R.S. - Topicals + Disp. Review

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

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Memorandum

TO: Bruce Kapner, Project Manager
Special Pesticide Review Division (TS-791)

THRU: Henry T. Craven
Registration Standards Coordinator
Ecological Effects Branch
Hazard Evaluation Division (TS-769)

Clayton Bushong, Chief
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Hazard Evaluation Division (TS-769)

SUBJECT: Terbufos Registration Standard

Attached are the Ecological Effects Topical Discussions, Disciplinary Review, and Data Evaluation Records for terbufos.

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cc: Amy Rispin, OD/HED
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21 pages

Ecological Effects

TOPICAL DISCUSSIONS

Effects on Birds

Eight studies (within eleven references) were received and evaluated under this topic. Seven studies are acceptable for use in hazard assessment and one study is not acceptable.

Author	MRID No.
Beavers and Fink	FE0TER02
Roberts and Wineholt	00087717
Krize and Terrell	00035120
Fink and Reno	00097892
Fink and Reno	00085177
Labisky and Anderson	00085178
Wang	00087726
Manuel	00085180
Labisky	00085179
Manuel	00085183
Labisky	FE0TER01

The minimum data required to establish the acute and subacute toxicity of terbufos to birds (using technical terbufos) are as follows:

1. An avian single-dose acute oral LD_{50} study using one of the two species tested for the avian dietary LC_{50} (preferably the mallard, bobwhite quail or other native quail, or the ring-necked pheasant);

2. a subacute dietary LC_{50} study on one species of waterfowl (preferably the mallard duck); and

3. a subacute dietary LC_{50} study on one species of upland game bird (preferably the bobwhite quail or other native quail, or the ring-necked pheasant).

The acceptable acute oral LD_{50} study is listed below:

Species	% a.i.	LD_{50} and 95% C.I. (mg/kg)	Author	Date	MRID No.	Fulfills Guideline Requirements
Bobwhite quail	89.6%	28.6(22.2-57.2)	Beavers and Fink	1982	FE0TER02	Yes

There is sufficient information to characterize terbufos as highly toxic to the bobwhite quail, based on the above acute oral study. The avian acute oral LD_{50} guideline requirement has been satisfied.

The acceptable dietary LC_{50} studies are listed below:

Species	% a.i.	LC_{50} and 95% C.I. (ppm)	Author	Date	MRID No.	Fulfills Guideline Requirements
Mallard	86.0%	no adverse effects seen at dietary levels of 100 or 150 ppm*	Krize and Terrell	1978	00035120	Partial
Bobwhite quail	86.0%	143 (103-214) ppm	Roberts and Wineholt	1976	00087717	yes

*Because of severe reduction in food consumption in this study, a comparable LC_{50} cannot be determined. A prior mallard study was invalidated for this and other reasons. Because of the food rejection problem, further mallard testing is not deemed warranted.

There is sufficient information to characterize terbufos as highly toxic to the bobwhite quail, based on the avian dietary LC_{50} studies. The avian dietary LC_{50} guideline requirement has been satisfied.

Avian reproduction studies with technical terbufos are needed as per Section 163.71-4 of proposed guidelnes (7/10/78) due to the broad use of terbufos

on corn at the avian breeding season, repeat applications, and the combination of terbufos' high toxicity to birds (see above) and persistence in soil (e.g., EFB-validated half-life of approximately 11 weeks in a silt-loam soil). Two avian reproduction studies have been submitted.

The acceptable avian reproduction studies are listed below:

Species	% a.i.	Results	Author	Date	MRID no.	Fulfills Guideline Requirements
Mallard	89.0%	No statistically significant impairment is reported at dietary levels of 2-20 ppm, but impairment is approaching significance (p=0.05) at 20 ppm.*	Fink and Reno	1973	00097892	partial
Bobwhite quail	89.0%	No statistically significant impairment is reported at dietary levels of 2-20 ppm.*	Fink and Reno	1973	00085177	partial

*Pen-by-pen data are required for full statistical evaluation of results.

Simulated and/or actual field testing with birds is required as per Section 163.71-5(a) due to the high acute toxicity of terbufos to birds and the high potential for avian exposure to granules at or near the soil surface over a large acreage of treated corn fields.

