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MEMORANDUM

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SUBJECT: Problem Formulation for Ecological Risk Assessment, for Carbon Dioxide and Gas Fumigant Producing Cartridges: Carbon, Sawdust, Sodium Nitrate, Potassium Nitrate and Sulfur

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Please find attached the ecological risk assessment problem formulation for carbon dioxide and gas fumigant producing cartridges: carbon, sawdust, sodium nitrate, potassium nitrate and sulfur.

Problem Formulation, For Ecological Risk Assessment, For Carbon Dioxide, and Gas Fumigant Producing Cartridges: Sawdust, Sodium Nitrate, Potassium Nitrate and Sulfur

Case Number 4019, 4052, 0031

Environmental Fate and Effects Division
Office of Pesticide Programs
U.S. Environmental Protection Agency

Table of Contents 2

II. Problem Formulation

A. Nature of Regulatory Action 3

B. Stressor Source and Distribution 3
1. Nature of the Chemical Stressor 3
2. Overview of Pesticide Usage 4

C. Receptors 8
1. Aquatic and Terrestrial Effects 8
2. Ecosystems Potentially at Risk 9

D. Assessment Endpoints 10

E. Conceptual Model 10
1. Risk Hypothesis 11
2. Conceptual Diagram 11

F. Analysis Plan 12
1. Conclusions from Previous Risk Assessments 12
2. Preliminary Identification of Data Gaps and Analysis Plan 13
3. Measures of Effects and Exposure 13

Bibliography 19

II. Problem Formulation

The purpose of this problem formulation is to provide the foundation for the ecological risk assessment being conducted for carbon, sawdust, sodium nitrate, potassium nitrate and sulfur when used in fumigant gas producing cartridge products. It also includes carbon dioxide which has indoor fumigant uses. It does not include sulfur uses other than the gas cartridge use. It also does not include the active ingredient nitrite because there are no nitrite products registered at this time. As such, it articulates the purpose and objectives of the risk assessment, evaluates the nature of the problem, and provides a plan for analyzing the data and characterizing the risk (EPA, 1998).

A. Nature of Regulatory Action

This report summarizes the Environmental Fate and Effects Division's Problem Formulation for the Registration Review of; 1) carbon, carbon dioxide, and sawdust (Case Number 4019); 2) sodium and potassium nitrate (Case Number 4052); and 3) the cartridge use of sulfur (Case Number 0031). In 1991, the USEPA issued Reregistration Eligibility documents for carbon and carbon dioxide, sodium nitrate and potassium nitrate, and sulfur which serves as the basis for this assessment. At the time, sawdust was not included in the document. It was concluded that, for these chemicals, application of the cartridges to burrows (subsurface) precludes exposure to avian and aquatic organisms. However, organisms that live in burrows, including endangered species, may be impacted. The label as of the date of issuance of the RED documents included provisions to protect those species. For carbon dioxide, which only has indoor uses, the Agency concluded that exposure to non-target organisms was unlikely.

B. Stressor Source and Distribution

1. Nature of the Chemical Stressor

Carbon, sodium and potassium nitrates, sawdust, and sulfur are used in pyrotechnic fumigant gas producing cartridge products. After the cartridges are ignited they produce toxic gases that cause asphyxiation of the pests. These toxic gases, not the active ingredients, are the stressors for these products. Not all the gasses have been identified, however, for one product (Large Gas Cartridge, EPA Reg. No. 56228-21) over forty combustion products were identified, including carbon monoxide, carbon dioxide and nitrogen. For example, the following is a possible reaction (Savarie, *et.al.* 1980).

$$4C + 2NaNO_3 \rightarrow 3CO + Na_2CO_3 + N_2$$

The gases displace the oxygen in the burrows, creating an un-breathable atmosphere, causing asphyxiation of the target organisms.

Carbon dioxide (CAS No. 124-38-9; PC Code 016601) is an insecticide gas used as an indoor fumigant. For this use, carbon dioxide is the stressor. Carbon dioxide is "poured" indoors as a fumigant in such places like sealed trucks, trailers, sealed railroad cars, food handling establishments and ships. The area to be fumigated is sealed, and the atmosphere is filled at a minimum of 60% carbon dioxide for up to 4-5 days, causing the

pests to die of asphyxiation. Table II.1 provides some basic characteristics of carbon dioxide.

Table II.1. Nature of the Chemical Stressor	
Common name	***Carbon Dioxide***
Chemical name	*Carbon Dioxide*
Pesticide type	*Insecticide, Rodenticide*
Chemical class	*NA*
CAS number	*124-38-9*
Empirical formula	*CO_2*
Molecular mass (g/mol)	*44.01*
Vapor pressure	*$4.83x10^4$ mm Hg @ 25 deg C*
Henry's Law Constant (atm-m^3/mol)	*NA*
Solubility in water (g/L)	*0.145 g/100 mL at 25°C*
Log K_{ow}	*NA*
PK_a/PK_b	*NA*
Physical state	*Colorless odorless gas*
Melting point (°C)	*-56.6 at 5.2 atm*
Boiling point (°C)	*-78.5*
Density/Specific gravity (Air=1)	*1.527*
pH of saturated carbon dioxide solution	*3.7 at 1 atm to 3.2 at 23.4 atm*
Solubilities	*Miscible with hydrocarbons and most organic liquids*

Carbon dioxide is in the atmospherek; analyses of air in the temperate zones of the earth show 0.027-0.036% (v/v) of carbon dioxide (HSDB). Carbon dioxide is considered an inert ingredient without toxicological significance to non-target organisms in the environment.

