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Part III

Environmental Protection Agency

40 CFR Part 180

Carbofuran; Final Tolerance Revocations; Final Rule

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 180

[EPA–HQ–OPP–2005–0162; FRL–8413–3]

Carbofuran; Final Tolerance Revocations

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: EPA is revoking all tolerances for carbofuran. The Agency has determined that the risk from aggregate exposure from the use of carbofuran does not meet the safety standard of section 408(b)(2) of the Federal Food, Drug, and Cosmetic Act (FFDCA).

DATES: This final rule is effective August 13, 2009. Written objections, requests for a hearing, or requests for a stay identified by the docket identification (ID) number EPA–HQ–OPP–2005–0162 must be received on or before July 14, 2009, and must be filed in accordance with the instructions provided in 40 CFR part 178 (see also Unit I.C. of the **SUPPLEMENTARY INFORMATION**).

ADDRESSES: Written objections and hearing requests, identified by the docket ID number EPA–HQ–OPP–2005–0162, may be submitted to the Hearing Clerk by one of the following methods:

- *Mail*: U.S. EPA Office of the Hearing Clerk, Mailcode 1900 L, 1200 Pennsylvania Ave., NW., Washington, DC 20460–0001.
- *Delivery*: U.S. EPA Office of the Hearing Clerk, 1099 14th St., NW., Suite 350, Franklin Court, Washington, DC 20005. Deliveries are only accepted during the Office's normal hours of operation (8:30 a.m. to 4 p.m., Monday through Friday, excluding legal holidays). Special arrangements should be made for deliveries of boxed information. The Office's telephone number is (202) 564–6262.

In addition to filing an objection or hearing request with the Hearing Clerk as described in 40 CFR part 178, please submit a copy of the filing that does not contain any CBI for inclusion in the public docket that is described in **ADDRESSES**. Information not marked confidential pursuant to 40 CFR part 2 may be disclosed publicly by EPA without prior notice. Submit this copy, identified by docket ID number EPA–HQ–OPP–2005–0162, by one of the following methods:

- *Federal eRulemaking Portal*: *http://www.regulations.gov*. Follow the on-line instructions for submitting comments.
- *Mail*: Office of Pesticide Programs (OPP) Regulatory Public Docket (7502P), Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460–0001.
- *Delivery*: OPP Regulatory Public Docket (7502P), Environmental Protection Agency, Rm. S-4400, One Potomac Yard (South Bldg.), 2777 S. Crystal Dr., Arlington, VA. Deliveries are only accepted during the Docket's normal hours of operation (8:30 a.m. to 4 p.m., Monday through Friday, excluding legal holidays). Special arrangements should be made for deliveries of boxed information. The Docket Facility telephone number is (703) 305–5805.

Docket: All documents in the docket are listed in the docket index. Although listed in the index, some information is not publicly available, *e.g.*, CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available in the electronic docket at *http://www.regulations.gov*, or, if only available in hard copy, at the OPP Regulatory Public Docket in Rm. S–4400, One Potomac Yard (South Bldg.), 2777 S. Crystal Dr., Arlington, VA. The Docket Facility is open from 8:30 a.m. to 4 p.m., Monday through Friday, excluding legal holidays. The Docket Facility telephone number is (703) 305–5805.

Submitting CBI. Do not submit this information to EPA through regulations.gov or e-mail. Clearly mark the part or all of the information that you claim to be CBI. For CBI information in a disk or CD-ROM that you mail to EPA, mark the outside of the disk or CD-ROM as CBI and then identify electronically within the disk or CD-ROM the specific information that is claimed as CBI. In addition to one complete version of the objection that includes information claimed as CBI, a copy of the objection that does not contain the information claimed as CBI must be submitted for inclusion in the public docket. Information so marked will not be disclosed except in accordance with procedures set forth in 40 CFR part 2.

FOR FURTHER INFORMATION CONTACT: Jude Andreasen, Special Review and Reregistration Division (7508P), Office of Pesticide Programs, Environmental Protection Agency, 1200 Pennsylvania Ave, NW., Washington, DC 20460–0001; telephone number: (703) 308–9342; e-mail address: *andreasen.jude@epa.gov*.

SUPPLEMENTARY INFORMATION:

I. General Information

A. Does This Action Apply to Me?

You may be potentially affected by this action if you are an agricultural producer, food manufacturer, or pesticide manufacturer. Potentially affected entities may include, but are not limited to:

- Crop production (NAICS code 111).
- Animal production (NAICS code 112).
- Food manufacturing (NAICS code 311).
- Pesticide manufacturing (NAICS code 32532).

This listing is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be affected by this action. Other types of entities not listed in this unit could also be affected. The North American Industrial Classification System (NAICS) codes have been provided to assist you and others in determining whether this action might apply to certain entities. To determine whether you or your business may be affected by this action, you should carefully examine the applicability provisions in Unit II.A. If you have any questions regarding the applicability of this action to a particular entity, consult the person listed under **FOR FURTHER INFORMATION CONTACT**.

B. How Can I Access Electronic Copies of This Document?

In addition to accessing an electronic copy of this **Federal Register** document through the electronic docket at *http://www.regulations.gov*, you may access this **Federal Register** document electronically through the EPA Internet under the ''**Federal Register**'' listings at *http://www.epa.gov/fedrgstr*. You may also access a frequently updated electronic version of EPA's tolerance regulations at 40 CFR part 180 through the Government Printing Office's pilot e-CFR site at *http://www.gpoaccess.gov/ecfr*.

C. What Can I Do if I Wish the Agency To Maintain a Tolerance That the Agency Has Revoked?

Any affected party has 60 days from the date of publication of this order to file objections to any aspect of this order with EPA and to request an evidentiary hearing on those objections (21 U.S.C. 346a(g)(2)). A person may raise objections without requesting a hearing.

The objections submitted must specify the provisions of the regulation deemed objectionable and the grounds for the objection (40 CFR 178.25). Each objection must be accompanied by the fee prescribed by 40 CFR 180.33(i). If a

hearing is requested, the objections must include a statement of the factual issue(s) on which a hearing is requested, the requestor's contentions on such issues, and a summary of any evidence relied upon by the objector (40 CFR 178.27).

Although any person may file an objection, the substance of the objection must have been initially raised as an issue in comments on the proposed rule. As explained in the July 31, 2008 proposed rule (73 FR 44864) (FRL–8378–8), EPA will treat as waived any issue not originally raised in timely submitted comments. Accordingly, EPA will not consider any legal or factual issue presented in objections that was not presented by a commenter in response to the proposed rule, if that issue could reasonably have been raised at the time of the proposal.

Similarly, if you fail to file an objection to an issue resolved in the final rule within the time period specified, you will have waived the right to challenge the final rule's resolution of that issue (40 CFR 178.30(a)). After the specified time, issues resolved in the final rule cannot be raised again in any subsequent proceedings on this rule. *See Nader v EPA*, 859 F.2d 747 (9th Cir. 1988), *cert denied* 490 US 1931 (1989).

You must file your objection or request a hearing on this regulation in accordance with the instructions provided in 40 CFR part 178. To ensure proper receipt by EPA, you must identify docket ID number EPA–HQ–OPP–2005–0162 in the subject line on the first page of your submission. All requests must be in writing, and must be received by the Hearing Clerk as required by 40 CFR part 178 on or before July 14, 2009.

EPA will review any objections and hearing requests in accordance with 40 CFR 178.30, and will publish its determination with respect to each in the **Federal Register**. A request for a hearing will be granted only to resolve factual disputes; objections of a purely policy or legal nature will be resolved in the Agency's final order, and will only be subject to judicial review pursuant to 21 U.S.C. 346a(h)(1), (40 CFR 178.20(c) and 178.32(b)(1)). A hearing will only be held if the Administrator determines that the material submitted shows the following: There is a genuine and substantial issue of fact; there is a reasonable probability that available evidence identified by the requestor would, if established, resolve one or more of such issues in favor of the requestor, taking into account uncontested claims to the contrary; and resolution of the issue(s) in the manner sought by the requestor would be adequate to justify the action requested (40 CFR 178.30).

II. Introduction

A. What Action Is the Agency Taking?

EPA is revoking all of the existing tolerances for residues of carbofuran. Currently, tolerances have been established on the following crops: Alfalfa, forage; alfalfa, hay; artichoke, globe; banana; barley, grain; barley, straw; beet, sugar roots; beet, sugar tops; coffee bean, green; corn, forage; corn, grain (including popcorn); corn, stover; corn, sweet, kernel plus cob; cotton, undelinted seed; cranberry; cucumber; grape; grape raisin; grape, raisin, waste; melon; milk; oat, grain; oat, straw; pepper; potato; pumpkin; rice, grain; rice, straw; sorghum, forage; sorghum, grain grain; sorghum, grain, stover; strawberry; soybean, forage; soybean, hay; squash; sugarcane, cane; sunflower, seed; wheat, grain; wheat, straw.

As discussed at greater length in Unit VII., on September 29, 2008, the sole registrant of carbofuran pesticide products, FMC Corporation requested that EPA cancel certain registrations. Consistent with the request, the registrant indicated that it no longer seeks to maintain the tolerances associated with the domestic use of carbofuran on the eliminated crops, and therefore no longer opposes the revocation of those tolerances. No other commenter indicated any interest in maintaining these tolerances. EPA is therefore revoking the tolerances associated with those domestic uses on two separate grounds. The first is that the tolerances will no longer be necessary because the registrations for these uses have been canceled (74 FR 11551, March 18, 2009) (FRL–8403–6). The tolerances that EPA is revoking on this basis are: Alfalfa, forage; alfalfa, hay; artichoke, globe; barley, grain; barley, straw; beet, sugar roots; beet, sugar tops; corn, fresh (including sweet); cotton, undelinted seed; cranberry; cucumber; grape; grape raisin; grape, raisin, waste; melon; oat, grain; oat, straw; pepper; rice, straw; sorghum, forage; sorghum, grain grain; sorghum, grain, stover; strawberry; soybean, forage; soybean, hay; squash; wheat, grain; and wheat, straw. The second basis is that EPA also finds, that as outlined in its July 31, 2008 proposed rule, revocation of these tolerances is warranted on the grounds that aggregate exposure to residues from these tolerances do not meet the safety standard of section 408(b)(2) of the FFDCA. The Agency is therefore revoking tolerances for these crops because aggregate dietary exposure to these residues of carbofuran, including all anticipated dietary exposures and all other exposures for which there is reliable information, is not safe.

The remaining tolerances the commenters seek to retain are: Banana; coffee bean; corn, forage; corn, grain; corn, stover; milk; potato; pumpkin; rice, grain; sugarcane, cane; and sunflower, seed. EPA has determined that aggregate exposure to carbofuran greater than 0.000075 milligrams/kilogram/day (mg/kg/day) (*i.e.*, greater than the acute Population Adjusted Dose (aPAD)) does not meet the safety standard of section 408(b)(2) of the FFDCA. For the 11 remaining tolerances, based on the contribution from food alone, exposure levels are below EPA's level of concern. At the 99.9th percentile of exposure, aggregate carbofuran dietary exposure from food alone was estimated to range between 0.000020 mg/kg/day for children 6 to 12 years old (29% of the aPAD) and 0.000058 mg/kg/day (78% of the aPAD) for children 1 to 2 years old, the population subgroup with the highest estimated dietary exposure. However, EPA's analyses show that those individuals—both adults and children—who receive their drinking water from sources vulnerable to carbofuran contamination are exposed to carbofuran levels that exceed EPA's level of concern—in some cases by orders of magnitude. This primarily includes those populations consuming drinking water from ground water from shallow wells in acidic aquifers overlaid with sandy soils that have had crops treated with carbofuran. Aggregate exposures from food and from drinking water derived from ground water in vulnerable areas (*e.g.*, from shallow wells associated with sandy soils and acidic aquifers) result in significant estimated exceedances. The estimates for aggregate food and ground water exposure from such sources range between 780% of the aPAD for adults over 50 years, to 9,400% of the aPAD for infants. Similarly, EPA analyses show substantial exceedances for those populations that obtain their drinking water from reservoirs (*i.e.*, surface water) located in small agricultural watersheds, prone to runoff, and predominated by crops that are treated with carbofuran, even though there is more uncertainty associated with these exposure estimates. For example, estimated aggregate exposures from food and drinking water derived from surface water, based on corn use in Nebraska, range between 330% of the aPAD for

youths 13 to 19 years old and 3,900% of the aPAD for infants.

Every analysis EPA has performed has shown that estimated exposures from drinking water from each remaining domestic use significantly exceed EPA's level of concern for children. Accordingly, aggregate exposures from food and water significantly exceed safe levels. Although the magnitude of the exceedance varies depending on the level of conservatism in the assessment, the fact that in each case aggregate exposures to residues of carbofuran fail to meet the FFDCA section 408(b)(2) safety standard, including where EPA relied on highly refined estimates of risk, using all relevant data and methods, strongly corroborates EPA's conclusion that aggregate exposures to residues of carbofuran are not safe.

B. Overview of Final Rule

EPA's final rule preamble is organized primarily into two sections. Following a brief summary of the July 31, 2008 proposed rule, EPA summarizes the major comments received on the proposed rule, along with the Agency's responses in Unit VII. Because EPA only presents a summary of all of the comments received, readers are encouraged to also consult EPA's Response to Comments Documents, found in the docket for today's action (Refs. 111, 112, 113). These documents contain EPA's complete responses to all of the significant comments received on this rulemaking, and therefore will contain a more detailed explanation on many of the issues presented in Unit VII.

Unit VIII. presents the results of EPA's analyses of carbofuran's dietary risks. This Unit generally describes the bases for the Agency's conclusions that carbofuran presents unacceptable dietary risks to children. Readers are also encouraged to consult EPA's underlying risk assessment support documents, identified in the References section, and contained in the docket for today's action, for a more detailed presentation of EPA's scientific analyses.

Each of these units is generally organized consistent with the structure of a risk assessment. Each unit begins with a discussion of carbofuran's toxicity, and EPA's hazard identification, including a discussion of the issues surrounding the selection of the children's safety factor EPA has applied to this chemical. EPA then discusses issues relating to carbofuran's exposures from food and drinking water. The final section of each unit relates to EPA's conclusions regarding the risks from carbofuran's aggregate (*i.e.*, food + water) exposures.

C. What Is the Agency's Authority for Taking This Action?

EPA is taking this action, pursuant to the authority in FFDCA sections 408(b)(1)(b), 408(b)(2)(A), and 408(e)(1)(A). 21 U.S.C. 346a(b)(1)(b), (b)(2)(A), (e)(1)(A).

III. Statutory and Regulatory Background

A ''tolerance'' represents the maximum level for residues of pesticide chemicals legally allowed in or on raw agricultural commodities (including animal feed) and processed foods. Section 408 of FFDCA, 21 U.S.C. 346a, as amended by the Food Quality Protection Act (FQPA) of 1996, Public Law 104–170, authorizes the establishment of tolerances, exemptions from tolerance requirements, modifications to tolerances, and revocation of tolerances for residues of pesticide chemicals in or on raw agricultural commodities and processed foods. Without a tolerance or exemption, food containing pesticide residues is considered to be unsafe and therefore ''adulterated'' under section 402(a) of the FFDCA, 21 U.S.C. 342(a). Such food may not be distributed in interstate commerce (21 U.S.C. 331(a)). For a food-use pesticide to be sold and distributed, the pesticide must not only have appropriate tolerances under the FFDCA, but also must be registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 U.S.C. 136 *et seq.*). Food-use pesticides not registered in the United States must have tolerances in order for commodities treated with those pesticides to be imported into the United States.

Section 408(e) of the FFDCA, 21 U.S.C. 346a(e), authorizes EPA to modify or revoke tolerances on its own initiative. EPA is revoking these tolerances to implement the Agency's findings made during the reregistration and tolerance reassessment processes. As part of these processes, EPA is required to determine whether each of the existing tolerances meets the safety standard of section 408(b)(2) (21 U.S.C. 346a(b)(2)). Section 408(b)(2)(A)(i) of the FFDCA requires EPA to modify or revoke a tolerance if EPA determines that the tolerance is not ''safe'' (21 U.S.C. 346a(b)(2)(A)(i)). Section 408(b)(2)(A)(ii) of the FFDCA defines ''safe'' to mean that ''there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information'' (21 U.S.C. 346a(b)(2)(A)(ii). This includes exposure through drinking water and in residential settings, but does not include occupational exposure.

Risks to infants and children are given special consideration. Specifically, section 408(b)(2)(C) states that EPA:

> shall assess the risk of the pesticide chemical based on— . . .
>
> (II) available information concerning the special susceptibility of infants and children to the pesticide chemical residues, including neurological differences between infants and children and adults, and effects of *in utero* exposure to pesticide chemicals; and
>
> (III) available information concerning the cumulative effects on infants and children of such residues and other substances that have a common mechanism of toxicity. . . .

(21 U.S.C. 346a(b)(2)(C)(i)(II) and (III)).

This provision further directs that ''[i]n the case of threshold effects, . . .an additional tenfold margin of safety for the pesticide chemical residue and other sources of exposure shall be applied for infants and children to take into account potential pre- and post-natal toxicity and completeness of the data with respect to exposure and toxicity to infants and children'' (21 U.S.C. 346a(b)(2)(C)). EPA is permitted to ''use a different margin of safety for the pesticide chemical residue only if, on the basis of reliable data, such margin will be safe for infants and children'' (Id.). The additional safety margin for infants and children is referred to throughout this final rule as the ''children's safety factor.''

IV. Carbofuran Background and Regulatory History

In July 2006, EPA completed a refined acute probabilistic dietary risk assessment for carbofuran as part of the reassessment program under section 408(q) of the FFDCA. The assessment was conducted using Dietary Exposure Evaluation Model-Food Commodity Intake Database (DEEM-FCID™, Version 2.03), which incorporates consumption data from the United States Department of Agriculture's (USDA's) Nationwide Continuing Surveys of Food Intake by Individuals (CSFII), 1994–1996 and 1998, as well as carbofuran monitoring data from USDA's Pesticide Data Program[1] (PDP), estimated percent crop treated information, and processing/cooking factors, where applicable. The assessment was conducted applying a

[1] USDA's Pesticide Data Program monitors for pesticides in certain foods at the distribution points just before release to supermarkets and grocery stores.

500–fold safety factor that included a 5X children's safety factor, pursuant to section 408(b)(2)(C). That refined assessment showed acute dietary risks from carbofuran residues in food above EPA's level of concern (Ref. 19). Since 2006, EPA has evaluated additional data submitted by the registrant, FMC Corporation, and has further refined its original assessment by incorporating more recent 2005/2006 PDP data, and by conducting additional analyses. In January 2008, EPA published a draft Notice of Intent to Cancel (NOIC) all carbofuran registrations, based in part on carbofuran's dietary risks. As mandated by FIFRA, EPA solicited comments from the FIFRA Scientific Advisory Panel (SAP) on its draft NOIC. Having considered the comments from the SAP, EPA initiated the process to revoke all carbofuran tolerances, publishing its proposed revocation on July 31, 2008 (73 FR 44864). The comment period for the proposed rule closed on September 29, 2008. Having considered all comments received by this date, EPA is now finalizing the revocation of all existing carbofuran tolerances. As noted above, aggregate exposures from food and water to the U.S. population at the upper percentiles of exposure substantially exceed the safe daily levels and thus are ''unsafe'' within the meaning of FFDCA section 408(b)(2) (Ref. 71). It is particularly significant that under every analysis EPA has conducted, the levels of carbofuran exceed the safe daily dose for children, even when EPA used the most refined data and models available. Based on these findings, EPA has decided to move expeditiously to address the unacceptable dietary risks to children. EPA anticipates issuing the NOIC subsequent to undertaking the activities required to revoke the carbofuran tolerances.

V. EPA's Approach to Dietary Risk Assessment

EPA performs a number of analyses to determine the risks from aggregate exposure to pesticide residues. A short summary is provided below to aid the reader. For further discussion of the regulatory requirements of section 408 of the FFDCA and a complete description of the risk assessment process, see *http://www.epa.gov/fedrgstr/EPA-PEST/1999/January/Day-04/p34736.htm*

To assess the risk of a pesticide tolerance, EPA combines information on pesticide toxicity with information regarding the route, magnitude, and duration of exposure to the pesticide. The risk assessment process involves four distinct steps: (1) Identification of the toxicological hazards posed by a pesticide; (2) determination of the exposure ''level of concern'' for humans; (3) estimation of human exposure; and (4) characterization of human risk based on comparison of human exposure to the level of concern.

A. Hazard Identification and Selection of Toxicological Endpoint

Any risk assessment begins with an evaluation of a chemical's inherent properties, and whether those properties have the potential to cause adverse effects (*i.e.*, a hazard identification). EPA then evaluates the hazards to determine the most sensitive and appropriate adverse effect of concern, based on factors such as the effect's relevance to humans and the likely routes of exposure.

Once a pesticide's potential hazards are identified, EPA determines a toxicological level of concern for evaluating the risk posed by human exposure to the pesticide. In this step of the risk assessment process, EPA essentially evaluates the levels of exposure to the pesticide at which effects might occur. An important aspect of this determination is assessing the relationship between exposure (dose) and response (often referred to as the dose-response analysis). In evaluating a chemical's dietary risks EPA uses a reference dose (RfD) approach, which involves a number of considerations including:

- A ''point of departure'' (PoD)—the value from a dose-response curve that is at the low end of the observable data and that is the toxic dose that serves as the 'starting point' in extrapolating a risk to the human population.
- An uncertainty factor to address the potential for a difference in toxic response between humans and animals used in toxicity tests (*i.e.*, interspecies extrapolation).
- An uncertainty factor to address the potential for differences in sensitivity in the toxic response across the human population (for intraspecies extrapolation).
- The need for an additional safety factor to protect infants and children, as specified in FFDCA section 408(b)(2)(C).

EPA uses the chosen PoD to calculate a safe dose or RfD. The RfD is calculated by dividing the chosen PoD by all applicable safety or uncertainty factors. Typically in EPA risk assessments, a combination of safety or uncertainty factors providing at least a hundredfold (100X) margin of safety is used: 10X to account for interspecies extrapolation and 10X to account for intraspecies extrapolation. Further, in evaluating the dietary risks for pesticide chemicals, an additional safety factor of 10X is presumptively applied to protect infants and children, unless reliable data support selection of a different factor. In implementing FFDCA section 408, EPA also calculates a variant of the RfD referred to as a Population Adjusted Dose (PAD). A PAD is the RfD divided by any portion of the children's safety factor that does not correspond to one of the traditional additional uncertainty/safety factors used in general Agency risk assessment. The reason for calculating PADs is so that other parts of the Agency, which are not governed by FFDCA section 408, can, when evaluating the same or similar substances, easily identify which aspects of a pesticide risk assessment are a function of the particular statutory commands in FFDCA section 408. For acute assessments, the risk is expressed as a percentage of a maximum acceptable dose or the acute PAD (*i.e.*, the acute dose which EPA has concluded will be ''safe''). As discussed below in Unit V.C., dietary exposures greater than 100% of the acute PAD are generally cause for concern and would be considered ''unsafe'' within the meaning of FFDCA section 408(b)(2)(B). Throughout this document general references to EPA's calculated safe dose are denoted as an acute PAD, or aPAD, because the relevant point of departure for carbofuran is based on an acute risk endpoint.

Carbofuran is a member of the class of pesticides called *n*-methyl carbamates (NMCs). The primary toxic effect caused by NMCs, including carbofuran, is neurotoxicity resulting from inhibition of the enzyme acetylcholinesterase (AChE, See Unit VIII.A.). The toxicity profile of these pesticides is characterized by rapid time to onset of effects followed by rapid recovery (minutes to hours). Consistent with its mechanism of action, toxicity data on AChE inhibition from laboratory rats provide the basis for deriving the PoD for carbofuran.

B. Estimating Human Dietary Exposure Levels

Pursuant to section 408(b) of the FFDCA, EPA has evaluated carbofuran's dietary risks based on ''aggregate exposure'' to carbofuran. By ''aggregate exposure,'' EPA is referring to exposure to carbofuran by multiple pathways of exposure. EPA uses available data and standard analytical methods, together with assumptions designed to be protective of public health, to produce separate estimates of exposure for a highly exposed subgroup of the general population, for each potential pathway and route of exposure. For acute risks,

EPA then calculates potential aggregate exposure and risk by using probabilistic [2] techniques to combine distributions of potential exposures in the population for each route or pathway. For dietary analyses, the relevant sources of potential exposure to carbofuran are from the ingestion of residues in food and drinking water. The Agency uses a combination of monitoring data and predictive models to evaluate environmental exposure of humans to carbofuran.

1. *Exposure from Food*. Data on the residues of carbofuran in foods are available from a variety of sources. One of the primary sources of data comes from federally conducted surveys, including the PDP conducted by the USDA. Further, market basket surveys, which are typically performed by registrants, can provide additional residue data. These data generally provide a characterization of pesticide residues in or on foods consumed by the U.S. population that closely approximates real world exposures because they are sampled closer to the point of consumption in the chain of commerce than field trial data, which are generated to establish the maximum level of legal residues that could result from maximum permissible use of the pesticide. In certain circumstances, when EPA believes the information will provide more accurate exposure estimates, EPA will rely on field trial data (see below in Unit VIII.E.1.).

EPA uses a computer program known as the DEEM-FCID™ to estimate exposure by combining data on human consumption amounts with residue values in food commodities. DEEM-FCID™ also compares exposure estimates to appropriate RfD or PAD values to estimate risk. EPA uses DEEM-FCID™ to estimate exposure for the general U.S. population as well as for 32 subgroups based on age, sex, ethnicity, and region. DEEM-FCID™ allows EPA to process extensive volumes of data on human consumption amounts and residue levels in making risk estimates. Matching consumption and residue data, as well as managing the thousands of repeated analyses of the consumption database conducted under probabilistic risk assessment techniques, requires the use of a computer.

DEEM-FCID™ contains consumption and demographic information on the individuals who participated in the USDA's CSFII in 1994–1996 and 1998. The 1998 survey was a special survey required by the FQPA to supplement the number of children survey participants. DEEM-FCID™ also contains ''recipes'' that convert foods as consumed (*e.g.*, pizza) back into their component raw agricultural commodities (*e.g.*, wheat from flour, or tomatoes from sauce). This is necessary because residue data are generally gathered on raw agricultural commodities rather than on finished ready-to-eat food. Data on residue values for a particular pesticide and the RfD or PADs for that pesticide are inputs to the DEEM-FCID™ program to estimate exposure and risk.

For carbofuran's assessment, EPA used DEEM-FCID™ to calculate risk estimates based on a probabilistic distribution. DEEM-FCID™ combines the full range of residue values for each food with the full range of data on individual consumption amounts to create a distribution of exposure and risk levels. More specifically, DEEM-FCID™ creates this distribution by calculating an exposure value for each reported day of consumption per person (''person-day'') in CSFII, assuming that all foods potentially bearing the pesticide residue contain such residue at a value selected randomly from the concentration data sets. The exposure amounts for the thousands of person-days in the CSFII are then collected in a frequency distribution. EPA also uses DEEM-FCID™ to compute a distribution taking into account both the full range of data on consumption levels and the full range of data on potential residue levels in food. Combining consumption and residue levels into a distribution of potential exposures and risk requires use of probabilistic techniques.

The probabilistic technique that DEEM-FCID™ uses to combine differing levels of consumption and residues involves the following steps:

(1) Identification of any food(s) that could bear the residue in question for each person-day in the CSFII.

(2) Calculation of an exposure level for each of the thousands of person-days in the CSFII database, based on the foods identified in Step #1 by randomly selecting residue values for the foods from the residue database.

(3) Repetition of Step #2 one thousand times for each person-day.

(4) Collection of all of the hundreds of thousands of potential exposures estimated in Steps ## 2 and 3 in a frequency distribution.

The resulting probabilistic assessment presents a range of exposure/risk estimates.

2. *Exposure from water*. EPA may use field monitoring data and/or simulation water exposure models to generate pesticide concentration estimates in drinking water. Monitoring and modeling are both important tools for estimating pesticide concentrations in water and can provide different types of information. Monitoring data can provide estimates of pesticide concentrations in water that are representative of the specific agricultural or residential pesticide practices in specific locations, under the environmental conditions associated with a sampling design (*i.e.*, the locations of sampling, the times of the year samples were taken, and the frequency by which samples were collected). Although monitoring data can provide a direct measure of the concentration of a pesticide in water, it does not always provide a reliable basis for estimating spatial and temporal variability in exposures because sampling may not occur in areas with the highest pesticide use, and/or when the pesticides are being used and/or at an appropriate sampling frequency to detect high concentrations of a pesticide that occur over the period of a day to several days.

Because of the limitations in most monitoring studies, EPA's standard approach is to use simulation water exposure models as the primary means to estimate pesticide exposure levels in drinking water. Modeling is a useful tool for characterizing vulnerable sites, and can be used to estimate peak pesticide water concentrations from infrequent, large rain events. EPA's computer models use detailed information on soil properties, crop characteristics, and weather patterns to estimate water concentrations in vulnerable locations where the pesticide could be used according to its label (69 FR 30042, 30058–30065, May 26, 2004) (FRL–7355–7). These models calculate estimated water concentrations of pesticides using laboratory data that describe how fast the pesticide breaks down to other chemicals and how it moves in the environment at these vulnerable locations. The modeling provides an estimate of pesticide concentrations in ground water and surface water. Depending on the modeling algorithm (*e.g.*, surface water modeling scenarios), daily concentrations can be estimated

[2] Probabilistic analysis is used to predict the frequency with which variations of a given event will occur. By taking into account the actual distribution of possible consumption and pesticide residue values, probabilistic analysis for pesticide exposure assessments ''provides more accurate information on the range and probability of possible exposure and their associated risk values'' (Ref. 101). In capsule, a probabilistic pesticide exposure analysis constructs a distribution of potential exposures based on data on consumption patterns and residue levels and provides a ranking of the probability that each potential exposure will occur. People consume differing amounts of the same foods, including none at all, and a food will contain differing amounts of a pesticide residue, including none at all.

continuously over long periods of time, and for places that are of most interest for any particular pesticide.

EPA relies on models it has developed for estimating pesticide concentrations in both surface water and ground water. Typically EPA uses a two-tiered approach to modeling pesticide concentrations in surface and ground water. If the first tier model suggests that pesticide levels in water may be unacceptably high, a more refined model is used as a second tier assessment. The second tier model for surface water is actually a combination of two models: The Pesticide Root Zone Model (PRZM) and the Exposure Analysis Model System (EXAMS). The second tier model for ground water uses PRZM alone.

A detailed description of the models routinely used for exposure assessment is available from the EPA OPP Water Models web site: *http://www.epa.gov/oppefed1/models/water/index.htm*. These models provide a means for EPA to estimate daily pesticide concentrations in surface water sources of drinking water (a reservoir) using local soil, site, hydrology, and weather characteristics along with pesticide application and agricultural management practices, and pesticide environmental fate and transport properties. Consistent with the recommendations of the FIFRA SAP, EPA also considers regional percent cropped area factors (PCA) which take into account the potential extent of cropped areas that could be treated with pesticides in a particular area. The PRZM and EXAMS models used by EPA were developed by EPA's Office of Research and Development (ORD), and are used by many international pesticide regulatory agencies to estimate pesticide exposure in surface water. EPA's use of the PCA area factors and the Index Reservoir scenario was reviewed by the FIFRA SAP in 1999 and 1998, respectively (Refs. 37 and 38).

