**Agricultural Pesticide Application (2461850000)**

***a. Source Category Description***

Pesticides are substances used to control nuisance species and can be classified by targeted pest group: weeds (herbicides), insects (insecticides), fungi (fungicides), and rodents (rodenticides). They can be further described by their chemical characteristics: synthetics, non-synthetics (petroleum products), and inorganics. Different pesticides are made through various combinations of the pest-killing material, also called the active ingredient (AI), and various solvents (which serve as carriers for the AI). Both types of ingredients contain volatile organic compounds (VOC) that may be emitted to the air during application or after application as a result of evaporation.1

Approximately 68 to 75 percent of pesticides used in the United States are applied to agricultural lands, both cropland and pasture. Agricultural pesticides continue to be a cost-effective means of controlling weeds, insects, and other threats to the quality and yield of food production. Since application rates for a particular pesticide may vary from region to region, the regional application rates should be considered when estimating potential VOC emissions.

For this source category, the following SCC was assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCC** | **SCC Level One** | **SCC Level Two** | **SCC Level Three** | **SCC Level Four** |
| 2461850000 | Solvent Utilization | Miscellaneous Non-industrial: Commercial | Pesticide Application: Agricultural | All Processes |

***b. Emissions Factors***

The VOC emission factor is derived for each active ingredient based on the pesticide profiles database maintained by the California Department of Pesticide Regulation2. The California Department of Pesticide Regulation’s (CA DPR) database contains the chemical formulation for pesticides registered in the State of California and provides key inputs for the development of VOC emissions factors. These key inputs include mass fraction of each active ingredient and the emission potential (EP) of registered pesticide products. The EP value represents the VOC content of the pesticide product and it is determined empirically through thermogravimetric analysis (TGA). Because the CA DPR database lists both agricultural and non-agricultural pesticide products, it was necessary to screen out entries that were likely formulated as a consumer product. Pesticide products that contained terms suggesting non-agricultural applications were excluded. Terms used to screen out likely consumer products are listed in Table 1.

**Table 1. Terms Used to Screen Out Consumer Products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ALGAE | DEODORIZING | GERM | MRSA | STAIN |
| ANT | DETERGENT | HAMSTER | ORNAMENTAL | SWIM |
| BATHROOM | DISHWASHER | HOME | POND | TICK |
| BEDBUG | DISINFECT | HORNET | POTTY | TURF |
| BEE | DOG | HORSE | PRESCRIPTION | WASP |
| CAT | DRAIN | HOUSE | RAT | WIPES |
| CATTLE | EQUINE | INDOOR | ROACH | YARD |
| CLEANER | FLEA | KLEEN | RODENTICIDE |  |
| DECK | FLY | LANDSCAPE | ROOF |  |
| DEGREASER | FOGGER | LAWN | SANI |  |
| DEODORIZER | GERBIL | MOUSE | SPA |  |

Each record in the DPR database is for a specific pesticide product, and provides product name, primary active ingredient, the mass percent of active ingredient, emission potential (EP), registration number, and method used to estimate the EP. The pesticide specific EP of reactive organic gases (i.e., the mass percentage of product that contributes to VOC emissions) and the mass percent of active ingredient were used to calculate pesticide-specific VOC emissions factors.

EFpesticide = 1/(AI%/100) × (EProg/100)

where: EFpesticide = pesticide-specific emissions factor (lb VOC / lb AI)

AI% = average mass percent of active ingredient in pesticide

EProg = emissions potential of reactive organic gases (expressed as % of pesticide mass)

For active ingredients not in the DPR database, a weighted average emission factor (EFavg) was calculated. This weighted average was estimated by weighting the emission factors from the DPR database using the total pounds of active ingredient reported in the USGS report “Preliminary Estimates of Annual Agricultural Pesticide Use for Counties of the Conterminous United States, 2013.”3 A crosswalk between compound name in the USGS database and the chemical name in the CA DPR database is provided in Table 2.

EFavg = Σpesticides(EFpesticide × AI/T)

where: EFavg = average emissions factor (lb VOC / lb AI)

EFpesticide = pesticide-specific emissions factor (lb VOC / lb AI)

AI = active ingredient applied (lb)

T = total mass of all active ingredients applied (lb)

This resulted in an EFavg value of 0.4 pounds of VOC per pound of active ingredient. The VOC emissions factors by active ingredient are shown in Table 3.

For the estimation of HAP emissions, a variation of the EIIP’s preferred method (9-4.1) based on vapor pressure of the active ingredient was implemented. The subset of HAPs was extracted from the list of active ingredients and is shown in Table 4 along with the HAP emissions factors. Note that these HAPs are also VOCs and are therefore included in the pesticide-specific VOC emissions factors calculated above.

The HAP emissions are based on the quantity of active ingredient applied and are estimated as follows:

EHAP = AI × EFHAP

where: EHAP = HAP emissions from pesticide active ingredient applications in pounds;

EFHAP = emission factor in pounds of emission per pound of active ingredient from EIIP Table 9.4-4 based on vapor pressure of HAP. If the EIIP method resulted in HAP emissions exceeding VOC emissions, then the emissions factor was set to the pesticide-specific VOC emissions factor calculated above for total VOC emissions.

***c. Activity***

The activity for pesticide application is the pounds of active ingredient applied per pesticide for the year 2013. These data are available from the USGS report “Preliminary Estimates of Annual Agricultural Pesticide Use for Counties of the Conterminous United States, 2013.”3, which gives county-level pesticide data in terms of kg of active ingredient applied. The report estimates preliminary annual county-level pesticide use for 387 herbicides, insecticides, and fungicides applied to agricul­tural crops grown in the conterminous United States during 2013. For all States except California, pesticide-use data are compiled from proprietary surveys of farm operations located within U.S. Department of Agriculture Crop Reporting Districts (CRDs). Surveyed pesticide-use data were used in conjunction with county annual harvested-crop acres reported by the U.S. Department of Agriculture 2012 Cen­suses of Agriculture and the 2013 County Agricultural Pro­duction Survey to calculate use rates per harvested-crop acre, or an “estimated pesticide use” (EPest) rate, for each crop by year. County-use estimates were then calculated by multiply­ing EPest rates by harvested-crop acres for each pesticide crop combination. Use estimates for California were obtained from annual Department of Pesticide Regulation-Pesticide Use Reports.

