicity Findings					
Test Species	**% SDS-3701**	**LC_{50} (ppm)**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Bluegill	not avail.	45	00029415	slightly toxic	Yes (for SDS-3701)
Bluegill	99	15	00030393	slightly toxic	Yes (for SDS-3701)

These studies show that SDS-3701 is "slightly toxic" to the bluegill and therefore is significantly less toxic than parent chlorothalonil.

Early Life-Stage - Fish: Data from fish early life-stage testing is required for chlorothalonil since it can be expected to be transported to water from the intended use site, acute LC_{50} values are less than 1 mg/L, and aquatic EECs are $\geq$ 0.01 of LC_{50}s. Previous reviews have determined that the full fish life cycle study fulfills the requirement. Fish full life-cycle testing findings are summarized in the following table:

Fish Full Life-Cycle Toxicity Findings							
Test Species	**% a.i.**	**NOEL (ppb)**	**LOEL (ppb)**	**MATC (ppb)**	**Citation (MRID #)**	**Endpoints Affected**	**Fulfills Guideline?**
Fathead minnow	96	3	6.5	>3<6.5 (geom. mean = 4.4)	00030391	hatching success and survivability	Yes

The results indicate that fathead minnow hatching success and survival are affected at between 3 and 6.5 ppb. The guideline requirement is fulfilled.

Aquatic Field Testing: An aquatic field study was previously submitted and reviewed (MRID # 00127862). It included some limited information regarding exposure for one soybean site. The highest reported water and sediment concentrations in two adjacent ponds were 0.6 ppb and 1.1 ppb for water and 31 ppb and 51 ppb for sediment, respectively. No mortality was obvserved in the study. However, the submission is considered supplemental, in part because there was only one site studied and conditions did not represent a reasonable high runoff scenario.

Freshwater Intervertebrates

Toxicity of Chlorothalonil: The minimum testing required to assess the hazard of a pesticide to freshwater invertebrates is a freshwater aquatic invertebrate toxicity test, preferably using first instar *Daphnia magna* or early instar amphipods, stoneflies, mayflies, or midges. The freshwater invertebrate toxicity findings for the technical are summarized in the following table:

Freshwater Invertebrate Toxicity Findings					
Test Species	**% a.i.**	**LC_{50} (ppb)**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Daphnia magna	Tech.	68	00068754	very highly toxic	Yes

There is sufficient information to characterize chlorothalonil as "very highly toxic" to aquatic invertebrates. The guideline requirement is fulfilled.

Toxicity of Formulated Product: Formulated product testing is specified for products with direct application to aquatic habitats and for typical end-use products where the EEC for the active ingredient is $\geq LC_{50}$. The freshwater invertebrate toxicity findings for formulated product testing are summarized in the following table:

Freshwater Invertebrate Toxicity Findings					
Test Species	**% a.i.**	**LC_{50} (ppb) formulation**	**Citation (MRID #)**	**Toxicity Category (FP)**	**Fulfills Guideline? (for FP tested)**
Daphnia magna	54 (Bravo 720)	180 (97; ai)	42433806	highly toxic	Yes

There is sufficient information to characterize Bravo 720 as "highly toxic" to aquatic invertebrates. However, there is no suggestion that this formulation is more toxic than the active ingredient or makes the a.i. more toxic.

Toxicity of SDS-3701: Because of the aquatic persistence of the degradate SDS-3701, acute testing of this material has been previously requested and reviewed. The freshwater invertebrate toxicity findings for the degradate, SDS-3701, are summarized in the following table:

Freshwater Invertebrate Toxicity Findings					
Test Species	**% SDS-3701**	**LC_{50} (ppm)**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Daphnia magna	99	26	00030394	slightly toxic	Yes (for SDS-3701)

The above data indicate that SDS-3701 is "slightly toxic" to *D. magna* and therefore is significantly less toxic than parent chlorothalonil.

Chronic Aquatic Testing: Because chlorothalonil is expected to be transported to water from the intended use site, acute LC_{50} values are less than 1 mg/L, and aquatic EECs are $\geq$ 0.01 of LC_{50}s, chronic aquatic testing is specified. The aquatic invertebrate life-cycle toxicity findings are summarized in the following table:

Aquatic Invertebrate Life-Cycle Toxicity Findings							
Test Species	**% a.i.**	**NOEL (ppb)**	**LOEL (ppb)**	**MATC (ppb)**	**Citation (MRID #)**	**Endpoints Affected**	**Fulfills Guideline?**
Daphnia magna	99.8	39	79	>39<79 (geom. mean = 55.5)	00115107	survival, cumulative numbers of offspring/ female	Yes

The results indicate that chlorothalonil can affect aquatic invertebrate reproduction between 39 and 79 ppb. The guideline requirement is fulfilled.

Estuarine and Marine Animals

Acute Toxicity of Chlorothalonil: Acute toxicity testing with estuarine and marine organisms is required when an end-use product is intended for direct application to the marine/estuarine environment or is expected to reach this environment in significant concentrations. Peanuts and turf are some of the registered use sites for Chlorothalonil that the Agency considers to be associated with estuarine/marine habitat.

The requirements under this category include a 96-hour LC_{50} for an estuarine fish, a 96-hour LC_{50} for shrimp, and either a 48-hour embryo-larvae study or a 96-hour shell deposition study with oysters. The estuarine/marine acute toxicity findings are summarized in the following table:

Estuarine/Marine Acute Toxicity Findings

Test Species	% a.i.	LC_{50}/EC_{50} (ppb)	Citation (MRID #)	Toxicity Category	Fulfills Guideline?
Sheepshead minnow	Tech.	32	00127863	very highly toxic	Yes
Pink Shrimp	Tech.	154	00127864	highly toxic	Yes
Eastern Oyster (shell deposition)	Tech.	3.6	00138143	very highly toxic	Yes

There is sufficient information to characterize chlorothalonil as "very highly toxic" to the sheepshead minnow and Eastern oyster, and "highly toxic" to the pink shrimp. The guideline requirement is fulfilled.

Acute Toxicity of Formulated Product: Acute testing with marine/estuarine organisms, using formulated product, may be required to evaluate those use patterns with marine/estuarine exposure where the EEC $\geq LC_{50}$ for the active ingredient. End use formulations do not demonstrate significantly greater toxicity to freshwater organisms than technical chlorothalonil (within what may be considered statistical differences between tests or laboratories). Although testing on estuarine fish with Bravo 720 may result in a slightly lower LC50 than 32 ppb it would most likely be above the oyster EC50 of 3.6 ppb, therefore, risk to estuarine organisms would still be based on technical chlorothalonil's impact to oysters.

Except for oysters, invertebrates appear to be less sensitive to chlorothalonil and SDS-3701 than fish. Nevertheless, several factors support testing oysters with Bravo 720 -- 1) it may be used in coastal areas, 2) oysters are more sensitive than other invertebrates by factors of 20 - 50X, 3) oysters can not move out of contaminated areas, and 4) oysters bioconcentrate chlorothalonil at greater than 2000X. On the other hand, value added for oyster testing may be reduced for two reasons: 1) if the toxicity was twice that of parental chlorothalonil the EC50 would be 1.8 ppb (this two-fold difference is not considered to be significant relative to the EECs, which are 10-fold higher than the EC50 of 3.6 ppb); and 2) drift at the time of application is the only means by which oysters are exposed to the entire formulation. The frequency of such an occurrence could be low, as would be the resulting water concentration. The value added for this study is low to medium -- primarily because a risk assessment based on the formulation may not be significantly different from one on parent chlorothalonil.

Chronic Toxicity of Chlorothalonil: Marine/estuarine chronic testing was required due to potential exposure from such sites as turf and peanuts. The marine/estuarine chronic (invertebrate life-cycle toxicity findings) data are summarized in the following table:

Invertebrate Life-cycle Toxicity Findings

Test Species	% a.i.	NOEL (ppb)	LOEL (ppb)	MATC (ppb)	Citation (MRID #)	Endpoints Affected	Fulfills Guideline?
Mysid shrimp	100	0.83	1.2	>0.83<1.2 (geom. mean = 1.0)	42433807	reproduction	Yes

The above results indicate that mysid shrimp reproduction will be effected at exposures between 0.83 and 1.2 ppb, and higher. The guideline requirement for this test has been fulfilled. However, chronic data are also required for a marine/estuarine fish species, preferably the sheepshead minnow (fish early life-stage). The value added, however, is considered low since a fathead minnow full life-cycle study is available, and the fathead minnow was slightly more sensitive than the sheepshead minnow in acute testing.

Toxicity to Plants

Terrestrial

Tier 1 toxicity data on the technical material are summarized in the following table:

Nontarget Terrestrial Plant Toxicity Findings				
Study	**% a.i.**	**Results (lb ai/A)**	**Citation (MRID #)**	**Fulfills Guideline?**
Seed germination/seedling emergence--Tier 1 (122-1A): 10 species	97.9	NOEL ≥ 16	42433808	Yes
Vegetative vigor--Tier 1 (122-1B): 10 species	97.9	NOEL ≥ 16	42433809	Yes

The results indicate that seed germination/seedling emergence and vegetative vigor were not affected in a statistically significant manner at test levels of 16 lb ai/A. Presently, the highest registered application rate is 22.4 lb ai/A. Since at 16 lb ai/A the most sensitive species (onions) showed only an 11% negative response, best professional judgement suggests that detrimental effects greater than 25% would not occur at 22.4 lb ai/A. Since twenty-five percent is the threshold for testing at Tier 2, testing under Guideline 123-1 (Tier 2) will not be required.

Aquatic

Aquatic plant testing is required for chlorothalonil because it has outdoor non-residential terrestrial uses and it may move off site of application by drift (e.g., it has aerial and air blast applications).

Tier 2 toxicity data on the technical/TEP material are summarized in the following table:

Nontarget Aquatic Plant Toxicity Findings				
Test Species	**% a.i.**	**Results (ppb)**	**Citation (MRID #)**	**Meets Guideline Requirements**
Selenastrum capricornutum	97.9	EC_{50} = 190 NOEC = 50 LOEC = 100	42432801	Yes

The results indicate that the freshwater green alga tested has an EC_{50} of 190 ppb, with a NOEC of 50 ppb. The guideline requirements for a test on *Selanastrum capricornutum* are fulfilled.

Due to the effects seen, testing may also be required for an additional four species in Tier 2. At this time the Agency requires only a Tier 2 test on *Lemna gibba*. If *Lemna* is more sensitive than *Selenastrum capricornutum* then *Skeletonema costatum*, *Anabaena flos-aquae*, and a freshwater diatom must be tested with parental chlorothalonil. Furthermore, if *Lemna gibba* is more sensitive than Selenastrum capricornutum then *Lemna* must be tested against the degradate SDS-3701. The value added for the Lemna study is high as it is the only representative for an aquatic vascular plant.

Environmental Fate

Status of Data. Based on the available data, the Agency is reasonably confident in its environmental fate assessment of chlorothalonil. A prospective small-scale groundwater monitoring study which was precipitated by the presence of chlorothalonil and/or degradates/ metabolites in groundwater (see below) has been concluded, although the final report is still pending. The study provides a quantitative measure of groundwater contamination potential. Spray drift and droplet size data are needed for estimates of exposure from drift; however, this requirement may be fulfilled with data from the Spray Drift Task Force, which should be available in the near future.

Estimates of the concentrations of the SDS-3701 metabolite on/in plants are based on selected residue chemistry studies reviewed by the Health Effects Division (HED) for residues on human food items or domesticated animal food or fodder. Such studies are generally not well-suited for environmental fate and effects purposes because the concentrations of residues in food harvested for humans and domestic animals generally differ from wildlife food sources because of weathering, handling, and processing conditions in the field. To improve estimates for concentrations of SDS-3701 on/in plants and the resultant potential exposure effects to non-target organisms, dedicated studies would be needed.

In addition, the Agency would need the leaching rate of chlorothalonil from painted surfaces into the aquatic environment to evaluate an antifouling paint use.

Environmental Fate Assessment

Key points to keep in perspective for this assessment are the following:

* There is widespread use of chlorothalonil on many different crops. Including agricultural and industrial applications, the registrant recently reported that over 17 million pounds of this fungicide are being used annually in the U.S. (roughly 15% of all U.S. fungicide use by weight). Many repeat applications with short time intervals between applications at relatively high application rates are typical.

* OPP classifies chlorothalonil as a polychlorinated aromatic fungicide (2,4,5,6-tetrachloroisophthalonitrile), but it is atypical in that it does not show so high a degree of persistence as is associated with many other chlorinated organics. However, several of its primary metabolites are also polychlorinated and appear to be more persistent and more mobile, as evidenced by laboratory studies, field studies, a groundwater monitoring study, and their appearance in groundwater (see Water Resources below). Therefore, longer term environmental focus should be transferred from parent to metabolites. SDS-3701, the most prevalent metabolite, is persistent and typically reaches amounts equivalent to 10 to 40% of total applied parent in soil.

* Chlorothalonil and metabolites runoff with surface water. Parent and/or degradates have been detected in some groundwater. (See Water Resources below.)

Transformation Processes. Chlorothalonil is transformed principally by aerobic and anaerobic microbial metabolism. Simple hydrolysis or photolysis are not major degradative pathways. Mineralization (carbon dioxide production) or evolution of volatiles is not significant under any circumstances.

Rates of degradation and dissipation. Residence times of chlorothalonil in the environment vary considerably. Ten to 60 day half-lives (overall) for field dissipation would be a reasonable range for typical terrestrial uses. This range of half-lives is consistent with the laboratory aerobic soil metabolism results in four different soils for which half-lives ranged from about 10 to 40 days. Initial terrestrial field dissipation half-lives from 4 to 90 days have been reported according to a recent review of the literature, with a value of 30 days considered representative (Ware, 1992). Temperature and moisture are prominent rate factors. Interpretation of preliminary data from a groundwater monitoring study being conducted on peanuts in North Carolina (see Water Resources below) indicates a field dissipation half-life as long as approximately 4 to 6 months. For modeling purposes (PRZM/EXAMS and GENEEC), the Agency used the upper 90% confidence bound on the mean of half-lives for the four aerobic soils tested in the laboratory. The calculated value is approximately 30 days, in agreement with the value selected in the Ware literature review.

In two different soils under anaerobic aquatic laboratory conditions (reflective of hydrosoil or sediments) half-lives were in the range of 5 to 15 days. Various laboratory aerobic aquatic results give effective metabolic half-lives ranging from around two hours up to around 6 or 8 days; these "half-lives" appear to be very sensitive to experimental conditions and to show some concentration dependence. The Agency has "selected" aerobic aquatic "half-lives" of 2 and 44 hours for modeling purposes (see Aerobic Aquatic Metabolism and/or Water Resources below) to estimate environmental concentrations (EECs) and to derive risk quotients for aquatic systems. In the modeling process, the input values for aerobic aquatic half-lives (2 hours and 44 hours) were adjusted to a lower temperature (25°C to 20°C) and the 2-hour value was also multiplied by 3 to allow for uncertainty with a single value estimate as traditionally done by EFED. Modeled *instantaneous* pond water concentrations are essentially insensitive to the selected values for this short-lived compound. Both the more conservative 44-hr. and the adjusted less conservative 2-hr. half-lives are used for comparison in the risk assessment.

Based on all observations, degradation rates strongly depend on local physical and biochemical conditions. Metabolism is faster under wet, flooded or aquatic conditions, especially when there is aeration and mixing. Rates will vary depending on the availability of water and oxygen; the types of soils or sediments and their sorption characteristics; sediment concentrations; presence of microfauna, microflora (including algal forms) or even larger life forms.

