JAN 10 1997

MEMORANDUM

SUBJECT: **Carbofuran.** Storage Stability in Various Laboratory Fortified Crop and Animal Matrices, Magnitude of the Residue in Field Corn, Bell Peppers, Rice, and Sugarcane, and Magnitude of the Residue in Processed Commodities of Field Corn, Potatoes, Rice, and Sugarcane.
DP Barcodes: D221430, D221439, D221443, D221447, D221462, D221463, D221470, D221471, D222844, D222845, D222861; CBRS Nos. 16637, 16641, 16634, 16640, 16702, 16693, 16697, 16639, 16913, 16912, and 16915. MRID Nos.: 438426-01, 438427-01, 438429-01, 438510-01, 438546-01, 438517-01, 438523-01, 438524-01, 439076-01, 439077-01, and 439078-01; Case No. 0101.

FROM: David J. Miller, HSO, US Public Health Service
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Chemistry Branch II--Reregistration Support
Health Effects Division (7509C)

THRU: R.B. Perfetti, Ph.D., Acting Branch Chief
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TO: Paula Deschamp, Section Head
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Risk Characterization and Analysis Branch (7509C)

Attached is a review of storage stability, field trial, and processing studies for carbofuran. The studies were submitted by FMC Corporation. This information was reviewed by Dynamac Corporation under the supervision of CBRS/HED. The data assessment has undergone

secondary review in the Branch and has been revised to reflect Agency policies.

CBRS makes the following conclusions with respect to the submitted studies:

- Adequate validation data have been submitted which support the residue analytical methods used in the field trials.

- The supplemental storage stability data are adequate. The data are sufficient to allow CBRS to conclude that carbofuran and its carbamate metabolites are generally stable in raw agricultural commodities for up to 24-26 months of frozen storage. CBRS has no storage stability concerns associated with the current submissions.

- The submitted data indicate that the established 5 ppm tolerance for carbofuran carbamate metabolites in/on corn forage may be too low and the established 25 ppm tolerance for total carbofuran residues (carbamates + phenols) may be too high. The registrant must propose increased tolerances for residues of carbofuran (carbamate) and carbofuran (total) of 8 ppm and 20 ppm, respectively.

- The submitted field trial data are inadequate to satisfy reregistration requirements for bell peppers because field trials were not conducted at the maximum registered use pattern of carbofuran on bell peppers. The registrant stated that the subject field trials were conducted at reduced rates in keeping with EPA's desire for risk mitigation to the environment. The registrant must modify the labels for SLN Nos. AZ910001 and TX930011 to reflect the use pattern used in the submitted field trials. In addition, the registrant must submit data from an additional field trial conducted in AZ to fulfill the requirements for geographic representation. If the registrant wishes to pursue a federal registration of the 4 lb/gal FlC formulation on peppers, then two additional field trials with bell peppers must be conducted in Regions 5 and 10.

- The submitted rice field trial data reflect application of the 4 lb/gal FlC formulation to rice. Currently, only granular formulations are registered for use on rice and these uses are being phased out. The registrant must propose a use pattern for the 4 lb/gal FlC formulation on rice before the submitted data can be evaluated. If the registrant wishes to rely on the submitted data, additional field trials with rice must be conducted in Regions 4 (9 trials), 5 (1 trial), and 6 (1 trial) for adequate geographic representation.

- The submitted field trial data on sugarcane indicated that the established 0.1 ppm tolerance may be too low. No maximum seasonal rate for use of carbofuran on sugarcane is specified on the product label and the submitted data do not reflect the 17 day PHI specified on the label. The registrant must modify the existing

product label to match the application rates/timing used in the field trials and propose to increase the established tolerance to 0.2 ppm.

- The submitted corn processing data in conjunction with previous corn processing submissions indicate that carbofuran residues of concern do not concentrate in corn flour, corn starch, grits, meal, or refined oil (wet and dry processing). CBRS concludes that no tolerances are required for carbofuran residues of concern in field corn processed commodities.

- The submitted potato processing data are adequate and indicate that total residues of carbofuran metabolites concentrate in chips and granules, but do not concentrate in wet peel processed from potatoes bearing detectable residues of carbofuran and/or its metabolites. The maximum expected residues in potato chips, however, do not exceed the established tolerance for potatoes and no tolerance is necessary for potato chips. A tolerance for residues of carbofuran, its carbamate metabolite, and phenol metabolites is required for potato granules/flakes; the submitted data will support a tolerance of 6 ppm (of which no more that 2 ppm are carbamates).

- The submitted rice processing data indicate that total residues of carbofuran concentrate in hulls (at least 2x) and bran (5x), but do not concentrate in polished rice processed from rice grain bearing detectable residues of carbofuran and/or its metabolites. Since field trial data for rice remain outstanding, appropriate levels for tolerances for rice hulls and rice bran will be determined when this material is submitted.

- The submitted sugarcane processing data indicate that total residues of carbofuran concentrate in molasses (5.5x), but do not concentrate in sugar processed from sugarcane bearing detectable residues of carbofuran and/or its metabolites. A tolerance for residues of carbofuran, its carbamate metabolite, and phenol metabolites in sugarcane molasses is required. The submitted data will support a tolerance of 1 ppm.

If you need additional information, please advise.

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cc: RF, SF, List A Rereg. File, Circ., DJM.
RDI: Pilot Team: 1/8/97;RPerfetti: 1/9/97.

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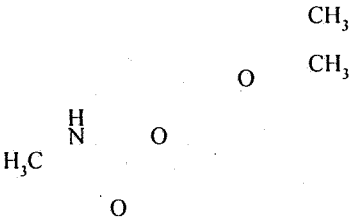
CARBOFURAN



Shaughnessy No. 090601; Case No. 0101

(CBRS No. 16634, DP Barcode D221443; CBRS No. 16637, DP Barcode D221430; CBRS No. 16639, DP Barcode D221471; CBRS No. 16640, DP Barcode D221447; CBRS No. 16641, DP Barcode D221439; CBRS No. 16693, DP Barcode D221463; CBRS No. 16697, DP Barcode D221470; CBRS No. 16702, DP Barcode D221462; CBRS No. 16912, DP Barcode D222845; CBRS No. 16913, DP Barcode D222844; CBRS No. 16915, DP Barcode D222861)

REGISTRANT'S RESPONSE TO RESIDUE CHEMISTRY DATA REQUIREMENTS

BACKGROUND

In response to the Carbofuran Reregistration Standard Update, dated 1/9/91, and the EPA Data Call-In (DCI) Notice, dated 3/9/92, FMC Corporation has submitted data depicting the magnitude of carbofuran residues in/on field corn (1990; MRID 43907701), bell peppers (1995; MRID 43852401), rice (1993; MRID 43851001), sugarcane (1992; MRID 43907601), and processed commodities of field corn (starch; 1995; MRID 43851601), potatoes (1995; MRID 43851701), rice (1995; MRID 43852301), and sugarcane (1992; MRID 43907801). In addition, a description and method validation data for a residue analytical method for various crops and animal commodities (1989; MRID 43842701) and storage stability data for carbofuran and its carbamate and phenolic metabolites in/on various crop and animal commodities (1989; MRID 43842601, and 1994; MRID 43842901) have been submitted. Data from these submissions are evaluated herein for adequacy in fulfilling residue chemistry data requirements for the reregistration of carbofuran. The Conclusions and Recommendations stated below pertain only to the above submissions. All other residue chemistry data requirements stated in the Carbofuran Update and the Carbofuran DCI Notice are not addressed herein.

Since the issuance of the Carbofuran Update, most uses of granular carbofuran have been discontinued (56 FR 64621, 12/11/91) because of adverse effects to avian species. Use of granular carbofuran on rice was to have been phased out by 8/31/95; however, because no effective alternative was registered, an extension of the use has been allowed.

The qualitative nature of carbofuran residues in plants is not adequately understood; additional data regarding the components in an extract of soybean hay are required. The qualitative nature of the residue of carbofuran in animals is adequately understood based on acceptable studies conducted on ruminants and poultry. CBRS tentatively concluded, pending receipt of the outstanding plant metabolism data, that the residues of concern in plant and animal commodities are the residues which are currently regulated, i.e., parent carbofuran and its metabolites 3-hydroxy-carbofuran, 7-phenol-carbofuran, 3-hydroxy-7-phenol carbofuran, and 3-keto-7-phenol-carbofuran. The HED Metabolism Committee has concluded that field trials must include analysis for the regulated metabolites as well as the metabolite 3-keto carbofuran.

Tolerances are established [40 CFR §180.254 (a), (b), and (c), §185.600, and §186.600] for the combined residues of carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl-*N*-methylcarbamate), its carbamate metabolite 3-hydroxy carbofuran (2,3-dihydro-2,2-dimethyl-3-hydroxy-7-benzofuranyl-*N*-methylcarbamate), and its phenolic metabolites 7-phenol carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranol), 3-keto-7-phenol carbofuran (2,3-dihydro-2,2-dimethyl-3-oxo-7-benzofuranol), and 3-hydroxy-7-phenol carbofuran (2,3-dihydro-2,2-dimethyl-3,7-benzofurandiol), in or on various raw agricultural commodities, food, and feed items. All tolerances, except those for bananas, sugar beets, coffee beans, rice, sorghum grain, and sugarcane, specify a maximum level for carbamate residues in/on the commodity.

Analytical methods are available for the determination of carbofuran and its regulated metabolites. These methods (Methods I through X and Methods A through C) are located in PAM Vol. II, Section 180.254.

Codex MRLs are expressed as the sum of carbofuran and 3-hydroxy carbofuran. Issues pertaining to compatibility of U.S. tolerances with Codex MRLs will be addressed at the issuance of the RED.

CONCLUSIONS AND RECOMMENDATIONS

Residue Analytical Methods

1. The submitted validation data indicate that GC method P-2163M is adequate for the determination of residues of carbofuran and its carbamate metabolites in/on alfalfa forage and hay, field corn grain and silage, oranges, peanut nutmeat, peanut hulls, potatoes, sorghum stalk, sugar beet roots and tops, milk, and cattle muscle.

Storage Stability

2. The supplemental storage stability data reflecting the stability of carbofuran and its carbamate metabolites in various plant and animal commodities are adequate. The data are sufficient to allow CBRS to conclude that carbofuran and its carbamate

metabolites are generally stable in raw agricultural plant and animal commodities during up to 24-26 months of frozen storage. CBRS has no storage stability concerns with the present submissions.

Magnitude of the Residue in Plants

3. The submitted corn forage field trial data indicate that the established 5-ppm tolerance for residues of carbofuran carbamate metabolites in/on corn forage may be too low. The registrant must propose an increased tolerance for residues of carbofuran carbamates and total carbofuran (carbamates + phenols) in/on field corn forage and field corn stover. Based on the results of the present field trials (including those conducted in CA) and the previously-submitted field corn data on silage, CBRS will recommend a tolerance of 8 ppm for forage and stover (carbamates only) and a tolerance of 20 ppm for forage and stover (carbamates + phenols).

4. The submitted bell pepper field trial data are inadequate to satisfy reregistration requirements because field trials were not conducted at the maximum registered use pattern of carbofuran on bell peppers (a maximum of two sequential applications at 2 and 3 lb ai/A with a 21-day PHI). The registrant stated in the transmittal letter (MRID 43852400) that the subject field trials were conducted at reduced rates in keeping with EPA's desire for risk mitigation to the environment. The registrant must modify the labels for SLN Nos. AZ910001 and TX930011 to reflect the use pattern used in the submitted field trials. In addition, the registrant must submit data from an additional field trial conducted in AZ to fulfill the requirements for geographic representation. If the registrant wishes to pursue a federal registration of the 4 lb/gal FlC formulation on peppers, then two additional field trials with bell peppers must be conducted in Regions 5 and 10.

5. The submitted rice field trial data reflect application of the 4 lb/gal FlC formulation to rice; currently only granular formulations are registered for use on rice and these uses are being phased out. The registrant must propose a use pattern for the 4 lb/gal FlC formulation on rice before the submitted data can be evaluated. If the registrant wishes to rely on the submitted data, additional field trials with rice must be conducted in Regions 4 (9 trials), 5 (1 trial), and 6 (1 trial) for adequate geographic representation.

6. The submitted sugarcane field trial data indicate that the established 0.1-ppm tolerance may be too low. No maximum seasonal rate for use of carbofuran on sugarcane is specified on the product label and the submitted data do not reflect the 17-day PHI specified on the label. The registrant must modify the existing product label (EPA Reg. No. 279-2876) to reflect the use pattern used in the submitted field trials and propose to increase the established tolerance to 0.2 ppm.