The USGS report calculates both EPest-low and EPest-high rates. The EPest-high rates were used here to estimate VOC emissions. Both methods incorporated surveyed and extrapolated rates to estimate pesticide use for counties, but EPest-low and EPest-high estimations differed in how they treated situations when a CRD was surveyed and pesticide use was not reported for a particular pesticide-by-crop combi­nation. If use of a pesticide on a crop was not reported in a surveyed CRD, EPest-low reports zero use in the CRD for that pesticide-by-crop combination. EPest-high, however, treats the unreported use for that pesticide-by-crop combination in the CRD as unsurveyed, and pesticide-by-crop use rates from neighboring CRDs and, in some cases, CRDs within the same Farm Resources Region are used to calculate the pesticide-by-crop EPest-high rate for the CRD.

Due to data limitations in the USGS report, active ingredient usages for Alaska and Hawaii were pulled forward from 2011.

***d. Controls***

No controls were accounted for in the emissions estimation.

***e. Emissions Equation and Sample Calculation***

Emissions were estimated by summing the product of the active ingredient applied and the emissions factor for each pesticide at the county-level:

Total VOC Emissionscounty = Σpesticide (AI × EF)

Taking Autauga County, Alabama as an example:

2,874.9 kg of active ingredient of 2,4-D was applied

2,874.9 kg × 2.20462 lb/kg = 6,338.1 lb active ingredient.

EF2,4-D = 0.8273 (lb VOC/lb AI)

Emissions are calculated by multiplying activity data by the emissions factor:

EmissionsAutauga,2,4-D = 6,338.1 lb AI × 0.8273 lb VOC/lb AI = 5,244 lb VOC

This process was then repeated for all pesticide compounds and summed to the county level, resulting in approximately 39,585 lb, or 19.8 tons, of VOC emitted due to agricultural pesticide application in Autauga County.

***f. Changes to Methodology***

In the 2011 inventory, data estimating harvested acres per crop in each county was multiplied by the percent of acres treated to yield the number of acres treated for each combination of crop and pesticide compound in a given county. This acreage was multiplied by an application rate of active ingredient applied per treated acre (calculated using Crop Life Foundation Database application rates and 2007 USDA Census of Agriculture harvest acres). The result was the pounds of active ingredient applied for each compound and crop type at the county level. The mass of active ingredient was then multiplied by an average emissions factor derived from the CA DPR pesticide database.

Since the Crop Life Foundation Database was discontinued in 2008, the 2014 inventory uses county-level active ingredient applied for all crop types from the USGS report for year 2013. The amount of active ingredient (kg) applied was available at the county level by pesticide compound, but not by crop. The mass of active ingredient was then multiplied by pesticide-specific emissions factors derived from the CA DPR 2015 pesticide database (rather than an average emissions factor). In addition, the 2014 methodology includes HAP emissions estimates for all counties, except those in Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands (due to data limitations).

***g. Puerto Rico and US Virgin Islands Emissions Calculations***

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: 12011, Broward County for Puerto Rico and 12087, Monroe County for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island county, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory’s activity data) which served as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are “EACH”.

***h. References***

1. United States Environmental Protection Agency, “*Pesticides - Agricultural and Nonagricultural*”, Vol. 3, Ch. 9, Section 5.1, p. 9.5-4, Emissions Inventory Improvement Program, June 2001.

2. California Department of Pesticide Regulation, “CDPR\_Emission\_Potential\_Database\_10\_2015.xlsx”, provided by Pam Wofford, Environmental Program Manager, CA DPR to Jonathan Dorn, Associate, Abt Associates (January 2016).

3. United States Geological Survey, “Preliminary *Estimates of Annual Agricultural Pesticide Use for Counties of the Conterminous United States, 2013*”, https://pubs.er.usgs.gov/publication/ofr20151176 (accessed July 2016).