The acceptable simulated and/or actual field tests are listed below:

Study	Results	Author	Date	MRID#	Fulfills Guideline Requirements
1) Terrestrial Field study	Counter™ 15G, applied to corn fields at ca. 1 lb a.i/acre at time of planting under the conditions of this study, has minimal acute effects on wildlife as far as can be determined by limited searches, residue analyses, and miscellaneous wildlife observations.	Labisky and Anderson	1973	00085178	partial
		Wang	1973	00087726	
		Manuel	1973	00085180	

2) Outdoor simulated field study: exposure to treated soil	Ring-necked pheasants were exposed (principally dermally) to soil treated with COUNTER™ 15G at rates equivalent to 1 and 5 lb technical/acre, and did not have detectable residues 22 days after initial exposure nor poisoning symptoms or mortality at any time during the 55 days of exposure, or in post-treatment observation. Two of three birds exposed to a simulated accidental large spill died within 12 hours of initial exposure.	Labisky Manuel Labisky	1974 1973 1975	00085179 00085183 FE0TER01	partial

In the terrestrial field study cited, the application rate was near the minimum rate presently labeled for corn; before and after application census data were not taken; searches for dead animals were limited (one per site) and were taken as late as 12-13 days post treatment; and no analyses for cholinesterase inhabition were made. The pen study cited indicated minimal hazard to the species tested (ring-necked pheasant) at up to 5 lb a.i./acre but exposure to COUNTER™ 15G was principally dermal since clean food and water were provided at all times.

Actual field testing should be conducted in which the present maximum application rate (2.4 oz a.i./1000 feet of now) is tested using a "worst case" row spacing (e.g., 20 inches) and a "typical" row spacing (e.g., 35-39 inches). Before and after census data should be taken; intensive searches for dead or dying animals should be made within one day of application; and analyses for cholinesterase inhibition should be conducted. A protocol for conducting this study should be submitted to the agency for review, allowing adequate time for Agency contribution to the study design.

Precautionary Labeling

If the avian acute oral LD_{50} is $\leq$ 100 mg/kg or an avian dietary LC_{50} is <500 ppm, the label statement "This pesticide is toxic to wildlife" is specified by Section 162.10 of the 7/3/75 Regulations and proposed Subdivision H (1982). These conditions are both met by terbufos and thus the above statement must appear on all labels.

Effects on Freshwater Invertebrates

Three studies (contained in three references) were received and evaluated under this topic. All were acceptable for use in hazard evaluation.

Author	MRID No.
Boudreau, et. al.	FE0TER03
Bentley	00085176
USEPA	FE0TER06

The minimum data required to establish the acute toxicity of terbufos to freshwater invertebrates are the results from an acute LC_{50} study using technical terbufos. Test organisms should be first instar daphnids or early instar amphipods, stoneflies, or mayflies. Daphnids shall be tested for 48 hours. The acceptable studies are listed below:

Species	% a.i.	LC_{50} and 95% C.I.	Author	Date	MRID#	Fulfills Guideline Requirements
Daphnia magna	88.6%	0.31 (0.27-0.36) ppb	Boudreau et.al.	1982	FEOTER03	Yes
Crayfish	88.6%	8.0 (6.9-10.2) ppb	Bentley	1973	00085176	partial

There is sufficient information to characterize terbufos as very highly toxic to Daphnia magna and the crayfish. The guideline requirement for a freshwater invertebrate LC_{50} with technical terbufos has been met.

An additional acute LC_{50} study using the 15% granular formulation with a freshwater invertebrate species, as above, may be needed for hazard evaluation of existing terbufos uses if, as per Section 163.72-1 (c), the LC_{50} of the technical grade of active ingredient approximates the expected residue level in the aquatic environment when the pesticide product is used as directed or if a product component other than the active ingredient is expected to substantially enhance the toxicity of the active ingredient. Based on initial modeling by the Environmental Fate Branch, estimated parental residues dissolved in the water column under the maximum use rate for corn do approach/exceed the lowest LC_{50} for a substantial portion of the period modeled. Further modeling and/or monitoring will enable an improved assessment of expected aquatic concentrations (see Disciplinary Review).

One acute LC_{50} study using the 15% granular formulation has been conducted and is listed below:

Species	LC_{50} (and 95% C.I.)	Author	Date	MRID No.
Daphnia magna	6.2 (5.1-7.7) ppb	USEPA	1976	FE0TER06

There is sufficient information to characterize this formulation as very highly toxic to D. magna. If needed, this study meets the intent of proposed guidelines (7/10/78).

An invertebrate life-cycle study using D. magna is required as per Section 163.72-4 because the lowest LC_{50} (0.31 ppb) is far below 1 mg a.i./liter, the

estimated concentration in water is far greater than 0.01 of the LC_{50} (based on initial modeling by EFB for the maximum use rate on corn, see Disciplinary Review), the hydrolytic half-life is greater than four days at pH 5, 7, and 9, some degradates (e.g., O,O-diethylphosphorodithioic acid), based on their structure, may have a toxicity similar or greater than that of the parent material, and terbufos has broad and repeated use on corn.

Simulated or actual field studies with aquatic invertebrates are not required for hazard evaluation at present, but may be required as per section 163.72-6 (a), pending further environmental fate information and/or results of other ecological effects studies.

Precautionary Labeling

Labeling for aquatic invertebrate hazard is not specified by proposed subdivision H (1982) since a hazard statement is already specified for fish (see below).