Degradates (formulas and structures given in the Appendix). Five related degradates/metabolites (SDS-3701, SDS-19221, SDS-46851, SDS-47523/SDS-47524, and SDS-47525) have been identified as products of aerobic soil or anaerobic aquatic conditions. SDS-3701 was an everpresent metabolite which always reached the highest concentration, typically 10 to 40% of the total. No single one of the other four metabolites exceeded 10%, and their combined maximum total at any one time was less than 20%. The availability of these five metabolites appears to reach constant levels or decrease slowly, indicating persistence. Except for the less mobile SDS-47523/SDS-47524,the *effective* persistence and mobility of these metabolic products is confirmed by their presence in groundwater and their behavior in a groundwater monitoring study (see Water Resources). These detections are as predicted based on satisfactory laboratory mobility studies and are consistent with partially satisfactory and ancillary terrestrial field studies.

Another class of metabolites (glutathione conjugates) was identified in an aerobic aquatic metabolism study (discussed below). However, rapid production of these substances in appreciable quantity may have been an artifact of experimental procedures. None of these substances were reported in any other soil or sediment metabolism or field studies.

The persistence of SDS-3701 has been specifically addressed at length in a recent memorandum from the Agency to the registrant (memorandum from EFED to SRRD dated 8 Oct 1996). All data, including summary information from two Canadian studies evaluated by the Environmental Protection Service of Canada (and submitted by the registrant as part of both MRID 44006001 and 44013302), clearly show the relative stability of this transformation product and its potential to leach. The Agency agrees with the Canadian conclusions that 1) SDS-3701 has the potential to leach and 2) SDS-3701 has the potential to carryover in significant percentages and to accumulate annually in soil.

In addition to identified degradates, at the end of all submitted metabolism or dissipation studies metabolites variously representing 30 to 75% of the total fungicide applied were sequestered as unidentified, recalcitrant soil or sediment bound substances (not considered biologically available) or as small amounts of polar (water soluble) substances. The manufacturing impurities hexachlorobenzene (HCB) and pentachlorobenzonitrile (PCBN) were also isolated in very low concentrations in some field studies.

Bioconcentration. Chlorothalonil did not appreciably bioconcentrate in oysters or bluegill sunfish. Metabolites (conjugate substances) concentrated about 2600 times in oysters and up to 500 times in fish viscera. These recalcitrant residues effectively entered the biochemical (carbon) pool of the organisms and were slow to be eliminated.

Environmental Fate and Transport

Proper chemical names are given only once within the following subsections. Thereafter compounds are referenced by code. Most chemical structural formulas and other designations for compounds are given in an appendix.

Degradation

Hydrolysis: The hydrolysis data requirement is fulfilled.

Chlorothalonil is stable at pH's 5 and 7. At pH 9, the "half-life" is in the range of 40-60 days and may be concentration dependent. After 89 days roughly 20% of parent chlorothalonil from an initial 0.4 ppm concentration remained; roughly 50% was the degradate SDS-19221 (3-cyano-2,4,5,6-tetrachlorobenzamide) and roughly 20% was the degradate SDS-3701 (4-hydroxy-2,5,6-trichloroisophthalonitrile). Analogous results were obtained during a 72 day period for an initial chlorothalonil concentration of about 1 ppm. There were no losses due to volatility.

The major pH 9 degradate above, SDS-19221, was also stable to hydrolysis at pHs 5 and 7. At pH 9, approximately 90% of SDS-19221 had not degraded after 30 days. The approximately 10% which did degrade was converted to SDS-3133 (2,4,5,6-tetrachloroisophthalamide). (MRID 0004539, Accession No. 258779)

Photolysis in Water: The data requirement for photolysis in water is fulfilled. Studies indicate that aqueous photolysis would not be a major degradative pathway. A 1987 study (MRID 40183418) gave an estimated half-life of about 65 days when the artificial source exposure time of 118 hours and intensity were converted to 12 hour sunlight days (study duration equivalent to about 33, 12 hour days of sunlight). At study end about 80% of chlorothalonil remained. The major photolyte SDS-3701 was still steadily increasing and had reached about 10%. Other minor amounts of unidentified products were extactable with organic solvents or remained in the water phase. No volatilization of parent or degradation products occurred. (MRID 40183418, MRID 00040540, MRID 00087281)

Photolysis on Soil: The data requirement for photolysis on soil is fulfilled. Chlorothalonil and the metabolite SDS-3701 (DAC-3701) are both stable against soil photolysis. Each was tested on the same two soils (silt loam, silty clay loam). There were no soil-bound residues. Additional information based on the study methodology indicated that chlorothalonil did not leach from the test soils, but that SDS-3701 did. No volatilization losses occurred. (MRID 00040543 and associated MRIDs 00143751 and 00156470).

Metabolism

Aerobic Soil Metabolism: The submitted study provides sufficient data, which, taken in the context of other information, is considered "acceptable", and fulfills the data requirement.

In this study, half-lives in four different soils ranged from about 10 to 40 days. After 60 days the metabolite SDS-3701 was present at up to 32% of the applied; the metabolite SDS-19221 was present at up to about 7% at both days 7 and 16 of the study. Water soluble residues comprising up to approximately 15% of the total were not identified. In sterilized soils half-lives were longer, ranging from about 20 to 200 days. Unextracted (bound) residues remaining after a single extraction with 4:1 acetone/0.3M HCl for 30 minutes increased over time in all cases, accounting for 40 to 75% of the dose by the end of the 90 day study. (MRID 00087351)

Anaerobic Aquatic Metabolism: The data requirement for anaerobic aquatic metabolism is fulfilled.

Anaerobic half-lives of chlorothalonil (combined water and soil) in two different flooded soils were in the range of 5 to 15 days. The major metabolite SDS-3701 (formula given previously) appeared to reach a broad maximum after 1 to 2 months and to remain at near constant levels of around 30 to 40% of the dose until the end of a 4 month study in a silt loam soil. Likewise, a similar plateau region at 15 to 20% of the dose appeared during a 2 month study in a sandy loam soil. Other metabolites included the two isomers SDS-47524/47523 (3-cyano-2,5,6-trichlorobenzamide and its isomer 3-cyano-2,4,5-trichlorobenzamide, respectively) at up to 9% combined, SDS-19221 (see formula above) at up to 7%, SDS-47525 (2-hydroxy-5-cyano-3,4,6-trichlorobenzamide) at up to 4%, and SDS-46851 (3-carboxy-2,5,6-trichlorobenzamide at up to 3%. Less than 0.1% of residues volatilized. Chlorothalonil, either insoluble or sorbed, was primarily associated with the soil, while metabolites were approximately in equal percentages in the soil and water phases. Unidentified soil bound residues constituted 30 to 40% of the total dose by the end of the studies. (MRID 00147975)

Aerobic Aquatic Metabolism: The Agency requires no further data on aerobic aquatic metabolism.

Chlorothalonil undergoes relatively rapid metabolism under aerobic aquatic conditions. However, aerobic aquatic lifetimes and metabolites require special interpretation if they are to be used for specialized purposes. In the aerobic aquatic metabolism lab study which the registrant submitted (MRID 42226101), rates of reaction and identity of degradation products were dramatically different when compared to other environmental fate laboratory and field studies. These studies include aerobic soil metabolism, anaerobic aquatic metabolism and aged mobility. Initial chlorothalonil concentrations were effectively and surprisingly reduced to less than half within 2 hours under enhanced conditions in both salt and fresh water sediments by a process which was not first-order. Apparent "half-lives" increased steadily with time. Parent represented less than 1% of the applied by 30 days.

The differences between the findings of the aerobic aquatic metabolism study and the other environmental fate studies appear to result from nonstandard experimental conditions in the aerobic aquatic metabolism studies. The study was conducted with vigorous and continuous agitation (platform shaker at 100 rpm) and aeration, and high concentration of suspended sediment (100,000 ppm, selectively screened to remove particles greater than 0.6 mm in diameter).

These enhanced conditions do not reliably reflect behavior in a quiescent body of water such as a lake or a pond modeled with 30 ppm of suspended sediment. Rather, the conditions of this study are similar to those used for shake-flask inherent biodegradability testing suitable for sewage treatment purposes. Rapid churning of large quantities of suspended sediment is ideal for sewage treatment, but would in general give higher rates of reaction than would be expected under natural conditions. Agitation and aeration could result in shorter half-lives.

Under these laboratory conditions, chlorothalonil at 25°C and at an initial system concentration of about 0.6 ppm was quickly removed from solution in both salt and fresh water sediments (water:sediment ratio of about 9:1). The immediate ("zero time") removal of most of the parent (about 90 percent from salt solution, 75 percent from freshwater) was most likely due to sorption. The reviewer estimated simple sorption coefficients derived from "zero time" concentrations are, in standard units, about 100 for the salt water system and 25 for fresh water. These coefficients are consistent with those calculated from adsorption/desorption study results. The observed rapid metabolism most likely took place at the interface between sediment and water.

The major identified transformation products (metabolites) were sequestered in the sediment as more complex, organically extractable glutathione[1] conjugates (or other sulfur species). These products were organically extractable from the sediment. None of these were identified in any other metabolism or field studies. It is plausible that production of these substances in appreciable quantity may have been an artifact of experimental procedures. Certain steps in the lab procedure involved the addition of up to 10% hydrochloric acid to the samples, with further concentration of the acid in subsequent steps. This harsh treatment is known to lyse cells of organisms present in the mixture, thus causing the release of cellular substances such as glutathione. These substances in above normal concentrations are then free to conjugate or otherwise react with chlorothalonil or its derivatives at rates higher than those due to normal

[1] Glutathione is a peptide (primary link in protein synthesis) which occurs widely in plant and animal tissues and plays an important role in biological oxidation-reduction processes and the activation of some enzymes. It contains one amino acid residue each of glutamic acid, cysteine,
and glycine.

internal metabolism, and to compete with other chemical reactions previously observed. Even in the absence of HCl, vigorous, sustained agitation of the sample mixture could also cause the mechanical rupture of cells through localized high pressure collisions or abrasion between substrate sediment particles.

In this study, the following compounds were predominant: SDS-67042, present up to 25 or 30% and SDS-67042 sulfoxide, present at around 15%. Other metabolites of this class were SDS-66432, SDS-66382, and SDS-13353. The non-conjugated product SDS-3701 (which is ubiquitous as a major metabolite in all other studies) comprised only up to 5 or 10% of the dose here. Some of the conjugate substances reached a fairly constant level (a combined total of 40-60% of the applied) after 30 days, and appeared eventually to become sequestered primarily as irreversibly or permanently bound residues. Another large component of the dose, unidentified sediment bound residues, remained at a fairly constant level after about 6 to 12 hours (20-35% after 30 days). Smaller amounts (9-14%) of unidentified polar materials are also formed.

The relatively high rates of metabolism observed in this study are supported in the outside literature. Davies (Davies, 1985a,b and 1988) found a range of half-lives of from about 4 to 150 hours in extensive laboratory experiments using both water and different substrates obtained from natural streams, different degrees of aeration, and cooler temperatures (5 to 15°C). Walker, et al. (Walker, 1988) at EPA laboratories compared the *relative* rates of degradation of 14 pesticides using a shake-flask test of inherent biodegradability. (Shake-flask rates should not be taken as absolutes for rates in natural environments.) Under the conditions of his experiment, Walker determined a half-life of about 44 hours in an estuarine water/sediment system and of about 200 hours in filtered estuarine water at 25°C. Chlorothalonil was among those pesticides which degraded fastest. Degradates were not identified in these published studies, but Davies has identified glutathione conjugates in fish tissue.

Although Walker's water/sediment samples were vigorously shaken and had coarse sand removed by settling, the suspended sediment concentration of 500 ppm used was markedly less than the 100,000 ppm used by the registrant. Additonally, Walker employed hexane as the extractant, and acid was not used in the extraction procedures. Without agitation and with less sediment, it is reasonable to assume that the rate of metabolism would be slower and the corresponding half-life even longer than the 44 hours observed by Walker. When corrected for temperature, Davies' independent results for still stream water match Walker's 44 hours for water/sediment, but are much less than the more directly comparable 200 hours for Walker's filtered estuarine water. Based on available data, and depending on ambient strata and conditions, OPP has determined effective degradation half-lives for chlorothalonil may range from two hours to 200 hours.

Mobility

The data requirements for mobility (batch equilibrium and aged column leaching) are fulfilled.

Integrated mobility results from the batch equilibrium and aged column leaching studies are summarized as follows. Five degradates (metabolites) were identified and tested: SDS-46851, SDS-47525, SDS-3701, SDS-47523/47524 (combined isomers), and SDS-19221. The first three of these were mobile and leached in all soils. In sand, parent chlorothalonil and the metabolite SDS-47523/47524 were moderately mobile to mobile and were detected in the leachate. They were only slightly mobile and did not appear in the leachate from the other representative soils. SDS-19221 was mobile in all soils and leached in all soils except a clay loam.

Lab batch equilibrium studies with four soils showed chlorothalonil to be only slightly mobile in silty clay loam, silt, and sandy loam and moderately mobile in sand. Freundlich K(ads) values were 26, 29, 20, and 3, respectively, but were only determined in the very narrow range of 0.1 to 0.5 ppm, rather than spanning several decades of concentrations, as required to establish a firm relationship. Exponents (1/n values) were sequentially 0.79, 0.83, 0.94 and 0.75. From corresponding percentages of soil organic matter of 3.2, 0.7, 3.2, and 0.6 yield, the reviewer calculated Freundlich K(oc) values of approximately 1400, 7000, 1100, and 900, respectively (based on the standard normalization: organic matter = 1.7 x organic carbon). From these results, it is apparent that sorption is not simple and that organic carbon alone does not account for the process. Desorption was less than 10% for all soils except the sand, for which desorption varied from about 10 to 30%. (MRID 00115105)

Aged soil column studies (7-14 day aging) with four soils different from those in the batch studies above were conducted. These soils were classified as sand, sandy loam, silt loam, and clay loam. Parent chlorothalonil and SDS 47523/47524 were detected in the sand leachate; they were slightly mobile in the other soils, but were not in their leachates. SDS-19221 was in the leachate from all soils except the clay loam, although it was mobile in this soil. The remaining metabolites leached from all soils. (MRID 00153730)

Accumulation

The data requirement for bioconcentration is fulfilled. In separate studies with bluegill sunfish and oysters, chlorothalonil did not appreciably bioconcentrate. Unidentified metabolites or conjugate substances concentrated up to 500x in the fish and about 2600x in oysters. These recalcitrant residues effectively entered the biochemical (carbon) pool and were slow to be eliminated (MRIDs 00086620 00029411, 00086630; MRID 43070601). The literature shows similar results with fish, and also shows the metabolic formation of glutathione conjugates (Davies, 1985a,b).

Terrestrial Field Dissipation (164-1)

Extensive data from field dissipation studies have been submitted for chlorothalonil, but historically none of these data have fully satisfactory. By considering the most useful ancillary data and verifying consistency with other Guideline studies and outside sources of information, the Agency is able to satisfactorily assess terrestrial fate, and requires no more field data. Conclusions from the various sources are summarized below.

Data submitted by the registrant show a range of initial field half-lives of 14 to 59 days. Compilations from other sources (Ware, 1992) show a wider span of from 4 to 90 days with a "selected" value of 30 days. Four field studies evaluated by the Environmental Protection Service of Canada (and submitted by the registrant as part of both MRID 44006001 and 44013302) provided similar but more comprehensive information on dissipation in two Canadian and two US soils. Overall, 10 to 60 days could be considered a reasonable range for half-lives for most uses of chlorothalonil.

Preliminary data from a groundwater monitoring study being conducted on peanuts in North Carolina (see Water Resources below) indicate a field dissipation half-life as long as approximately 4 to 6 months.

Metabolites identified are SDS-3701, SDS-47523/47524 (isomers combined), SDS-19221, SDS-47525, and SDS-46851. Sampling methodology was generally insufficient to define the depth of leaching, but chlorothalonil residues were detected at least to 45 cm and SDS-3701 down to 135 cm in some studies. Manufacturing impurities hexachlorobenzene (HCB) and pentachlorobenzonitrile (PCBN) were also isolated in some studies.