**Table 2. Crosswalk between USGS Compound Name and CA DPR Chemical Name**

| **USGS\_Compound\_Name** | **CA\_DPR\_chemname** |
| --- | --- |
| 2,4-D | 2,4-D |
| 2,4-DB | 2,4-DB ACID |
| 6-BENZYLADENINE | AVERAGE |
| ABAMECTIN | ABAMECTIN |
| ACEPHATE | ACEPHATE |
| ACEQUINOCYL | ACEQUINOCYL |
| ACETAMIPRID | ACETAMIPRID |
| ACETOCHLOR | AVERAGE |
| ACIBENZOLAR | ACIBENZOLAR-S-METHYL |
| ACIFLUORFEN | ACIFLUORFEN, SODIUM SALT |
| ALACHLOR | ALACHLOR |
| ALDICARB | ALDICARB |
| ALUMINUM PHOSPHIDE | ALUMINUM PHOSPHIDE |
| AMECTOCTRADIN | AMETOCTRADIN |
| AMETRYN | AMETRYNE |
| AMINOPYRALID | AMINOPYRALID, TRIISOPROPANOLAMINE SALT |
| ASULAM | ASULAM, SODIUM SALT |
| ATRAZINE | ATRAZINE |
| AVIGLYCINE | AVERAGE |
| AZADIRACHTIN | AZADIRACHTIN |
| AZINPHOS-METHYL | AZINPHOS-METHYL |
| AZOXYSTROBIN | AZOXYSTROBIN |
| BACILLUS AMYLOLIQUIFACIEN | BACILLUS AMYLOLIQUEFACIENS STRAIN D747 |
| BACILLUS CEREUS | BACILLUS CEREUS, STRAIN BP01 |
| BACILLUS FIRMUS | BACILLUS FIRMUS (STRAIN I-1582) |
| BACILLUS PUMILIS | BACILLUS PUMILUS GHA 180 |
| BACILLUS SUBTILIS | BACILLUS SUBTILIS GB03 |
| BACILLUS THURINGIENSIS | BACILLUS THURINGIENSIS (BERLINER) |
| BENFLURALIN | AVERAGE |
| BENOMYL | BENOMYL |
| BENSULFURON | BENSULFURON METHYL |
| BENSULIDE | BENSULIDE |
| BENTAZONE | BENTAZON, SODIUM SALT |
| BIFENAZATE | BIFENAZATE |
| BIFENTHRIN | BIFENTHRIN |
| BISPYRIBAC | BISPYRIBAC-SODIUM |
| BOSCALID | BOSCALID |
| BROMACIL | BROMACIL |
| BROMOXYNIL | BROMOXYNIL BUTYRATE |
| BUPROFEZIN | BUPROFEZIN |
| BUTRALIN | AVERAGE |
| CALCIUM POLYSULFIDE | AVERAGE |
| CAPTAN | CAPTAN |
| CARBARYL | CARBARYL |
| CARBOPHENOTHION | CARBOPHENOTHION |
| CARBOXIN | CARBOXIN |
| CARFENTRAZONE-ETHYL | CARFENTRAZONE-ETHYL |
| CHINOMETHIONAT | AVERAGE |
| CHLORANTRANILIPROLE | CHLORANTRANILIPROLE |
| CHLORETHOXYFOS | AVERAGE |
| CHLORFENAPYR | CHLORFENAPYR |
| CHLORIMURON | AVERAGE |
| CHLORMEQUAT | CHLORMEQUAT CHLORIDE |
| CHLORONEB | CHLORONEB |
| CHLOROPICRIN | CHLOROPICRIN |
| CHLOROPICRIN | CHLOROPICRIN |
| CHLOROPICRIN | CHLOROPICRIN |
| CHLOROPICRIN | CHLOROPICRIN |
| CHLOROPICRIN | CHLOROPICRIN |
| CHLOROTHALONIL | CHLOROTHALONIL |
| CHLORPROPHAM | CHLORPROPHAM |
| CHLORPYRIFOS | CHLORPYRIFOS |
| CHLORSULFURON | CHLORSULFURON |
| CLETHODIM | CLETHODIM |
| CLODINAFOP | AVERAGE |
| CLOFENTEZINE | CLOFENTEZINE |
| CLOMAZONE | CLOMAZONE |
| CLOPYRALID | CLOPYRALID |
| CLORANSULAM-METHYL | AVERAGE |
| CLOTHIANIDIN | CLOTHIANIDIN |
| CONIOTHYRIUM MINITANS | CONIOTHYRIUM MINITANS STRAIN CON/M/91-08 |
| COPPER | COPPER |
| COPPER HYDROXIDE | COPPER HYDROXIDE |
| COPPER OCTANOATE | COPPER OCTANOATE |
| COPPER OXYCHLORIDE | COPPER OXYCHLORIDE |
| COPPER OXYCHLORIDE S | COPPER OXYCHLORIDE SULFATE |
| COPPER SULF TRIBASIC | COPPER SULFATE (BASIC) |
| COPPER SULFATE | COPPER SULFATE (PENTAHYDRATE) |
| CPPU | AVERAGE |
| CRYOLITE | CRYOLITE |
| CUPROUS OXIDE | COPPER OXIDE (OUS) |
| CYANAMIDE | AVERAGE |
| CYAZOFAMID | CYAZOFAMID |
| CYCLANILIDE | CYCLANILIDE |
| CYCLOATE | CYCLOATE |
| CYDIA POMONELLA | AVERAGE |
| CYFLUFENAMID | CYFLUFENAMID |
| CYFLUTHRIN | CYFLUTHRIN |
| CYHALOFOP | CYHALOFOP-BUTYL |
| CYHALOTHRIN-GAMMA | AVERAGE |
| CYHALOTHRIN-LAMBDA | AVERAGE |
| CYMOXANIL | CYMOXANIL |
| CYPERMETHRIN | CYPERMETHRIN |
| CYPROCONAZOLE | AVERAGE |
| CYPRODINIL | CYPRODINIL |
| CYROMAZINE | CYROMAZINE |
| CYTOKININ | CYTOKININ |
| DAMINOZIDE | DAMINOZIDE |
| DAZOMET | DAZOMET |
| DCPA | AVERAGE |
| DECAN-1-OL | AVERAGE |
| DELTAMETHRIN | DELTAMETHRIN |
| DESMEDIPHAM | DESMEDIPHAM |
| DIAZINON | DIAZINON |
| DICAMBA | DICAMBA |
| DICHLOBENIL | DICHLOBENIL |
| DICHLOROPROPENE | AVERAGE |
| DICHLORPROP | DICHLORPROP, BUTOXYETHANOL ESTER |
| DICLOFOP | DICLOFOP-METHYL |
| DICLORAN | DICLORAN |
| DICLOSULAM | AVERAGE |
| DICOFOL | DICOFOL |
| DICROTOPHOS | DICROTOPHOS |
| DIENOCHLOR | DIENOCHLOR |
| DIETHATYL | DIETHATYL-ETHYL |
| DIFENOCONAZOLE | DIFENOCONAZOLE |
| DIFLUBENZURON | DIFLUBENZURON |
| DIFLUFENZOPYR | DIFLUBENZURON |
| DIMETHENAMID | DIMETHENAMID-P |
| DIMETHENAMID-P | DIMETHENAMID-P |
| DIMETHIPIN | DIMETHIPIN |
| DIMETHOATE | DIMETHOATE |
| DIMETHOMORPH | DIMETHOMORPH |
| DIMETHYL DISULFIDE | AVERAGE |