Effects on Freshwater Fish

Eight studies (within five references) were received and evaluated under this topic. All studies are acceptable for use in hazard assessment.

Author	MRID No.
Sleight	00037483
Bentley	00085176
Roberts and Wineholt	00087718
USEPA	FE0TER04
USEPA	FE0TER05

The minimum data required to establish the acute toxicity of terbufos to freshwater fish are the results from two 96-hour LC_{50} studies using technical terbufos, one using a coldwater species (preferably the rainbow trout) and one using a warmwater species (preferably the bluegill sunfish).

The acceptable acute toxicity studies are listed below:

Species	% a.i.	LC_{50} and 95% C.I.	Author	Date	MRID#	Fulfills Guideline Requirments
Bluegill sunfish	86%	0.77 (0.72 - 0.83) ppb	Roberts and Wineholt	1976	00087718	yes
Bluegill sunfish	86.3%	3.8 (2.8-4.9) ppb	Sleight	1972	00037483	yes
Bluegill sungish	88.6%	0.87 (0.77-1.0) ppb	Bentley	1973	00085176	partial
Brown trout	86%	20(12.6-34.3) ppb	Roberts and Wineholt	1976	00087718	yes

Rainbow trout	86.3%	9.4 (7.7-11.4) ppb	Sleight	1972	00037483	yes
Channel catfish	88.6%	9.6(8.5-11.1) ppb	Bentley	1973	00085176	partial

There is sufficient information to characterize terbufos as very highly toxic to all of the fish species tested. The guideline requirement for freshwater fish acute LC_{50} data with technical terbufos has been met.

Two 96-hour LC_{50} fish studies using the 15% granular formulation may be needed for hazard evaluation of existing terbufos uses if, as per Section 163.72-1 (c), the LC_{50} of the technical grade of active ingredient approximates the expected residue level in the aquatic environment when the pesticide product is used as directed or if a product component other than the active ingredient is expected to substantially enhance the toxicity of the active ingredient. If needed, one study should be conducted on a coldwater species and one on a warmwater species. Based on initial modeling by EFB, estimated parental residues dissolved in the water column under the maximum use rate for corn do approach/ exceed the lowest LC_{50} for a substantial portion of the period modeled. Further modeling and/or monitoring will enable an improved assessment of expected aquatic concentrations (see Disciplinary Review).

Two 96-hour LC_{50} studies have been conducted using the 15% granular formulation of terbufos and are listed below:

Species	LC_{50} (and 95% C.I.)	Author	Date	MRID No.
Bluegill sunfish	12.3 (9.8-15.2) ppb*	USEPA	1975	FE0TER04
Rainbow trout	59.7 (48.1-74.3)ppb*	USEPA	1975	FE0TER05

* values based on total formulation

There is sufficient information to characterize this formulation as very highly toxic to bluegill sunfish and rainbow trout. If needed, these studies meet the intent of proposed guidelines (7/10/78).

A fish embryo-larvae study using the bluegill sunfish is required as per Section 163.72-4 because the lowest fish LC_{50} value (0.77 ppb) is well under 1 mg a.i./liter, the estimated aquatic concentration in water is greater than 0.01 of the LC_{50} (based on initial modeling by EFB for the maximum use rate on corn, see Disciplinary Review), the hydrolytic half-life is greater than four days at pH 5, 7, and 9, some degradates (e.g., O, O-diethylphosphorodithioic acid), based on their structure, may have a toxicity similar or greater than that of the parent material, and terbufos has broad and repeated use on corn.

Effects on Estuarine and Marine Organisms

No studies were evaluated under this topic. Acute toxicity studies with

estuarine and marine organisms are needed for hazard evaluation as per Section 163.72-3(a) due to existing registrations on two crops (field corn and sorghum) with greater than 300,000 acres in coastal counties of the U.S. and EFB initial estimates of runoff from corn fields (see Disciplinary Review), indicating a potential for acutely toxic effects.

Ecological Effects

The following studies were sent to EEB but are not cited in the Topical Discuss They received abbreviated reviews.

Author	MRID No.
Sleight	00087697
Peterson	00087698
Wang, et. al.	00036244

The following IBT studies were sent to EEB but there is no information in these submissions or in EEB files indicating that these studies have been reviewed through the OPP IBT Program.