2. Overview of Pesticide Usage

Table II.2 provides a summary of data regarding gas cartridge products containing sawdust, carbon, sodium nitrate, potassium nitrate, and sulfur as well as the carbon dioxide products. The table shows the labeled target organisms and the use sites. It is noted that sawdust and carbon products are co-formulated either with sodium or potassium nitrate and in various formulations with sulfur. The products consist of cartridges that are lit and inserted into the pests' burrows, where they are sealed. When the cartridges ignite, they produce toxic gasses which cause asphyxiation of the target pests (rodents and some larger mammals). These cartridges are to be used outdoors only (refer to use sites in Table II.2).

Carbon dioxide, used as a fumigant, is used to control a number of insects in enclosed indoor areas. These areas may contain grains or other agricultural commodities (food or feed crops, stored), as indicated in the table. Carbon dioxide may also be used in residential settings.

Table II.2. **All Products Containing Carbon, Carbon Dioxide or Sawdust** **plus Sodium or Potassium Nitrate and Sulfur**		
Product Name, **Reg No.**	**Active Ingredients %**	**Target Species;** **Use Areas**
SMOKE'em 4-463	Potassium nitrate 46.2% Sulfur 34.8% Sawdust 8.7%	Woodchucks, ground squirrels; Open fields, non-crop areas
Dexol Gopher Degasser 192-49	Potassium nitrate 45.0% Sulfur 45.0% Carbon 8.0%	Gophers, ground squirrels; Lawns, golf courses, gardens, rangeland
Revenge Rodent Smoke Bomb 9086-4	Potassium nitrate 38.8% Sulfur 39.4% Carbon 12.5%	Gophers, moles, woodchucks, rats, skunks, ground squirrels; Lawns, golf courses, non-crop areas, rangeland, meadows, reforested areas, open fields, parks
The Giant Destroyer 10551-1	Sodium nitrate 46.2% Sulfur 34.8% Carbon 8.7%	Gophers, moles, woodchucks, rats, skunks, ground squirrels; Lawns, golf courses, non-crop areas, rangeland, meadows, reforested areas, open fields
Large Gas Cartridge 56228-21	Sodium nitrate 53.0% Carbon (Charcoal) 28.0%	Coyotes, red foxes, striped skunks; In dens only in rangeland, crop and non-crop areas
Gas Cartridge 56228-2	Sodium nitrate 53.0% Carbon (Charcoal) 28.0%	Woodchucks, yellow bellied marmots, ground squirrels, black tailed prairie dogs, white tailed prairie dogs, Gunnison prairie dogs; Open fields, non-crop areas, rangeland, reforested areas, lawns, golf courses
Carbon dioxide 10330-20	Carbon dioxide 99.8%	Beetles, Psocoptera, moths; Storage, trucks, trailers, sealed railroad cars and ships. The following may be treated-raw and processed agricultural products such as corn, barley, oats, rice, sorghum, wheat, rye, cocoa and coffee beans, flour, cereal, dry beans, peas, pasta products, dry milk, nuts, dried fruits, tobacco products, spices and herbs, etc.
Carbon dioxide 38719-5	Carbon dioxide 99.95%	Silos, trucks, trailers, sealed railroad, cars, and ships, food handling establishments, processing and storage facilities and residential structures. The following raw agricultural commodities may be treated: wheat, oats, rice, barley, corn, processed food

There is no information on the typical usage (number of applications, "rate" or interval between applications) for carbon, carbon dioxide or sawdust. The state of California does report usage of these pesticides and some useful data may be extrapolated (refer to tables named Carbon Usage, Carbon Dioxide Usage and Sawdust Usage below). It is noted that the total usage of carbon decreased by almost one half from 2003 to 2004 in California and did not increase in 2005. Major decrease in use was in vertebrate control, followed by landscape maintenance. Another important use of carbon appeared to be rights of way. Data available for sawdust shows that less than 2 lb of the product were used in California in 2003 and 2004, and only 0.143 lb (total) were used in 2005. The carbon dioxide usage is higher than the one for carbon or sawdust. In California, the chemical total pounds range from 132,000 lb (in 2005) to 202,000 lb (in 2004). Major uses appear to be almond, dried fruit, grapes, pistachio, tomatoes and walnuts. With respect to fumigation of structures, food processing plants and structural pest control appeared to be the important categories, and a category named "fumigation, only."

For sulfur, the California (CADPR) use information data indicate that there is an increasing trend on the use for "vertebrate control" in a period of three years, from 453 lb in 2003 to 4418 lb in 2005.

There is also no information on the typical usage (number of applications, "rate" or interval between applications) for sodium nitrate and potassium nitrate. The Screening Level Usage Analysis (SLUA) was verified for these chemicals. The SLUA provides the average annual pounds of pesticide applied for each agricultural crop (*i.e.* for the states surveyed, not for the entire U.S.). According to the SLUA for sodium nitrate, it appears that crops of major use for the chemical are almonds, kiwifruit, nectarines, olives, pistachios and prunes & plums. In each case, <500 lb of active ingredient were used in California. However, it is indicated that ≥95% of the U.S. acres that have this gas cartridge use are in California. For potassium nitrate, the SLUA lists almonds, nectarines, pistachios and prunes & plums as the crops of interest, but <500 lb active ingredient were utilized in California. As in the previous case, it is indicated that ≥95% of the U.S. acres that have potassium nitrate gas cartridge use are in California.