| DINOSEB | DINOSEB |
| DINOTEFURAN | DINOTEFURAN |
| DIQUAT | DIQUAT DIBROMIDE |
| DISULFOTON | DISULFOTON |
| DITHIOPYR | DITHIOPYR |
| DIURON | DIURON |
| DODINE | DODINE |
| EMAMECTIN | EMAMECTIN BENZOATE |
| ENDOSULFAN | ENDOSULFAN |
| ENDOTHAL | ENDOTHALL, DISODIUM SALT |
| EPTC | EPTC |
| ESFENVALERATE | ESFENVALERATE |
| ETHALFLURALIN | ETHALFLURALIN |
| ETHEPHON | ETHEPHON |
| ETHION | ETHION |
| ETHOFUMESATE | ETHOFUMESATE |
| ETHOPROPHOS | ETHOPROP |
| ETOXAZOLE | ETOXAZOLE |
| ETRIDIAZOLE | AVERAGE |
| FAMOXADONE | AVERAGE |
| FATTY ALCOHOLS | AVERAGE |
| FENAMIDONE | FENAMIDONE |
| FENAMIPHOS | FENAMIPHOS |
| FENARIMOL | FENARIMOL |
| FENBUCONAZOLE | FENBUCONAZOLE |
| FENBUTATIN OXIDE | FENBUTATIN-OXIDE |
| FENHEXAMID | FENHEXAMID |
| FENOXAPROP | FENOXAPROP-ETHYL |
| FENOXYCARB | FENOXYCARB |
| FENPROPATHRIN | FENPROPATHRIN |
| FENPYROXIMATE | FENPYROXIMATE |
| FENTIN | FENTIN HYDROXIDE |
| FERBAM | FERBAM |
| FIPRONIL | FIPRONIL |
| FLAZASULFURON | FLAZASULFURON |
| FLONICAMID | FLONICAMID |
| FLORASULAM | FLORASULAM |
| FLUAZIFOP | FLUAZIFOP-BUTYL |
| FLUAZINAM | FLUAZINAM |
| FLUBENDIAMIDE | FLUBENDIAMIDE |
| FLUCARBAZONE | AVERAGE |
| FLUDIOXONIL | FLUDIOXONIL |
| FLUFENACET | AVERAGE |
| FLUMETRALIN | FLUOMETURON |
| FLUMETSULAM | AVERAGE |
| FLUMICLORAC | FLUMICLORAC-PENTYL |
| FLUMIOXAZIN | FLUMIOXAZIN |
| FLUOMETURON | FLUOMETURON |
| FLUOPICOLIDE | FLUOPICOLIDE |
| FLUOPYRAM | FLUOPYRAM |
| FLUOXASTROBIN | FLUOXASTROBIN |
| FLURIDONE | FLURIDONE |
| FLUROXYPYR | FLUROXYPYR |
| FLUTHIACET-METHYL | AVERAGE |
| FLUTOLANIL | FLUTOLANIL |
| FLUTRIAFOL | FLUTRIAFOL |
| FLUVALINATE-TAU | AVERAGE |
| FLUXAPYROXAD | FLUXAPYROXAD |
| FOMESAFEN | AVERAGE |
| FORAMSULFURON | FORAMSULFURON |
| FORMETANATE | FORMETANATE HYDROCHLORIDE |
| FOSETYL | FOSETYL-AL |
| GALLEX | META-CRESOL |
| GAMMA AMINOBUTYRIC ACID | AVERAGE |
| GIBBERELLIC ACID | GIBBERELLINS |
| GLUFOSINATE | GLUFOSINATE-AMMONIUM |
| GLYPHOSATE | GLYPHOSATE |
| HALOSULFURON | HALOSULFURON-METHYL |
| HARPIN PROTEIN | HARPIN PROTEIN |
| HEXAZINONE | HEXAZINONE |
| HEXYTHIAZOX | HEXYTHIAZOX |
| HYDRAMETHYLNON | HYDRAMETHYLNON |
| HYDRATED LIME | CALCIUM HYDROXIDE |
| HYDROGEN PEROXIDE | HYDROGEN PEROXIDE |
| HYMEXAZOL | AVERAGE |
| IBA | IBA |
| IMAZALIL | IMAZALIL |
| IMAZAMETHABENZ | IMAZAMETHABENZ |
| IMAZAMOX | IMAZAMOX |
| IMAZAPIC | IMAZAPIC |
| IMAZAPYR | IMAZAPYR |
| IMAZAQUIN | AVERAGE |
| IMAZETHAPYR | IMAZETHAPYR |
| IMAZOSULFURON | IMAZOSULFURON |
| IMIDACLOPRID | IMIDACLOPRID |
| INDAZIFLAM | INDAZIFLAM |
| INDOXACARB | INDOXACARB |
| IODOSULFURON | AVERAGE |
| IPCONAZOLE | IPCONAZOLE |
| IPRODIONE | IPRODIONE |
| ISOXABEN | ISOXABEN |
| ISOXAFLUTOLE | AVERAGE |
| KAOLIN CLAY | KAOLIN |
| KINOPRENE | KINOPRENE |
| KRESOXIM-METHYL | KRESOXIM-METHYL |
| LACTOFEN | AVERAGE |
| L-GLUTAMIC ACID | GLUTAMIC ACID |
| LINURON | LINURON |
| MALATHION | MALATHION |
| MALEIC HYDRAZIDE | MALEIC HYDRAZIDE |
| MANCOZEB | MANCOZEB |
| MANDIPROPAMID | MANDIPROPAMID |
| MANEB | MANEB |
| MCPA | MCPA |
| MCPB | MCPB, SODIUM SALT |
| MECOPROP | MECOPROP-P |
| MEFENOXAM | MEFENOXAM |
| MEPIQUAT | MEPIQUAT CHLORIDE |
| MESOSULFURON | MESOSULFURON-METHYL |
| MESOTRIONE | MESOTRIONE |
| METALAXYL | METALAXYL |
| METALDEHYDE | METALDEHYDE |
| METAM | METAM-SODIUM |
| METAM POTASSIUM | METAM-SODIUM |
| METCONAZOLE | METCONAZOLE |
| METHAMIDOPHOS | METHAMIDOPHOS |
| METHIDATHION | METHIDATHION |
| METHIOCARB | METHIOCARB |
| METHOMYL | METHOMYL |
| METHOXYFENOZIDE | METHOXYFENOZIDE |
| METHYL BROMIDE | METHYL BROMIDE |
| METHYL BROMIDE | METHYL BROMIDE |
| METHYL IODIDE | METHYL IODIDE |
| METHYL PARATHION | METHYL PARATHION |
| METIRAM | METIRAM |
| METOLACHLOR | METOLACHLOR |
| METOLACHLOR-S | METOLACHLOR |
| METRAFENONE | METRAFENONE |
| METRIBUZIN | METRIBUZIN |
| METSULFURON | METSULFURON-METHYL |
| MEVINPHOS | MEVINPHOS |
| MSMA | MSMA |
| MYCLOBUTANIL | MYCLOBUTANIL |
| MYROTHECIUM VERRUCARIA | MYROTHECIUM VERRUCARIA, DRIED FERMENTATION SOLIDS |
| NALED | NALED |
| NAPHTHYLACETAMIDE | AVERAGE |
| NAPHTHYLACETIC ACID | AVERAGE |
| NAPROPAMIDE | NAPROPAMIDE |
| NAPTALAM | NAPTALAM, SODIUM SALT |
| NEEM OIL | AVERAGE |
