United States
Department of
Agriculture

Forest Service
Pacific Northwest Region

**Healthy Forests Make
A World of Difference**

July 25, 2000

Picloram

HERBICIDE INFORMATION PROFILE

This information profile is produced by the USDA Forest Service, Pacific Northwest Region, for employees, forest workers, and for the public. The profile provides information on forest and land management uses, environmental and human health effects, and safety precautions for the herbicide picloram and its formulations. A list of definitions is included in Section VIII of the information profile.

I. BASIC INFORMATION

COMMON NAME: Picloram

CHEMICAL NAME: 4-amino-3,5,6-trichloropicolinic acid

PRODUCT NAMES: Tordon* K and Tordon* 22K.

REGISTERED USE STATUS: All formulations that may be broadcast on soil or foliage are classified as "Restricted Use" pesticides. Sale and use of these picloram formulations are limited to licensed pesticide applicators or employees under their supervision, and only for uses covered by the applicator's certification. This is due to picloram's potential to contaminate groundwater, and its ability to damage nontarget plants, including important food crops (C&P Press 1998; U.S. EPA 1988a)

FORMULATIONS: Tordon* K and Tordon* 22K are the formulations of picloram currently available and used by the Forest Service. These formulations are produced by Dow AgroSciences as a liquid containing the potassium salt of picloram (24.4% w/v), which is equivalent to a concentration of 2 lbs a.e./gallon. The remaining 75.6% of the formulation consists of inerts including polyglycol 26-2. The U.S. EPA (1998) classifies polyglycol 26-2 among *Inerts of unknown toxicity (List 3)* that may be used in the formulation of pesticides.

The formulation testing reported in this profile applies only to the Tordon* K and Tordon* 22K formulations, which contain only picloram as an active herbicide ingredient. Other formulated products (for example, Tordon* 101 Mixture and Tordon* RTU) contain picloram and

another herbicide. This profile does not address the possible effects of exposure to the formulated herbicide mixtures.

RESIDUE ASSAY METHODS: Capillary gas chromatography with electron capture (CGCEC) detector and high performance liquid chromatography with an ultraviolet (HPLCU) detector are both listed by U.S. EPA (1997a) as accepted methods for the analysis of picloram in water. CGCEC is the more sensitive method, with a detection limit of 0.14 ppb. HPLCU has a detection limit of 0.3 ppm. A 1982 study found that water samples containing picloram at concentrations of 10 or 50 ppb were frequently underestimated and sometimes not detected by private laboratories using gas chromatography with a reported detection limit of 1 ppb (Norris 1982, 1986). The U.S. EPA (1997a), however, indicates that concentrations of 0.350 ppb should be detected with 99% confidence that the picloram concentration is greater than zero (i.e., only a 1% chance of a false negative reading).

In tests submitted to the U.S. EPA, Dow Elanco reports detection limits of picloram in soil at 5.0 ppb and in plants at 50 ppb (DowElanco Publication a. Undated). A study by Tan et al. (1996) indicates that the recovery of picloram from soil samples decreases as the organic matter in the soil increases (Tan et al. 1996).

II. HERBICIDE USES

REGISTERED FORESTRY, RANGELAND, RIGHT-OF-WAY USES: Tordon* K is used to prevent regrowth of woody plants in rights-of-way, such as along roads and power lines. In forestry, Tordon* K is used to control unwanted woody plants and to prepare sites for planting trees. On rangelands, Tordon* 22K is used to control noxious weeds and woody plants. It is also used to control plants on non-crop industrial/facility sites. Do not apply picloram on snow or frozen ground. Basal treatments can be applied throughout the year. Tree injection should not be done during periods of heavy sap flow.

OPERATIONAL DETAILS:

TARGET PLANTS: Picloram is used to control broadleaf plants, brush, conifers and broad-leaf trees.

MODE OF ACTION: Picloram is a pyridine herbicide that acts as a plant growth regulator. That is to say that picloram mimics naturally occurring plant auxins or hormones in a manner that leads to uncontrolled and abnormal plant growth, which may result in gross signs of toxicity or death. In general, picloram is more toxic to broadleaf plants than to grasses or grains.

METHOD OF APPLICATION: Both formulations can be applied by broadcast or spot treatment as foliar (leaf) or soil spray, as basal bark treatment, or by air as broadcast spray. Tordon may not be applied directly to water.

USE RATES: Ground rates vary according to local conditions and the nature of the target vegetation. Application rates of

0.125-1.5 lbs picloram a.e./acre are recommended on the product label (C&P Press 1998). The upper range of this application rate is only recommended for the control of woody plants and broadleaf weeds in southern states. Elsewhere, the maximum recommended application rate is 1 lb a.e./acre. The typical rate used in Forest Service programs is about 0.5 lbs a.e./acre.

SPECIAL PRECAUTIONS: Always read all of the information on the product label before using any pesticide. Read the label for application restrictions.

TIMING OF APPLICATION: Consult product label for precise timing of various soil and foliar treatments with picloram formulations. Do not apply picloram on snow or frozen ground. Basal treatments can be applied throughout the year. Tree injection should not be done during periods of heavy sap flow.

DRIFT CONTROL: Do not allow careless application or spray drift. Do not permit spray or spray drift to contact crops or other desirable broadleaf plants.

IV. ENVIRONMENTAL FATE

SOIL:

RESIDUAL SOIL ACTIVITY: Picloram can stay active in soil for a moderately long time, depending on the type of soil, soil moisture and temperature. Picloram may exist at levels toxic to plants for more than 1 year after application at normal rates. The half-life of picloram in soil is reported to vary from 1 month under favorable environmental conditions to more than 4 years in arid regions (USDA 1989). Picloram is degraded more rapidly under anaerobic than aerobic conditions and also degrades more rapidly at lower application rates (Krzyszowska et al. 1994).

ADSORPTION: Picloram chemically attaches to clay particles and organic matter. If the soil contains little clay or organic matter, picloram is easily moved by water.

PERSISTENCE AND DEGRADATION: Breakdown caused by sunlight and microorganisms in the soil are the main ways in which picloram degrades in the environment. Picloram will dissipate more quickly in warm, wet weather. Alkaline conditions, fine textured clay soils, and a low density of plant roots can increase the persistence of picloram.

METABOLITES/DEGRADATION PRODUCTS AND POTENTIAL ENVIRONMENTAL EFFECTS: Carbon dioxide is the major end-product of the breakdown of picloram in the soil. Carbon dioxide is a gas normally found in the air. The relatively small amount of carbon dioxide produced when picloram degrades in soil is not likely to be harmful to the environment.