Author	MRID No.
Fletcher	00069510
Fletcher	00052452
Fletcher	00037482

Scientific and Common Names of Species Referred to in Terbufos Topical Discussions and Disciplinary Review

Common Name	Scientific Name
Birds	
Mallard	*Anas platyrhynchos*
Bobwhite quail	*Colinus virginianus*
Ring-necked pheasant	*Phasianus colchicus*
Red-winged blackbird	*Agelaius phoeniceus*
Field sparrow	*Spizella pusilla*
Grasshopper sparrow	*Ammodramus savannarum*
House sparrow	*Passer domesticus*
Attwater's Greater Prairie Chicken	*Tympanuchus cupido attwateri*
Aleutian Canada goose	*Branta canadensis leucopareia*
Aquatic Invertebrates	
Water flea	*Daphnia magna*
Crayfish	*Procambarus clarkii*
Fish	
Bluegill sunfish	*Lepomis macrochirus*
Rainbow trout	*Salmo gairdneri*
Brown trout	*Salmo trutta*
Channel catfish	*Ictalurus punctatus*

Ecological Effects

DISCIPLINARY REVIEW

1. Ecological Effects Profile

A. Manufacturing Use

Avian acute oral toxicity data indicate that terbufos is highly toxic to the bobwhite quail, with an LD_{50} value of 28.6 mg/kg (Beavers and Fink, 1982, FE0TER02).

Avian dietary toxicity data indicate that terbufos is highly toxic to the bobwhite quail, with an LC_{50} value of 143 ppm (Roberts and Wineholt, 1976, 00087717).

Avian reproduction studies report no adverse reproductive effects in the bobwhite quail at dietary levels of 2 - 20 ppm. For the mallard, no adverse reproductive effects were reported at 2-20 ppm but 20 ppm is considered by the investigators to approach a level at which reproductive impairment should be expected since impairment at this level was approaching statistical significance (at p=0.05) (Fink and Reno, 1973, 00097892; Fink and Reno, 1973, 00085177). Pen-by-pen data is required for the Agency to fully evaluate the submitted results, however.

Freshwater invertebrate acute toxicity data indicate that terbufos is very highly toxic to D. magna, LC_{50} = 0.31 ppb (Boudreau, et. al., 1982, FE0TER03), and the crayfish, LC_{50} = 8.0 ppb (Bentley, 1973, 00085176).

Freshwater fish acute toxicity data indicate that terbufos is very highly toxic to the bluegill sunfish, LC_{50} values ranging form 0.77 - 3.8 ppb (Roberts and Wineholt, 1976, 00087718; Sleight, 1972, 00037483), rainbow trout, LC_{50} = 9.4 ppb (Sleight, 1972, 00037483), brown trout, LC_{50} = 20 ppb (Roberts and Wineholt, 1976, 00087718), and channel catfish, LC_{50} = 9.6 ppb (Bentley, 1973, 00085176).

B. Formulated Products

A terrestrial field study, with limited searches, residue analyses, and miscellaneous wildlife observations, implies minimal acute effects on wildlife when COUNTER™ 15G is applied to corn at ca. 1 lb a.i./acre (Labisky and Anderson, 1973, 00085178; Wang, 1973, 00087726; Manuel, 1973, 00085180). An outdoor simulated field study in which penned ring-necked pheasants were exposed (principally dermally) to soil treated with COUNTER™ 15G at rates equivalent to 1 and 5 lb technical/acre indicated non-detectable tissue residues 22 days after initial exposure. No birds died or exhibited signs of poisoning during the 55 days of exposure or in post-treatment observation. Two of three birds exposed to a simulated accidental large spill died within 12 hours of initial exposure. (Labisky, 1974, 00085179; Manuel, 1973, 00085183; Labisky, 1975, FE0TER01).

Freshwater invertebrate acute toxicity data indicates that COUNTER™ 15G is very highly toxic to D. magna, LC_{50} = 6.2 ppb (USEPA, 1976, FE0TER06). Freshwater fish acute toxicity data indicates that COUNTER™ 15G is very highly

toxic to the bluegill sunfish, LC_{50} = 12.3 ppb, and rainbow trout, LC_{50} = 59.7 ppb (USEPA, 1975, FE0TER04 and FE0TER05).

2. Ecological Hazard Assessment

Terbufos is a soil insecticide/nematicide presently registered in a 15% a.i. granular form for use on corn, sugar beets, and sorghum. Maximum application rates are 2.4 oz a.i./1000 feet of row for corn and sorghum and 1.35 oz a.i./1000 feet of row for sugar beets. Terbufos is applied only by certified applicators (or those under direct supervision of certified applicators) using ground equipment. 9.0 - 11.0 million pounds are manufactured in the U.S. annually, with approximately 10% exported (Thomas, 1982).

Corn is presently the major terbufos use. 9.3 million pounds of terbufos were applied to corn in 1980, 25.5% of all insecticide used on this crop (Eichers and Serletis, 1982). This makes terbufos the most heavily used corn insecticide in the U.S. Corn rootworm is the principal pest for which terbufos is used. Application is at planting in spring and/or post-emergence in late spring or early summer. Planting in the corn belt is at its peak around the middle of May. One to two applications are applied to corn fields that have been planted to corn for more than one season. Granules are applied by a band or an in-furrow application. Incorporation is light, to a maximum of two inches. With a band application, granules are pressed into the soil. Additional incorporation may or may not be made with the use of drag chains, tines, or other device. The minimum row width specified by the label (5/13/82) is 20 inches. The maximum row spacing generally used with corn is 48 inches with an average of 35-39 inches (Thomas, 1982).