| NICOSULFURON | NICOSULFURON |
| NORFLURAZON | NORFLURAZON |
| NOSEMA LOCUSTAE CANN | NOSEMA LOCUSTAE SPORES |
| NOVALURON | NOVALURON |
| ORTHOSULFAMURON | ORTHOSULFAMURON |
| ORYZALIN | ORYZALIN |
| OXADIAZON | OXADIAZON |
| OXAMYL | OXAMYL |
| OXYDEMETON-METHYL | OXYDEMETON-METHYL |
| OXYFLUORFEN | OXYFLUORFEN |
| OXYTETRACYCLINE | OXYTETRACYCLINE HYDROCHLORIDE |
| PACLOBUTRAZOL | PACLOBUTRAZOL |
| PARAQUAT | PARAQUAT DICHLORIDE |
| PARATHION | PARATHION |
| PELARGONIC ACID | AVERAGE |
| PENDIMETHALIN | PENDIMETHALIN |
| PENOXSULAM | PENOXSULAM |
| PENTHIOPYRAD | PENTHIOPYRAD |
| PERMETHRIN | PERMETHRIN |
| PETROLEUM DISTILLATE | PETROLEUM DISTILLATES |
| PETROLEUM OIL | PETROLEUM NAPHTHENIC OILS |
| PHENMEDIPHAM | PHENMEDIPHAM |
| PHORATE | PHORATE |
| PHOSMET | PHOSMET |
| PHOSPHORIC ACID | PHOSPHORIC ACID |
| PICLORAM | PICLORAM |
| PINOXADEN | PINOXADEN |
| PIPERONYL BUTOXIDE | PIPERONYL BUTOXIDE |
| POLYHEDROSIS VIRUS | POLYHEDRAL OCCLUSION BODIES (OB'S) OF THE NUCLEAR |
| POLYOXORIM | AVERAGE |
| POTASSIUM BICARBONATE | POTASSIUM BICARBONATE |
| POTASSIUM OLEATE | AVERAGE |
| PRIMISULFURON | AVERAGE |
| PRODIAMINE | PRODIAMINE |
| PROFENOFOS | PROFENOFOS |
| PROHEXADIONE | PROHEXADIONE CALCIUM |
| PROMETRYN | PROMETRYN |
| PROPAMOCARB HCL | PROPAMOCARB HYDROCHLORIDE |
| PROPANIL | PROPANIL |
| PROPARGITE | PROPARGITE |
| PROPAZINE | PROPAZINE |
| PROPICONAZOLE | PROPICONAZOLE |
| PROPOXYCARBAZONE | AVERAGE |
| PROPYZAMIDE | PROPYZAMIDE |
| PROSULFURON | AVERAGE |
| PROTHIOCONAZOLE | PROTHIOCONAZOLE |
| PSEUDOMONAS FLUORESCENS | PSEUDOMONAS FLUORESCENS, STRAIN A506 |
| PYMETROZINE | PYMETROZINE |
| PYRACLOSTROBIN | PYRACLOSTROBIN |
| PYRAFLUFEN ETHYL | PYRAFLUFEN-ETHYL |
| PYRASULFOTOLE | AVERAGE |
| PYRETHRINS | PYRETHRINS |
| PYRIDABEN | PYRIDABEN |
| PYRIMETHANIL | PYRIMETHANIL |
| PYRIPROXYFEN | PYRIPROXYFEN |
| PYRITHIOBAC-SODIUM | PYRITHIOBAC-SODIUM |
| PYROXASULFONE | AVERAGE |
| PYROXSULAM | PYROXSULAM |
| QUINCLORAC | QUINCLORAC |
| QUINOXYFEN | QUINOXYFEN |
| QUINTOZENE | AVERAGE |
| QUIZALOFOP | QUIZALOFOP-ETHYL |
| RIMSULFURON | RIMSULFURON |
| ROTENONE | ROTENONE |
| SABADILLA | SABADILLA ALKALOIDS |
| SAFLUFENACIL | SAFLUFENACIL |
| SETHOXYDIM | SETHOXYDIM |
| SILICATES | SILICA AEROGEL |
| SIMAZINE | SIMAZINE |
| SODIUM CHLORATE | SODIUM CHLORATE |
| SODIUM CHLORATE | SODIUM CHLORATE |
| SPINETORAM | SPINETORAM |
| SPINOSYN | SPINOSAD |
| SPIRODICLOFEN | SPIRODICLOFEN |
| SPIROMESIFEN | SPIROMESIFEN |
| SPIROTETRAMAT | SPIROTETRAMAT |
| STREPTOMYCIN | STREPTOMYCIN |
| SULFCARBAMIDE | AVERAGE |
| SULFENTRAZONE | SULFENTRAZONE |
| SULFOMETURON | SULFOMETURON-METHYL |
| SULFOSATE | AVERAGE |
| SULFOSULFURON | SULFOSULFURON |
| SULFOXAFLOR | SULFOXAFLOR |
| SULFUR | SULFUR |
| SULFURIC ACID | SULFURIC ACID |
| TCMTB | TCMTB |
| TEBUCONAZOLE | TEBUCONAZOLE |
| TEBUFENOZIDE | TEBUFENOZIDE |
| TEBUPIRIMPHOS | AVERAGE |
| TEBUTHIURON | TEBUTHIURON |
| TEFLUTHRIN | AVERAGE |
| TEMBOTRIONE | TEMBOTRIONE |
| TERBACIL | TERBACIL |
| TERBUFOS | AVERAGE |
| TETRABOROHYDRATE | AVERAGE |
| TETRACONAZOLE | TETRACONAZOLE |
| TETRATHIOCARBONATE | AVERAGE |
| THIABENDAZOLE | THIABENDAZOLE |
| THIACLOPRID | THIACLOPRID |
| THIAMETHOXAM | THIAMETHOXAM |
| THIAZOPYR | THIAZOPYR |
| THIDIAZURON | THIDIAZURON |
| THIENCARBAZONE-METHYL | AVERAGE |
| THIFENSULFURON | THIFENSULFURON-METHYL |
| THIOBENCARB | THIOBENCARB |
| THIODICARB | THIODICARB |
| THIOPHANATE-METHYL | THIOPHANATE-METHYL |
| THIRAM | THIRAM |
| TOPRAMEZONE | AVERAGE |
| TRALKOXYDIM | TRALKOXYDIM |
| TRIADIMEFON | TRIADIMEFON |
| TRIADIMENOL | TRIADIMENOL |
| TRI-ALLATE | TRIALLATE |
| TRIASULFURON | AVERAGE |
| TRIBENURON METHYL | TRIBENURON-METHYL |
| TRIBUFOS | AVERAGE |
| TRICLOPYR | TRICLOPYR, BUTOXYETHYL ESTER |
| TRIFLOXYSTROBIN | TRIFLOXYSTROBIN |
| TRIFLOXYSULFURON | TRIFLOXYSULFURON-SODIUM |
| TRIFLUMIZOLE | TRIFLUMIZOLE |
| TRIFLURALIN | TRIFLURALIN |
| TRIFLUSULFURON | AVERAGE |
| TRINEXAPAC | TRINEXAPAC-ETHYL |
| TRITICONAZOLE | TRITICONAZOLE |
| UNICONAZOLE | UNICONIZOLE-P |
| VINCLOZOLIN | VINCLOZOLIN |
| ZETA-CYPERMETHRIN | AVERAGE |
| ZINC | ZINC CHLORIDE |
| ZINEB | ZINEB |
| ZIRAM | ZIRAM |
| ZOXAMIDE | AVERAGE |