Magnitude of the Residue in Processed Food/Feed

7. The submitted corn processing data indicate that individual residues of carbofuran metabolites of concern do not concentrate in starch processed from field corn grain bearing detectable residues of 3-OH-carbofuran and 3-OH-7-Ph carbofuran following treatment at an exaggerated rate. The previously submitted field corn processing data indicated that carbofuran residues of concern do not concentrate in corn flour, grits, meal and refined oil (dry processing) and refined oil (wet processing). CBRS concludes that no tolerances are required for carbofuran residues of concern in field corn processed commodities.

8. The submitted potato processing data are adequate and indicate that total residues of carbofuran metabolites of concern concentrate in chips (>1x) and granules but do not concentrate in wet peel processed from potatoes bearing detectable residues of 7-Ph carbofuran following treatment at an exaggerated rate. Previously submitted potato processing data indicated that the combined residues of carbofuran carbamate and phenol metabolites concentrate in potato flakes up to 5x and in potato chips up to 1.5x. Based on an HAFT of 1.34 ppm and average concentration factors of 4x (granules/flakes) and 1.5x (chips) for total carbofuran residues of concern, the maximum expected residues in potato granules/flakes and chips would be calculated to be 5.4 ppm and 2.0 ppm, respectively. The maximum expected residues for potato chips do not exceed the established tolerance for potatoes and no tolerance is required; however, the maximum expected residues for potato granules/flakes do exceed the established tolerance for potatoes. Based on a HAFT for carbamate residues of 0.75 ppm and an estimated concentration factor for carbamates of 1.8x, the maximum expected residue level for carbamates in potato granules/flakes is 1.4 ppm. A tolerance for residues of carbofuran, its carbamate metabolite, and phenol metabolites in potato granules/flakes is required; the submitted data will support a tolerance of 6 ppm (of which no more than 2 ppm is carbamates).

9. The submitted rice processing data indicate that total residues of carbofuran metabolites of concern concentrate in hulls (at least 2x) and bran (5x) but do not concentrate in polished rice processed from rice grain bearing detectable residues of carbofuran, 3-OH carbofuran, 7-Ph carbofuran, and 3-OH-7-Ph carbofuran following treatment at an exaggerated rate. Field trial data for rice grain remain outstanding. When adequate rice field trial data have been submitted and evaluated, appropriate levels for tolerances for rice hulls and bran will be determined.

10. The submitted sugarcane processing data are adequate and indicate that total residues of carbofuran metabolites of concern concentrate in molasses (5.5x) but do not concentrate in sugar processed from sugarcane bearing detectable residues of carbofuran, 3-OH-carbofuran, 7-Ph carbofuran, and 3-OH-7-Ph carbofuran following treatment at an exaggerated rate. Based on an HAFT of <0.11 ppm and

concentration factor of 5.5x for total carbofuran residues of concern, the maximum expected residues in sugarcane molasses would be calculated to be <0.61 ppm, which exceeds the reassessed tolerance (0.2 ppm) for sugarcane. A tolerance for residues of carbofuran, its carbamate metabolite, and phenol metabolites in sugarcane molasses is required; the submitted data will support a tolerance of 1.0 ppm.

DETAILED CONSIDERATIONS

Residue Analytical Methods

FMC submitted (1989; MRID 43842701) a description and validation data for a GC method for the analysis of carbofuran and its carbamate metabolites, 3-keto carbofuran (3-keto) and 3-hydroxy carbofuran (3-OH) in/on crop and animal matrices. The method, P-2163M, is entitled "Method for the Analysis of Carbofuran and its Carbamate Metabolites on Various Crop and Animal Matrices." This method differs from the GC method discussed in the Carbofuran Update (P-1416M) in that this method reduces the amount of sample cleanup required prior to analysis. Briefly, samples are ground and acid hydrolyzed in 0.25 N HCl at reflux for 1 hour. Sodium chloride and a 4% sodium lauryl sulfate solution are added to an aliquot of the hydrolysate, and the solution is partitioned three times with dichloromethane (DCM). The DCM extracts are combined, a 10% solution of mineral oil in ethyl acetate is added, and the solution is concentrated in a steam bath. The sample is redissolved and concentrated twice in hexane. The concentrated sample in hexane is applied to a Florisil solid-phase extraction (SPE) column. Residues are eluted with ethyl acetate, concentrated, and redissolved in ethyl acetate. Carbofuran and its carbamate residues are quantitated using a GC equipped with a nitrogen-phosphorous detector (NPD) or mass-selective detector (MSD). Representative chromatograms were included in the submission.

The following limits of detection/limits of quantitation (LODs/LOQs) were reported: 0.1/0.5 ppm for field corn grain and stover, oranges, peanut nutmeat, potatoes, sugar beet roots, milk, and cattle muscle; 0.2/1.0 ppm for alfalfa forage, field corn forage and silage, sorghum stalk, and sugar beet tops; 0.4/2.0 ppm for peanut hulls; 0.5/2.5 ppm for alfalfa hay; 1.6/8.0 ppm for 3-OH only in alfalfa forage; and 4.0/20.0 ppm for 3-OH only in alfalfa hay.

Method validation data were submitted for samples of various crop and animal commodities fortified with carbofuran, 3-keto, and 3-OH at 0.5-20 ppm. Recoveries are reported in Table 1a. These data indicate that GC method P-2163M is adequate for the determination of residues of carbofuran and its carbamate metabolites in/on alfalfa forage and hay, field corn grain and silage, oranges, peanut nutmeats, peanut hulls, potatoes, sorghum stalk, sugar beet roots and tops, milk, and cattle muscle.

Table 1a. Method recoveries of carbofuran and its carbamate metabolites from fortified (0.5-20 ppm) samples of various commodities analyzed using method P-2163M.

Commodity [a]	Percent Method Recoveries for Carbofuran Carbamates		
	Carbofuran	3-keto	3-OH
Alfalfa, forage	82, 82	104, 104	89, 89
Alfalfa, hay	75, 86	82, 90	79, 83
Field corn, grain	73, 84	77, 79	77, 77
Field corn, silage	71, 93	72, 101	86, 108
Oranges	86, 89	93, 96	82, 84
Peanut, nutmeat	90, 100	104, 108	84, 89
Peanut, hulls	82, 98	111, 119	97, 110
Potatoes	124, 130	132, 139	132, 139
Sorghum, stalk	88, 89	90, 100	101, 102
Sugar beet, tops	96, 98	112, 116	113, 115
Sugar beet, roots	86, 91	84, 99	108, 118
Milk	80, 81	84, 85	86, 89
Muscle (cattle)	103, 127	108, 130	116, 147

[a] Alfalfa forage and hay, oranges, peanut hulls, sorghum stalk, and sugar beet roots and tops were analyzed by GC/NPD. The remaining commodities were analyzed by GC/MS.

Field corn forage, silage, and stover samples, and samples of various raw agricultural commodities from the storage stability study (MRID 43842601) were analyzed for residues of carbamates using the GC/NPD method discussed above (P-2163M). All other raw agricultural and processed commodity samples from the submitted field trial and processing studies and sorghum storage stability study were analyzed by FMC Corporation (Princeton, NJ) for residues of carbofuran, 3-keto, and 3-OH using an HPLC method with fluorescence detection, and for residues of 7-phenol-carbofuran (7-Ph), 3-hydroxy-7-phenol-carbofuran (3-OH-7-Ph), and 3-keto-7-phenol-carbofuran (3-keto-7-Ph) using GC/MS methods.

Briefly, samples were ground, acid hydrolyzed (in 0.25 N HCl at reflux for 1 hour), and stored under refrigeration (~8 C) until separately analyzed for carbamates and phenols. For the HPLC determination of carbamates, the hydrolysate was applied to a C_{18} solid-phase extraction (SPE) column coupled to an amino-propyl SPE cartridge. Residues were eluted with 1% methanol in dichloromethane (DCM), evaporated to dryness, and redissolved in acetonitrile (ACN) for analysis by HPLC using a C-18 column, a gradient mobile phase of ACN and water, a postcolumn reactor specific for carbamates, and a fluorescence detector. The LOQs for carbamates were 0.05 ppm (bell peppers, potato, rice grain and straw, and the processed commodities of potatoes) and 0.03 ppm (sugarcane and the processed commodities of corn, rice,

and sugarcane). The LODs for carbamates were 0.01 ppm (bell peppers, potato, rice grain and straw, sugarcane, and the processed commodities of corn, potato, rice, and sugarcane).

For the determination of phenolic metabolites in all samples except field corn forage, silage, and stover, rice grain and straw (field trial samples only), and sugarcane and its processed commodities, the hydrolysate was applied to a C_{18} SPE cartridge. Residues were eluted with 5% ethanol (EtOH) in DCM and partitioned twice with 0.25 N sodium hydroxide. The combined sodium hydroxide fractions were then derivatized with pentafluorobenzyl bromide (PFBB) in isopropanol (at 55 C for 45 minutes) and partitioned twice with hexane. The hexane fraction was dried with sodium sulfate, EtOH was added, and the hexane was evaporated. The EtOH was acidified with concentrated HCl to ethylate the 3-hydroxy-7-phenol PFBB derivative. After the addition of water, the ethylated mixture was re-partitioned with hexane three times. The hexane fractions were combined, concentrated and redissolved in EtOH prior to analysis by GC/MS using a DB-5 fused silica capillary column; for rice bran samples, the combined hexane fractions were cleaned up on a silica gel SPE column prior to concentration.

For the determination of phenolic metabolites in rice grain and straw (field trial samples only), the hydrolysate was applied to a C_{18} SPE cartridge. Residues were eluted with DCM, isopropanol was added to the eluate, and the eluate was concentrated. The concentrated extract was then cleaned up on a Diol SPE column and partitioned with 0.25 N sodium hydroxide. Residues were then derivatized with PFBB in isopropanol and partitioned twice with hexane. The hexane fractions were concentrated to near dryness and then redissolved in hexane prior to cleanup on a Florisil SPE column; residues were eluted with 35% ethyl acetate in hexane. The eluate was concentrated and redissolved in hexane prior to analysis by GC/MS.

Samples of field corn forage, silage, and stover, sugarcane, and sugarcane processed commodities were analyzed for residues of phenolic metabolites using method P-1416M, which was described in the Carbofuran Update (MRID 00160770); this method does not involve derivatization of phenols with PFBB. Briefly, the method involves acid hydrolysis of samples, a DCM:ether partition, ethoxylation, a base partition, and silica gel column cleanup prior to analysis by GC/MS.

The LOQs for phenols were 0.05 ppm (bell peppers, potatoes, rice grain and straw, and the processed commodities of potatoes) and 0.03 ppm (sugarcane, and the processed commodities of corn, rice, and sugarcane). The LODs for phenols were 0.01 ppm (bell peppers, potato, rice grain and straw, sugarcane, and the processed commodities of corn, potato, rice, and sugarcane).

Concurrent method recovery analyses were conducted by FMC Corporation (Princeton, NJ) to determine the suitability of the methods for residue data collection purposes. Untreated samples of RACs from the respective field trials and processed fractions from the processing studies were separately fortified with carbamates and phenols at various levels. Representative chromatograms, sample calculations, and standard curves were provided. The recovery data are presented in Table 1b. These data suggest that the methods are adequate for data collection for

carbofuran and its carbamate and phenolic metabolite residues in/on bell peppers, field corn (forage, silage, and stover), potato, rice (grain and straw), sugarcane, and the processed commodities of corn (starch), potatoes (chips, granules, and wet and dry peel), rice (polished rice, hulls, and bran), and sugarcane (bagasse, sugar, and molasses).

(continued; footnotes follow)

Table 1b. Concurrent method recoveries of carbofuran and its carbamate and phenol metabolites from fortified samples of various commodities from the submitted storage stability, field trial, and processing studies.