In modeling potential surface water concentrations, EPA attempts to model areas of the country that are vulnerable to surface water contamination rather than simply model ''typical'' concentrations occurring across the nation. Consequently, EPA models exposures occurring in small highly agricultural watersheds in different growing areas throughout the country, over a 30–year period. The scenarios are designed to capture residue levels in drinking water from reservoirs with small watersheds with a large percentage of land use in agricultural production. EPA believes these assessments are likely reflective of a small subset of the watersheds across the country that maintain drinking water reservoirs, representing a drinking water source generally considered to be more vulnerable to frequent high concentrations of pesticides than most locations that could be used for crop production.

EPA uses the output of daily concentration values from tier two modeling as an input to DEEM-FCID™, which combines water concentrations with drinking water consumption information in the daily diet to generate a distribution of exposures from consumption of drinking water contaminated with pesticides. These results are then used to calculate a probabilistic assessment of the aggregate human exposure and risk from residues in food and drinking water.

3. *Aggregate exposure analyses*. Using probabilistic analyses, EPA combines the national food exposures with the exposures derived for individual region and crop-specific drinking water scenarios to derive estimates of aggregate exposure. Although food is distributed nationally, and residue values are therefore not expected to vary substantially throughout the country, drinking water is locally derived and concentrations of pesticides in source water fluctuate over time and location for a variety of reasons. Pesticide residues in water fluctuate daily, seasonally, and yearly as a result of the timing of the pesticide application, the vulnerability of the water supply to pesticide loading through runoff, spray drift and/or leaching, and changes in the weather. Concentrations are also affected by the method of application, the location and characteristics of the sites where a pesticide is used, the climate, and the type and degree of pest pressure.

EPA's standard acute dietary exposure assessment calculates total dietary exposure over a 24–hour period; that is consumption over 24 hours is summed and no account is taken of the fact that eating and drinking occasions may spread out exposures over a day. This total daily exposure generally provides reasonable estimates of the risks from acute dietary exposures, given the nature of most chemical endpoints. Due to the rapid recovery associated with carbofuran toxicity (AChE inhibition), 24–hour exposure periods may or may not, *a priori*, be appropriate. To the extent that a day's eating or drinking occasions leading to high total daily exposure might be found close together in time, or to occur from a single eating event, minimal AChE recovery would occur between eating occasions (*i.e.*, exposure events). In that case, the ''24-hour sum'' approach, which sums eating events over a 24-hour period, would provide reasonable estimates of risk from food and drinking water. Conversely, to the extent that eating occasions leading to high total daily exposures are widely separated in time (within 1 day) such that substantial AChE recovery occurs between eating occasions, then the estimated risks under any 24–hour sum approach may be overstated. In that case, a more sophisticated approach – one that accounts for intra-day eating and drinking patterns and the recovery of AChE between exposure events — may be more appropriate. This approach is referred to as the ''Eating Occasions Analysis'' and it takes into account the fact that the toxicological effect of a first dose may be reduced or tempered prior to a second (or subsequent) dose.

Thus, rather than treating a full day's exposure as a one-time ''bolus'' dose, as is typically done in the Agency's assessments, the Eating Occasion Analysis uses the actual time of eating or drinking occasion, and amounts consumed as reported by individuals to the USDA CSFII. The actual CSFII-recorded time of each eating event is used to ''separate out'' the exposures due to each eating occasion; in doing so, this ''separation'' allows the Agency to distinguish between each intake event and account for the fact that at least some partial recovery of AChE inhibition attributable to the first (earlier) exposure occurs before the second exposure event. For chemicals for which the toxic effect is rapidly reversible, the time between two (or more) exposure events permits partial to full recovery from the toxic effect from the first exposure and it is this ''partial recovery'' that is specifically accounted for by the Eating Occasion Analysis. More specifically, an estimated ''persisting dose'' from the first exposure event is added to the second exposure event to account for the partial recovery of AChE inhibition that occurs over the time between the first and second exposures. The ''persisting dose'' terminology, and this general approach were originally offered by the FIFRA SAP in the context of assessing AChE inhibition from cumulative exposures to organophosphorous pesticides (OPs) (Ref. 40).

C. Selection of Acute Dietary Exposure Level of Concern

Because probabilistic assessments generally present a realistic range of residue values to which the population may be exposed, EPA's starting point for estimating exposure and risk for such aggregate assessments is the 99.9th percentile of the population under

evaluation, which represents one person out of every 1,000 persons. When using a probabilistic method of estimating acute dietary exposure, EPA typically assumes that, when the 99.9th percentile of acute exposure is equal to or less than the aPAD, the level of concern for acute risk has not been exceeded. By contrast, where the analysis indicates that estimated exposure at the 99.9th percentile exceeds the aPAD, EPA would generally conduct one or more sensitivity analyses to determine the extent to which the estimated exposures at the high-end percentiles may be affected by unusually high food consumption or residue values. To the extent that one or a few values seem to ''drive'' the exposure estimates at the high end of exposure, EPA would consider whether these values are reasonable and should be used as the primary basis for regulatory decision making (Ref. 101).

VI. Summary of the Proposed Rule

EPA proposed to revoke all of the existing tolerances for residues of carbofuran on the grounds that aggregate exposure from all uses of carbofuran fail to meet the FFDCA section 408 safety standard (73 FR 44864). Based on the contribution from food alone, EPA calculated that dietary exposures to carbofuran exceeded EPA's level of concern for all of the more sensitive subpopulations of infants and children. At the 99.9th percentile, carbofuran dietary exposure from food alone was estimated at 0.000082 mg/kg/day (110% of the aPAD) for children 3–5 years old, the population subgroup with the highest estimated dietary exposure (Ref. 16). In addition, EPA's analyses showed that those individuals—both adults as well as children—who receive their drinking water from vulnerable sources are also exposed to levels that exceed EPA's level of concern—in some cases by orders of magnitude. This primarily included those populations consuming drinking water from ground water from shallow wells in acidic aquifers overlaid with sandy soils that have had crops treated with carbofuran. It also included those populations that obtain their drinking water from reservoirs located in small agricultural watersheds, prone to runoff, and predominated by crops that are treated with carbofuran, although there was more uncertainty associated with these exposure estimates. The proposal discussed a number of sensitivity analyses the Agency had conducted in order to further characterize the potential risks to children. Every one of these sensitivity analyses determined that estimated exposures significantly exceeded EPA's level of concern for children.

VII. Summary of Public Comments and EPA Responses

This section presents a summary of some of the significant comments received on the proposed rule, as well as the Agency's responses. More detailed responses to these comments, along with the Agency's responses to other comments received can be found in the Response to Comments Documents, located in the docket for this rulemaking (Refs. 111, 112, and 113).

A. Tolerances Associated With Voluntarily Canceled Uses

On September 29, 2008, the registrant, FMC Corporation requested EPA to eliminate several uses from their end-use products. Consistent with this request, the registrant has indicated that it no longer seeks to maintain the tolerances associated with the domestic use of these products, and therefore no longer opposes the revocation of those tolerances. No other commenter indicated any interest in maintaining these tolerances. EPA is therefore revoking the tolerances associated with those domestic uses, on two separate grounds. The first ground is that the tolerances will no longer be necessary because the registrations for these uses have been canceled. The tolerances that EPA is revoking on this basis are: Alfalfa, forage; alfalfa, hay; artichoke, globe; barley, grain; barley, straw; beet, sugar roots; beet, sugar tops; corn, fresh (including sweet); corn, popcorn; cotton, undelinted seed; cranberry; cucumber; grape; grape raisin; grape, raisin, waste; melon; oat, grain; oat, straw; pepper; rice, straw; sorghum, forage; sorghum, grain grain; sorghum, grain, stover; strawberry; soybean, forage; soybean, hay; squash; wheat, grain; and wheat, straw.

EPA also finds, however, that revocation of these tolerances is warranted on the grounds that aggregate exposures to these residues of carbofuran do not meet the safety standard of section 408(b)(2) of the FFDCA. The Agency is therefore revoking tolerances for these crops because aggregate dietary exposures to residues of carbofuran, including all anticipated dietary exposures and all other exposures for which there is reliable information, are not safe.

As noted in the proposed rule, based on the contribution from only the foods bearing residues resulting from all of these tolerances, dietary exposures to carbofuran would be unsafe for the more sensitive children's subpopulations. At the 99.9th percentile, carbofuran dietary exposure from food alone was estimated at 0.000082 mg/kg/day (110% of the aPAD) for children 3–5 years old, the population subgroup with the highest estimated dietary exposure (Ref. 70). In addition, as discussed in more detail, both in the proposed rule, and in Unit VIII.E.2. below, drinking water residues of carbofuran contribute significantly to unsafe aggregate exposures. Accordingly, it has not been shown that exposures from these uses would meet the FFDCA safety standard.

B. Comments Relating to EPA's Toxicology Assessment

1. *Comments relating to EPA's PoD.* One group of commenters stated that the studies clearly support EPA's conclusion that the post-natal day (PND)11 brain data on the inhibition of AChE in juvenile rats provide the most appropriate PoD for risk assessment. The commenters also claimed, however, that ''the specific PoD proposed by EPA is 0.03 mg/kg/day, but our analysis of the best data for the risk assessment are found in the good laboratory practices (GLP) compliant studies and those studies support 0.033 as a better value for the PND11 rat.'' This group of commenters also described an analysis their consultant had conducted. According to the commenters, their consultant calculated the value of 0.033 mg/kg/day/day from the BMD_{10}s and $BMDL_{10}$s [3] in the four FMC studies with first observation time equal to 0.25 hours. The BMDs and BMDLs were calculated separately for each of these datasets. The results for the four datasets were combined, but, unlike EPA's analyses, the datasets themselves were not combined.

With respect to using the PND11 rat pup data as the PoD, the Agency acknowledges this area of agreement with the commenters. Ultimately, the $BMDL_{10}$ recommended by the commenters differs from the EPA's $BMDL_{10}$ by only 6% (0.031 mg/kg/day vs. 0.033 mg/kg/day), a difference that is not biologically significant. Moreover, when rounded to one significant digit, as is done by typical convention and consistent with the dose information provided in the comparative cholinesterase (ChE) studies (also called CCA studies), both values yield the identical PoD of 0.03 mg/kg/day.

Moreover, the Agency notes that the value of 0.033 mg/kg/day recommended

[3] BMD is an abbreviation for benchmark dose. The $BMDL_{10}$ is the lower 95% confidence limit on the BMD_{10}. The BMD_{10} is the estimated dose (*i.e.*, benchmark dose) to result in 10% AChE inhibition. EPA uses the BMDL, not the BMD, as the point of departure.

by the commenter does not include the 0.5–hr time-point from MRID no. 47143705 although this dataset yielded the lowest BMDL for individual datasets reported by the commenters. As such, the commenter's recommended value does not include all of the relevant data collected at the time of peak effect. The commenters have provided no rationale for why it would be appropriate to selectively exclude data from the time frame in this study most relevant to the risk assessment. Accordingly, as noted in footnote 115 of the comment, when the commenters included the data at 0.5–hr timepoint from MRID no. 47143705, the $BMDL_{10}$ was lowered from 0.033 to 0.030 mg/kg/day—a value almost identical to the Agency's $BMDL_{10}$ of 0.031 mg/kg/day.

Thus, although the commenters are critical of the Agency's approach, there is basic consensus between EPA and the commenters that the PoD is 0.03 mg/kg/day given the precision of available data in deriving the $BMDL_{10}$.

The Agency also notes that specific details about the commenter's BMD modeling were not provided to the Agency. The Agency is therefore unable to fully evaluate the scientific validity of the modeling procedure used by the commenter.

Some commenters claimed that ''EPA's derivation of its PoD, however, is not transparent and is not scientifically supported. Equally important, based on a recent review of the raw data from the Moser study (obtained via a FOIA request originally filed in April 2008), we believe that the Moser study may not meet minimum criteria for scientific acceptability. Critical data are simply unavailable for this study, including: a complete protocol, analysis of dosing solutions, clinical observations, standardization of brain and red blood cell (RBC) AChE results in terms of amount per unit of protein, and quality assurance records of inspections for the carbofuran portion of the study.'' As a result, the commenters assert that the better approach is to use the brain AChE inhibition values calculated from the GLP-compliant registrant studies, because the commenters claim that EPA has acknowledged them to be valid, and which the commenters claim are fully documented. Using EPA's BMD dose-time response model, the commenters claim that the correct PoD is 0.033 mg/kg/day.

The Agency disagrees with the commenters' assertions that the derivation of the PoD was not transparent. The Agency's analysis, computer code, and data have been placed in the docket for public scrutiny. EPA's models have been repeatedly reviewed and approved by the FIFRA SAP (Refs. 42, 43, and 44), and, as part of that process, been made available to the public. The most recent occasion was as part of the February 2008 FIFRA SAP meeting on the draft carbofuran NOIC. As EPA has explained numerous times, the Agency has not deviated from its standard practice. Most recently, EPA laid out its approach at length in the proposed rule. While it is true that EPA may not have repeated in this most recent analysis all of the specifics that it has previously provided, it is inaccurate for the commenter to claim that the information is not available, or that its review has in any way been hampered by this so-called lack of transparency. Indeed, given that the commenters appear to have been able to duplicate EPA's analyses, it seems reasonable to assume that the information was available. It is further worth noting that the commenters had sufficient access to the Moser data to allow a complete re-analysis before the 2008 SAP on the draft carbofuran NOIC, which was months before the FOIA request was filed with the Agency. In addition, a complete study protocol as well as a report of the quality assurance (QA) technical and data reviews of the study were included in the documents provided in response to the FOIA request. The Agency further notes that although the commenters complain about their perceived lack of transparency in EPA's BMD calculations, they did not provide any detailed information about the derivation of their proposed value.

EPA also disagrees with the claim that EPA's PoD is not scientifically supported. As an initial matter, EPA notes that the commenters' suggested PoD of 0.033 mg/kg/day is not significantly different than EPA's PoD of 0.03 mg/kg/day (see Unit VIII.B.). The criticisms of the Moser study are also incorrect. The procedures and documentation are in accordance with the ORD Quality Assurance Management Plan. Concerning standardization of brain and RBC AChE in terms of protein, it is interesting to note that, despite their complaints that EPA had failed to do this, the registrant also failed to do this in their own studies. However, in the Moser study, the AChE activity was standardized in terms of tissue weight per ml, so the amount of protein was consistent across samples. This is an acceptable and widely used practice. Further, abnormal (or ''clinical'') observations were recorded when they occurred; however, it is not technically possible to observe the animals while they are being tested for motor activity. Finally, the registrant is correct that the dosing solutions for the CCA study were not analyzed, but this was done for the adult studies in McDaniel *et al.,* (2007), and the preparation and stability of the carbofuran samples were confirmed therein.

If, however, the Agency elected to follow the commenters' recommendation to not use the ORD data in the risk assessment, there would be no high quality RBC AChE inhibition data available in juvenile rats. As such, there would be no surrogate data evaluating AChE inhibition in the peripheral nervous system (PNS), much less any data from the PNS itself. As discussed in Unit VIII.C., with the availability of some RBC data from ORD evaluating the effects in the PNS, the Agency is able to reduce the children's safety factor from 10X to 4X. Without the ORD data, the Agency would be required to retain the statutory 10X.

Some commenters raised concern that EPA's PoD was not sufficiently protective. The commenters point to comments from the February SAP review of EPA's draft carbofuran NOIC, quoting the following language from the report, which indicated concern that the starting point used in the risk assessment was not sufficiently protective:

> Some Panel members questioned the assumption that a 10% level of brain AChE inhibition (*i.e.*, BMD_{10}) is sufficiently harmless to be used as a point of departure in risk assessment. It was noted that as more refined brain data become available, we are beginning to understand that not all regions of this organ show the same level of AChE inhibition. Thus a 10% inhibition for the whole brain may imply significantly greater inhibition in a more sensitive region.

The FIFRA SAP report provides conflicting information on the issue of the benchmark dose response used by EPA in its BMD calculations. On page 53 of the FIFRA SAP report, the text suggests that the available data do not support the 10% response level used in BMD modeling and that a 20% response level is more appropriate. The text quoted by the commenters from the report argues that a 10% response level may not be sufficiently health protective, but that a 5% response level may be more appropriate. Given the lack of unanimous advice by the Panel in this case, and that past SAPs have previously supported the use of a 10% level in comparable cases, the Agency has concluded that the overall weight of the available evidence supports a decision that use of a 10% response level will be protective of human health.

A more detailed response to this issue can be found in the Agency's response to the SAP (Ref. 109).

2. *Comments relating to the children's safety factor*—a. *Reliance on RBC to predict effects on the PNS.* Some commenters argued that brain is a better surrogate for the PNS than RBC, and that therefore reliance on the brain data is sufficiently protective that no additional children's safety factor is necessary. The commenters claim that the carbofuran data on brain AChE inhibition and on clinical signs of toxicity indicate that PNS AChE inhibiton is sufficiently modeled by brain AChE inhibtion. They note that the available data show that brain AChE responds rapidly to carbofuran; it readily passes the blood-brain barrier and the data show maximal AChE inhibition within minutes. The commenters also alleged that brain and tissue AChE are more similar to each other than to RBC AChE. The commenters also point to the fact that oral time-course studies by EPA and the registrant show that brain cholinesterase responds quickly and recovers promptly. Carbofuran clearly reaches the brain quickly. They also cite to the fact that EPA has acknowledged that in adults, no difference in sensitivity is seen between brain and RBC AChE inhibition.

The commenters repeatedly mention the rapid speed by which carbofuran reaches the brain and the rapid onset and recovery of AChE inhibition as support for the notion that reliance on the brain data will be adequately protective of PNS toxicity. The Agency agrees with the commenters on the rapid nature of carbofuran toxicity. However, this rapid toxicity occurs in multiple tissues, not just the brain. Moreover, the time course of such toxicity is not relevant to determining which tissue is more sensitive. Therefore, these comments are not relevant to a discussion of the use of brain versus RBC AChE as a surrogate for PNS toxicity.

The commenters' allegation that brain and tissue AChE are more similar to each other than to RBC AChE is not scientifically supportable. Radic and Taylor (2006), for example, state, ''In humans and most other vertebrate species, only one gene encodes AChE'' (Ref. 81). Accordingly, if only one gene encodes the enzyme, then the structure of the active site is the same throughout the body.

Responses in adult animals are not necessarily predictive or relevant to responses in juveniles since the metabolic capacity of juveniles is less than that of adults. As such, juveniles can be more sensitive to some toxic agents. Specific to carbofuran, multiple studies have shown juvenile rats to be more sensitive than adult rats. Thus, comments about responses in adults are less relevant compared to data in pups from the carbofuran risk assessment, particularly in the evaluation of the children's safety factor.

One group of commenters argue that there is evidence that RBC AChE activity can be inhibited to a greater degree than AChE in peripheral organs. For example, Marable *et al.*, (2007), showed that chlorpyrifos caused much greater inhibition of AChE in RBC than in diaphragm, left atrium, and quadriceps, as well as in brain. Similarly, Padilla *et al.*, (2005), reported a greater inhibition of AChE in RBC than in diaphragm or brain. Bretaud *et al.*, (2000), showed that carbofuran caused significant inhibition of AChE in brain tissues but not in muscle in goldfish. The commenters claim that these results demonstrate that RBC AChE activity does not reflect AChE activity in peripheral organs.

The commenters mention three references: Padilla *et al.*, 2005; Marable *et al.*, 2007; Bretaud *et al.*, 2000. Two of these studies involve testing with chlorpyrifos in rats (Refs. 65 and 77) and the third involves testing fish with carbofuran (Ref. 14). Quantitative extrapolation of RBC and peripheral AChE inhibition differences from fish to mammals is highly uncertain because distribution of carbofuran across fish and mammalian tissues may be quite different. The Padilla *et al.*, (2005) and Marable *et al.*, (2007) references include testing with chlorpyrifos, an OP whose primary mode of action is also AChE inhibition (Refs. 65 and 77). Exposure to OP and NMC insecticides results in inhibition of AChE. The Agency assumes it is this similarity in mechanism of toxicity, which provides the basis for inclusion of these chlorpyrifos references by the commenters.

The Agency believes that direct comparison between the results of studies with chlorpyrifos and carbofuran should be done with great caution. OP and NMC insecticides have different time courses of effects, which lead to toxicity profiles that are somewhat different. The studies cited by the commenters (Padilla *et al.*, 2005, Marable *et al.*, 2007) involve long-term treatment (chronic exposure) in adult animals where blood, brain and peripheral tissue AChE inhibition were at steady-state. The time course and AChE inhibition in various tissues at steady state is distinctly different from acute AChE inhibition at the time of peak effect, like that in the carbofuran studies. In the case of acute toxicity with NMCs, the time course of inhibition and reactivation of the AChE is rapid (minutes to hours). In the case of OPs, when steady state inhibition is achieved in adults, recovery is slow (days to weeks) and is influenced by synthesis of new AChE protein. In addition, as stated above, responses in adults are not adequate for drawing conclusions in the young. As such, the Agency views the Padilla *et al.*, (2005) and Marable, *et al.*, (2007) references as providing limited useful information for the carbofuran risk assessment.

Although the Agency is cautious about direct comparisons between OPs and NMCs, it must be noted in this case that: (1) The commenters have provided an incomplete review of the literature and ignored more relevant studies; and (2) the chlorpyrifos literature does, in fact, generally support the Agency's conclusions with respect to carbofuran.

The commenters state specifically that ''[t]here is also evidence that RBC AChE activity can be inhibited to a greater degree than AChE in peripheral organs.'' The assertion that RBC AChE activity can be more inhibited than peripheral tissues ignores relevant chlorpyrifos data. For example, Richardson and Chambers (2003) showed that lung AChE can be more sensitive than serum and brain AChE in rat fetuses (Ref. 82).

EPA's response to comments document provides a more extensive review of chlorpyrifos studies (those that include data in peripheral tissue) than that discussed by the commenters (Ref. 112). While there are many studies that have measured AChE inhibition with chlorpyrifos, the Agency has limited its discussion here only to those in pregnant rats and fetuses which provide peripheral AChE data (*e.g.*, heart, lung, and liver) as they are the most relevant to the present issues raised by the commenters. Several chlorpyrifos studies in pregnant dams and/or their fetuses show that peripheral AChE is more sensitive than brain AChE. For example, a study conducted by Dow AgroSciences showed that a dose of 1 mg/kg results in 4–6 fold more inhibition in heart AChE than in brain tissues (Refs. 66 and 67). Similarly, Hunter *et al.*, (1999) showed that in pregnant dams at doses of 3 mg/kg liver AChE was inhibited 84% when brain tissues were inhibited by only 41% (Ref. 51). Fetuses evaluated at or near the peak time of effect in the Hunter *et al.*, (1999) study showed 2–8 fold more AChE inhibition in liver than in brain. (Id.). Although there is some variation among studies, the preponderance of data supports the

conclusion that peripheral tissues are more sensitive to chlorpyrifos exposure than brain tissues. Thus, the chlorpyrifos data in fetuses and pregnant rats supports the Agency's concern that sole reliance on brain data may not be protective of the PNS following carbofuran exposure. Chlorpyrifos data in post-natal pups are described in the Agency's Response to Comments on the proposed tolerance revocation (Ref. 112).

Although OPs and NMCs both inhibit AChE, the chemical reaction at the active site differs. This difference leads to different time courses of toxicity and recovery. As such, comparisons, particularly quantitative ones, between chlorpyrifos and carbofuran should be done with care. However, in general, review of these data supports the Agency's conclusion for carbofuran that in the absence of high quality data that is relevant for risk assessment in either peripheral tissue or a surrogate (*i.e.*, RBCs), the Agency cannot be certain that brain AChE inhibition is protective of potential peripheral toxicity following carbofuran exposure. Therefore, the chlorpyrifos data support the Agency's conclusion that at least a portion of the children's safety factor must be retained for carbofuran given the lack of peripheral AChE data and lack of RBC AChE (as a surrogate for peripheral AChE) at the low end of the dose-response curve.

b. *Comments relating to EPA's approach to deriving the 4X factor*. One group of commenters argued that EPA's approach to calculating its 4X Children's Safety Factor was flawed. According to the commenters, it would be more plausible and straightforward to compare the RBC and brain AChE levels at the same time in the same rat when these rats are exposed to carbofuran. Based on an analysis of the RBC and brain AChE inhibition data, the commenters' claim that the percentage reduction in RBC AChE in a rat is almost the same as the percentage reduction in brain AChE in that same rat. The commenters summarize a statistical evaluation of the experimental data on AChE inhibitions in RBC and brain in rats due to carbofuran exposure conducted by their contractor, and claim that this evaluation shows that the percentage inhibition of RBC AChE in a rat compared to the percentage inhibition of brain AChE in the rat is no more than 1.5X—a difference that they claim is not meaningful from a physiological perspective and does not warrant imposition of a 4X FQPA safety factor.

EPA notes that the commenters recommended this approach of comparing the degree of inhibition for each animal as part of their presentation to the Carbofuran SAP. EPA also addressed this approach, comparing RBC to brain in the same animals, at the SAP and in the responses to the SAP report (Ref. 109). It is notable that the SAP did not endorse this approach.

EPA's analyses of the commenters' approach identified several significant deficiencies. First, the comparison suggested by the commenter means that EPA would need to ignore existing data. This is because only EPA's study of PND11 animals contains both brain and RBC data, so the comparisons suggested by the commenter can only be made using that dataset. However, the dose levels in that study were so high that the lower portion of the dose-response curve was missed. At these higher doses, there is little difference between the levels of brain and RBC inhibition. This phenomenon, namely the relative sensitivity of RBC compared to brain appears smaller at higher doses. This phenomenom is also shown in multiple chlorpyrifos studies, where blood or peripheral measures of AChE inhibition are more sensitive than brain at low to mid doses but the tissues appear to be similar at higher doses.

Second, the commenters' approach is fundamentally flawed. The commenters' suggested alternative relies exclusively on comparisons between the degree of inhibition in the treated animals without any regard to the doses at which the effects occurred. For example, one animal may have shown, on average, 10% inhibition in the brain, when it demonstrated 20% RBC inhibition. Under this approach, what would be relevant would simply be the ratio of 1:2. But the Agency believes it is critical to focus on the ratios of *potency*, which is the ratio of the doses in the data that cause the same level of AChE inhibition. The Agency's approach of comparing potencies is more directly relevant for regulatory purposes than comparisons of average inhibition. This is because dose corresponds more directly to potential exposures, which is what EPA regulates (*i.e.*, how much pesticide residue does a child ingest). By comparison, the commenters' suggested reliance purely on the average degree of inhibition provides no information that corresponds to a practical basis for regulation.

Finally, the range of ratios of effects that the commenters propose as an alternative is consistent with range of potencies that EPA has calculated at the higher doses in the available data, so the commenters' results do not ultimately contradict EPA's assessment, which tries to account for what occurs at lower doses. Briefly, if the dose-responses for RBC and brain inhibition were linear, ratios of inhibition would equal ratios of BMDs. However, these dose-responses are not at all linear, and the available data demonstrate that brain and blood dose-responses have somewhat different shapes. Thus, estimates of relative effects at particular, relatively high, doses are not relevant to the problem of estimating potency ratios at lower doses. The dose-response curves level off at about the same level of inhibition, so, at high doses, there is no difference between the ratio of inhibitions. Except at the lowest dose, where the ratio is slightly greater than 2, the remaining ratios are only slightly greater than 1. Given the inevitable statistical noise in these measures, it is clear that the ratios expected from EPA's modeling are substantially similar to what the commenter finds in its comparison between individuals. Accordingly, the commenter's suggested comparisons at higher doses provide no evidence of what occurs at lower doses; and thus provides no evidence that demonstrates that EPA's modeling results at lower doses is inaccurate.

One group of commenters claimed that the statistical comparisons that support EPA's selection of a 4X children's safety factor are flawed. The commenters claim that, even assuming that RBC values are relevant, EPA's conclusion that RBC effects in the relevant studies were four times more sensitive than brain effects is not mathematically supportable. The commenters reference statistical analyses performed for them by a contractor, which they claim show that EPA's calculation of the 4X children's safety factor is simply incorrect. The commenters complain that the datasets EPA used for brain differ not only because they were from different studies, but also because the data were taken at different times ranging from 15 minutes to 4 hours after dosing. The commenters also raise the concern that EPA's decision to combine data for different strains of rats, sexes, experiments, laboratories, dates, dose preparations, rat ages, and times between dosing and AChE measurement, is problematic, claiming that these differences in study design severely limit the validity of EPA's comparisons. In addition, the commenters claim to have found a number of errors and inconsistencies in how the modeling was conducted. Correcting for these errors, the commenters claim, shows that the

BMDs for brain and RBC data are essentially the same.

As discussed at length below, and in EPA's Response to Comments document, EPA disagrees that its statistical modeling was in any way flawed (Ref. 112).

In general, EPA believes that consideration of all available data is the scientifically more defensible approach, rather than the selective exclusion of reliable data. The Agency's Draft BMD Guidance says the following: ''Data sets that are statistically and biologically compatible may be combined prior to dose response modeling, resulting in increased confidence, both statistical and biological, in the calculated BMD'' (Ref. 100). The Agency's carbofuran analysis has included all available, valid data in its analysis. Further regarding combining data from multiple strains, the SAP was fully aware that the Agency was planning to derive BMD estimates from data sets using different strains of rats (Ref. 43).

By contrast, the commenters' suggested analysis ignores relevant, scientifically valid data. The FMC analysis left out the 30–minute data from MRID no. 47143705. The commenters have provided no rationale as to why it would be appropriate to selectively exclude data from the time frame in this study most relevant to the risk assessment (*i.e.*, peak AChE inhibition). The commenters' analysis of the individual datasets from MRID no. 47143705, showed that at 30 minutes the females and males provide $BMDL_{10}$s of 0.009 mg/kg/day and 0.014 mg/kg/day, respectively. When the datasets were combined, inclusion of the 30–minute timepoint from MRID no. 47143705 decreased the $BMDL_{10}$ from 0.033 mg/kg/day to 0.030 mg/kg/day.

EPA has used a sophisticated analysis of multiple studies and datasets to develop the PoD for the carbofuran risk assessment. However, instead of this analysis, EPA could simply have followed the general approach laid out in its BMD policy (Ref. 100), which is used in the majority of risk assessments. Under this general approach, EPA would regulate using the most sensitive effect, study, and/or dataset. If the Agency chose not to combine the data in its analyses, as the commenters' suggested, data collected at or near the peak time of effect (*i.e.*, 30 minutes) would in fact provide the more relevant datasets. If this more simple approach were taken, in accordance with BMD guidance, EPA would select the lowest $BMDL_{10}$. Assuming the commenters' values were used, EPA would have selected a PoD of 0.009 mg/kg/day, instead of 0.03 mg/kg/day, which is the value EPA is currently using in its risk assessment.

Further, the commenters complain that EPA's approach of combining data across multiple studies is scientifically inappropriate. The commenters have, however, combined the results of analysis from four datasets. It is notable that most of the issues cited by the commenters also apply equally to the commenter's own analysis, as described in more detail in EPA's Response to Comments document (Ref. 112).

