

PP # 4F1445-
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: PP# 4F1445, Chlorpyrifos in Beans and Corn.

DATE:

MAY 3 1974

FROM:

TO: Coordination Branch
and Toxicology Branch, RD

The Dow Chemical Company proposes tolerances for residues of the insecticide chlorpyrifos, [0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl)phosphorothioate], and its metabolite 3,5,6-trichloro-2-pyridinol in or on bean forage at 0.2 ppm; fresh corn including sweet corn (kernels plus cob with husk removed) and corn fodder and forage at 0.1 ppm; lima beans and snap beans at 0.05 ppm.

Tolerances for chlorpyrifos (§180.342) are established at 0.25 ppm on bananas of which not more than 0.05 ppm is in pulp (F.R. 10/10/73).

Tolerances are pending (PP# 3F1306) for residues of chlorpyrifos in meat, fat, and meat byproducts of cattle at 1.5 ppm; meat, fat, and meat byproducts of turkeys at 0.2 ppm; field corn grain, forage and fodder (0.1 ppm) and peaches at 0.05 ppm.

Conclusions

1. The nature of the residue is adequately understood.
2. Adequate analytical methods are available for enforcement of the proposed tolerances as well as our suggested tolerances for chlorpyrifos and its metabolite, TCP.
- 3(a). The proposed tolerance levels for lima beans and snap beans are adequate.
- 3(b). The proposed tolerance level for bean forage is inadequate to reflect combined residues of chlorpyrifos and TCP. A level of 1.0 ppm is more appropriate.
4. Combined residues of chlorpyrifos and its metabolite in or on fresh corn including sweet corn (kernels plus cob with husks removed) and corn fodder and forage are not likely to exceed the proposed tolerance.
5. No residues are likely to occur in poultry and eggs from the proposed use [§180.6(a)(3)].

- 6(a). There is a reasonable expectation of residues in milk, fat, meat, and meat byproducts of livestock [§180.6(a)(2)]. Therefore, tolerances are necessary to cover residues which could occur in livestock (except cattle).
- 6(b). The pending cattle tolerance is also adequate to cover residues resulting from the proposed use.
7. We suggest the following tolerance levels to cover residues of chlorpyrifos and its metabolite 3,5,6-trichloro-2-pyridinol in the following items.
- | | |
|----------|---|
| 0.25 ppm | in milk fat (reflecting residues in whole milk of 0.01 ppm) |
| 0.10 ppm | fat, meat, and meat byproducts of goats, hogs, horses, and sheep. |

Recommendation

We recommend against the proposed tolerances. A favorable recommendation is contingent upon resolution of questions raised in conclusions 3b, 6 and 7.

Detailed Considerations

Proposed Use

Chlorpyrifos is formulated as LORSBAN^(R) 25-SL, a wettable powder containing 25% active ingredient (a.i.), for use as a preplant, slurry treatment of seed of lima beans, snapbeans and sweet corn.