One study regarding the breakdown of picloram in soil identifies two compounds produced in minor amounts: 4-amino-3,5-dichloro-6-hydroxy-picolinic acid and 4-amino-2,3,5-trichloro-pyridine. These metabolites also were found in plants exposed to picloram. According to the study, the compounds are not part of the major metabolic pathway for picloram in soil and do not accumulate in soil (DowElanco Publication b Undated).

WATER

SOLUBILITY: Picloram dissolves readily in water.

POTENTIAL FOR LEACHING INTO GROUNDWATER: U.S. EPA characterizes the mobility of picloram in soil as intermediate to very mobile in soils ranging in texture from clay to loam. Picloram movement is greatest for soils with low organic matter content, alkaline soils, and soils that are highly permeable, sandy, or light-textured. Under certain environmental conditions, picloram is known to leach from soil into groundwater as a result of agricultural use.

Because picloram is relatively mobile in soil, the product labels for both Tordon* K (Dow AgroSciences 1999a) and Tordon* 22K (Dow AgroSciences 1999b) recommend several specific precautions for decreasing the potential of groundwater contamination. These precautions are followed in all Forest Service programs.

A recent study conducted by the U.S. Geologic Survey (USGS 1998) found picloram in 0.11-0.20% of the groundwater surveyed. The maximum level detected was 2.2 ppb. Picloram was detected in 3% of groundwater samples in the Red River basin covering parts of Minnesota, North Dakota, and South Dakota, at a concentration of less than 10 ppb (Stoner et al. 1998).

SURFACE WATERS: Picloram can contaminate surface water through spray drift. Moreover, picloram may have a high potential for runoff into surface water when conditions favor poorly draining or wet soils that slope toward surface waters, frequently flooded areas, areas over-laying extremely shallow groundwater, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and areas over-laying tile drainage systems that drain to surface water (DowAgro Sciences 1999a,b).

Picloram was not detected in 3384 samples from 1058 streams in major aquifers monitored by the U.S. Geologic Survey (USGS 1998). Monitoring data indicate that peak concentrations of picloram in surface water after various methods of application were 7.4-37 mg/L per lb/acre for injection, 2.2 mg/L per lb/acre for broadcast ground spray, and 48-78 mg/L per lb/acre for broadcast aerial spray (Michael and Neary 1993, Table 3, p. 407).

AIR:

VOLATILIZATION: Although picloram does not evaporate easily, its vapors were shown to be injurious to plants. In a closed container, picloram vapors damaged plant seedlings (Gentner 1964).

POTENTIAL FOR BY-PRODUCTS FROM BURNING OF TREATED VEGETATION: More than 95% of picloram residue is destroyed during burning. Brown-and-burn operations may result in the formation of combustion products of picloram, and these products may pose a health risk. On combustion at 225°C, picloram undergoes decarboxylation and is converted to 2,3,5-trichloro-4-aminopyridine (4A-TCP) (Bush et al. 1987). 4A-TCP, which is also found in plant and soil decomposition, is generally more toxic than picloram to microorganisms. There is no information about the toxicity of 4A-TCP to mammals.

At 900°C, picloram decomposes to carbon dioxide, carbon monoxide, chlorine gas, hydrogen chloride, and ammonia. Organo-chlorines are not identified as combustion products of picloram (Dost 1984).

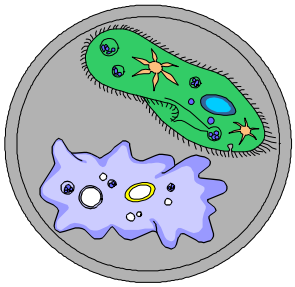
By-products from burning plants treated with picloram were not identified in the field.

IV. ECOLOGICAL EFFECTS

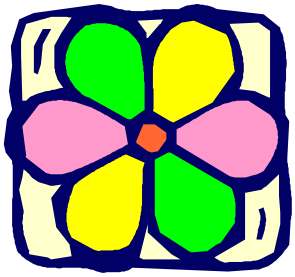
Please refer to Section X for definitions of ecotoxicological categories.

NONTARGET TOXICITY:

SOIL MICROORGANISMS: Higher soil concentrations of picloram result in longer persistence of the compound. Accordingly, at high application rates, picloram may inhibit microbial activity (Krzyszowska et al. 1994).



At a level of 10 ppm in sandy loam soil, picloram caused a transient decrease in nitrification after 2 but not 3 weeks of incubation and no effect on ammonia formation or sulfur oxidation (Tu 1994). The decrease in nitrification was relatively mild and does not portend a substantial or prolonged impact on microbial activity.



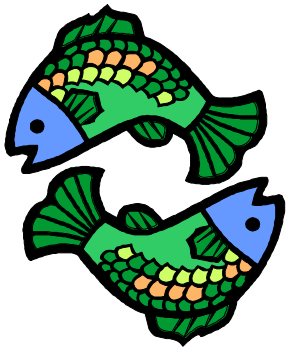
PLANTS: Picloram is highly toxic to many nontarget plants. Most grasses, however, are resistant to the herbicidal effects of picloram. Because picloram is active in soil, it can pass from soil into growing plants. Moreover, it can move from treated plants, through the roots, to nearby plants. Furthermore, irrigation water polluted with picloram may damage or kill crop plants.

In assessing the potential effects of herbicides on nontarget terrestrial plant species, the U.S. EPA developed a standardized set of plant bioassays for seed germination, seed emergence, and post-emergence applications. The lowest reported adverse effect level for the potassium salt of picloram is about 0.000012 lbs a.e./acre, the EC_{25} for seed emergence in soybeans (U.S. EPA 1995).

This effect level is a factor of about 40,000 below the typical application rate of 0.5 lbs a.e./acre. The highest reported NOAEL in any of the terrestrial plant bioassays is about 0.062 lbs a.e./acre, for post-emergent application in wheat and seed germination in barley, a factor of about 8 below the typical application rate for Forest Service programs [0.5 lbs a.e./acre ÷ 0.062 lbs a.e./acre]. Consequently, although picloram is more toxic to broadleaf plants than grains or grasses, picloram will kill or injure numerous plant species at the typical application rate of 0.5 lbs a.e./acre. Picloram treats for the control of knapweed have been associated with transient decreases in seven native and one exotic forb species (Rice and Toney 1996).