Sugar beet application is at spring planting or post-emergence in late spring/early summer. Only one application per season is permitted. Planting is generally March through May in the states of North Dakota, Wyoming, Idaho, and Colorado. Granules are applied in a 5-7" band over the row. Power or mechnical incorporation may be used to lightly incorporate the granules into the soil. As with corn, a minimum row spacing of 20 inches is specified on the existing label (5/13/82). Maximum row spacing is not likely to be greater than 22 inches (Thomas, 1982).

Sorghum application is at planting or bedding and can be banded (5-7 inches) or knifed-in (drilled below and/or to side of seed). Only one application is permitted per year.

Terrestrial organisms can be exposed to terbufos directly via the granules. Aquatic organisms may be exposed via runoff of the granules or via transport of soil or water containing residues of terbufos or its degradates.

Since corn is by far the principal currently-registered terbufos use, application to this crop can be used to estimate non-target hazard. The maximum application rate of 2.4 oz a.i./1000 feet of row is equivalent to 3.92 lb a.i./acre at the minimum permitted row spacing (20"), 1.64 lb a.i./acre at the maximum spacing generally used (48"), and 2.24 - 2.01 lb a.i./acre at a "typical" spacing (35-39").

Granule weight estimates made by R. Balcomb of EEB indicate that there are approximately 4 million terbufos granules/lb of formulated product. Each granule thus weighs approximately 0.1 mg. At 15% a.i, each granule would contain

approximately 0.015 mg active ingredient. With an LD_{50} of 28.6 mg a.i./kg (bobwhite quail), it would take approximately 0.4 mg a.i., or about 27 granules, to reach the LD_{50} of a small bird such as a field sparrow or grasshopper sparrow (0.0139 kg), if such a bird had the same sensitivity to terbufos as the bobwhite quail. However, in toxicity screening studies by R. Balcomb, using the formulated product (COUNTER™ 15G), it was found that 10 granules were sufficient to kill all five redwinged blackbirds given this dose. Doses of one and five granules did not kill any of the blackbirds and a dose of 20 granules killed four of the five blackbirds receiving this dose. Doses of one and five granules did not kill any of the house sparrows tested and 10 granules killed two of the five birds receiving this dose.

The above results suggest that an approximate LD_{50} for the redwinged blackbird is likely >5 and <10 granules, on > 0.075 and < 0.15 mg terbufos. With a red-winged blackbird weight of approximately 0.07 kg, the LD_{50} would be >1.1 and <2.1 mg a.i./kg body weight. Since only granules were tested, it is not clear whether the increased toxicity compared to the 28.6 mg/kg value for bobwhite quail (>13X) is due to differences in sensitivity between the two test species or increased toxicity of the formulation, or both. Elwood F. Hill of the USFWS Patuxent Wildlife Research Center is presently testing both technical terbufos and COUNTER 15G for acute oral toxicity to the bobwhite quail. His results should indicate whether COUNTER™ 15G is more toxic than terbufos technical on an active ingredient basis. The results will not address the differential interspecific sensitivity question, however.

When a granular pesticide is applied in front of the planter press wheel, as is done with terbufos (EPA Index, 1982), approximately 7.9% of applied granules can be expected on the soil surface following incorporation with a drag chain, 5.8% with incorporation by spring tine, and 14.7% without incorporation (other than the press wheel), with an average of 9.5% for this location of application (Erbach an Tollefson, unpublished). With terbufos applications from 1.6 - 3.92 lb a.i/acre depending on row spacing (at 2.4 oz a.i./1000 ft. of row), there would be 16.7 - 40.8 mg a.i./sq. ft. applied. This is equivalent to 1113 - 2720 granules/sq. ft. (0.015 mg a.i/granule). An average of 9.5% of these on the surface would 106 - 258 granules/ sq ft., well over the number needed to achieve an LD_{50} for small birds. Turn rows may get substantially more granules on the surface. The label specifies that these are to be covered by deep discing. Granules could be ingested intentionally by birds as grit,or inadvertently while foraging for insects, seeds, or other food items. Granules could also be stuck to the outer surface of avian prey items such as worms and be ingested in this manner. Residues could also be present within live and/or dead invertebrate or plant food items of birds. In turn, residues within small birds or mammals would be available to larger birds of prey. Because of the relatively low bioaccumulation potential of terbufos (see environmental fate chapter), this availability to birds of prey would likely be a temporary phenomenon. However, it could be a frequently repeated one and as such may pose a hazard to these birds.