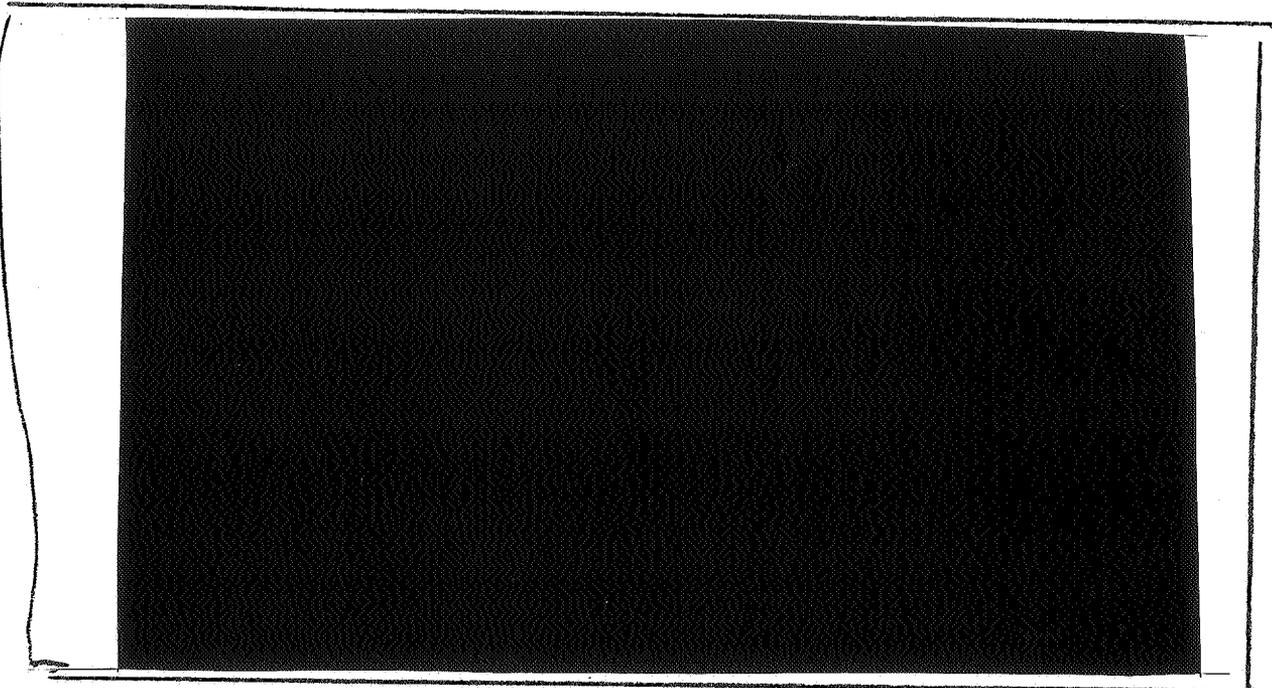
Use 4 ounces of LORSBAN-25 SL per 100 pounds of seed (1 oz. a.i./100 lb. seed).

Treated seed are not to be used for human consumption, as feed for livestock or poultry or for oil purposes.

The formulation is prepared from the technical chlorpyrifos which has the following composition,

Chlorpyrifos

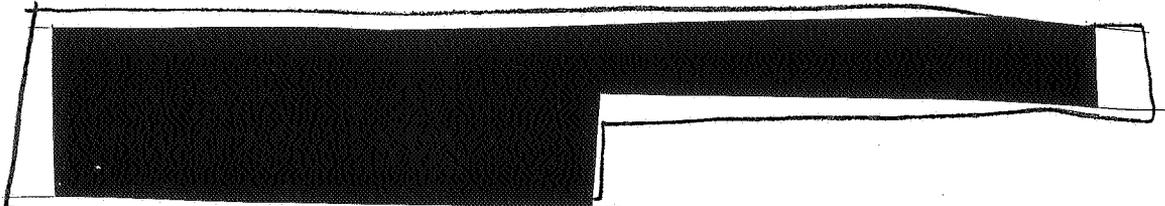
minimum 94%



The impurity [REDACTED]

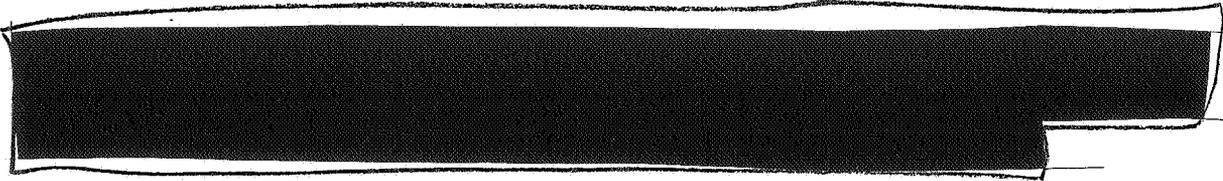
[REDACTED] The chlorpyrifos formulation will contain
[REDACTED] at a maximum level of [REDACTED]. Because of the relative
quantities involved and the dilution factors, the impurity [REDACTED]
as well as the remaining impurities are not expected to produce
a residue problem.

The formulation's inert ingredients are as follows.



All inerts are cleared for use under §180.1001.

Manufacturing Process



INERT INGREDIENT INFORMATION IS NOT INCLUDED
MANUFACTURING PROCESS INFORMATION IS NOT INCLUDED

Nature of the Residue

We have discussed the nature of plant residues (bean, corn) and animal residues in PP# 3F1306 (memo 3/1/73, F.D.R.Gee). Metabolism studies with radiolabelled (^{36}Cl , ^{14}C) chlorpyrifos and its metabolite 3,5,6-trichloro-2-pyridinol (TCP) and residue data in this petition (PP# 4F1445) show that chlorpyrifos is absorbed and translocated. Chlorpyrifos is metabolized and/or degraded in soil and plants thru hydrolysis to yield TCP which could be conjugated (the residue method could determine bound residues). TCP is metabolized via dechlorination and formation of diols and triols and subsequent cleavage of the pyridine ring. The oxygen analog of chlorpyrifos was not noted.