Carbon Usage

Publicly available data from the California Department of Pesticide Regulation was used to produce the following table outlining the pounds of carbon used in California over the three most recent years available (2003-2005).

Crop/Area	2003 Lbs. Applied	2004 Lbs Applied	2005 Lbs. Applied
ALMOND	40	29	17
CHERRY		4	1
GRAPE			30
KIWI	0.1		
LANDSCAPE MAINTENANCE	283	145	110
LEMON	1		

NURSERY OUTDOOR TRANSPLANTS	2	3	
NURSERY GREENHOUSE TRANSPLANTS			2
NECTARINE			3
OAT (FORAGE - FODDER)		2	
PEAR	0.1	2	
PISTACHIO	28		18
RANGELAND		3	
REGULATORY PEST CONTROL	9	16	42
RESEARCH COMMODITY	0.01	0.03	
RIGHTS OF WAY	376	488	570
STRUCTURAL PEST CONTROL	3	1	2
UNCULTIVATED AG	9		
VERTEBRATE CONTROL	1,296	345	224
WALNUT	4	11	37
Chemical Total	**2,051**	**1,047**	**1,056**

Prepared by: Jenna Carter 7/31/07

Source: Cal DPR data - http://www.cdpr.ca.gov/docs/pur/purmain.htm

Carbon Dioxide Usage

Publicly available data from the California Department of Pesticide Regulation was used to produce the following table outlining the pounds of carbon dioxide used in California over the three most recent years available (2003-2005).

Site	2003 Pounds Applied	2004 Pounds Applied	2005 Pounds Applied
ALMOND	10,779	15,762	45,003
COMMODITY FUMIGATION	24,348	9,290	28,655
CORN, HUMAN CONSUMPTION		88	7
CORN (FORAGE - FODDER)	1,071		
DRIED FRUIT	7,988	6,877	3,785
FIG	152	613	157
FOOD PROCRESSING PLANT	1,533	29,985	
FUMIGATION, OTHER	111,635	32,409	22,623
GRAPE	7,350	13,651	18,330
GRAPE, WINE	1,066	119	
LANDSCAPE MAINTENANCE		294	83
NUTS			923
PEAS			43
PISTACHIO	4,565	4,945	5,255
PUBLIC HEALTH			300
RICE		125	
RICE, WILD	8	22	39
RIGHTS OF WAY	698	41	

STORAGE AREA/BOX	183	267	411
STRUCTURAL PEST CONTROL	461	15,107	1,114
TOMATO	921	1,441	1,254
TOMATO, PROCESSING	421	1,127	902
UNKNOWN [1]	74	62,969	122
WALNUT	500	7,313	3,134
Chemical Total	**173,757**	**202,446**	**132,139**

[1] Site not specified in source data

Prepared by: Jenna Carter 6/29/07

Source: Cal DPR data - http://www.cdpr.ca.gov/docs/pur/purmain.htm

Sawdust Usage

Publicly available data from the California Department of Pesticide Regulation was used to produce the following table outlining the pounds of sawdust used in California over the three most recent years available (2003-2005).

Crop/Site	2003 Lbs. Applied	2004 Lbs. Applied	2005 Lbs. Applied
CHERRY			0.11
LANDSCAPE MAINTENANCE	0.4956	0.88	0.011
STRUCTURAL PEST CONTROL	0.12		
VERTEBRATE CONTROL	0.5412	0.5368	0.022
Chemical Total	**1.1568**	**1.4168**	**0.143**

Prepared by: Jenna Carter 8/01/07

Source: Cal DPR data - http://www.cdpr.ca.gov/docs/pur/purmain.htm

C. Receptors

1. Aquatic and Terrestrial Effects

The receptor is the biological entity that is exposed to the stressor (EPA, 1998). Various types of receptors may inhabit burrows, where carbon, sawdust, sulfur, sodium nitrate, and potassium nitrate are applied in the form of explosive cartridges. These include rodents and other small mammals. The areas to be fumigated are to be located outdoors only. In addition, several forms of life may be exposed to carbon dioxide, when it is applied to enclosed areas, such as ships, railroads, cars and storage facilities (may include insects, mites and rodents); however, these are usually considered the target pests, beetles, moths and other insects.

Consistent with the process described in the Overview Document (EPA, 2004), risk assessments use a surrogate species approach in its evaluation of pesticides such as carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate and sawdust.

Toxicological data generated from surrogate test species, which are intended to be representative of broad taxonomic groups, are used to extrapolate to potential effects on a variety of species (receptors) included under these taxonomic groupings. For the gas cartridge use of carbon, carbon dioxide, sawdust, sulfur, sodium nitrate and potassium nitrate all data requirements for ecological studies have been waived.