Results of the terrestrial field study cited in the above ecological effects profile did not indicate any substantial acute effects. However, the application rate was near the present minimum label rate for corn; before and after aplication census data were not taken; searches for dead animals were limited (one per site) and were taken as late as 12-13 days post-treatment; and no analyses for cholinesterase inhibition were made. The pen study cited indicated minimal hazard to the species tested (ring-necked pheasant) at up to 5 lb a.i./acre

but exposure to COUNTER™ 15G was principally dermal since clean food and water were provided at all times.

Mammalian toxicity data is being reviewed and validated by the Toxicology Branch (TB). Based on preliminary acute oral data (11/3/82 EEB review), terbufos is up to 17.9 times more acutely toxic to small mammals than birds. Pending final TB review, it may thus be necessary to include mammals in the required terrestrial field study (see Generic Data Requirements Table).

EEB requested (11/10/82) that estimated environmental concentrations (EECs) of terbufos and its principal degradates in water be calculated by the Environmental Fate Branch (EFB) for the present maximum use rate of COUNTER™ 15G on corn (2.4 oz a.i/1000 linear feet of row) with a band treatment. It was requested that EECs be reported for both a "worst - case" row spacing (e.g., 20 inches) and a "typical" row spacing (e.g., 35-39 inches) and that the persistence of estimated aquatic concentrations of parent material and principal degrades also be provided.

EFB responded (12/10/82) with the results of modeling using both a runoff model (SWRRB) and the Exposure Analysis Modeling System (EXAMS) to estimate expected aquatic concentrations of terbufos. The SWRRB model was used to estimate runoff from two basins containing corn, one located in Coshocton, Ohio and the other in Tifton, Georgia. Calculations of daily runoff were estimated for three years, 1968-1970. In this initial report, EFB provided only runoff values under the maximum application rate with a "worst-case" row spacing (i.e., 3.92 lb a.i./acre), using two applications (May and early June). The SWRRB model predicted measurable runoff events on three to five days per year at the Coshocton site (0.001-0.054 lb a.i./acre) and four to five days per year at the Tifton site (0.001-0.067 lb a.i./acre).

EFB considered the three runoff events at the Coshocton site in 1970 (0.002, 0.005, and 0.009 lb a.i./acre) to be typical and used these values in the EXAMS model to estimate environmental concentrations in the water column and in the benthic sediment of a pond whose drainage area is 15 hectares. A "pulsed" version of EXAMS was used which permits the modeling of "pulses" of pesticide entry to the aquatic system, as might occur under actual rainfall events. EFB (considering the above runoff quantities in lb a.i./acre to be roughly equivalent to kg a.i./hectare) multiplied the runoff values by 15 to account for the EXAMS basin size and entered the resulting pesticide loads into the pond model as follows: 0.075 kg on Day 5, 0.135 kg on Day 15, and 0.030 kg on Day 35. Residues were modeled for a total of 60 days. Peak residues dissolved in the water column were 7.4 ppb on Day 15, immediately after the second runoff event. Peak residues sorbed to benthic sediments were 3.7 ppb on Day 26. By Day 60, residues dissolved in the water column declined to 0.035 ppb and residues sorbed to the benthic sediments declined to 2.1 ppb. These residues are for parental terbufos only; EFB was not able to consider degradates, certain of which (based on molecular structure) may be as toxic as parental terbufos.

Residue levels of concern to EEB, for fish and aquatic invertebrates, are shown in the following table:

	Fish	Aquatic Invertebrates
Restricted Use ($\geq$ 1/10-1/2 LC_{50})	$\geq$ 0.077-0.385 ppb	$\geq$ 0.031-0.155 ppb
RPAR (>1/2 LC_{50})	> 0.385 ppb	> 0.155 ppb
Endangered Species		
1) $\geq$ 1/10 LC_{10}	$\geq$ 0.051 ppb	$\geq$ 0.021 ppb
2) $\geq$ 1/20 LC_{50}	$\geq$ 0.0385 ppb	$\geq$ 0.0155 ppb

The lowest validated LC_{50} and LC_{10} values for each taxon are used in this table. These residues are of concern if present in aquatic habitat for $\geq$ 96 hours for fish and $\geq$ 48 hours for aquatic invertebrates. Modeled residues dissolved in the water column (after the first runoff) exceed the above criteria for endangered species continuously through Day 57 (fish, both criteria) and Day 60 (aquatic invertebrates, both criteria); for Restricted Use, continuously through Day 54 (fish) and Day 60 (aquatic invertebrates); for RPAR, continuously through Day 44, except Days 33-34 (fish) and Day 49 (aquatic invertebrates). In sum, residue levels of concern are exceeded for 38-56 days out of 56 days following initial pesticide runoff. It thus appears that there is a potential for substantial hazard to aquatic organisms under existing terbufos registrations. Results of further modeling (e.g., of other use patterns/rates) and/or field monitoring of residues will enable an improved hazard assessment.