The significant components of plant residues are the parent compound chlorpyrifos and its hydrolysis product 3,5,6-trichloro-2-pyridinol.

The metabolism of chlorpyrifos in animals is likely to occur through oxidation and hydrolysis to yield water-soluble phosphoric acid components, TCP, and the parent. The organs of elimination (liver and kidney) contain the greater quantity of TCP residues whereas the parent is temporarily stored in the fat. Excretion occurs primarily thru the urine.

The nature of the residue is adequately delineated.

Analytical Method

The method to be used for residue determinations varies with the commodity and the compound. The methods are discussed and evaluated below.

Chlorpyrifos

Snapbeans and snapbean forage (DOW method ACR. 72.15)

A bean or forage sample is blended with acetone and filtered. An aliquot is concentrated, dried over sodium sulfate, and taken up with hexane.

The hexane solution is cleaned up on a Florisil column and eluted with benzene. The solvent is evaporated, and the residue is taken up in hexane for determination by Gas-Liquid Chromatography (GLC) using a flame photometric detector which is sensitive to phosphorus. Residues are quantified by reference to a standard curve.

Untreated (control) snapbean and snapbean forage samples had <0.01 ppm chlorpyrifos equivalent residues. Controls were fortified with chlorpyrifos at levels of 0.01-0.50 ppm. Recoveries were 74-104%.

The method is adequate for the determination of chlorpyrifos in snapbeans and snapbean forage at levels of approximately 0.01 ppm and above. We believe the method to be applicable to lima beans and lima bean forage as well.

Sweet Corn (DOW method ACR. 72.9)

A sample of corn or corn forage is extracted by blending with acetone, filtering, and concentration of the filtrate.

Residues in the filtrate are extracted into hexane which is dried over sodium sulfate. The solvent is concentrated, and residues are extracted into acetonitrile which is evaporated. The residue is taken up with hexane and cleaned up on a silica gel column. The eluate is evaporated to dryness, and the residue is taken up with acetone for determination by GLC using a photometric detector sensitive to phosphorus.

Control samples of sweet corn kernels and cobs, husks and green forage had <0.01 ppm chlorpyrifos equivalent residues. Controls, fortified with chlorpyrifos at levels of 0.01-1.0 ppm, yielded recoveries of 71-109%.

The method is adequate for the determination of chlorpyrifos in sweet corn and sweet corn forage at levels of approximately 0.01 ppm and above.

3,5,6-Trichloro-2-pyridinol (DOW Method ACR. 71.19R)

Lima beans and Snapbeans and forages

A sample is heated with a dilute sodium hydroxide in methanol solution, cooled, blended, and filtered. (This treatment converts any chlorpyrifos to trichloropyridinol).

An aliquot of the filtrate is concentrated and diluted with aqueous hydrochloric acid and sodium chloride. The residues are extracted into benzene and further cleaned up on an alumina column using a diethyl ether/buffer solution as the eluting solvent.

The residues are extracted into a sodium bicarbonate solution which is acidified with hydrochloric acid. The residues are extracted into benzene, treated with N,O-bis (trimethylsilyl) acetamide which forms the pyridinol trimethylsilyl derivative. The derivative is determined by gas chromatography using an electron capture detector (ECGC).

Control samples of beans and green plants showed less than 0.05 ppm trichloropyridinol equivalent residues. Controls, fortified with trichloropyridinol at levels of 0.05-2.0 ppm, had recoveries of 70-120%.

The method is sufficiently sensitive for the determination of 3,5,6-trichloro-2-pyridinol at levels of 0.05 ppm and above.

Corn grain, forage, and stover (DOW Method ACR 71.19)

The method is essentially the same as the above method for beans (ACR 71.19R). However, the volumes of solvents used on various commodities differ.

