CONTROLLING BURROWING RODENTS WITH BURROW FUMIGANTS

Fumigants: General Information

Burrow fumigants are gaseous pesticides placed in animal burrows to control pests, typically rodents. These include prairie dogs, pocket gophers, Richardson's ground squirrels and Columbian ground squirrels. Some burrow fumigants also are labelled for use against striped skunks, coyotes, and red fox.

Though burrow fumigants may be used as a primary control technique, the cost in materials and labor generally restrict their use to small acreages, sparse populations or as "clean up" following toxic bait applications. Researchers estimate that fumigation costs 5 to 10 times more than toxic bait. A benefit of burrow fumigants, however, is that they lack residual and secondary toxicity. Animals may reoccupy treated burrows or feed on carcasses killed by fumigants with no ill effects.

Before using fumigants or any other pesticide products, carefully read and follow the pesticide label. When not in use, store pesticides in a dry, cool and secure area. Always keep pesticides in their original, labeled container.

Burrow fumigants are highly toxic to nontarget wildlife inhabiting burrows. Read and follow label instructions carefully as it contains guidelines that will help reduce the risk of killing nontarget animals. Some labels will require you contact the U.S. Fish and Wildlife Service [406-449-5225 (Helena) or 406-758-6868 (Kalispell)] prior to applying the fumigant. Likewise, survey your property for nontarget animals and their sign. Do not fumigate burrows occupied by nontarget animals. The "Label is the Law."

Signs of Nontarget Burrows

- The black-footed ferret, an endangered species, is known to occupy prairie dog burrows. Look for troughs created by ferrets excavating soil from the burrow (Fig. 1). Black-footed ferret presence can also be indicated by the finding prairie dog burrows backfilled with soil as they attempt to defend against ferret predation.

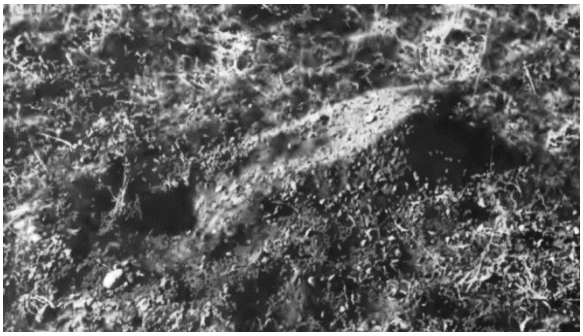

Figure 1. A trough commonly created by black-footed ferrets.

- Ferret tracks look similar to mink tracks.
- Burrowing owls leave white scat and feathers around the den entrance (Fig. 2).

Figure 2. Burrowing owl den. Note the white scat and feather in the lower portion of the image.

- Weasels create toilettes near den sites. Their scats tend to be long tubes with pointed ends ¼ inch in diameter and up to three inches long which is quite different than the pelleted (tubular) scat of ground squirrels and prairie dogs (Fig. 3).

Figure 3. Pelleted-style scat of a Richardson's ground squirrel.

- Burrow entrance size and/or shape can also help identify non-target burrows.
  - Swift fox: typically, less than 8 inches wide. Dens often occur in clusters.
  - Badgers: 6 to 8 inches in diameter and accompanied by a fan-shaped soil plume caused by the badger's excavation.

Signs of Target Burrows

- Many rodent pest species are easily seen during daylight hours.
- Consider the diameter of the burrow opening. If you encounter a burrow that does not match the typical burrow size of the animal you are targeting, avoid it or make sure to investigate carefully before treating it. Below are typical burrow diameters for target species.
  - Ground squirrel 2 to 4 inches.
  - Prairie dog: 4 to 10 inches
  - Red fox: 8 to 15 inches
- Foxes and coyotes often scatter carcasses of prey remains around their dens.

Treat only active burrows containing the target species. Application of pesticides to inactive burrows wastes time, money and puts non-target animals at unnecessary risk.

Consider the following clues to help you identify inactive burrows:

- Burrow is completely or partially collapsed.
- The burrow seems unkempt and lacks evidence of recent digging activity.
- Burrow area lacks presence of fresh droppings/feces.
- A spider web spans burrow opening (Fig. 4).

Figure 4. Inactive prairie dog burrow identified by the spider web and unkempt character.

Another way to distinguish active from inactive burrows is by closing holes in affected areas by disking or raking. Active holes will be reopened in a few days. Treat burrows that subsequently reopen provided that evidence of non-target animals is not present.

Fumigants work best when soil moisture is high, such as in early spring, after soaking rains or irrigation. Moisture helps fill gaps within soil particles thereby keeping gases contained within the burrow system.

Note: even when using best practices, fumigants seldom control 100 percent of the treated burrows. So, follow-up treatment of active burrows is usually required. Fumigants have no residual effect, allowing neighboring animals to reoccupy treated burrows.

EPA Registered Fumigants

Presently, only three types of fumigants are registered by the EPA and the Montana Department of Agriculture (MDA), ignitable gas cartridges, carbon dioxide (dry ice) pellets and aluminum phosphide-based tablets/pellets.

Ignitable Gas Cartridges

Ignitable gas cartridges have been the traditional burrow fumigant because they are effective and do not require a pesticide license to use.

The U.S. Department of Agriculture through the Animal and Plant Health Inspection Service (USDA-APHIS) manufactures two gas cartridges. Both cartridges contain sodium nitrate and charcoal as active ingredients that when lit produce toxic carbon monoxide gas.