Commodity	Fortification Level (ppm)		Percent Recovery [a]					
			Carbamates			Phenols		
	Carbamates	Phenols	Carbofuran	3-keto	3-OH	7-Ph	3-keto-7-Ph	3-OH-7-Ph
Corn, field, forage	1.0	1.0	73-118 (3)	87-118 (3)	63; 96, 116	60-67 (3); 71-81 (3)	80-110 (5); 128	74-94 (6)
Corn, field, silage	0.5, 1.0	0.5, 1.0	71-104 (5)	77-99 (3); 126, 128	67, 68; 74-95 (3)	52, 53; 73-91 (5)	65; 76-97 (5); 122	66, 67; 73-116 (5)
Corn, field, stover	0.5	0.5	57, 63; 74	84-106 (3)	65; 78, 86	42-68 (6)	79-103 (6)	64; 71-102 (5)
Corn, field, grain (processing)	0.03, 0.1	0.03, 0.10	77-89 (4)	80-98 (4)	86-112 (4)	73-80 (4)	102-113 (4)	72-84 (4)
Corn, starch	0.03-0.1	0.03, 0.10	99, 101	77, 85	74, 91	68 (2)	102 (2)	122, 123
Peppers, bell	0.05, 0.1	0.05-1.0	74-90 (4)	75-96 (4)	70-82 (4)	71-95 (5)	90-111 (4); 129	93-120 (5)
Potato, tubers (processing)	0.05, 0.10	0.05, 0.10	77, 82	100, 109	81 (2)	81, 99	83, 102	64; 82
Potato, chips	0.05, 0.10	0.05, 0.10	68; 79	83, 90	69; 77	57, 65	72, 89	80, 97
Potato, granules	0.05, 0.10	0.05, 0.10	80, 82	66; 100	75, 94	93, 105	89, 97	84, 94
Potato, wet peel	0.05, 0.10	0.05, 0.10	72, 73	87, 90	79, 90	123, 126	102, 104	106, 110
Potato, dry peel	0.05, 0.10	0.05, 0.10	70, 77	82, 89	66; 70	91, 98	90, 105	86, 89
Rice, grain	0.05, 0.10	0.05, 0.10	73-99 (5)	72-102 (5)	80-102 (5)	69; 71-77 (4)	73-106 (5)	99-117 (3); 121, 134
Rice, straw	0.1, 0.5	0.05-1.0	65, 68; 81-82 (3)	74-87 (5)	80-109 (5)	66; 72-79 (6)	68; 71-113 (6)	85-119 (6); 145 [b]
Rice, grain (processing)	0.03, 0.10	0.03, 0.10	72-87 (4)	66; 73-95 (3)	75-101 (4)	64, 68; 73, 74	88-111 (4)	97-104 (3); 124
Polished rice	0.03, 0.10	0.03, 0.10	78, 92	65; 99	69; 85	71, 91	69; 85	100, 101
Rice hulls	0.03, 0.10	0.03, 0.10	62, 64	72, 76	73, 79	53, 54	91, 92	96, 105
Rice bran	0.03, 0.10	0.03, 1.00	73, 81	87, 102	93 (2)	95-103 (3)	74-105 (3)	91-103 (3)
Sorghum, silage	0.1-4.0	0.2-2.0	70-99 (15)	64; 78-109 (14)	79-94 (15)	67; 71-116 (17)	64, 69; 71-115 (13); 124-132 (3)	68; 78-119 (16); 121
Sorghum, grain	0.03-8.0	0.03-1.0	74-97 (14)	67; 77-109 (14)	69; 70-103 (14)	63, 64; 71-110 (15)	67, 69; 73-119 (14); 123, 124	65-69 (4); 71-108 (14)
Sorghum, fodder	0.2-25.0	0.2-4.0	72-96 (15)	82-109 (15)	68 (2); 72-94 (13)	60, 61; 72-109 (18)	81-120 (18)	67, 68; 72-111 (15); 138
Sugarcane	0.03, 0.10	0.03	79-102 (11)	76-100 (11)	77-97 (11)	76-113 (9); 124	77-119 (9); 122	83-118 (9); 130
Sugarcane (processing)	0.03-0.2	0.03, 0.06	71-98 (8)	64, 68; 73-93 (6)	80-96 (8)	74-113 (5)	96-115 (4); 126	80-108 (4); 136
Sugarcane bagasse	0.03-1.0	0.06, 0.5	66-69 (4); 77	66; 70-83 (4)	79-94 (5)	63, 67; 90	69; 84, 109	61; 75, 98
Sugarcane, sugar	0.03, 0.06	0.03-0.50	84-89 (3)	76-83 (3)	78-91 (3)	114, 116; 121	112; 120, 127	87-93 (3)
Sugarcane, molasses	0.03, 0.06	0.06-1.0	75-81 (3)	62, 63; 80	84-109 (3)	106-111 (3); 124	101, 120; 127, 134	75-98 (4)

(continued; footnotes follow)

Table 1b *(continued)*.

[a] Each recovery value represents one sample unless otherwise indicated in parentheses; recovery values outside the acceptable 70-120% range are listed separately.
[b] The registrant considers this value to be an outlier based on the other recovery values.

Storage Stability Data

The registrant has submitted (1989; MRID 43842601) supplemental storage stability data for carbofuran and its carbamate metabolites in/on various raw agricultural and animal commodities. Untreated samples from field trials and animal studies were homogenized and fortified with carbofuran, 3-keto, and 3-OH at 0.5-20.0 ppm. The spiking solvent was evaporated, and fortified and unfortified samples were stored at -18 C. Data from the 9- to 11-month storage intervals were presented in the Carbofuran Update. Recoveries of carbofuran carbamate residues from samples following 24-26 months of frozen storage are presented in Table 2a. Samples were analyzed using method P-2163M described in "Residue Analytical Methods." The registrant stated that the averages of the fresh fortified recoveries were used to correct the residue levels in the storage stability samples. The registrant reported the same fresh fortified recoveries for the 24- to 26-month data as were reported for the method validation study (see "Residue Analytical Methods"). Because the actual recovery values used to correct the storage stability results could not be determined by the study reviewer, only the corrected storage stability recoveries are presented in Table 2a.

Table 2a. Storage stability of residues of carbofuran and its carbamate metabolites in/on fortified samples of various raw agricultural and animal commodities during frozen storage.

Commodity	Storage Period (months)	Analyte	Fortification Level (ppm)	Corrected Recovery in Stored Samples (%) [a]
Alfalfa, forage	26	carbofuran	1.0	83, 92, 96
		3-keto	1.0	94, 94, 111
		3-OH	8.0	91, 101, 105
Alfalfa, hay	26	carbofuran	2.5	82, 97, 104
		3-keto	2.5	85, 94, 101
		3-OH	20.0	85, 93, 122
Field corn, grain	26	carbofuran	0.5	102, 116, 122
		3-keto	0.5	106, 110, 116
		3-OH	0.5	88, 108, 118
Field corn, silage	26	carbofuran	1.0	102, 105, 109
		3-keto	1.0	99, 116, 120
		3-OH	3.0	97, 103, 105
Orange	24	carbofuran	0.5	106, 106, 110
		3-keto	0.5	94, 98, 100
		3-OH	0.5	80, 98, 100
Peanut, nutmeat	24	carbofuran	0.5	62, 92, 94
		3-keto	0.5	52, 88, 94
		3-OH	0.5	54, 124, 128
Peanut, hulls	24	carbofuran	2.0	110, 114, 124
		3-keto	2.0	83, 86, 98
		3-OH	2.0	96, 101, 115
Potato, tubers	26	carbofuran	0.5	84, 86, 88
		3-keto	0.5	72, 74, 78
		3-OH	0.5	74, 82, 82
Sorghum, stalk	26	carbofuran	1.0	87, 91, 101
		3-keto	1.0	85, 87, 90
		3-OH	1.0	78, 80, 80
Sugar beet, tops	26	carbofuran	1.0	85, 85, 88
		3-keto	1.0	34, 45, 58
		3-OH	1.0	75, 80, 81
Sugar beet, root	26	carbofuran	0.5	92, 96, 108
		3-keto	0.5	68, 68, 80
		3-OH	0.5	92, 92, 106
Milk	26	carbofuran	0.5	92, 100, 102
		3-keto	0.5	84, 88, 94
		3-OH	0.5	74, 88, 124

(continued; footnotes follow)

Table 2a *(continued)*.

Commodity	Storage Period (months)	Analyte	Fortification Level (ppm)	Corrected Recovery in Stored Samples (%) [a]
Muscle (cattle)	26	carbofuran	0.5	64, 76, 84
		3-keto	0.5	60, 74, 82
		3-OH	0.5	62, 66, 80

[a] Storage stability results were corrected by the registrant using the average of the fresh fortification recovery analyses.

The registrant also submitted (1994; MRID 43842901) storage stability data for weathered residues of carbofuran and its carbamate and phenolic metabolites in/on sorghum commodities in support of the sorghum field trials. Sorghum silage, grain, and fodder samples from a field trial where carbofuran (Furadan 4F) was applied at an exaggerated rate [5.5x; 3.0 lb ai/A at-planting application plus 2 (silage) or 4 (grain and fodder) foliar applications at 2.0 lb ai/A/application] were frozen at the field and shipped to FMC Laboratories (Princeton, NJ). Samples were ground with liquid nitrogen and stored frozen (-18 C) until analysis. Samples were analyzed within two days of harvest for the 0-time point, and again at 2-3, 4-8, 12, and 24-26 months after frozen storage. At each storage interval the samples were acid hydrolyzed, and the hydrolysates were stored refrigerated (~8 C) until analysis was completed (maximum of 3 months). Adequate storage stability data demonstrating that carbofuran and its metabolites are stable in acid hydrolysates in various RACs for up to 8 months for carbamate residues and 6 months for phenol residues have previously been submitted (CBRS Nos. 16638, 16694, 16695, 16914, and 17452; DP Barcodes D221473, D221469, D221465, D223210, and D221476, currently under review at CBRS). Samples were analyzed for carbamates using the HPLC method, and samples were analyzed for phenols using method P-1416M. These methods are described in "Residue Analytical Methods" and data from concurrent method recovery analyses are presented in Table 1b. The results of the storage stability study are presented in Table 2b. The registrant stated that residue levels in storage stability samples were not corrected for method recoveries. Because the actual recovery values obtained concurrently with the storage stability samples could not be determined by the study reviewer, only the uncorrected storage stability recoveries are presented in Table 2b.

Table 2b. Storage stability of weathered residues of carbofuran and its carbamate and phenolic metabolites in/on treated samples of sorghum silage, grain, and fodder during frozen storage.

Sorghum Commodity	Storage Interval (months)	Uncorrected Residues in Stored Samples, ppm (% Recovery) [a]					
		Carbamates			Phenols		
		Carbofuran	3-keto	3-OH	7-Ph	3-keto-7-Ph	3-OH-7-Ph
Silage	0	3.53, 3.84, 4.12 (3.83 = 100%)	0.17, 0.30, 0.32 (0.26 = 100%)	0.84, 0.89, 0.96 (0.90 = 100%)	1.27, 1.31, 1.62 (1.40 = 100%)	0.16, 0.18, 0.21 (0.18 = 100%)	0.29, 0.45, 0.53 (0.42 = 100%)
	3	3.67, 3.77, 3.88 (96, 98, 101)	<0.01, <0.01, <0.01 (4, 4, 4)	0.81, 0.87, 0.91 (90, 97, 101)	1.94, 1.95, 2.31 (139, 139, 165)	0.27, 0.29, 0.29 (147, 158, 158)	0.67, 0.68, 0.73 (158, 161, 172)
	5	--	--	--	0.96, 1.14, 1.17 (69, 81, 84)	0.17, 0.17, 0.18 (93, 93, 98)	0.40, 0.40, 0.44 (94, 94, 104)
	6	2.52, 2.54, 2.74 (66, 66, 72)	<0.01, <0.01, <0.01 (4, 4, 4)	0.52, 0.56, 0.62 (58, 62, 69)	1.15, 1.41, 1.53 (82, 101, 109)	0.17, 0.20, 0.22 (93, 109, 120)	0.25, 0.43, 0.49 (59, 102, 116)
	12	--	--	--	1.52, 1.79, 1.85 (109, 128, 132)	0.18, 0.22, 0.24 (98, 120, 132)	0.54, 0.55 (128, 130)
	13	2.83, 3.04, 3.33 (74, 79, 87)	0.04, 0.04, 0.04 (15, 15, 15)	0.63, 0.69, 0.77 (70, 77, 86)	--	--	--
	24	--	--	--	1.17, 1.30, 1.36 (84, 93, 97)	0.21, 0.23, 0.23 (115, 125, 125)	0.25, 0.40, 0.43 (59, 94, 102)
	25	3.41, 3.53, 3.59 (89, 92, 94)	0.04, 0.04, 0.06 (15, 15, 23)	0.76, 0.85, 0.96 (85, 95, 107)	--	--	--
Grain	0	4.72, 5.19, 5.54 (5.15 = 100%)	<0.01, 0.01, 0.01 (0.01 = 100%)	0.20, 0.22, 0.25 (0.22 = 100%)	0.28, 0.31, 0.33 (0.31 = 100%)	0.12, 0.13, 0.14 (0.13 = 100%)	0.16, 0.16, 0.18 (0.17 = 100%)
	2	5.15, 5.59, 5.90 (100, 109, 115)	0.01, 0.01, 0.01 (100, 100, 100)	0.14, 0.15, 0.23 (63, 67, 103)	0.55, 0.59, 0.77 (179, 192, 251)	0.12, 0.12, 0.16 (92, 92, 123)	0.13, 0.14, 0.19 (78, 84, 114)
	4	--	--	--	0.63, 0.69, 0.81 (205, 225, 264)	0.18, 0.23, 0.23 (138, 177, 177)	0.22, 0.27, 0.31 (132, 162, 186)
	8	6.20, 6.33, 6.56 (120, 123, 127)	0.02, 0.02, 0.02 (200, 200, 200)	0.28, 0.28, 0.29 (125, 125, 130)	0.66, 0.70, 0.82 (215, 228, 267)	0.17, 0.19, 0.20 (131, 146, 154)	0.19, 0.19, 0.19 (114, 114, 114)
	12	6.18, 6.99, 7.37 (120, 136, 143)	0.02, 0.02, 0.03 (200, 200, 300)	0.26, 0.27, 0.30 (116, 121, 134)	0.70, 0.83, 0.90 (228, 271, 293)	0.20, 0.22, 0.23 (154, 169, 177)	0.22, 0.22, 0.25 (132, 132, 150)
	26	6.91, 6.92, 8.28 (134, 134, 161)	0.02, 0.02, 0.02 (200, 200, 200)	0.27, 0.32, 0.34 (121, 143, 152)	0.68, 0.69, 0.70 (222, 225, 228)	0.25, 0.25, 0.27 (192, 192, 208)	0.20, 0.22, 0.23 (120, 132, 138)

(continued; footnotes follow)

Table 2b *(continued)*.