Picloram is also toxic to aquatic plants, both small single-cell plants, commonly referred to as algae, and larger multicellular plants, commonly referred to as macrophytes. In general, single-cells plants appear to be less sensitive than larger plants. The RED for picloram reports a NOAEL of 13.1 ppm and an EC_{25} of 52.6 ppm for growth inhibition in one species of unicellular algae exposed to the potassium salt of picloram (U.S. EPA 1995). Picloram did not affect growth in two species of macrophytes at concentrations of 0.01 and 0.1 ppm but inhibited flowering at 0.1 ppm (Forsyth et al. 1997). The metabolism of picloram appears to increase toxicity to two species of single-cell plants (Baarschers et al. 1988). There are no data in the literature regarding the toxicity of picloram metabolites to multicellular plants.

AQUATIC ANIMALS: The toxicity of picloram to aquatic animals was tested in various species of trout and *Daphnia magna*, a small aquatic invertebrate. Acute LC_{50} values for most aquatic species range from about 5 to 75 ppm, with trout being more sensitive than other aquatic species (Dow AgroSciences 1998a,b; Gersich et al. 1985; Mayes et al. 1987; U.S. EPA 1995). Chronic studies using reproductive or developmental effects for trout (Mayes et al. 1987) and *Daphnia* (Gersich et al. 1985) report no-effect levels of 0.55 ppm (trout) and 11.8 ppm (*Daphnia*) and adverse effect levels of 0.88 ppm (trout) and 18.1 ppm (*Daphnia*). An earlier study (Woodward 1976) reports a much lower AEL of 0.032 ppb for chronic toxicity in trout, based on survival and growth in young trout. As reviewed by the U.S. EPA (1995), this study was not used by the U.S. EPA (1995) in the risk assessment on picloram because the study involved exposure to picloram acid rather than the potassium salt of picloram, which is used in both Tordon formulations.



TERRESTRIAL ANIMALS: The toxicity of picloram is relatively well characterized in experimental mammals; however, few wildlife species have been studied. Despite this substantial reservation, picloram appears to be relatively nontoxic to terrestrial animals. Animals exposed to picloram excrete most of the compound, unchanged, in the urine.

Acute oral LD_{50} values for picloram range from 3000 to 5000 mg/kg body weight, and the highest NOAEL from a chronic study is 20 mg/kg/day (SERA 1999). Some

additional studies are available on birds, bees, and snails that generally support the characterization of picloram as relatively nontoxic to terrestrial animals. One recent field study by Nolte and Fulbright (1997) reported no detectable effects on mammalian or avian diversity after the application of picloram. The 48-hour contact toxicity of picloram to bees is 14.5 μg/bee (U.S. EPA 1995).

A New Zealand study found a possible association between sheep grazing on pastures treated with picloram and an increased incidence of intestinal cancer. The results, however, are inconclusive because of the small number of sheep exposed only to picloram (Newell et al. 1984)

Tordon* 22K was tested for acute oral toxicity to birds and is considered practically nontoxic. Moreover, the formulation did not cause reproductive or developmental effects in chickens, when sprayed on fertilized eggs (U.S. EPA 1995).

THREATENED AND ENDANGERED SPECIES: Picloram applied to pastures, rangeland, or forests may be hazardous to endangered plants. Also, picloram may be hazardous to some endangered invertebrates if it is applied to areas where they live. It is not, however, expected to be hazardous to other endangered animals or birds.

V. HEALTH EFFECTS TESTING

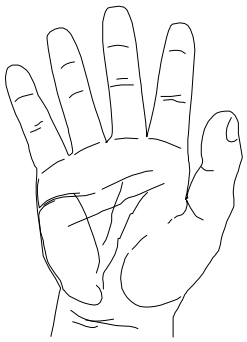
Most of the data on potential human health effects from exposure to picloram are derived from the results and analyses of animal studies involving exposure to picloram.

For picloram and formulations containing picloram as the only active ingredient, the data are from studies conducted by the manufacturer. These studies were submitted to the U.S. EPA to support product registration but are not available to the general public.

ACUTE TOXICITY:

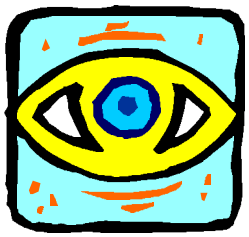
ACUTE ORAL TOXICITY: The LD_{50} values for picloram acid and the potassium salt of picloram are greater than 5000 mg/kg for male rats. Female rats seem somewhat more sensitive, with LD_{50} values of 4012 mg/kg for picloram acid and 3536 mg/kg for the potassium salt of picloram. Based on these data, picloram is classified as practically nontoxic (Category IV) for male rats and slightly toxic (Category III) for female rats (U.S. EPA 1995).

ACUTE DERMAL TOXICITY: Dermal exposure to 2000 mg/kg picloram acid or the potassium salt of picloram did not cause systemic toxicity in rabbits, based on standard acute/single application bioassays with 14-day observation periods (U.S. EPA 1995). In general, dermal LD_{50} values are higher than oral LD_{50} values (Gaines 1969). Since the acute oral LD_{50} values for



picloram are 5000 mg/kg or greater, the lack of apparent toxicity at dermal doses up to 2000 mg/kg/day is to be expected, and the studies do not have much impact on the assessment of risk for picloram.

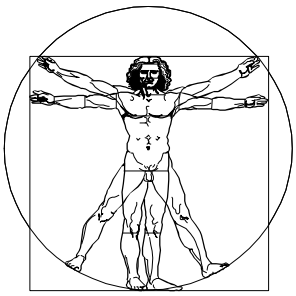
In addition to the acute dermal studies, a 21-day dermal toxicity analysis of the potassium salt of picloram was conducted in New Zealand white rabbits at doses of 0, 65, 217, and 650 mg a.e./kg/day, 5 days/week, for 3 weeks. No systemic toxicity was observed (U.S. EPA 1995).



SKIN AND EYE IRRITATION SCORE: Both picloram acid and the potassium salt of picloram (the forms used by the Forest Service) are classified as moderate eye irritants (Category III) but as non-irritants to the skin (Category IV) (U.S. EPA 1995).

ACUTE INHALATION TOXICITY: The inhalation toxicity LC_{50} values of > 0.035 mg/L for picloram acid (Category I) and > 1.63 mg/L for the potassium salt of picloram (Category II) are classified as high to moderate (U.S. EPA 1995).

DERMAL SENSITIZATION: The potassium salt form of picloram is considered a skin sensitizer (U.S. EPA 1995).



CHRONIC TOXICITY: These data are based on tests in laboratory animals. U.S. EPA requires these tests only for the active ingredient picloram. No tests of formulations for chronic toxicity are reported. Please refer to Section X for an explanation of how the NOEL (No-observed-effects level) is calculated.

The PNW Region FEIS evaluated the quality of the testing done on picloram up to 1988. Quality considerations for individual studies include: the dose ranges and species tested, exposure duration, and identification of the most sensitive effect. In addition, the degree of quantitative agreement among all tests for an effect is considered. Please refer to Section X for an explanation of qualitative ratings in this section.