As indicated previously, the pest species are not exposed to the active ingredients in gas cartridges, but rather to the products of the pyrolysis. The cartridge application is subsurface into burrows, and exposure to aquatic organisms and most avian species is not anticipated. However, any organism living in or inhabiting burrows may be exposed and, thus, impacted and killed by the cartridges. There is a potential direct impact to non-target species and endangered species. To address the potential risks to non-target organisms, the Agency will review product efficacy data to ensure that labeling instructions are explicit concerning actions users must take before applying the product.

The potential direct effect of carbon dioxide on endangered species is minimal since it is utilized in enclosed structures, such as silos, trailers, food handling establishments, processing, storage facilities and residential structures.

Incident Reports

The Agency's Ecological Incident Information System (EIIS) does not contain any reports of damage or adverse effects to non-target organisms attributed to the use of carbon, sawdust, sulfur, sodium nitrate or potassium nitrate gas cartridge uses or carbon dioxide indoor fumigant uses. No incidents of contamination of surface, ground and drinking water have been reported to the Agency. A lack of reported incidents does not necessarily mean that such incidents have not occurred.

2. Ecosystems Potentially at Risk

The ecosystems at risk are often extensive in scope, and as a result it may not be possible to identify specific ecosystems during the development of a baseline risk assessment. However, in general terms, terrestrial ecosystems potentially at risk could include the treated field and areas immediately adjacent to the treated field that may receive drift or runoff (note that these are not routes of dissipation for the carbon, sawdust, sodium nitrate, potassium nitrate, and sulfur gas cartridge use or the indoor carbon dioxide fumigant use). The gas cartridges may be used in sealed burrows in such areas as open fields, non-crop areas, rangeland, reforested areas, lawns and golf courses; however, this will result in limited exposure. Areas adjacent to the treated field could include cultivated fields, fencerows and hedgerows, meadows, fallow fields or grasslands, woodlands, riparian habitats and other uncultivated areas. Carbon dioxide is used in enclosed areas; therefore, there are no extensive terrestrial ecosystems at risk.

Aquatic ecosystems potentially at risk include water bodies adjacent to, or down stream from, the treated field and might include impounded bodies such as ponds, lakes and reservoirs, or flowing waterways such as streams or rivers. For uses in coastal areas,

aquatic habitat also includes marine ecosystems, including estuaries. The use of carbon dioxide is not expected to result in exposure to aquatic ecosystems because it is used in enclosed areas and the sealed burrow application of carbon, sawdust, sodium nitrate, potassium nitrate, and sulfur gas cartridge is also not expected to result in exposure to aquatic ecosystems. No extensive exposure is anticipated if used according to the label.

D. Assessment Endpoints

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected." Defining an assessment endpoint involves two steps: 1) identifying the valued attributes of the environment that are considered to be at risk; and 2) operationally defining the assessment endpoint in terms of an ecological entity (*i.e.*, a community of fish and aquatic invertebrates) and its attributes (*i.e.*, survival and reproduction). Therefore, selection of the assessment endpoints is based on valued entities (*i.e.*, ecological receptors), the ecosystems potentially at risk, the migration pathways of pesticides, and the routes by which ecological receptors are exposed to pesticide-related contamination. The selection of clearly defined assessment endpoints is important because they provide direction and boundaries in the risk assessment for addressing risk management issues of concern. Changes to assessment endpoints are typically estimated from the available toxicity studies, which are used as the measures of effects to characterize potential ecological risks associated with exposure to pesticides, such as carbon, carbon dioxide, sodium nitrate, potassium nitrate, sulfur and sawdust.

To estimate exposure concentrations, the ecological risk assessment considers a single application at the maximum application rate to fields that have vulnerable soils. The most sensitive toxicity endpoints are used from surrogate test species to estimate treatment-related direct effects on acute mortality and chronic reproductive, growth and survival assessment endpoints. Toxicity tests are intended to determine effects of pesticide exposure on birds, mammals, fish, terrestrial and aquatic invertebrates, and plants. These tests include short-term acute, sub-acute, and reproduction studies and are typically arranged in a hierarchical or tiered system that progresses from basic laboratory tests to applied field studies. The toxicity studies are used to evaluate the potential of a pesticide to cause adverse effects, to determine whether further testing is required, and to determine the need for precautionary label statements to minimize the potential adverse effects to non-target animals and plants.

Registrant submitted ecological toxicity data were waived for carbon, carbon dioxide, sodium nitrate, potassium nitrate, sulfur and sawdust based on the gas cartridge uses and the indoor fumigant uses. No additional data is required to determine relevant endpoints. The registrant has submitted ecological toxicity data for sulfur to support the non-gas cartridge uses.

E. Conceptual Model

For a pesticide to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a

pesticide moves in the environment from a source to an ecological receptor. For an ecological pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure.

A conceptual model provides a written description and visual representation of the predicted relationships between carbon, sulfur, sodium nitrate, potassium nitrate, carbon dioxide and/or sawdust, potential routes of exposure, and the predicted effects for the assessment endpoint. A conceptual model consists of two major components: risk hypothesis and a conceptual diagram (EPA, 1998).