Control samples of corn grain, forage, and fodder had less than 0.05 ppm trichloropyridinol equivalent residues. Control samples were fortified with chlorpyrifos and trichloropyridinol separately at levels of 0.088-8.93 ppm and 0.05-0.20 ppm, respectively. Corresponding recoveries were 81-100% and 76-117%.

The method is sufficiently sensitive for the determination of chlorpyrifos and trichloropyridinol at levels of 0.05 ppm and above.

The methods for 3,5,6-trichloro-2-pyridinol determine the parent compound chlorpyrifos as well as trichloropyridinol as the trimethylsilyl derivative of trichloropyridinol. The methods do not, however, distinguish between chlorpyrifos and trichloropyridinol.

Successful method trials have been performed with chlorpyrifos on peaches at levels of 0.025 ppm and 0.05 ppm and beef fat at levels of 0.1 ppm and 0.5 ppm (PP# 3F1306; memo 6/12/73, Jesse E. Mayes). The method tested on beef fat is similar to the above method for chlorpyrifos in corn.

Successful method trials have been performed on bananas with trichloropyridinol at levels of 0.05 ppm and 0.10 ppm (PP# 3F1370, memo 9/25/73, F.D.R. Gee) and beef fat at levels of 0.1 ppm and 0.5 ppm (PP# 3F1306, memo 11/1/73, F.D.R. Gee).

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A TLC method is available as a confirmatory procedure.

We believe that the results of the method trials can be extended to include beans, bean forages, corn, and corn fodder and forage. Therefore, we are not recommending for a method trial.

Adequate analytical methods are available for enforcement of the proposed tolerances as well as our suggested tolerance. (For a discussion of meat and milk methodology, see under Meat, Milk, Poultry, and Eggs).

The commodities are analyzed for the parent chlorpyrifos and the metabolite 3,5,6-trichloro-2-pyridinol (TCP) separately. While the chlorpyrifos method would determine only chlorpyrifos, the method for the metabolite would determine both the parent and the metabolite as the metabolite. Consequently, residue levels obtained with the TCP method reflect total residues of the parent plus TCP.

Residue levels in the residue data will be reported as combined levels of TCP and chlorpyrifos.

Residue Data

Samples of lima beans and snap beans were obtained from crops grown in Wisconsin, New York, Mississippi, Florida, Oregon, and Illinois.

Lima Beans: crops were grown from seed treated at 1X-3X the proposed rate. The beans were sampled and analyzed at harvest (70-110 days after planting) and green plants were sampled and analyzed at intervals of 22-110 days after planting.

The beans showed no detectable residues (<0.05 ppm) at harvest resulting from either proposed or exaggerated rates. Therefore, the proposed tolerance level for lima beans is adequate.

The green plant^{had} residues of <0.05-0.75 ppm at 22-28 days after planting from the proposed rate. Residues were <0.05-0.29 ppm at 42-59 days, and <0.05 ppm at 73-110 days (normal bean harvest) from the proposed rate. Residues from the exaggerated (2X-3X) were generally higher at all intervals.

It should be emphasized that the levels noted reflected real residues. The identity of residues in treated samples were confirmed by p-values, chemical hydrolyses, and mass spectrometry.

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We conclude that residues of chlorpyrifos and its metabolite TCP in lima bean forage are not likely to exceed the proposed tolerance (0.2 ppm) from the proposed use (see our discussion below for bean forage in general).

Snap beans

Samples were obtained from crops grown from seed treated at 1X-3X the proposed rate. The bean had no detectable residues (<0.05 ppm) at harvest (55-61 days after planting) from proposed or exaggerated rates.

The proposed tolerance level for snap beans is adequate.

The green plant had residues of <0.05-0.37 ppm at 16-31 days after planting from the proposed rate. Residues at harvest (41-61 days) were <0.05-0.49 ppm from the proposed rate. Residues at exaggerated rates were generally higher at the corresponding intervals after planting.

The proposed tolerance level (0.2 ppm) for snap bean forage is insufficient to reflect residues of chlorpyrifos and TCP from the proposed use. A level of 1.0 ppm would be adequate to reflect such residues in snap bean forage. The petitioner should be so informed.

The level of 1.0 ppm should apply to bean forage, in general. The two were separated for purposes of evaluating the residue data as submitted.