Note: AVERAGE indicates the use of an average emissions factor since the pesticide active ingredient is not in the CA DPR database.

**Table 3. VOC Emissions Factors**

| **PESTICIDE** | **Avg\_VOC\_per\_LB\_AI (lb)** |
| --- | --- |
| 2,4-D | 0.827 |
| 2,4-DB ACID | 0.067 |
| ABAMECTIN | 15.236 |
| ACEPHATE | 0.275 |
| ACEQUINOCYL | 0.135 |
| ACETAMIPRID | 0.207 |
| ACIBENZOLAR-S-METHYL | 0.063 |
| ACIFLUORFEN, SODIUM SALT | 1.887 |
| ALACHLOR | 0.513 |
| ALDICARB | 0.064 |
| ALUMINUM PHOSPHIDE | 0.055 |
| AMETOCTRADIN | 0.041 |
| AMETRYNE | 0.024 |
| AMINOPYRALID, TRIISOPROPANOLAMINE SALT | 0.160 |
| ASULAM, SODIUM SALT | 0.202 |
| ATRAZINE | 0.148 |
| AZADIRACHTIN | 10.092 |
| AZINPHOS-METHYL | 0.464 |
| AZOXYSTROBIN | 0.344 |
| BACILLUS AMYLOLIQUEFACIENS STRAIN D747 | 0.076 |
| BACILLUS CEREUS, STRAIN BP01 | 0.106 |
| BACILLUS FIRMUS (STRAIN I-1582) | 0.052 |
| BACILLUS PUMILUS GHA 180 | 2,050.000 |
| BACILLUS SUBTILIS GB03 | 190.333 |
| BACILLUS THURINGIENSIS (BERLINER) | 0.487 |
| BENOMYL | 0.074 |
| BENSULFURON METHYL | 0.031 |
| BENSULIDE | 0.553 |
| BENTAZON, SODIUM SALT | 0.053 |
| BIFENAZATE | 0.084 |
| BIFENTHRIN | 1.566 |
| BISPYRIBAC-SODIUM | 0.038 |
| BOSCALID | 0.229 |
| BROMACIL | 0.850 |
| BUPROFEZIN | 0.164 |
| CALCIUM HYDROXIDE | 0.003 |
| CAPTAN | 0.144 |
| CARBARYL | 0.321 |
| CARBOPHENOTHION | 0.446 |
| CARBOXIN | 0.437 |
| CARFENTRAZONE-ETHYL | 0.653 |
| CHLORANTRANILIPROLE | 0.364 |
| CHLORFENAPYR | 0.137 |
| CHLORMEQUAT CHLORIDE | 0.586 |
| CHLORONEB | 0.074 |
| CHLOROPICRIN | 1.272 |
| CHLOROTHALONIL | 0.113 |
| CHLORPROPHAM | 0.325 |
| CHLORPYRIFOS | 1.538 |
| CHLORSULFURON | 0.028 |
| CLETHODIM | 1.840 |
| CLOFENTEZINE | 0.147 |
| CLOMAZONE | 0.149 |
| CLOPYRALID | 0.050 |
| CLOTHIANIDIN | 0.153 |
| CONIOTHYRIUM MINITANS STRAIN CON/M/91-08 | 0.698 |
| COPPER | 0.218 |
| COPPER HYDROXIDE | 0.060 |
| COPPER OCTANOATE | 2.198 |
| COPPER OXIDE (OUS) | 0.029 |
| COPPER OXYCHLORIDE | 0.023 |
| COPPER OXYCHLORIDE SULFATE | 0.026 |
| COPPER SULFATE (BASIC) | 0.048 |
| COPPER SULFATE (PENTAHYDRATE) | 0.062 |
| CRYOLITE | 0.025 |
| CYAZOFAMID | 0.166 |
| CYCLANILIDE | 2.468 |
| CYCLOATE | 0.507 |
| CYFLUFENAMID | 0.175 |
| CYFLUTHRIN | 1.736 |
| CYHALOFOP-BUTYL | 0.452 |
| CYMOXANIL | 0.044 |
| CYPERMETHRIN | 1.521 |
| CYPRODINIL | 0.049 |
| CYROMAZINE | 0.228 |
| CYTOKININ | 0.254 |
| DAMINOZIDE | 0.045 |
| DAZOMET | 1.000 |
| DELTAMETHRIN | 3.949 |
| DESMEDIPHAM | 3.668 |
| DIAZINON | 0.760 |
| DICAMBA | 0.084 |
| DICHLOBENIL | 0.434 |
| DICLOFOP-METHYL | 1.042 |
| DICLORAN | 0.087 |
| DICOFOL | 0.424 |
| DICROTOPHOS | 0.258 |
| DIENOCHLOR | 0.182 |
| DIFENOCONAZOLE | 1.120 |
| DIFLUBENZURON | 0.159 |
| DIMETHENAMID-P | 0.135 |
| DIMETHIPIN | 0.367 |
| DIMETHOATE | 0.830 |
| DIMETHOMORPH | 0.038 |
| DINOSEB | 0.455 |
| DINOTEFURAN | 0.191 |
| DIQUAT DIBROMIDE | 1.456 |
| DISULFOTON | 1.186 |
| DITHIOPYR | 0.955 |
| DIURON | 0.072 |
| DODINE | 0.049 |
| EMAMECTIN BENZOATE | 3.055 |
| ENDOSULFAN | 0.492 |
| EPTC | 0.517 |
| ESFENVALERATE | 8.919 |
| ETHALFLURALIN | 1.554 |
| ETHEPHON | 0.302 |
| ETHION | 0.397 |
| ETHOFUMESATE | 0.691 |
| ETHOPROP | 0.416 |
| ETOXAZOLE | 0.059 |
| FENAMIDONE | 0.101 |
| FENAMIPHOS | 1.043 |
| FENARIMOL | 1.404 |
| FENBUCONAZOLE | 0.049 |
| FENBUTATIN-OXIDE | 0.058 |
| FENHEXAMID | 0.037 |
| FENOXAPROP-ETHYL | 3.132 |
| FENOXYCARB | 0.655 |
| FENPROPATHRIN | 1.469 |
| FENPYROXIMATE | 8.721 |
| FENTIN HYDROXIDE | 0.039 |
| FERBAM | 0.045 |
| FIPRONIL | 6.463 |
| FLAZASULFURON | 0.148 |
| FLONICAMID | 0.060 |
| FLORASULAM | 0.052 |
| FLUAZIFOP-BUTYL | 1.464 |
| FLUAZINAM | 0.406 |
| FLUBENDIAMIDE | 0.102 |
| FLUDIOXONIL | 0.308 |
| FLUMICLORAC-PENTYL | 0.565 |
| FLUMIOXAZIN | 0.075 |
| FLUOMETURON | 0.046 |
| FLUOPICOLIDE | 0.136 |
| FLUOPYRAM | 0.291 |
| FLUOXASTROBIN | 0.172 |
| FLURIDONE | 0.629 |
| FLUROXYPYR | 0.279 |
| FLUTOLANIL | 0.031 |
| FLUTRIAFOL | 0.331 |
| FLUXAPYROXAD | 0.020 |
| FORAMSULFURON | 0.252 |
| FORMETANATE HYDROCHLORIDE | 0.011 |
| FOSETYL-AL | 0.049 |
| GIBBERELLINS | 2.819 |
| GLUFOSINATE-AMMONIUM | 0.442 |
| GLUTAMIC ACID | 0.063 |
| GLYPHOSATE | 0.159 |
| HALOSULFURON-METHYL | 0.032 |
| HARPIN PROTEIN | 1.233 |
| HEXAZINONE | 0.142 |