Spray Drift

The registrant has not submitted drift data. The Agency believes that Droplet Size Spectrum (201-1) and Drift Field Evaluation (202-1) data are necessary to address ecotoxicological issues. ISK Biosciences is a member of the Spray Drift Task Force and has the option to satisfy these requirements through the Spray Drift Task Force according to PR Notice 90-3.

Water Resources--Groundwater and Surface Water

Ground Water

The available information is inadequate to assess exposure to chlorothalonil and chlorothalonil degradates from ground water on a national level. However, sufficient information is available on local detections of chlorothalonil residues (mostly degradates) in ground water which can be used to extrapolate the following conclusions and generalizations. The data clearly show that at least for hydrogeologically vulnerable conditions ground water contamination by chlorothalonil degradates, most notably degradate SDS-46851, is likely to occur. The degradate SDS-46851 has been determined to be non-toxic. Limited occurrences of chlorothalonil parent at low concentrations (≤ 1.1 µg/L) in ground water have also been noted. Several of the parent chlorothalonil detections may have been due to contamination or faulty well construction. Detections of chlorothalonil degradates in ground water were attributed to potato and peanut use.

A number of chlorothalonil degradates have been identified in groundwater. Four of these degradates, not chlorothalonil itself, were found in ground water in Long Island, New York, and were attributed to potato use. The reported ground water metabolites are SDS-46851, SDS-47525, SDS-3701, and SDS-19221, and were measured at the highest combined concentration of approximately 16 ppb (µg/L) in New York. Parent chlorothalonil has been detected in Massachusetts, Florida, Maine, and California at levels typically below 1.0 µg/L. Several of these detections may be due to faulty well construction or contamination during well installation. Chlorothalonil parent (trace to 0.3 µg/L) and the degradates SDS-46851 (trace to 10.1 µg/L) and SDS-47525 (0.2 µg/L) have recently been detected by the registrant in a ground-water monitoring study currently being conducted in North Carolina, on peanuts. The results of the North Carolina prospective monitoring study are summarized separately at the end of this section; the other ground-water monitoring studies are described below and are summarized in the table below (previously detailed in DP Barcode D177471, 1/14/93).

Summary of Wells Sampled, Wells with Detections, and Concentration Ranges of Chlorothalonil and Degradates from completed Ground-water Monitoring Studies.

Source	MDL (µg/L)	Parent # Wells			Degradates # Wells		
		Sampled	Detects	Range (µg/L)	Sampled	Detects	Range (µg/L)
CA	0.10	614	1	0.8-1.1	NA[1]	NA	-
FL		25	1	0.14	NA	NA	-
MA	0.015	19	2	0.22-0.38	NA	NA	-
ME			1	trace	NA	NA	-
NY	2.0	24	0	ND[2]	24	8	2.0-12.6
NPS	0.060	1347	0	ND	NA	NA	-

[1] NA is not analyzed for.
[2] ND is not detected.

Massachusetts. Chlorothalonil residues were detected (0.22 µg/L, 0.38 µg/L) in two shallow ground-water wells by the Cape Cod Golf Course Monitoring Project (Eichner and Carbonell, 1990). The detection limit was reported as 0.015 µg/L. The authors postulate that the detections may be due to contamination resulting from well installation.

New York. Metabolites (DS-3701, DS-19221, DS-46851, and DS-47525) of chlorothalonil (DS-2787) were detected in 16.4 percent (11 of 67 samples) of samples in Suffolk County, New York (Harris and Andreoli, 1988). The concentration of degradates in the New York study ranged from 1.1 to 12.6 µg/L for individual breakdown products. The highest combined concentration of chlorothalonil and degradation products was 16.3 µg/L. Contaminants were primarily found in shallow private wells, but also were detected in a 97-foot deep public water supply well. The detection limit was not reported. Wells sampled, when the depth was known, ranged in depth from 5 to 100 feet. The source of the chlorothalonil was agricultural use on potatoes. The wells sampled were located generally near (< 10 to 2500 ft) the potato fields.

An earlier, EPA review (USEPA, 1984) appears to contain a more complete assessment of the data later summarized and reported by Harris and Andreoli (1988), and described above. This review indicates that 24 wells were sampled in Suffolk County, Long Island, New York from September 14, 1981 to October 22, 1981 (R.R. Griffiths. Report Doc. # 561-3AS-82-0065-001 DS2787. Acc. # 253315). From 23 of the 24 wells, five separate analyses were conducted for the analytes DS-3701, DS-19221, DS-46851, DS-47524, and DS-47525. The parent chlorothalonil was also analyzed for in all 24 wells. The parent and degradate DS-47524 were not detected in any of the samples. Degradates were identified in 8 of the 24 wells, and in 11 of 139 (67 + 72) samples. The detections, by degradate, were as follows: DS-3701 (3.6 µg/L), DS-19221 (2.8 µg/L), DS-46851 (5.9, 2.0, 7.9, 12.6, 2.0, 3.9, and 8.5 µg/L), and DS-47525 (2.0, 2.0, and 5.0 µg/L). The reported quantification limit was 2.0 µg/L.

Other States. The Pesticide in Ground Water Database (USEPA, 1991; 1992) also reported detections of chlorothalonil residues in ground water in 1 of 25 wells in Florida (0.14 µg/L), Maine (trace) and 1 of 614 wells in Humbolt County, California (0.8 to 1.1 µg/L) with a detection limit of 0.1 µg/L. The chlorothalonil detections in California were attributed to faulty well construction.

National Pesticide Survey. The National Survey of Pesticides in Drinking Water Wells (NPS) conducted by the USEPA (1990) sampled 1347 well water samples from community and rural domestic drinking water wells. The survey was designed to obtain results that would be statistically representative of 10.5 million rural domestic wells and more than 94,600 wells in 38,300 community water systems. The NPS (USEPA, 1990) did not detect parent chlorothalonil in any well water samples with a minimum reporting limit for parent chlorothalonil of 0.060 µg/L. The lack of detections for chlorothalonil in this study is not entirely unexpected because chlorothalonil parent is not very persistent and has limited mobility. The inclusion of chlorothalonil degradates (especially SDS-46851) would have increased the probability of detections. The likelihood of any of the limited number of wells sampled in the NPS being located in an area where chlorothalonil was used was not considered (may not be known).

Prospective Ground-Water Monitoring Study (166-1). The registrant began a small-scale prospective ground-water monitoring study in North Carolina on peanuts in 1994. The study, which was conducted according to an Agency-approved protocol, has been completed, although the final report has not yet been submitted. The field portion of the study was terminated in the summer of 1997. The registrant has submitted several interim reports (MRID#436421-01, D125423; MRID#439594-01, D224906; MRID# 442911-01, D237337). A detailed review of the study results will not occur until after the data have undergone quality assurance/qualtiy control and the final report has been submitted. The North Carolina site is not as vulnerable as the Long Island, New York site, but still "hydrologically" vulnerable. Water table depths over time ranged between ~23 to ~28 feet. Bromide tracer movement shows that recharge has occurred at the site. The April 1997 Interim Report indicated frequent detections of the degradate SDS-46851 in 8 of 9 monitoring wells during a 24-month period, and a very limited number of detections of chlorothalonil parent (SDS-2787) and degradate SDS-47525. Reported concentrations of SDS-46851 ranged from trace levels (<0.1 µg/L) to 10.1 µg/L and SDS-47525 from trace levels (<0.2 ug/L) to 0.20 ug/L. Chlorothalonil ranged from trace levels to 0.3 µg/L and occurred only during three sampling intervals (a two-month period prior to the 7th and 8th applications through sampling one month after the final application.) These chlorothalonil detections may be due to movement around well casing or other preferential flow pathways, as these detections sometimes occurred before the arrival of the bromicide tracer. The maximum SDS-46851 concentration (10.1 µg/L) for the NC study is of the same order of magnitude as the New York data (12.6 µg/L). The New York sampling is the only other groundwater sampling analyzed for this metabolite.

Although final conclusions concerning the prospective ground-water monitoring study can not be made, several conclusions concerning the potential of chlorothalonil and its degradates to contaminate ground water can be made. It appears that parent chlorothalonil has limited potential to reach ground water, even under hydrologically vulnerable conditions. Where there have been detections of chlorothalonil, concentrations have been low (generally < 1.0 µg/L) and often attributed to atypical sources. This also appears to be generally true for degradates SDS-3701 and SDS-47525. The degradate SDS-46851, which is nontoxic, however, appears likely to contaminate ground water at concentrations that have been as high as 10.1 µg/L in NC and 12.6 µg/L under vulnerable conditions. Since the degradates have only been included for analysis in vulnerable conditions (NC, NY), concentrations at less vulnerable areas are not known. It would be anticipated that concentrations would tend to be lower at less vulnerable use sites.

Surface Water

Chlorothalonil can contaminate surface water at application via spray drift. Substantial fractions of applied chlorothalonil could be available for runoff for several weeks to months post-application (aerobic soil metabolism half-lives of 10, 10, 15 and 40 days for 4 soils; typical terrestrial field dissipation half-lives of 10-60 days). The intermediate soil/water partitioning of chlorothalonil (Freundlich K_ds of 3, 20, 26, 29 and corresponding K_{oc}s of 900, 1100, 1400, and 7000); SCS/ARS database K_{oc} of 1380) indicate that chlorothalonil runoff will probably be via both dissolution in runoff water and adsorption to eroding soil in typical cases where runoff volume greatly exceeds sediment yield.

The resistance of chlorothalonil to hydrolysis, direct aqueous photolysis, and volatilization (Henry's Law constant = 2.6×10^{-7} atm*m^3/mol), coupled with only an intermediate susceptibility to degradation in soil under aerobic conditions indicate that chlorothalonil may be somewhat persistent in the water columns of some aqueous systems that have low microbiological activities and relatively long hydrological residence times. Aerobic aquatic metabolism half-lives from around two hours to 6-8 days have been reported under various conditions. The two hour half-life is associated with experimental conditions which correspond more closely to aerated and agitated sewage treatment (shake-flask test for inherent biodegradability) than to natural systems. However, the Agency has included the 2 hour half-life in a range of aerobic aquatic half-lives for modeling purposes to estimate potential environmental concentrations. Based on anaerobic aquatic metabolism half-lives of 5-15 days, chlorothalonil would also be susceptible to degradation in anaerobic sediments.

The intermediate soil/water partitioning of chlorothalonil indicates that its concentration in suspended and bottom sediment will be substantially greater than its concentration in water. However, in typical cases where water volume greatly exceeds suspended and available bottom sediment, a substantial percentage of chlorothalonil within an aquatic system will also be dissolved in the water column in addition to being adsorbed to suspended and bottom sediment. Bioconcentration Factors (BCFs) substantially less than 1000X (75X edible and 264X whole for bluegill; 9.4X edible and 16X whole for catfish) indicate that the bioaccumulation potential of chlorothalonil is low. A total residue (consisting primarily of degradates) BCF of 2600X in oysters suggests some potential for the bioaccumulation of chlorothalonil degradates in oysters.

The major degradate of chlorothalonil in the soil under aerobic conditions is SDS-3701. As exemplified by findings discusssed previously in this document (e.g., detection in groundwater, behavior in a groundwater monitoring study, and laboratory stability), SDS-3701 may be more persistent and mobile than chlorothalonil. Consequently, substantial amounts of SDS-3701 may be available for runoff for longer periods than chlorothalonil, and SDS-3701 may be more persistent in water/sediment systems than chlorothalonil. The apparent greater mobility of SDS-3701 suggests that it exhibits lower soil/water partitioning than chlorothalonil--that is, that SDS-3701 would be associated more with water than soil relative to the parent. Therefore, the ratio of SDS-3701 runoff loss via dissolution in runoff to runoff loss via adsorption to eroding soil for SDS-3701 may be substantially greater than for chlorothalonil.

In addition, the ratios of concentrations dissolved in the water column to concentrations adsorbed to suspended and bottom sediment may be substantially higher for SDS-3701 than for chlorothalonil. Degradates such as DS-19221, DS-46851 and DS-47525 have also been detected in ground water and may also have comparable or greater persistence and mobility than parent chlorothalonil.

An ancillary 1982 aquatic field surface water study reviewed again in 1994 (MRIDs 00137146, 00127862) did not represent a "reasonable high runoff scenario", and suffered several other major deficiencies. However, in concert with established lab soil mobility studies, it does indicate the potential for runoff of parent and metabolites in varying proportions in the water and soil phases should favorable conditions arise shortly after application.

The screening model GENEEC was used to generate Tier 1 (generic high runoff site over 56 days) EECs for chlorothalonil in a 1 ha surface area, 2 m deep pond draining 10 ha turf plots. OPP estimated maximum peak, 4-day average, 21-day and 56-day average concentrations. The GENEEC EECs for turf, the assumed application rates/intervals, and assumed environmental fate input are listed in a table in the Exposure and Risk to Non-target Aquatic Animals Section of this document. The EECs were generated for a range of assumed aerobic aquatic half-lives (2 hours and 44 hours). The aerobic aquatic half-lives (2 hours and 44 hours) were adjusted, for modeling, to a lower temperature (25°C to 20°C) and the 2-hour value was also multiplied by 3 to allow for uncertainty with a single value estimate as traditionally done by EFED. OPP has decided not to continue to generate Tier 2 EECs for turf because of the difficulties and uncertainties associated with modeling turf.

PRZM 2.3/EXAMS 2.94 was used to generate Tier 2 (single site over multiple years) EECs for chlorothalonil in a 1 ha surface area, 2 m deep pond draining 10 ha cucurbit, peanut, potato, and tomato fields. Each site was simulated over 36 years. OPP estimated 1 in 10 year maximum peak, 4-day average, 21-day average, 60-day average and 90-day average concentrations. The PRZM/EXAMS EECs are listed in a table in the Exposure and Risk to Non-target Aquatic Animals Section of this document along with the assumed application rates/intervals, and assumed environmental fate inputs. As was the case for the GENEEC EECs, the PRZM/EXAMs EECs were generated for a range of assumed aerobic aquatic half-lives (2 hours and 44 hours). As previously stated, real-life localized, ambient conditions and substrates could extend the range of actual half-lives.

The GENEEC and PRZM/EXAMS EECs are generated for high exposure agricultural scenarios and represent one in ten year EECs in a stagnant pond with no outlet that receives pesticide loading from an adjacent 100% cropped, 100% treated field. As such, the computer generated EECs represent conservative screening levels for ponds, lakes, and flowing water and should only be used for screening purposes.

The South Florida Water Management District (SFWMD; Miles and Pfeuffer 1994) summarized chlorothalonil detections in samples collected every two to three months from 27 surface water sites within the SFWMD from November 1988 through November 1993. Approximately 810 samples (30 sampling intervals X 27 sites sampled/interval) were collected from the 27 sites from November 1988 through November 1993. Chlorothalonil was detected in 25 samples at concentrations ranging from 0.003 to 0.035 μg/L, above detection limits generally ranging from 0.001 to 0.006 μg/L and a quantification limit of approximately 0.2 μg/L. Six of the samples had concentrations $\geq$ 0.010 μg/L. There was no testing for degradates, which, based on groundwater and environmental fate data, could be prevalent at considerably higher concentrations than parent.

As part of the National Water Quality Assessment (NAWQA) program, the USGS collected ground and surface water samples from 20 study units during 1993-1995 and analyzed them for pesticides including chlorothalonil. Samples were collected at fixed intervals once every week or every two weeks during use seasons and less frequently (generally monthly) at other times. Additional samples were also collected during high flow. Although no detailed results are currently available to OPP, the USGS did provide OPP with a summary for all 20 study units combined (David J. Wangsness of USGS - personal communication). For surface water, chlorothalonil was detected in only 6 of 1850 samples (6/1850 = 0.32%) above a detection limit of 0.035 ug/L ranging to a maximum concentration of 0.68 ug/L.