1. Risk Hypothesis

For carbon, sawdust, sulfur, sodium nitrate, potassium nitrate and carbon dioxide, the following ecological risk hypotheses are being employed for this baseline risk assessment:

> *Carbon, sawdust, sodium nitrate, potassium nitrate, sulfur and sawdust by-products from gas cartridge use, when used in accordance with the label, result in potential adverse effects upon the survival of non-target terrestrial organisms.*
>
> *Carbon dioxide, when used in accordance with the label, does not result in potential adverse effects to non-target terrestrial and aquatic organisms.*

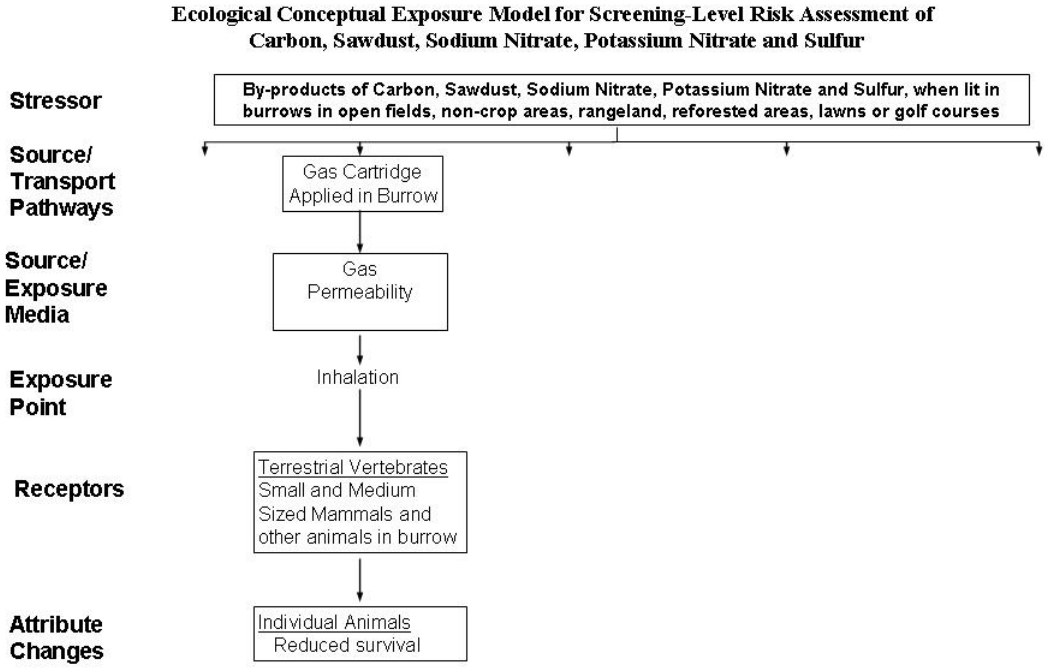
2. Conceptual Diagram

The conceptual site model is a generic graphic depiction of the risk hypothesis, and assumes that as rodenticides/ predacides with a inhalation toxic mode of action, carbon, sulfur, sodium nitrate, potassium nitrate and sawdust by-products are capable of affecting terrestrial (and less likely aquatic) animals provided that environmental concentrations are sufficiently elevated as a result of proposed label uses. However, through a preliminary iterative process of examining available data, the conceptual model (i.e., the risk hypothesis) has been refined to reflect the likely exposure pathways and the organisms that are most relevant and applicable to this assessment (Figure II.1). It includes the potential stressor (reaction by-products from the gas cartridge use, *e.g.* carbon monoxide, carbon dioxide and nitrogen), the source and/or transport pathways, exposure media, exposure point, biological receptor types, and attributes changes.

The stressor resulting from application of gas cartridges applied to sealed burrows in open fields, rangelands, lawns, golf courses, non-crop areas or reforested areas are gases that are formed after the explosion of the cartridges, including carbon monoxide. The exposure media/ source is gas permeability, that is, carbon monoxide and other gases that may be inhaled by terrestrial animals that inhabit burrows, resulting in death by asphyxiation (the attribute change is reduced survival). Since the instructions of these cartridges indicate that the burrows are to be sealed quickly after the cartridge is activated and inserted in burrow, the gases are to remain for an extended period inside the burrow,

and the exposure to non-target animals is expected to be minimal, except for animals living in burrows.

Figure II.1. Conceptual Diagram for Carbon, Sawdust, Sodium Nitrate, Potassium Nitrate and Sulfur Risk to Terrestrial Animals



F. Analysis Plan

1. Conclusions from Previous Risk Assessments

In 1991, Re-registration Eligibility Documents for carbon and carbon dioxide, potassium nitrate and sodium nitrate, and for sulfur were issued and covered various products containing these chemicals. The general conclusion is that there are no unreasonable effects to the environment due to the use of these active ingredients. The use of carbon, potassium nitrate, sodium nitrate, and sulfur could result in potential impact to certain endangered species, while carbon dioxide is an indoor use only fumigant with limited exposure potential.

2. Preliminary Identification of Data Gaps and Analysis Plan-Need uses

All the environmental fate and ecological effects data requirements are waived for carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate and sawdust for the gas cartridge uses. The waivers were based on the ecological effects assessment of carbon, sulfur, sodium nitrate, potassium nitrate and sawdust, the fact that some of these chemicals are widespread and/or the physical and chemical properties are understood. Carbon dioxide has only indoor uses. For indoor uses, usually, only hydrolysis is required; however, since carbon dioxide is a gas at room temperature, the data requirement is also waived.