Sweet Corn

Samples of green plants, kernels, ears, ear and husks, and husk were obtained from crops grown from seed which had been treated with chlorpyrifos at rates of 1X-3X the proposed rate. The green plants were sampled at various intervals after planting (28-31 days; ^{41-48 days} and 61-126 days). The remaining commodities were sampled at normal harvest (72-126 days after planting). Crops were grown in plots in Florida, Illinois, Iowa, Mississippi, New York, Oregon, and Wisconsin.

No detectable residues of either chlorpyrifos (<0.01 ppm) or TCP (<0.05 ppm) were noted in any commodity from the proposed or exaggerated rates. Thus, an appropriate tolerance level would reflect the methods' sensitivities for chlorpyrifos and TCP. Therefore, the proposed tolerance is adequate and residues in or on fresh corn including sweet corn (kernels plus cob with husk removed) and corn fodder and forage are not likely to exceed the proposed 0.1 ppm tolerance.

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While no data are submitted on cannery waste, the residue data for corn and corn forage indicate that residues, if any, in cannery waste would not exceed the level of 0.1 ppm.

Meat, Milk, Poultry and Eggs

Corn forage, cannery waste (corn or beans), and bean forage may be used as livestock (excluding poultry) feed items. However, vines from harvested green beans or lima beans are not fed to dairy cattle. While limited feeding of vines to other livestock may occur, it is not a common practice. Generally, the waste plant parts from combining operations are plowed under (PP# 4F1421).

Bean cannery waste (about equal weights of weeds-leaves-stems-vines, and cull beans) is usable as a feed to livestock including dairy cows. Cannery waste makes up about 10-25% of the total ration.

Cannery waste is fed only as a green feed and only during the 6-8 week period when processing plants are in operation; it is not dried or stored as silage.

The maximum concentration of residues in cannery waste can be calculated (PP# 4F1421).

Vines at 1 ppm + beans at 0.05 ppm = $\frac{(1 + 0.05) \text{ ppm}}{2} = 0.5 \text{ ppm}$
Concentration of residues in ration due to cannery waste = $\frac{25\%}{100} (0.5 \text{ ppm}) = 0.125 \text{ ppm maximum.}$

Generally, vines of lima and snap are not fed to livestock. However, bean vines may occasionally be ensiled at 20-30% bean vines with corn. The maximum concentration of ingested residues from corn and vines silage would be; $\frac{[30\% (1.0 \text{ ppm}) + 0.1 \text{ ppm}]}{2} = 0.2 \text{ ppm.}$

Therefore, the maximum concentration of residues likely to be ingested in the daily diet would be approximately 0.2 ppm.

Since the above items are not fed to poultry, we conclude that no residues are likely to occur in eggs and/or poultry from the proposed use [§180.6(a)(3)].

Livestock Feeding Studies (PP# 3F1306, Sec. D)

Dairy Cows were fed chlorpyrifos in the daily diet at levels of 0.3-30 ppm for two weeks at each level. No detectable residues (<0.01 ppm) of the parent chlorpyrifos, its oxygen analog, or 3,5,6-trichloro-2-pyridinol (TCP) were noted at the 3 ppm and 10 ppm feeding levels. Combined residues of chlorpyrifos and TCP were noted at the 10 ppm level in the cream (<0.04 ppm) and the 30 ppm level in the cream (<0.18 ppm).

Cream was separated from milk, and analyses performed on each. Samples were powdered with silica gel, extracted with methylene chloride, and evaporated to dryness. The residue is partitioned between hexane and acetonitrile, cleaned up on a silicic acid column and determined by GLC using a flame photometric detector sensitive to phosphorus. The sensitivity is reported to be sensitive to 0.01 ppm for chlorpyrifos in milk and cream. Milk and cream samples, fortified with chlorpyrifos at levels of 0.01-0.1 ppm, yielded average recoveries of $88 \pm 6\%$ (milk) and $88 \pm 9\%$ (cream) at 95% confidence limits.

The above method is similar to that tested successfully on beef fat (PP# 3F1306). However, the modifications include the initial extraction with methylene chloride and determination by GLC using a flame photometric detector.

A second method used for chlorpyrifos in milk and cream is essentially the same as that successfully tested in PP# 3F1306 on beef fat. A method sensitivity of 0.01 ppm is reported. Milk and cream samples, fortified at 0.01-0.1 ppm, yielded average recoveries of $86 \pm 4\%$ (milk) and $87 \pm 16\%$ (cream) at the 95% confidence limit.