Of the 20 study units sampled, 17 overlapped areas of chlorothalonil use. These include the Appalachicola - Chattahoochee River Basin which overlaps heavy chlorothalonil use on peanuts along the southern Georgia/Alabama border. These data represent flowing water and dilution effects in actual watersheds. Again, there was no testing for degradates. Both a map of the study units and their overlap with chlorothalonil use areas are shown in the figures at the end of this chapter.

The NAWQA data demonstrate the large effects of dilution from untreated portions of the watersheds. Since the concentrations were measured in samples collected from study units that generally overlapped areas of chlorothalonil use, including intensive use on peanuts in the southeast, they can probably be used for estimating actual typical risks in the flowing water portions of chlorothalonil treated watersheds. However, since the NAWQA study is not a chlorothalonil specific study, sampling sites were not selected to represent reasonable worst case scenarios immediately downstream of heavily treated areas. Consequently, despite the substantial overlap of most NAWQA study units and chlorothalonil use areas, the concentrations reported in the NAWQA program may not represent reasonable worst case ones for chlorothalonil in flowing surface water.

Exposure and Risk Characterization

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of this integration is called the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by acute and chronic ecotoxicity values.

RQ = EXPOSURE/TOXICITY

RQs are then compared to OPP's levels of concern (LOCs). These LOCs are used by OPP to analyze potential risk to nontarget organisms and the need to consider regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories: (1) **acute high** -- potential for acute risk is high; regulatory action may be warranted in addition to restricted use classification, (2) **acute restricted use** -- the potential for acute risk is high, but may be mitigated through restricted use classification, (3) **acute endangered species** - endangered species may be adversely affected, and (4) **chronic risk** - the potential for chronic risk is high regulatory action may be warranted. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to nontarget insects, or chronic risk from granular/bait formulations to birds or mammals.

The ecotoxicity test values (i.e., measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. Examples of ecotoxicity values derived from short-term laboratory studies that assess acute effects are: (1) LC50 (fish and birds), (2) LD50 (birds and mammals), (3) EC50 (aquatic plants and aquatic invertebrates) and (4) EC25 (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOEC (birds, fish, and aquatic invertebrates), (2) NOEC (birds, fish and aquatic invertebrates), and (3) MATC (fish and aquatic invertebrates). For birds and mammals, the NOEC generally is used as the ecotoxicity test value in assessing chronic effects, although other values may be used when justified. Generally, the MATC (defined as the geometric mean of the NOEC and LOEC) is used as the ecotoxicity test value in assessing chronic effects to fish and aquatic invertebrates. However, the NOEC is used if the measurement endpoint is production of offspring or survival.

Risk presumptions and the corresponding RQs and LOCs are tabulated below.

Risk Presumptions for Terrestrial Animals (Birds and Wild Mammals)

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or LD50/sqft[2] or LD50/day[3]	0.5
Acute Restricted Use	EEC/LC50 or LD50/sqft or LD50/day (or LD50 < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC50 or LD50/sqft or LD50/day	0.1
Chronic Risk	EEC/NOEC	1

[1] Estimated Environmental Concentration (in ppm) on avian/mammalian food items
[2] mg/ft^2
[3] mg of toxicant consumed/day LD50 * wt. of bird

Risk Presumptions for Aquatic Animals (Fish and Invertebrates)

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or EC50	0.5
Acute Restricted Use	EEC/LC50 or EC50	0.1
Acute Endangered Species	EEC/LC50 or EC50	0.05
Chronic Risk	EEC/MATC or NOEC	1

[1] EEC = (ppm or ppb) in water

Risk Presumptions for Plants (Terrestrial and Aquatic)

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/EC25	1
Acute Endangered Species	EEC/EC05 or NOEC	1
	Aquatic Plants	
Acute High Risk	EEC[2]/EC50	1
Acute Endangered Species	EEC/EC05 or NOEC	1

[1] EEC = lbs ai/A
[2] EEC = (ppb/ppm) in water

Exposure and Risk to Nontarget Terrestrial Animals
Birds

Residues found on dietary food items following chlorothalonil application may be compared to LC_{50} and NOEL values to predict acute and chronic risk, respectively. The maximum concentrations of residues of chlorothalonil which may be expected to occur on selected avian or mammalian dietary food items following a single 1.0 lb foliar application rate are provided in the table below. Residues per lb ai applied for four food types are developed from Hoerger and Kenaga (1972) and Kenaga (1973), with modifications suggested by Fletcher, et. al. (1994); the "broadleaf plants" category includes forage and is considered applicable to small insects while the "fruits" category includes seeds and is considered applicable to large insects.

Estimated Environmental Concentrations on Avian and Mammalian Food Items (ppm) Following a Single Application at 1 lb ai/A)

Food Items	EEC (ppm) Predicted Maximum Residue[1]	EEC (ppm) Predicted Mean Residue[1]
Short grass	240	85
Tall grass	110	36
Broadleaf/forage plants and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

[1] Predicted maximum and mean residues are for a 1 lb ai/a application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

Fletcher residue values based upon the application rate are used to estimate the amount of residue added to various environmental media (e.g., short grass, insects) at each application. The FATE model is then used to estimate degradation between applications and both maximum and time averaged residue concentrations over the multiple applications. Since foliar half-life data are not available for chlorothalonil, a terrestrial field dissipation half-life in soil was used. This "half-life" (30 days) was selected by the Agency, based on terrestrial field studies cited in Ware 1992. (In some instances where specified, because of the range of studies available, a lower end value of 7 days was also run.) Both maximum and time averaged EEC's were based on maximum Fletcher residue values. See attachment for a sample FATE run for estimating chlorothalonil residues on insects for cucurbits.

The following two assumptions along with the Fletcher values form the basis for estimating residues to which terrestrial organisms may be exposed:

1) Use sites, excluding turf and orchards, are assumed not to contain significant amounts of short grass or long grass in the field. For these sites, the only avian food items likely to receive a **direct** application are insects, the broadleaf vegetation of the treated crop and any fruit of the crop. However, estimates of chlorothalonil residues on short grass in agricultural fields will be included in the risk tables to offset the potential additional impact from other routes of exposure -- inhalation, dermal and drinking water.

2) To be consistent with the assumption in aquatic exposure models for aerial application, only 5% of the application rate is assumed to drift to the edge of the field where it would contaminate vegetation (forbs and long grass). Ground application (not mist blowers) is assumed to result in 1% or less drift outside the field or the immediate border area. Therefore, the risk to birds or mammals feeding beyond the field border would be 5% or 1%

of what would be the risk if feeding in the field. Although the border area immediately adjacent to the treated field may contain higher residues than the area beyond the field border they would not be higher than within the field.

Acute: No mortality of birds occurred in any of the acute and subacute tests with chlorothalonil. There was no mortality at 10,000 ppm for bobwhite quail (MRID #30388) and mallards (MRID #30389). Another study showed no mortality at 21,500 ppm for mallards (MRID #3146). These data by themselves suggest minimal potential for acute risk to birds, but chlorothalonil is used at relatively high rates and is often applied several times per season. For example, on cucurbits, single applications of chlorothalonil are applied at up to 6.25 lbs ai/acre. When multiple applications are made, we have assumed that chlorothalonil will degrade between treatments with a foliar half-life of 30 days. On cucurbits and tomatoes, chlorothalonil is applied up to eight times at 2.25 lb ai/acre, and on turf, it is applied two or three times at up to 16.5 lb ai/acre or up to 10 times at 8.25 lb ai/acre. If these rates were applied to short grass, the EEC would be 1,500 ppm for cucurbits, 2,627 ppm for tomatoes, and 10,631 ppm and 6,883 ppm for turf. Most of these levels do not exceed the concentrations at which no mortality occurred. The highest EEC, for turf (10,630 ppm), barely exceeds the bobwhite quail 10,000 ppm no mortality level and is well below the mallard no mortality level of 21,500 ppm. Based on this analysis, it is likely that all uses of chlorothalonil represent minimal acute risk to birds, including endangered species.

Chronic: If these maximum exposure short grass levels presented above are used with the avian reproductive NOEL of 1,000 ppm to calculate chronic risk quotients, the LOC would be exceeded for most use sites. However, except for turf, most use sites would not have an abundance of short grass in the treatment area, although there may be a greater abundance immediately adjacent to the treated field.

The following table provides some specific EEC's and chronic risk quotients for food items likely to be found in sites where a majority (>80%) of chlorothalonil is used. The table shows chronic risk quotients calculated based on the <u>average</u> residues on food items. Average residues result from the pesticide being applied repeatedly, degrading over the course of time from the first application to one "between-treatment" interval beyond the last application. Note that for turf, exposure values were calculated using both 7 and 30 day half-life values in order to consider the effect mowing may have on residue accumulation in grass as well as the observing whether the risk from high rates would be drastically altered when using a shorter half-life. Only a range of residue and risk values are calculated for turf and cherries (stone fruits) with insects at 7 days and short grass at 30 days being the lower and upper bounds, respectively. Furthermore, the inclusion of short grass exposure and risk values for the non-turf sites serves to offset potential additional chronic risks from multiple routes of exposure not directly accounted for in our analysis (e.g., dermal, inhalation, drinking water).

Avian Chronic Risk Quotients for Multiple Applications of **Chlorothalonil** Products (Broadcast) Based on a Bobwhite NOEC of 1,000ppm and **Average** Residues.

Site/Application Method	Application Rate in lbs ai/A (No. of Applications; interval - in days)	Food Items[1]	Average EEC[2] (ppm)	NOEC (ppm)	Chronic RQ (EEC/NOEC)
Cucurbits (bellyrot)	6.25 (1;-)[3]	Insects	718	1,000	0.72
		Short grass	1,276	1,000	1.27
Cucurbits (regular)	2.25 (8;7)[3]	Insects	925	1,000	0.93
		Short grass	1,644	1,000	1.64
	1.75 (4;7)[4]	Insects	480	1,000	0.48
		Short grass	853	1,000	0.85
Stone Fruits (Cherries)	4.1 (4;10)[3]	Insects	497 (7 day)	1,000	0.50
		Short grass	1,820	1,000	1.82
Peanuts (SE US)	1.125 (9;10)[3]	Insects	418	1,000	0.42
		Short grass	743	1,000	0.74
Potatoes	1.125 (10;7)[3]	Insects	659	1,000	0.66
		Short grass	1,172	1,000	1.17
Tomatoes (Delmarva)	2.25 (8;7)[5]	Insects	925	1,000	0.93
		Short grass	1,644	1,000	1.64
Turf (Brown patch)	16.5 (3;5)[3]	Insects	2,816 (7 day)	1,000	2.82
		Short grass	7,183	1,000	7.18
	8.25 (10;14)[4]	Insects	812 (7 day)	1,000	0.81
		Short grass	4,637	1,000	4.63
(Dollar spot)	8.25 (3;7)[3]	Short grass	3,390	1,000	3.39
	4.0 (10;10)[4]	Insects	536 (7 day)	1,000	0.54
		Short grass	2752	1,000	2.75
(Snow mold)	22.7 (1;-)[4]	Insects	986 (7 day)	1,000	0.99
		Short grass	3,883	1,000	3.88
	11.7 (3;30)[5]	Insects	516 (7 day)	1,000	0.52
		Short grass	2,812	1,000	2.81
	22.7 (2;30)[3]	Insects	993 (7 day)	1,000	0.99
		Short grass	4,881	1,000	4.88

1. Insects are estimated to have the same residue concentration as broadleaves.
2. Assumes degradation using FATE program and 30-day aerobic soil half-life, unless specified as 7-day. Average residues calculated during time from first application to one interval period beyond last application.
3. Maximum proposed by ISK..
4. Typical application rate.
5. Proposed by ISK for modelling.
6. Using the 30-day aerobic soil half-life would result in the chronic Level of Concern of 1.0 being exceeded.

Mammals

Acute: Chlorothalonil is considered to be "practically non-toxic" for acute effects to mammals, based on an available rat LD_{50} of >10,000 mg/kg (MRID #00094940). An LD50 may be used to estimate 1-day LC50s for mammals based on the amount of food a mammal eats relative to its body weight.

$$\text{1-day LC50 (ppm)} = \frac{\text{LD50 (mg/kg) X body weight (g)}}{\text{food consumption (g)}}$$

Some small mammals consume almost 95% of their body weight per day. For them, an LD50 of 10,000 mg/kg may approach a 1-day LC50 of 10,000 ppm. For mammals that consume a lower proportion of their body weight per day, the calculated 1-day LC50 would be even higher. Note that since the LD50 is >10,000 mg/kg and no mortality occurred at this level, the calculated LC50 value would also be >10,000 ppm and it is assumed that no mortality would occur at that level. As was previously discussed, the highest estimated residues (10,631 ppm) for all sites would occur on turf grass following 3 applications at 16.5 lbs ai/A. Since this concentration is only slightly higher than what is probably a no mortality level, chlorothalonil appears to be of minimal risk to endangered and non endangered small mammals on an acute basis for all uses (turf, orchard, and other crops).

Chronic: The chlorothalonil chronic NOEL for mammals is 2,000 ppm, based on a rat developmental study (Acces# 00130733). This level is compared in the table below with average residues calculated on the food items of mammals within and immediately around treatment areas.

Mammalian Chronic Risk Quotients for Multiple Applications of **Chlorothalonil** Products (Broadcast) Based on a rat NOEL of 2,000 ppm in a Developmental study.

Site/Application Method	Application Rate in lbs ai/A (No. of Applications; interval - in days)	Food Items[1]	Average EEC[2] (ppm)	NOEC (ppm)	Chronic RQ (EEC/NOEC)
Cucurbits (bellyrot)	6.25 (1;-)[3]	Insects	718	2,000	0.36
		Short grass	1,276	2,000	0.64
Cucurbits (regular)	2.25 (8;7)[3]	Insects	925	2,000	0.46
		Short grass	1,644	2,000	0.82
	1.75 (4;7)[4]	Insects	480	2,000	0.24
		Short grass	853	2,000	0.48
Stone Fruits (Cherries)	4.1 (4;10)[3]	Insects	497 (7 day)	2,000	0.24
		Short grass	1,820	2,000	0.91
Peanuts (SE US)	1.125 (9;10)[3]	Insects	418	2,000	0.21
		Short grass	743	2,000	0.37
Potatoes	1.125 (10;7)[3]	Insects	659	2,000	0.33
		Short grass	1,172	2,000	0.59
Tomatoes (Delmarva)	2.25 (8;7)[5]	Insects	925	2,000	0.47
		Short grass	1,644	2,000	0.82
Turf (Brown patch)	16.5 (3;5)[3]	Insects	2,816 (7 day)	2,000	1.41
		Short grass	7,183	2,000	3.59
	8.25 (10;14)[4]	Insects	812 (7 day)	2,000	0.41
		Short grass	4,637	2,000	2.32
(Dollar spot)	8.25 (3;7)[3]	Short grass	3,390	2,000	1.69
	4.0 (10;10)[4]	Insects	536 (7 day)	2,000	0.22
		Short grass	2752	2,000	1.37
(Snow mold)	22.7 (1;-)[4]	Insects	986 (7 day)	2,000	0.49
		Short grass	3,883	2,000	1.94
	11.7 (3;30)[5]	Insects	516 (7 day)	2,000	0.25
		Short grass	2,812	2,000	1.40
	22.7 (2;30)[3]	Insects	993 (7 day)	2,000	0.50
		Short grass	4,881	2,000	2.44

1 Insects are estimated to have the same residue concentration as broadleaves.
2 Assumes degradation using FATE program and 30-day aerobic soil half-life, unless specified as 7-day. Average residues calculated during time from first application to one interval period beyond last application.
3 Maximum proposed by ISK.
4 Typical application rate.
5 Proposed by ISK for modelling.
Using the 30-day aerobic soil half-life would result in the chronic Level of Concern of 1.0 being exceeded.