EPA has addressed all of the commenters' claimed inconsistencies in its Response to Comments document (Ref. 112). The majority of these claimed flaws and inconsistencies were either misunderstandings by the commenters or areas where it was the commenters who were incorrect, not EPA. However, in response to some of their allegations, EPA conducted new analyses to determine whether the suggested alternative approaches would make any significant difference in EPA's modeling outcomes. For example, in response to one of their comments, EPA used the dose-time-response model to extrapolate BMD_{50}s to develop a common point of comparison between all studies. Specifically, EPA extrapolated the PND11 brain analysis to estimate BMD_{50} for 40 minutes after dosing for comparison with the existing PND11 RBC BMD_{50}, and extrapolated the PND11 RBC BMD_{50} to 15 minutes after dosing for a range of assumed recovery half-lives, for comparison to the existing PND11 brain BMD_{50} (Refs. 30 and 31). In either approach, the estimate of the RBC to brain potency ratio in PND11 animals is increased, and EPA's safety factor would correspondingly increase to reflect that larger difference. For example, when the PND11 brain BMD_{50} is extrapolated to 40 minutes, the RBC to brain potency ratio grows to 4.7 (Ref. 30), and when the PND11 RBC BMD_{50} is extrapolated to 15 minutes, using a range of estimates for the recovery half-life of the RBC endpoint, the RBC to brain potency ratio ranges from 4.2 to 4.6 (Ref. 31). The commenter's approach would therefore support a children's safety factor of 5X rather than 4X.

Similarly, in response to the complaint that EPA should have generated a new dose-response model in order to calculate the BMD_{50}s for brain and RBC, EPA conducted the suggested calculation (Ref. 112). The ratio of brain to RBC BMD_{50}s in this new analysis is the same as that calculated by EPA using the mathematical expression. Both provide a ratio of brain to RBCs BMD_{50} of 4X. Specifically, the values are for PND11 brain BMD_{50} 0.35 and for RBC, 0.086, resulting in a ratio of 4.09 (Ref. 112).

Several commenters disagreed with the Agency's decision to apply a 4X, arguing that the high bar set by the statute for lessening the tenfold safety factor has not been achieved because ''important data gaps exist.'' These commenters raised the concern that key data on carbofuran toxicity and exposure for the very young are inadequate. Examples include: No data were presented for pre-natal sensitivity as would have been desirable for addressing the need to protect developing individuals; BMD_{10} estimates from the available RBC AChE inhibition data are not reliable due to lack of data at the low end of the dose response curve. The commenters also highlighted EPA's assumption that the RBC and brain AChE dose response curves are parallel, noting that there are currently no data to test this assumption for carbofuran. One commenter raised the concern that ''EPA has no substantial research on alternate mechanisms of carbofuran toxicity. EPA has acknowledged but failed to incorporate in its assessment the potential for lasting adverse effects from transient exposures during fetal and newborn life-stages, and EPA has acknowledged that there are uncertainties in the available data (as raised by the SAP).'' The commenters concluded that the Agency does not have the requisite ''completeness of data'' required by law to lessen the safety factor,'' and urged the Agency to reinstate the default 10X safety factor.

Section 408(b)(2)(C) of the FFDCA requires that EPA consider the ''completeness of data with respect to exposure and toxicity to infants and children'' when evaluating whether retention of the default 10X safety factor is appropriate. The Agency has concluded that available exposure information is sufficient for purposes of developing its human health risk assessment, and has adequately accounted for the lack of certain hazard information with the retention of a 4X children's safety factor. Moreover, the Agency has concluded that the exposure assessment does not substantially underestimate food or water exposure. The completeness of the hazard database and the interpretation of available toxicity studies were described elsewhere in this final rule preamble. The Agency continues to believe that a 4X children's safety factor is appropriate for carbofuran.

Several commenters alleged that application of a 4X children's safety factor, rather than a 10X, is inconsistent with the SAP's advice. These

commenters argued that the SAP report reflected strong support, if not unanimity, among panel members for a safety factor of at least fivefold, and pointed to the statement in the report that ''some Panel members considered it reasonable to retain the full 10X [children's] safety factor (Panel Scenario 5). Given the uncertainty in the data and in its interpretation for risk assessment by the entire Panel, these Panel members believed that this standard for change had not been met.''

As described in detail in the Agency's response to the SAP report (Ref. 109), the Agency believes there was a general consensus that a children's safety factor of 2X or greater was necessary. The Agency does note that one Panel member thought a 1X was appropriate and at least two believed a 2X was appropriate. Given that the Panel did not take a vote on the record and the report notes that the Panel did not endorse a particular approach, any conclusions about the possible ''unanimity'' of the Panel is speculation. However, as described in the Agency's response to the SAP and in the July 2008 proposed rule, EPA believes that on balance, its reliance on the data derived factor of 4X is consistent with the SAP's advice, as a whole.

Several commenters raised concern that EPA's application of a 4X children's safety factor did not adequately account for the differences between children and adults. The commenters raised several reasons that children are more vulnerable than adults to carbofuran. These include the following:

(1) Children are growing. Pound for pound, children eat more food, drink more water and breathe more air than adults. Thus, the commenters conclude, they are likely to be more exposed to substances in their environment than are adults. Children have higher metabolic rates than adults and are different from adults in how their bodies absorb, detoxify and excrete toxicants.

(2) Children's bodies, including their nervous, reproductive, digestive, respiratory and immune systems, are developing. This process of development creates periods of vulnerability. Exposure to toxicants at such times may result in irreversible damage when the same exposure to a mature system may result in little or no damage.

(3) Children behave differently than adults, leading to a different pattern of exposures to the world around them. For example, they exhibit hand-to-mouth behavior, ingesting whatever substances may be on their hands, toys, household items, and floors. Children play and live in a different space than do adults. For example, very young children spend hours close to the ground where there may be more exposure to toxicants in dust, soil, and carpets as well as low-lying vapors.

(4) The recovery time from carbofuran exposure for the very young is more than four times that of adults, as the SAP noted.

Carbofuran does not have any residential uses. As such, comments about the breathing rate of children and hand-to-mouth behavior do not apply to carbofuran's risk assessment. The Agency agrees with the commenters that infants and children represent a potentially susceptible lifestage to carbofuran exposure. Accordingly, the Agency has taken steps to incorporate lifestage specific information in its risk assessment. For example, the Agency's hazard assessment has used data from PND11 rat pups as the PoD in extrapolating human risk. Although it is not possible to directly correlate ages of juvenile rats to humans, PND11 rats are believed to be close in development to newborn humans (Refs. 5, 12, and 26). The Agency's food exposure assessment relies on DEEM-FCID™, which uses the CSFII database, including the 1998 supplemental survey of children. As such, the Agency's aggregate risk assessment accounts for the decreased metabolic capacity of juveniles in addition to age-specific behaviors in eating and drinking.

One commenter noted that while they agreed that the use of brain and RBC AChE inhibition data is an appropriate endpoint for use in EPA's risk assessment, they did not believe that it is sufficiently health-protective to only rely on this endpoint without an uncertainty factor because it has not been established scientifically that AChE inhibition is the most sensitive endpoint. The commenter noted that one SAP member argued for retaining a 10X children's safety factor because of uncertainty in both the dosimetry in subtle developmental effects and also the available data on related pesticides suggesting effects on nerve outgrowth at cholinesterase inhibition levels of 20% or less, and some effects at less than 10%. The commenter asserted that ''this position is supported by published studies on the toxicity of a related family of pesticides, the OPs, reporting that exposures during fetal and newborn life-stages affect diverse cellular functions by mechanisms of toxicity that are independent of cholinesterase inhibition, and may occur at exposures that elicit less than 20% inhibition (Refs. 1, 2, 32, and 91). This is important because while the systemic toxicity that results from cholinesterase inhibition is reasonably well characterized, it does not explain why rodents exposed pre- and post-natally seem to recover from cholinesterase inhibition relatively rapidly, yet display persistent and more severe damage to the central nervous system'' (Ref. 90). The commenter also pointed to what they assert is a ''growing body of science for OPs demonstrating that non-cholinergic mechanisms of toxicity may be acting to disrupt multiple brain targets'' (Ref. 80). According to the commenter, experts have warned that ''the fact that alterations in neurodevelopment occur with OPs below the threshold for cholinesterase inhibition reinforces the inadequacy of this biomarker [cholinesterase inhibition] for assessing exposure or outcome related to developmental neurotoxicity'' (Ref. 92). When reviewing the EPA assessment of the OPs, the commenter asserted that the FIFRA SAP in 2002 had raised the same concern, stating that ''reliance on a single biochemical assay to measure brain damage may become problematic'' (Ref. 41).

The Agency is aware of the available studies noted by the commenters on the OPs and has recently developed a draft issue paper on many such studies as part of its on-going review of chlorpyrifos. The Agency cautions the commenters against extrapolating these studies to the NMCs. The Agency is not aware of any studies in laboratory animals where long-term behavioral or other effects were noted with exposure to NMCs. Moreover, the Agency is not aware of any epidemiology study that has associated NMC exposure with adverse birth or neurodevelopmental outcomes in children. Although OPs and NMCs both inhibit AChE, the chemical reaction at the active site differs. This difference leads to different time courses of toxicity and recovery. Time to peak effect and time to recovery for the NMCs is very rapid in comparison to OPs. Moreover, once reactivation of the AChE occurs, the parent compound is no longer active. As such, NMCs may not be present in the body long enough to cause the types of outcomes associated with OP exposure. The Agency concludes that there are no data which link NMC exposure, including studies with carbofuran, at relatively low doses to long-term outcomes in juvenile animals or children. Therefore, the Agency further concludes that the OP studies noted by the commenters have limited relevance to the carbofuran human health risk assessment.

c. *Comments regarding consistency in approach*. One group of commenters

claimed that the derivation of carbofuran's PoD and children's safety factor was inconsistent with EPA's analyses for other NMCs, including aldicarb and carbaryl.

The commenters are incorrect. The Agency's recent hazard assessments of carbaryl and aldicarb are each consistent with OPP policies and practice, as well as with the Agency's approach to the assessment of carbofuran.

The commenters' assertions regarding aldicarb were based on an earlier assessment. At the time the Agency conducted the assessment to which the commenters refer, the Agency was unaware of the differences in sensitivity between PND17 and PND11 animals. Since EPA became aware of the differences, EPA has required the aldicarb registrant to conduct a CCA study in PND11 rats; the Agency anticipates the receipt of this study and the companion range-finding and time course studies in 2009. In the absence of these data, EPA will apply the statutory default children's safety factor to account for the additional sensitivity of PND11 animals, because the Agency lacks any data that could be used to derive a reduced factor that EPA could determine will be ''safe for infants and children.''

Carbaryl was not evaluated any differently than carbofuran. EPA's typical practice which was used in both the carbofuran and carbaryl risk assessments, is to use the central estimate on the BMD to provide an appropriate measure for comparing chemical potency and to use the lower limit on the central estimate (*i.e.*, BMDL) to provide an appropriate measure for extrapolating risk. This approach is also consistent with the NMC cumulative risk assessment (CRA) and single chemical risk assessments for multiple OPs.

In the case of carbaryl, the commenters inappropriately focused on the $BMDL_{10}$s, instead of the BMD_{10}s. The more appropriate comparison is between the BMD_{10}s; the carbaryl brain BMD_{10} is 1.46 mg/kg/day compared with the RBC BMD_{10} of 1.11 mg/kg/day. As such, the brain to RBC ratio is 1.3X. Therefore, for carbaryl, the brain and RBC AChE data are similarly sensitive, and, when the tissues are similarly sensitive, the Agency prefers to use data from the nervous system tissue (*i.e.*, brain) over data from a surrogate tissue (*i.e.*, RBC) (Ref. 108). Thus, for carbaryl, the RBC AChE inhibition (a surrogate for PNS AChE inhibition) and brain AChE inhibition were basically equivalent. This contrasts with the situation with carbofuran where a significant difference in AChE inhibition between the two is noted.

With regard to the carbaryl children's safety factor, the available brain and RBC dose-response data in PND11 pups include data from the lower end of the dose-response curves. ORD's comparative AChE data with carbaryl show that at the lowest dose at or near 20% inhibition in brain and RBC AChE was observed. Although not ideal, the carbaryl data provide information closer to the benchmark response of 10%, which allows for a reasonable estimation of the BMD_{10} and $BMDL_{10}$. This is distinctly different from ORD's data with carbofuran in PND11 and PND17 pups where 50% or greater RBC AChE inhibition was observed at the lowest dose.

C. Comments Relating to EPA's Exposure Assessment

1. *Food exposures*. One group of commenters alleged that it is more appropriate to apply USDA PDP residue monitoring data from winter squash to pumpkins, rather than residue data from cantaloupes.

The Agency agrees with the commenters. An appropriate residue assignment has been made in the latest dietary exposure assessment (Ref. 71). The results of this assessment are discussed below in Unit VIII.E.1.b.

One group of commenters asserted that the measurable residues of carbofuran in milk obtained by the USDA PDP program should be ''adjusted to a lower level because a significant proportion of the milk residues in the PDP database are due to carbofuran use on alfalfa, which is no longer permitted under the carbofuran label.'' The same commenters discussed the results of an exposure assessment that they apparently conducted, in which they have reduced the residues anticipated to be found in milk by some unspecified amount.

Based on the commenters' results, their adjustments to milk residues appear to have about a 50% reduction on the risk estimates for the food only results. While the commenters appeared to have made the adjustments to milk residues in most of their food-only assessments, as well as their food+water assessment, they did not: (1) Describe the amount by which residues were reduced; (2) present the DEEM-FCID™ input files detailing the residue inputs used in their assessment; or (3) provide to the Agency related data to support any such reduction factor—information that the Agency would need to accept such an adjustment. Because of the lack of any explanation or rationale, the Agency attempted to determine how the commenters made the ''adjustment to residues'' to account for the cancellation of use on alfalfa. As described in the Agency's Response to Comments, EPA was not able to reproduce the commenters' results, but did approximate their reported results after reducing milk residues by 77% (Ref. 112).

In actuality, it is difficult to ascertain how the recent cancellation of carbofuran use on alfalfa may affect future residues found on milk (from dairy feed items associated with corn, potatoes or sunflowers). This is especially true for milk since it is a blended commodity. That is, milk may be obtained from dairy cows from multiple farms (*i.e.*, a dairy cooperative). The milk in any particular PDP sample may have come from dairy cows that might have had a diet that contained substantial amounts of alfalfa, or a diet that contained predominately corn, or from multiple farms using various combinations of feed that may or may not have been treated with carbofuran. In any case, the aggregate pesticide use statistics do not support the contention that most residues in milk are (or have been) due to carbofuran use on alfalfa—the USDA and Proprietary use data indicate that field corn has historically had a greater overall amount of total carbofuran use than alfalfa. Potatoes and sunflowers rank 3rd and 4th.

The Agency included a summary of dietary burdens for dairy cattle in the dietary exposure analysis memorandum documenting the higher dietary burden involved with field corn feed stuffs (Refs. 70 and 71). These two diets represent a corn-based diet and an alfalfa-based diet, accounting for appropriate amounts of roughage and protein. Based on these dietary burdens, milk from dairy cows having a corn-based diet may have higher concentrations of carbofuran than milk from cows having an alfalfa-based diet (Refs. 70 and 71).

The Agency notes that 3-hydroxy carbofuran was detected in about 7.5% of all PDP milk samples analyzed in 2004 and 2005 (7.5% = 110 detects in 1,485 samples).

Considering all of the various factors involved with the PDP milk samples–*e.g.*, uncertainty regarding mixture of feeds, pesticide use and corresponding residues—the Agency finds no basis for applying estimated reduction factors to actual measured concentrations of carbofuran residues found by the PDP program in milk based on the cancellation of alfalfa uses. In the absence of supporting data the Agency has no scientific basis for making the

commenters' recommended changes to the dietary exposure assessment with regard to carbofuran residues in milk. Certainly, the commenters' have failed to provide any scientific justification for their position. Moreover, since the Agency was unable to reproduce the commenters' results, EPA could not make the suggested adjustment, even if they had provided details on the exact adjustment figure they wanted EPA to apply.

One group of commenters raised concern that PCT estimates used by the Agency for bananas, potatoes, and milk are conservatively high.

In response to those comments, the Agency reviewed its PCT estimates for the two crops and revised its PCT estimates for bananas from 78% to 25%. The Agency also developed a regional PCT estimate for potatoes of 5% based on projected limited use in the Northwest, and has applied these estimates in its revised dietary risk assessment (Ref. 71). The Agency also applied a 5% CT for milk, based on the PCT for potatoes, which is the feed stuff with the highest PCT. Further discussion regarding the Agency's previous and revised PCT estimates can be found in References 71 and 122. As discussed below in Unit VIII.E.1.b., these adjustments had relatively modest effects on the dietary exposure assessment of those crops the registrant now seeks to maintain.

Some commenters claimed that the Agency acted inconsistently in the way in which it conducted its ''Eating Occasion Analyses'' to account for the extent to which individuals recover from AChE inhibition between exposure events. The commenters claimed that the Agency analyzed aldicarb and carbofuran differently, and came to different conclusions concerning the effects of reversibility for these two compounds.

The commenter's assertion that the Agency came to different conclusions concerning the effects of reversibility for aldicarb and carbofuran is incorrect. EPA discusses the Eating Occasion Analysis it conducted for carbofuran in greater detail in Unit VIII.E.3. below and in its Response to Comments document (Ref. 112).

The Agency concurs with the commenter that ''there is no basis for treating aldicarb-treated potatoes differently from carbofuran treated potatoes.'' The commenters' assertions regarding what the Agency has or has not done with respect to the Eating Occasion Analysis (*i.e.*, ''reversibility'') to some extent reflects confusion resulting from the several assessments the Agency has produced since 2006. Since that period, EPA has conducted several risk assessments, based on the tolerances FMC has variously indicated that it wished EPA to retain. EPA notes, for clarity, that for the proposed rule, EPA conducted a risk assessment of ''all registered carbofuran uses'' that did incorporate the concept of reversibility (*i.e.*, ''persisting dose''). The proposed rule also contained an assessment of the subset of ''6 domestic uses'' that EPA believed the registrant primarily wished to retain, which did not incorporate this concept because these were not the only crops on which carbofuran was legally permitted to be used. However, now that the registrant has cancelled all but four domestic food uses, the Agency's risk assessment of all the remaining uses accounts for reversibility, performed using the same DEEM-based Eating Occasion Analyses previously used for both carbofuran and aldicarb.

In support of their contention, the commenters took an observation in the aldicarb IRED that exposures did not pass at the per capita 99.9th percentile, but were equal to the aPAD at a lower percentile—out of context, and used that statement to infer that the Agency regulates at this lower percentile. This is incorrect. The aldicarb registrant agreed to a number of risk mitigation measures that brought the aggregate risks to below the aPAD at the 99.9th per capita percentile. The registrant agreed to modify the aldicarb label to require a 500–foot well set back for aldicarb use on peanuts (GA soil type), since aggregate exposure at the per capita 99.9th percentile for infants continued to exceed the level of concern even after reversibility was accounted for in the Eating Occasions Analyses under the 300–foot well set back scenario.

In summary, the Agency did not analyze aldicarb exposure and risk any differently than it analyzed carbofuran exposure and risk; the ''persisting dose'' concept was used in both assessments. Mathematically and conceptually, the calculations of the adjustment for reversibility are the same for both exposure assessments. Any differences in the conclusions EPA drew from the analyses are attributable purely to the factual differences between the two compounds. The reduction in ''persisting dose'' is slightly greater for aldicarb due to its quicker recovery times (2–hour half-life for aldicarb), but in both cases, the Agency applied the same procedure to account for reversibility. The qualitative results for the food only and food + water scenarios presented in Unit VIII.E., produce similar qualitative results: in both cases, accounting for reversibility between eating occasions for food alone results in relatively modest reductions in the ''persisting dose'' at the per capita 99.9th percentile, and a relatively large effect on exposure for water alone, or food+water, when water is the predominant contributor (73 FR 44864). These Eating Occasion Analyses support the Agency's position that reversibility has a relatively greater effect for drinking water exposures than for food exposures.

One group of commenters claimed that the Agency should have calculated the effects of carbofuran exposure based on the ''persisting dose'' over the 1,440 person-minutes rather than on the person-days that are currently used by the Agency.

In effect, the commenters suggest that the ''persisting dose'' should be calculated over the entire 1,440 minutes of each modeled person-day (1,440 minutes/day = 24 hrs $\times$ 60 minutes/hr). EPA has rejected this approach for a number of reasons. While the commenters' person-minute approach may be an attempt to capture multiple measures with one statistic, it does not properly capture the Agency's concern regarding peak inhibition, and the commenters' assertion that the Agency should use all person-minutes to calculate the per capita 99.9th percentile is misguided at best since: (1) It does not reflect a comparison to peak inhibition which is what the Agency believes is the most appropriate and relevant toxicological measure and (2) it produces risk estimates that are entirely dependent upon the time of day at which consumption occurs. Hence, this approach will obtain different values depending upon the reported time of consumption even if exposure occurs on a single eating occasion. The commenters suggested approach does not appear to capture peak inhibition, or other temporal aspects of cholinesterase inhibition (*e.g.*, duration over which inhibtion exceeds 10%). EPA's Response to Comments document provides a further explanation of this issue and details why the Agency's approach is consistent with the identified endpoint (peak inhibition) and the corresponding point of departure ($BMDL_{10}$ that serves as the basis for calculating a %aPAD (Ref. 112).

2. *Drinking water exposures.* As part of their comments on the proposed tolerance revocation, FMC submitted a revised label with use restrictions intended to address drinking water contamination. These measures include eliminating a number of crop uses, prohibiting use in a broad swath of areas with potentially vulnerable soils, and

requiring application buffers in other areas. In addition to these label modifications, the registrant, along with two other commenters, submitted comments summarizing the results of risk assessments they had previously submitted, and the results of new risk assessments they claim to have conducted. The commenters did not provide to the Agency either the new risk assessments they claim to have conducted, or the underlying support documents for those assessments, including the ''national leaching assessment'' or the ''crop-specific evaluation of use patterns and the registrant's proposed non-application buffers using the PRZM-EXAMS model.'' FMC concludes that their label revisions have a pronounced effect on dietary risk and result in ''exposure that even fit within the risk cup that EPA has proposed.''

EPA has reviewed the September 2008 proposed label modifications, and a synopsis of the Agency's conclusions are summarized below in this Unit. More detailed analyses can be found in EPA's Response to Comments (Ref. 111). In addition, EPA's revised risk assessment, discussed below in Unit VIII.E., is based on this revised label.

The label revisions leave two national food uses on the label, corn and sunflowers, and two regional food uses, potatoes in the northwest and pumpkins in the southeast. EPA has assessed the impact of all of these remaining uses, taking into consideration all label restrictions, and has concluded that remaining uses may result in concentrations in some locations that are similar in magnitude to those estimated previously (Refs. 57, 58, 60, and 62).

a. *Comments relating to EPA's ground water analyses.* One group of commenters alleged that ''[g]roundwater sources are vulnerable to carbofuran leaching only under certain conditions, namely where permeable soils (*e.g.*, areas with soils greater than 90% sand and less than 1% organic matter), acidic soil and water conditions, and shallow water tables predominate (*e.g.*, where ground water is less than 30 feet).'' The commenters claim that these conditions are rare in areas where carbofuran is used. They further assert that in ''most states where carbofuran is used, less than 2% of the entire surface areas possess sandy soil texture'' and that ''low pH conditions are not found in carbofuran use areas allowed under the registrant's amended label''.

EPA disagrees that the commenter's specific criteria define 100% of conditions where ground water sources are vulnerable to carbofuran leaching. No comprehensive analysis was provided evaluating how they reached this conclusion. Although these criteria appear on the revised carbofuran label restricting use, the spatial extent of the label restrictions is not provided. As discussed in greater detail in EPA's Response to Comments, the information provided as part of FMC's comments (primarily maps depicting areas identified as vulnerable) is not sufficient to allow the Agency to evaluate their claim (Ref. 111). For example, water table depth can vary with the time of the year, depending on such factors as the amount of rainfall that has occurred in the recent past, and how much irrigation has been removed from the aquifer. It is difficult to determine how the depth to the water table varies throughout fields, and the definition of a ''shallow'' water table is indeterminate (*e.g.*, less than 30 feet). Furthermore, the vulnerability associated with depth varies with location; for example, deeper aquifers may be more vulnerable in areas with greater precipitation and rapid recharge.

While the assertion regarding percent sand is in part true, it is misleading. While many states have only small areas of sandy soils, some states have quite extensive areas. For example, according to FMC's own assessment of high use states (Ref. 8), Texas had 4.2% sand, Michigan had 21.3% and Nebraska had 26.3%. In addition, this statement implies that soils that are sandy textured define the universe of soil textures that are vulnerable to leaching. It is possible that more fine-textured soils, for example sandy loams or silt loams, could also be sufficiently permeable to result in carbofuran leaching as it has not been established how much of a reduction in leaching might occur as texture becomes finer. Furthermore, finer textured soils tend to have more cracks and root channels and thus are more prone to preferential flow.

EPA also disagrees that the commenters have provided sufficient information to support their general claim that only high pH conditions (pH above 7) exist in all the areas in which carbofuran could be used under FMC's September 2008 revised label. There is considerable spatial variability in pH conditions for both the subsurface and surface environments. The pH has a large effect on the persistence of carbofuran as, for more acidic conditions, the hydrolysis half-life increases from 28 days at pH 7 to years or more at pHs less than 6. Further, the results of EPA's corn ground water simulations (bounded by the high and low pH values of the aquifer system underlying the scenario location) showed that a relatively small (0.5) decrease in pH from 7 to 6.5 resulted in an increase by 4 orders of magnitude in the 1–in–10–year peak concentration of carbofuran. EPA has presented its assessment of the newly submitted label in its Response to Comments document and these issues are addressed in more detail there (Ref. 111).

Accordingly, the criteria the commenters suggest are not sufficient to prohibit use in all areas that could reasonably be expected to be vulnerable to ground water contamination from carbofuran use. EPA's assessment identifies an example of one area where carbofuran use would still be permitted on the proposed labels; an additional scenario for the updated ground water modeling provided in Reference 111 was based on this location in the south-central region of Wisconsin. This scenario is in no way unique; EPA expects that other similar sites exist in other locations where carbofuran could still be used across the United States.

One group of commenters claimed that the most recent label modifications ''has ensured that carbofuran use will not occur in these vulnerable areas by removing them from the label.'' They support this by reference to a map of the carbofuran use areas in 2005, that identifies counties with DRASTIC scores as high as that of the location of the prospective ground water study (PGW study) conducted by FMC in Maryland, defining that combination as vulnerable.

DRASTIC is a USEPA model that was developed as a screening tool to identify ground water resources that are ''generally vulnerable to the release of contaminants at the surface * * *.'' (Ref. 6). The commenters indicate that the map provided in their comments shows counties ''identified as vulnerable,'' based on DRASTIC scores that exceed 185, and 2005 carbofuran usage, although the map's level of resolution is insufficient to provide more than a general impression of the location of ground water classified as vulnerable. In FMC's September 2008 label revisions, FMC expanded the areas where carbofuran cannot be applied, apparently because of ground water concerns. The specific criteria that FMC used to determine these further locations were not provided to the Agency. Nevertheless, EPA does agree that ground water in the Atlantic Coastal Plain is vulnerable, and that FMC has restricted use in those areas.

However, EPA does not agree with the premise that only locations with DRASTIC scores as high as that of the location of the Maryland PGW study are those that require mitigation. DRASTIC

scores as high as those identified by the commenters would indicate that the site is located in a generally sensitive or vulnerable area. The Agency agrees that the DRASTIC tool can be used to generally identify areas that may be vulnerable to pesticide contamination. However, DRASTIC is somewhat dated (1987), and better methods currently exist that can take advantage of geospatial data at a more refined level than the county level used here. FMC apparently agrees with this criticism since they subsequently developed the ''National Leaching Assessment'' as part of their comments on the proposed tolerance revocation, to replace their earlier DRASTIC assessment.

Importantly, EPA believes that FMC has used an inappropriate criterion for determining whether a site is vulnerable–that it has the same or greater vulnerability (based on a DRASTIC score greater than 185) as that of the Maryland PGW study site. The maximum concentration at the Maryland PGW site, adjusted to simulate an application rate of 1 lb/acre, was 21 µg/L this exceeds acceptable exposure thresholds by factors of 10 to 20 (Ref. 71). Thus, sites that are less vulnerable (*e.g.*, deeper aquifer, high soil sand content, higher organic matter), with lower DRASTIC scores, could still be prone to have carbofuran concentrations exceeding acceptable exposures.

Further, the commenters provide no detail on the specific data used to generate their DRASTIC estimates. In footnote 39 of their comments they indicate that ''Data to support these [DRASTIC] inputs were primarily collected from state-wide, statistically designed studies conducted by state and federal agencies (primarily the National Water Quality Assessment Program (''NAWQA''), but also state surveys and other state and federal agricultural data, where NAWQA data were not available.'') Given EPA's general reservations about their approach, EPA cannot conclude that the commenters' assessment is scientifically supportable or useful, without information on the sources of the data, the geographic scale of the data, or how that input data was prepared for the analysis.

One group of commenters assert that their ''assessments revealed that the soils and water pHs are generally higher in those states in the Midwest and Northwest where most carbofuran is used, providing further confirmation that conditions that favor carbofuran leaching in those areas do not exist.''

Since the commenters have not provided all of the assessments they appear to have conducted, EPA is unable to confirm whether their assessments do in fact support their contention. However, as a general matter, none of the previously submitted assessments provided a comprehensive analysis of the distribution of soil and water pHs for the Midwest, Northwest or any other region of the country where carbofuran use would be permitted on the September 2008 label, nor have the commenters provided such an analysis with their most recent comments. Further, the available scientific information does not support their contention.

EPA examined readily available data with respect to ground water and soil pH in order to evaluate the spatial variability of pH. Data from the United States Geological Survey (USGS) and other readily available sources do not necessarily encompass the entire range of ground water pH values present within a state. This is especially true for shallow ground water systems, where local conditions can greatly affect the quality and characteristics of the water. Also, pH in a water body can be higher or lower than the tabulated average values. In addition, average ground water pH values for a given area do not truly characterize the area's temporal and especially spatial heterogeneity. This can be seen by comparing differences in pH values between counties within a state, and noting that even within a county individual wells will consistently yield ground water with either above- or below-average pH values for that county. The ground water simulations in Reference 111 Appendix I reflect variability in pH by modeling carbofuran leaching in four different soil and subsurface pH conditions (pH 5.25, 6.5, 7.0, and 8.7), representing the range in the aquifer system in that area. This range also approximates the pH range of natural waters in general. The results of the ground water simulations for corn use showed that a relatively small (0.5) decrease in pH from 7 to 6.5 resulted in an increase in the 1–in–10–year peak concentrations of carbofuran in ground water of 4 orders of magnitude.

FMC summarized the results of their ''National Leaching Assessment'' which used PRZM and ''databases specifically created to provide access to all necessary inputs for a national scale PRZM modeling.'' They claim that after accounting for the use prohibitions on their September 2008 label, the maximum 1–in–10–year peak concentrations in all potential carbofuran use areas is 1.2–1.3 ppb, while expected concentrations in most areas covered by this assessment are below 1.0 ppb. They claim to have modeled a single application to corn at 1 lb/acre—which is the application rate on the September 2008 labels applicable to the rescue treatment on corn—and simulated ground water recharge and lateral flow. They assert that their estimate that 1–in–10–year peak carbofuran concentrations will not exceed ''~1 ppb'' is consistent with EPA's NMC CRA.

Neither the ''National Leaching Assessment,'' nor the ''National Pesticide Assessment Tool'' upon which the assessment appears to have been based, were submitted to EPA for review, therefore EPA cannot comment further on the methodology for reaching these conclusions, or indeed, whether the assessment actually supports their claims. Based on the information provided, EPA cannot confirm or negate the assertion that there is no overlap between use and all potentially vulnerable ground water, as the information provided does not enable the Agency to evaluate this claim.

EPA's assessment of the impacts of FMC's September 2008 label differs significantly from the commenters' summary conclusions; these differences are addressed more completely in EPA's Response to Comments document, and are based on application by FMC of unsupported factors (Ref. 111).