All the ecological effects data requirements are waived for gas cartridge uses of carbon, carbon dioxide, sawdust, sulfur, sodium nitrate and potassium nitrate. The cartridges are applied to burrows, subsurface, which precludes substantive exposure to avian and aquatic organisms or terrestrial organisms that do not live in burrows. However, organisms that live in burrows may be at risk. A review of gas cartridge efficacy data will be conducted to ensure there is appropriate labeling language regarding timing of application and observation of signs indicating the presence or absence of target and non-target organisms.

Status of Data Requirements

Ecological Effects

All ecological effects data requirements for carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate and sawdust have been waived for the gas cartridge use. Efficacy data on the gas cartridges will be evaluated.

Environmental Fate

All environmental fate data requirements for carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate and sawdust have been waived.

3. Measures of Effects and Exposure

Ecological effects data are waived. The preliminary assessment of carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate, and sawdust indicates that they are chemically un-reactive in the environment. There is no evidence to suggest a hazard to the environment when these pesticides are used according to the label. However, any non-target organism inhabiting a burrow in which the gas cartridges are applied would potentially be adversely affected.

For a chemical, a number of measures of exposure are used, which are the measures of stressor existence and movement in the environment and their contact or co-occurrence with the assessment endpoint. Measures of exposure are potentially estimated using models. Aquatic exposure usually consists of aquatic EECs based on a total residue approach and derived using a water-body that is vulnerable and representative of static

ponds and first order waterways. Terrestrial exposure is usually estimated using a model that assumes a direct application to a variety of avian, mammal and reptilian food items. Exposure to terrestrial plants is usually estimated using a model that assumes that a chemical drifts or moves with runoff to adjacent habitats. Models require quantitative measurements for endpoints to evaluate the effects of the chemicals on the various species. In the absence of fate data, these measures of exposure could not be modeled.

Table II.5 provides a summary of the assessment endpoints previously identified as survival, growth and reproduction along with the measure of effects and exposure. No registrant submitted data to support the gas cartridge or indoor fumigant use are available for the measures of effects.

Table II.5. Measures of Ecological Effects and Exposure for Carbon, Carbon Dioxide, Sulfur, Sodium Nitrate, Potassium Nitrate, and Sawdust

		Surrogate Species and Measures of Ecological Effect[1]	Measures of Exposure
Birds[2]	Survival	Bobwhite acute oral LD_{50} Bobwhite and mallard subacute dietary LC_{50} (data waived)	Maximum residues on food items (foliar)
	Reproduction and growth	Bobwhite and mallard chronic reproduction NOAEC and LOAEC (data waived)	
Mammals	Survival	Laboratory rat acute oral LD_{50} (data waived)	
	Reproduction and growth	Laboratory rat oral reproduction chronic NOAEC and LOAEC (data waived)	
Freshwater fish[3]	Survival	Rainbow trout and bluegill sunfish acute LC_{50} (data waived)	Peak EEC[4]
	Reproduction and growth	Fathead minnow chronic (early life-stage) NOAEC and LOAEC (data waived)	60-day average EEC[4]
Freshwater invertebrates	Survival	Water flea (and other freshwater invertebrates) acute EC_{50} (data waived)	Peak EEC[4]
	Reproduction and growth	Water flea chronic (life cycle) LOAEC (data waived)	21-day average EEC[4]
Estuarine/marine fish	Survival	Sheepshead minnow acute LC_{50} (data waived)	Peak EEC[4]
	Reproduction and growth	Sheepshead minnow chronic (early life-stage) NOAEC and LOAEC (data waived)	60-day average EEC[4]
Estuarine/marine invertebrates	Survival	Eastern oyster acute EC_{50} and mysid acute LC_{50} (data waived)	Peak EEC[4]

		Surrogate Species and Measures of Ecological Effect[1]	Measures of Exposure
	Reproduction and growth	Mysid chronic NOAEC and LOAEC (data waived)	21-day average EEC[4]
Terrestrial plants[5]	Survival and growth	Monocot and dicot seedling emergence and vegetative vigor $EC_{25,}$ EC_{05}, and NOAEC values (data waived)	Estimates of runoff and spray drift to non-target areas
Insects	Survival (not quantitatively assessed)	Honeybee acute contact LD_{50} (data waived)	Maximum application rate
Aquatic plants and algae	Survival and growth	Algal and vascular plant (i.e., duckweed) EC_{50} and NOAEC values for growth rate and biomass measurements (data waived)	Peak EEC

[1] If species listed in this table represent most commonly encountered species from registrant-submitted studies, risk assessment guidance indicates most sensitive species tested within taxonomic group are to be used for baseline risk assessments.
[2] Birds represent surrogates for amphibians (terrestrial phase) and reptiles.
[3] Freshwater fish may be surrogates for amphibians (aquatic phase).
[4] One in 10-year return frequency.
[5] Four species of two families of monocots - one is corn, six species of at least four dicot families, of which one is soybeans. LD_{50} = Lethal dose to 50% of the test population; NOAEC = No observed adverse effect concentration; LOAEC = Lowest observed adverse effect concentration; LC_{50} = Lethal concentration to 50% of the test population; EC_{50}/EC_{25} = Effect concentration to 50%/25% of the test population.