SYSTEMIC TOXICITY:

REPRODUCTION/DEVELOPMENTAL: Picloram was tested for teratogenic and reproductive effects in rats, mice, and rabbits (U.S. EPA 1992b, 1999). The lowest-observed-adverse-effects level (LOAEL) was 500 mg/kg/day and was associated with developmental changes in bones (Thompson et al. 1972). Nevertheless, the LOAEL is 25 times greater than the systemic NOAEL of 20 mg/kg/day. NOAELs for reproductive effects are as great as 400 mg/kg/day, which is 20 times greater than the systemic NOAEL.

CARCINOGENICITY/MUTAGENICITY: Picloram was tested for mutagenicity in several test systems and was analyzed for

carcinogenic activity in rats and mice. A review and detailed evaluation of the mutagenicity studies on picloram, recently completed by U.S. EPA (1992b) concludes the following:

No compelling evidence of a mutagenic effect in relevant biological systems was uncovered. Although picloram at a single reported dose was mutagenic in S. coelicolor, the weight of evidence from well-conducted microbial (Ames test), mammalian cell, and Drosophila mutagenicity studies tends to support the conclusion that picloram does not exhibit mutagenic activity (U.S. EPA 1992b, pp. V19 to V20).

Similarly, the Health Effects Division Carcinogenicity Peer Review Committee of the U.S. EPA Office of Pesticides reviewed the carcinogenicity data on picloram acid and the potassium salt of picloram and classified these agents as Group E (no evidence of carcinogenicity), based on the lack of carcinogenic activity in rats and mice exposed to picloram (U.S. EPA 1999).

OTHER POSSIBLE HEALTH EFFECTS: There are no data regarding potential effects on the nervous system or immune system in humans or animals after exposure to picloram.

VI. HUMAN HEALTH EFFECTS

FOREST SERVICE EVALUATION OF HUMAN HEALTH RISKS: The PNW Region FEIS (1988) evaluated a range of picloram health effects data, including some laboratory studies cited in Section V. SERA conducted an updated risk assessment for the Forest Service (1999) using the most recent health effects information and risk assessment procedures. Both assessments evaluate the quantitative (numerical) estimates of toxicity and the quality of the data used to make numerical estimates. Using different risk assessment procedures from those in the PNW Region FEIS (1988), SERA (1999) rated health risk to workers and the public for some picloram applications in a higher risk category. Section X of this profile displays and discusses the risk ratings from both assessments. The Mitigation Measures from the PNW Region FEIS for herbicide applications are sufficiently protective to continue to minimize potential risks to human health from Forest Service applications of picloram.

There are no recent studies that would change the hazards of picloram identified by the PNW Region FEIS.

The PNW Region FEIS predicts the levels of exposure to project workers and the public from typical forestry operations and from a large accidental spill. The risks are compared with U.S. EPA standards of acceptable risk for human health effects. The PNW Region FEIS identified mitigation measures to reduce human exposure in all approved herbicide applications. Also, the FEIS specified additional mitigation measures to restrict or eliminate use where a specific herbicide application method generated a "High" risk rating.

The level of exposure to picloram that is identified by U.S. EPA as the threshold for potential risk of human health effects is based on effects from repeated exposure to

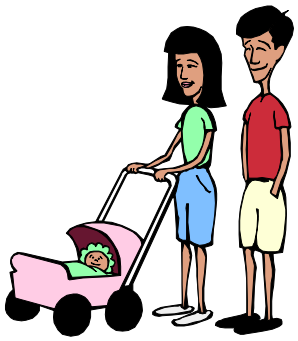
picloram over a long time (chronic exposure). This level is called the Reference Dose (RfD). U.S. EPA (1999) determined that picloram has much lower toxicity in tests conducted for a single, one-time (acute) exposure than the RfD level indicates.

The complete set of risk ratings for the PNW Region FEIS and the SERA (1999) assessments are provided in Section X. The quality of the existing data affects the reliability of the risk ratings. The PNW Region FEIS judges the overall quality of available data on picloram toxicity to be "adequate:" the studies are of sufficient quality and quantity that estimates are considered reliable; new studies are unlikely to change estimates of health effects.

POTENTIAL FOR HEALTH EFFECTS TO THE PUBLIC: Forest visitors and nearby residents could be exposed to picloram drift, to vegetation with picloram residues, and to accidental spraying of picloram. Furthermore, they could eat food or drink water contaminated with picloram residue.

The PNW Region FEIS and the SERA (1999) risk assessment indicate that under normal conditions the general public will not be exposed to levels of picloram that exceed the RfD. Although there are ample monitoring data to indicate that picloram can be transported to groundwater and surface water, these monitoring studies do not suggest that typical levels of exposure will approach the RfD.

MITIGATING MEASURES TO REDUCE IDENTIFIED RISKS TO THE PUBLIC: Under foreseeable conditions of application in National Forests of the Pacific Northwest, there is no exposure scenario that suggests that the public could be repeatedly exposed to picloram levels that exceed the RfD. For some accidental exposures modeled in the SERA risk assessment, maximum one-time exposures would exceed the RfD established for repeated long-term exposures.



The Forest Service considers the potential for public exposure when designing contact procedures, posting and signing needs in the Herbicide Application Plan. Current mitigating measures including mandatory safety responses (that is, cleaning the exposed area or the avoidance of further exposure) will help to reduce the possibility of any health consequences. In addition, every effort is made to prevent public contact with accidental spills (emergency spill notification system, restrict public access to the spill site).

PROBABILITY OF A WORKER RECEIVING A DOSE THAT AFFECTS GENERAL HEALTH OR REPRODUCTION: Worker exposure and dose are estimated for typical forestry applications. Studies are available that measure actual worker doses of herbicide for some typical forestry applications. The PNW Region FEIS used central estimates of exposures from these studies. The SERA (1999) risk assessment used a different method that accounted variability in the study data. The differences in

methods used result in differences in qualitative risk ratings between the two risk assessments in some situations.

In the PNW Region FEIS, the probability of worker exposure to a toxic concentration of picloram for general health effects is rated Negligible for all application methods. The upper-limit worker risk estimates in the SERA risk assessment would be classified as Low for aerial and backpack foliar applications, and Moderate for broadcast ground application. The higher ratings result from a scenario in which a worker wears herbicide-contaminated gloves for one hour. The maximum exposure to picloram from this one-time exposure would exceed the RfD established for repeated long-term exposures.