Part of EPA's assessment of ground water exposure for the proposed tolerance revocation was based on simulation modeling using PRZM for corn grown on the Delmarva Peninsula in Maryland receiving an annual application of 1.0 lb/acre-1. The 1–in–10–year peak estimated drinking water concentration (EDWC) was 30.8 µg/L. FMC's assessment of the same label resulted in their estimate of concentrations up to 22.7 µg/L. The September 2008 labels prohibit application at sites in the Atlantic Coastal Plain with similar vulnerability to the Delmarva site. However, EPA believes that the study and the resulting scenario derived from this study remain relevant for other areas with similar conditions, where use remains. Based on the September 2008 labels, EPA has concluded that there are locations in the United States where carbofuran could still be applied, and in which ground water concentrations are estimated to be high enough to cause concern. For example, simulations of corn grown the central sands region of Wisconsin had an estimated 1–in–10–year peak concentration of 16 µg/L at pH 6.5 and 284 µg/L at pH 5.25, both of which are in the pH range for aquifers in this area (Ref. 115). For higher pH's in that area,

estimated carbofuran concentrations were generally close to zero.

As noted the ''National Leaching Assessment'' has not been provided to EPA for review, and consequently, the Agency cannot determine model input parameters or check model algorithms. In many cases, model inputs cannot be directly inferred from values in the available weather and soil databases (*e.g.*, NOAA SAMSON weather datasets, NRCS Soil Datamart) (Refs. 75 and 93). Methods used by FMC to select or calculate values for model input from these databases were not described. The only model output provided was in map format. While maps are useful for interpreting results, maps alone are insufficient for a thorough evaluation of the assessment, in part because of their spatial resolution. Further, the maps provided by FMC do not represent all carbofuran use patterns. For example, Figure IV-2 on page 42 of FMC's comments does not address the granular use patterns and proposed label prohibitions.

FMC contends that their results are consistent with the NMC CRA, but this is untrue. The NMC CRA examined carbofuran at two sites, northeast Florida and the Delmarva Peninsula. In Florida, concentrations were found to be below levels of concern because of high pH, but in Delmarva, both in corn and in melon scenarios EPA estimated that 90% of daily concentrations could be as high as 20.5 and 25.6 µg/L, respectively. These values are greater than the 1 µg/L that FMC claims is the maximum expected 1–in–10–year peak concentration. The claim that EPA's modeling fails to address use patterns ''changing naturally over time'' is ambiguous, and EPA cannot evaluate any inputs included by FMC to address this in their own modeling, if indeed they did so. Because of these deficiencies, EPA is unable to verify or evaluate the results of FMC's analysis and can reach no conclusion on its validity or utility.

FMC asserts that ''EPA's approach is not consistent with the Agency's treatment of other carbamates. For example, in the aldicarb assessment, EPA used monitoring data to develop eight different region-specific scenarios, 'based on broad similarity in compound usage, crop type or soil conditions', and taking a 'single maximum sample result detected within [each] region during the last 5 to 10 years to represent ground water concentrations within that entire region.' The Agency estimated drinking water concentrations for risk assessment purposes by accounting for the effect of ground water mitigation measures (*i.e.*, setbacks).'' In footnote 53 of their comments, FMC apparently quotes from the aldicarb IRED ''[H]igher residue values that may have resulted from historical use if aldicarb in vulnerable areas were excluded.''

EPA disagrees with FMC's assertion that the carbofuran drinking water exposure assessment was not consistent with other carbamates, particularly aldicarb. In both cases, Tier 2 modeling, using the PRZM and EXAMS models, was used to characterize surface water exposure and in both cases available monitoring data were summarized. For carbofuran, ground water exposure was characterized using a combination of targeted and non-targeted monitoring data, a PGW study, and Tier 2 modeling, through the course of two RED chapters and several post-RED drinking water exposure assessments. For aldicarb, two different ground water exposure assessments were conducted for the initial and the final IRED chapters. In the comment quoted above, FMC has described the process used for the aldicarb risk assessment supporting the initial aldicarb IRED dated May 12, 2006.

The second aldicarb ground water exposure assessment supported the revised dietary exposure assessment in February 2007 (Ref. 48). This is a more refined assessment, which relies on simulation modeling for ground water using PRZM in places vulnerable to ground water leaching where aldicarb was used. While FMC has correctly quoted ''[H]igher residue values that may have resulted from historical use of aldicarb in vulnerable areas were excluded,'' the implication that this is different from EPA's evaluation of carbofuran is not correct. For example, the carbofuran IRED describes monitoring in New York where carbofuran use was canceled in 1984, and where detections of carbofuran continue. The carbofuran IRED did not use the high concentrations of carbofuran measured in drinking water wells in that study, up to 178 ppb, which resulted from historical use of carbofuran. In both cases, historical monitoring data were described (Refs. 10 and 47), but endpoints used for ground water exposure assessment were only based on monitoring relevant to use patterns current at the time of the assessment. For aldicarb, the Agency utilized retrospective monitoring data collected after 1990. For carbofuran, the most relevant monitoring data set was the Maryland PGW study. Because of the design of that study, results could be adjusted to represent current use patterns.

The aldicarb assessment took into account the impact of well setbacks on estimated concentrations in ground water modeling conducted in 2007. The carbofuran modeling in EPA's most recent assessment also took into account the impact of well setbacks on estimated concentrations in ground water. Previous carbofuran assessments did not assess the impact of well setbacks, as setbacks were not included on a proposed carbofuran label until September 2008.

In summary, both assessments for aldicarb and carbofuran used a combination of monitoring data and simulation modeling for the drinking water exposure assessments, simulating the impact of mitigation measures on the labels.

b. *Comments relating to EPA's surface water assessment.* One group of commenters summarized conclusions based on a previously submitted surface water assessment based in Indiana. Specifically, they claim that: (1) EPA's standard index reservoir scenario overestimates surface water concentrations compared with ''expected concentrations in actual Indiana community water system (CWS) where carbofuran is used,'' (2) ''Indiana CWSs bracket the Index Reservoir scenario (*i.e.*, some reservoirs are more sensitive and others are less); however, in each instance the expected concentrations in the Indiana CWSs were significantly less than those estimated by the Index Reservoir scenario.''

EPA has reviewed the Indiana surface water assessment submitted by the registrant previously, and has provided comments on that submission (Ref. 59). FMC's first major conclusion from this study is that ''EPA's standard index reservoir scenario overestimates surface water concentrations compared with expected concentrations in actual Indiana CWS where carbofuran is used.'' The Index Reservoir is designed to be used as a screen, and as such, represents watersheds more vulnerable than most of those which support a drinking water facility. It is thus protective of most drinking water on a national basis. That, however, does not mean that EPA believes this scenario overestimates concentrations for all drinking water reservoirs. While EPA agrees that it is an appropriate refinement to simulate local and regional watersheds, and has in fact done so (Refs. 58, 60, 61, 62, and 111), EPA does not believe that FMC's assessment refutes the concern for carbofuran occurrence in Indiana surface water source drinking water. Even accepting the Indiana surface water assessment at face value (which we do not), FMC estimated 1–in–10–

year peak concentrations at some facilities as high as 6.88 µg/L, and these concentrations substantially exceed the concentration they now claim represent reasonable estimates.

FMC's second major conclusion has two parts: (1) That the vulnerability of the Indiana CWSs ''bracket'' the Index Reservoir, and (2) that the concentrations they estimated for these locations are significantly less than EPA estimates. Regarding the vulnerability of the CWS, FMC's assessment describes their approach for modifying the parameters of the Index Reservoir scenario to represent 15 reservoir-based watersheds in Indiana cropped in corn. FMC indicates they have included data that, based on our review of these submissions, are not available at the appropriate scale to determine all site-specific parameters. FMC modified some of the parameters based on available data to represent more localized conditions that are more or less vulnerable than for the Index Reservoir. From FMC's description, their approach is similar to the methods that EPA uses to develop new scenarios, in that soil and weather data are varied in order to represent different locations. However, for other parameters, EPA believes FMC's modifications are inconsistent with fundamental assumptions upon which the modeling is based. In submissions made to the Agency, FMC has described that they have made modifications to scenarios to reflect local conditions of each CWS in Indiana by modifying the soil, and weather data and altering the ratio of watershed drainage area to the reservoir capacity (Ref. 120). EPA agrees that soils and weather data can be modified to reflect conditions at local watersheds. However, other modifications FMC made cannot reasonably be justified for all scales without contradicting the assumptions upon which the modeling relies (uniformity of soils, equal and simultaneous movement of runoff to the reservoir, and uniform weather across the watershed).

FMC also calculated their own PCAs for this assessment. The PCA is the fraction of the drinking water watershed that is used to grow a particular crop. EPA uses the maximum PCA calculated for any HUC8 (8-digit hydrologic unit code) watershed in exposure estimates. HUC8s are cataloging units for a watershed developed by the USGS and are used as surrogates for drinking water watersheds. The process by which PCAs were developed and how they are used by the Agency has been vetted with the FIFRA SAP (Refs. 37 and 38). The Agency has developed PCAs for four major crops, corn, soybeans, wheat, and cotton, and uses a default PCA based on all agricultural land for characterizing other crops. The Agency has also calculated regional default PCAs for use in charactering regional differences in drinking water exposure. EPA limited further development of PCAs for additional crops, as a result of FIFRA SAP peer review comments, which concluded that data were not available at the appropriate scale to do so. In their assessment, FMC estimated PCAs for specific watersheds in Indiana. FMC did not provide sufficient detail in their descriptions of how they calculated PCAs to enable EPA to assess their validity.

Regarding FMC's statement that the concentrations they estimated for these locations in Indiana are significantly less than EPA estimates, EPA has determined that FMC has included an adjustment factor to account for the percent of a crop that is treated with carbofuran. As discussed in more detail below, although EPA does evaluate such factors in conducting ''sensitivity analyses'' to understand the impact that various PCT assumptions may have, EPA does not believe that it is appropriate to base its aggregate risk estimates on PCT within watersheds. This is because data and/or methods are not available that would allow EPA to develop PCT at the watershed scale with the necessary level of confidence to allow EPA to make a safety finding. The PCT factors that FMC generated would lead to significantly lower concentrations than those estimated by EPA.

One group of commenters reiterated conclusions from a previously submitted surface water assessment, the ''Nationwide CWS Assessment.'' Based on this assessment, the commenters allege that: ''use intensity in the majority (~ 75%) of carbofuran use areas is less than 2.1 lbs a.i./sq. mi,'' and that based on this use intensity, the commenters' modeling results in surface water concentrations ''that are not above the applicable level of concern.'' The commenters also claim that, because areas with historical use intensities greater than 2.1 lbs. a.i./sq. mi may be more sensitive to carbofuran, the registrant proposed no-application buffers which effectively mitigate the risks in these areas.

EPA has reviewed FMC's ''Nationwide CWS Assessment'' previously and has provided a response to the submission (Ref. 59). It is worth noting that FMC only assessed use intensity for reservoir-based systems and excluded use intensity for all stream- or river-based systems from their assessment.

Similar to the Indiana CWS study discussed in the previous response, this study relied on county-level usage estimates to estimate use intensity. This value was subsequently used in modeling to draw their second major conclusion, which FMC states formed the basis for their decisions to propose no-application buffers to mitigate risks in those areas, their third conclusion. To respond to this comment, therefore, it is important to understand how FMC arrived at these use intensities. Their methods have been poorly described in statements, but EPA was able to piece together a general sense of the methods from the various reports FMC provided to EPA.

To summarize, for FMC's National CWS Assessment, the registrant relied on sales data to generate its use intensity estimates, but these data were not provided to EPA. The method FMC used to generate the county-level use estimates from the sales data is not described. The actual county level use estimates used in the use intensity calculations were not provided. There is a limited description indicating only that the county level use estimates were apportioned to different crops, but the method FMC used to do this was not provided. FMC used an objective method to group the county-level use estimates into 5 classes, but the method is only briefly described. Thus, because EPA cannot determine how use intensity was estimated, the Agency cannot determine if the conclusions made in the National CWS Assessment are justified by the underlying data.

Since carbofuran sales data used for FMC's assessment were not provided in the document submitted to EPA, or with the comments to the SAP (Ref. 33), or with the comments on the proposed tolerance revocation, it was not possible for EPA to determine if FMC's claim that 75% of the use areas have a carbofuran use intensity of less than 2.1 lbs a.i./sq. mi., is accurate. Use intensity data in maps provided in their comments appear to indicate that carbofuran use varies year by year, however, it is also not clear for which year or years FMC is making this conclusion.

EPA agrees that using lower rates of carbofuran will result in lower exposure. But EPA does not agree that it has been demonstrated that a use intensity below 2.1 lbs a.i./sq. mile will assure that surface water concentrations will be below the applicable level of concern. The National CWS Assessment does not justify such a finding, nor has any other assessment that has been submitted to date. The Agency modeled use rates for carbofuran on corn based

on the label proposed in September 2008 and results are described in Unit VIII. and in Reference 111.

EPA is equally unable to confirm the claims that the no-application buffers on the September 2008 labels will adequately mitigate the risks ''in areas with historical use intensities greater than 2.1 lbs a.i./sq. mi.'' On the September 2008 labels, FMC included buffers of 300 feet on water bodies in Kansas, and 66 feet around water bodies in other places, but EPA cannot evaluate how these buffers relate to areas where carbofuran use intensities exceeded a specific value, for all of the reasons stated above. EPA did, however, model the effects from the buffers proposed on the September 2008 labels and found that these buffers reduce exposure by 5.1% (33.5 to 31.8 µg/L) for corn in Kansas with a 300 foot spray drift buffer and 4.7% (29.9 to 28.5 µg/L) for corn in Texas with a 66 foot spray drift buffer. These results are described in more detail in Reference 111, Appendix I.

One group of commenters claimed that EPA's modeling assumptions are ''implausible for most surface water systems across the country.'' They specifically criticize the following assumptions: (i) ''a lack of inflow to or meaningful outflow from the CWS; (ii) instantaneous and homogeneous mixing throughout the entire CWS; (iii) all receiving water directly abut the treated field and there are no buffers; and (iv) a lack of variation in pH across water bodies in the United States.''

All of the commenters' claims are incorrect. Their first contention, that EPA assumes that there is a lack of inflow to or meaningful outflow from the CWS, is incorrect. EPA's modeling assumes the inflow to the reservoir is equivalent to the mean annual runoff into the reservoir. Since the EXAMS model is a steady state model, outflow will equal inflow to the reservoir. Assuming that outflow equals inflow and that mixing occurs instantaneously throughout the reservoir are reasonable assumptions; the commenters made the same assumptions in their modeling. Secondly, the commenters believe the assumption that there is instantaneous and homogeneous mixing throughout the entire reservoir supporting the community water supply is implausible. This is a reasonable assumption for small, un-stratified reservoirs like the Index Reservoir. Also, the commenters made the same modeling assumption in their modeling in the Indiana CWS study, and apparently in the modeling done in support of their submitted comments on the proposed tolerance revocation. Thirdly, the commenters believe it is implausible to assume that all receiving water directly abuts the treated field, and there are no buffers. This claim is also not accurate. Until the September 2008 label, carbofuran labels did not require buffers, thus, EPA did not have reason to assess the impact of buffers. EPA's assessment of FMC's September 2008 labels considered the impact of the buffers (see Ref. 111, Appendix I). Finally, FMC contends that EPA's assumption of pH was implausible. EPA disagrees; EPA's assessment was based on the middle of the range of pH occurring in natural waters. In addition, as a sensitivity analysis, EPA assessed exposure assuming a high pH, representative of a high end pH of waters in Western Kansas, as well as the high end of natural waters in general.

One group of commenters summarizes conclusions from a previously submitted assessment based on the Watershed Regression for Pesticides (WARP) (Ref. 117) model. They claim, based on this assessment that ''[t]he maximum 1–in–10 day estimated concentrations of carbofuran at the 90th percentile level in Illinois, Indiana. Iowa, and Nebraska (where a majority of current carbofuran is located) will be less than or equal to 0.3687 ppb.'' They claim that WARP's 1–in–10–day estimates are a reasonable surrogate for the 1–in–10–year peak concentrations typically relied on by the Agency because ''the extreme nature of a 1–in–10–year event (*i.e.*, severe rain) would result in dilution effects that cancel out any increased loading.'' They also allege that the differences in surface water concentrations estimates in their assessment and EPA's modeling are due to their use of ''actual county-level usage data.''

EPA has reviewed the WARP assessment previously and has provided comments on the submission (Refs. 59 and 117). The WARP model has not been fully evaluated for quantitative use in exposure estimation by the Agency, although it has been preliminarily reviewed by the SAP (Ref. 39). EPA used WARP to select monitoring sites for the herbicide atrazine, based on predicted vulnerability of watersheds to atrazine runoff within the corn/sorghum growing regions. EPA presented its approach to the FIFRA SAP in December 2007. The SAP report concluded that ''WARP appears to be a logical approach to identify the areas of high vulnerability to atrazine exposure,'' endorsing EPA's use of this tool only for atrazine, and for the limited purpose of designing a monitoring program. The SAP noted that the most important explanatory value with WARP was use intensity, and underscored the importance of having the most accurate data for this parameter.

WARP is a regression model developed by the USGS to estimate concentrations of the pesticide atrazine in rivers and streams. As a regression model, it is based on monitoring data, in this case from 112 USGS National Ambient Water Quality Assessment (NAWQA) monitoring locations. WARP does not directly estimate daily concentrations, but predicts the percent of the time in a randomly selected year that concentrations of the pesticide are less than a specified value, with a specified level of confidence. USGS attempted to develop an approach to estimate annual time series for other pesticides, and concluded that ''further data collection and model development may be necessary to determine whether the model should be used for areas for which fewer historical data are available * * * Because of the relative simplicity of the time-series model and because of the inherent noise and unpredictability of pesticide concentrations, many limitations of the model need to be considered before the model can be used to assess long-term pesticide exposure risks.'' (Ref. 126).

The commenter's conclusion that the ''maximum 1–in–10–day estimated concentrations of carbofuran at the 90th percentile level in Illinois, Indiana, Iowa, and Nebraska [* * *] will be less than or equal to 0.3687 ppb,'' is erroneous. WARP does not provide direct estimates of return frequency, *i.e.*, 1–in–10 days, but rather percentiles of the expected distribution of measurements. This may be similar but not identical to the return frequency expressed as a percentile, depending on the number of measurements used to support the regression. EPA lacked the information necessary to determine whether FMC's contractor calibrated the model correctly. However, taking the conclusion at face value, the value FMC predicted using WARP, 0.3687 ppb, appears to represent the maximum of the estimated values of the annual 90th percentile among all the sites evaluated. Such a site would be expected to have higher concentrations than 0.3687 ppb about 37 days a year (10% of the year). Generally, the 90% prediction intervals tend to be about plus or minus an order of magnitude. Thus, roughly 5% of such sites could have about 37 days a year greater than about 3.7 ppb.

The Agency also disagrees that the differences between FMC and EPA estimates are only due to FMC's use of county-level usage data. Most importantly, the Agency does not concur that 1–in–10–day estimates are a reasonable surrogate the for the 1–in–

10–year peak concentrations estimates used routinely by EPA. 1–in–10–day concentrations are not the measurement endpoint EPA uses for human health risk assessment and are not appropriate for estimating drinking water exposure. The Agency uses 1–in–10–year peak concentrations for screening level assessments, and the full time series (typically 30 years) of daily concentration values for refined assessments. For example, EPA's estimate of the 1–in–10–year peak concentration from the simulation of corn in Kansas with a 300 ft buffer was 31.8 µg/L. EPA's estimate of the 1–in–10–day concentration from the same simulation was 4.5 µg/L. The measurement endpoint used by EPA, which has been subject to peer review by the FIFRA SAP, is the 1–in–10–year, peak concentration. A concentration that occurs 1–in–10 days occurs 350 times as often as a 1–in–10–year event. Assuming this statistic instead of the one EPA used would result in a significantly lower estimates of pesticide water concentration and human exposure. Such an approach would be inconsistent with the SAP's advice and EPA's typical practice, as well as with EPA's statutory requirement to protect human health. EPA disagrees with FMC's claim that ''the extreme nature of a 1–in–10–year event would result in dilution effects that cancel out any increased loading.'' The Index Reservoir scenario has been validated against monitoring collected at the site it was designed to represent, Shipman City Lake in Illinois (Ref. 56). This assessment showed that the 1–in–10–year event EPA modeled was similar in magnitude to the peak value of the pesticide concentrations shown in 5 years of monitoring data collected at that site. The 1–in–10–year peak concentration calculated for that pesticide (not carbofuran), using the Index Reservoir was 33 µg/L, while the peak value from 5 years of monitoring was 34 µg/L.

EPA cannot comment on the use intensities assumed for FMC's assessment. The source of county level use data was not described. Based on the comments submitted to the SAP by FMC (Ref. 33) the source is likely to be sales data at the distributor level. However, the method chosen to estimate county level use estimates from the sales data was not provided. The county level estimates used in the assessment for 2002 to 2004 for Illinois were provided in a table. These estimates for each county were averaged over the 3 years for input to the model. A summary description of how watershed-scale use estimated from county level use data was provided, but because the sales data and method that was used to generate county level estimates were not available, this validity of this assessment cannot be evaluated.

Several commenters criticize the Agency for the assumption that 100% of the cropped area in a watershed is treated. These commenters claim that actual carbofuran sales data on a county basis confirm that the actual carbofuran PCT is less that 5%, with most PCTs less than 1%. The commenters claim that these county level sales data either were provided to EPA as part of reports prepared by their consultants, or would be provided to EPA. They further claim that ''how these data were analyzed, interpreted, and applied'' was provided to EPA in a report on best management practices.

While the Agency typically uses PCT in developing estimates of pesticide residues in food, this is entirely different than developing estimates of the percent of a watershed that is treated for purposes of estimating drinking water exposures. Food is generally randomly distributed across the nation without regard to where it is grown. This tends to even out any PCT variations that may arise on local levels. By contrast, the source of water consumption (and consequently exposure) is localized, either in a private well or a community water system. The PCT in any watershed will therefore directly impact the residues to which people living in that watershed will be exposed.

For this reason, among others, for drinking water exposure estimation, the Agency assumes that 100% of the cropped area (or 100% PCT) is treated. EPA also makes this assumption due to the large uncertainties in the actual PCT on a watershed-by-watershed basis. EPA developed an extensive discussion of the uncertainties in PCT and how they impact drinking water exposure assessment in its proposed rule (73 FR 44834) and in a background document provided to the SAP considering the draft carbofuran NOIC (Ref. 59). Because usage is often not evenly distributed across the landscape, due to differences in factors like pest pressure, local consultant recommendations and weather, it may be much higher in some areas. Further, temporal uncertainties can result in changes in use that might be driven by weather, changes in insect resistance over time, and changes in agronomic practices. To date, methods that account for this uncertainty, given the nature of the available data, have not been developed. Consequently, EPA cannot accurately estimate a drinking-water watershed scale PCT that, when used in a quantitative risk assessment on a national or regional basis, standing alone, provides the necessary level of certainty to allow the Agency to confidently conclude that exposures will meet the FFDCA 408 safety standard.

In most cases, EPA agrees that it is unlikely that 100% of the crop will be treated in most watersheds, particularly in larger watersheds. However, for small watersheds, it is reasonable to assume that an extremely high percentage of the crops in the watershed may be treated.

Moreover, EPA has an obligation to evaluate all legally permitted use practices under the label, and to ensure that all such use meets the requisite statutory standards, not simply to base its decisions on the practices the majority might typically use. The September 2008 proposed label imposes no restriction on the application of carbofuran related to whether a particular percent of the watershed has been treated. Thus, even with the restrictions on FMC's September 2008 labels, it remains legally permissible for 100% of the watershed to be treated with carbofuran.

Nor is EPA aware of an enforceable mechanism to ensure that farmers applying pesticide to their individual fields will have the ability to determine whether a particular percentage of the watershed has been treated. There are significant practical difficulties inherent in implementing such label directions, as they force individual growers to have continual knowledge of the variances of the behavior of other farmers across the entire watershed. While for small watersheds that involve only one or two farms it might be feasible for neighbors to coordinate applications with respect to adjacent fields, for larger watersheds, the practical difficulties increase significantly.

However, in the proposed rule, EPA conducted a sensitivity analysis to explore the impact of PCT assumption on dietary risk using an assumed 10% PCT, a figure proposed previously by FMC (73 FR 48864). The results of that analysis demonstrated that even at these low percentages, which may significantly underestimate exposures, particularly in small watersheds, carbofuran exposures from drinking water contribute significantly to children's dietary risks. EPA conducted a similar sensitivity analysis for this final rule, discussed below in Unit VIII.E.3., which demonstrates that even assuming that a low percentage of a watershed is treated, exposures will be unsafe for infants.

FMC has submitted three assessments that relied in part on what they refer to as ''county-level usage data'' (Refs. 36, 96, and 120). The description that EPA has been able to piece together from the registrant's various submissions indicates that the original source of the ''county-level usage data'' is sales data, apparently collected at the distributor level. FMC claims to have augmented these sales data in an unspecified manner, by incorporating information from the distributor, which FMC used to allocate carbofuran usage at the county level. FMC has provided maps representing county level and watershed-scale use estimates, but has not provided the actual usage estimates in any clearly understandable format. Nor, as of the close of the comment period, has any commenter provided either the ''actual sales data'' FMC used to develop these estimates, or the methods used to estimate county level usage from the sales data. FMC has provided only a limited description of how these data were collected and no description of how they were actually analyzed or validated; what FMC characterizes as ''careful and proven techniques to capture this data'' were not described. The method FMC used to attribute carbofuran sales to counties was not described. In the absence of the data or analyses described above, EPA is unable to verify or evaluate the results of any analyses that rely on these data and can reach no conclusion on its validity or utility.

The Agency agrees that county-level use data would be useful in generating reasonable estimates of PCT that could be used in drinking water assessments. However, as discussed in the previous responses, FMC has only provided county-level use estimates (not the underlying data nor the analyses that presumably are the basis for the estimates) for Illinois; county-level estimates to support other risk assessments have not been submitted by FMC as of the end of the comment period. The underlying sales data (*i.e.*, measurements) used to make the county-level estimates and the methods FMC used to estimate county level use from them have also not been submitted. FMC has provided limited characterization of the source data, noting that these data were derived from FMC billings and ''EDI data'', which they did not define, and that the sales data had been adjusted to reflect different use patterns and by removing use for patterns which they no longer support (*e.g.*, alfalfa). However, FMC did not provide adequate details on the methodology they used to make these adjustments.

A major problem with the method FMC seemingly used is that it does not appear to account for uncertainties due to variation in time and space and the potential for use to be locally concentrated due to pest pressures. The method FMC summarily describes as having been used to allocate county-level usage estimates to watersheds appears to be similar to a method that has been used by others for calculating ''best-estimate'' county-level PCT (Ref. 95) to map nation-scale pesticide usage. However, these methods are not appropriate for calculating PCTs for surface drinking water sources or watersheds that drain to CWSs, because they do not adequately account for the uncertainty in the data at the appropriate spatial scale. This methodology produces an estimate that is a measure of central tendency and, as such, roughly half the estimated values will underestimate the PCT. Furthermore, because, pesticide use varies from year to year, and can in some cases be patchy, with high levels of use in small areas and little use in most areas, the underestimates of PCT can be substantial in small watersheds. As previously noted, methods for calculating PCT that account for these uncertainties have not been developed.

Several commenters allege that carbofuran use will not concentrate in areas due to pest pressure. One commenter criticizes EPA for failing to support its conclusion that the pest pressure and infestation patterns could result in concentrated usage that could occur within vulnerable watersheds, and claims that EPA ignored the county-level sales data provided by the registrant which can be used both to determine whether carbofuran usage is evenly dispersed or locally clustered (an assessment [FMC's contractor] expressly undertook) and the probability of concentrated usage within vulnerable watersheds.

Two commenters claim that, because ''more than 60% of the total corn acreage is made up of rootworm resistant GMO corn, which vary rarely requires treatment,'' and the remaining acreage ''is refugia acreage for GMO fields which is widely distributed geographically,'' it is a ''virtual impossibility'' that all corn acreage in a particular watershed will require a rescue treatment in any given year. Another commenter made similar allegations for sunflower acreage. The commenter claims that ''[s]unflowers are a specialty crop that is only grown on a small proportion of agricultural acreage generally, particularly in states where carbofuran is used (*i.e.*, Nebraska, Colorado, Kansas, and Texas).'' According to the commenter, the available data suggests that sunflowers are only used on 25% of total cropped area, and that carbofuran is not used on all of these acres. As further support for this point, another commenter cites to the sunflower PCAs they calculated for Nebraska, Kansas, Colorado, and Texas,'' which they claim is 2.12%.

The Agency agrees that the true PCT is not likely to be 100%. However, as discussed in several places throughout this preamble, the Agency is certain that PCT is higher in some cases than values calculated by the commenter. The degree of spatial correlation, however, is unknown, and thus is a major uncertainty. FMC's own analysis of carbofuran use in watersheds in Indiana suggests that carbofuran use is indeed localized, as carbofuran use was found in watersheds of only 12 of the 35 community water supplies that they considered in the state (Ref. 120). This suggests that when pest pressure occurs it is not unreasonable to assume it will be localized. Other factors, such as market pressures, consultant recommendations, or local availability may also be driving disparate levels of use in different locations. Since there is no method to account for this uncertainty in estimating PCT, it cannot be estimated in this assessment with the degree of confidence consistent with the statutory requirement of a reasonable certainty of no harm.

The commenters raise several valid points that, taken together, reduce the probability that carbofuran usage will be concentrated over large geographical areas. However, the commenters failed to rebut EPA's conclusion that carbofuran's use patterns could be concentrated in certain locations, such that a large percentage of a small watershed is treated. Their first observation that carbofuran is applied as a rescue treatment on 0.27% of all U.S. corn acreage is true at the national level. However, the commenters failed to note that there are regional differences in carbofuran use, and as the scale becomes smaller, one would expect these differences to become even greater, precisely because use of carbofuran is sporadic in both time and space. Large areas would not be treated, but smaller areas, such as some drinking water watersheds considered by EPA may have a significantly higher proportion of their acreage treated than compared to national estimates.

The commenters' point that control failures are more likely to occur on biotech corn refugia is valid and will tend to prevent treatment of large

contiguous areas of corn. However, not all farmers plant biotech corn. Further, farmers who do grow biotech corn do not locate their refugia universally in one part of the field, and there is no requirement that farmers in contiguous fields coordinate the location of their respective refugia. Consequently, the possibility that several contiguous corn fields could be simultaneously treated in any given year is not precluded. It is worth noting in this context that the September 2008 labels do not restrict application to the refugia. Moreover, in those areas where carbofuran is applied aerially, such as Nebraska, it is frequently easier for applicators to treat an entire field, rather than restricting their application to only select portions of the field. This is particularly true in smaller fields. Finally, because usage is often not evenly distributed across the landscape due to differences in factors like pest pressure, local consultant recommendations and weather, it may be much higher in some areas, and methods that account for this uncertainty, given the nature of the data, have not been developed.

EPA agrees that the 87% default PCA that has been used for EPA's drinking water exposure assessments is likely a conservative estimate of sunflower acreage in a watershed. However, EPA has not developed PCAs for specific crops other than for corn, wheat, and cotton, consistent with guidance provided by the FIFRA SAP (Ref. 38). Nevertheless, the sunflower growers' own estimate of sunflower PCAs range as high as 25%, which certainly cannot support a PCA of 2.12% as one of the commenters suggested.