Sorghum Commodity	Storage Interval (months)	Uncorrected Residues in Stored Samples, ppm (% Recovery) [a]					
		Carbamates			Phenols		
		Carbofuran	3-keto	3-OH	7-Ph	3-keto-7-Ph	3-OH-7-Ph
Fodder	0	21.8, 22.3, 22.7 (22.3 = 100%)	0.02, 0.03, 0.03 (0.03 = 100%)	0.78, 0.81, 0.83 (0.81 = 100%)	1.45, 1.59, 1.66 (1.57 = 100%)	0.18, 0.21, 0.21 (0.20 = 100%)	0.22, 0.32, 0.32 (0.29 = 100%)
	3	15.4, 17.5, 19.0 (69, 78, 85)	0.03, 0.03, 0.03 (113, 113, 113)	0.68, 0.75, 0.80 (84, 93, 99)	3.12, 3.39, 3.80 (199, 216, 243)	0.20, 0.21, 0.23 (100, 105, 115)	0.67, 0.70, 0.74 (234, 244, 258)
	4	--	--	--	3.30, 3.39, 3.78 (211, 216, 241)	0.23, 0.23, 0.25 (115, 115, 125)	0.60, 0.63, 0.66 (209, 220, 230)
	8	16.1, 16.7, 16.8 (72, 75, 75)	0.02, 0.03, 0.03 (75, 113, 113)	0.37, 0.60, 0.63 (46, 74, 78)	3.07, 3.29, 3.65 (196, 210, 233)	0.18, 0.20, 0.21 (90, 100, 105)	0.28, 0.31, 0.35 (98, 108, 122)
	12	18.0, 19.2, 21.9 (81, 86, 98)	0.03, 0.03, 0.03 (113, 113, 113)	0.76, 0.80, 0.89 (94, 99, 110)	2.49, 2.62, 3.26 (159, 167, 208)	0.19, 0.22, 0.29 (95, 110, 145)	0.51, 0.53, 0.64 (178, 185, 223)
	26	19.3, 19.7, 19.9 (87, 88, 89)	0.03, 0.03, 0.04 (113, 113, 150)	0.89, 0.89, 0.93 (110, 110, 115)	3.46, 3.61, 3.68 (221, 230, 235)	0.24, 0.24, 0.25 (120, 120, 125)	0.33, 0.50, 0.51 (115, 174, 178)

[a] Percent recoveries were calculated by the study reviewer by dividing residue values by the average 0-time residue value.

Study summary: The supplemental storage stability data reflecting the stability of carbofuran and its carbamate metabolites in various plant and animal commodities are adequate. The data are sufficient to allow CBRS to conclude that carbofuran and its carbamate metabolites are generally stable in raw agricultural plant and animal commodities for up to 24-26 months of frozen storage. We note that recoveries of residues of 3-keto carbofuran in sugar beet tops at 26 months were low (34-58%); however, 3-keto carbofuran is not a residue of concern of carbofuran. Interim results of this study were discussed in the Carbofuran Update, and it was concluded that residues of 3-OH carbofuran declined during storage in alfalfa forage. However, adequate recoveries of 3-OH carbofuran were obtained from alfalfa forage following 26 months of frozen storage.

The submitted storage stability data reflecting the stability of weathered residues of carbofuran and its carbamate and phenol metabolites in sorghum commodities during frozen storage are adequate. The sorghum storage stability data indicate that residues of carbofuran and its carbamate and phenol metabolites are generally stable in/on sorghum silage, grain, and fodder stored under frozen conditions for 24-26 months. We note that: (i) residues of the phenol metabolites tended to increase during storage in sorghum grain and fodder; and (ii) residues of 3-keto carbofuran appeared to decrease during storage in sorghum silage.

The RAC samples from the submitted field trial studies were promptly frozen after harvest and were shipped frozen to FMC Corporation (Princeton, NJ) where they were stored frozen until homogenized and acid hydrolyzed. Following acid hydrolysis, samples were stored refrigerated (~8 C) until residue analysis. Samples collected for the processing studies were frozen after harvest and then shipped frozen to the processing facilities, where samples were stored frozen for 37 days (field corn) or 63 days (rice) until processing; potatoes and sugarcane were shipped and stored fresh for up to 2 days until processing. All samples of processed commodities were stored frozen and shipped to the analytical laboratory where they were stored frozen until acid hydrolysis. Following hydrolysis, samples were stored refrigerated (~8 C) prior to residue analysis. All samples were acid hydrolyzed within 37 days of collection except bell pepper samples from two field trials which were stored frozen for 101-155 days prior to hydrolysis. The storage intervals between acid hydrolysis and carbamate analysis were 1-242 days (up to ~8 months) and the storage intervals between acid hydrolysis and phenol analysis were 0-252 days (up to ~8 months).

Adequate storage stability data for carbofuran residues of concern in/on various plant commodities and in the acid hydrolysates of plant commodities are available to support the storage intervals of the submitted field trial and processing studies. Data pertaining to the stability of carbofuran and its carbamate and phenolic metabolites in refrigerated hydrolysates of plant commodities have previously been submitted (CBRS Nos. 16638, 16694, 16695, 16914, and 17452; DP Barcodes D221473, D221469, D221465, D223210, and D221476); these data indicated that residues were generally stable for up to 8 months (carbamates) or 6 months (phenols) of refrigerated storage in hydrolysate samples.

Magnitude of the Residue in Plants

Corn, field

Established tolerances: Tolerances have been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on corn grain (including popcorn) at 0.2 ppm (of which no more than 0.1 ppm is carbamate), and corn forage and fodder at 25 ppm (of which no more than 5 ppm is carbamate) [40 CFR §180.254(a)].

Registered use patterns: The 4 lb/gal FlC formulation of carbofuran is registered for use on field corn and popcorn for the following applications: (i) a banded, in-furrow, or injection at-planting application at 0.08 lb ai/1,000 linear feet of row (1 lb ai/A with 40-inch row spacing) (ii) a postplanting band, side dressing, or basal application at 0.08 lb ai/1,000 linear feet of row (1 lb ai/A with 40-inch row spacing); (iii) up to two foliar applications at 0.25-1 lb ai/A; this application may be directed into the whorl or ear zone; and/or (iv) broadcast foliar applications at 0.5-1 lb ai/A with a 7-day (0.5 lb ai/A rate) or 14-day (1 lb ai/A rate) retreatment interval. Foliar applications may be made in a minimum of 1 gal/A using aerial equipment or 10 gal/A using ground equipment. No more than four foliar applications at the 0.5 lb ai/A rate may be made and no more than two foliar applications at the 1 lb ai/A rate may be made.

In SC, a single postemergence banded application at 1-2 lb ai/A may be made using ground equipment (minimum of 10 gal/A); this application may not be made if a G formulation was applied at planting at >1 lb ai/A.

A 30-day PHI has been established. These use directions were obtained from the product label for EPA Reg. No. 279-2876 (label accepted 1/30/96) and associated SLNs LA910018, SC790026, and TX810006.

Discussion of the data: FMC Corporation has submitted data (1990; MRID 43907701) from 17 trials from six tests conducted in CA, MN, MO, NC, OH, and TX in 1988 depicting residues of carbofuran and its carbamate metabolites (3-keto and 3-OH), and its phenolic metabolites (7-Ph, 3-keto-7-Ph, and 3-OH-7-Ph) in/on field corn forage, silage, and stover. Corn forage was harvested 35-84 days following the first application and just prior to the second application, and corn silage and stover were harvested 21-47 and 54-89 days, respectively, following the last application of the treatment program. The first application was made at planting as an in-furrow treatment of either the 15% G (EPA Reg. No. 279-3023) or 4 lb/gal FlC formulation (EPA Reg. No. 279-2876) at 1.3 lb ai/A. This application was followed by a postemergence foliar whorl application of the 15% G at 1.0 lb ai/A, 35-84 days after the first application, and a postemergence foliar spray (broadcast) application of the 4 lb/gal FlC at 1.0 lb ai/A, 31-42 days after the second application. In eight trials, an additional foliar spray application of the 4 lb/gal FlC at 1.0 lb ai/A, was made 7-26 days following the third application. Total application rates were 3.3 and 4.3 lb ai/A for the three- and four-application programs, respectively (0.8x and 1.1x

the maximum seasonal application rate, respectively). Foliar spray applications were made in ~3-42 gal/A of water using ground equipment.

One control and duplicate treated samples were collected from each test site. Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated corn forage, silage, and stover were determined using the GC/NPD (carbamates) and GC/MS (phenols) methods described above. Apparent residues of carbamates and phenols were less than the LOD (<0.2 ppm each) in/on three samples of untreated corn forage and four samples of untreated silage, and less than the LOD (<0.1 ppm) in/on three untreated samples of corn stover, except that detectable residues of 3-keto carbofuran were observed in one silage sample at 0.25 ppm. Additional untreated samples were analyzed only for carbamates or only for phenol metabolites; apparent residues of carbamates were less than the LOD (<0.2 ppm) in/on one untreated sample of silage, and apparent residues of phenols were less than the LODs in three samples of untreated forage (<0.2 ppm), four samples of untreated stover (<0.1 ppm), and in two samples of untreated silage (<0.2 ppm). Residues in/on treated samples are presented in Table 3. Residue values were corrected by the registrant for method recovery. The registrant reported that there were difficulties with the method and that the only results reported were those from sets in which recoveries were in the 60-120% range.

Table 3. Residues of carbofuran and its carbamate and phenolic metabolites in/on **field corn forage** harvested following an at-planting application of the 15% G or 4 lb/gal FlC formulation at 1.3 lb ai/A, and in/on **field corn silage and stover** harvested following the last application of the specified application program (3.3 or 4.3 lb ai/A/season).

Test Location	PTI (days)	Residues (ppm) [a]								
		Carbamates				Phenols				Combined [b]
		Carbofuran	3-keto	3-OH	Total [b]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	
Forage (Treatment: 15% G or 4 lb/gal FlC at-planting application at 1.3 lb ai/A)										
CA	35	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
	35	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
	35	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
	35	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
MN	35	NA [c]	NA	NA	NA	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	-- [d]
	35	NA	NA	NA	NA	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	--
NC	37	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
	37	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
	37	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
	37	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
OH	55	NA	NA	NA	--	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	--
	55	NA	NA	NA	--	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	--
TX	84	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
Silage (Treatment: 15% G or 4 lb ai/gal FlC at-planting application at 1.3 lb ai/A; 15% G foliar whorl application at 1.0 lb ai/A; 4 lb/gal FlC foliar application at 1.0 lb ai/A = 3.3 lb ai/A/season)										
CA	29	0.81 0.74	<0.2 <0.2	(0.38) (0.33)	1.2 1.1	<0.2 <0.2	<0.2 <0.2	(0.28) (0.27)	<0.7 <0.7	<1.9 <1.8
	29	1.0 0.71	<0.2 <0.2	(0.36) (0.33)	1.4 1.0	<0.2 <0.2	<0.2 <0.2	(0.26) (0.22)	<0.7 <0.6	<2.1 <1.6
MN	47	<0.2 <0.2	0.27 <0.2	1.2 (0.39)	<1.4 <0.6	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<2.0 <1.2
MO	32	<0.2 <0.2	<0.2 <0.2	1.1 (0.92)	<1.3 <1.1	NA	NA	NA	--	--
	32	<0.2 <0.2	<0.2 <0.2	1.0 (0.69)	<1.2 <0.9	NA	NA	NA	--	--
NC	37	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	(0.36) <0.2	(0.58) (0.25)	<1.1 <0.7	<1.5 <1.1
	37	<0.2 <0.2	1.1 1.0	(0.33) (0.72)	<0.5 <0.9	(0.27) <0.2	(0.42) <0.2	1.1 <0.2	1.8 <0.6	<2.3 <1.0

(continued; footnotes follow)

Table 4 (*continued*).