MITIGATING MEASURES TO REDUCE IDENTIFIED RISKS TO WORKERS: The PNW Region FEIS does not identify special mitigations for picloram applications to reduce worker exposure. The mitigating measures that apply to all herbicide applications were sufficient to reduce worker exposure below the identified thresholds of unacceptable risk to their health.

ACUTE TOXICITY (POISONING): Cases of eye and skin irritation were reported in workers exposed to picloram formulations.

LONG-TERM HUMAN HEALTH EFFECTS: There are no reported cases of long-term health effects in humans after exposure to picloram or its formulations.

POTENTIAL FOR ADVERSE HEALTH EFFECTS FROM INERT INGREDIENTS CONTAINED IN THE FORMULATED PRODUCT: The manufacturer identified some inert chemicals in picloram formulations. Both of the Tordon formulations contain Polyglycol 26-2 [CAS No. 069029-39-6] (C&P Press 1998). This compound is classified by the U.S. EPA (1998) as a List 3 inert. Other inerts in the formulations were not identified to the public.

The identity of all inert ingredients in picloram formulations were disclosed to the U.S. EPA. The U.S. EPA classifies all inerts into one of four categories, called "Lists". List 1 contains chemicals of known toxic concern. List 2 contains chemicals of suspected toxic concern which are high priority for testing. List 4 contains chemicals of known nontoxic character, generally recognized as safe to humans. All other chemicals are classified on List 3: Inerts of unknown toxicity. U.S. EPA did not find enough information available on the toxic properties of List 3 chemicals to classify them on Lists 1, 2, or 4. All inert ingredients used in Tordon formulations are classified by the U.S. EPA on List 3 or List 4.

HEALTH EFFECTS ASSOCIATED WITH CONTAMINANTS: Almost no chemical manufacturing process yields a totally pure product. The available toxicity studies on picloram were conducted with the technical grade product. Consequently, if toxic impurities are present in the technical grade product, they are likely to be accounted for by the toxicity studies on the technical grade product.

On the other hand, any amount of a carcinogen in an otherwise noncarcinogenic mixture may pose a carcinogenic risk. This is the situation with picloram. Technical grade picloram contains hexachlorobenzene. Nominal or average concentrations of hexachlorobenzene are 8 ppm, and the maximum concentration is 50 ppm (U.S. EPA 1997b). The U.S. EPA classifies hexachlorobenzene as a probable human carcinogen for which the data are adequate to consider risk quantitatively.

Accidental exposure scenarios for workers and members of the general public result in short-term exposures to hexachlorobenzene that are above the background dose of 0.000001 mg/kg/day. The highest dose estimate is about 0.02 mg/kg, the upper range of exposure for a worker wearing contaminated gloves for 1 hour. For members of the general public, the highest dose estimate is about 0.006 mg/kg and is associated with the short-term consumption of contaminated fish. The highest chronic exposure scenario for members of the general public is 0.00000035 mg/kg/day, associated with the consumption of contaminated fish by subsistence populations.

Based on the standard assumptions used in Forest Service risk assessments, the contamination of picloram with hexachlorobenzene does not appear to present a substantial cancer risk. Administratively, the Forest Service has adopted a substantial cancer risk level of one in one-million (1 ÷ 1,000,000) as a trigger that would require special steps to mitigate exposure or restrict and possibly eliminate use. All cancer risks associated with hexachlorobenzene in picloram are below one in one-million.

HEALTH EFFECTS ASSOCIATED WITH OTHER FORMULATIONS: Some formulations contain picloram mixed with the herbicides 2,4-D or triclopyr. Information Profiles for 2,4-D or Triclopyr describe the properties and potential effects of exposure to these herbicide ingredients.

None of the profiles on individual herbicides fully describe the potential for health or environmental effects from exposure to formulations containing multiple herbicides. There may be greater concern for mixtures of picloram and 2,4-D. Tordon 202c, a commercial formulation of picloram and 2,4-D, is associated with adverse reproductive effects in mice (Blakley et al. 1989a,b,c).

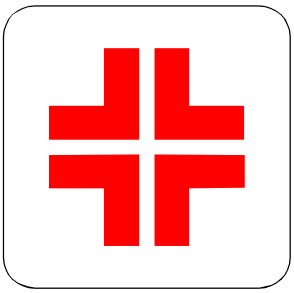
Additional information about the properties of these formulations and their potential effects on human health and the environment will be prepared before the formulations are used in the PNW Region.

SOCIETAL PERCEPTIONS: Public opinion about herbicide use, in general, ranges from a perception that herbicides are completely safe, to a perception that they are very hazardous. A full range of opinion is available in the PNW Region FEIS. This profile provides workers and the general public with information that may be useful in assessing the hazards associated with the use of picloram in PNW Region National Forests.

VII. SAFETY PRECAUTIONS

SIGNAL WORDS AND DEFINITIONS:
All of the following are taken from product labels and material safety data sheets (Dow AgroSciences 1998a,b, 1999a,b).

PRECAUTIONARY STATEMENTS (Tordon* K and Tordon* 22K**)**: Causes moderate eye irritation. Avoid contact with eyes or clothing. Prolonged or frequent repeated skin contact may cause allergic skin reactions in some individuals.



PERSONAL PROTECTIVE EQUIPMENT (PPE) (Tordon* K and Tordon* 22K**)**: Applicators and other handlers must wear: long-sleeved shirt and long pants, waterproof gloves, shoes and socks.

USER SAFETY RECOMMENDATIONS (Tordon* K and Tordon* 22K). Users should: wash hands before eating, drinking chewing gum, using tobacco or using the toilet; remove clothing immediately if pesticide gets inside, then wash thoroughly and put on clean clothing; remove PPE immediately after handling this product; wash the outside of gloves before removing; and as soon as possible, wash thoroughly and change into clean clothing.

FIRST AID (Tordon* K and Tordon* 22K**)**:

EYES: Irrigate with flowing water immediately and continuously for 15 minutes. Consult medical personnel.

SKIN: Wash off in flowing water or shower.

INGESTION: If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

NOTE TO PHYSICIAN: If burn is present, treat as any thermal burn, after decontamination. No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

HANDLING STORAGE AND DISPOSAL (Tordon* K and Tordon* 22K**)**: Keep out of reach of children. Do not contaminate food, feed, or water by storage or disposal.

Pesticide wastes are toxic. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. See product label for additional clean-up instructions.

EMERGENCY (SPILL) HAZARDS AND PROCEDURES (Tordon* K and Tordon* 22K**)**: Absorb in inert material such as dry sand. In case of large spills, dike area to contain product. Call Dow AgroSciences at 800-992-5994.