One commenter complained that as part of the NMC CRA, EPA relied on actual ''county-or multi-county level pesticide use information, based on agricultural chemical use surveys'' to develop its estimates of potential exposure, rather than assuming 100% PCT.'' The commenter compares their surface water estimations to those developed by EPA for the NMC cumulative assessment, and claims that the two are consistent.

While it is true that in the NMC assessment, EPA used PCT numbers to estimate the cumulative exposure from the contamination of such pesticides in surface water, this was done in order to more accurately account for the likelihood of pesticide co-occurrence at a single drinking water facility. But this does not mean that use of PCT is appropriate in conducting an assessment of aggregate exposure from carbofuran residues in surface water. This difference in approach between the assessment of a single chemical's aggregate exposure, and the assessment of the cumulative exposures from several chemicals, stems from the differences in the purpose and scope of the two assessments. These differences inevitably require the application of different methodologies.

In evaluating the acute risks associated with a single chemical's contamination of drinking water, EPA must consider all of the variations permitted under the label. Drinking water exposures are driven by uniquely local factors; not only is the source of drinking water local (i.e. a person drinks water from his or her local water system not from a combination of water systems from across the United States), but the likelihood and degree of contamination of any particular, local drinking water source, whether it is a reservoir or well, varies widely based on local conditions (e.g, from local pest pressures, weather). Given this local variability, EPA must evaluate how all of the practices permitted under the label will affect drinking water exposures, because all are legally allowed, and farmers may choose any of them based on their particular individual local conditions. This means that even if typically growers, on a national or regional basis, do not frequently use a particular practice, EPA must still evaluate whether aggregate exposures from that practice would be safe because the practice is legally permissible and may be used due to local conditions. Thus, for example, even if most growers tend to apply the chemical only to a portion of the field, or typically only apply one-half of the maximum application rate, EPA must determine whether use by all or some growers to the entire field or at the maximum rate in a local watershed would result in unsafe drinking water concentrations.

By contrast, it is not feasible to conduct the identical analysis for a cumulative assessment of related chemicals. Since the potential combinations of variations in pesticide use practices for the group of pesticides to be assessed are essentially infinite, even with computer modeling it would be impossible to model or evaluate all of the combinations allowed under the labels. EPA therefore needed to narrow its evaluation of the possible combinations to those deemed ''likely'' to occur. In contrast to the single chemical assessment, a cumulative assessment is intended to develop a snapshot in time of what is likely occurring at the moment. Moreover, the purpose of a cumulative assessment is to identify major sources of risk that could potentially accrue due to the concurrent use of several pesticides that act through a common mechanism of toxicity. Thus, EPA is primarily interested in the subset of circumstances in which residues from such pesticides occur concurrently (or co-occur).

In addition, one of the important attributes of a cumulative risk assessment is that its scope and complexity can potentially lead to inflated estimates of risk due to compounding conservatisms, which would reduce the interpretability and ultimately the utility of the assessments. Because many data sets need to be combined, reducing the impact and likelihood of compounding conservative assumptions and over-estimation bias becomes very important in constructing a reasonable cumulative risk assessment.

When little or no information is available to inform potential sources of exposure, such as a reasonable or maximum watershed scale PCT, it is both scientifically and legally reasonable for a single chemical assessment to incorporate conservative assumptions to reflect reasonable worst-case exposure estimates. But in a cumulative risk assessment, the incorporation of such conservative assumptions would imply multiple simultaneous reasonable worst-case exposure estimates for each individual chemical. This is so unlikely that the results would no longer represent even a reasonable worst-case estimate of the likely risks. Consequently, some of the conservative assumptions appropriately used in the single chemical risk assessments are not appropriate or reasonable for use in a cumulative risk assessment, and vice versa.

As a result, EPA chose in the NMC to work with those data that most closely reflect ''representative'' exposures, and developed ''representative'' estimates of PCT in regional watersheds. However, to be clear, the PCT values used in the NMC assessment do not represent estimates of 50% of watersheds, or even the ''average'' watershed; rather, they represent values that are expected to be as likely to be accurate as not, based on a random selection of watersheds. A comparable example is the statistic that the average American family has approximately 2 children; this may or may not be true for any individual family, but there is an equally good chance that it will be accurate for any randomly selected family, as that it will not be accurate. For the cumulative assessment, EPA is able accept this level of uncertainty in these estimates, precisely because it has confidence that aggregate exposures from the individual chemicals will be safe, based on the level of conservatism in the single

chemical assessments. But given the statute's mandate to ensure a ''reasonable *certainty* of *no harm*,'' EPA could not rely on the approach used under the cumulative assessment in the absence of the more conservative single-chemical assessment that evaluates the full range of exposures permitted by the registration.

Nevertheless, as discussed in Unit VIII.E.3., in response to FMC's concerns EPA performed a sensitivity analysis of an exposure assessment using a PCT in the watershed to determine the extent to which some consideration of this factor could meaningfully affect the outcome of the risk assessment. The results suggest that, even at levels below 10% CT, exposures from drinking water derived from surface waters can contribute significantly to the aggregate dietary risks, particularly for infants and children. Accordingly, these assessments suggest that use of a reasonably conservative PCT estimate, even if one could be developed, would not meaningfully affect the carbofuran risk assessment, as aggregate exposures would still exceed 100% of the aPAD.

One commenter raised the concern that USGS monitoring found that concentrations of carbofuran in agricultural streams ranged from non-detect to 7 ppb (with a 95th percentile concentration of 0.044 ppb), noting that the monitoring strategy used by USGS for this program is likely to underestimate peak contamination levels (Ref. 114). The commenter argued that the USGS monitoring program is not designed to target waterways where carbofuran is in high use, or timed to coincide with predicted peak levels of pesticide runoff into waterways. Moreover, the frequency of sampling is normally weekly or bi-weekly, not enough to reliably sample the sporadic peaks that are predicted to be associated with pesticide application days or heavy runoff following rains. This monitoring strategy is more likely to capture the trends in chronic pollutants, but miss peak events such as pesticide runoff following rain. The sampling strategy biases towards the null; that is, it is likely to underestimate contamination by missing peak events when they occur, but will not over-represent non-detects. The commenter alleged that the fact that these data show routine detections of carbofuran in streams from agricultural land use areas suggests that there are likely to be peak events that go undetected. These data further support EPA's decision to cancel carbofuran and support rejecting FMC's proposal to restrict its use only in a limited number of watersheds. Because carbofuran is detected in streams across the nation, FMC's spatially limited mitigation plan would fail to protect many waterways from contamination.

One commenter argued that FMC's proposal to restrict uses of carbofuran in the most vulnerable watersheds, to limit ground water contamination, would fail to provide adequate protection. The commenter noted ''substantial monitoring data showing that carbofuran has been detected by the USGS in 10.4% of over 2,000 stream-water samples taken from 83 agricultural streams monitored from 1992–2001, demonstrating that it is a widespread water pollutant and that geographically limited mitigation measures are not likely to be adequately protective.'' (Ref. 114).

EPA agrees with the commenters that the risks of surface water contamination from carbofuran are significant, and that FMC's September 2008 labels do not mitigate the risks sufficiently.

3. *Aggregate exposures*. One group of commenters presented a summary of some of the results of their own aggregate exposure assessment. According to these commenters, the results of their risk assessment demonstrate that carbofuran residues from the four domestic food uses, imports, and drinking water are ''safe.''

EPA notes that the commenters merely provided summaries of the results of this assessment, and describe their methodology in only the most general terms, but chose not to provide the actual risk assessment to the Agency. Nor did the commenters provide any of their input files. Consequently, EPA was unable to fully evaluate the scientific adequacy of this assessment.

The Agency's analyses result in food only exposures comparable to some of those reported by the commenters (*e.g.*, exposures from the four import tolerances). But the remaining scenarios could not be verified since the commenters did not elaborate on the methods by which the detected concentrations found in the PDP milk samples were adjusted. Nor could EPA replicate the commenters' reported results. As discussed in more detail in Unit VIII.E.1., the Agency's assessment for this subset of foods differs slightly from the commenters due to PCT estimates (bananas), and more significantly, in the treatment of milk residues detected by the PDP program. Those differences cause the commenters' food only scenario (without accounting for any reversibility of AChE inhibition) to be slightly lower than the Agency's revised estimates (67% vs 78%).

EPA was also unable to replicate the commenters' results for drinking water exposures, or for aggregated exposures from food and drinking water. The commenters report that in their water only scenario, the DEEM results were 350% aPAD, assuming a 5% crop treated value. However, as discussed previously VII.C.2.b., EPA believes that it lacks sufficient basis to assume that only 5% of the crop in a watershed will be treated.

The commenters presented the results of their ''Eating Occasions Analyses'' for only one aggregate scenario, which was based on a Kansas corn drinking water scenario, and only for the infant subpopulation. It is based on this scenario that the commenters claim that aggregate exposure to carbofuran residues will be safe. The commenters appear to have also developed some other scenarios for corn, sunflowers, and potatoes that produce similar predicted drinking water concentrations; some of which have slightly higher peak concentrations. However, they did not present any results for those scenarios, nor provide any of the analyses to the Agency as part of their comments. As noted, EPA was unable to replicate these results. But as discussed below in Unit VIII.E., EPA disagrees that aggregate exposures to carbofuran residues are safe.

One commenter raised the concern about the numbers of people exposed to unsafe levels of carbofuran. The commenter stated that EPA has determined that the aggregate exposures to carbofuran from food and water at doses greater than 0.000075 mg/kg/day/day, the aPAD, will not meet the safety standard of FFDCA section 408(b)(2). At the 99.9th percentile of exposure, aggregate dietary exposure from food alone exceeds the aPAD by 160% for children 6–12 years (approximately 36,000 kids), and 210% for children 3–5 years old. The commenter stated that when these estimates are aggregated with ground water sources of drinking water from vulnerable areas, the predicted exposure exceeds the aPAD by 1,100% for adults over 50 years (approximately 71,000 people) and over 10,000% for infants at the 99.9th percentile (approximately 4,000 infants). According to the commenter there are approximately 24,000,000 children under 5 years old in the United States, so 0.1% of this age group would mean leaving approximately 24,000 children at risk, using the 99.9th percentile exposure estimates. According to the commenter, no reading of the statute will support any approach that allows thousands of children to be

exposed to a pesticide at levels that exceed the aPAD.

EPA agrees that aggregate exposures to carbofuran do not meet the FFDCA's safety standard. The precise figures calculated by the commenter were based on exposures from all of the registered uses assessed in EPA's proposed rule; as many of those uses have been canceled, the number of affected children is expected to be lower. However, EPA agrees that based on its revised estimates, allowing children to continue to be exposed to carbofuran would not be consistent with the statute.

D. Comments Relating to Legal or Policy Issues

A number of commenters raised concern that EPA had proposed to revoke all carbofuran tolerances before taking action against the pesticide registrations under FIFRA ''in the absence of an imminent health hazard.'' Several of these commenters raised concern that EPA had failed to comply with FFDCA section 408(l)'s requirement to ''coordinate action [under the FFDCA] with any related necessary action under the [FIFRA].

EPA has determined with respect to carbofuran both that the tolerances established for that chemical fail to meet the safety standard set forth in section 408 of the FFDCA and must therefore be revoked under that statute, and that the pesticide registrations fail to meet the relevant standard under FIFRA, and must therefore be canceled under that statute. Section 408(l)(1) of the FFDCA provides that ''[t]o the extent practicable and consistent with the review deadlines in subsection (q), in issuing a final rule that suspends or revokes a tolerance or exemption for a pesticide chemical residue in or on food, the Administrator shall coordinate such action with any related necessary action under [FIFRA].'' 21 U.S.C. 346a(l)(1). Nothing in this provision establishes a predetermined order for how the Agency is to proceed to resolve dietary risks. Nor does FIFRA include any provision that imposes a requirement that the Agency act first under FIFRA before it may act under the FFDCA in a situation such as carbofuran, where pesticide registrations and tolerances fail to meet the relevant legal standards of FIFRA and the FFDCA. Accordingly, there is no support for the notion that, as a matter of law, the Agency lacks the legal authority to revoke pesticide tolerances under the FFDCA that do not meet the safety standard of that statute unless the Agency has first canceled associated pesticide registrations under FIFRA.

Coordination is defined as ''to place or arrange in proper order or position, to combine in harmonious relation or action.'' Thus, the requirement to ''coordinate'' is a direction to ensure that the substance of actions taken under the two statutes are consistent, and that the Agency make a determination as to the proper order of action under the two statutes. This cannot be read as a requirement that actions under FIFRA precede actions under the FFDCA, or that any particular order is necessarily required. Indeed, to the extent that this provision offers any direction with respect to the order of preference, the language actually suggests that the order in which EPA has proceeded is entirely appropriate. Section 408(l)(1) requires EPA to proceed ''consistent with the review deadlines in subsection (q).'' 21 U.S.C. 346a(l)(1).

One commenter raised concern that the FFDCA requires EPA to harmonize actions under FFDCA and FIFRA ''to the extent practicable.'' The commenter alleges that there is no excuse for not ''harmonizing action under both statutes'' in the absence of an ''imminent hazard.'' According to the commenter, ''harmonization would allow the key science issues to be resolved in an orderly manner before hasty action is taken, would avoid needless disruption and confusion of agriculture and the channels of trade, and would allow the benefits of the pesticide to be properly taken into account.''

As explained in the previous response, the comment is based on a misconstruction of FFDCA section 408(l)(1). As a preliminary matter, EPA interprets the commenter's phrase ''harmonizing action under both statutes'' to mean either: (1) Pursuing action to cancel registrations under FIFRA prior to revoking tolerances or (2) holding a hearing pursuant to FIFRA and the FFDCA simultaneously. Section 408(l)(1) does not require EPA to do this; as discussed previously EPA is merely required to ''coordinate'' action under the two statutes, ''to the extent practicable and consistent with the review deadlines.'' Nor is there any basis in either FIFRA or the FFDCA for the commenter's alleged requirement that EPA determine that a pesticide presents an ''imminent hazard,'' as that term is defined in FIFRA, prior to taking action to resolve dietary risks under the FFDCA.

EPA chose to initially take action exclusively under the FFDCA to resolve carbofuran's dietary risks for a number of reasons. First and foremost, this was determined to be the quickest way to resolve acute dietary risks to children. In addition, the fact that this would resolve the issues most quickly would be beneficial to all parties, including the registrant and growers, since it would reduce costs and uncertainty for all by resolving the question of carbofuran's dietary risks.

An additional consideration was the belief that this route would be more transparent, and would ensure that there would be no confusion as to the appropriate standard that would be used to resolve dietary risk concerns. The Agency was concerned that holding a hearing under FIFRA would lead growers to misunderstand the role that benefits could play in the ultimate decision. Indeed, the commenter's claim that ''harmonization would allow the benefits of the pesticide to be properly taken into account'' confirms that EPA's concern was justified.

Whether under FIFRA or the FFDCA, a pesticide's benefits are irrelevant in determining whether a pesticide presents an unacceptable dietary risk. Section 408(b)(2) clearly provides that the only standard is whether the pesticide chemical residues will be ''safe.'' 21 U.S.C. 346a (b)(2). Nor is the evaluation of a pesticide's ''benefits'' included among the factors to be considered in determining whether residues will be ''safe.'' 21 U.S.C. 346a (b)(2)(B). FIFRA section 2(bb) incorporates the FFDCA's standard explicitly and without modification, clearly distinct from the provisions that relate to consideration of the benefits of the pesticide. Thus, in any FIFRA hearing, if it is determined that use of a pesticide fails to meet the FFDCA section 408 safety standard, the pesticide must be canceled, irrespective of whether the benefits outweigh the ecological and occupational risks. But since under FIFRA, all issues are addressed in one hearing, the potential existed for confusion on the part of the members of the public, who might have an interest in the proceedings.

Finally, EPA disagrees that it has failed to proceed in an orderly manner or that it has taken hasty action. By the time these tolerance revocations will be effective, EPA will have provided numerous opportunities for public comment, obtained peer review of the key science issues from the SAP, and will, if appropriate, hold a hearing on remaining issues of material fact. Further, notwithstanding the statutory deadlines in section 408(q) for identifying and resolving dietary risks, the registrant had 8 additional months to generate data to rebut the Agency's conclusions in the IRED. In total, the registrant and the public will have been

granted numerous opportunities and well over 2 years to comment on the key science issues. Given that carbofuran presents acute dietary risks to children, and the clear statutory deadline in FFDCA section 408(q), EPA believes it would be difficult to characterize its action as ''hasty.''

Some commenters objected to EPA's revocation of tolerances on the grounds that it was poor public policy because the action ''sets up farmers and food producers for unanticipated, unwarranted, and unfair enforcement action and penalties for presence of residues in food from otherwise legally treated crops.''

EPA shares the concerns that farmers' crops not be subject to unfair or unwarranted penalties based on the Agency's choice to resolve carbofuran's dietary risks before proceeding with a cancellation. EPA has taken a number of measures in response to these concerns, to ensure that growers will not be unfairly penalized by the Agency's action.

First, EPA has established delayed effective dates for all of the tolerance revocations, to provide growers with sufficient time to use up stocks of carbofuran that they currently have on hand. These dates are well after the end of the current growing season. These delayed effective dates also ensure that growers have sufficient notice of when these requirements will be applicable to allow them to factor this into their purchasing and application decisions. By the time the rule is scheduled to become effective, growers will have been informed of EPA's intentions well over a year in advance; this should be more than sufficient time to allow growers to plan around the final revocation dates. Finally, EPA has initiated discussions with FDA, and will continue to coordinate with FDA, to ensure that food that was treated before the effective date of the tolerance revocations will continue to be allowed to be sold.

Late comments. EPA received a number of submissions after the close of the comment period. The majority of these were from FMC, the registrant of carbofuran. These submissions included a request to stay the effective date of the tolerance revocation, as well as requests that EPA consider additional issues and factual information in this final rule. In addition, one timely submitted comment questioned the legal basis for the statement in the proposed rule that failure to raise issues during the comment period would constitute a waiver of those issues, asserting that ''EPA's requirement. . .does not appear to be legally binding.''

Sections 408(e)–(g) of the FFDCA provides a multi-step process for the establishment and revocation of tolerances, that provides ample opportunities for those with an interest in the tolerance to protect those interests. The process essentially consists of informal rulemaking, supplemented as appropriate with an administrative hearing. *See,* 21 U.S.C. 321a(e)–(g). As an informal rulemaking, the process is governed by section 553 of the Administrative Procedures Act, (APA) except to the extent section 408 provides otherwise, or to the extent the FFDCA falls within one of the APA's exceptions. Accordingly, the legal basis for the Agency's statement that issues not raised during the comment period on the proposed tolerance revocation may not be raised as objections or in any future proceeding, stems directly from the requirements of section 553 of the APA, and the case law interpreting these requirements. In this regard, it is well established that the failure to raise factual or legal issues during the comment period of a rulemaking, constitutes waiver of the issues in futher proceedings, [*e.g.*, *Forest Guardians v US Forest Service*, 495 F.3d 1162, 1170–1172 (10th Cir. 2007)] (Claim held waived where comments ''failed to present its claims in sufficient detail to allow the agency to rectify the alleged violation''); *Nuclear Energy Institute v EPA*, 373 F.3d 1251, 1290–1291 (D.C. Cir. 2004) (''To preserve a legal or factual argument, we require its proponent to have given the agency a 'fair opportunity' to entertain it in the administrative forum before raising it in the judicial forum.'') *Native Ecosystems Council v Dombeck*, 304 F.3d 886, 889-900 (9th Cir. 2002) (Purpose of requirement that issues not presented at administrative level are deemed waived is to avoid premature claims and ensure that agency be given a chance to bring its expertise to bear to resolve a claim); *Kleissler v. U.S. Forest Service*, 183 F.3d 196, 202 (3d Cir. 1999) (Policy underlying exhaustion requirement is that ''objections and issues should first be reviewed by those with expertise in the contested subject area''); *National Association of Manufacturers v US DOI*, 134 F.3d 1095, 1111 (D.C. Cir. 1998) (''We decline to find that scattered references to the services concept in a voluminous record addressing myriad complex technical and policy matters suffices to provide an agency like DOI with a 'fair opportunity' to pass on the issue.'') *Linemaster Switch Corporation v EPA*, 938 F.2d 1299, (D.C.Cir. 1991) (declining to consider in challenge to final rule, data alluded to in comments, but not submitted during the comment period, and information submitted to EPA office that was not developing the rule). And nothing in the language or structure of the FFDCA alters this. As such, this is indisputably a binding legal requirement.

The fact that section 408 of the FFDCA in certain limited circumstances supplements the informal rulemaking with a hearing, does not change the fundamental nature of the process. In other words, the addition of further process, through the availability of an administrative hearing to resolve certain factual disputes, does not fundamentally alter the requirements applicable to informal rulemakings. To this end, EPA interprets the notice and comment rulemaking portion of the process as inextricably linked to the administrative hearing. The point of the rulemaking is to resolve the issues that can be resolved, and to identify and narrow any remaining issues for adjudication. Accordingly the administrative hearing does not represent an unlimited opportunity to supplement the record, particularly with information that was available during the comment period, but that commenters have chosen to withhold. To read the statute otherwise would be to render the rulemaking portion of the process entirely duplicative of the hearing, and thus, ultimately meaningless. *See, e.g.*, *FDA v. Brown & Williamson Tobacco*, 529 U.S. 120, 132–133 (2000) (Court must interpret statute as a symmetrical and coherent regulatory scheme, and fit, if possible, all parts into an harmonious whole.) *APW, AFL-CIO v Potter*, 343 F.3d 619, 626 (2nd Cir. 2003) (''A basic tenet of statutory construction. . .[is] that a text should be construed so that effect is given to all its provisions, so that no part will be inoperative or superfluous, void or insignificant, and so that one section will not destroy another...''), quoting, *Silverman v Eastrich Mulitple Investor Fund*, 51 F.3d 28, 31 (3rd Cir. 1995). The equities of this construction are particularly strong, where, as here, the information was (or should have been) available during the comment period. *See, Kleissler*, 183 F.3d at 202 (''[A]dministrative proceedings should not be a game or a forum to engage in unjustified obstructionism by making cryptic and obscure reference to matters that ''ought to be'' considered and then, after failing to do more to bring the matter to the agency's attention, seeking to have that agency determination vacated'') *citing Vermont Yankee Nuclear Power Corp. v. N RDC*, 435 U.S. 519, 553–54 (1978).

Accordingly, in this final rule, EPA has not considered any of the information submitted after the close of the comment period.

VIII. Aggregate Risk Assessment and Conclusions Regarding Safety

Consistent with section 408(b)(2)(D) of FFDCA, EPA has reviewed the available scientific data and other relevant information in support of this action. EPA's assessment of exposures and risks associated with carbofuran use follows:

A. Toxicological Profile

Carbofuran is an NMC pesticide. Like other pesticides in this class, the primary toxic effect seen following carbofuran exposure is neurotoxicity resulting from inhibition of the enzyme AChE. AChE breaks down acetylcholine (ACh), a compound that assists in transmitting signals through the nervous system. Carbofuran inhibits the AChE activity in the body. When AChE is inhibited at nerve endings, the inhibition prevents the ACh from being degraded and results in prolonged stimulation of nerves and muscles. Physical signs and symptoms of carbofuran poisoning include headache, nausea, dizziness, blurred vision, excessive perspiration, salivation, lacrimation (tearing), vomiting, diarrhea, aching muscles, and a general feeling of severe malaise. Uncontrollable muscle twitching and bradycardia (abnormally slow heart rate) can occur. Severe poisoning can lead to convulsions, coma, pulmonary edema, muscle paralysis, and death by asphyxiation. Carbofuran poisoning also may cause various psychological, neurological and cognitive effects, including confusion, anxiety, depression, irritability, mood swings, difficulty concentrating, short-term memory loss, persistent fatigue, and blurred vision (Refs. 19 and 20).

The most sensitive and appropriate effect associated with the use of carbofuran is its toxicity following acute exposure. Acute exposure is defined as an exposure of short duration, usually characterized as lasting no longer than a day. EPA classifies carbofuran as Toxicity Category I, the most toxic category, based on its potency by the oral and inhalation exposure routes. The lethal potencies of chemicals are usually described in terms of the ''dose'' given orally or the ''concentration'' in air that is estimated to cause the death of 50 percent of the animals exposed (abbreviated as LD_{50} or LC_{50}). Carbofuran has an oral LD_{50} of 7.8-6.0 mg/kg, and an inhalation LC_{50} of 0.08 mg/l (Refs. 16 and 20). The lethal dose and lethal concentration levels for the oral and inhalation routes fall well below the limits for the Toxicity Category I, ≤ 50 mg/kg and ≤ 0.2 mg/l, respectively (40 CFR 156.62).

Carbofuran has a steep dose-response curve. In other words, a marginal increase in administered doses of carbofuran can result in a significant change in the toxic effect. For example, carbofuran data in juvenile rats (PND11 and 17) demonstrate that small differences in carbofuran doses (0.1 mg/kg to 0.3 mg/kg) can change the measured effect from significant brain and RBC AChE inhibition without clinical signs (0.1 mg/kg) to significant AChE inhibition, and resultant tremors, and decreased motor activity (0.3 mg/kg) (Refs. 45 and 83). In other words there is a slight difference in exposure levels that produce no noticeable outward effects and the level that causes adverse effects. This means that small differences in human exposure levels can have significant adverse consequences for large numbers of individuals.

B. Deriving Carbofuran's Point of Departure

There are laboratory data on carbofuran for ChE activity in plasma, RBC, and brain from studies in multiple laboratory animals (rat, mouse, and dog). These studies have been submitted to EPA as part of pesticide registration and include a variety of durations of exposure and types of toxic effects (neurotoxicity, developmental toxicity, cancer, etc). Consistent with its mode of action, data on AChE inhibition provide the most sensitive effects for purposes of deriving a RfD or PAD.

EPA uses a weight-of-evidence approach to determine the toxic effect that will serve as the appropriate PoD for a risk assessment for AChE inhibiting pesticides, such as carbofuran (Ref. 102). Neurotoxicity resulting from carbofuran exposures can occur in both the central (brain) and PNS. In its weight-of-the-evidence analysis, EPA reviews data, such as AChE inhibition data from the brain, peripheral tissues and blood (*e.g.*, RBC or plasma), in addition to data on clinical signs and other functional effects related to AChE inhibition. Based on these data, EPA selects the most appropriate effect on which to regulate; such effects can include clinical signs of AChE inhibition, central or peripheral nervous tissue measurements of AChE inhibition or RBC AChE measures (Id). Due to the rapid nature of NMC pesticide toxicity, measures of AChE inhibition in the PNS are very rare for NMC pesticides. Although RBC AChE inhibition is not adverse in itself, it is a surrogate for inhibition in peripheral tissues when peripheral data are not available. As such, RBC AChE inhibition provides an indirect indication of adverse effects on the nervous system (Id). EPA and other state and national agencies such as California, Washington, Canada, the European Union, as well as the World Health Organization (WHO), across the world use blood measures in human health risk assessment and/or worker safety monitoring programs as surrogates for peripheral AChE inhibition.

AChE inhibition in brain and the PNS is the initial adverse biological event which results from exposure to carbofuran, and with sufficient levels of inhibition leads to other effects such as tremors, dizziness, as well as gastrointestinal and cardiovascular effects, including bradycardia (Ref. 20). Thus, AChE inhibition provides the most appropriate effect to use in risk extrapolation for derivation of RfDs and PADs. Protecting against AChE inhibition ensures that the other adverse effects associated with cholinergic toxicity, mentioned above, do not occur.

There are three studies available which compare the effects of carbofuran on PND11 rats with those in young adult rats (herein called comparative AChE studies) (Refs. 3, 4, 5, and 83). Two of these studies were submitted by FMC, the registrant, and one was performed by EPA-ORD. An additional study conducted by EPA-ORD involved PND17 rats (Ref. 79). Although it is not possible to directly correlate ages of juvenile rats to humans, PND11 rats are believed to be close in development to newborn humans. PND17 rats are believed to be closer developmentally to human toddlers (Refs. 12, 26, and 27). Other studies in adult rats used in the Agency's analysis included additional data from EPA-ORD (Refs. 69, 78, and 83).

The studies in juvenile rats show a consistent pattern that juvenile rats are more sensitive than adult rats to the effects of carbofuran. These effects include inhibition in AChE in addition to incidence of clinical signs of neurotoxicity such as tremors. This pattern has also been observed for other NMC pesticides, which exhibit the same mechanism of toxicity as carbofuran (Ref. 107). It is not unusual for juvenile rats, or indeed, for infants or young children, to be more sensitive to chemical exposures as metabolic detoxification processes in the young are still developing. Because juvenile rats, called 'pups' herein, are more sensitive than adult rats, data from pups provide the most relevant information

for evaluating risk to infants and young children and are thus used to derive the PoD. In addition, typically (and this is the case for carbofuran) young children (ages 0–5 years) tend to be the most exposed age groups because they tend to eat larger amounts of food per their body weight than do teenagers or adults. As such, the focus of EPA's analysis of carbofuran's dietary risk from residues in food and water is on young children (ages 0 to 5 years). Since these age groups experience the highest levels of dietary risk, protecting these groups against the effects of carbofuran will, in turn, also protect other age groups.

EPA evaluated the quality of the AChE data in all the available studies. In this review, particular attention was paid to the methods used to assay AChE inhibition in the laboratory conducting the study. Because of the nature of carbofuran inhibition of AChE, care must be taken in the laboratory such that experimental conditions do not promote enzyme reactivation (*i.e.*, recovery) while samples of blood and brain are being processed and analyzed. If this reactivation occurs during the assay, the results of the experiment will underestimate the toxic potential of carbofuran (Refs. 50, 55, 76, 119, and 123). Through its review of available studies, the Agency identified problems and irregularities with the RBC AChE data from both FMC supported comparative ChE studies. These problems are described in detail in the Agency's study review (Refs. 24 and 25). As such, the Agency determined that the RBC AChE inhibition data from the two FMC comparative ChE studies were unreliable and not useable in extrapolating human health risk. In addition, RBC data from a study performed at EPA ORD did not provide doses low enough to adequately characterize the full dose-response in PND11 rats. In the recent SAP review of the draft carbofuran NOIC, the Panel unanimously agreed with the Agency's conclusion, remarking that ''[t]he Agency is well-justified in taking the position that the data on AChE inhibition in rat RBC, particularly with regard to the PND11 pups, are not acceptable for the purpose of predicting health risk from carbofuran'' (Ref. 44). By contrast, the brain AChE data from the FMC and EPA-ORD studies are acceptable and have been used in the Agency's dose-response analysis.

EPA has relied on a BMD approach for deriving the PoD from the available rat toxicity studies. A BMD is a point estimate along a dose-response curve that corresponds to a specific response level. For example, a BMD_{10} represents a 10% change from the background; 10% is often used as a typical value for the response of concern (Ref. 100). Generically, the direction of change from background can be an increase or a decrease depending on the biological parameter and the chemical of interest. In the case of carbofuran, inhibition of AChE is the toxic effect of concern. Following exposure to carbofuran, the normal biological activity of the AChE enzyme is decreased (*i.e.*, the enzyme is inhibited). Thus, when evaluating BMDs for carbofuran, the Agency is interested in a decrease in AChE activity compared to normal activity levels, which are also termed ''background'' levels. Measurements of ''background'' AChE activity levels are usually obtained from animals in experimental studies that are not treated with the pesticide of interest (*i.e.*, ''negative control'' animals).