| HEXYTHIAZOX | 0.423 |
| HYDRAMETHYLNON | 0.614 |
| HYDROGEN PEROXIDE | 0.356 |
| IBA | 0.559 |
| IMAZALIL | 0.794 |
| IMAZAMETHABENZ | 0.504 |
| IMAZAMOX | 0.016 |
| IMAZAPIC | 0.016 |
| IMAZAPYR | 0.025 |
| IMAZETHAPYR | 0.019 |
| IMAZOSULFURON | 0.049 |
| IMIDACLOPRID | 0.305 |
| INDAZIFLAM | 0.416 |
| INDOXACARB | 0.453 |
| IPCONAZOLE | 0.122 |
| IPRODIONE | 0.203 |
| ISOXABEN | 0.103 |
| KAOLIN | 0.015 |
| KINOPRENE | 0.466 |
| KRESOXIM-METHYL | 0.034 |
| LINURON | 0.077 |
| MALATHION | 0.409 |
| MALEIC HYDRAZIDE | 0.015 |
| MANCOZEB | 0.047 |
| MANDIPROPAMID | 0.209 |
| MANEB | 0.071 |
| MCPA | 0.470 |
| MCPB, SODIUM SALT | 1.206 |
| MECOPROP-P | 0.622 |
| MEFENOXAM | 0.587 |
| MEPIQUAT CHLORIDE | 0.661 |
| MESOSULFURON-METHYL | 0.822 |
| MESOTRIONE | 0.236 |
| META-CRESOL | 73.605 |
| METALAXYL | 0.506 |
| METALDEHYDE | 0.691 |
| METAM-SODIUM | 0.566 |
| METCONAZOLE | 0.369 |
| METHAMIDOPHOS | 0.710 |
| METHIDATHION | 1.068 |
| METHIOCARB | 0.220 |
| METHOMYL | 0.115 |
| METHOXYFENOZIDE | 0.223 |
| METHYL BROMIDE | 1.159 |
| METHYL IODIDE | 1.212 |
| METHYL PARATHION | 0.502 |
| METIRAM | 0.110 |
| METOLACHLOR | 0.198 |
| METRAFENONE | 0.074 |
| METRIBUZIN | 0.087 |
| METSULFURON-METHYL | 0.037 |
| MEVINPHOS | 0.534 |
| MSMA | 0.315 |
| MYCLOBUTANIL | 0.451 |
| MYROTHECIUM VERRUCARIA, DRIED FERMENTATION SOLIDS | 0.127 |
| NALED | 0.494 |
| NAPROPAMIDE | 0.385 |
| NAPTALAM, SODIUM SALT | 0.588 |
| NICOSULFURON | 0.037 |
| NORFLURAZON | 0.031 |
| NOSEMA LOCUSTAE SPORES | 7.085 |
| NOVALURON | 2.273 |
| ORTHOSULFAMURON | 0.097 |
| ORYZALIN | 0.212 |
| OXADIAZON | 0.182 |
| OXAMYL | 0.721 |
| OXYDEMETON-METHYL | 0.928 |
| OXYFLUORFEN | 1.012 |
| OXYTETRACYCLINE HYDROCHLORIDE | 0.199 |
| PACLOBUTRAZOL | 0.983 |
| PARAQUAT DICHLORIDE | 0.311 |
| PARATHION | 0.357 |
| PENDIMETHALIN | 0.559 |
| PENOXSULAM | 0.208 |
| PENTHIOPYRAD | 0.054 |
| PERMETHRIN | 3.345 |
| PETROLEUM DISTILLATES | 1.142 |
| PETROLEUM NAPHTHENIC OILS | 0.884 |
| PHENMEDIPHAM | 3.129 |
| PHORATE | 0.448 |
| PHOSMET | 1.162 |
| PHOSPHORIC ACID | 0.434 |
| PICLORAM | 0.398 |
| PINOXADEN | 10.388 |
| PIPERONYL BUTOXIDE | 4.504 |
| POLYHEDRAL OCCLUSION BODIES (OB'S) OF THE NUCLEAR | 8.922 |
| POTASSIUM BICARBONATE | 0.027 |
| PRODIAMINE | 0.126 |
| PROFENOFOS | 0.367 |
| PROMETRYN | 0.184 |
| PROPAMOCARB HYDROCHLORIDE | 0.180 |
| PROPANIL | 0.099 |
| PROPARGITE | 0.196 |
| PROPAZINE | 0.200 |
| PROPICONAZOLE | 1.052 |
| PROPYZAMIDE | 0.055 |
| PROTHIOCONAZOLE | 0.139 |
| PSEUDOMONAS FLUORESCENS, STRAIN A506 | 0.022 |
| PYMETROZINE | 0.020 |
| PYRACLOSTROBIN | 0.549 |
| PYRAFLUFEN-ETHYL | 5.343 |
| PYRETHRINS | 6.737 |
| PYRIDABEN | 0.019 |
| PYRIMETHANIL | 0.188 |
| PYRIPROXYFEN | 1.387 |
| PYRITHIOBAC-SODIUM | 0.193 |
| PYROXSULAM | 0.135 |
| QUINCLORAC | 0.121 |
| QUINOXYFEN | 0.060 |
| QUIZALOFOP-ETHYL | 4.121 |
| RIMSULFURON | 0.070 |
| ROTENONE | 0.808 |
| SABADILLA ALKALOIDS | 2.018 |
| SAFLUFENACIL | 0.015 |
| SETHOXYDIM | 3.751 |
| SILICA AEROGEL | 0.381 |
| SIMAZINE | 0.089 |
| SODIUM CHLORATE | 0.025 |
| SPINETORAM | 0.138 |
| SPINOSAD | 0.483 |
| SPIRODICLOFEN | 0.229 |
| SPIROMESIFEN | 0.119 |
| SPIROTETRAMAT | 0.101 |
| STREPTOMYCIN | 0.133 |
| SULFENTRAZONE | 0.128 |
| SULFOMETURON-METHYL | 0.076 |
| SULFOSULFURON | 0.027 |
| SULFOXAFLOR | 0.060 |
| SULFUR | 0.013 |
| SULFURIC ACID | 0.088 |
| TCMTB | 0.995 |
| TEBUCONAZOLE | 0.178 |
| TEBUFENOZIDE | 0.163 |
| TEBUTHIURON | 0.075 |
| TEMBOTRIONE | 0.096 |
| TERBACIL | 0.023 |
| TETRACONAZOLE | 0.492 |
| THIABENDAZOLE | 0.117 |
| THIACLOPRID | 0.119 |
| THIAMETHOXAM | 0.178 |
| THIAZOPYR | 1.756 |
| THIDIAZURON | 0.396 |
| THIFENSULFURON-METHYL | 0.049 |
| THIOBENCARB | 0.158 |
| THIODICARB | 0.133 |
| THIOPHANATE-METHYL | 0.118 |
| THIRAM | 0.219 |
| TRALKOXYDIM | 0.141 |
| TRIADIMEFON | 0.162 |
| TRIADIMENOL | 0.243 |
| TRIALLATE | 0.573 |
| TRIBENURON-METHYL | 0.030 |
| TRICLOPYR, BUTOXYETHYL ESTER | 0.433 |
| TRIFLOXYSTROBIN | 0.083 |
| TRIFLOXYSULFURON-SODIUM | 0.014 |
| TRIFLUMIZOLE | 0.067 |
| TRIFLURALIN | 0.737 |
| TRINEXAPAC-ETHYL | 2.386 |
| TRITICONAZOLE | 0.240 |
| UNICONIZOLE-P | 125.636 |
| VINCLOZOLIN | 0.055 |
| ZINC CHLORIDE | 0.329 |
| ZINEB | 0.082 |
| ZIRAM | 0.031 |