4. Endangered Species Considerations

Pesticide ecological risk assessments for registration review will address Endangered Species Act, Section 7 (a)(2) obligations. Data requirements were waived for carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate, and sawdust for the gas cartridge use; therefore no RQs can be calculated to assess the risk to endangered species. At this time, no incident reports are available that indicate risk to endangered species.

All the labels for carbon, sulfur, sodium nitrate, potassium nitrate, and sawdust gas cartridge products have an "Endangered Species Considerations" section, in which it is specified that the product should not be used in the presence of specified endangered species. Additional specifications, such as time of the year during which the product should or should not be used, temperature, etc. may appear in some labels.

Path Forward

The Agency realizes that when the gas cartridges are used, any organism in a properly treated burrow will likely be killed and is concerned about potential impact to populations of non-target and endangered species. Due to the potential risk to non-target organisms, the Agency will review product efficacy data. This information will be used to ensure that label instructions are explicit concerning actions users must take before applying the products. It may require more extensive labeling regarding timing of application and observation of signs indicating the presence or absence of target and non-target organisms.

The planned ecological risk assessment will evaluate the lines-of-evidence and make a determination of potential effects to endangered species. If the planned ecological risk assessment indicates that carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate and sawdust may affect, either directly or indirectly, listed species or affect critical habitat, the Agency will take steps to refine the assessment to determine whether this pesticide's uses are likely to adversely affect, or are not likely to adversely affect the species. In the case of critical habitat, the Agency will assess whether use of the pesticide may destroy or adversely modify any principle constituent elements for the critical habitat.

If the Agency's assessment results in a determination that the pesticide may affect but is not likely to adversely affect a listed species or designated critical habitat, the Agency will request concurrence by the USFWS and NMFS (Services) on that determination. If the Services do not concur, the Agency will enter into Formal Consultation with them under the Endangered Species Act. If the Agency's assessment results in a determination that the pesticide is likely to adversely affect a listed species or designated critical habitat, the Agency will initiate Formal Consultation with the Services. Formal Consultation concludes with issuance of a Biological Opinion to the Agency. The Agency may seek to change the terms of registration to address unacceptable risks to a listed species should EPA determine such risks exist.

Other Information Needs

Information is requested for confirmation on the following label information:

1. confirmation on the following label information
    a. maximum application rates
    b. frequency of application, application intervals, and maximum number of applications per season
    c. geographic limitations on use
2. use or potential use distribution (e.g., acreage and geographical distribution of relevant crops)
3. use history
4. median and 90th percentile reported use rates (lbs ai/acre) from usage data – national, state, and county

5. application timing (date of first application and application intervals) by crop – national, state, and county
6. sub-county crop location data
7. usage/use information for non-agricultural uses (e.g., forestry, residential, rights-of-way)
8. directly acquired county-level usage data (not derived from state level data)
    a. maximum reported use rate (lbs ai/acre) from usage data – county
    b. percent crop treated – county
    c. median and 90th percentile number of applications – county
    d. total pounds per year – county
    e. the year the pesticide was last used in the county/sub-county area
    f. the years in which the pesticide was applied in the county/sub-county area
9. typical interval (days)
10. state or local use restrictions
11. ecological incidents not already reported to the Agency
12. monitoring data

The analysis plan will be revisited and may be revised depending upon the information submitted by the public in response to the opening of the Registration Review docket. is not expected to be a risk issue to humans based currently registered use patterns.

Summary

- Carbon dioxide is a naturally occurring substance; analyses of air in the temperate zones of the earth show 0.027-0.036% (v/v) of carbon dioxide (HSDB). Carbon, sawdust, sulfur, potassium nitrate, sodium nitrate, and carbon dioxide are considered ingredients without toxicological significance to non-target organisms in the environment.
- The state of California reports usage of carbon, carbon dioxide and sawdust and useful data may be extrapolated. The total usage of carbon decreased by almost one half from 2003 to 2004 and did not increase in 2005. Major decrease in use was in vertebrate control, followed by landscape maintenance. Data available for sawdust shows that only 0.143 lb (total) were used in 2005. In California, the carbon dioxide total pounds range from 132,000 lb (in 2005) to 202,000 lb (in 2004). Major uses appear to be almond, dried fruit, grapes, pistachio, tomatoes and walnuts.
- The California (CADPR) use information data for sulfur indicate that there is an increasing trend on the use for "vertebrate control" in a period of three years, from 453 lb in 2003 to 4418 lb in 2005.
- According to the SLUA for sodium nitrate, it appears that crops of major use for the chemical are almonds, kiwifruit, nectarines, olives, pistachios and prunes & plums. In each case, <500 lb of active ingredient were used in California. However, it is indicated that ≥95% of the U.S. acres are in California. For potassium nitrate, the SLUA lists almonds, nectarines, pistachios and prunes & plums as the crops of interest, but <500 lb active ingredient were utilized in California. As in the previous case, it is indicated that ≥95% of the U.S. acres are in California.
- All the environmental fate data requirements are waived for carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate and sawdust. The fate data are waived based on the ecological effects assessment of the chemicals, and the fact that some of these chemicals are widespread or natural chemicals and the physical and chemical properties

of the chemicals are understood. Carbon dioxide has only indoor uses. Usually, only hydrolysis is required; however, since carbon dioxide is a gas at room temperature, the data requirement is also waived.