Test Location	PTI (days)	Residues (ppm) [a]								
		Carbamates				Phenols				
		Carbofuran	3-keto	3-OH	Total [b]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined [b]
OH	33	<0.2 <0.2	<0.2 <0.2	(0.95) <0.2	<1.2 <0.4	(0.29) <0.2	(0.55) (0.34)	(0.78) (0.45)	1.6 <1.0	<2.8 <1.4
	33	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.4 <0.4	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.0 <1.0
Silage (Treatment: 15% G or 4 lb ai/gal FlC at-planting application at 1.3 lb ai/A; 15% G foliar whorl application at 1.0 lb ai/A; 4 lb/gal FlC foliar application at 1.0 lb ai/A; 4 lb/gal FlC foliar application at 1.0 lb ai/A = 4.3 lb ai/A/season)										
CA	29	1.2 1.6	<0.2 <0.2	0.59 0.69	1.8 2.3	<0.2 <0.2	<0.2 <0.2	(0.24) <0.2	<0.6 <0.6	<2.4 <2.9
	29	(0.49) 4.5	1.1 <0.2	(0.34) 1.6	0.8 6.1	<0.2 <0.2	<0.2 <0.2	(0.24) (0.33)	<0.6 <0.7	<1.4 <6.8
MN	21	<0.2 <0.2	(0.23) <0.2	1.1 (0.34)	<1.3 <0.5	<0.2 <0.2	<0.2 <0.2	<0.2 <0.2	<0.6 <0.6	<1.9 <1.1
MO	30	NA	NA	NA	--	<0.2 <0.2	(0.34) <0.2	1.0 (0.62)	<1.5 <1.0	--
	30	NA	NA	NA	--	<0.2 <0.2	(0.32) (0.29)	(0.99) (0.85)	<1.5 <1.3	--
NC	30	<0.2 <0.2	1.6 (0.85)	(0.55) (0.34)	<0.75 <0.54	<0.2 <0.2	(0.50) (0.37)	(0.67) (0.59)	<1.4 <1.2	<2.1 <1.7
	30	<0.2 <0.2	2.0 2.4	1.0 <0.2	<1.2 <0.4	(0.23) <0.2	(0.28) <0.2	(0.53) (0.30)	<1.0 <0.7	<2.2 <1.1
TX	26	NA	NA	NA	--	(0.36) (0.34)	(0.30) (0.25)	(0.39) (0.36)	1.0 1.0	--
Stover (Treatment: 15% G or 4 lb ai/gal FlC at-planting application at 1.3 lb ai/A; 15% G foliar whorl application at 1.0 lb ai/A; 4 lb/gal FlC foliar application at 1.0 lb ai/A = 3.3 lb ai/A/season)										
CA	63	1.4 0.63	(0.16) (0.21)	0.94 1.1	2.3 1.7	(0.23) (0.14)	(0.15) (0.15)	(0.31) (0.33)	0.7 0.6	3.0 2.3
	63	0.40 0.65	(0.28) (0.19)	1.9 0.59	2.3 1.2	(0.14) (0.16)	(0.17) (0.19)	(0.58) (0.35)	0.9 0.7	3.2 1.9
MN	80	NA	NA	NA	--	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.3 <0.3	--
MO	60	NA	NA	NA	--	<0.1 <0.1	(0.17) (0.15)	0.53 0.54	<0.8 <0.8	--
	60	NA	NA	NA	--	<0.1 <0.1	(0.18) (0.25)	0.64 0.75	<0.9 <1.1	--
NC	72	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.2 <0.2	<0.1 <0.1	<0.1 <0.1	<0.1 (0.27)	<0.3 <0.5	<0.5 <0.7
	72	<0.1 <0.1	<0.1 <0.1	(0.25) (0.15)	<0.4 <0.3	<0.1 <0.1	<0.1 <0.1	(0.28) (0.19)	<0.5 <0.4	<0.9 <0.7
OH	69	(0.43) (0.24)	(0.30) (0.16)	1.1 0.74	1.5 1.0	<0.1 <0.1	(0.21) (0.24)	(0.39) (0.40)	<0.7 <0.7	<2.2 <1.7
	69	<0.1 <0.1	<0.1 <0.1	<0.1 (0.19)	<0.2 <0.3	<0.1 <0.1	<0.1 <0.1	<0.1 <0.1	<0.3 <0.3	<0.5 <0.6

(*continued; footnotes follow*)

Table 4 *(continued)*.

Test Location	PTI (days)	Residues (ppm) [a]								
		Carbamates				Phenols				Combined [b]
		Carbofuran	3-keto	3-OH	Total [b]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	
Stover (Treatment: 15% G or 4 lb ai/gal FlC at-planting application at 1.3 lb ai/A; 15% G foliar whorl application at 1.0 lb ai/A; 4 lb/gal FlC foliar application at 1.0 lb ai/A; 4 lb/gal FlC foliar application at 1.0 lb ai/A = 4.3 lb ai/A/season)										
CA	63	1.3 0.48	0.61 (0.16)	2.6 0.91	3.9 1.4	(0.29) (0.38)	(0.34) (0.32)	(0.73) (0.66)	1.4 1.4	5.3 2.8
	63	0.70 0.74	(0.27) (0.31)	1.3 1.4	2.0 2.1	(0.20) (0.20)	(0.17) (0.20)	(0.37) (0.45)	0.7 0.9	2.7 3.0
MN	54	NA	NA	NA	--	<0.1 (0.29)	<0.1 <0.1	<0.1 <0.1	<0.3 <0.5	--
MO	49	NA	NA	NA	--	<0.1 <0.1	(0.19) (0.18)	0.59 0.71	<0.9 <1.0	--
	49	NA	NA	NA	--	<0.1 <0.1	(0.16) (0.22)	0.62 0.86	<0.9 <1.2	--
NC	65	<0.1 (0.21)	<0.1 <0.1	(0.21) (0.38)	<0.3 0.6	<0.1 <0.1	(0.13) (0.13)	(0.56) (0.52)	<0.8 <0.8	<1.1 <1.4
	65	0.20 <0.2	0.13 <0.2	(0.40) (0.23)	0.6 <0.4	<0.1 <0.1	(0.13) (0.14)	0.53 0.59	<0.8 <0.8	<1.4 <1.2
TX	89	NA	NA	NA	--	<0.1 <0.1	<0.1 <0.1	<0.1 (0.13)	<0.3 <0.3	--

[a] Residues in/on treated samples were corrected for concurrent recovery. Residue values in parentheses are estimates; ≥ LOD but ≤ LOQ. Forage and Silage: LOQ=1.0 ppm and LOD=0.2 ppm; Stover: LOQ=0.5 ppm and LOD=0.1 ppm.

[b] Does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.

[c] NA = not analyzed or not reported.

[d] Totals cannot be determined because samples were not analyzed for all analytes (carbamates and/or phenolic metabolites).

Geographic representation of the submitted residue data is adequate. The test states of CA(7%), MN(7%), MO(1%), NC(2%), OH(3%), and TX(1%) from the submitted studies, and AR(<0.5%), CO(3%), IL(2%), NY(10%), NC(2%), and WI(9%) from the previously submitted field trials (CB No. 1389, 1/15/87, J. Garbus) accounted for ~50% of the 1991 U.S. field corn silage production *(1992 USDA Agricultural Statistics)*.

Study summary: The submitted data indicate that the established 5-ppm tolerance for residues of carbofuran carbamate metabolites in/on corn forage may be too low. The combined residues of carbofuran and its carbamate and phenol metabolites in/on field corn silage (forage) harvested 29-47 days following the last of a single preplant application of the 15% G or 4 lb/gal FlC formulation at 1.3 lb ai/A, a postemergence foliar whorl application of the 15% G at 1.0 lb ai/A, and a postemergence foliar spray (broadcast) application of the 4 lb/gal FlC formulation at 1.0 lb ai/A (3.3 lb ai/A/season; 0.8x) were <1.0-<2.8 ppm (of which <0.4-1.4 ppm were carbamates). The combined residues of carbofuran and its metabolites in/on corn stover harvested 60-80 days following the same treatment were <0.5-3.2 ppm (of which <0.2-2.3 ppm were carbamates). The combined residues in/on corn silage (forage) harvested 21-30 days following the same treatment plus an additional foliar application of the 4 lb/gal FlC formulation at 1.0 lb ai/A (4.3 lb ai/A/season; 1.1x) were <1.1-<6.8 ppm (of which <0.4-6.1 ppm were carbamates). The

combined residues of carbofuran and its metabolites in/on corn stover harvested 49-89 days following the same treatment were <1.1-5.3 ppm (of which <0.4-3.9 ppm were carbamates). The combined residues of carbofuran and its metabolites in/on corn forage harvested 35-84 days following a single application of the 15% G or 4 lb/gal FlC formulation at 1.0 lb ai/A/application were <1.0 ppm (of which <0.4 ppm were carbamates).

Previously submitted (CB No. 1389, 1/15/87, J. Garbus) field trial data on corn forage and stover harvested ~30 and 54-89 days, respectively, following the last of a single preplant application of the 15% G or 4 lb/gal FlC formulation at 3 lb ai/A, a postemergence foliar whorl application of the 15% G at 1.0 lb ai/A and two postemergence foliar spray (broadcast) application of the 4 lb/gal FlC formulation at 1.0 lb ai/A/application (6 lb ai/A/season) were found to be acceptable if the established tolerance was amended to increase the limit on carbamates to 8 ppm.

The registrant has stated that carbamate residue values in both the previously and recently submitted studies exceeded the tolerance only in the CA trials and proposes to amend the product label by limiting applications to field corn in CA. Chemistry Branches do not believe that there are sufficient data to conclude that residues in CA are consistently and systematically higher than in other states. Therefore, CBRS will recommend tolerance levels for field corn forage (including silage) and stover that are adequate to cover the entire data set. If the registrant nevertheless wishes to lower application rates in CA, CBRS would have no objection. In order for CBRS to lower the tolerance to account for any lowered application rates in CA, the registrant would need to submit additional data.

Based on the results of the present field trials with forage/silage and stover (including the CA trials), and the previously submitted field corn data on silage, CBRS will recommend a tolerance of 8 ppm for carbamate residues on forage and stover and 20 ppm for carbofuran (carbamates + phenol) on forage and stover.

Peppers

Established tolerance: A tolerance of 1 ppm (of which no more than 0.2 ppm is carbamate) has been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on peppers [40 CFR §180.254(a)].

Registered use patterns: The 4 lb/gal FlC formulation is registered for use limited to AZ and TX on peppers at 5 lb ai/A/season. A limit of two applications, the first (2 lb ai/A) may be made as an in-furrow application during planting and the second (3 lb ai/A) as a sidedress 4-6 weeks later. A PHI of 21 days is in effect. These use directions were obtained from EPA SLN Nos. AZ910001 and TX930011, with parent EPA Reg. No. 279-2876; the parent product is not registered for use on peppers.

Discussion of the data: FMC Corporation has submitted data (1995; MRID 43852401) from four trials conducted in CA, FL, NJ, and TX in 1994 depicting residues of carbofuran and its carbamate (3-keto and 3-OH), and phenolic (7-Ph, 3-keto-7-Ph, and 3-OH-7-Ph) metabolites in/on bell peppers. Mature bell peppers were harvested 28 days following the last of two applications, at a 34- to 87-day retreatment interval, of the 4 lb/gal FlC formulation (EPA Reg. No. 279-2876) for a total of 2.5 lb ai/A/season. The first application was made as an at-planting in-furrow treatment or a sidedress treatment ~4 weeks posttransplant at 1.0 lb ai/A, followed by a sidedress application at 1.5 lb ai/A using ground equipment; in FL the first application was made at 0.75 lb ai/A and the second application was made at 1.75 lb ai/A. Applications were made in 10-53 gal/A of water.

One control and duplicate treated samples were collected from each test site. Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated bell peppers were determined using the HPLC and GC/MS methods described above. Apparent residues were less than the LOD (<0.01 ppm) in/on four untreated samples of bell peppers. Residues in/on treated samples are presented in Table 4.

Table 4. Residues of carbofuran and its carbamate and phenolic metabolites in/on **bell peppers** harvested 28 days following two applications of the 4 lb/gal FlC formulation at 1.0 and 1.5 lb ai/A (CA, NJ, TX; 2.5 lb ai/A/season) or two applications of the 4 lb/gal FlC formulation at 0.75 and 1.75 lb ai/A (FL; 2.5 lb ai/A/season).