An analysis of the results indicates that for multiple broadcast applications of chlorothalonil and based on average residues, the mammalian chronic level of concern is exceeded for applications to turf and orchards. Depending upon the half-life (7 vs 30 day) the chronic risk quotient ranges from approximately 0.2 (insects) to 2.3 (short grass) for applications from 4 to 8.25 lb ai/A. Chronic risk from higher rates, especially those on turf are exceeded regardless of the half-life utilized.

Degradate SDS-3701 and its risk to birds and mammals

A primary degradate of chlorothalonil, SDS-3701, is more toxic to mammals and birds than parent chlorothalonil.

Chemical	Acute Toxicity			Chronic NOELs	
	Birds (LD50) mg/kg	Birds (LC50) ppm	Mammals (LD50) mg/kg	Birds (ppm)	Mammals (ppm)
Chlorothalonil	>4640	>10,000	>10,000	1,000	2,000
SDS-3701	158	1,746	242	50	33

Because SDS-3701 is more toxic than parent chlorothalonil, it is considered important to discuss its risk potential.

There is insufficient data to characterize with certainty how much SDS-3701 will form on avian and mammalian food items. Most of the available residue studies were designed to measure the amount of SDS-3701 that is taken up by crops and how much accumulates in vegetable items associated with human consumption such as beans and fruits. These studies typically show very small amounts of SDS-3701 occurring in crops; much less than 1 ppm. Residues of less than 1 ppm would be of minimal concern for acute or chronic effects to birds or mammals. Unfortunately, most of these studies do not provide a dependable basis for estimating how much SDS-3701 will form on avian and mammalian food items in the days immediately following treatment with chlorothalonil.

Several studies provide some indication as to how much SDS-3701 will be present on/in avian and mammalian food items (short grass, leaves, seeds and insects). These studies are on turf and peanut hay.

Peanut Hay Study

The residue study on peanut hay (MRID 43843601; reviewed by Chemistry Branch II, HED) suggests an inverse correlation between the residue levels of parent chlorothalonil and the percent of SDS-3701 that forms. The residues of SDS-3701 that formed ranged from 2.6% to 24% of parent chlorothalonil. When the actual residue level of parent chlorothalonil was about 45 ppm, SDS-3701 residues were about 1 ppm, or about 2.6% of the parent. When the actual chlorothalonil residues were about 1.7 ppm, SDS-3701 residues were 0.4 ppm or about 24%. Peanut hay could be a surrogate for foliage that small herbivores might consume.

It should be noted that 1) the peanut hay was sampled at six different sites at various times ranging from 2 to 6 weeks after the last application, and 2) that, in the process of making hay, the peanut plants (vines) were dried for several days to a week, then raked and baled. In this process much of foliage (leaf mass) is lost, with most of the mass of the bale composed of vine stem. Therefore, because of the time delay (with associated dissipation) and loss of exposed plant mass, it cannot be concluded that SDS-3701 would not occur at greater than 1 ppm on any treated vegetation.

Turf (Golf Green) Studies

At two study sites (related MRIDs 422220-01, -02, -03), residues of SDS-3701 were measured in turf clippings on each day for 14 days while chlorothalonil was being applied at approximately 7 day intervals. Application rates were from 5.6 to 10.6 lbs ai/acre. These studies showed that residues of SDS-3701 never exceeded 1 ppm in the turf clippings treated at 5.6 lbs ai/acre and never exceeded 7 ppm in turf clippings that had been treated at 10.6 lbs ai/acre. It is important to note two things about this study:

1) The grass that was treated and subsequently sampled was mowed daily so that a fraction of the parent and degradate that was on the grass was discarded daily as the grass was cut and removed. Subsequent samples in the form of clippings would include fresh growth that diluted the concentration of both parent and degradate. This would tend to reduce the residues more than if the grass was allowed to grow, and all the parent and degradate allowed to remain for sampling. However, these studies do suggest that at least on turf that is mowed frequently, the residues of SDS-3701 do not accumulate above 7 ppm.

2) Based on the rates at each application, i.e. 5.6 lb ai/acre and 10.6 lb ai/acre, and the fact that the vegetation treated and sampled was short grass on a putting green, this study represents a "high exposure" scenario relative to other chlorothalonil uses. This is also evidenced by the residues of chlorothalonil during the study, which were in the thousands of

ppm. Even under these high use conditions, the actual residues of SDS-3701 did not exceed 7 ppm.

Grass grown for seed

Another study (MRID 42875926) measured the residues of chlorothalonil and SDS-3701 in grass seed, seed screenings and straw. Samples were collected 37 days after the last aerial application at 1.5 lb ai/acre. While parent residues on seed and straw ranged from 30 ppm to 54 ppm, residues of SDS-3701 never exceeded 1 ppm. The difficulty in interpreting this study stems from the fact that samples were collected more than a month after the last application. It is not known what the levels of parent and degradate would have been in the interim.

Acute and Chronic Risk Discussion:

Based on residues alone

While SDS-3701 is more acutely and chronically toxic to birds and mammals than parent chlorothalonil, residues less than 33 ppm SDS-3701 would not present either an acute or chronic risk. On the basis of measured residues alone, which never exceeded 7 ppm, it could be concluded that exposure from SDS-3701 represents little or no acute or chronic risk to birds or mammals. However, it is conceivable that under different conditions, and that SDS3701 was 24% of the total measured residues in peanut hay, residues of SDS-3701 could reach higher levels. Since there is high uncertainty as to what these levels may be, the degree of risk is unknown.

Based on percentage SDS-3701 formed

As indicated in the discussion above, there is no firm basis for estimating the residues of SDS-3701. If 10% is chosen as a relatively conservative upper limit of how much SDS-3701 forms relative to parent chlorothalonil, the approximate ranges for turf (and orchards) and other non orchard crops would be as follows:

Table: Estimates of SDS-3701 Residues on Terrestrial Food Items (ppm)*

	TURF/ORCHARD		NON-ORCHARD	
	Insects	Short Grass	Insects/Broad Leaf	Short Grass
Maximum (ppm)	86-572	152-1016	24-148	43-262
Average (ppm)	53-426	95-757	14-92	25-164

* Assuming 10% of parent chlorothalonil residues transform into SDS-3701. Lower number represents lowest application rate and shorter half-life (7 days); Higher number represents highest application rate and longer half-life (30 days).

Estimations of acute and chronic risk can be made by comparing maximum EECs to acute toxicity values and average EECs to chronic values. Birds would be considered at high acute risk (LC50 1,746 ppm) when exposed to short grass on turf and orchards and at chronic risk (NOEL 50 ppm) on all sites. Mammals would be at high acute (estimated LC50 242 ppm) and chronic risk (NOEL 33 ppm) for all sites. Given the uncertainty of the data used to characterize the formation and fate of SDS-3701, to calculate such RQs would imply a confidence in the 10% factor that is greater than is warranted. Therefore RQs will not be calculated for birds and mammals.

Exposure and Risk to Nontarget Aquatic Animals

Expected Aquatic Concentrations:

Technical chlorothalonil displays very high toxicity to all fish species tested. As seen earlier, it is considerably more toxic to the aquatic organisms tested than is the SDS-3701 degradate. As discussed in Section 2, the Agency used an aquatic exposure screening model (GENEEC) to develop generic EEC levels based on runoff from a 10 hectare field to a 1 hectare x 2 meter deep water body. These generic EECs take into account degradation in the field prior to a rain event. GENEEC was used to calculate the EEC for the turf use because the Agency does not have a refined aquatic exposure model for turf. GENEEC was also run for cherries and papaya (at current label rates and intervals) to compare with a rate on turf (4 lbs ai/A; 10 apps; at 10 day intervals) proposed by a registrant for risk mitigation. This rate falls within the 3.0 - 4.1 lbs ai/A) range for orchard crops.

Refined EECs were calculated for the following use sites: tomatoes, cucurbits, potatoes, and peanuts. Furthermore, these modeled crops were used as surrogates for the other non orchard sites. The latter sites are presently registered at "unmitigated" rates ranging from 1.1 - 2.3 lbs ai/A. Refined EECs were calculated using the Pesticide Root Zone Model (PRZM2.3) to simulate pesticides in field runoff and the Exposure Analysis Modeling System (EXAMS2.94) to simulate pesticide fate and transport in an aquatic environment. Tier I EECs and refined EECs for chlorothalonil were summarized in Section 2 and are presented below.

Estimated Environmental Concentrations (EECs) for Chlorothalonil using PRZM2-EXAMS with two aerobic aquatic metabolism half-lives.								
Crop	Application Method	Aerobic Aquatic ($T_{1/2}$) (hours)	Application Rate in lbs a.i./A (Nos. of application; interval - in days)	Peak EEC (ppb)	4-Day EEC (ppb)	21-Day EEC (ppb)	60-Day EEC (ppb)	90-Day EEC (ppb)
Cucurbits	"	2	1.75 (4;7)*	17.6	2.6	0.81	0.81	0.56
"	"	44	1.75 (4;7)	18.5	8.8	3.6	2.4	1.7
"	"	2	2.25 (8;7)	32.4	5.2	1.4	1.8	1.3
"	"	44	2.25 (8;7)	33.1	16.9	6.0	4.9	3.6
"	"	2	6.25 (1;-)	17.6	3.5	1.1	0.81	0.55
"	"	44	6.25 (1;-)	20.1	11.9	4.5	2.3	1.6
Peanuts	"	2	1.125(6;14) *	17.5	3.3	0.91	0.88	0.69
"	"	44	1.125(6;14)	20.3	9.9	3.4	2.4	1.8
"	"	2	1.125(9;10)	24.2	4.1	1.1	1.3	1.0
"	"	44	1.125(9;10)	25.8	13.6	4.3	3.4	2.8
Potatoes	"	2	1.125(6;10) *	5.5	1.3	0.51	0.56	0.37
"	"	44	1.125(6;10)	7.7	4.3	2.2	1.5	1.0
"	"	2	1.125(10;7)	6.8	1.6	0.54	0.77	0.58
"	"	44	1.125(10;7)	9.4	5.1	2.3	2.0	1.5
Tomatoes	"	2	1.75 (5;7)*	26.1	4.2	1.1	1.0	0.69
"	"	44	1.75 (5;7)	26.8	14.0	4.6	2.8	1.9
"	"	2	2.25 (8;7)	42.3	6.8	1.7	1.9	1.3
"	"	44	2.25 (8;7)	43.8	22.6	7.2	5.0	3.5

KOC = 1380
Aerobic Soil T1/2 = 30 days
Anaerobic Soil T1/2 =15 days
Solubility = 0.80 ppm
Aerobic Aquatic T1/2 = 2 hr (~8 hrs adj) and 44 hr (~59 hrs adj); see discussion in text
5 Percent spray drift; 75 Percent application efficiency
* "Typical" application rate

Estimated Environmental Concentrations (EECs) for Chlorothalonil on Turf, Orchards, and Cranberries using GENEEC with two aerobic aquatic metabolism half-lifes.							
Crop (disease)	Application Method	Aerobic Aquatic ($T_{1/2}$) (hours)	Application Rate in lbs. a.i./A (No.apps; intervals in days)	Peak EEC (ppb)	Average 4-Day EEC (ppb)	Average 21-Day EEC (ppb)	Average 56 Day EEC (ppb)
Turf (Snowmold)	foliar	2	22.7 (2;30)	324	94	18	6.7
"	"	44	"	363	250	68	26
" MidWest, NE	"	2	22.7 (1;-)	202	57	11	4
"	"	44	"	227	156	42	16
" N. West	"	2	11.4 (3;30)*	190	55	10	3.9
"	"	44	"	210	144	39	15
Turf (Brown Patch)	"	2	8.25 (10;14)**	273	78	15	5.6
"	"	44	"	288	195	53	20
	"	2	16.5 (3;5)	423	122	23	8.7
	"	44	"	462	316	86	32
Turf (Dollar Spot)	"	2	4.0 (10;10)**	166	48	9.1	3.4
"	"	44	"	173	118	32	12
"	"	2	8.25 (3;7)	203	59	11	4.2
"	"	44	"	220	150	41	15
Cherries	"	2	4.1 (4;10)**	114	33	6.2	2.3
" "	"	44	"	122	83	23	8.4
" "	"	2	3.6 (6;14)	106	31	5.8	4.6
" "	"	44	"	113	77	21	7.8
Papaya	"	2	3.0 (5;14)	83	24	4.5	1.7
"	"	44	"	88	60	16	6.2

Cranberries		2	5.3(3;10)	82	21	3.9	1.4
"		44		81.9	51	12	4.6

KOC = 1380
Aerobic Soil T1/2 = 30 days
Anaerobic Soil T1/2 =15 days
Solubility = 0.80 ppm
5 percent spray drift
Aerobic Aquatic T1/2= 2 hr (˜0.33 day adj); 44 hr (˜2.46 days adj); see discussion in text
1. Concentration in discharge from bog. This concentration would decrease by dilution when added to water in the receiving water.
* ISK suggested modelling.
** "Typical" application rate.

Freshwater Fish

The acute and chronic risk quotients for freshwater fish based on modeled EECs utilizing the 2-hour adjusted aerobic aquatic half-life are summarized below:

Risk Quotients (RQ) for Freshwater Fish
[LC_{50} for fathead minnow, most sensitive species, = 23 ppb; acute RQ = peak EEC/ 96hr LC_{50}; chronic RQ = 90-day EEC*/fish full life-cycle NOEL (3 ppb)]

Crop/application rate (lb ai/A); nos. of apps; interval(days)		Acute RQ	Chronic RQ
Turf (Snow mold)	22.7 (2;30)	14.5	2.2
" Mid West, N.E.	22.7 (1;-)	8.7	1.4
" N. West	11.4 (3:30)**	8.2	1.3
(Brown patch)	16.5 (3;5)	18.4	2.9
	8.25 (10;14)***	11.9	1.9
(Dollar spot)	8.25 (3;7)	8.8	1.4
	4.0 (10;10)***	7.2	1.1
Cherries	4.1 (4:10)***	4.9	0.76
"	3.6 (6;14)	4.6	0.73
Papaya	3.0 (5;14)	3.6	0.56
Cucurbits	6.25 (1;-)	0.77	0.18

Risk Quotients (RQ) for Freshwater Fish [LC_{50} for fathead minnow, most sensitive species, = 23 ppb; acute RQ = peak EEC/ 96hr LC_{50}; chronic RQ = 90-day EEC*/fish full life-cycle NOEL (3 ppb)]			
Crop/application rate (lb ai/A); nos. of apps; interval(days)		Acute RQ	Chronic RQ
	2.25 (8;7)	1.4	0.43
	1.75 (4;7)***	0.77	0.19
Tomatoes	2.25 (8;7)	1.8	0.43
	1.75 (5;7)***	1.1	0.23
Potatoes	1.125 (10;7)	0.30	0.19
	1.125 (6;10)***	0.24	0.12
Peanuts	1.125 (9;10)	1.1	0.33
	1.125 (6;14)***	0.76	0.23

*56-day EEC for turf and orchards (GENEEC model) value.
** ISK suggested modelling
*** Typical application rate

Acute Risk: GENEEC based acute risk quotients for turf and orchards as well as PRZM/EXAMS based acute risk quotients at all other modeled sites, except potatoes, exceed the acute high risk. The acute risk quotients for all uses including potatoes exceed the restricted use and endangered species LOCs. The non orchard sites (that were not modeled) are assumed to have exposure concentrations similar to the modeled crops, therefore the acute risk is assumed to be similar. Since the peak exposure concentrations are nearly identical for both the 2 and 44-hour aquatic aerobic half-life based modelling runs the RQ values are virtually the same.