In addition to the BMD, a confidence limit was also calculated. Confidence limits express the uncertainty in a BMD that may be due to sampling and/or experimental error. The lower confidence limit on the dose used as the BMD is termed the BMDL, which the Agency uses as the PoD. Use of the BMDL for deriving the PoD rewards better experimental design and procedures that provide more precise estimates of the BMD, resulting in tighter confidence intervals. Use of the BMDL also helps ensure with high confidence (*e.g.*, 95% confidence) that the selected percentage of AChE inhibition is not exceeded. From the PoD, EPA calculates the RfD and aPAD.

Numerous scientific peer review panels over the last decade have supported the Agency's application of the BMD approach as a scientifically supportable method for deriving PoDs in human health risk assessment, and as an improvement over the historically applied approach of using no-observed-adverse-effect levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs). The NOAEL/LOAEL approach does not account for the variability and uncertainty in the experimental results, which are due to characteristics of the study design, such as dose selection, dose spacing, and sample size. With the BMD approach, all the dose response data are used to derive a PoD. Moreover, the response level used for setting regulatory limits can vary based on the chemical and/or type of toxic effect (Refs. 40, 42, 43, and 100). Specific to carbofuran and other NMCs, the FIFRA SAP has reviewed and supported the statistical methods used by the Agency to derive BMDs and BMDLs on two occasions, February 2005 and August 2005 (Refs. 42 and 43). Recently, in reviewing EPA's draft NOIC, the SAP again unanimously concluded that the Agency's approach in using a benchmark dose to derive the PoD from carbofuran brain AChE data in juvenile rats is ''state of the art science and the Panel strongly encouraged the Agency to follow this approach for all studies where possible'' (Ref. 44).

In EPA's BMD dose analysis to derive PoDs for carbofuran, the Agency used a response level of 10% brain AChE inhibition and thus calculated BMD_{10}s and $BMDL_{10}$s based on the available carbofuran brain data. These values (the central estimate and lower confidence bound, respectively) represent the estimated dose where AChE is inhibited by 10% compared to untreated animals. In the last few years EPA has used this 10% value to regulate AChE inhibiting pesticides, including OPs and NMCs including carbofuran. For a variety of toxicological and statistical reasons, EPA chose 10% brain AChE inhibition as the response level for use in BMD and BMDL calculations. EPA analyses have demonstrated that 10% is a level that can be reliably measured in the majority of rat toxicity studies; is generally at or near the limit of sensitivity for discerning a statistically significant decrease in AChE activity across the brain compartment; and is a response level close to the background AChE level (Ref. 107)

The Agency used a meta-analysis to calculate the BMD_{10} and $BMDL_{10}$ for pups and adults; this analysis includes brain data from studies where either adult or juvenile rats or both were exposed to a single oral dose of carbofuran. The Agency used a dose-time-response exponential model where benchmark dose and half-life to recovery can be estimated together. This model and the statistical approach to deriving the BMD_{10}s, $BMDL_{10}$s, and half-life to recovery have been reviewed and supported by the FIFRA SAP (Refs. 42, 43, and 44). The meta-analysis approach offers the advantage over using single studies by combining information across multiple studies and thus provides a robust PoD.

Using quality brain AChE data from the three studies (two FMC, one EPA-ORD) conducted with PND11 rats, in combination, provides data to describe both low and high doses. By combining the three studies in PND11 animals together in a meta-analysis, the entire dose-response range is covered. The Agency believes the BMD analysis for the PND11 brain AChE data is the most robust analysis for purposes of PoD selection.

The results of the BMD analysis for PND11 pup brain AChE data provide a BMD_{10} of 0.04 mg/kg/day and $BMDL_{10}$

of 0.03 mg/kg/day—this $BMDL_{10}$ of 0.03 mg/kg/day provides the PoD (Ref. 89).

Some commenters provided extensive critique with regard to the BMD modeling conducted by the Agency. However, ultimately, the $BMDL_{10}$ recommended by the commenters differs from the EPA's $BMDL_{10}$ by only 6% (0.031 mg/kg/day vs. 0.033 mg/kg/day) — a difference that is not biologically significant. Moreover, when rounded to one significant digit, both approaches yield the identical PoD of 0.03 mg/kg/day. Thus, although the commenters are critical of the Agency's approach, there is basic consensus that the PoD is approximately 0.03 mg/kg/day.

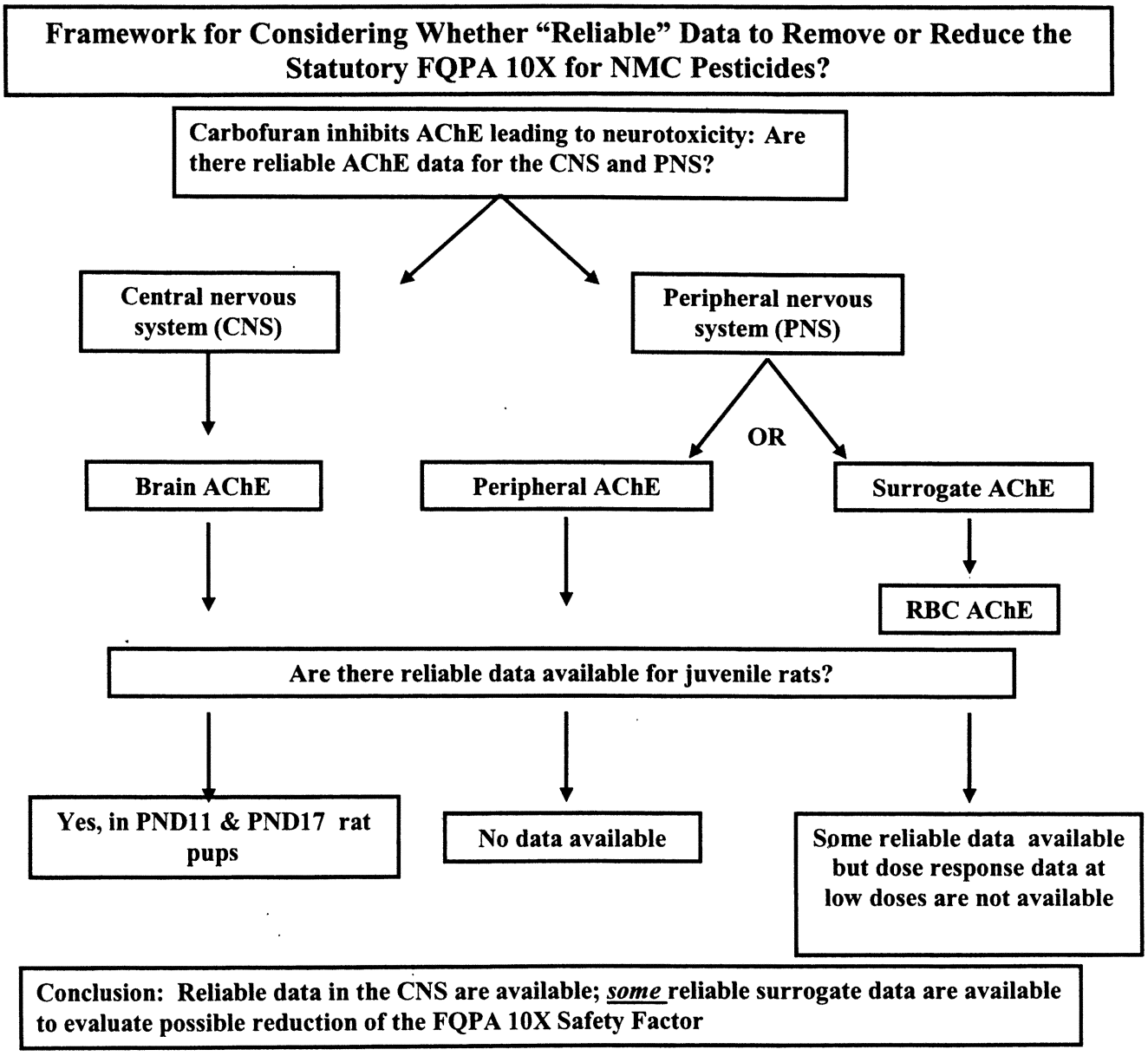
As noted, although EPA does not consider RBC AChE inhibition as an adverse effect in its own right, in the absence of data from peripheral tissues, RBC AChE inhibition data are a critical component to determining that a selected PoD will be sufficiently protective of PNS effects. Because of the problems discussed previously with the available RBC AChE inhibition data, there remains uncertainty surrounding the dose-response relationship for RBC AChE inhibition in pups, which the EPA-ORD data clearly show to be a more sensitive endpoint than brain AChE inhibition. Consequently, EPA cannot reliably estimate the BMD_{10} and $BMDL_{10}$ for RBC AChE data in pups. Furthermore, given that the EPA-ORD data clearly show pup RBC AChE to be more sensitive than pup brain AChE, EPA cannot conclude that reliance on the pup brain data as the PoD would be sufficiently protective of PNS effects in pups. As a result of this uncertainty EPA must retain some portion of the children's safety factor as described below.

C. Safety Factor for Infants and Children

1. *In general.* Section 408 of FFDCA provides that EPA shall apply an additional tenfold margin of safety for infants and children in the case of threshold effects to account for prenatal and postnatal toxicity and the completeness of the data base on toxicity and exposure unless EPA determines, based on reliable data, that a different margin of safety will be safe for infants and children. Margins of safety are incorporated into EPA assessments either directly through use of a margin of exposure analysis or through using uncertainty (safety) factors in calculating a dose level that poses acceptable risk to humans.

In applying the children's safety factor provision, EPA has interpreted the statutory language as imposing a presumption in favor of applying an additional 10X safety factor (Ref. 105). Thus, EPA generally refers to the additional 10X factor as a presumptive or default 10X factor. EPA has also made clear, however, that the presumption can be overcome if reliable data demonstrate that a different factor is safe for children (Id.). In determining whether a different factor is safe for children, EPA focuses on the three factors listed in section 408(b)(2)(C) - the completeness of the toxicity database, the completeness of the exposure database, and potential pre- and post-natal toxicity. In examining these factors, EPA strives to make sure that its choice of a safety factor, based on a weight-of-the-evidence evaluation, does not understate the risk to children. (Id.). The Agency's approach to evaluating whether sufficient ''reliable'' data exist to support the reduction or removal of the statutory default 10X is described below in Figure 1.

Figure 1. Scheme for Children's Safety Factor Evaluation for Carbofuran and other NMC Pesticides



2. *Prenatal and postnatal sensitivity.* Prenatal developmental toxicity studies with carbofuran in rat and rabbit, in addition to the reproductive toxicity and developmental neurotoxicity (DNT) studies do not provide evidence for developmental or reproductive effects from *in utero* exposure. Moreover, effects noted in these studies are less sensitive than AChE inhibition. Post-natal exposure to juvenile rat pups provides the most sensitive lifestage in available animal toxicology studies with NMCs, including carbofuran (Refs. 19, 107, 108, and 124).

As noted in the previous section, there are several studies in juvenile rats that show they are more sensitive than adult rats to the effects of carbofuran. These effects include inhibition of brain AChE in addition to the incidence of clinical signs of neurotoxicity (such as tremors) at lower doses in the young rats. The SAP concurred with EPA that the data clearly indicate that the juvenile rat is more sensitive than the adult rat with regard to brain AChE (Ref. 44). However, the Agency does not have AChE data for carbofuran in the peripheral tissue of adult or juvenile animals; nor does the Agency have adequate RBC AChE inhibition data at low doses relevant to risk assessment to serve as a surrogate in pups. As previously noted the RBC AChE data from both FMC supported studies are not reliable and thus are not appropriate for use in risk assessment. Although the EPA studies did provide reliable RBC data, they did not include data at the low end of the dose-response curve, which is the area on the dose-response curve most relevant for risk assessment.

There is indication in a toxicity study where pregnant rats were exposed to carbofuran that effects on the PNS are of concern; specifically, chewing motions

or mouth smacking was observed in a clear dose-response pattern immediately following dosing each day (Ref. 116). Based on this study, the California Department of Pesticide Regulation calculated a BMD_{05} and $BMDL_{05}$ of 0.02 and 0.01 mg/kg/day, and established the acute PoD (Refs. 15 and 44). These BMD estimates are notable as they are close to the values EPA has calculated for brain AChE inhibition and which are being used as the PoD for extrapolating risk to children. It is important to note that these clinical signs have been reported for at least one other cholinesterase inhibiting pesticide at doses producing only blood, not brain, AChE inhibition (Ref. 68). Thus, although RBC AChE inhibition is not an adverse effect, per se, blood measures are used as surrogates in the absence of peripheral tissue data. Assessment of potential for neurotoxicity in peripheral tissues is a critical element of hazard characterization for NMCs like carbofuran. The lack of an appropriate surrogate to assess the potential for RBC AChE inhibition at low doses is a key uncertainty in the carbofuran toxicity database. Thus, EPA cannot conclude that reliance on the pup brain data solely as the PoD will be protective of PNS effects in pups.

To account for the lack of data in the PNS and/or a surrogate (*i.e.*, RBC AChE inhibition data) in pups at the low end of the response curve, and for the fact that RBC AChE inhibition appears to be a more sensitive point of departure compared to brain AChE inhibition (and is considered an appropriate surrogate for the PNS), EPA is retaining a portion of the children's safety factor. On the other hand, there are data available, albeit incomplete, which characterize the toxicity of carbofuran in juvenile animals, and the Agency believes the weight-of-the-evidence supports reducing the statutory factor of 10X to a value lower than 10X. This results in a children's safety factor that is less than 10 but more than 1.

This modified children's safety factor should take into account the greater sensitivity of the RBC AChE. The preferred approach to comparing the relative sensitivity of brain and RBC AChE inhibition would be to compare the BMD_{10} estimates. However, as described above, BMD_{10} estimates from the available RBC AChE inhibition data are not reliable due to lack of data at the low end of the dose response curve. As an alternative approach, EPA has used the ratio of brain to RBC AChE inhibition at the BMD_{50}, since there are quality data at or near the 50% response level such that a reliable estimate can be calculated. There is, however, an assumption associated with using the 50% response level—namely that the magnitude of difference between RBC and brain AChE inhibition is constant across dose. In other words, EPA is assuming the RBC and brain AChE dose response curves are parallel. There are currently no data to test this assumption for carbofuran.

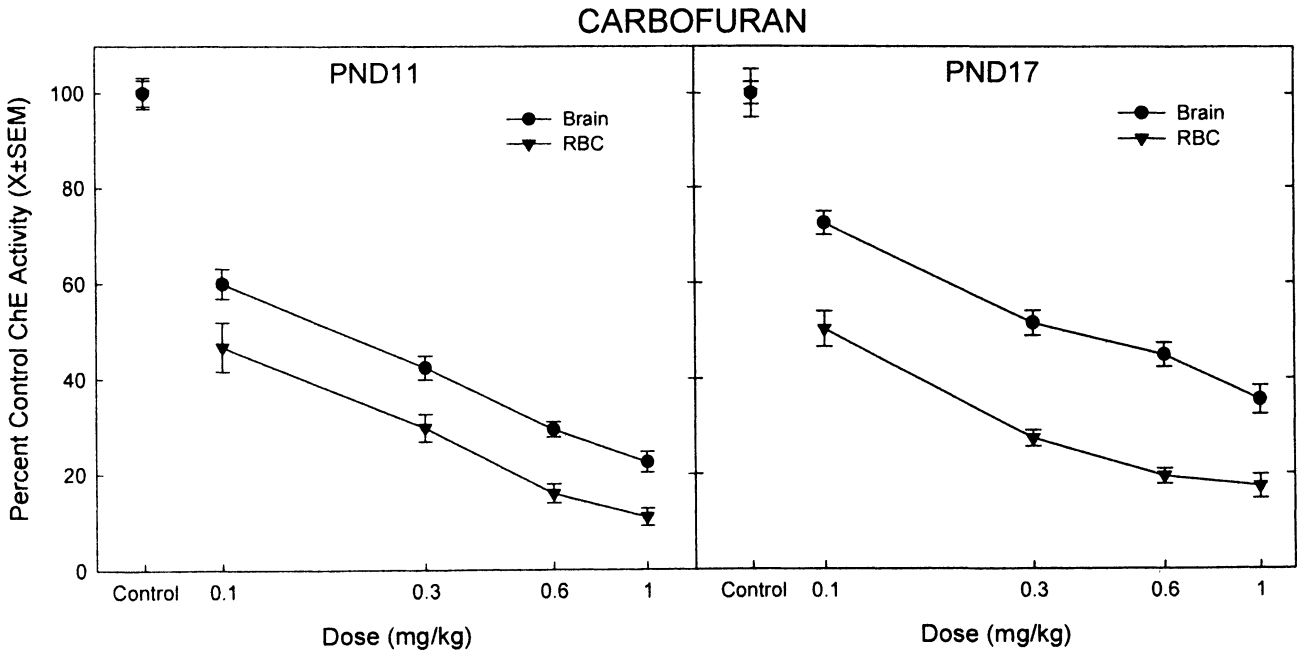
The Agency has determined that a children's safety factor of 4X is appropriate based on a weight-of-evidence approach. This safety factor is calculated using the ratio of RBC and brain AChE inhibition, using the data on administered dose for the PND11 animals from the EPA-ORD studies and the FMC studies combined. In other words, EPA estimated the BMD_{50} for PND11 animals for RBC and brain from each quality study and used the ratio from the combined analysis, resulting in a BMD_{50} ratio of 4.1X. EPA estimated the RBC to brain potency ratio using EPA's data for RBC (the only reliable RBC data in PND11 animals for carbofuran) and all available data in PND11 animals for brain.

EPA also compared the BMD_{50} ratios for PND17 pups (who are slightly less sensitive than 11-day olds; see Figure 2) in the EPA-ORD study, to confirm that the differences in sensitivity between RBC and brain were not unique to the PND11 data. The result of EPAs modeling shows a BMD_{50} ratio of 2.6[4] X between brain and RBC in the PND17 pups.

On the basis of the available data, EPA believes that application of a 4X factor will be ''safe'' for infants and children. This selection was made based on: (1) The remaining uncertainty regarding lack of an appropriate measure of peripheral toxicity (*i.e.*, lack of RBC AChE inhibition data at the low end of the dose response curve), and (2) the RBC to brain AChE ratio at the BMD_{50} for PND11 animals of 4.1X.

[4] One commenter noted that EPA had inadvertently failed in its BMD analysis of the PND17 data, to convert the units from hours to minutes. EPA has corrected its error, and has recalculated the BMD_{50}s for the PND17 animals, using the corrected times. The BMD_{50} ratio for brain and RBC is now 2.6, rather than the 3.3 originally estimated based on its original oversight.

Figure 2. Comparison of Brain and RBC AChE Inhibition in PND11 and PND17 Pups



EPA presented its dietary risk assessment of carbofuran to the FIFRA SAP, and requested comment on the Agency's approach to selecting the PoD and the children's safety factor. As described in the proposal, the Agency believes that the Panel's responses unambiguously support the Agency's approach with regard to carbofuran's hazard identification and hazard characterization (73 FR 44864). In addition, EPA believes that, on balance, the application of a 4X children's safety factor is consistent with the SAP's advice. Additional detail on the SAP's advice and EPA's responses can be found at Reference 34.

EPA received the greatest number of comments for the proposed tolerance revocation on the children's safety factor. However, none of the commenters provided any new data nor information that changes the Agency's major conclusions with regard to the uncertainty factor, and the methodology used to assess risks as a result of dietary exposures to carbofuran.

In sum, EPA has concluded that there is reliable data to support the application of a 4X safety factor and has therefore applied this safety factor in its dietary risk estimates.

D. Hazard Characterization and Point of Departure Conclusions.

The doses and toxicological endpoints selected and Margins of Exposures for various exposure scenarios are summarized below.

TABLE 1.—TOXICOLOGY ENDPOINT SELECTION TABLE

Exposure Scenario	Dose Used in Risk Assessment, UF	FQPA factor and Endpoint for Risk Assessment	Study and Toxicological Effects
Acute Dietary Infants and Children	$BMDL_{10}$ = 0.03 mg/kg/day UF = 100 Acute RfD = 0.0003 mg/kg/day	Children's SF = 4X aPAD = 0.000075 mg/kg/day	Comparative AChE Studies in PND11 rats (FMC and EPA-ORD) BMD_{10} = 0.04 mg/kg/day $BMDL_{10}$ = 0.03 mg/kg/day, based on brain AChE inhibition of postnatal day 11 (PND11) pups
Acute Dietary Youth (13 and older) and Adults	$BMDL_{10}$ = 0.02 mg/kg/day UF = 100 Acute RfD = 0.00024 mg/kg/day	aRfD = 0.0002 mg/kg/day	Comparative AChE Study (EPA-ORD), Padilla et al (2007), McDaniel et al (2007) BMD_{10} = 0.06 mg/kg/day $BMDL_{10}$ = 0.02 mg/kg/day, based on RBC AChE inhibition in adult rat

E. Dietary Exposure and Risk Assessment

1. *Dietary exposure to carbofuran—Food*—a. *EPA methodology and background.* As noted earlier, in their September 29, 2008 comments on the Agency's risk assessment, FMC requested cancellation of a large number of domestic food uses, including, among other uses, artichokes, peppers, and all cucurbits except pumpkins. EPA granted the request, and accordingly, conducted a refined (Tier 3) acute probabilistic dietary risk assessment for the remaining carbofuran residues in food. The remaining sources of ''food'' exposures are from the domestic uses of field corn, potato, sunflower, pumpkins, as well as milk (indirect residues through use on corn, potatoes and sunflower), and from four import tolerances (bananas, coffee, sugarcane, and rice). To conduct the assessment, EPA relied on DEEM-FCID(TM), Version 2.03, which uses food consumption data from the USDA's CSFII from 1994–1996 and 1998.

Using data on the percent of the crop actually treated with carbofuran and data on the level of residues that may be present on the treated crop, EPA developed estimates of combined anticipated residues of carbofuran and 3-hydroxycarbofuran on food. 3-hydroxycarbofuran is a degradate of carbofuran and is assumed to have toxic potency equivalent to carbofuran (Refs. 16 and 20). Anticipated residues of carbofuran for most foods were derived using USDA PDP monitoring data from recent years (through 2006 for all available commodities). In some cases, where PDP data were not available for a particular crop, EPA translated PDP monitoring data from surrogate crops based on the characteristics of the crops and the use patterns. For example, PDP data for winter squash were used to derive anticipated residues for pumpkins.

The PDP analyzed for parent carbofuran and its metabolite of concern, 3-hydroxycarbofuran. Most of the samples analyzed by the PDP were measured using a high Level of Detection (LOD) and contained no detectable residues of carbofuran or 3-hydroxycarbofuran. Consequently, the acute assessment for food assumed a concentration equal to one-half of the LOD for PDP monitoring samples with no detectable residues, and zero ppm carbofuran to account for the percent of the crop not treated with carbofuran.

An additional source of data on carbofuran residues was provided by a market basket survey of NMC pesticides in single-serving samples of fresh fruits and vegetables collected in 1999-2000 (Ref. 18), which was sponsored by the Carbamate Market Basket Survey Task Force. EPA relied on these data to construct the residue distribution files for bananas because the use of these data resulted in more refined exposure estimates. The combined Limits of Quantitation (LOQs) for carbofuran and its metabolite in the Market Basket Survey (MBS) were between tenfold and twentyfold lower than the combined LODs in the PDP monitoring data.

For certain crops where PDP data were not available (sugarcane, and sunflower seed), anticipated residues were based on field trial data. EPA also relied on field trial data for particular food commodities that are blended during marketing (field corn and rice), as use of PDP data can result in significant overestimates of exposure when evaluating blended foods. Field trial data are typically considered to overestimate the residues that are likely to occur in food as actually consumed because they reflect the maximum application rate and shortest preharvest interval allowed by the label. However, for crops that are blended during marketing, such as corn or wheat, use of field trial data can provide a more refined estimate than PDP data, by allowing EPA to better account for the percent of the crop actually treated with carbofuran.

EPA used average and maximum PCT estimates for most crops, following the guidance provided in HED SOP 99.6 (*Classification of Food Forms with Respect to level of Blending*; 8/20/99), and available processing and/or cooking factors. The maximum PCT estimates were used to refine the acute dietary exposure estimates. Maximum PCT ranged from <1 to 10%. The estimated percent of the crop imported was applied to crops with tolerances currently maintained solely for import purposes (banana, coffee, sugarcane, and rice).

b. *Acute dietary exposure (food alone) conclusions.* The estimated acute dietary exposure from carbofuran residues in food alone (*i.e.*, assuming no additional carbofuran exposure from drinking water), are below EPA's level of concern for the U.S. Population and all population subgroups. Children 1 to 2 years of age (78% aPAD) were the most highly exposed population subgroup when food only was included. The major driver of the acute dietary exposure risk (food only) for Children 1 to 2 years is milk at greater than 90% of the exposure. (See results from Table 2 below).

TABLE 2.—RESULTS OF ACUTE DIETARY EXPOSURE ANALYSIS FOR FOOD ALONE

Population Subgroup	aPAD (mg/kg/day)	99th Percentile		99.9th Percentile	
		Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD
All Infants (< 1 year old)	0.000075	0.000013	18	0.000039	52
Children 1–2 years old	0.000075	0.000024	32	0.000058	78
Children 3–5 years old	0.000075	0.000015	20	0.000034	45
Children 6–12 years old	0.000075	0.000010	13	0.000022	29

Exposure estimates for all of the major food contributors were based on PDP monitoring data adjusted to account for the percent of the crop treated with carbofuran and, therefore, may be considered highly refined.

As noted previously, in response to comments, the Agency revised its PCT estimates for the bananas from 78% to 25%. The Agency also developed a regional PCT estimate for potatoes of 5% based on projected limited use in the Northwest, and has applied that estimate in its revised dietary risk assessment (Ref. 71). Based on the estimated 5% crop treated for potato, which is the highest PCT of any feed stuff that can be treated with carbofuran, EPA estimated a 5% CT for milk.

The Agency notes that these PCT changes on bananas, potatoes and milk had relatively modest effects on the dietary exposure estimates. The PCT estimates are used by the Agency to account for the fact that not all samples are treated, and that some fraction of samples (specifically, the complement to the PCT fraction) actually have residues of zero. This allows the Agency to incorporate a residue concentration of zero (a true zero) for that fraction of the crop which is not treated and a residue concentration of ½ the analytical limit of detection for that portion of the crop which is treated, but show no detectable residues because of insufficient sensitivity of the analytical method. Specifically in this case, if one were to assume for banana, potatoes, and milk that all samples without detectable residues were not treated and are thus ''true zeroes,'' then exposure at the per capita 99.9th percentile falls only slightly: from 77.8% to 75.2% of the aPAD for children 1 to 2 years old, and from 45.4% to 44.1% of the aPAD for children 3-5 years old.

The relative insensitivity of exposure estimates to PCT found under EPA's most recent risk assessment based on the September 2008 revised label, is counter to earlier sensitivity analyses that the Agency performed that indicate exposures at the per capita 99.9th percentile fall by about 50% when all non-detects were set at 0 ppm (Ref. 70). Those effects were due to the watermelons and other commodities (cucumbers, cantaloupes) that were the primary source of unacceptable single exposures. The Half LODs for the four domestic uses that the commenters currently are interested in retaining, and milk, are relatively low, such that exposures from residues at Half LOD concentrations produce nominal contributions to high-end exposures.

As a further consequence of the cancellation of the use on melons and cucmbers, the risk assessment now shows that single exposures from food alone are not expected to be the source of unacceptable single eating events. However, as discussed in Unit VIII.E.2. below, concerns still remain that children will receive unacceptable exposures from a single consumption of contaminated drinking water. Further, even after accounting for carbofuran's reversibility throughout the day and the fact that drinking water can be consumed over multiple occasions during the day, EPA has concluded that carbofuran exposures through the drinking water pathway exceed the Agency's level of concern for infants and children.

2. *Drinking water exposures*. EPA's drinking water assessment uses both monitoring data for carbofuran and modeling methods, and takes into account contributions from both surface water and ground water sources (Refs. 17, 54, 58, 61, and 84). Concentrations of carbofuran in drinking water, as with any pesticide, are in large part determined by the amount, method, timing and location of pesticide application, the chemical properties of the pesticide, the physical characteristics of the watersheds and/or aquifers in which the community water supplies or private wells are located, and other environmental factors, such as rainfall, which can cause the pesticide to move from the location where it was applied. While there is a considerable body of monitoring data that has measured carbofuran residues in surface and ground water sources, the locations of sampling and the sampling frequencies generally are not sufficient to capture peak concentrations of the pesticide in a watershed or aquifer where carbofuran is used. Capturing these peak concentrations is particularly important for assessing risks from carbofuran because the toxicity end-point of concern results from single-day exposure (acute effects). Because pesticide loads in surface water tend to move in relatively quick pulses in flowing water, frequent targeted sampling is necessary to reliably capture peak concentrations for surface water sources of drinking water. Pesticide concentrations in ground water, however, are generally the result of longer-term processes and less frequent sampling can better characterize peak ground water concentrations. However, such data must be targeted at vulnerable aquifers in locations where carbofuran applications are documented in order to capture peak concentrations. As a consequence, monitoring data for both surface and ground water tends to underestimate exposure for acute endpoints. Simulation modeling complements monitoring by making estimations at vulnerable sites and can be used to represent daily concentration profiles, based on a distribution of weather conditions. Thus, modeling can account for the cases when a pesticide is used in drinking water watersheds at any rate and is applied to a substantial proportion of the crop. It can also account for stochastic processes, such as rainfall represented by 30 years of existing weather data maintained by NOAA.

a. *Exposure to carbofuran from drinking water derived from ground water sources*. Drinking water taken from shallow wells is highly vulnerable to contamination in areas where carbofuran is used around sandy, highly acidic soil, although sites that are less vulnerable (*e.g.*, deeper aquifer, higher organic matter) could still be prone to have concentrations exceeding acceptable exposures. The results of the ground water modeling simulations from the South-Central Wisconsin scenario show that the persistence of carbofuran in ground water is dependent on soil and water pH, and what might appear as relatively small variations in soil pH can have a significant impact on estimates of carbofuran in ground water. Estimated 1–in–10-year peak ground water concentrations at pH 7 are 1.6×10^{-3} µg/L; however, the estimated 1–in–10-year peak ground water concentration at pH 6.5 is 16 µg/L, nearly 4 orders of magnitude greater. Because of carbofuran's sensitivity to pH, EPA has concerns that any given set of mitigation measures will not successfully protect ground water source drinking water. Data indicate that pH varies across an agricultural field, and also with depth (Ref. 64). In particular, the pH can be different in ground water than in the overlying soil. The upper bound of the carbofuran concentrations estimated by EPA at pH 6.5 is much greater than the concentrations FMC report in their comments.

In EPA's revised assessment, ground water concentrations were estimated for all remaining crops on carbofuran labels, and used two new Tier 2 scenarios. Based on a new corn scenario, representative of potentially vulnerable areas in the upper Midwest, EPA estimated 1–in–10-year concentrations for ground water source drinking water of 16 to 1.6 x 10-*3* µg/L, for pH 6.5 and 7, respectively. A potato scenario representing use in the Northwest estimated no measurable concentrations of carbofuran in ground water. Other remaining uses were modeled using a Tier 1 ground water model (Screening Concentration in-Groundwater) with estimated peak 90–day concentrations of 48 – 178 µg/L, depending on application rate. Well setback prohibitions of 50 feet were proposed on the new label for the flowable and granular formulations in select counties in Kentucky (seven counties), Louisiana (one county), Minnesota (one county), and Tennessee (one county). Analysis of the impact of these setbacks for the use on corn indicated that the setbacks would not reduce concentrations significantly at locations where exposure to carbofuran in ground water is of concern because

at acid pHs, carbofuran does not degrade sufficiently during the travel time from the application site to the well to substantially reduce the concentration.