**Table 4. HAP Emission Factors**

| **HAP\_Emission\_Factors** | | | | |
| --- | --- | --- | --- | --- |
| **Compound** | **Pollutant Code** | **Vapor Pressure**  **(mm Hg at 20°C to 25°C)** | **Emissions Factor**  **(lb per lb AI)** | **Source** |
| 2,4-D | 94757 | 0.000008 | 0.35 | EIIP, Volume 3, Chapter 9, Table 9.4-4 |
| CAPTAN | 133062 | 0.00000008 | 0.1441 | Set equal to VOC emissions factor calculated from the CA DPR |
| CARBARYL | 63252 | 0.0000012 | 0.3208 | Set equal to VOC emissions factor calculated from the CA DPR |
| METHYL BROMIDE | 74839 | 1,420 | 0.58 | EIIP, Volume 3, Chapter 9, Table 9.4-4 |
| METHYL IODIDE | 74884 | 400 | 0.58 | EIIP, Volume 3, Chapter 9, Table 9.4-4 |
| PARATHION | 56382 | 0.0000378 | 0.35 | EIIP, Volume 3, Chapter 9, Table 9.4-4 |
| TRIFLURALIN | 1582098 | 0.00011 | 0.58 | EIIP, Volume 3, Chapter 9, Table 9.4-4 |