Chronic Risk: When using the 2-hour aquatic half life, the following is observed: none of the chronic risk quotients (based on PRZM/EXAMS EECs) for non orchard crops exceed the chronic LOC for fish. The chronic risk quotients for turf (based on GENEEC 56-day average EECs) exceed the chronic risk LOC for all current application rates. Based on GENEEC 56-day average EEC's for the two modeled orchard crops, only cherries at the highest rate (6.25 lb ai/A) nearly equals (2.9) the chronic NOEL of 3 ppb. All other orchard crops will have 56-day average exposures less than 3 ppb. If the orchard uses were examined using PRZM/EXAMS, the 90-day average EEC most likely would fall below the chronic NOEL. Therefore, the Agency assumes minimal chronic risk to fish from chlorothalonil's use in orchards.

The above findings concerning chronic risk are altered when the 44-hour aerobic aquatic half life derived EECs are utilized. Turf, having previously shown risk, had exposure concentrations approximately 4 times higher than those calculated from a 2-hour half-life. The two surrogate orchard uses showed higher EECs ranging from 4.86 ppb for papayas to around 12 ppb for cherries. Therefore the fish chronic LOC is exceeded for all orchard uses. Non orchard uses all have 90 day average EECs around 3 ppb (tomatoes and curcubits are slightly above), peanuts and potatoes are slightly below.

It should be noted that GENEEC is a screening model designed to estimate concentrations greater than any that would be expected to be seen in the actual aquatic environment. PRZM/EXAMS estimated EECs may be somewhat comparable to concentrations in an edge of the field pond receiving all of the drainage and spray drift from a 100% treated field.

These estimated one-in-ten-year EECs are probably substantially greater than actual concentrations in most natural waters. This includes not only flowing water receiving drainage from a partially treated watershed but also lakes and ponds within treated areas, most of which do not receive all of the drainage and spray drift from an adjacent 100% treated field. Consequently, EECs generated by GENEEC and PRZM/EXAMS for an adjacent pond should only be used for screening purposes.

Incidents: There is one reference to a field kill incident involving fish in the Agency's files. The incident reportedly involved improper rinsing of equipment into a small lake in Texas on 1/14/76. Approximately 200 - 300 fish were reportedly killed. Chlorothalonil residues of 0.275 ppm in water and 0.250 (presumably ppm) in a fish sample were cited.

In addition, information regarding three additional fish kills, possibly caused in part by chlorothalonil, has been located. The following two are recorded in OPP's Incident Data System:

- **#I002200, including 5/23/95 memo by Lebelle Hicks, Maine Dept. Agriculture, Food, and Rural Resources**

  8/7/94 fish kill-- ME/New Brunswick border: 10,000 brook trout, newly released from hatchery, found dead in Ouelette pond, Grand Falls, New Brunswick. Potatoes are grown in area and recent rains occurred. Maneb, esfenvalerate, and chlorothalonil found in fish tissues (but not in three water samples or one brook bank soil sample). Cause considered "undeterminable" but "not likely due solely to pesticide runoff" by L. Hicks.

  I002261 includes 6/6/95 correction by L. Hicks (regarding minimum detection limits) to her memo above.

- **I000636-14 (4-27-84 report by Robert White, Conservation Agent, Missouri Dept. of Conservation)**

4/19/84 fish kill, Viburnum, MO, following 4/17/84 golf course application of several chemicals, including chlorothalonil. R. White concluded: "Specific agent of cause: undetermined--probably fungicides and herbicides sprayed on golf greens".

- **A third fish kill was recently reported to the Agency by the Environmental Protection Service of Canada (Brian H. Belliveau--personal telephone communication) and the Prince Edward Island, Canada, Department of Fisheries and Environment (James P. Mutch--personal e:Mail and telephone communication).**

7/20/96 fish kill, Prince Edward Island, Canada: 40,000 salmon (parr stage) and a large (unspecified) number of trout in and upstream of Profit's Pond on Prince Edward Island. Dead trout were found at least 800 meters above the pond. Dead slugs were observed up to 400 meters above the pond. Live invertebrates were observed on rocks throughout. The kill was noticed around midday on July 20, 1996. Approximately 1.25 inches of rain which had fallen in a downpour in the area of Profit's Pond on the night of July 19-20 caused considerable erosion and runoff. Similar erosive rainfall events occur in the area, but usually without noticeable effects on fish. Water and sediment analysis for 10 pesticides used in this major potato growing area detected only chlorothalonil as discussed below. However, it is possible that other pesticides were present at concentrations which would cause toxic effects, but which were below the detection limit, or which may have had additive or synergistic effects. Fish tissues were not analyzed for chlorothalonil, and there was no testing for its degradates. Conditions for late potato blight were bad at the time, and farmers were typically moving towards increased use of chlorothalonil (Bravo). The closest field was about 500 meters (0.3 mile) away, while the farthest was about 2500 meters (1.6 miles) away. A water sample taken from the pond in the afternoon of July 20 contained 4 ppb of chlorothalonil. Sediment samples taken from the pond and surrounding sites had chlorothalonil concentrations ranging from approximately 10 to 60 ppb.

An autopsy on trout indicated that they were otherwise healthy and their condition was consistent with a toxic chemical effect. Although for technical reasons Canadian authorities did not establish a definitive, formal attribution for the cause of the kill, the event does clearly show that chlorothalonil is susceptible to runoff and may cause adverse effects.

Freshwater Invertebrates

The acute and chronic risk quotients for freshwater invertebrates based on modeled EECs utilizing the 2-hour adjusted aerobic half-life are summarized in the following table:

Risk Quotients (RQ) for Freshwater Invertebrates
[lowest LC_{50} for *D. magna* = 68 ppb; acute RQ = peak EEC/LC_{50}; chronic RQ = 21-day EEC/freshwater invertebrate life-cycle NOEL (39 ppb)]

Crop/application rate (lb ai/A); nos. of apps.; interval(days)		Acute RQ	Chronic RQ
Turf (Snow mold)	22.7 (2;30)	4.8	.46
" MW, NE	22.7 (1;-)	3.0	.28
" NW	11.4 (3;30)*	2.8	.26
(Brown patch)	16.5 (3;5)	6.2	.60
	8.25 (10;14)**	4.0	.38
(Dollar spot)	8.25 (3;7)	3.0	.28
	4.0 (10;10)**	2.4	.23
Cherries	4.1 (4;10)**	1.7	.16
" "	3.6 (6;14)	1.6	.15
Papaya	3.0 (5;14)	1.2	.12
Cucurbits	6.25 (1;-)	.26	.03
	2.25 (8;7)	.48	.04
	1.75 (4;7)**	.26	.02
Tomatoes	2.25 (8;7)	.62	.04
	1.75 (5;7)**	.38	.03
Potatoes	1.125 (10;7)	.10	.01
Potatoes	1.125 (6;10)**	.08	.01
Peanuts	1.125 (9;10)	.36	.03
	1.125 (6;14)**	.26	.02

* ISK suggested modelling
**"Typical" application rate.

Acute risk quotients based on the GENEEC exposure model exceed the acute high risk

LOC. These quotients are for turf and orchard uses. Only the highest rate for tomatoes exceeds the acute high LOC for the PRZM/EXAM modeled crop uses. Except for potatoes (and mint at 1.1 lb ai/A) which exceed only the endangered species acute LOC, the acute risk quotients at all sites exceed the restricted use and endangered species LOCs for aquatic invertebrates. The chronic risk quotients for all sites are below the chronic LOC for freshwater aquatic invertebrates.

When the 44-hour aerobic aquatic half-life is used to estimate exposure neither the acute nor the chronic risk are significantly changed.

Estuarine and Marine Animals

The acute and chronic risk quotients based on modeled EECs utilizing the 2-hour adjusted aerobic aquatic half-life are summarized below:

Risk Quotients (RQ) for Estuarine and Marine Organisms
[acute RQ = peak EEC/LC_{50} (sheepshead= 32 ppb, pink shrimp= 154 ppb and oyster= 3.6 ppb); chronic RQ = 21-day EEC/mysid life cycle NOEL (0.83 ppb)]

Crop/application rate; nos. of apps; interval(days)		Test Species	Acute RQ	Chronic RQ
Turf (Snow mold)	22.7 (2;30)	Sheepshead minnow Oyster Pink shrimp Mysid	10.1 90 2.1 ---	---- ---- ---- 21.7
Turf (Midwest, Northeast)	22.7 (1;-)	Sheepshead minnow Oyster Pink shrimp Mysid	6.3 56.1 1.3 ---	--- --- --- 13.3
Turf (Northwest)	11.4 (3;30)*	Sheepshead minnow Oyster Pink shrimp Mysid	5.9 52.8 1.2 ---	--- --- --- 12.0
(Brown patch)	16.3 (3;5)	Sheepshead minnow Oyster Pink Shrimp Mysid	13.2 117.5 2.7 ----	---- ---- ---- 28.0
	8.25 (10;14)**	Sheepshead minnow Oyster Pink Shrimp Mysid	8.5 75.8 1.8 ----	---- ---- ---- 18.0
(Dollar spot)	8.25 (3;7)	Sheepshead minnow Oyster Pink Shrimp Mysid	6.3 56.4 1.3 ----	---- ---- ---- 13.4

Risk Quotients (RQ) for Estuarine and Marine Organisms
[acute RQ = peak EEC/LC_{50} (sheepshead= 32 ppb, pink shrimp= 154 ppb and oyster= 3.6 ppb); chronic RQ = 21-day EEC/mysid life cycle NOEL (0.83 ppb)]

Crop/application rate; nos. of apps; interval(days)		Test Species	Acute RQ	Chronic RQ
	4.0 (10;10)**	Sheepshead minnow	5.2	----
		Oyster	46.1	----
		Pink Shrimp	1.1	----
		Mysid	----	11.0
Cherries	4.1 (4;10)**	Sheepshead minnow	3.6	---
		Oyster	31.7	---
		Pink Shrimp	.74	---
		Mysid	---	7.5
"	3.6 (6;14)	Sheepshead minnow	3.3	---
		Oyster	29.4	---
		Pink Shrimp	.69	---
		Mysid	---	7.0
Papaya	3.0 (5;14)	Sheepshead minnow	2.6	---
		Oyster	23.1	---
		Pink Shrimp	.54	---
		Mysid	---	5.4
Cucurbits	6.25 (1;-)	Sheepshead minnow	0.55	----
		Oyster	4.9	----
		Pink shrimp	0.11	----
		Mysid	----	1.3
	2.25 (8;7)	Sheepshead minnow	1.0	----
		Oyster	9.0	----
		Pink shrimp	0.21	----
		Mysid	----	1.7
	1.75 (4;7)**	Sheepshead minnow	.55	----
		Oyster	4.9	----
		Pink shrimp	0.11	----
		Mysid	----	0.97
Tomatoes	2.25 (8;7)	Sheepshead minnow	1.3	----
		Oyster	11.8	----
		Pink shrimp	0.27	----
		Mysid	----	2.0
	1.75 (5;7)**	Sheepshead minnow	0.82	----
		Oyster	7.3	----
		Pink shrimp	0.17	----
		Mysid	----	1.3
Potatoes	1.125 (10;7)	Sheepshead minnow	0.21	----
		Oyster	1.9	----
		Pink shrimp	0.04	----
		Mysid	----	0.65

Risk Quotients (RQ) for Estuarine and Marine Organisms [acute RQ = peak EEC/LC_{50} (sheepshead= 32 ppb, pink shrimp= 154 ppb and oyster= 3.6 ppb); chronic RQ = 21-day EEC/mysid life cycle NOEL (0.83 ppb)]				
Crop/application rate; nos. of apps; interval(days)		Test Species	Acute RQ	Chronic RQ
	1.125 (6;10)**	Sheepshead minnow Oyster Pink shrimp Mysid	0.17 1.5 0.04 ----	---- ---- ---- 0.61
Peanuts	1.125 (9;10)	Sheepshead minnow Oyster Pink shrimp Mysid	0.76 6.7 0.16 ----	---- ---- ---- 1.3
	1.125 (6;14)**	Sheepshead minnow Oyster Pink shrimp Mysid	0.55 4.9 0.11 ----	---- ---- ---- 1.1

* ISK suggested modelling.
**Typical application rate.

The acute risk quotients for marine organisms exceed the acute high risk, restricted use, and endangered species LOCs for marine/estuarine fish and invertebrates for all modeled (and presumably those not modeled) use sites. Acute risk quotients for estuarine fish exceed the high risk LOC for all use sites except for potatoes. However, the margin of exceedence is substantially lower than for oysters. For shrimp, the acute risk quotients exceed the high risk LOC for turf and cherries, but for no other use sites. This suggests that estuarine organisms with sensitivities similar to oysters are at greater risk than fish or shrimp. The chronic risk quotients at all modeled sites, except potatoes, exceed the chronic LOCs for marine/estuarine invertebrates (using mysid as the representative species). Chronic exceedences for use sites other than turf are relatively small.

When the 44-hour aerobic aquatic half-life is used to estimate exposure the acute risk to estuarine organisms is not significantly changed. The LOC for chronic risk to invertebrates is exceeded 4 fold for all uses; therefore even the potato use presents a chronic risk.

Exposure and Risk to Nontarget Plants

Terrestrial Plants: Non-target terrestrial plants inhabit non-aquatic areas. Non-target "semi-aquatic" plants are plants that usually inhabit low-lying wet areas that may or may not be dry in certain times of the year. These plants are not obligatory aquatic plants in that they do not live in a continuously aquatic environment. The terrestrial and "semi-aquatic" plants are exposed to pesticides from runoff, drift or volatilization.

Runoff exposure is determined from a preliminary EEC. This runoff is characterized as a one acre to one acre sheet runoff (for chlorothalonil, 1% runoff, given a solubility < 10 ppm) to an adjacent acreage that impacts terrestrial plants; or a channelized runoff from 10 acres (i.e., 10X the sheet runoff) to a low lying areas some distance away that impacts "semi-aquatic" and terrestrial plants.

Spray drift exposure is determined by assuming 5% of the pesticide application will drift over to an adjacent acreage or to a much longer distance for aerial application, and 1% for ground application.

The EC_{25} value of the most sensitive species in the seedling emergence study is used with runoff exposure to determine the risk quotient. The value can also be used with drift exposure to emerging non-target plants. The EC_{25} value of the most sensitive species in the vegetative vigor study is used with the drift exposure. For evaluation of risk to endangered plant species, the NOEC (or EC05 value) is used from both the seedling emergence and vegetative vigor studies.

In the case of chlorothalonil, a Tier II study was not conducted because there was a less than 25% response at 16 lb ai/A rate. Therefore for the purpose of this assessment it is assumed that the EC_{25} in Tier I studies for both seedling emergence and vegetative vigor studies is $\geq$ 16 lb ai/A. Although studies were not conducted at the maximum rate of 22.4 lb ai/acre the most severe impact at 16 lb ai/A was an 11% reduction in the fresh weight of onions. Thus, all risk quotients, whether for exposure to roots or to foliage, and whether for endangered or non-endangered species, will be based on an EC_{25} > 16 lb ai/A). The risk quotients and EEC values for terrestrial and semi-aquatic plant species are summarized in the following table:

RQ and EEC Values for Terrestrial Plants Inhabiting Dry and Semi-aquatic Areas (EC25 >16 lbs ai/A)

Use Site	Maximum Application Rate	Type of EEC	EEC (lbs a.i./A)	Risk Quotient (Non-end. species)	Risk Quotient (End. species)
Turf	22.7 lb ai/A	sheet runoff	0.22	< 0.014	≤ 0.014
		channel runoff	2.24	< 0.14	≤ 0.14
		drift + sheet runoff	1.34	< 0.08	≤ 0.08
		drift + channel runoff	3.36	< 0.21	≤ 0.21
		spray drift (aerial applic.)	1.12	< 0.07	≤ 0.07
		spray drift (ground applic.)	0.22	< 0.014	≤ 0.014

As seen in the above table, even at this high-rate site of turf, all risk quotients are still well below the LOC of 1. Thus, no site is considered to exceed an LOC for terrestrial or semi-aquatic plants with a single application.