Exposure estimates for this assessment are drawn primarily from EPA's modeling. To conduct its modeling, EPA examined readily available data with respect to ground water and soil pH to evaluate the spatial variability of pH. Ground water pH values can span a wide range; this is especially true for shallow ground water systems, where local conditions can greatly affect the quality and characteristics of the water (higher or lower pHs compared to average values). Thus, average ground water pH values for a given area do not truly characterize the (temporal and especially spatial) heterogeneity common in most areas. This can be seen by comparing differences in pH values between counties within a state, and noting that even within each county specific area, wells will consistently yield ground water with either above- or below-average pH values for that county. The ground water simulations reflect variability in pH by modeling carbofuran leaching in four different pH conditions (pH 5.25, 6.5, 7.0, and 8.7), representing the range in the Wisconsin aquifer system. The upper and lower bound of pH values that EPA chose for this assessment were measured values from the aquifer, and the remaining two values were chosen to reflect common pH values between the measured values.

The Idaho potato scenario is representative of areas where ground water is relatively deep and the soils have a relatively alkaline pH. The results from the Idaho potato ground water simulation estimated no measurable concentrations of carbofuran in ground water. This is consistent with EPA's findings above, as soils where potatoes are typically grown are more alkaline.

The results of EPA's revised corn modeling, based on a new scenario in Wisconsin, are consistent with the results of the PGW study developed by the registrant in Maryland in the early 1980s. Using higher use rates than currently permitted, the peak concentration measured in the PGW study was 65 ppb; when scaled to current use rates, the estimated peak concentration was 11 ppb. EPA's modeling is also consistent with a number of other targeted ground water studies conducted in the 1980s showing that high concentrations of carbofuran can occur in vulnerable areas; the results of these studies as well as the PGW study are summarized in References 17 and 84. For example, a study in Manitoba, Canada assessed the movement of carbofuran into tile drains and ground water from the application of liquid carbofuran to potato and corn fields. The application rates ranged between 0.44–0.58 pounds a.i./acre, and the soils at the site included fine sand, loamy fine sand, and silt loam, with pH ranging between 6.5-8.3. Concentrations of carbofuran in ground water samples ranged between 0 (non-detect) and 158 ppb, with a mean of 40 ppb (Refs. 17 and 84).

While there have been additional ground water monitoring studies that included carbofuran as an analyte since that time, there has been no additional monitoring targeted to carbofuran use in areas where aquifers are vulnerable. However, as discussed in the next section, data compiled in 2002 by EPA's Office of Water show that carbofuran was detected in treated drinking water at a few locations. Based on samples collected from 12,531 ground water supplies in 16 states, carbofuran was found at one public ground water system at a concentration of greater than 7 ppb and in two ground water systems at concentrations greater than 4 ppb (measurements below this limit were not reported). An infant receiving these concentrations receive 220% of the aPAD or 130% aPAD, respectively, based on a single 8 ounce serving of water. As this monitoring was not targeted to carbofuran, the likelihood is low that these samples capture peak concentrations. Given the lack of targeted monitoring, EPA has primarily relied on modeling to develop estimates of carbofuran residues in ground water sources of drinking water.

Based on EPA's assessment, the maximum 1–in–10–year peak carbofuran concentrations in vulnerable ground water for a single application on corn in Wisconsin, at a rate of 1 pound per acre were estimated to range from a low of less than 1 ppb based on a pH of 7 or higher, to a high of 16 ppb, based on a pH of 6.5[5]. Because the degradate, 3-hydroxycarbofuran, which is assumed to be of equal potency with the parent compound, was not measured in the PGW study, and key environmental fate data are not available to use in modeling, exposure was not estimated. Although the failure to include the degradate is expected to underestimate exposure to some degree, the extent to which it would contribute to exposure is unclear.

EPA compiled a distribution of estimated carbofuran concentrations in water based on these estimates that were used to generate probabilistic assessments of the potential exposures from drinking water derived from vulnerable ground water sources. The results of EPA's probabilistic assessments are represented below in Table 3. As discussed in the previous section, it is important to remember that the aPAD for carbofuran is quite low, hence, relatively low concentrations of carbofuran monitored or estimated in vulnerable ground water can have a significant impact on the aPAD utilized.

TABLE 3.—RESULTS OF ACUTE DIETARY (GROUND WATER ONLY) EXPOSURE ANALYSIS USING DEEM-FCID(TM) AND INCORPORATING THE WISCONSIN GROUND WATER SCENARIO, pH OF 6.5 (REPRESENTING PRIVATE WELLS)

Population Subgroup	aPAD (mg/kg/day)	95th Percentile		99th Percentile		99.9th Percentile	
		Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD
All Infants (< 1 year old)	0.000075	0.001602	2,100	0.003536	4,700	0.007078	9,400
Children 1–2 years old	0.000075	0.000677	900	0.001481	2,000	0.003163	4,200
Children 3–5 years old	0.000075	0.000623	830	0.001345	1,800	0.002845	3,800

[5] Although higher estimates were generated at a pH of 5.25, use should be precluded in such sites based on the September 2008 labels.

TABLE 3.—RESULTS OF ACUTE DIETARY (GROUND WATER ONLY) EXPOSURE ANALYSIS USING DEEM-FCID(TM) AND INCORPORATING THE WISCONSIN GROUND WATER SCENARIO, pH OF 6.5 (REPRESENTING PRIVATE WELLS)—Continued

Population Subgroup	aPAD (mg/kg/day)	95th Percentile		99th Percentile		99.9th Percentile	
		Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD
Children 6–12 years old	0.000075	0.000431	570	0.000934	1,200	0.002015	2,700
Youth 13–19 years old	0.0002	0.000334	170	0.000756	380	0.001743	870
Adults 20–49 years old	0.0002	0.000414	210	0.000893	450	0.001890	950
Adults 50+ years old	0.0002	0.000413	210	0.000852	430	0.001546	770

While the registrant has attempted to address drinking water exposure from ground water sources by including additional restrictions on their September 2008 proposed labels, EPA's analyses show that these do not sufficiently reduce exposures to acceptable levels. The proposed labels include well setback prohibitions at 50–foot-distances for the flowable and granular formulations in a select set of counties in Kentucky, Louisiana, Minnesota, and Tennessee. The impact of the well setbacks was modeled for the corn use using the approach developed for the NMC cumulative assessment (Ref. 107), resulting in reductions in concentrations that vary with pH (to account for degradation of the compound in subsurface flow from the application site to a private well down gradient). At acid pHs the slow degradation rate reduced the effectiveness of a 50–foot well setback at the well head (1–in–10–year peak concentration of 16 to 14 µg/L, a reduction factor of 0.73 at pH 6.5). Additional setback distances (100, and 300 ft) were evaluated using an aquifer pH of 6.5, resulting in reduction factors of 0.54 and 0.16, respectively. At alkaline pH, the 50-foot setback is effective, but concentrations at these sites are already low due to hydrolytic degradation occurring during recharge. These results suggest that a 50–foot well setback is less effective in low pH environments due to the persistence of carbofuran under these conditions.

In addition, the revised labels prohibit use throughout the Atlantic Coastal plain, and prohibit application to areas with soils greater than 90% sand and less than 1% organic matter, acidic soil and water conditions, and where shallow water tables predominate (*e.g.*, where ground water is less than 30 feet). While EPA agrees in principle that precluding use in sites vulnerable to leaching can mitigate the risks, and even presuming that the methodology used by FMC adequately identifies those sites, these criteria are not sufficient to prohibit use in all areas that could reasonably be expected to be vulnerable to ground water contamination from carbofuran use. Based on carbofuran's characteristics, a diversity of soil conditions in the remaining proposed use area, and available monitoring data, there are valid scientific reasons to believe that additional soil and site characteristics could result in ground water contamination. For example, water table depth can vary with the time of the year, depending on such factors as the amount of rainfall that has occurred in the recent past, and how much irrigation has been applied to a field or removed from the aquifer. It is difficult to determine how the depth to the water table varies throughout fields, and the definition of a ''shallow'' water table on the September 2008 label is indeterminate (*e.g.*, less than 30 ft.). Furthermore, the vulnerability associated with depth varies with location, for example, deeper aquifers may be vulnerable in areas with greater precipitation and rapid recharge. The September 2008 label restrictions in no way addressed these less sensitive, but still vulnerable, sites (Refs. 94 and 111). Accordingly, EPA continues to believe that its assessment of drinking water from ground water sources based on current labels is a reasonable assessment of potential exposures to those portions of the population consuming drinking water from shallow wells in highly vulnerable areas.

b. *Exposure from drinking water derived from surface water sources.* EPA's evaluation of environmental drinking water concentrations of carbofuran from surface water, as with its evaluation of ground water, takes into account the results of both surface water monitoring and modeling.

Data compiled in 2002 by EPA's Office of Water show that carbofuran was detected in treated drinking water at a few locations. Based on samples collected from 12,531 ground water and 1,394 surface water source drinking water supplies in 16 states, carbofuran was found at no public drinking water supply systems at concentrations exceeding 40 ppb (the MCL). Carbofuran was found at one public ground water system at a concentration of greater than 7 ppb and in two ground water systems and one surface water public water system at concentrations greater than 4 ppb (measurements below this limit were not reported). Sampling is costly and is conducted typically four times a year or less at any single drinking water facility. The overall likelihood of collecting samples that capture peak exposure events is, therefore, low. For chemicals with acute risks of concern, such as carbofuran, higher concentrations and resulting risk is primarily associated with these peak events, which are not likely to be captured in monitoring unless the sampling rate is very high.

Unlike drinking water derived from private ground water wells, drinking water from public water supplies (surface water or ground water source) will generally be treated before it is distributed to consumers. An evaluation of laboratory and field monitoring data indicate that carbofuran may be effectively removed (60 – 100%) from drinking water by lime softening and activated carbon; other treatment processes are less effective in removing carbofuran (Ref. 107). The detections between 4 and 7 ppb, reported above, represent concentrations in samples collected post-treatment. As such, these levels are of particular concern to the Agency. An infant who consumes a single 8–ounce serving of water with a concentration of 4 ppb, as detected in the monitoring, would receive approximately 130% of the aPAD from water consumption alone. An infant who consumes a single 8–ounce serving of water with the higher detected concentration of 7 ppb, as detected in the monitoring, would receive approximately 220% of the aPAD from water consumption alone.

To further characterize carbofuran concentrations in surface water (*e.g.*,

streams or rivers) that may drain into drinking water reservoirs, EPA analyzed the extensive source of national water monitoring data for pesticides, the USGS NAWQA program. The NAWQA program focuses on ambient water rather than on drinking water sources, is not specifically targeted to the high use area of any specific pesticide, and is sampled at a frequency (generally weekly or bi-weekly during the use season) insufficient to provide reliable estimates of peak pesticide concentrations in surface water. For example, significant fractions of the data may not be relevant to assessing exposure from carbofuran use, as there may be no use in the basin above the monitoring site. Unless ancillary usage data are available to determine the amount and timing of the pesticide applied, it is difficult to determine whether non-detections of carbofuran were due to a low tendency to move to water or from a lack of use in the basin. The program, rather, provides a good understanding on a national level of the occurrence of pesticides in flowing water bodies that can be useful for screening assessments of potential drinking water sources. A detailed description of the pesticide monitoring component of the NAWQA program is available on the NAWQA Pesticide National Synthesis Project (PNSP) web site (http://ca.water.usgs.gov/pnsp/).

A summary of the first cycle of NAWQA monitoring from 1991 to 2001 indicates that carbofuran was the most frequently detected carbamate pesticide in streams and ground water in agricultural areas. Overall, where carbofuran was detected, these non-targeted monitoring results generally found carbofuran at levels below 0.5 ppb. In the NMC assessment, EPA summarized NAWQA monitoring for carbofuran between 1991 and 2004. Maximum surface-water concentrations exceeded 1 ppb in approximately nine agricultural watershed-based study units, with detections in the sub-parts per billion range reported in additional watersheds (Ref. 107). The highest concentrations of carbofuran are reported from a sampling station on Zollner Creek, in Oregon. Zollner Creek, located in the Molalla-Pudding sub-basin of the Willamette River, is not directly used as a drinking water source. This creek is a low-order stream and its watershed is small (approximately 40 km^2) and intensively farmed, with a diversity of crops grown, including plant nurseries. USGS monitoring at that location from 1993 to 2006 detected carbofuran annually in 40–100 % of samples. Although the majority of concentrations detected there are also in the sub-part per billion range, concentrations have exceeded 1 ppb in 8 of the 14 years of sampling. The maximum measured concentration was 32.2 ppb, observed in the spring of 2002. The frequency of detections generally over a 14–year period suggests that standard use practices rather than aberrational misuse incidents in the region are responsible for high concentration levels at this location.

While available monitoring from other portions of the country suggests that the circumstances giving rise to high concentrations of carbofuran may be rare, overall, the national monitoring data indicate that EPA cannot dismiss the possibility of detectable carbofuran concentrations in some surface waters under specific use and environmental conditions. Even given the limited utility of the available monitoring data, there have been relatively recent measured concentrations of carbofuran in surface water systems at levels above 4 ppb and levels of approximately 1 to 10 ppb measured in streams representative of those in watersheds that support drinking water systems (Ref. 107). Based on this analysis, and since monitoring programs have not been sampling at a frequency sufficient to detect daily-peak concentrations that are needed to assess carbofuran's acute risk, the available monitoring data, in and of themselves, are not sufficient to establish that the risks posed by carbofuran in surface drinking water are below thresholds of concern. Nor can the non-detections in the monitoring data be reasonably used to establish a lower bound of potential carbofuran risk through this route of exposure.

To further characterize carbofuran risk through drinking water derived from surface water sources, EPA modeled estimated daily drinking water concentrations of carbofuran using PRZM to simulate field runoff processes and EXAMS to simulate receiving water body processes. These models were summarized in Unit V.B.2.

There are sources of uncertainty associated with estimating exposure of carbofuran in surface water source drinking water. Several of the most significant of these are the effect of treatment in removing carbofuran from finished drinking water before it is delivered to the consumer supply system, the impact of percent crop treated assumptions, and the variation in pH across the landscape. The effect of the percent crop treated assumption in the case of carbofuran is discussed in detail in EPA's assessment of additional data submitted by the registrant (Refs. 22 and 94) and summarized below. Available data on the degree to which carbofuran may be removed from treatment systems was summarized previously and is discussed in more detail in Appendix E-3 of the Revised NMC CRA (Ref. 107). Although EPA is aware of the mitigating effects of specific treatment processes, the processes employed at public water supply utilities across the country vary significantly both from location to location and throughout the year, and therefore are difficult to incorporate quantitatively in drinking water exposure estimates. For example, lime softening would likely reduce carbofuran concentrations. That process is used in 3 to 21% of drinking water treatment systems in the United States (Ref. 19). Activated carbon has been shown to also reduce carbofuran concentrations, but is used in 1 to 15% of drinking water treatment facilities (Ref. ibid.). Therefore, EPA assumes that there is no reduction in carbofuran concentrations in surface water source drinking water due to treatment, which is a source of conservatism in surface water exposure estimates used for human health risk assessment. While it is well established that carbofuran will degrade at higher rates when the pH is above 7, and lower rates when below pH 7, due to the high variation of pH across the country for many of the scenarios, a neutral pH (pH 7) default value was used to estimate water concentrations. Finally, available environmental fate studies do not show formation of 3-hydroxycarbofuran through most environmental processes except soil photolysis, where in one study it was detected in very low amounts. Although 3-hydroxycarbofuran was not explicitly considered as a separate entity in the drinking water exposure assessment, it is unclear whether it would significantly add to exposure estimates.

EPA compiled a distribution of estimated carbofuran concentrations in surface water in order to conduct probabilistic assessments of the potential exposures from drinking water. For the IRED, EPA modeled crops representing 80 percent of total carbofuran use at locations that would be considered among the more vulnerable where the crops are grown. Subsequently, for a refined dietary risk assessment, EPA generated distributions for 13 different scenarios representing all labeled uses of carbofuran treated at maximum label rates and adjusted with PCA factors (Refs. 17, 53, and 84).

EPA subsequently conducted several rounds of modeling to refine estimates for specific uses and agricultural practices. One set of refinements addressed use of carbofuran on corn at

typical rather than maximum label rates, another set included simulation of different types of applications to corn (*e.g.*, applications to control European corn borer, a rescue treatment for corn rootworm, and an in-furrow application at plant).

For this final rule, EPA conducted additional refined modeling, based on the September 2008 label submitted by FMC. The modeling addressed all of the domestic uses that remain registered, and included certain refinements to better understand the impacts of varying pH. EPA also conducted modeling to assess the impact of the proposed spray drift buffer requirements and other spray drift measures included on the September label.

EPA estimated carbofuran concentrations resulting from the use on pumpkins by adjusting the EDWCs from a previous run simulating melons in Missouri; adjustments accounted for differences in application rate and row spacing. Two EDWCs were calculated for pumpkins: One based on a 36–inch row spacing, representing pumpkins for consumption (77.6 µg/L); and a second based on a 60–inch row spacing, representing decorative pumpkins (46.6 µg/L).

EPA had previously evaluated the corn rootworm rescue treatment at seven representative sites, representing use in states with extensive carbofuran usage at locations more vulnerable than most in each state in areas corn is grown. Using measured rainfall values, and assuming typical rather than maximum use rates, peak concentrations for the corn rescue treatments simulated for Illinois, Iowa, Indiana, Kansas, Minnesota, Nebraska, and Texas ranged from 16.6 – 36.7 ppb (Ref. 61). Under the revised assessment to account for the new use restrictions, concentrations for corn, calculated including the proposed spray drift buffers in Kansas and Texas, decreased 5.1% and 4.7%, respectively, from simulations with no buffer from the previous assessment (Ref. 61). In Kansas, the 1–in–10-year peak EDWCs decreased from 33.5 to 31.8 ppb when a 300–foot buffer was added, and in Texas, from 29.9 to 28.5 ppb with the addition of a 66–foot buffer.

For the sunflower use, 12 simulations were performed for sunflowers, 9 in Kansas, and 3 in North Dakota. The North Dakota scenario was used to represent locations where sunflowers are grown that are vulnerable to pesticide movement to surface water while the Kansas scenario represents places that are not particularly vulnerable, based on the limited rainfall and generally well-drained soils (hydrologic group B soils) that are found in that area. Estimated 1–in–10–year concentrations ranged from 11.6 to 32.7 µg/L. When simulating three applications, one at plant and two foliar with a 14–day interval between the two foliar applications and a 66–foot buffer, the 1–in–10-year peak EDWC for North Dakota was 22.4 µg/L. In contrast, the same three applications in Kansas with a 14–day interval between the foliar applications and a 300-foot buffer produced a 1–in–10-year peak EDWC of 20.5 µg/L. The 1–in–10–year peak EDWCs assuming that carbofuran is applied only at plant were 14.0 and 16.0 µg/L in Kansas and North Dakota respectively. EPA also evaluated the impact of pH on carbofuran concentrations for sunflowers, resulting in a 10% decrease in 1–in–10–year peak concentrations assuming high pH in the reservoir. Spray drift buffers of 66 and 300 feet decreased concentrations 4.7 and 5.1% for corn and 10.0% and 16.0% for sunflowers, respectively, in comparison to previous labels that had no spray drift buffer requirements. Additional details on these assessments can be found at Reference 111. Consistent with the analysis summarized above these predicted carbofuran water concentrations are similar or lower than the peak concentrations reported in the USGS-NAWQA monitoring data and similar to or not more than tenfold higher than the 4 ppb reported in finished water from a surface water drinking plant.

There are few surface water field-scale studies targeted to carbofuran use that could be compared with modeling results. Most of these studies were conducted in fields that contain tile drains, which is a common practice throughout midwestern states to increase drainage in agricultural fields (Ref. 17). Drains are common in the upper Mississippi river basin (Illinois, Iowa, and the southern part of Minnesota), and the northern part of the Ohio River Basin (Indiana, Ohio, and Michigan) (Ref. 74). Although it is not possible to directly correlate the concentrations found in most of the studies with drinking water concentrations, these studies confirm that carbofuran use under such circumstances can contaminate surface water, as tile drains have been identified as a conduit to transport water and contaminants from the field to surface waters. For example, one study conducted in the United Kingdom in 1991 and 1992 looked at concentrations in tile drains and surface water treated at a rate of 2.7 lbs a.i. per acre (granular formulation). Resulting concentrations in surface water downstream of the field ranged from 49.4 ppb almost 2 months after treatment to 0.02 ppb 6 months later, and were slightly lower than concentrations measured in the tile drains, which were a transport pathway. Even with the factors that limit the study's relevance to the majority of current carbofuran use—the high use rate and granular formulation—the study clearly confirms that tile drains can serve as a source of significant surface water contamination. Although EPA's models do not account for tile drain pathways, and acknowledging the uncertainties in comparing carbofuran monitoring data to the concentrations predicted from the exposure models, as noted previously, estimated (model-derived) peak concentrations of carbofuran are similar to peak concentrations reported in stream monitoring studies. These are no more than tenfold higher than a value reported from a drinking water plant where it is unlikely the sample design would have ensured that water was sampled on the day of the peak concentration.

EPA conducted dietary exposure analyses based on the modeling scenarios for the proposed September 2008 label. Exposures from all modeled scenarios substantially exceeded EPA's level of concern (Ref. 16). For example, a Kansas sunflower scenario, assuming two foliar applications at a typical 1-lb a.i. per acre use rate, applied at 14–day intervals, estimated a 1–in–10-year peak carbofuran water concentration of 11.6 ppb. Exposures at the 99.9th percentile based on this modeled distribution ranged from 160% of the aPAD for youths 13 to 19 years, to greater than 2,000% of the aPAD for infants. As previously noted, this scenario is intended to be representative of sites that are less vulnerable than most on which sunflowers could be grown. By contrast, exposure estimates from a comparable North Dakota sunflower scenario, intended to represent more vulnerable sites, estimated a 1–in–10-year peak concentration of 22.4 ppb. These concentrations would result in estimated exposures ranging between 450% aPAD for youths 13 to 19 years, to 5,500% aPAD for infants. Similarly, exposures based on a Washington surface water potato scenario, and using a 3 lb a.i. acre rate, ranged from 230% of the aPAD for children 6 to 12 years to 890% of the aPAD for infants, with a 1–in–10-year peak carbofuran concentration of 7.2 ppb. Although other crop scenarios resulted in higher exposures, estimates for these two crops are presented here, as they are major

crops on which a large percentage of carbofuran use occurs. More details on these assessments, as well as the assessments EPA conducted for other crop scenarios, can be found in References 16, 61, and 84.

Restricting the sunflower application to a single at-plant application from three applications reduces the 1–in–10–year peak EDWCs from 32.7 to 16.0 µg/L for the North Dakota scenario and from 20.5 to 14.0 µg/L in western Kansas. These concentrations would result in estimated exposures, based on the North Dakota scenario ranging between 350% aPAD for youths 13 to 19 years, to 4,300% aPAD for infants. Based on the Kansas scenario, the estimated exposures would range between 250% aPAD for youths 13 to 19 years, to 3,100% aPAD for infants.

Table 4 below presents the results of one of EPA's refined exposure analyses that is based on a Nebraska corn rootworm ''rescue treatment'' scenario, and assumes a single aerial application at a typical rate of 1-pound a.i. per acre. To simulate an application made post-plant, at or near rootworm hatch, EPA modeled an application of carbofuran 30 days after crop emergence. EPA used a crop specific PCA of 0.46 which is the maximum proportion of corn acreage in a HUC-8–sized basin in the United States. (The USGS has classified all watersheds in the United States into basins of various sizes, according to hydrologic unit codes, in which the number of digits indicates the size of the basin). The full distribution of daily concentrations over a 30–year period was used in the probabilistic dietary risk assessment. The 1–in–10–year peak concentration of the distribution of values for the Nebraska corn rescue treatment was 22.3 ppb. More details on these assessments, as well as the assessments EPA conducted for other crop scenarios, can be found in References 16, 61, and 84.

TABLE 4.—RESULTS OF ACUTE DIETARY (SURFACE WATER ONLY) EXPOSURE ANALYSIS INCORPORATING THE NEBRASKA CORN ROOTWORM RESCUE SCENARIO

Population Subgroup	aPAD (mg/kg/day)	95th Percentile		99th Percentile		99.9th Percentile	
		Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD
All Infants (< 1 year old)	0.000075	0.000424	560	0.001201	1,600	0.002895	3,900
Children 1–2 years old	0.000075	0.000182	240	0.0005047	670	0.001261	1,700
Children 3–5 years old	0.000075	0.000169	230	0.000461	620	0.001137	1,500
Children 6–12 years old	0.000075	0.000117	160	0.000320	430	0.000794	1,100
Youth 13–19 years old	0.0002	0.000087	43	0.000248	120	0.000760	380
Adults 20–49 years old	0.0002	0.000113	57	0.000305	150	0.000760	380
Adults 50+ years old	0.0002	0.000120	60	0.000300	150	0.000672	340

The populations described in the ''Nebraska corn'' assessments are those people who consume water from a reservoir located in a small watershed predominated by corn production (with the assumption that treatment does not reduce carbofuran concentrations). The only crop treated by carbofuran in the watershed is corn, and all of that crop is assumed treated with carbofuran at the rate of 1 lb per acre. To the extent a drinking water plant drawing water from the reservoir normally treats the raw intake water with lime softening or activated carbon processes the finished water concentrations could be reduced from 60 to 100% with the resultant aPADs ranging from approximately 198% to 2,340% of the aPAD to 0% of the aPAD, respectively, at the 99.9th percentile of exposure.

As discussed in the previous sections, it is important to remember that carbofuran's aPAD is quite low, hence relatively low concentrations of carbofuran monitored or estimated in surface water can have a significant impact on the percent of the aPAD utilized. Thus, while the refined carbofuran water concentrations for the corn ''rescue'' treatment in the range of approximately 16.6 to 36.7 ppb are comparable to maximum peak concentrations reported in the monitoring studies, these concentrations can result in very significant exceedences of the aPAD for various age groups, primarily because carbofuran is inherently very toxic.

As noted, EPA's modeling indicates that while there is some mitigation value in the use of spray drift buffers, the loading to surface water is dominated by runoff even in semi-arid locations such as western Kansas, and the proposed mitigation measures do not substantially reduce exposure to carbofuran in surface water source drinking water systems.

It is important to note that spray drift calculations have been conducted assuming that certain BMPs were used during the aerial spray application. Those practices are ½ swath displacement windward, a 10 foot release, wind speed no greater than 10 mph, and a spray boom less than 75% of the aircraft's wing (Ref. 106). There is advisory language on the revised labels regarding wind speed (''Drift potential increases at wind speeds less the 3 mph (due to inversion potential) or more than 10 mph,'' and boom height (''setting the boom to the lowest height (if specified) which provides uniform coverage reduces the exposure of droplets to evaporation and wind.''). The boom width is specifically restricted (''the boom length should not exceed ¾ the wing or rotor length.''). There is no language on the label regarding swath displacement. While these ''best management practices'' are frequently used by aerial applicators, they are not used universally. To the extent these management practices are not used, EPA's assessment would underestimate the additional loading expected to result from spray drift.

Equally important is that EPA only assumed that the buffers would be effective in reducing spray drift from neighboring fields, rather than assuming that the buffers would be effective in preventing or mitigating field runoff. As explained in the proposed rule, EPA disagrees that these measures will be effective in reducing carbofuran's movement to surface water. The proposed buffers were for fields where

soils were considered to be highly erodible. Buffer widths varied, and were to be vegetated with ''crop, seeded with grass, or other suitable crop.'' In 2000, EPA participated in the development of a guidance document on how to reduce pesticide runoff using conservation buffers (Ref. 98). Results of this effort found that properly designed buffers can reduce runoff of weakly absorbed pesticides like carbofuran by increasing filtration so that the pesticide can be trapped and degraded in the buffer. However, it is of critical importance that sheet flow be maintained across the buffer in order for this to occur. To ensure sheet flow, buffers need to be specifically designed for that purpose and they must be well-maintained, as over time sediment trapped in the buffer causes flow to become more channelized and the buffer then becomes ineffective. The guidance concludes that un-maintained, un-vegetated buffers around water bodies, often referred to a 'setback,' are ineffective in reducing pesticide movement to surface water.

As discussed in Unit VII.C.2., FMC has criticized EPA's assessment for failing to account more fully for the percent of the crop likely to be treated in its modeling. In response to FMC's concerns, EPA performed a sensitivity analysis of an exposure assessment using a PCT in the watershed to determine the extent to which some consideration of this factor could meaningfully affect the outcome of the risk assessment. The registrant has at different times, suggested the application of a 5 or 10% crop treated factor based on county sales data. While substantial questions remain as to the support for these percentages for a given basin where carbofuran may be used, EPA used the upper figure for the purpose of conducting a sensitivity analysis. To be clear, this means that EPA assumed that 10% of the 46% of the watershed on which corn could be grown, would be treated with carbofuran, resulting in less than 5% of the watershed treated with carbofuran—an assumption that clearly underestimates exposures in many highly agricultural areas, such as Nebraska, and as discussed previously, requires several unrealistic assumptions. The results suggest that, even at levels below 10% crop treated, exposures from drinking water derived from surface waters can contribute significantly to the aggregate dietary risks, particularly for infants and children. For example, applying a 10% crop treated figure to the Nebraska corn scenario described above, in addition to the corn-PCA of 0.46 incorporated into that scenario, results in estimated exposures from water alone, ranging from 110% of the aPAD for children 6 to 12 years to 390% of the aPAD for infants, assuming water treatment processes do not affect concentrations in drinking water consumed. Details on the assessments EPA conducted for other crop scenarios, which showed higher contributions from drinking water, can be found in References 16, 17, and 84. Accordingly, these assessments suggest that EPA's use of PCA alone, rather than in conjunction with PCT, will not meaningfully affect the carbofuran risk assessment, as even if EPA were to apply an extremely low PCT, aggregate exposures would still exceed 100% of the aPAD.

In response to this sensitivity analysis, which had been presented in the proposed rule, FMC complained that EPA had failed to account in these analyses for the rapid nature of carbofuran's recovery. Or in other words, the commenter wanted EPA to both apply a PCT figure and conduct an Eating Occasion Analysis, claiming that this analysis would show that carbofuran ''passed.''

EPA disagrees that conducting the analysis the commenter suggests would be appropriate, or would provide any information on which EPA could properly rely to support a determination of safety. As previously explained, the available information and methodology does not allow EPA to generate PCT estimates with any degree of confidence, and certainly not with the ''reasonable certainty'' demanded by the statute. EPA conducted its analysis purely in an attempt to understand the extent to which its assumption of PCT affected the risk assessment conclusions. It is not necessary to gain an understanding of the PCT impact, to compound the uncertainty by adding assumptions about the reversibility of carbofuran's effects.

The commenter provided the results of their dietary assessment, in which they appear to have conducted the analysis suggested above, and reported that the aPAD for infants from aggregate exposures (*i.e.*, food + water) was 107.06%. As previously discussed, the commenter did not provide any of the underlying support documentation for these reported results, and EPA was unable to replicate them. However, in its efforts to replicate the commenter's analysis, the lowest aggregate exposure EPA was able to estimate for infants using the commenter's PCT and half-life inputs was 126% of the aPAD, a figure that, for reasons discussed subsequently, is certainly an underestimate of exposure. Further discussion of the Eating Occasion Analyses EPA conducted for carbofuran is presented in Unit VIII.E.1.d. and in Reference 112.