	Residues (ppm) [a]								
	Carbamates				Phenols				
Test Location	Carbofuran	3-keto	3-OH	Total [b]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined [b]
CA	(0.01)	<0.01	<0.01	<0.02	(0.03)	(0.01)	(0.01)	0.05	<0.07
	(0.01)	<0.01	<0.01	<0.02	(0.03)	(0.01)	<0.01	<0.05	<0.07
FL	<0.01	<0.01	<0.01	<0.02	0.09	0.09	(0.03)	0.21	<0.23
	<0.01	<0.01	<0.01	<0.02	0.10	0.08	(0.03)	0.21	<0.23
NJ	<0.01	<0.01	<0.01	<0.02	(0.03)	(0.02)	<0.01	<0.06	<0.08
	<0.01	<0.01	<0.01	<0.02	(0.02)	(0.02)	<0.01	<0.05	<0.07
TX	<0.01	<0.01	<0.01	<0.02	(0.03)	(0.01)	<0.01	<0.05	<0.07
	<0.01	<0.01	<0.01	<0.02	(0.02)	(0.01)	<0.01	<0.04	<0.06

[a] Residues in/on treated samples were not corrected for concurrent recovery. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.05 ppm).

[b] Total does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.

Geographic representation is inadequate to support the registered SLN uses in AZ and TX because no field trials were conducted in AZ. The registrant stated that they intend to pursue a federal registration (Section 3) of the 4 lb/gal FlC formulation on peppers. The subject field trials were conducted in Regions 1 (NJ), 3 (FL), 6 (TX), and 10 (CA). A minimum of six bell pepper field trials are required for a federal registration on peppers (OPPTS 860.1500, Tables 1 and 4). To fulfill geographic representation requirements for the registered SLN uses, an additional field trial must be conducted in AZ. To fulfill geographic representation requirements

for a future federal registration, two additional field trials with bell peppers must be conducted in Regions 5 and 10.

Study summary: The submitted data indicate that the combined carbofuran residues of concern were <0.06-<0.23 ppm [including <0.02 ppm carbamates] in/on bell peppers harvested 28 days following the last of two applications, with a 34- or 87-day retreatment interval, of the 4 lb/gal FlC formulation at 1.0 and 1.5 lb ai/A (2.5 lb ai/A/season) in ~10-53 gal of water/A using ground equipment. The submitted data do not reflect the maximum registered use pattern of carbofuran on bell peppers (a maximum of two sequential applications at 2 and 3 lb ai/A with a 21-day PHI). The registrant stated in the transmittal letter (MRID 43852400) that the subject field trials were conducted at reduced rates in keeping with EPA's desire for risk mitigation to the environment. The registrant must modify the labels for SLN Nos. AZ910001 and TX930011 to reflect the use pattern used in the submitted field trials. In addition, the registrant must submit data from an additional field trial conducted in AZ to fulfill the requirements for geographic representation. If the registrant wishes to pursue a federal registration of the 4 lb/gal FlC formulation on peppers, then two additional field trials with bell peppers must be conducted in Regions 5 and 10.

Rice

Established tolerances: Tolerances have been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on rice at 0.2 ppm, and rice straw at 1 ppm (of which no more than 0.2 ppm is carbamate) [40 CFR §180.254(a)].

Registered use patterns: Only granular formulations are registered for use on rice. Use of granular carbofuran on rice was to have been phased out by 8/31/95; however, because no effective alternative was registered, an extension of the use has been allowed.

Discussion of the data: FMC Corporation has submitted data (1993; MRID 43851001) from five trials conducted in 1992 in AR, CA(2), LA, and TX depicting residues of carbofuran and its carbamate metabolites (3-keto and 3-OH), and its phenolic metabolites (7-Ph, 3-keto-7-Ph, and 3-OH-7-Ph) in/on rice. Mature rice grain and straw were harvested 128 or 151 days following a single application of the 4 lb/gal FlC formulation (EPA Reg. No. 279-2876) at 1 lb ai/A to the soil surface and incorporated 1-5 days prior to flooding and aerial seeding, or 72-117 days following a single early postemergence application (immediately prior to flooding) of the 4 lb/gal FlC formulation at 1 lb ai/A. Applications were made in 10-20 gal/A of water using ground equipment.

One control and one treated sample were collected from each test site. Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated rice grain and straw were determined using the HPLC and GC/MS methods described above. Apparent residues were each less than the LOD (<0.01 ppm) in/on two untreated samples each of rice grain and straw. Apparent residues were detectable but less than the LOQ (<0.05 ppm) in/on three untreated

samples each of rice grain (0.01 ppm 3-OH-7-Ph; 0.04 ppm 3-OH-7-Ph; and 0.01 ppm 3-OH-7-Ph) and straw (0.01 3-keto; 0.02 ppm 7-Ph; and 0.04 ppm 3-OH-7-Ph); residues were less than the LOD for all other carbamate and phenol metabolites in these samples. Residues in/on treated samples are presented in Table 5.

Table 5. Residues of carbofuran and its carbamate and phenolic metabolites in/on **rice grain and straw** harvested 128 or 151 days following a single soil-incorporated application of the 4 lb/gal FlC formulation at 1 lb ai/A prior to flooding and aerial seeding, or 72-117 days following a single early postemergence application (immediately prior to flooding) of the 4 lb/gal FlC formulation at 1 lb ai/A.

	Residues (ppm) [a]								
	Carbamates				Phenols				
Test Location	Carbofuran	3-keto	3-OH	Total [b]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined [b]
Rice grain (preplanting/flooding application)									
CA	<0.01	<0.01	<0.01	<0.02	(0.01)	<0.01	(0.02)	<0.04	<0.06
CA	<0.01	<0.01	(0.01)	<0.02	(0.01)	<0.01	(0.02)	<0.04	<0.06
Rice grain (postemergence/preflooding application)									
AR	<0.01	<0.01	<0.01	<0.02	(0.03)	<0.01	(0.02)	<0.06	<0.08
LA	<0.01	<0.01	<0.01	<0.02	0.06	<0.01	0.07	<0.14	<0.16
TX	<0.01	<0.01	<0.01	<0.02	0.05	<0.01	0.05	<0.11	<0.13
Rice straw (preplanting/flooding application)									
CA	<0.01	<0.01	(0.02)	<0.03	0.19	(0.02)	(0.04)	0.25	<0.28
CA	(0.03)	(0.02)	(0.04)	0.09	0.95	0.06	0.19	1.20	1.29
Rice straw (postemergence/preflooding application)									
AR	<0.01	<0.01	(0.02)	<0.03	0.13	(0.01)	0.07	0.21	<0.24
LA	<0.01	<0.01	0.05	<0.06	0.21	(0.01)	0.10	0.32	<0.38
TX	<0.01	<0.01	0.06	<0.07	0.16	<0.01	0.16	<0.33	<0.40

[a] Residues in/on treated samples were not corrected for concurrent recovery. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.05 ppm).

[b] Total does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.

The registrant stated in the transmittal letter (MRID 43851000) that the rice straw sample bearing residues totalling 1.29 ppm was a statistical outlier and provided information regarding use of the Grubbs test to determine outliers. CBRS believes, however, that there is insufficient data to reject this value, but will reconsider this issue upon submission of additional field trials (see below).

Geographic representation is inadequate to support use of carbofuran on rice. The subject field trials were conducted in Regions 4 (AR, LA), 6 (TX), and 10 (CA). A minimum of 16 field trials (32 samples) is required for a federal registration on rice (OPPTS 860.1500, Table 1). To fulfill geographic representation requirements, additional field trials with rice must be conducted in Regions 4 (9 trials), 5 (1 trial), and 6 (1 trial).

Study summary: The submitted data indicate that the combined carbofuran residues of concern were <0.06 ppm in/on rice grain and <0.28 and 1.29 ppm (<0.03-0.05 ppm carbamates) in/on rice straw harvested 128 or 151 days following a single preplant soil-incorporated application of the 4 lb/gal FlC formulation at 1 lb ai/A in ~10-20 gal of water/A using ground equipment. The submitted data indicate that the combined carbofuran residues of concern were <0.08-<0.16 ppm in/on rice grain and <0.24-0.40 ppm (<0.03-<0.07 ppm carbamates) in/on rice straw harvested 72-117 days following a single postemergence application of the 4 lb/gal FlC formulation at 1 lb ai/A in ~10-20 gal of water/A using ground equipment and applied immediately prior to flooding. When additional field trial residue values are made available, CBRS will reconsider whether the 1.29 ppm residue value for rice straw can be rejected as a statistical outlier.

The submitted data reflect application of the 4 lb/gal FlC formulation to rice; there are currently no registered uses of this formulation on rice. The registrant must propose the use pattern they wish to support for use of the 4 lb/gal FlC formulation on rice before the submitted data can be evaluated. If the registrant wishes to rely on the submitted data, additional field trials with rice must be conducted in Regions 4 (9 trials), 5 (1 trial), and 6 (1 trial) for adequate geographic representation.

Sugarcane

Established tolerance: A tolerance of 0.1 ppm has been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on sugarcane [40 CFR §180.254(a)].

Registered use patterns: The 4 lb/gal FlC formulation is registered for multiple foliar applications to sugarcane once visible joints form at 0.5-0.75 lb ai/A using ground or aerial equipment. No maximum seasonal rate has been established. A PHI of 17 days has been established. Use is prohibited in HI. The 4 lb/gal FlC formulation is also registered for use in LA only as a single at-planting band application at 1 lb ai/A using ground equipment. Applications should be made in 20 gallons of spray for hand-planted cane and 30 gallons of spray for machine-planted cane. These use directions were obtained from the product labels for EPA Reg. No. 279-2876 (label accepted 1/30/96) and associated SLN LA930021.

Discussion of the data: FMC Corporation has submitted data (1992; MRID 43907601) from 10 trials conducted in 1990-1991 in FL(4), LA(4), and TX(2) depicting residues of carbofuran and its carbamate metabolites (3-keto and 3-OH), and its phenolic metabolites (7-Ph, 3-keto-7-Ph, and 3-OH-7-Ph) in/on sugarcane. Mature sugarcane was harvested 30 days following the last of three applications of the 4 lb/gal FlC formulation (EPA Reg. No. 279-2876): an initial (fall 1990) at-planting in-furrow application at 1 lb ai/A using ground equipment in 20-30 gal/A spray, and two subsequent (summer 1991, 272-298 days retreatment interval and fall 1991, 31-58 days retreatment interval) foliar applications at 0.75 lb ai/A/application using aerial equipment in 9-10 gal/A spray. Total applications were 2.5 lb ai/A/season.

One control and one treated sample was collected from each test site. Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated sugarcane were determined using the HPLC and GC/MS methods described above. Apparent residues of carbofuran and its carbamate and phenolic metabolites were each less than the LOD (<0.01 ppm) in/on ten untreated samples of sugarcane. Residues in/on treated samples are presented in Table 6.

Table 6. Residues of carbofuran and its carbamate and phenolic metabolites in/on **sugarcane** harvested 30 days following three applications of the 4 lb/gal FlC formulation at 1.0 (at-planting in-furrow application) and 0.75 (two aerial foliar applications) lb ai/A/application (2.5 lb ai/A/season).

	Residues (ppm) [a]								
	Carbamates				Phenols				
Test Location	Carbofuran	3-keto	3-OH	Total [b]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined [b]
FL	0.05 0.05	<0.01 <0.01	<0.01 <0.01	<0.06 <0.06	(0.01) (0.01)	<0.01 <0.01	<0.01 <0.01	<0.03 <0.03	<0.09 <0.09
FL	0.06 0.06	<0.01 <0.01	<0.01 (0.01)	<0.07 0.07	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.03 <0.03	<0.10 <0.10
FL	0.05 0.05	<0.01 <0.01	<0.01 <0.01	<0.06 <0.06	(0.01) (0.02)	<0.01 <0.01	<0.01 <0.01	<0.03 <0.04	<0.09 <0.10
FL	0.04 0.05	<0.01 <0.01	<0.01 <0.01	<0.05 <0.06	(0.02) (0.02)	<0.01 <0.01	<0.01 <0.01	<0.04 <0.04	<0.09 <0.10
LA	0.04 0.04	<0.01 <0.01	<0.01 (0.02)	<0.05 0.06	(0.02) (0.02)	<0.01 <0.01	<0.01 <0.01	<0.04 <0.04	<0.09 <0.10
LA	0.04 0.06	<0.01 <0.01	<0.01 <0.01	<0.05 <0.07	(0.02) (0.02)	<0.01 <0.01	(0.01) (0.01)	<0.04 <0.04	<0.09 <0.11
LA	(0.02) (0.02)	<0.01 <0.01	<0.01 <0.01	<0.03 <0.03	(0.02) (0.02)	<0.01 <0.01	<0.01 <0.01	<0.04 <0.04	<0.07 <0.07
LA	(0.01) (0.02)	<0.01 <0.01	<0.01 <0.01	<0.02 <0.03	<0.01 <0.01	<0.01 <0.01	(0.01) (0.01)	<0.03 <0.03	<0.05 <0.06
TX	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.02 <0.02	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.03 <0.03	<0.05 <0.05
TX	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.02 <0.02	<0.01 <0.01	<0.01 <0.01	<0.01 (0.01)	<0.03 <0.03	<0.05 <0.05

[a] Residues in/on treated samples were not corrected for concurrent recovery. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.03 ppm).