Based on the ongoing EEB endangered species review for pesticides used on corn, it appears that the only endangered threatened terrestrial species likely to be exposed under this use pattern are the Attwater's Greater Prairie Chicken and the Aleutian Canada Goose. Terbufos is not presently used on corn in California and thus the latter species, which winters in California, would not currently be exposed if/when foraging in corn fields here. Based on a 7/9/82 letter from the U.S. Office of Endangered Species (OES) regarding terbufos and the OES biological opinion on Phorate, a structurally and toxicologically similar compound used on sorghum and sugar beets (among other crops), it does not appear terbufos use on these crops would potentially jeopardize any additional terrestrial endangered/threatened species. The OES review indicates that the Aleutian Canada Goose may feed on "cereal grains" in California. Sorghum is a cereal grain grown in California. As long as labeling prohibits the use of terbufos in the range of the above two bird species, it does not appear at present that there would be a "may effect" situation for terrestrial species with existing terbufos registrations. If results of outstanding testing or further EEB review indicates a "may effect" situation, formal consultation with the Office of Endangered Species, U.S. Department of Interior, will be initiated.

As indicated above, initial modeling by EFB indicates that parental terbufos concentrations dissolved in the water column under the maximum use rate for corn, with one repeat application, exceed endangered species hazard criteria for 53-56 of 56 days following initial runoff. It thus appears that, under the conditions of the model, there is a "may affect" situation and formal consultation with OES will likely be required. Results of further modeling and/or field monitoring of residues will enable an improved hazard assessment.

3. Data Gaps

See the generic data requirements table.

4. Precautionary Labeling

A. Manufacturing Use Products

"This pesticide is toxic to fish and wildlife. Do not discharge into lakes, streams, ponds, or public waters unless in accordance with an NPDES permit. For guidance, contact your Regional Office of the Environmental Protection Agency."

B. End use Products

"This pesticide is toxic to fish and wildlife. Runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water by cleaning equipment or disposal of wastes. Cover or incorporate granules that are spilled during loading."

"Under the federal Endangered Species Act, it is a federal offense to use any pesticide in a manner that could jeopardize the continued existence of a federally-listed endangered/threatened species. Use of COUNTER™ 15G in the Texas counties of Aransas, Austin, Brazoria, Colorado, Ft. Bend, Galveston, Goliad, Harris, Refugio, or Victoria may jeopardize the Attwater's Greater Prairie Chicken. Use of COUNTER™ 15G in the California counties of Butte, Colusa, Glenn, Solano, Sutter, or Yolo from mid-August through the end of December or the counties of Merced, San Joaquin, or Stanislaus from mid-September through mid-March may jeopardize the Aleutian Canada Goose."

"Prior to making applications in these counties, the user must confirm that these species will not be exposed to the applied pesticide. If in doubt, the user must contact either the regional U.S. Fish and Wildlife Service Office (Endangered Species Specialist) or personnel of the state fish and wildlife agency."

Labeling for aquatic endangered species is reserved pending formal consultation, if needed, with the U.S. Office of Endangered Species.

REFERENCES

Eichers, T. and Serletis, W. 1982. Farm pesticide supply-demand trends, 1982. USDA Agric. Econ. Report #485, Washington, DC.

Thomas, E.D. 1982. Registration standard's phase I qualitative use assessment for terbufos (105001). BFSD/OPP/EPA, 6/4/82, Washington, DC.

Scientific and Common Names of Species Referred to in Terbufos Topical Discussions and Disciplinary Review

	Common Name	Scientific Name
Birds		
	Mallard	*Anas platyrhynchos*
	Bobwhite quail	*Colinus virginianus*
	Ring-necked pheasant	*Phasianus colchicus*
	Red-winged blackbird	*Agelaius phoeniceus*
	Field sparrow	*Spizella pusilla*
	Grasshopper sparrow	*Ammodramus savannarum*
	House sparrow	*Passer domesticus*
	Attwater's Greater Prairie Chicken	*Tympanuchus cupido attwateri*
	Aleutian Canada goose	*Branta canadensis leucopareia*
Aquatic Invertebrates		
	Water flea	*Daphnia magna*
	Crayfish	*Procambarus clarkii*
Fish		
	Bluegill sunfish	*Lepomis macrochirus*
	Rainbow trout	*Salmo gairdneri*
	Brown trout	*Salmo trutta*
	Channel catfish	*Ictalurus punctatus*