VIII. DEFINITIONS

Absorption -- The process by which a chemical passes through the body membranes

and enters the bloodstream. The main routes by which toxic agents are absorbed are the gastrointestinal tract, lungs, and skin.

Acute toxicity – The amount of a substance as a single dose to cause poisoning in a test animal.

Acute exposure -- A single exposure or multiple exposure occurring within a short time (24 hours or less).

Adverse-effect level (AEL) -- Signs of toxicity that must be detected by invasive methods, external monitoring devices, or prolonged systematic observations.

a.e. – Acid equivalents.

Arid – A terrestrial region lacking moisture, or a climate in which the rainfall is not sufficient to support the growth of trees or woody plants.

Assay -- A kind of test (noun); to test (verb).

Basal treatment – Application method by which herbicide is applied to the stem of a plant just above the soil.

Bioconcentration factor -- The concentration of a compound in an aquatic organism divided by the concentration in the ambient water of the organism.

Broadleaf weed -- A nonwoody dicotyledonous plant with wide bladed leaves designated as a pest species in gardens, farms, or forests.

Carcinogen -- A chemical capable of inducing cancer.

Chronic exposure -- Long-term exposure studies often used to determine the carcinogenic potential of chemicals. These studies are usually performed in rats, mice, or dogs and extend over the average lifetime of the species (for a rat, exposure is 2 years).

Contaminants -- Impurities present in a commercial grade chemical.

Degraded -- Broken down or destroyed.

Dermal -- Pertaining to the skin.

Drift -- That portion of a sprayed chemical that is moved by wind off a target site.

EC_{25} – The concentration of a chemical that is estimated to cause a toxic effect in 25% of the treated subjects.

Formulation -- A commercial preparation of a chemical including any inerts or contaminants.

Half-life – For compounds that are eliminated by first-order kinetics, the time required for the concentration of the chemical to decrease by one half.

Herbicide -- A chemical used to control, suppress, or kill plants, or to severely interrupt their normal growth processes.

Inerts -- Adjuvants or additives in commercial formulations of glyphosate that are not readily active with the other components of the mixture.

Invertebrate -- An animal that does not have a spine (backbone).

LC_{50} – The concentration of a chemical calculated to kill 50% of test animals.

LD_{50} – The dose of a chemical calculated to kill 50% of test animals.

Leach – To dissolve out by the action of water

Lowest-observed-adverse-effect level (LOAEL) -- The lowest dose of a chemical in a study, or group of studies, that produces statistically or biologically significant increases in frequency or severity of adverse effects

between the exposed population and its appropriate control.

Margin of safety (MOS) -- The ratio between an effect or no effect level in an animal and the estimated human dose.

Metabolite -- A compound formed as a result of the metabolism or biochemical change of another compound.

mg/kg -- A common way of expressing dose: milligram of a toxic agent per kilogram of body weight.

Microorganisms -- A generic term for all organisms consisting only of a single cell, such as bacteria, viruses, and fungi.

Mutagenicity -- The ability to cause genetic damage (that is damage to DNA or RNA). Mutations can lead to birth defects, miscarriages, or cancer.

Nontarget -- Any plant or animal that a treatment inadvertently or unavoidably harms.

No-observed-adverse-effect level (NOAEL) -- The dose of a chemical at which no statistically or biologically significant increases in frequency or severity of adverse effects were observed between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

No-observed-effect level (NOEL) -- The dose of a chemical at which no treatment-related effects were observed.

Persistence – The tendency of an applied pesticide to remain in the environment.

ppb -- An abbreviation for *parts per billion*. Equivalent to µg/L for concentrations in water and to µg/kg for concentrations in soil or other non-aqueous media.

ppm -- An abbreviation for *parts per million*. Equivalent to mg/L for concentrations in water and to mg/kg for concentrations in soil or other non-aqueous media.

Reproductive effects -- Adverse effects on the reproductive system that may result from exposure to a chemical or biological agent.

RfD -- A daily dose that is not expected to cause adverse human health effects over a lifetime of exposure. These values are derived by the U.S. EPA.

Systemic toxicity -- Effects that require absorption and distribution of a toxic agent to a site distant from its entry point at which point effects are produced. Systemic effects are the obverse of local effects.

Teratogen – A compound that causes birth defects**.**

Toxicity -- The inherent ability of an agent to affect living organisms adversely.

Uncertainty Factor (UF) -- A factor used in operationally deriving the RfD and similar values from experimental data. UFs are intended to account for (1) the variation in sensitivity among members of the human population; (2) the uncertainty in extrapolating animal data to the case of humans; (3) the uncertainty in extrapolating from data obtained in a study that is less than lifetime exposure; and (4) the uncertainty in using LOAEL data rather than NOAEL data. Usually each of these factors is set equal to 10.

IX. Information Sources

For general information on herbicide use by the Forest Service, refer to the PNW Region Treatment Methods Profile for Herbicides.

The principal sources of information and findings in this profile are the PNW Region FEIS (USDA/FS 1988) and a more recent risk assessment on picloram prepared for the Forest Service (SERA 1999).

The PNW Region asked the parties to the Mediated Agreement for Managing Competing and Unwanted Vegetation ROD to submit any significant new information on picloram to be evaluated for this Profile revision. NCAP (Northwest Coalition for Alternatives to Pesticides) provided references to one article (Cox, 1998) and two web sites (Stoner, 1998) and (USGS, 1998). The three references were evaluated in both the SERA risk assessment (SERA1999) and in relevant topic sections of this Profile.

Baarschers WH; Donnelly JG; Heitland HS. 1988. Microbial toxicity of triclopyr and related herbicides. Tox. Assess. 3 (2): 127-136.

Blakley PM; Kim JS; Firneisz GD. 1989a. Effects of paternal subacute exposure to Tordon 202c on fetal growth and development in CD-1 mice. Teratology. 39 (3): 237-241.

Blakley PM; Kim JS; Firneisz GD. 1989b. Effects of preconceptional and gestational exposure to Tordon 202c on fetal growth and development in CD-1 mice. Teratology. 39(6): 547-553.

Blakley PM; Kim JS; Firneisz GD. 1989c. Effects of gestational exposure to Tordon 202c on fetal growth and development in CD-1 mice. J Toxicol Environ Health. 28(3): 309-316.

Bush PB; Neary DG; McMahon CK, Taylor, Jr. JW. 1987. Suitability of hardwoods trated with phenoxy and pyridine herbicides for use as firewood. Arch. Environ. Contam. Toxicol. 16: 333-341.

C&P Press (Chemical and Pharmaceutical Press). 1998. EPR II for Windows. Electronic Pesticide Reference.

Cox C. 1998. Picloram. Journal of Pesticide Reform. 18 (1):13-20.