[b] Total does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.

Geographic representation is adequate to support the registered uses. The subject field trials were conducted in Regions 3 (FL), 4 (LA), and 6 (TX) which satisfy the geographic representation requirements specified in OPPTS 860.1500 (Table 5).

Study summary: The submitted data indicate that the established 0.1-ppm tolerance may be too low. The combined carbofuran residues of concern were <0.05-<0.11 ppm in/on sugarcane harvested 30 days following the last of three applications of the 4 lb/gal FlC formulation: an initial at-planting in-furrow application at 1 lb ai/A using ground equipment in 20-30 gal/A

spray, and two subsequent foliar applications at 0.75 lb ai/A/application using aerial equipment in 9-10 gal/A spray.

No maximum seasonal rate for use of carbofuran on sugarcane is specified on the product label; however, the submitted data do not reflect the 17-day PHI specified on the label. The registrant must modify the existing product label (EPA Reg. No. 279-2876) to reflect the use pattern used in the submitted field trials and propose to increase the established tolerance to 0.2 ppm.

Magnitude of the Residue in Processed Food/Feed

Corn Processed Commodities

Established tolerances: Tolerances have been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on corn grain (including popcorn) at 0.2 ppm (of which no more than 0.1 ppm is carbamate), and corn forage and fodder at 25 ppm (of which no more than 5 ppm is carbamate) [40 CFR §180.254(a)]. No food/feed additive tolerances have been established for residues of carbofuran in any corn processed commodities.

Registered use patterns: See "Registered use patterns" under "Corn, field" (page 18).

Discussion of the data: FMC Corporation submitted data (1995; MRID 43851601) pertaining to the potential for concentration of residues of carbofuran and its carbamate and phenolic metabolites in the corn wet-milled processed commodity, starch. In one test conducted in IA in 1994, field corn grain was harvested 67 days following the last of four applications of the 4 lb/gal FlC formulation (EPA Reg. No. 279-2876): an initial single at-planting in-furrow treatment at 3.9 lb ai/A, a single whorl-stage application at 3 lb ai/A, 37 days after the first application, and two foliar spray (broadcast) applications at 3 lb ai/A/application, 43 and 13 days after the second and third applications, respectively. The total application rate was 12.9 lb ai/A (3.2x the maximum seasonal application rate). Applications were made in ~6-18 gal/A of water using ground equipment.

At crop maturity, a bulk sample of corn grain was separated from the rest of the plant and frozen. A subsample of the bulk grain sample was sent directly to FMC Corporation (Princeton, NJ) for residue analysis. The remainder of the bulk corn grain sample was shipped frozen by refrigerator truck to the processor (Food Protein R & D Center, Texas A&M University, Bryan, TX) where it was processed into starch within 37 days of harvest.

Corn grain was processed according to simulated commercial procedures using a small-scale wet milling procedure into starch. Briefly, corn grain was dried and cleaned by aspiration and screening. The cleaned grain was conditioned in water and sulfurous acid. The resulting steeped corn was ground milled to separate germ from hulls, endosperm, and bound germ. After germ

removal the remaining fraction, composed of starch, gluten, and coarse hull material, was milled and screen water washed. The remaining process water was centrifuged to separate the starch and gluten. The registrant submitted adequate descriptions and material balance sheets for the processing procedures.

Unprocessed grain and processed starch fractions were shipped overnight frozen on dry ice to the analytical laboratory (FMC Corporation, Princeton, NJ) and prepared (acid hydrolyzed) for analysis within 11 days of processing. The hydrolysates were refrigerated (~8 C) for no more 91 days prior to analysis. Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated corn grain and processed starch were determined using the HPLC and GC/MS methods described above. The results of the corn processing study are presented in Table 7. Apparent residues of carbofuran and its carbamate and phenolic metabolites were nondetectable (<0.01 ppm each) in/on two samples of untreated grain, and one sample of starch processed from untreated corn grain.

Table 7. Residues of carbofuran and its carbamate and phenolic metabolites in/on **starch processed from corn grain** treated with four applications (a single preplant in-furrow and three foliar applications), with 13- to 43-day retreatment intervals, of the 4 lb/gal FlC formulation at 3.9, 3, 3, and 3 lb ai/A/application (12.9 lb ai/A/season; 3.2x).

Corn	Carbamates				Phenols				
Commodity	.Carbofuran	3-keto	3-OH	Total[a]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined[a]
Residues (ppm) [b]									
Grain (field)	<0.01	<0.01	(0.02)	<0.03	<0.01	<0.01	0.03	<0.05	<0.08
Grain (processor)	<0.01	<0.01	(0.01)	<0.02	<0.01	<0.01	0.03	<0.05	<0.07
Starch	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.03	<0.05
Concentration/Reduction Factors									
Starch	--	--	<0.5x	<1x	--	--	<0.3x	<1x	<1x

[a] Does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.
[b] Each residue value represents the highest value obtained from triplicate analyses of a single sample. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.03 ppm).

Study summary: The submitted corn processing data indicate that individual residues of carbofuran metabolites of concern do not concentrate in starch processed from field corn grain bearing detectable residues of 3-OH-carbofuran and 3-OH-7-Ph carbofuran following treatment at an exaggerated rate.

Previously submitted field corn processing data were determined to be inadequate due to problems with storage stability (CBRS No. 10194, DP Barcode D180489, 2/16/93, S. Knizner). Starch samples from that study were stored for a period of time (26 months) during which phenol metabolites were unstable; however, residues of carbofuran, the carbamate metabolites, and the phenol metabolites were found to be stable in corn meal, crude oil, and refined oil during the storage intervals of samples from the processing study. In the new study, field corn samples

were processed within 37 days of harvest, prepared (acid hydrolyzed) for analysis within 11 days of processing, and the hydrolysates were analyzed within 91 days of hydrolysis. Carbofuran residues of concern have been determined to be stable in acid hydrolysates of plant commodities for up to 8 months for carbamate metabolites and 6 months for phenol metabolites (CBRS Nos. 16638, 16694, 16695, 16914, and 17452; DP Barcodes D221473, D221469, D221465, D223210, and D221476). Therefore, adequate storage stability data are available to support the storage intervals of the starch samples from the submitted study.

The previously submitted processing data indicated that carbofuran residues of concern do not concentrate in corn flour, grits, meal and refined oil (dry processing) and refined oil (wet processing). CBRS concludes that no tolerances are required for carbofuran residues of concern in field corn processed commodities.

Potato Processed Commodities

Established tolerances: Tolerances have been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on potatoes at 2 ppm (of which no more than 1 ppm is carbamates) [40 CFR §180.254(a)]. No food/feed additive tolerances are established for residues of carbofuran in any potato processed commodities.

Registered use patterns: The 4 lb/gal FlC formulation is registered for a maximum of eight foliar applications to potato plants at 0.5-1 lb ai/A using ground or aerial equipment. Foliar applications may be repeated as necessary to maintain control; however, foliar applications may not exceed 3 lb ai/A/season if an at-planting application was made. Applications are to be made in a minimum of 10 gal/A of spray with ground equipment and 3 gal/A spray with aircraft. A 14 day PHI has been established and use is prohibited on Long Island, NY. The 4 lb/gal FlC is also registered for: (i) an at-planting in-furrow application at 3 lb ai/A using ground equipment (SLNs DE920001, PA940003, and VA920002); foliar applications may not exceed 3 lb ai/A/season if an at-planting application is made; and (ii) postemergence shank or band application at 3 lb ai/A using ground equipment; applications may be made to the potato plant up to a four-inch rosette (SLNs OR910006 and WA910006); foliar applications up to 3 lb ai/A (WA910006) or no foliar applications (OR910006) may be made if this band application is made. These use directions were obtained from the product label for EPA Reg. No. 279-2876 (label accepted 1/30/96) and associated SLNs DE920001, OR910006, PA940003, VA920002, and WA910006.

Discussion of the data: FMC Corporation submitted data (1995; MRID 43851701) pertaining to the potential for concentration of residues of carbofuran and its carbamate and phenolic metabolites in the processed commodities of potatoes. In one test conducted in WA in 1994, mature potato tubers were harvested 22 days following the last of four applications of the 4 lb/gal FlC formulation (EPA Reg. No. 279-2876): an at-planting in-furrow treatment at 6 lb ai/A using ground equipment (2x the maximum application rate for this type of application), followed by

three foliar spray (broadcast) applications at 2 lb ai/A/application using ground equipment, with 91-, 14-, and 14-day retreatment intervals, respectively. The total application rate was 12 lb ai/A (2x the maximum seasonal application rate for foliar treatments following an at-planting application). Applications were made in ~19-20 gal/A of water.

At crop maturity, a bulk sample of untreated and treated potatoes were harvested. A subsample of the bulk potato sample was sent frozen directly to FMC Corporation (Princeton, NJ) for residue analysis. The remainder of the bulk potato sample was shipped fresh by trailer truck to the processor (Wm. J. Englar and Associates, Moses Lake, WA) where it was processed into chips, granules, and wet and dry peel; processing was initiated within 1 day of harvest.

Potatoes were processed according to simulated commercial procedures into chips, granules, and wet and dry peel. Briefly, potatoes were washed with water. A subsample of washed potatoes was peeled, hand trimmed to remove damaged areas, sliced, fried in oil at 171-177 C, drained, and salted for potato chips. The remaining washed potatoes were steam peeled, mechanically scrubbed to remove the peel, and hand trimmed to remove damaged areas. The peel was hydraulically pressed and combined with the cut trim waste as the wet peel fraction. A wet peel subsample was air-dried and milled for the dry peel fraction. A subsample of peeled potatoes was sliced, spray-washed with water to remove starch, pre-cooked at 71-74 C, and cooled to <32 C. The cooled sample was steam cooked at 94-100 C, mashed, mixed with food additives, and frozen until further processing. Once thawed, a subsample of the mash was dried in a fluid-bed drier to 10% moisture, more mash was added and the drying procedure repeated until ~8 kg of mash sample was dried. The dried mash was combined with 20% solids mash, dried again at 80-94 C, sifted through mesh screens, and cooled to 8-10% moisture for the potato granule fraction. The registrant submitted adequate descriptions and material balance sheets for the processing procedures.

Unprocessed potatoes and processed potato chips, granules, and wet and dry peel fractions were shipped frozen on dry ice to the analytical laboratory (FMC Corporation, Princeton, NJ). Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated potatoes and potato processed commodities were determined using the HPLC and GC/MS methods described above. The results of the potato processing study are presented in Table 8. Apparent residues of carbofuran and its carbamate and phenolic metabolites were nondetectable (<0.01 ppm each) in/on one sample of untreated potatoes and in one sample each of chips, granules, wet peel, and dry peel processed from untreated potatoes.

Table 8. Residues of carbofuran and its carbamate and phenolic metabolites in/on **chips, granules, and wet and dry peel processed from potatoes** treated with four applications (a single preplant in-furrow and three foliar applications), with 91-, 14-, and 14-day retreatment intervals, of the 4 lb/gal FlC formulation at 6 (at planting) and 2 (foliar) lb ai/A/application (12 lb ai/A/season; 2x the maximum seasonal application rate).

Potato	Carbamates				Phenols				
Commodity	Carbofuran	3-keto	3-OH	Total [a]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined [a]
Residues (ppm) [b]									
Potato tubers	<0.01	<0.01	<0.01	<0.02	(0.03)	<0.01	<0.01	<0.05	<0.07
Chips	<0.01	<0.01	<0.01	<0.02	0.05	<0.01	(0.01)	<0.07	<0.09
Granules	<0.01	<0.01	<0.01	<0.02	0.14	(0.02)	(0.02)	0.18	<0.20
Wet peel	<0.01	<0.01	<0.01	<0.02	(0.02)	<0.01	<0.01	<0.04	<0.06
Dry peel	<0.01	<0.01	<0.01	<0.02	0.12	(0.02)	(0.03)	0.17	<0.19
Concentration/Reduction Factors									
Chips	--	--	--	--	2x	--	>1x	>1x	>1x
Granules	--	--	--	--	5x	>2x	>2x	>4x	3x
Wet peel	--	--	--	--	0.7x	--	--	0.8x	0.9x
Dry peel	--	--	--	--	4x	>2x	>3x	3x	3x

[a] Does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.
[b] Each residue value represents the highest value obtained from triplicate analyses of a single sample. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.05 ppm).

Study summary: The submitted potato processing data are adequate and indicate that total residues of carbofuran metabolites of concern concentrate slightly in chips (>1x) and concentrate in granules but do not concentrate in wet peel processed from potatoes bearing detectable residues of 7-Ph carbofuran following treatment at an exaggerated rate.