- All the ecological effects data requirements are waived for carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate and sawdust for the gas cartridge use. The ecological requirements for carbon, sulfur, sodium nitrate, potassium nitrate and sawdust are waived based on the lack of exposure to most non-target organisms and the fact that any non-target organism inhabiting a properly treated burrow with the gas cartridges would be killed. Furthermore, carbon dioxide, a naturally occurring gas, is used indoors only. No exposure to non-target organisms is anticipated.
- Efficacy data will be reviewed for the gas cartridge uses to determine if label language needs to be revised.
- The Agency's Ecological Incident Information System (EIIS) does not contain any reports of damage or adverse effects to non-target organisms attributed to the use of carbon, carbon dioxide, sulfur, sodium nitrate, potassium nitrate or sawdust.

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Table 1. Carbon, Carbon Dioxide, Sawdust, Sodium Nitrate, Potassium Nitrate and Sulfur Table of Environmental Fate Data Requirements for Gas Cartridge and Indoor Fumigant Use

Guide-line #	Data Requirement	Study ID	Study Classification	Are Additional Data Needed for Risk Assessment?
161-1	Hydrolysis	No data	Waived[1]	no
161-2	Photolysis in Water	No data	Waived[1]	no
161-3	Photodegradation on Soil	No data	Waived[1]	no
161-4	Photodegradation in Air	No data	Waived[1]	no
162-1	Aerobic Soil Metabolism	No data	Waived[1]	no
162-2	Anaerobic Soil Metabolism	No data	Waived[1]	no
162-3	Anaerobic Aquatic Metabolism	No data	Waived[1]	no
162-4	Aerobic Aquatic Metabolism	No data	Waived[1]	no
163-1	Leaching-Adsorption/ Desorption	No data	Waived[1]	no
163-2	Laboratory Volatility	No data	Waived[1]	no
163-3	Field Volatility	No data	Waived[1]	no
164-1	Terrestrial Field Dissipation	No data	Waived[1]	no
164-2	Aquatic Field Dissipation	No data	Not required[2]	no
164-3	Forestry Dissipation	No data	Not required[2]	no
165-4	Accumulation in Fish	No data	Waived[1]	no

1. Data requirements were waived for carbon, sawdust, sodium nitrate and potassium nitrate based on the limited exposure that is expected to non-target organisms when used according to label specifications. These pesticides are applied in cartridges in sealed burrows. Carbon dioxide data requirements were also waived based on no exposure due to indoor only uses. Carbon, sawdust and carbon dioxide are considered inert ingredients without toxicological significance to non-target organisms in the environment.

2. Data are not required because carbon, sawdust, sodium nitrate, potassium nitrate and sulfur do not have aquatic uses; carbon dioxide only has indoor uses.

Table I-2. Ecological Effects Data Requirements for Carbon, Carbon Dioxide, Sawdust, Sodium Nitrate, Potassium Nitrate and Sulfur for Gas Cartridge and Indoor Fumigant Use					
Guideline #	**Data Requirement**	**Formulation**	**Are Additional Data Needed for Risk Assessment?**	**MRID or Acc. Number**	**Study Classification**
71-1	Avian Acute Oral Toxicity	NA	No	No data submitted	N/A
71-2	Avian Subacute Dietary Toxicity	NA	No	No data submitted	N/A
71-4	Avian Reproduction Toxicity	NA	No	No data submitted	N/A
72-1	Freshwater Fish LC_{50}	NA	No	No data submitted	N/A
72-2	Freshwater Invertebrate Acute LC_{50}	NA	No	No data submitted	N/A
72-3(a)	Estuarine/Marine Fish LC_{50}	NA	No	No data submitted	N/A
72-3(b)	Estuarine/Marine Invertebrate (Mollusk)	NA	No	No data submitted	N/A
72-3(c)	Estuarine/Marine Invertebrate (Mysid)	NA	No	No data submitted	N/A
72-3 (d)	Estuarine/Marine Crustacean	NA	No	No data submitted	N/A
72-4 (a)	Freshwater Fish Early Life-Stage	NA	No	No data submitted	N/A

Table I-2. Ecological Effects Data Requirements for Carbon, Carbon Dioxide, Sawdust, Sodium Nitrate, Potassium Nitrate and Sulfur for Gas Cartridge and Indoor Fumigant Use					
Guideline #	**Data Requirement**	**Formulation**	**Are Additional Data Needed for Risk Assessment?**	**MRID or Acc. Number**	**Study Classification**
72-4	Aquatic Invertebrate Life-Cycle (Freshwater) Chronic Toxicity	NA	No	No data submitted	N/A
72-4	Aquatic Invertebrate Life-Cycle (Marine) Chronic Toxicity	NA	No	No data submitted	N/A
72-5	Freshwater Fish Full Life-Cycle (marine)	NA	No	No data submitted	N/A
72-7	Aquatic Field Study	NA	No	No data submitted	N/A
141-1	Acute Honeybee Contact Toxicity Test	NA	No	No data submitted	N/A
141-2	Residues on Foliage Honeybee Toxicity Test	NA	No	No data submitted	N/A
141-4	Subacute Honeybee Feeding Toxicity Test	NA	No	No data submitted	N/A

NA=Not Available; N/A=Not Applicable