Dost FN. 1984. Combustion of herbicides. Unpublished report for Bonneville Power Administration, U.S. Department of Energy.

DowAgroSciences. 1998a. Material Data Safety Sheet: Tordon* K. Product Code 87096, MSDS: 000380. Dow AgroSciences LLC, Indianapolis, IN.

DowAgroSciences. 1998b. Material Data Safety Sheet: Tordon* 22K. Product Code 87116, MSDS: 000380. Dow Agro-Sciences LLC, Indianapolis, IN.

Dow AgroSciences 1999a. Specimen Label: Tordon* K. Revised 02-12-99

Dow AgroSciences 1999b Specimen Label: Tordon* 22K. Revised 02-12-99

DOWELANCO PUBLICATIONS:

a. Picloram Technical Information Guide. Undated.

b. Mullison WR. Undated. A Toxicological and Environmental Review of Picloram.

Durkin PR; Rubin L; Withey J; Meylan W. 1995. Methods of assessing dermal absorption with emphasis on uptake from contaminated vegetation. Toxicol. Indust. Health. 11(1): 63-79.

Forsyth DJ; Martin PA; Shaw GG. 1997. Effects of herbicides on two submersed aquatic macrophytes, Potamogeton pectinatus L. and Myriophyllum sibiricum Komarov, in a prairie wetland. Environ. Pollut. 95(2): 259-268.

Gaines TB. 1969. Acute toxicity of pesticides. Tox. Appl. Pharamacol. 14: 515-534.

Gentner WA. 1964. Herbicidal Activity of Vapors of 4-amino-3,5,6-trichloro-picolinic Acid. Weeds. 12: 239-240

Gersich FM; Hopkins DL; Milazzo DP. 1985. Acute and chronic toxicity of technical picloram (4-amino-3,5,6- trichloropicolinic acid) to Daphnia magna Straus. Bull Environ Contam Toxicol. 35 (1):121-6.

Grier N. 1999. Letter to Leslie Rubin, USDA from Norma Grier, Northwest Coalition for Alternatives to Pesticides, dated December 17, 1999.

Krzyszowska AJ; Allen RD; Vance GF. 1994. Assessment of the fate of two herbicides in a Wyoming rangeland soil: column studies. J. Environ. Qual. 23(5): 1051-1058.

Mayes MA; Hopkins DL; Dill DC. 1987. Toxicity of picloram (4-amino-3,5,6-trichloropicolinic acid) to life stages of the rainbow trout. Bull. Environ. Contam. Toxicol. 38(4): 653-660.

Landry T; Johnson K; Cieszlak F; et al. 1986. Picloram: A Two-year Dietary Chronic Toxicity-oncogenicity Study in Fischer 344 Rats. Unpublished study prepared by Dow Chemical U.S.A. 243 p. MRID 00132705. (Cited in U.S. EPA 1992a, 1999).

Mayes MA; Hopkins DL; Dill DC. 1987. Toxicity of picloram (4-amino-3,5,6-trichloropicolinic acid) to life stages of the rainbow trout. Bulletin of Environmental Contamination and Toxicology. 38 (4):653-660.

Michael JL; Neary DG. 1993. Herbicide dissipation studies in southern forest ecosystems. Environ. Toxicol. Chem. 12(3): 405-410.

Newell KW; Ross AD; Renner RM. 1984. Phenoxy and Picolinic Acid Herbicides and Small Intestinal Adenocarcinoma in Sheep. Lancet. December 8, 1984: 1301-1305.

Nolte KR; Fulbright TE. 1997. Plant, small mammal, and avian diversity following control of honey mesquite. J. Range Manag. 50(2): 205-212.

Norris LA. 1982. Accuracy and Precision of Analyses for 2,4-D and Picloram in Water by Contract Laboratories. Unpublished report for Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture.

Norris LA. 1986. Accuracy and Precision of Analyses for 2,4-D and Picloram in Water by Contract Laboratories. Weed science. 34(3): 485-489.

Rice PM; Toney JC. 1996. Plant population responses to broadcast herbicide applications for spotted knapweed control. Down to Earth. 51(2):14-19.

SERA (Syracuse Environmental Research Associates, Inc.). 1999. Picloram (Tordon K and Tordon 22K): Final Report. Prepared by SERA, Inc., Fayetteville, NY under USDA/FS Contract No. 53-3187-5-12.

Stoner JD; Lorenz DL; Goldstein RM; Brigham ME; Cowdery TK. 1998. Water Quality in the Red River of the North Basin, Minnesota, North Dakota, and South Dakota, 1992-95. U.S. Geological Survey Circular 1169. Update 4/12/98. http://water.usgs.gov/pubs/circ1169

Tan LK; Humphries D; Yeung PYP; Florence LZ. 1996. Determinations of clopyralid, picloram, and silvex at low concentration in soils by calcium hydroxide-water extraction and gas chromatography measurement. J. Agricult. Food Chem. 44(4): 1135-1143.

Thompson OJ; Emerson JL; Strebing RJ; Gerbig CG; Robinson VB. 1972. Teratology and postnatal studies on 4-amino-3,5,6-trichloropicolinic acid (picloram) in the rat. Food Cosmet. Toxicol. 10: 797-803.

Tu CM. 1994. Effects of herbicides and fumigants on microbial activities in soil. Bulletin of Environmental Contamination and Toxicology. 53 (1):12-17.

USDA Forest Service (United States Department of Agriculture Forest Service). 1988. Managing Competing and Unwanted Vegetation, Final Environmental Impact Statement. Pacific Northwest Region.

USDA Forest Service (United States Department of Agriculture Forest Service). 1989. Pesticide Background Statements. Volume I. Herbicides. Agriculture Handbook No. 663.

U.S. EPA (United States Environmental Protection Agency). 1988a. Guidance for the Reregistration of Pesticide Products Containing Picloram as the Active Ingredients. U.S. EPA, OPTS, Washington, DC. EPA Publication No. 540/RS-88-132.

U.S. EPA (United States Environmental Protection Agency). 1988b. Picloram Health Advisory. U.S. EPA, ODW, Washington, DC.

U.S. EPA (United States Environmental Protection Agency). 1992a. Integrated Risk Information System, Picloram. Rev. 5/1/92. www.epa.gov/ngispgm3/iris/subst/0256.htm

U.S. EPA (United States Environmental Protection Agency). 1992b. Drinking water criteria document for picloram. United States Environmental Protection Agency. Health and Ecological Criteria Division.

U.S. EPA (United States Environmental Protection Agency). 1995. Reregistration

Eligibility Decision (RED): Picloram. Prevention, Pesticides, and Toxic Substances, EPA 738-R95-019. August 1995.