Previously submitted potato processing data (discussed in the Carbofuran Update) indicated that the combined residues of carbofuran carbamate and phenol metabolites concentrate in potato flakes up to 5x and in potato chips up to 1.5x. Based on an HAFT of 1.34 ppm (CB No. 6667, 6/25/90, F. Toghrol) and average concentration factors of 4x (granules/flakes) and 1.5x (chips) for total carbofuran residues of concern, the maximum expected residues in potato granules/flakes and chips would be calculated to be 5.4 ppm and 2.0 ppm, respectively. The maximum expected residues for potato chips do not exceed the established tolerance for potatoes and no tolerance is therefore required; however, the maximum expected residues for potato granules/flakes do exceed the established tolerance for potatoes. Based on a HAFT for carbamate residues of 0.75 ppm (CB No. 6667, 6/25/90, F. Toghrol) and an estimated concentration factor for carbamates of 1.8x (Carbofuran Update), the maximum expected residue level for carbamates in potato granules/flakes is 1.4 ppm. A tolerance for residues of carbofuran, its carbamate metabolite, and phenol metabolites in potato granules/flakes is required; the submitted data will support a tolerance of 6 ppm (of which no more than 2 ppm is carbamates).

Rice

Established tolerances: Tolerances have been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on rice at 0.2 ppm [40 CFR §180.254(a)]. No food/feed additive tolerances are established for residues of carbofuran in any rice processed commodities.

Registered use patterns: Only granular formulations are registered for use on rice. Use of granular carbofuran on rice was to have been phased out by 8/31/95, however, because no effective alternative was registered, an extension on the use has been allowed.

Discussion of the data: FMC Corporation submitted data (1995; MRID 43852301) pertaining to the potential for concentration of residues of carbofuran and its carbamate and phenolic metabolites in the processed commodities of rice. In one test conducted in AR in 1994, mature rice grain was harvested 110 days following a single postemergence broadcast application, on the day of flooding, of the 3% G formulation (EPA Reg. No. 279-2792) at 3 lb ai/A using ground/hand equipment. The registrant stated that applications were made at 5x the intended use rate.

At crop maturity, a bulk sample of untreated and treated rice grain was harvested and frozen. A subsample of the bulk rice grain sample was sent directly to FMC Corporation (Princeton, NJ) for residue analysis. The remainder of the bulk rice grain sample was shipped frozen to the processor (Food Protein R & D Center, Texas A & M University, Bryan, TX) where it was processed into polished rice, hulls, and bran within 63 days of harvest. The registrant submitted flow charts and material balance sheets for the processing of rice; however, a description of the procedure was not provided.

Unprocessed rice grain and processed polished rice, hulls, and bran fractions were shipped frozen on dry ice to the analytical laboratory (FMC Corporation, Princeton, NJ). Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated rice grain and rice processed commodities were determined using the HPLC and GC/MS methods described above. The results of the rice processing study are presented in Table 9. Apparent residues of carbofuran and its carbamate and phenolic metabolites were each less than the LOD (<0.01 ppm) in/on two untreated samples of rice grain and one sample each of polished rice, hulls, and bran processed from untreated rice grain.

Table 9. Residues of carbofuran and its carbamate and phenolic metabolites in/on **polished rice, hulls, and bran** processed from rice treated with a single postemergence broadcast application of the 3% G formulation at 3 lb ai/A.

Rice	Carbamates				Phenols				
Commodity	Carbofuran	3-keto	3-OH	Total [a]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined [a]
Residues (ppm) [b]									
Rice grain (field)	<0.01	<0.01	(0.02)	<0.03	0.05	<0.01	(0.02)	<0.08	<0.11
Rice grain (processor)	(0.01)	<0.01	(0.02)	0.03	0.05	<0.01	(0.02)	<0.08	<0.11
Polished rice	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.03	<0.05
Hulls	(0.02)	(0.02)	0.05	0.07	0.10 [c]	0.03	0.05	0.18	0.25
Bran	<0.01	<0.01	<0.01	<0.02	0.42	(0.02)	0.04	0.48	<0.50
Concentration/Reduction Factors [d]									
Polished rice	<1x	--	<0.5x	0.7x	<0.2x	--	<0.5x	<0.4x	0.5x
Hulls	2x	>2x	3x	2x	2x	>3x	3x	2x	>2x
Bran	<1x	--	<0.5x	0.7x	8x	>2x	2x	6x	5x

[a] Does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.
[b] Each residue value represents the highest value obtained from triplicate analyses of a single sample. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.03 ppm).
[c] The registrant stated that residues for 7-Ph in rice hulls were doubled due to low method recovery (53-54%).
[d] Concentration/reduction factors were determined relative to the rice grain sample from the processor.

Study summary: The submitted rice processing data indicate that total residues of carbofuran metabolites of concern concentrate in hulls (at least 2x) and bran (5x) but do not concentrate in polished rice processed from rice grain bearing detectable residues of carbofuran, 3-OH carbofuran, 7-Ph carbofuran, and 3-OH-7-Ph carbofuran following treatment at an exaggerated rate.

Field trial data for rice grain remain outstanding. When adequate rice field trial data have been submitted and evaluated, appropriate levels for tolerances for rice hulls and bran will be determined.

Sugarcane Processed Commodities

Established tolerances: A tolerance of 0.1 ppm has been established for the combined residues of carbofuran, its carbamate metabolite, and its phenolic metabolites in/on sugarcane [40 CFR §180.254(a)]. No food/feed additive tolerances have been established for residues of carbofuran in any sugarcane processed commodities.

Registered use patterns: See "Registered use patterns" under "Sugarcane" (page 27).

Discussion of the data: FMC Corporation submitted data (1992; MRID 43907801) pertaining to the potential for concentration of residues of carbofuran and its carbamate and phenolic

metabolites in the processed commodities of sugarcane. In one test conducted in LA in 1990-1991, sugarcane was harvested 31 days following the last of three applications of the 4 lb/gal FlC formulation (EPA Reg. No. 279-2876): an at-planting in-furrow treatment at 3 lb ai/A using ground equipment (3x the maximum application rate for this type of application), followed by two foliar spray (broadcast) applications at 2.25 lb ai/A/application (3x the maximum single application rate for foliar applications) using aerial equipment, 272 and 74 days after the first and second applications, respectively. The total application rate was 7.5 lb ai/A. Applications were made in ~26 gal/A of water using ground equipment, and 10 gal/A of water using aerial equipment.

At crop maturity, a bulk sample of untreated and treated sugarcane was harvested. A subsample of the bulk sugarcane sample was sent frozen directly to FMC Corporation (Princeton, NJ) for residue analysis. The remainder of the bulk sugarcane sample was shipped fresh by trailer truck to the processor (Audubon Sugar Institute, Louisiana State University, Baton Rouge, LA) where it was processed into molasses, sugar, and bagasse within 2 days of harvest.

Sugarcane was processed according to simulated commercial procedures into molasses, sugar, and bagasse. Briefly, sugarcane was chopped and pressed through a mill with water. The mixed juice was limed cold to a pH of 7-7.4, then heated and allowed to settle in clarifiers. A polyelectrolyte was added to aid the clarification process. The clarified juice was evaporated to syrup, and the syrup (in the crystallization stage) boiled. The resulting mixture of molasses and sugar was separated by centrifugation, and dried, yielding sugar and molasses. The sugar was water washed to increase the purity to 96-97% to more closely simulate commercial refined raw sugar. The registrant submitted adequate descriptions and material balance sheets for the processing procedures.

Unprocessed sugarcane stems and bagasse, and processed sugar and molasses fractions were shipped frozen on dry ice to the analytical laboratory (FMC Corporation, Princeton, NJ). Residues of carbofuran and its carbamate and phenolic metabolites in/on treated and untreated sugarcane and its processed commodities were determined using the HPLC and GC/MS methods described above. The results of the sugarcane processing study are presented in Table 10. Apparent residues of carbofuran and its carbamate and phenolic metabolites were nondetectable (<0.01 ppm each) in/on two samples of untreated sugarcane stems, and one sample each of bagasse, sugar, and molasses processed from untreated sugarcane.

Table 10. Residues of carbofuran and its carbamate and phenolic metabolites in/on **bagasse, sugar, and molasses processed from sugarcane** treated with three applications (a single at-planting in-furrow and two foliar applications), with 272- and 74-day retreatment intervals, of the 4 lb/gal FlC formulation at 3, 2.25, and 2.25 lb ai/A/application (7.5 lb ai/A/season).

Sugarcane	Carbamates				Phenols				
Commodity	Carbofuran	3-keto	3-OH	Total [a]	7-Ph	3-keto-7-Ph	3-OH-7-Ph	Total	Combined [a]
Residues (ppm) [b]									
Stems (field)	0.07 0.08	<0.01 <0.01	(0.02) (0.02)	0.09 0.10	0.05 0.08	<0.01 <0.01	(0.02) (0.02)	<0.08 <0.08	<0.17 <0.17
Stems (processor)	0.13 0.15	<0.01 <0.01	(0.02) (0.03)	0.15 0.18	0.04 0.05	<0.01 <0.01	(0.02) (0.02)	<0.07 <0.08	<0.22 <0.26
Bagasse	0.93 0.84	(0.02) (0.02)	0.21 0.22	1.14 1.06	0.19 0.17	0.05 0.06	0.20 0.16	0.44 0.37	1.58 1.43
Sugar	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.02 <0.02	(0.02) (0.02)	(0.01) <0.01	0.03 0.03	0.06 <0.05	<0.08 <0.07
Molasses	<0.01 <0.01	<0.01 <0.01	<0.01 <0.01	<0.02 <0.02	0.34 0.41	0.09 0.10	0.43 0.53	0.86 1.04	<0.88 <1.06
Concentration/Reduction Factors									
Bagasse	13x 11x	>2x >2x	11x 11x	13x 11x	4x 3x	>5x >6x	10x 8x	6x 5x	9x 8x
Sugar	<0.1x <0.1x	--	<0.5x <0.5x	<0.2x <0.2x	<0.4x <0.4x	>1x --	2x 2x	0.8x <0.6x	0.5x 0.4x
Molasses	<0.1x <0.1x	--	<0.5x <0.5x	<0.2x <0.2x	7x 8x	>9x >10x	22x 27x	11x 13x	5x 6x

[a] Does not include residues of 3-keto-carbofuran which is not a residue of concern of carbofuran.

[b] Each residue value represents the highest value obtained from replicate analyses of a single sample. Residue values in parentheses are estimates; ≥ LOD (0.01 ppm) but ≤ LOQ (0.03 ppm).

Study summary: The submitted sugarcane processing data are adequate and indicate that total residues of carbofuran metabolites of concern concentrate in molasses (5.5x) but do not concentrate in sugar processed from sugarcane bearing detectable residues of carbofuran, 3-OH-carbofuran, 7-Ph carbofuran, and 3-OH-7-Ph carbofuran following treatment at an exaggerated rate.

Based on an HAFT of <0.11 ppm and concentration factor of 5.5x for total carbofuran residues of concern, the maximum expected residues in sugarcane molasses would be calculated to be <0.61 ppm, which exceeds the reassessed tolerance (0.2 ppm) for sugarcane. A tolerance for residues of carbofuran, its carbamate metabolite, and phenol metabolites in sugarcane molasses is required; the submitted data will support a tolerance of 1 ppm.

AGENCY MEMORANDA CITED IN THIS DOCUMENT

CBRS No.:	1389
Subject:	EPA No. 279-GNAR: Carbofuran: Residue Data on Corn in Response to Registration Standard.
From:	J. Garbus
To:	D. Edwards
Date:	1/15/87
MRID(s):	00160773-00160775

CBRS No.:	6667
Subject:	EPA Reg. No. 279-2876 FMC Corporation proposes (letter dated 5/15/90) a new Direction Use for Carbofuran (Furadan 4F) on Potatoes for Future 24(c) Registration from Northeast States
From:	F. Toghrol
To:	D. Edwards/Jenkins
Date:	6/25/90
MRID(s):	None

CBRS No.:	10194
DP Barcode:	D180489
Subject:	Carbofuran. Magnitude of the Residue in Processed Parts of Field Corn Grain, Storage Stability of Processed Parts of Field Corn Grain, and Protocols for Nature of the Residue Studies in Potatoes, Corn, Soybean, and Lactating Goats. Waiver for Residue Analytical Method - Plant and Animal. reregistration Case No. 0101. Chemical No. 090601.
From:	S. Knizner
To:	J. Edwards
Date:	2/16/93
MRID(s):	42374003 and 42374004

MASTER RECORD IDENTIFICATION NUMBERS

43842601 Schreier, T. (1989) Cold Storage Stability of Carbofuran and its Carbamate Metabolites on Various Laboratory Fortified Crop and Animal Matrices: Lab Project Number: P-2163: 078CSSR04. Unpublished study prepared by FMC Corp. 60 p.

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