While it is theoretically possible to estimate residues on off-site plants from multiple applications of chlorothalonil, given the assumed rate of degradation of chlorothalonil on foliage (half-life is assumed to range from 7 to 30 days based on roughly estimated foliar dissipation and aerobic soil metabolism studies), it is unlikely chlorothalonil residues would accumulate to levels greater than 16 lb ai/acre. Presumably, multiple applications of chlorothalonil are permitted because the non-systemic chlorothalonil is needed protect newly emerged plant growth, or because it otherwise degrades or dissipates between treatments. The Agency assumes there is little or no risk to either endangered or non-endangered terrestrial plants from two applications at the 22.7 lb ai/A rate (the highest rate/number of applications combination, found on turf).

Aquatic Plants: Exposure to non-target aquatic plants may occur through either runoff or drift from terrestrial sites. Aquatic EECs are the same as are used in the above risk assessment for fish and aquatic invertebrates.

Normally the aquatic risk assessment is based on testing for five species. The species for which test data are missing include: *Lemna gibba, Anabaena flos-aquae, Skeletonema costatum,* and a freshwater diatom. The risk assessment is usually made for endangered and non endangered aquatic vascular plants from the surrogate duckweed *Lemna gibba*. This study is not available for chlorothalonil. Algae and diatom risk assessments are considered useful indicators of impact to food sources of aquatic organisms. The only available aquatic plant study is with the freshwater green alga *Selenastrum capricornutum*. Therefore, this species will serve as a surrogate for endangered as well as non endangered aquatic plants. The risk quotients and EEC values for aquatic plants are summarized in the following table:

Risk Quotients for Aquatic Plant Species (EC50 = 190 ppb; NOEC = 50 ppb); RQ = EEC/EC_{50} or NOEC. EECs are derived using the adjusted 2-hour aerobic aquatic half-life.

Crop/application rate (lb ai/A)		Risk Quotient (Non E.S.)	Risk Quotient (E.S.)
Turf (Snow mold)	22.7 (2:30)	1.7	6.5
" " MW, NE	22.7 (1:-)	1.1	4.0
" " NW	11.4 (3:30)*	1.0	3.8
(Brown patch)	16.5 (3:5)	2.2	8.5
	8.25 (10:14)**	1.4	5.5
(Dollar spot)	8.25 (3:7)	1.1	4.1
	4.0 (10:10)**	0.8	3.3
Cherries	4.1 (4: 10)**	0.6	2.3

Crop/application rate (lb ai/A)		Risk Quotient (Non E.S.)	Risk Quotient (E.S.)
Turf (Snow mold)	22.7 (2;30)	1.7	6.5
"	3.6 (6;14)	0.6	2.1
Papaya	3.0 (5;14)	0.4	1.7
Cucurbits	6.25 (1;-)	0.09	0.35
	2.25 (8;7)	0.17	0.7
	1.75 (4;7)**	0.09	0.35
Tomatoes	2.25 (8;7)	0.22	0.9
	1.75 (5;7)**	0.14	0.5
Potatoes	1.125 (10;7)	0.04	0.14
	1.125 (6;10)**	0.03	0.11
Peanuts	1.125 (9;10)	0.13	0.5
	1.125 (6;14)**	0.09	0.35

* ISK proposed modelling.
**Typical application rate.

Except for turf uses, risk quotients at other sites do not exceed the LOC (1) for aquatic plants, including endangered aquatic plants. The aquatic plant risk quotients for turf (and presumably orchards, using GENEEC modeled estimates) exceed the non endangered and endangered LOC by small margins. This risk assessment for plants reflects toxicity for only one aquatic plant species (*Selenastrum capricornutum*).

When utilizing the 44-hour aerobic aquatic half-life the acute risk LOC for non endangered plants is not exceeded. However endangered plants would be at potential risk from all sites (except potatoes); these RQs range from 1.4 to 3.4.

Endangered Species

The registered uses of chlorothalonil may affect birds (chronically), mammals (chronically), freshwater fish (acutely and chronically), freshwater invertebrates (acutely) and aquatic plants.

Currently, the Agency is developing a crop-based program ("The Endangered Species Protection Program") for the protection of these species. Limitations in the use of chlorothalonil may be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

Risk Characterization

Overview of Usage

Chlorothalonil is a broad spectrum fungicide registered for use on a variety of food and non-food use sites. The actual poundage used per year has reached over 17 million lbs. (1993 registrant estimates). Most uses represent very small percentages of the total that is applied annually nationwide for all uses. The exceptions are peanuts (>50% of the annual total), golf courses (about 8%) and lawns (about 5%). It is registered on other turf sites, but the amount used is minimal. Application rates range from 0.75 lbs a.i./A (tomatoes) to over 22 lbs a.i./A (turf), with multiple applications typically at intervals of 2 to 21 days. Peanut use ranges from 6 to 9 applications of 1.125 lbs a.i./A per season, 10 to 14 days apart. There are numerous additional crop uses allowing for multiple applications at rates ranging from 1.1 - 6.2 lbs ai/A for mint and cherries respectively.

Impact to Water Resources

Groundwater

It appears that parent chlorothalonil has limited potential to reach groundwater, even under hydrologically vulnerable conditions. Where there have been detections of chlorothalonil (California, Florida, Maine, Massachusetts, and North Carolina), concentrations have been low (generally < 1.0 μg/L) and often attributed to atypical sources.

Degradates (metabolites) of chlorothalonil have been found in ground water in New York and North Carolina. The reported metabolites in ground water are SDS-46851, SDS-47525, SDS-3701, and SDS-19221, and were measured at the highest combined concentration of approximately 16 μg/L in New York in 1981. The degradate SDS-46851, which is nontoxic, appears likely to contaminate ground water at concentrations that have been as high as 10.1 μg/L in NC and 12.6 μg/L under vulnerable conditions.

Surface Water

Chlorothalonil can contaminate surface water at application via spray drift. Substantial fractions of applied chlorothalonil are also available for runoff for several weeks to months post-application. The intermediate soil/water partitioning of chlorothalonil (Freundlich K_ds of 3, 20, 26, 29) indicate that chlorothalonil runoff will probably be via both dissolution in runoff water and adsorption to eroding soil in typical cases where runoff volume greatly exceeds sediment yield.

The resistance of chlorothalonil to hydrolysis, direct aqueous photolysis, and volatilization (Henry's Law constant = 2.6 X 10^{-7} atm*m^3/mol), coupled with only an intermediate susceptibility to degradation in soil under aerobic conditions indicate that chlorothalonil may be somewhat persistent in the water columns of some aqueous systems that have low microbiological activities and relatively long hydrological residence times. Aerobic aquatic metabolism half-lives from around two hours to 6-8 days have been reported under various conditions. The two hour half-life is associated with experimental conditions which correspond more closely to aerated and agitated wastewater treatment (shake-flask test for inherent biodegradability) than to natural systems.

Bioconcentration Factors (BCFs) are substantially less than 1000X, considered to be a threshold of concern--75X edible and 264X whole for bluegill, 9.4X edible and 16X whole for catfish-- indicating that the bioaccumulation potential of chlorothalonil is low. A total residue BCF (consisting primarily of degradates) of 2600X in oysters suggests some potential for the bioaccumulation of chlorothalonil degradates in oysters.

The major degradate of chlorothalonil in the soil under aerobic conditions is SDS-3701. For reasons given previously in this document (including detection in some ground water, its behavior in a groundwater monitoring study, and its laboratory stability), SDS-3701 appears to be more persistent and mobile than chlorothalonil. Consequently, substantial amounts of SDS-3701 may be available for runoff for longer periods than chlorothalonil and SDS-3701 may be more persistent in water/sediment systems than chlorothalonil.

As indicated previously, under the NAWQA program, the USGS collected ground and surface water samples from 20 study units during 1993-1995 and analyzed them for pesticides including chlorothalonil. The USGS provided OPP with a summary for all 20 study units combined. Seventeen of 20 study units sampled overlapped areas of chlorothalonil use. For surface water, chlorothalonil was detected in only 6 of 1850 samples (6/1850 = 0.32%) above a detection limit of 0.035 ug/L ranging to a maximum concentration of 0.68 ug/L.

The NAWQA data are actual measured chlorothalonil concentrations in flowing water and demonstrate the large effects of dilution from untreated portions of the watersheds. Since the concentrations were measured in samples collected from study units that generally overlapped areas of chlorothalonil use, they can probably be used for estimating actual typical risks in the flowing water portions of chlorothalonil treated watersheds. However, since the NAWQA study is not a chlorothalonil-specific study, sampling sites may not represent reasonable worst case scenarios for chlorothalonil in flowing surface water.

The GENEEC and PRZM/EXAMS EECs previously discussed are generated for high exposure agricultural scenarios and represent reasonable worst case or one in ten year EECs in a stagnant pond with no outlet that receives pesticide loading from an adjacent 100% cropped, 100% treated field. As such, the computer generated EECs represent conservative screening levels for ponds, lakes, and flowing water and should only be used for screening purposes.

Environmental Risk

Chlorothalonil is atypical for a fungicide of its type in that it does not show the high degree of persistence associated with many other chlorinated organics. Several of its metabolites exhibit greater persistent and more mobile, and so are of significant longer term environmental focus.

Based on predominance of use on different sites and potential exposures to wildlife, the use sites that have been most closely examined in this analysis are peanuts, cucurbits, tomatoes and turf.

Peanuts, Potatoes, Cucurbits and Tomatoes

Peanut, cucurbit and tomato uses represent a significant portion of chlorothalonil usage (25% for peanuts, 30% for potatoes, >7% for cucurbits and >6% for tomatoes)*. The risk quotients for these three crops exceed high acute freshwater and estuarine LOCs; and chronic estuarine invertebrates. Chronic risk to birds may result from multiple routes of exposure in chlorothalonil treated tomato and cucurbit fields. The highest RQs are for estuarine organisms -- acute for mollusks (represented by oysters) and chronic for crustacea (represented by shrimp). The risk to mollusks includes freshwater mussels (a phylum that includes numerous freshwater endangered species). When chlorothalonil is used extensively near estuarine or marine habitats, the risk quotients suggest possible adverse impacts to invertebrates such as mollusks (shellfish) and crustacea. However the edge of the field pond scenario is probably as conservative for estuaries as it is for flowing freshwater.

* 1998 correspondence from J.R. French, ISK (see References)

Highest Risk Quotients for Peanut, Potato, Cucurbit and Tomato Uses

	Avian Acute/Chronic	Mammal Acute/Chronic	Freshwater Fish Acute/Chronic	Freshwater Inv. Acute/Chronic	Aquatic Plant (Endang-ered)	Estuarine Acute Fish/Oys/Shrimp	Estuarine Chronic (mysid)
Peanut **Max** EEC	<LOC/na	<LOC/na	**1.1**/na	0.36/na	0.48	0.76/**6.7**/0.16	na
Peanut **Avg** **EEC**	na/0.74	na/0.37	na/0.33 (approx. 0.9 for 44-hr aq. half-life)	na/0.03	na	na	**1.3 (approx. 5.2 for 44-hr aq. half-life)**
Potato **Max** EEC	<LOC/na	<LOC/na	0.3/na	0.1/na	0.14	0.21/**1.29**/0.04	na
Potato **Avg.** EEC	na/**1.17**	na/0.59	na/0.19 (approx. 0.6 for 44-hr. aq. half-life)	na/0.01 (approx. 0.03 for 44-hr. aq. half-life)	na	na	0.65 **(approx. 1.9 for 44-hr. aq. hf.lf.**
Tomato **Max** EEC	<LOC/na	<LOC/na	**1.8**/na	**0.62**/na	0.85	**1.3**/**11.8**/0.27	na
Tomato **Avg** EEC	na/**1.64**	<LOC/0.82	na/0.43 **(approx. 1.1 for 44-hr aq. half-life)**	na/0.04	na	na	**2.0 (approx. 8.0 for 44 hr. aq. half-life)**
Cucurbit **Max** EEC	<LOC/na	<LOC/na	**1.4**/na	0.48/na	0.65	**1.0**/**9.0**/0.21	na
Cucurbit **Avg** EEC	na/**1.64**	na/0.82	na/0.43 **(approx. 1.1 for 44-hr aq. half-life)**	na/0.04	na	na	**1.7 (approx. 6.8 for 44-hr aq. half-life)**

Risk quotients in boldface indicate high acute or chronic LOCs which are exceeded. <LOC means a qualitative conclusion of minimal risk was made. Peak EECs were used to calculate acute risk quotients for aquatic organisms (see discussion below on use of peak EECs versus 96-hour averages for acute risk). Average EECs were used to calculate chronic risk quotients. Risk quotients based on 2-hour aerobic aquatic half-life and 30-day aerobic soil half-life.

Turf

Turf (sod farms, lawns and golf courses), to which about 14% of the annual poundage of chlorothalonil is applied, represents the next highest annual usage of chlorothalonil after peanuts, cucurbits and tomatoes. In addition, the application rates for turf are distinctly higher than for other crops. Birds and mammals are at chronic risk from the parent; acute risk is not expected to be high. Freshwater and estuarine fish and aquatic invertebrates are at high acute risk from chlorothalonil's use on turf. Based on presently available data, only freshwater fish and estuarine invertebrates are at chronic risk. Aquatic plants are at high risk from use of chlorothalonil on turf. Risk to aquatic organisms is based on exposure concentrations derived from GENEEC since refined models have not yet been developed for turf in EFED. Therefore there is some uncertainty as to the real impact from turf (see discussion under uncertainty).

The chronic risk quotients for birds and mammals on turf range from about 0.5 to 7.6 (birds) and 0.2 to 3.8 (mammals). Of special concern is the fact that many golf courses are frequented by animals such as ducks, geese and rabbits that graze extensively on the short grass. Chronic risk quotients for birds and mammals from the turf use are greater than other sites because the applications rates are much higher and the prevalent vegetation would be short grass, which will have higher residues than other food items.

Highest(*) Risk Quotients for Chlorothalonil Turf Use

	Avian Acute/Chronic	Mammalian Acute/Chronic	Fish Acute/Chronic	Aquatic Invertebrates Acute/Chronic	Aquatic Plants	Estuarine Acute Fish/Oys/ Shrimp	Estuarine chronic (mysid)
Max EECs	<LOC/na	<LOC/na	**18.5**/na	**6.3**/na	**2.2**	**13/118/2.8**	na
Ave EECs	na/**7.6**	na/**2.41**	na/**2.9**	na/0.6	na	na	**28**

Acute and chronic risk quotients in boldface indicate LOC is exceeded. <LOC means a qualitative conclusion of minimal risk was made. Peak EECs were used to calculate acute risk quotients for aquatic organisms (see discussion below on use of peak EECs versus 96-hour averages for acute risk). Average EECs were used to calculate chronic risk quotients. (*) Terrestrial risk derived from EECs based on 30-day aerobic soil half-life. Aquatic risk derived from EECs based on 2-hr aquatic aerobic half-life.

Other Crops (Orchards and non orchards)

Orchard crops are estimated to present a slightly lower, but similar risk to birds, mammals, fish and freshwater aquatic invertebrates as the 4 lb ai/A use on turf. This is based on comparing the EECs for cherries (4.1 lb ai/A, 4 applications at 10 day intervals) and the turf (4.0 lb ai/A, 10 applications at 10 day intervals). This comparison shows aquatic EECs -- peak (cherries = 114 ppb vs. turf = 166 ppb); average 21 day (cherries = 6.2 ppb vs. turf = 9.1) -- and average short grass EECs (cherries = 1820 ppm vs turf = 2752 ppm). Regarding the magnitude of risk to estuarine organisms since these orchards are not associated significantly with coastal counties, risk to estuarine organisms is considered low. Concerning risk to aquatic plants, to the extent that aquatic plants are at risk from turf, a similar risk may exist for orchards. Finally the other crops (ie. mint, onions, etc.) appear to have a similar risk as the three crops (peanuts, tomatoes and cucurbits) that have been examined in detail.