U.S. EPA (U.S. Environmental Protection Agency). 1997a. EMMI: Environmental Monitoring Methods Index. EPA Database of Analytical Methods for Regulated Substances. CD-ROM Version developed by Enviro Dynamics, Inc. Government Institutes, Rockville MS 20850.

U.S. EPA (United States Environmental Protection Agency). 1997b. Hexachlorobenzene: IRIS Entry. Last update 3/1/97. http://www.epa.gov/ iris/subst/ 0347.htm.

U.S. EPA (U.S. Environmental Protection Agency). 1998. Lists of Inert Pesticide Ingredients. Http://www.epa.gov/ opprd001/ inerts/lists.html. Updated Augurs 7, 1998.

U.S. EPA (United States Environmental Protection Agency). 1999. Picloram; Time-Limited Pesticide Tolerances. Federal Register. 64(2):418-425.

USGS (U.S. Geological Survey). 1998. Data on Pesticides in Surface and Ground Water of the United States., Results of the National Water Quality Assessment Program (NAWQA). Revised Oct. 23, 1998. Http://wwwdwatcm.wr.usgs.gov/cppt/pns_data/data.html.

Woodward DF. 1976. Toxicity of the herbicides dinoseb and picloram to cutthroat and lake trout. J. Fish. Res. Board Canada. 33: 1671-1676.

X. Toxicity and Risk Categories

ESTIMATES OF HEALTH RISK TO THE PUBLIC AND TO WORKERS FROM FOREST SERVICE OPERATIONS: The FEIS predicts levels of human exposure (dose) for project workers and for the public, for both a typical field project and for a large accidental spill. These dose levels are compared with the highest dose level in animal tests that showed no effect (NOEL). This level of exposure is referred to as the Margin of Safety or Margin of Exposure approach. The SERA (1999) risk assessment used a conceptually similar approach in which the estimated level of exposure is divided by some estimate of acceptable exposure. Both the FEIS and the SERA (1999) assessment also express risk qualitatively. In the FEIS, the risk is ranked from "Negligible" to "High" based on the margin between the expected human dose and the highest NOEL "no effect" dose. A "High" risk rating means that the highest NOEL dose is not more than 10 times larger than predicted human dose under the specified conditions. A "Moderate" risk rating means that the highest NOEL dose is between 10 and 100 times larger than the expected human dose.

As illustrated in the following tables, the qualitative expression of risk for both workers and the general public is reasonably consistent between the FEIS and the updated SERA (1999) risk assessments. The PNW Region determined that no new information summarized in this profile or in SERA (1999) would change the public or worker mitigations in the 1988 FEIS, which were based on potential human health risks.

Estimated Health Risks To Project Workers[a].			
Scenario	Risk Category		
	Typical	Lower	Upper
Directed ground[b]	Negligible	Negligible	Negligible */Low*
Broadcast ground spray[c]	Negligible	Negligible	Negligible */Moderate*
Aerial	Negligible	Negligible	Negligible */Low*

[a] From PNW FEIS and SERA 1999. Where risk classification differ in the two assessments, the classification from SERA is presented in italics.
[b] Backpack, cut surface, and streamline
[c] Boomspray

Estimated Health Risks To The Public[a].			
Scenario	Risk Category		
	Typical	Lower	Upper
Accidental Spray[b]	Negligible	Negligible	Negligible */Moderate*
Dermal, vegetation [c]	Negligible */Low*	Negligible	Negligible */Moderate*
Contaminated fruit [d]	Negligible	Negligible	Low
Contaminated water [d]	Negligible	Negligible	Low/ *Negligible*
Contaminated fish [d]	Negligible	Negligible	Negligible

[a] From PNW FEIS and SERA 1999. Where risk classification differ in the two assessments, the classification from SERA is presented in italics.
[b] PNW is based on spray drift. SERA 1999 assessment is based on direct spray.
[d] PNW based on deposition data. SERA 1999 based on Durkin et al.(1995).
[d] PNW is based on short-term exposures. SERA 1999 assessment is based on longer-term exposures.

ECOTOXICOLOGICAL CATEGORIES

Mammalian (Acute Oral):	
mg/kg	**Risk Category**
< 10	very highly toxic
10-50	highly toxic
51-500	moderately toxic
501-2000	slightly toxic
> 2000	practically non toxic

Avian (Acute Oral):	
mg/kg	**Risk Category**
< 10	very highly toxic
10-50	highly toxic
51-500	moderately toxic
501-2000	slightly toxic
> 2000	practically non toxic

Avian (Dietary):	
mg/kg	**Risk Category**
< 50	very highly toxic
50-500	highly toxic
501-1000	moderately toxic
1001-5000	slightly toxic
> 5000	practically non toxic

Aquatic:	
ppm	**Risk Category**
< 0.1	very highly toxic
0.1-1	highly toxic
> 1-10	moderately toxic
> 10-100	slightly toxic
> 100	practically non toxic

TABLES OF CATEGORIES OF TOXICITY

Human Hazards				
		Route of Administration		
Risk Category	**Signal Word**	**Oral (mg/kg)**	**Dermal (mg/kg)**	**Inhalation (mg/kg)**
I	**DANGER -- Poison**	0-50	0-200	0-0.2
II	**WARNING**	> 50-500	> 200-2000	> 0.2-2.0
III	**CAUTION**	> 500-5000	> 2000-20,000	> 2.0-20
IV	**NONE**	> 5000	> 20,000	> 20

	Hazard	
Category	**Eye Irritation**	**Skin Irritation**
I	corrosive: corneal opacity not reversible within 7 days	corrosive
II	corneal opacity reversible within 7 days; irritation persisting for 7 days	severe irritation at 72 hours
III	no corneal opacity; irritation reversible within 7 days	moderate irritation at 72 hours
IV	no irritation	mild or slight irritation at 72 hours

Category of Quality of Health Effects Data	
Inadequate:	Inadequate information available for evaluating toxicity. There were too few studies of sufficient quality to yield useful or reliable information.
Marginal-Inadequate:	Some useful information exists for evaluating toxicity. There were studies of marginal quality that provided useful information, but studies were inconsistent and some contained flaws. It is likely that new studies would change estimates of health effects.
Marginal:	Marginal but useful information available for evaluating toxicity. There were studies of adequate quality, and results did not vary greatly, but more information would increase reliability. Although new studies may change estimates of health effects, the results are considered moderately reliable.
Adequate:	Adequate information is available. Studies are of sufficient quality and quantity that estimates of human health are considered reliable. New studies are unlikely to change estimates of health effects.