In conclusion, the large difference between concentrations seen in the monitoring data on the low side, and the simulation modeling on the high side, is an indication of the uncertainty in the assessment for surface-water source drinking water exposure. The majority of drinking water concentrations resulting from use of carbofuran are likely to be occurring at higher concentrations than those measured in most monitoring studies, but below those estimated with simulation modeling; however the exact values within the range obtained from the monitoring and the model simulations are uncertain. However, the monitoring data show a consistent pattern of low concentrations, with the occasional, infrequent spike of high concentrations. Those infrequent high concentrations are consistent with EPA's modeling, which is intended to capture the exposure peaks. For a chemical with an acute risk, like carbofuran, the spikes or peaks in exposures, even though infrequent, are the most relevant for assessing the risks. And, as previously noted, the available monitoring has its own limitations for estimating exposure for risk assessment.

Further, the results of the modeling analyses provide critical insights regarding locations in the country where the potential for carbofuran contamination to surface water and associated drinking water sources is more likely. These locations include areas with soils prone to runoff (such as those high in clay or containing restrictive layers), in regions with intensive agriculture with crops on which carbofuran is used (*e.g.*, corn), which have high rainfall amounts and/or are subject to intense storm events in the spring around the times applications are being made. Drinking water facilities with small basins tend to be more vulnerable, as it is more likely that a large proportion of the crop acreage will be treated in small basins.

3. *Aggregate dietary exposures (food and drinking water)*. EPA conducted a number of probabilistic analyses to combine the national food exposures with the exposures from the individual region and crop-specific drinking water scenarios. As discussed in Unit V.B.3., although food is distributed nationally, and residue values are therefore not expected to vary substantially throughout the country, drinking water is locally derived and concentrations of pesticides in source water fluctuate over

time and location for a variety of reasons. Consequently, EPA conducted several estimates of aggregate dietary risks by combining exposures from food and drinking water. These estimates showed that, because drinking water exposures from any of the crops on the label exceed safe levels, aggregate exposures from food and water are unsafe. Although EPA's assessments showed that, based on the Idaho potato scenarios, exposures from ground water from use on potatoes would be safe, surface water exposures from carbofuran use on potatoes far exceed the safety standard. More details on the individual aggregate assessments presented below, as well as the assessments EPA conducted for other regional and crop scenarios, can be found in References 16 and 17.

Table 5 reflects the results of aggregate exposures from food and from drinking water derived from ground water in extremely vulnerable areas (*i.e.*, from shallow wells associated with sandy soils and acidic aquifers, such as are found in Wisconsin). The estimates range between 780% of the aPAD for adults, to 9,400% of the aPAD for infants.

TABLE 5.—RESULTS OF ACUTE DIETARY (FOOD AND WATER) EXPOSURE ANALYSIS INCORPORATING THE WISCONSIN GROUND WATER SCENARIO PH 6.5

Population Subgroup	aPAD (mg/kg/day)	95th Percentile		99th Percentile		99.9th Percentile	
		Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD
All Infants (< 1 year old)	0.000075	0.001602	2,100	0.003537	4,700	0.007053	9,400
Children 1–2 years old	0.000075	0.000680	910	0.001490	2,000	0.003180	4,200
Children 3–5 years old	0.000075	0.000626	840	0.001350	1,800	0.002845	3,800
Children 6–12 years old	0.000075	0.000432	580	0.000935	1,200	0.002019	2,700
Youth 13–19 years old	0.0002	0.000334	170	0.000751	380	0.001721	860
Adults 20–49 years old	0.0002	0.000415	210	0.000896	450	0.001906	950
Adults 50+ years old	0.0002	0.000415	210	0.000853	430	0.001552	780

The peak concentration estimates in the Wisconsin ground water scenario time series are consistent with monitoring data from wells in vulnerable areas where carbofuran was used. For example, the maximum water concentration from the time series is 34 ppb while maximum values from a targeted ground water monitoring study in Maryland, with a higher application rate, was 65 ppb, with studies at other sites having similar or higher peak concentrations (Refs. 17 and 84). For studies with multiple measurements at each well, central tendency estimates were also in the same range as the time series. For example, the mean carbofuran concentration from wells under no-till agriculture in Queenstown, MD was 7 ppb, while the median for the modeling was 15.5 ppb. The 90–day average concentration, based on the registrant's PGW study conducted on corn in the Delmarva (adjusted for current maximum application rates) is 11 ppb.

Table 6 presents the results of aggregate exposure from food and water derived from one of the least conservative surface water scenarios: Kansas sunflower, with two foliar applications. This table reflects the risks only for those people in watersheds with characteristics similar to that used in the scenario, and assuming that water treatment does not remove carbofuran. As discussed previously, the estimated water concentrations are comparable to the maximum peak concentrations reported in monitoring studies that were not designed to detect peak, daily concentrations of carbofuran in vulnerable locations.

TABLE 6.—RESULTS OF ACUTE DIETARY (FOOD AND WATER) EXPOSURE ANALYSIS USING THE DEEM-FCID(TM) AND INCORPORATING THE KANSAS SURFACE WATER SUNFLOWER FOLIAR APPLICATION PH 7.8 SCENARIO

Population Subgroup	aPAD (mg/kg/day)	95th Percentile		99th Percentile		99.9th Percentile	
		Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD	Exposure (mg/kg/day)	% aPAD
All Infants (< 1 year old)	0.000075	0.000087	120	0.000425	570	0.001555	2100
Children 1–2 years old	0.000075	0.000044	59	0.000185	250	0.000660	880
Children 3–5 years old	0.000075	0.000039	53	0.000172	230	0.000610	800
Children 6–12 years old	0.000075	0.000027	36	0.000117	160	0.000416	560
Youth 13–19 years old	0.0002	0.000019	10	0.000089	45	0.000330	160
Adults 20–49 years old	0.0002	0.000026	13	0.000114	57	0.000395	200
Adults 50+ years old	0.0002	0.000028	14	0.000119	60	0.000373	190

More details on this assessment, as well as the assessments EPA conducted for other crop scenarios, can be found in References 16, 61, and 84. For example, in the proposed rule, EPA presented the results from aggregate exposures resulting from a Nebraska surface water scenario based on a Nebraska corn rootworm ''rescue treatment.'' Estimated exposures from that scenario ranged from 330% of the aPAD for youths 13 to 19 years to 3,900% of the aPAD for infants.

As noted previously, EPA's food and water exposure assessments typically sum exposures over a 24–hour period, and EPA used this 24–hour total in developing its acute dietary risk assessment for carbofuran. Because of the rapid nature of carbofuran toxicity and recovery, EPA considered durations of exposure less than 24 hours. Accordingly, EPA has conducted an analysis using information about dietary exposure, timing of exposure within a day, and half-life of AChE inhibition from rats to estimate risk to carbofuran at durations less than 24 hours. Specifically, EPA has evaluated individual eating and drinking occasions and used the AChE half-life to recovery information (herein called half-life information) to estimate the residual effects from carbofuran from previous exposures within the day. The carbofuran analyses are described in the 2009 aggregate (dietary) memo (Ref. 71).

EPA used the same approach for considering the impact of carbofuran's rapid reversibility on exposure estimates in the food and drinking water risk assessments that had been previously used in the cumulative risk assessment of the NMC pesticides and/or risk assessments for other NMC pesticides (*e.g.*, methomyl and aldicarb) (Ref. 107).

Using the two FMC time course studies in rat pups, EPA calculated half-lives for recovery of 186 and 426 minutes. The two values were derived from two different studies using rat pups of the same age (Refs. 30 and 31); the two values provide an indication that half-lives to recovery can vary among juvenile rats. By extension, children are expected to vary in their ability to recover from AChE inhibition where longer recoveries would be associated with a potentially higher ''persisting dose'' (as described below). Incorporating Eating Occasion Analysis and the 186–minute or 426–minute recovery half-lives for carbofuran into the food only analysis does not significantly change the risk estimates when compared to baseline levels (for which a total daily consumption basis – and not eating occasion - was used). From this, it is apparent that modifying the analysis such that information on eating (*i.e.*, food) occasions and carbofuran half-life is incorporated results in only minor reductions in estimated risk from food alone.

Regarding drinking water exposure, accounting for drinking water consumption throughout the day and using the half-life to recovery information, risk is reduced by approximately 2-3X. Consequently, risk estimates for which food and drinking water are jointly considered and incorporated (*i.e.*, Food + Drinking Water) are also reduced considerably—by a factor of two or more in some cases—compared to baseline. This is not unexpected, as infants receive much of their exposures from indirect drinking water in the form of water used to prepare infant formula, as shown in the above example. But even though the risk estimates from aggregate exposure are reduced, they nonetheless still substantially exceed EPA's level of concern for infants and children. Using drinking water derived from the surface water from the Idaho potato surface water scenario, which estimated one of the lowest exposure distributions, aggregate exposures at the 99.9th percentile ranged from 328% of the aPAD under the scenario for which infants rapidly metabolize carbofuran (*e.g.*, 186 minute half-life), to a high of 473% of the aPAD under the scenario for which infants metabolize carbofuran more slowly, (*e.g.*, scenarios in which a 426 minute half life is assumed).

Moreover, even accounting for the estimated decreased risk from accounting for carbofuran's rapid reversibility, the Agency remains concerned about the risks from single eating or drinking events, as illustrated in the following example, based on an actual food consumption diary from the CSFII survey. A 4–month old male non-nursing infant weighing 10 kg is reported to have consumed a total of 1,070 milliters (ml) of indirect water over eight different occasions during the day. The first eating occasion occurred at 6:30 a.m., when this 4 month old consumed 8 fluid ounces of formula prepared from powder. The FCID food recipes indicate that this particular food item consists of approximately 87.7% water, and therefore, 8 ounces of formula contains approximately 214 ml (or grams) of indirect water; with the powder (various nutrients, dairy, soy, oils, etc.) accounting for the remaining 12.3%. This infant also reportedly consumed a full 8–ounce bottle of formula at 12 p.m., 4 p.m., and 8 p.m. that day. The food diary also indicates that the infant consumed about 1 tablespoon of water (14.8 ml) added to prepare rice cereal at 10:00 a.m., about 2 ounces of water (59.3 ml) added to pear juice at 11 a.m., another ½ tsp of water (2.5 ml) to prepare more rice cereal at 8:30 p.m.; and finally, he consumed another 4 ounces of formula (107 ml) at 9:30 p.m.

The infant's total daily water intake (1,070 ml, or approximately 107 ml/kg/day) is not overly conservative, and represents substantially less than the 90th percentile value from CSFII on a ml water/kg bodyweight (ml/kg/bw) basis. As noted, carbofuran has been detected in finished water at concentrations of 4 ppb. For this 10 kg body weight infant, an 8–ounce bottle of formula prepared from water containing carbofuran at 4 ppb leads to drinking water exposures of 0.0856 micrograms of active ingredient/kilogram of bodyweight (µg ai/kg bw), or 114% of the aPAD. Based on the total daily water intake of 1,070 ml/day (no reversibility), total daily exposures from water at 4 ppb concentration would amount to 0.4158 µg ai/kg bw, or 555% of the aPAD; this is the amount that would be used for this person-day in the Total Daily Approach.

Peak inhibition occurs following each occasion on which the infant consumed 8 fluid ounces of formula (6 a.m., 12 p.m., 4 p.m. and 8 p.m.); however, the maximum persisting dose occurs following the 9:30 p.m. eating occasion, based on a 186–minute half-life parameter. This produces a maximum persisting dose of 0.1457 µg ai/kg bw, or about 30% of the total daily exposure of 0.4158 µg ai/kg bw derived above, or expressed as a fraction of the level of concern, the maximum persisting dose amounts to about 194% of the aPAD (or 30% of 554%). Note that with drinking water concentration at 4 ppb, an infant consuming one 8 oz bottle of formula - prepared from powder and tap water containing carbofuran at 4 ppb will obtain exposures of approximately 114% of aPAD. Since many infants consume the equivalent of this amount on a single eating occasion, accounting for reversibility over multiple occasions is not essential to ascertain that infants quite likely have obtained drinking water exposures to carbofuran exceeding the level of concern based on drinking water concentrations found in public drinking water supplies.

The approach discussed above is used to evaluate the extent to which the Agency's 24–hour approach to dietary risk assessment overestimates risk from carbofuran exposure. The results of both approaches indicate that the risk from carbofuran is indeed not substantively overestimated using the current

exposure models and the 24–hour approach.

In this regard, it is important to note EPA's Eating Occasion Analyses underestimate exposures to the extent that they do not take into account carry-over effects from previous days, and because drinking water concentrations are randomly picked from the entire 30–year distribution. As discussed previously, DEEM-FCID(TM) is a single day dietary exposure model, and the DEEM-based Eating Occasion Analysis accounts for reversibility within each simulated person-day. All of the empirical data regarding time and amounts consumed (and corresponding exposures based on the corresponding residues) from the CSFII survey are used, along with the half-life to assess an equivalent persisting dose that produced the peak inhibition expected over the course of that day. This is a reasonable assumption for food alone; since the time between exposure events across 2 days is relatively high (compared to the half-life)—most children (>9 months) tend to sleep through the night—and the time between dinner and breakfast the following morning is long enough it is reasonable to ''ignore'' persisting effects from the previous day. A single day exposure model will underestimate the persisting effects from drinking water exposures (formula) among infants, and newborns in particular (<3 months), since newborns tend to wake up every 2 to 4 hours to feed. Any carry over effects may be important, especially if exposures from the previous day are relatively high, since the time between the last feeding (formula) of the day and the first feeding of the subsequent day is short. A single day model also does not account for the effect of seasonal variations in drinking water concentrations, which will make this effect more pronounced during the high use season (*i.e.*, the time of year when drinking water concentrations are high). Based on these analyses, the Agency concludes that the current exposure assessment methods used in the carbofuran dietary assessment provide realistic and high confidence estimates of risk to carbofuran exposure through food and water.

The result of all of these analyses clearly demonstrates that aggregate exposure from all uses of carbofuran fail to meet the FFDCA section 408 safety standard, and revocation of the associated tolerances is warranted. EPA's analyses show that those individuals–both adults as well as children—who receive their drinking water from vulnerable sources are also exposed to levels that exceed EPA's level of concern—in some cases by orders of magnitude. This primarily includes those populations consuming drinking water from ground water from shallow wells in acidic aquifers overlaid with sandy soils that have had crops treated with carbofuran. It could also include those populations that obtain their drinking water from reservoirs located in small agricultural watersheds, prone to runoff, and predominated by crops that are treated with carbofuran, although there is more uncertainty associated with these exposure estimates.

Although the recent cancellation of several registered uses has reduced the dietary risks to children, EPA's analyses still show that estimated exposures significantly exceed EPA's level of concern for children.

While the registrant claims to have conducted an alternate analysis showing that aggregate carbofuran exposures to children will be safe, FMC failed to provide the data and details of that assessment to the Agency. They have also failed to provide several critical components that served to support key inputs into that assessment. And for several of these, EPA was unable to replicate the claimed results based on the information contained in the comments. In the absence of such critical components, the Agency cannot accept the validity or utility of the analyses, let alone rely on the results.

But based on the summary descriptions provided in their comments, it is clear that the commenters' analyses contain a critical flaw. The commenters' determination of safety rests on the presumption that under real world conditions, events will always occur exactly as hypothesized by the multiple assumptions in their assessment. For example, they assume, despite all available evidence to the contrary, that children will not be appreciably more sensitive to carbofuran's effects than adults. They assume that carbofuran's effects will be highly reversible, and that children will be uniformly sensitive, such that the effects will be adequately accounted for by the assumption of a 150–minute half-life. They further assume that there will be no carry over effect from the preceding day's exposures for infants. They assume that the cancellation of use on alfalfa will reduce carbofuran residues in milk by over 70%. They assume that residues will decrease between 19 and 23% as a result of the buffer requirements on the September 2008 label, even though the label does not require the use of all of the recommended ''best management practices'' (*e.g.*, no language regarding swath displacement), and applicators do not universally use such practices in the absence of any requirement. They assume that average ground water pH adequately characterizes the temporal and spatial heterogeneity common in most areas, despite the available evidence to the contrary. Finally, they assume that PCT in watersheds will never exceed 5% CT, despite varying pest pressures, consultant recommendations, and individual grower decisions. Leaving aside that EPA believes most, if not all of these assumptions are not supported by the available evidence, as described throughout this final rule, the probability of all these assumptions always simultaneously holding true under real world conditions is unreasonably low, and certainly does not approach the degree of certainty necessary for EPA to conclude that children's exposures will be safe.

Determining whether residues will be safe for U.S. children is not a theoretical paper exercise; it cannot suffice to hypothesize a unique set of circumstances that make residues ''fit in the box.'' There must be a reasonable certainty that under the variability that exists under real world conditions, exposures will be ''safe.'' EPA's assessments incorporate a certain degree of conservatism precisely to account for the fact that assumptions must be made that may not prove accurate. This consideration is highly relevant for carbofuran, because as refined as EPA's assessments are, areas of uncertainty remain with regard to carbofuran's risk potential. For example, a recent epidemiological study reported that 45% of maternal and cord blood samples in a cohort of New York City residents of Northern Manhattan and the South Bronx between 2000 and 2004, contained low, but measurable residues of carbofuran (Ref. 118). The Agency is currently unable to account for the source of such sustained exposures at this frequency.

A further consideration is that the risks of concern are acute risks to children. For acute risks, the higher values in a probabilistic risk assessment are often driven by relatively high values in a few exposures rather than relatively lower values in a greater number of exposures. This is due to the fact that an acute assessment looks at a narrow window of exposure where there are unlikely to be a great variety of consumption sources. Thus, to the extent that there is a high exposure it will be more likely due to a high residue value in a single consumption event. Additionally worrisome in this regard is that carbofuran is a highly potent (*i.e.*,

has a very steep dose-response curve), acute toxicant, and therefore any aPAD exceedances are more likely to have greater significance in terms of the potential likelihood of actual harm.

In sum, these results strongly support EPA's conclusion that aggregate exposures to carbofuran are not safe.

IX. Procedural Matters

A. When Do These Actions Become Effective?

The revocations of the tolerances for all commodities will become effective December 31, 2009. EPA had proposed to establish an extended effective date for artichokes and sunflower seed; however, EPA ultimately agrees with those commenters who raised concern that continuance of use for an additional year on these crops would be inconsistent with the acute risks that carbofuran poses to children. Accordingly, the revocation for tolerances on these two crops will now be effective December 31, 2009. The Agency has set the effective date in December because this is the quickest time frame in which the decision could be practically implemented, given that some additional time will be necessary to allow the process applicable to stay requests to be completed. In addition, this time frame ensures that growers will have a reasonable amount of time to make reasoned decisions about their pest management strategies, and to exhaust any stocks of carbofuran currently in their possession.

Any commodities listed in this rule treated with the pesticide subject to this rule, and in the channels of trade following the tolerance revocations, shall be subject to FFDCA section 408(l)(5). Under this section, any residues of these pesticides in or on such food shall not render the food adulterated so long as it is shown to the satisfaction of the Food and Drug Administration that:

1. The residue is present as the result of an application or use of the pesticide at a time and in a manner that was lawful under FIFRA, and

2. The residue does not exceed the level that was authorized at the time of the application or use to be present on the food under a tolerance or exemption from tolerance. Evidence to show that food was lawfully treated may include records that verify the dates when the pesticide was applied to such food.

B. Request for Stay of Effective Date

A person filing objections to this final rule may submit with the objections a petition to stay the effective date of this final rule. Such stay petitions must be received by the Hearing Clerk on or before July 14, 2009. A copy of the stay request filed with the Hearing Clerk shall be submitted to the Office of Pesticide Programs Docket Room. A stay may be requested for a specific time period or for an indefinite time period. The stay petition must include a citation to this final rule, the length of time for which the stay is requested, and a full statement of the factual and legal grounds upon which the petitioner relies for the stay.

EPA received comments asserting that a hearing would definitely be requested, and requesting a stay pending resolution of that hearing.

Until EPA has published its final rule, any request for a stay is purely speculative. EPA is only authorized to issue a stay of the regulation, ''if after issuance of such regulation or order, objections are filed with respect to such regulation...'' 21 U.S.C. 346a(g)(1). No objections have been filed, nor could they be until EPA publishes its final rule. Further, no demonstration has yet been made that any hearing is warranted, nor indeed, could the commenters have done so at this stage of the tolerance revocation process. See, 40 CFR 178 Subpart B. EPA's regulations require all parties who request a stay to justify the request with a statement of the factual and legal grounds upon which the petitioner relies. To the extent the commenters still wish to seek a stay of EPA's final rule, they will have the opportunity to do so, as discussed above.

In determining whether to grant a stay, EPA will consider the criteria set out in the Food and Drug Administration's regulations regarding stays of administrative proceedings at 21 CFR 10.35. Under those rules, a stay will be granted if it is determined that:

(1) The petitioner will otherwise suffer irreparable injury;

(2) The petitioner's case is not frivolous and is being pursued in good faith;

(3) The petitioner has demonstrated sound public policy grounds supporting the stay;

(4) The delay resulting from the stay is not outweighed by public health or other public interests.

Under FDA's criteria, EPA may also grant a stay if EPA finds such action is in the public interest and in the interest of justice.

Any person wishing to comment on any stay request may submit such comments and objections to a stay request to the Hearing Clerk, on or before July 29, 2009. Any subsequent decisions to stay the effect of this order, based on a stay request filed, will be published in the **Federal Register**, along with EPA's response to comments on the stay request.

X. Are The Agency's Actions Consistent With International Obligations?

The tolerance revocations in this final rule are not discriminatory and are designed to ensure that both domestically-produced and imported foods meet the food safety standard established by the FFDCA. The same food safety standards apply to domestically produced and imported foods.

EPA considers Codex Maximum Residue Limits (MRLs) in setting U.S. tolerances and in reassessing them. MRLs are established by the Codex Committee on Pesticide Residues, a committee within the Codex Alimentarius Commission, an international organization formed to promote the coordination of international food standards. It is EPA's policy to harmonize U.S. tolerances with Codex MRLs to the extent possible, provided that the MRLs achieve the level of protection required under FFDCA. EPA's effort to harmonize with Codex MRLs is summarized in the tolerance reassessment section of individual Reregistration Eligibility Decision documents. EPA has developed guidance concerning submissions for import tolerance support (65 FR 35069, June 1, 2000) (FRL–6559–3). This guidance will be made available to interested persons. Electronic copies are available on the internet at *http://www.epa.gov/*. On the Home Page select ''Laws, Regulations, and Dockets,'' then select Regulations and Proposed Rules and then look up the entry for this document under ''**Federal Register**—Environmental Documents.'' You can also go directly to the ''**Federal Register**'' listings at *http://www.epa.gov/fedrgstr/*.

XI. Statutory and Executive Order Reviews

In this final rule, EPA is revoking specific tolerances established under FFDCA section 408. The Office of Management and Budget (OMB) has exempted tolerance regulations from review under Executive Order 12866, entitled *Regulatory Planning and Review* (58 FR 51735, October 4, 1993). Because this final rule has been exempted from review under Executive Order 12866, this final rule is not subject to Executive Order 13211, *Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use* (66 FR 28355, May 22, 2001) or Executive Order 13045, entitled *Protection of Children from*

Environmental Health Risks and Safety Risks (62 FR 19885, April 23, 1997), which both apply to regulation actions reviewed under Executive Order 12866. This final rule does not contain any information collections subject to OMB approval under the Paperwork Reduction Act (PRA), 44 U.S.C. 3501 et seq., or impose any enforceable duty or contain any unfunded mandate as described under Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) (Public Law 104–4). Nor does it require any special considerations as required by Executive Order 12898, entitled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629, February 16, 1994). This action does not involve any technical standards that would require Agency consideration of voluntary consensus standards pursuant to section 12(d) of the National Technology Transfer and Advancement Act of 1995 (NTTAA), Public Law 104–113, section 12(d) (15 U.S.C. 272 note).

In addition, the Agency has determined that this action will not have a substantial direct effect on States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132, entitled *Federalism* (64 FR 43255, August 10, 1999). This final rule directly regulates growers, food processors, food handlers and food retailers, not States. This action does not alter the relationships or distribution of power and responsibilities established by Congress in the preemption provisions of section 408(n)(4) of the FFDCA. For these same reasons, the Agency has determined that this final rule does not have any ''tribal implications'' as described in Executive Order 13175, entitled *Consultation and Coordination with Indian Tribal Governments* (65 FR 67249, November 6, 2000). This final rule will not have substantial direct effects on tribal governments, on the relationship between the Federal Government and Indian tribes, or on the distribution of power and responsibilities between the Federal Government and Indian tribes, as specified in Executive Order 13175. Thus, Executive Order 13175 does not apply to this final rule.

The Regulatory Flexibility Act (RFA) 5 USC 601 et.seq, generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedures Act or any other statute. This is required unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions. The Agency has determined that no small organizations or small governmental jurisdictions are impacted by today's rulemaking. For purposes of assessing the impacts of today's determination on businesses, a small business is defined either by the number of employees or by the annual dollar amount of sales/revenues. The level at which an entity is considered small is determined for each North American Industry Classification System (NAICS) code by the Small Business Administration (SBA). Farms are classified under NAICS code 111, Crop Production, and the SBA defines small entities as farms with total annual sales of $750,000 or less.

The Agency has examined the potential effects today's final rule may have on potentially impacted small businesses. EPA prepared an analysis for the proposal and certified that its proposed rule would not have a significant economic impact on a substantial number of small entities. EPA received no comments on its analysis or certification. Based on its analysis, EPA concludes that the Agency can certify that revoking the food tolerances for carbofuran will not have a significant economic impact on a substantial number of small entities for alfalfa, artichoke, banana, chili pepper, coffee, cotton, cucurbits (cucumber, melons, pumpkin, and squash), grape, grains (barley, flax, oats, and wheat), field corn, potato, soybean, sorghum, sugarbeet, sugarcane, sunflower, and sweet corn. Even in a worst-case scenario, in which a grower obtains income only from a single crop and his/her entire acreage is affected, the impact generally amounts to less than 2% of gross income and would be felt by fewer than 3% of affected small producers. Estimates of impacts to corn growers were refined to account for the sporadic nature of need for carbofuran while still maintaining some assumptions that would bias the estimates upward. Refined estimates were also made for artichoke and sunflower, which consider the diversity in growers' revenue. The largest impact may be felt by artichoke growers, with impacts as high as 5% of gross revenue, but fewer than five growers are likely to be affected. Moreover, as the registrant has voluntarily cancelled the use of carbofuran on artichokes, any impact is more properly traced to the registrant's decision to cancel the registration, than to the revocation of the tolerance. EPA could not quantify the impacts to banana, sugarcane, and sweet corn producers, but the number of impacted farms is less than 2% of the farms subject to the action. Additional detail on the analyses EPA conducted in support of this certification can be found in Reference 85.

XII. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 et seq., generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report to each House of the Congress and the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of the rule in the **Federal Register**. This rule is not a ''major rule'' as defined by 5 U.S.C. 804(2).

XIII. References

The following is a list of the documents that are specifically referenced in this final rule and placed in the docket that was established under Docket ID number EPA-HQ-OPP-2005-0162. The public docket includes information considered by EPA in developing this final rule, such as the documents specifically referenced in this action that are listed in this unit, documents that are referenced in the documents that are in the docket, any public comments received, and other information related to this action. For information on accessing the docket, refer to the **ADDRESSES** unit at the beginning of this document.

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List of Subjects in 40 CFR Part 180

Environmental protection, Administrative practice and procedure, Agricultural commodities, Pesticides and pests, Reporting and recordkeeping requirements.

Dated: May 11, 2009.

Debra Edwards,

Director, Office of Pesticide Programs.

■ Therefore, 40 CFR chapter I be amended as follows:

PART 180—[AMENDED]

■ 1. The authority citation for part 180 continues to read as follows:

Authority: 21 U.S.C. 321(q), 346a and 371.

■ 2. Section 180.254 is amended by revising the tables in paragraphs (a) and (c) to read as follows:

§ 180.254 Carbofuran; tolerances for residues.

(a) * * *

Commodity	Parts per million (ppm)	Expiration/ Revocation date
Alfalfa, forage (of which no more than 5 ppm are carbamates)	10	12/31/09
Alfalfa, hay (of which no more than 20 ppm are carbamates)	40	12/31/09
Banana	0.1	12/31/09
Barley, grain (of which not more than 0.1 ppm is carbamates)	0.2	12/31/09
Barley, straw (of which no more than 1.0 ppm is carbamates)	5.0	12/31/09
Beet, sugar, roots	0.1	12/31/09
Beet, sugar, tops (of which no more than 1 ppm is carbamates)	2	12/31/09
Coffee, bean, green	0.1	12/31/09
Corn, forage (of which no more than 5 ppm are carbamates)	25	12/31/09
Corn, grain (including popcorn) (of which no more than 0.1 ppm is carbamates)	0.2	12/31/09
Corn, stover (of which no more than 5 ppm are carbamates)	25	12/31/09
Corn, sweet, kernel plus cob with husks removed (of which no more than 0.2 ppm is carbamates)	1.0	12/31/09
Cotton, undelinted seed (of which no more than 0.2 ppm is carbamates)	1.0	12/31/09
Cranberry (of which no more than 0.3 ppm is carbamates)	0.5	12/31/09
Cucumber (of which not more than 0.2 ppm is carbamates)	0.4	12/31/09
Grape (of which no more than 0.2 ppm is carbamates)	0.4	12/31/09
Grape, raisin (of which no more than 1.0 ppm is carbamate	2.0	12/31/09
Grape, raisin, waste (of which no more than 3.0 ppm is carbamates	6.0	12/31/09
Melon (of which not more than 0.2 ppm is carbamates)	0.4	12/31/09
Milk (of which no more than 0.02 ppm is carbamates)	0.1	12/31/09
Oat, grain (of which not more than 0.1 ppm is carbamates)	0.2	12/31/09
Oat, straw (of which not more than 1.0 ppm is carbamates)	5.0	12/31/09
Pepper (of which no more than 0.2 ppm is carbamates)	1	12/31/09
Potato (of which no more than 1 ppm is carbamates)	2	12/31/09
Pumpkin (of which not more than 0.6 ppm is carbamates)	0.8	12/31/09
Rice, grain	0.2	12/31/09
Rice, straw (of which no more than 0.2 ppm is carbamates)	1	12/31/09
Sorghum, forage (of which no more than 0.5 ppm is carbamates)	3	12/31/09
Sorghum, grain, grain	0.1	12/31/09
Sorghum, grain, stover (of which no more than 0.5 ppm is carbamates)	3	12/31/09
Strawberry (of which no more than 0.2 ppm is carbamates)	0.5	12/31/09
Soybean (of which not more than 0.2 ppm is carbamates)	1.0	12/31/09
Soybean, forage (of which not more than 20.0 ppm are carbamates)	35.0	12/31/09
Soybean, hay (of which not more than 20.0 ppm are carbamates)	35.0	12/31/09
Squash (of which not more than 0.6 ppm is carbamates)	0.8	12/31/09
Sugarcane, cane	0.1	12/31/09
Sunflower, seed (of which not more than 0.5 ppm is carbamates)	1.0	12/31/09
Wheat, grain (of which not more than 0.1 ppm is carbamates)	0.2	12/31/09
Wheat, straw (of which not more than 1.0 ppm is carbamates)	5.0	12/31/09

* * * * * (c) * * *

Commodity	Parts per million (ppm)	Expiration/ Revocation date
Artichoke, globe (of which not more than 0.2 ppm is carbamates)	0.4	12/31/09

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