Guideline Citation	Data Requirement	Composition and Use Pattern 1/	Does EPA Have Data To Satisfy This Requirement? (Yes, No or Partially)	Bibliographic Citation	Must Additional Data Be Submitted Under FIFRA Section 3(c)(2)(B) 2/
71-1	Avian Single - Dose Oral LD_{50}	A	yes	Beavers and Fink, FE0TER02	no
71-2	Avian Dietary LC_{50}	A	yes	Roberts and Wineholt, 00087717 Krize and Terrell, 00035120	no
71-3	Wild Mammal Toxicity	----	----	-----	no
71-4	Avian Reproduction	A[3]	partially[4]	Fink and Reno, 00085177 Fink and Reno, 00097892	yes[4]
71-5	Simulated and Actual Field Testing for Mammals & Birds	A	partially[5]	Labisky & Anderson, 00085178 Wang, 00087726 Manuel, 00085180 Labisky, 00085179 Manuel, 00085183 Labisky, FE0TER01	yes[5]
72-1	Fish Acute LC_{50}	A	yes	Sleight, 00037483 Bentley, 00085176 Roberts and Wineholt, 00087718	no
		A[6]	yes	USEPA, FE0TER04 USEPA, FE0TER05	no

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Guideline Citation	Data Requirement	Composition and Use Pattern 1/	Does EPA Have Data To Satisfy This Requirement? (Yes, No or Partially)	Bibliographic Citation	Must Additional Data Be Submitted Under FIFRA Section 3(c)(2)(B) 2/
72-2	Acute LC_{50} Aquatic Invertebrates	A	yes	Boudreau, et. al., FE0TER03 Bentley, 00085176	no
		A[6]	yes	USEPA, FE0TER06	no
72-3	Acute LC_{50} Estuarine + Marine Organisms	A[7]	no	-----	yes[7]
72-4	Fish Early Life-Stage/Aquatic Invertebrate Life Cycle	A[8]	no	-----	yes[8]
72-5	Fish Life-Cycle	reserved[9]	no	-----	no[9]
72-6	Aquatic Organism Accumulation	reserved[9]	no	-----	no[9]
72-7	Simulated or Actual Field Testing for Aquatic Organisms	reserved[9]	no	-----	no[9]

Composition of the material to be tested is technical grade unless otherwise specified. The use patterns are coded as follows: A=Terrestrial, Food Crop; B=Terrestrial, Non-Food; C=Aquatic, Food Crop; D=Aquatic, Non-Food; E=Greenhouse, Food Crop; F=Greenhouse, Non-Food; G=Forestry; H=Domestic Outdoor; I=Indoor.

Data must be submitted no later than 24 months from the published date of the Standard.

This data is necessary to support corn and sorghum uses.

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4/ All pen-by-pen data must be provided to enable full statistical evaluation of results.

5/ Testing under this guideline is required for hazard assessment for terrestrial uses due to the high acute toxicity of turbufos to terrestrial organisms and the high potential for exposure to granules at or near the soil surface over a large acreage of treated fields. Actual field testing should be conducted in which the present maximum application rate (2.4 oz a.i./1000 feet of row) is tested using a "worst case" row spacing (e.g., 20 inches) and a "typical" row spacing (e.g., 35-39 inches). Census data should be taken before and after treatment, intensive searches for dead or dying animals should be made within one day of application, and analyses for cholinesterase inhibition should be conducted. A protocol for conducting this study should be submitted to the Agency for review, allowing adequate time for Agency contribution to the study design.

6/ Formulated product testing under this guideline may be required for hazard assessment of existing uses if the LC_{50} of the technical grade of active ingredient approximates the expected residue level in the aquatic environment. Based on initial modeling by the Environmental Fate Branch (12/10/82), estimated parental residues dissolved in the water column under the maximum use rate for corn with one repeat application do approach/exceed the lowest aquatic LC_{50} values for a substantial portion of the 60-day period modeled. These tests have already been conducted by the Agency.

7/ Testing under this guideline is required for hazard assessment to support corn and sorghum uses because there are more than 300,000 acres of these crops in coastal counties of the U.S. and existing runoff modeling indicates a potential for acutely toxic concentrations in the estuarine/marine environment. 96-hour LC_{50} studies should be conducted for estuarine/marine shrimp and fish species and either a 48-hour embryo-larvae LC_{50} study or a 96-hour shell deposition EC_{50} study conducted for an estuarine/marine mollusc species.

8/ Testing under this guideline is required for hazard assessment of existing use patterns because the lowest fish and aquatic invertebrate LC_{50} values (0.77 ppb and 0.31 ppb, respectively) are well below 1 ppm; initial modeling by EFB indicates aquatic concentrations well above 0.01 the lowest LC_{50} values; the hydrolytic half-life of parental terbufos is >4 days at pH 5, 7, and 9; certain of the degradates (based on structure) may have a toxicity similar or greater than that of the parent material; and terbufos has broad and repeated use on corn. The fish embryo-larvae study should be conducted using the bluegill sunfish (Lepomis macrochirus) and the aquatic invertebrate life-cycle study should be conducted using the water flea (Daphnia magna).

9/ The need for these studies to support existing use patterns is reserved pending completion of outstanding data requirements.