The analysis for TCP residues was essentially the same as that method successfully tested in PP# 3F1306 for TCP in beef fat. The levels of sensitivity is reported as 0.01 ppm in milk and 0.025 ppm in cream. Milk and cream samples, fortified at levels of 0.01-5 ppm, yielded average recoveries of $85 \pm 4\%$ (milk) and $83 \pm 4\%$ (cream) at 95% confidence limit.

The feeding study shows that residues tend to store in the fat portion of the milk (cream) when present. Moreover, residues could be present from the lower feeding levels (0.3 ppm and 3 ppm), but are too small to be detected. Therefore, we conclude that it is not possible to establish with certainty whether finite residues will be incurred in milk, but there is a reasonable expectation of finite residues [§180.6(a)(2)]. Consequently, a tolerance is warranted to cover such residues as might occur. A tolerance level of 0.25 ppm in milk fat (reflecting residues in whole milk of 0.01 ppm) is appropriate.

The petitioner should be so informed.

In another study, cattle were fed chlorpyrifos in their daily diet for 30 days at levels of 3, 10, 30, or 100 ppm. Samples of muscle, liver, kidney, omental fat, renal fat, and subcutaneous fat were collected and analyzed for residues of chlorpyrifos, its oxygen analog, and TCP.

No residues of the oxygen analog were detected in any tissue from any feeding level.

Residues of chlorpyrifos were noted mainly in the fatty tissue and appeared at the 3 ppm feeding level (<0.01-0.05 ppm). Residues increased with increasing feeding levels.

For TCP, residue appeared in the liver and kidney at the 3 ppm level, but in other tissues only at higher levels. Maximum residue levels at the 3 ppm feeding level were 0.23 ppm (liver) and 0.15 ppm (kidney). Residues were higher at higher feeding levels.

The feeding study indicates that residues of chlorpyrifos and TCP could occur in the meat, fat, and meat byproducts of cattle under the proposed use [§180.6(a)(2)].

Pigs were fed chlorpyrifos in the daily diet at levels of 1, 3, and 10 ppm for 30 days. Samples of muscle, liver, kidney, omental fat, renal fat, and subcutaneous fat were analyzed for residues of chlorpyrifos and TCP. Like the cattle study, residues of chlorpyrifos concentrated in the fat, while residues of TCP were predominant in the liver and kidney. Maximum chlorpyrifos levels were in the fat and were 0.02 ppm at the 1 ppm feeding level; 0.04 ppm at the 3 ppm feeding level; and 0.22 ppm at the 10 ppm feeding level.

Residues of TCP in liver and kidney were not detectable (<0.05 ppm) at the 1 ppm feeding level. Maximum residues at the 3 ppm level were 0.08 ppm (liver) and <0.05 ppm (kidney). Maximum residues at the 10 ppm level were 0.3 ppm (liver) and 0.2 ppm (kidney).

The study shows that residues of chlorpyrifos and TCP could occur in the meat, fat, and meat byproduct of hogs [§180.6(a)(2)]. Thus, a tolerance is necessary to cover residues which could occur. In view of the likely ingestion level, we believe that a tolerance level of 0.10 ppm is sufficient to cover such residues as might occur.

The methods for chlorpyrifos and TCP in fat and meat tissues are similar to those methods tested successfully on beef fat in PP# 3F1306. Some minor modifications include the change in initial extraction solvent: fat tissues with hexane; muscle tissue with acetone; and liver and kidney tissues with methylene chloride. Residues are determined with thermionic detection which is sensitive to phosphorus. The methods' sensitivities are reported as 0.01 ppm for chlorpyrifos and 0.05 ppm for TCP.

In view of the similarities between methods used in the feeding studies for meat and milk and those successfully tested in PP# 3F1306 on beef fat, we believe that the results of the successful tests can be extended to include milk and tissues as well as fat.

Considering the foregoing studies, we believe that a tolerance is warranted to cover residues which could occur in livestock in general (except poultry) under the proposed use. As a result, the tolerance could be appropriately expressed as follows:

0.1 ppm fat, meat and meat byproducts in goats, hogs, horses, and sheep.

The pending tolerance for cattle reflecting dermal applications is also adequate to cover residues resulting from the presently proposed use.

Adequate analytical methods are available to enforce these tolerances as well as the milk tolerance.

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ELC 5/3/74