Uncertainties and Points of Clarification

Use of GENEEC for Turf

GENEEC is a screening model to determine which uses and/or chemicals may be a risk to aquatic organisms and need to be analyzed further. Normally further analysis would involve refined modeling of EECs. Since a refined model has not been developed for turf, GENEEC values are all that can be used for risk quotient calculation. GENEEC may overestimate exposure values. The PRZM/EXAMS model used for the other crops, although refined, is also a screening tool that models the same pond scenario; however, because it takes into account more fate factors, PRZM/EXAMS, which is a Tier II screening model, usually generates lower EECs than the GENEEC or Tier I screening estimates.

Use of modeled EECs for Marine/Estuarine Organisms

GENEEC and PRZM2.3/EXAMS2.94 are both based on a scenario where 10 hectares of treated land drain into a 1 hectare pond 2 meters deep. This scenario does not reflect estuarine or marine habitat situations. Thus, any risk quotients calculated for estuarine or marine organisms are probably more valuable as comparative risk numbers (between species and between uses) as opposed to representing absolute risk. It is not possible to state with certainty that exposure concentrations in estuaries would be less or greater than the modeled EEC.

Acute Risk to Fish

Based on GENEEC values for turf, orchards and cranberries, fish are considered to be at risk of acute impact, although as indicated above, these conclusions are qualified by limitations of the modeling system . Other data have been useful in helping us determine the likelihood that chlorothalonil will kill fish. In addition to the incident data cited previously, a study by Ernst, W., et al., was intended to determine the residues in a pond treated with chlorothalonil, and determine, among other things, any acute impacts to fish. Residue levels in the pond immediately after direct spraying of the water surface ranged from 171 to 883 ppb. Rainbow trout were exposed by placing them in cages suspended in the treated pond (10 fish per cage; five cages). No mortalities of caged rainbow trout were observed.

This study represents a situation where aqueous concentrations apparently exceed the fish LC50, but no fish died. It represents only one pond, and we do not know if these results would be duplicated in other situations where fish were exposed. The sizes of the trout in the study are not provided, although they are described as 1-year old hatchery grown fish. At this age, they could be as large as five or six inches. This is much larger than the specimens used in laboratory tests, which are usually between one and two inches long. It is likely that smaller fish would be more sensitive than the fish used in this study. However, the results of this study should not be dismissed entirely.

Four fish kill incidents are described in the Exposure and Risk to Non-target Aquatic Animals Section. One incident was attributed to improper rinsing into a lake which caused measured chlorothalonil concentrations of 275 ppb in lake water. The three other fish kills may have been caused, at least in part, by normal use of chlorothalonil; however, for technical reasons, a definitive, formal attribution of cause could not be made.

SDS-3701

A primary degradate of chlorothalonil, SDS-3701, is substantially more toxic to birds and mammals, but is less toxic to fish and aquatic invertebrates than parent chlorothalonil. Therefore, the Agency spent considerable time investigating the possibility that SDS-3701 may represent a risk. It is concluded, with some certainty, that SDS-3701 does not represent a significant risk to aquatic organisms. Available residue studies suggest it is not present in/on avian or mammalian food items at concentrations likely to be an acute or chronic risk to these organisms. However when assuming 10% of the degradate is formed on terrestrial food items both acute and chronic risk is predicted for birds and mammals. Birds would be considered at high acute risk in orchards and turf and at chronic risk on all sites. Mammals would be at high acute and chronic risk for all sites. Given the uncertainty of the data used to characterize the formation and fate of SDS-3701 additional residue data on foliage is required to describe the magnitude of the exposure. Following receipt of this data a terrestrial risk assessment for SDS-3701 will be redone.

Persistence of Chlorothalonil

Chorothalonil's potential chronic impact to aquatic organisms, principally to fish, should be considered in light of the relative persistence of chlorothalonil in aquatic environments. Half lives range from a low of around 2 hours to around two weeks. Although EECs indicating chronic NOELs were exceeded are from a farm pond scenario (non-flowing), the shorter half life (2 hours) that was used in the models was generated under conditions that maximized the degradation rate such as would occur in flowing water with substantial suspended sediment. Longer half-lives may occur in sluggish or standing water with little suspended sediment.

A shorter half-life may reduce the total impact of chlorothalonil to aquatic organisms. It would be a factor in some situations such as in flowing water where movement of the pesticide downstream would continually expose new organisms. The more rapid the degradation, the shorter the distance downstream where hazardous residue levels would occur. In summary, whereas aquatic organisms in non-flowing aquatic habitat appear to be at high acute and chronic risk, those residing in flowing water may be at reduced risk.

Extent of Usage

Compared to many pesticides, the poundage of chlorothalonil used annually is relatively high. This suggests that nationally the impact of chlorothalonil use could be high. In addition, it is applied repeatedly at very high rates on some use sites, especially turf, such that "hot spots" may occur with adverse effects to localized ecosystems. Potential regional concern for impacts to estuaries arises from chlorothalonil's use on peanuts. Peanuts are grown throughout the southeast, but are not distributed evenly. They are concentrated in an area extending from southeastern Alabama to southwestern Georgia. This is probably not near estuarine habitats. However if chlorothalonil is used on peanuts grown along the Texas Gulf, coastal Virginia and North Carolina, the oyster beds in these regions may be adversely affected. Chlorothalonil was reported as having the highest volume of three fungicides discussed in NOAA's publication, Agricultural Pesticide Use in Coastal Areas: A National Summary (NOAA, 1992).

Mollusks: Special Risk Concern

Oysters and presumably other mollusks are particularly sensitive to chlorothalonil. They appear to be at higher risk than other aquatic or marine species from all modeled use sites. With an EC50 of 3.6 ppb based on shell deposition, oysters are almost 10x and 40x more sensitive than sheepshead minnow and shrimp, respectively. Oysters are important both ecologically, as filter feeders, and economically. Freshwater mussels are also represented in this risk assessment by the oyster data. The mitigating factor for both freshwater and estuarine mollusks is water movement, e.g., flowing streams and rivers for mussels and tidal flushing for oysters.

Date: 8/3/95
Case No: 0097
Chemical No: 081901

PHASE V
DATA REQUIREMENTS FOR CHLOROTHALONIL
ECOLOGICAL EFFECTS BRANCH

Data Requirements	Composition[1]	Use Pattern[2]	Does EPA Have Data To Satisfy This Requirement? (Yes, No)	Bibliographic Citation (MRID/Accession No.)	Must Additional Data Be Submitted under FIFRA3(c)(2)(B)?
6 Basic Studies in Bold					
71-1(a) Acute Avian Oral, Quail/Duck	TGAI	ABCDFIJKM	yes	68753	no
	DS-3701	ABCDJK	yes	30395	no
71-1(b) Acute Avian Oral, Quail/Duck	(TEP)				
71-2(a) Acute Avian Diet, Quail	TGAI	ABCDJK	yes	30388	no
	DS-3701	ABCDJK	yes	115109	no
71-2(b) Acute Avian Diet, Duck	TGAI	ABCDJK	yes	39146 30389	no
	DS-3701	ABCDJK	yes	115108	no
71-3 Wild Mammal Toxicity					
71-4(a) Avian Reproduction Quail	TGAI	ABCJK	yes	41440	no
	SDS-3701	ABCJK	yes	40729404	no
71-4(b) Avian Reproduction Duck	TGAI	ABCJK	yes	41441	no
	SDS-3701	ABCJK	yes	40729402	no
71-5(a) Simulated Terrestrial Field Study					
71-5(b) Actual Terrestrial Field Study					
72-1(a) Acute Fish Toxicity (Warmwater)	TGAI	ABCDFJK	yes	30390 30391 41439 127862 29410	no
	DS-3701	ABCDJK	yes	29415 30393	no

Date: 8/3/95
Case No: 0097
Chemical No: 081901

PHASE V
DATA REQUIREMENTS FOR CHLOROTHALONIL
ECOLOGICAL EFFECTS BRANCH

Data Requirements	Composition[1]	Use Pattern[2]	Does EPA Have Data To Satisfy This Requirement? (Yes, No)	Bibliographic Citation (MRID/Accession No.)	Must Additional Data Be Submitted under FIFRA3(c)(2)(B)?
72-1(b) Acute Fish Toxicity Bluegill	(TEP)	ABCDJK	yes	42433804 87258	no
72-1(c) Acute Fish Toxicity Rainbow Trout	TGAI	ABCDFIJKM	yes	56486	no
72-1(d) Acute Fish Toxicity Rainbow Trout	(TEP)	ABCDJK	yes	43302101 87303 87304	no
72-2(a) Acute Aquatic Invertebrate Toxicity	TGAI	ABCDFIJKM	yes	68754	no
	DS-3701	ABCDJK	yes	30394	no
72-2(b) Acute Aquatic Invertebrate Toxicity	(TEP)	ABCJK	yes	42433806	no
72-3(a) Acute Estu/Mari Tox Fish	TGAI	ABCDFJK	yes	127863	no
72-3(b) Acute Estu/Mari Tox Mollusk	TGAI	ABCDFJK	yes	138143	no
72-3(c) Acute Estu.Mari Tox Shrimp	TGAI	ABCDFJK	yes	127864	no
72-3(d) Acute Estu/Mari Tox Fish	(TEP)	ABCDJK	no		yes[3]
72-3(e) Acute Estu/Mari Tox Mollusk	(TEP)	ABCDJK	no		yes[3]
72-3(f) Acute Estu/Mari Tox Shrimp	(TEP)	ABCDJK	no		yes[3]
72-4(a) Early Life-Stage Fish					
-Freshwater	TGAI	ABCDFJK	no		no[4]
-Marine/estuarine	TGAI	ABCDFJK	no		yes[4]
72-4(b) Life-Cycle Aquatic Invertebrate					
-Freshwater	TGAI	ABCDFJK	yes	115107	no
-Marine/estuarine	TGAI	ABCDFJK	yes	42433807	no
72-5 Life-Cycle Fish	TGAI	ABCDJK	yes	30391	no
72-6 Aquatic Org. Accumulation					
72-7(a) Simulated Aquatic Field Study					
72-7(b) Actual Aquatic Field Study					

Date: 8/3/95
Case No: 0097
Chemical No: 081901

PHASE V
DATA REQUIREMENTS FOR CHLOROTHALONIL
ECOLOGICAL EFFECTS BRANCH

Data Requirements	Composition[1]	Use Pattern[2]	Does EPA Have Data To Satisfy This Requirement? (Yes, No)	Bibliographic Citation (MRID/Accession No.)	Must Additional Data Be Submitted under FIFRA3(c)(2)(B)?
122-1(a) Seedling Emerg.	TGAI	ABCDFIJK	yes	42433808	no
122-1(b) Vegetative Vigor	TGAI	ABCDJK	yes	42433809	no
122-2 Aquatic Plant Growth	TGAI				
123-1(a) Seedling Emerg.	TGAI				
123-1(b) Vegetative Vigor	TGAI				
123-2 Aquatic Plant Growth	TGAI	ABCDFJK	partially	42432801	yes[5]
124-1 Terrestrial Field Study					
124-2 Aquatic Field Study					
141-1 Honey Bee Acute Contact	TGAI	ABCDK	yes	36935 77759	no
141-2 Honey Bee Residue on Foliage					
141-5 Field Test for Pollinators					

1. Composition: TGAI-Technical grade of the active ingredient; PAIRA-Pure active ingredient, radiolabeled; TEP-Typical end-use product; DS-3701 and SDS-3701 refer to a chlorothalonil degradate.

2. Use Patterns: A=Terrestrial Food Crop; B=Terrestrial Feed Crop; C=Terrestrial Non-Food Crop; D=Aquatic Food Crop; E=Aquatic Non-Food Outdoor; F=Aquatic Non-Food Industrial; I=Greenhouse Non-Food Crop; J=Forestry; K=Outdoor Residential; M=Indoor Non-Food;

3. Testing with TEP(s) is needed to evaluate those use patterns with marine/estuarine exposure where the EEC $\geq$ LC50 with TGAI.

4. The freshwater fish life-cycle study cited has been previously determined to fulfill the requirement for a freshwater fish early life-stage study. An early life-stage test, however, is required for a marine/estuarine fish species, preferably the sheepshead minnow.

5. Aquatic plant testing is required for chlorothalonil since it has outdoor non-residential terrestrial uses and it may move off-site of application by drift (e.g., it has aerial and air blast applications). Testing with *Lemna gibba* is required, in Tier 2 due to effects seen in a test with *Selenastrum capricornutum*. Testing with the degradate SDS-3701 is reserved pending results of the requested *Lemna gibba* study.

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ATTACHMENT 1

DAILY ACCUMULATED PESTICIDE RESIDUES---MULTP. APPL.

Scenario-----------CUCURBITS - INSECTS - MAXIMUM FLETCHER VALUE
Initial concentration (ppm) ----- 236 ppm (1.75 lbs ai x 135 ppm/lbs ai)
Half-life ---------------------- 30 days
Number of application ---------- 4
Application interval ----------- 7
Length of simulation (day) ----- 28

DAY	RESIDUE (PPM)
0	236
1	231
2	225
3	220
4	215
5	210
6	205
7	437
8	427
9	417
10	408
11	398
12	389
13	380
14	608
15	594
16	580
17	567
18	554
19	541
20	528
21	753
22	736
23	719
24	702
25	686
26	671
27	655
28	640

Maximum residue ------ 753
Average residue ------ 480

GENEEC ESTIMATES OF EECs FOR CHLOROTHALONIL ON THREE ORCHARD CROPS
(using 44 hr aerobic aquatic half-life adjusted for temperature)

RUN No. 1 FOR CHLOROTHALONIL INPUT VALUES **CHERRIES** (aerial spray)

RATE (#/AC) ONE(MULT)	APPLICATIONS NO.-INTERVAL	SOIL KOC	SOLUBILITY (PPM)	% SPRAY DRIFT	INCORP DEPTH(IN)
6.200 (15.027)	3-10	1380	800.0	5.0	0.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METAB. (POND)	COMBINED (POND)
30.00	0	N/A	.00-.00	2.46	2.46

GENERIC EECs (IN PPB)

PEAK GEEC	AVERAGE 4 DAY GEEC	AVERAGE 21 DAY GEEC	AVERAGE 56 DAY GEEC
155.19	106.02	28.75	10.80

RUN No. 2 FOR CHLOROTHALONIL INPUT VALUES **PLUMS** (aerial spray)

RATE (#/AC) ONE(MULT)	APPLICATIONS NO.-INTERVAL	SOIL KOC	SOLUBILITY (PPM)	% SPRAY DRIFT	INCORP DEPTH(IN)
4.200(10.179)	3-10	1380	800.0	5.0	0 .0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METAB. (POND)	COMBINED (POND)
30.00	0	N/A	.00-.00	2.46	2.46

GENERIC EECs (IN PPB)

PEAK GEEC	AVERAGE 4 DAY GEEC	AVERAGE 21 DAY GEEC	AVERAGE 56 DAY GEEC
105.13	71.82	19.48	7.32

RUN No. 3 FOR CHLOROTHALONIL INPUT VALUES **PAPAYA** (aerial spray)

RATE (#/AC) ONE(MULT)	APPLICATIONS NO.-INTERVAL	SOIL KOC	SOLUBILITY (PPM)	% SPRAY DRIFT	INCORP DEPTH(IN)
3.000(6.742)	3-14	1380.0	800.0	5.0	0.0

FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)

METABOLIC (FIELD)	DAYS UNTIL RAIN/RUNOFF	HYDROLYSIS (POND)	PHOTOLYSIS (POND-EFF)	METAB. (POND)	COMBINED (POND)
30.00	0	N/A	.00-.00	2.46	2.46

GENERIC EECs (IN PPB)

PEAK GEEC	AVERAGE 4 DAY GEEC	AVERAGE 21 DAY GEEC	AVERAGE 56 DAY GEEC
69.84	47.74	12.95	4.86