The smaller gas cartridge is 1½ inches wide by 6 inches long and weighs about five ounces (Fig. 5). It is registered for the control of woodchucks, yellow-bellied marmots, ground squirrels, black-tailed prairie dogs, white-tailed prairie dogs and Gunnison prairie dogs in open fields, non-crop areas, rangelands, reforested areas, lawns and golf courses.

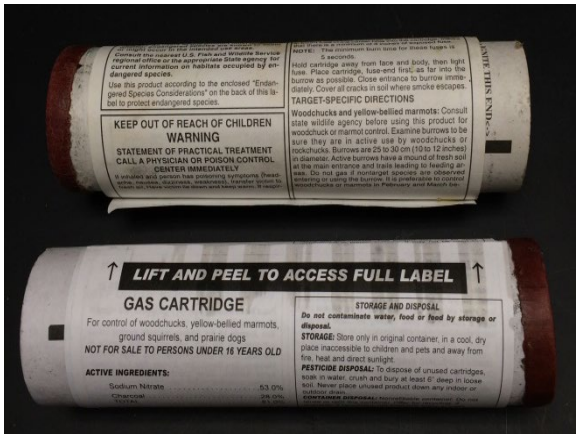

Figure 5. The small-sized ignitable cartridge manufactured by USDA-APHIS.

The large gas cartridge is 1½- inches wide by 12 inches long and weighs 10.2 ounces. It is only registered for control of denning coyotes, red foxes and striped skunks in rangelands, crops and non-crop areas.

Read and follow the label carefully before you purchase and use the product. These products are restricted for use in outdoor, below-ground burrows actively used by the target species. Labels contain information on how to identify dens actively used by target species. If the label requires you to contact the Montana Fish, Wildlife & Parks call 406-444-2535 and speak with the non-game wildlife biologist designated for your area. Do not treat burrows used by non-target or protected species.

Effective use of the product requires the cartridges to burn thoroughly and the gasses to be contained in the burrow. Neglect of either point will result in lower levels of control.

Whenever possible, identify connecting holes to the burrow(s) you plan to treat. Fill them with soil prior to igniting the cartridge. Have soil available to fill the hole you plan on placing the fumigant cartridge in prior to lighting. The goal is to ensure that as much of the toxic gas remains in the burrow as possible.

Puncture the end of the cartridge at the marked locations using a nail at least ⅛-inch in diameter. These holes will allow the gases to escape when the contents burn. If cartridges seem compacted, insert a nail to loosen the contents of the cartridge to assure complete combustion. Insert a fuse in the middle of one end of the cartridge. Ensure that at least three inches of the fuse is exposed before lighting. Three inches of exposed wick will burn for about nine seconds.

After lighting the fuse, place the cartridge, fuse end first, into the burrow as far as possible. Begin sealing the hole immediately to ensure the

burrow holds as much toxic gas as possible. Do not allow soil to smother the cartridge as this may prevent complete burning. Cover any openings from which smoke escapes (Fig. 6).

Figure 6. Sod plugs may also be used to cover a burrow opening.

The Atlas Chemical Corporation manufactures an ignitable gas cartridge called "The Giant Destroyer®" (Fig. 7). Its active ingredients are sodium nitrate, carbon and sulfur. When burned, this cartridge produces toxic carbon monoxide as well as sulfur-based oxides.

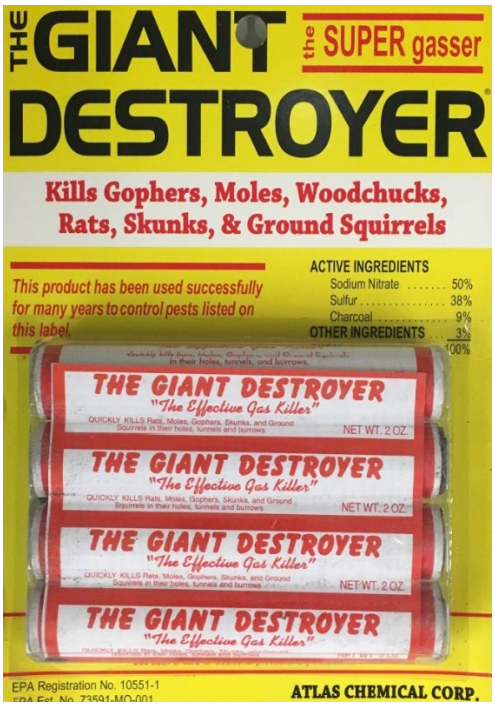

Figure 7. The Giant Destroyer fumigant.

This product is registered to control pocket gophers, moles, woodchucks, Norway rats, skunks and ground squirrels in outdoor burrows located in non-crop areas including residential lawns, parks, golf courses, reforested areas, open fields and rangeland. Note that moles do not live in Montana. Use directions are very similar to those required by USDA fumigants. The minimum fuse length for The Giant Destroyer fuse is only two inches.

Cautions with Ignitable Cartridges

Generally, the gases produced from a single cartridge are sufficient to fill a burrow system. Under normal soil moisture, gas cartridges will achieve control efficacy of 75 percent or higher.

Fumigant effectiveness can be reduced when used in complex burrow systems, in burrows with several openings and interconnecting tunnels or with turns, dips and rises or when soil is extremely dry and/or cracked. In these conditions, additional applications may be necessary if permitted by the label.

Gas cartridges burn with considerable heat and flame. Take great care to prevent accidental fires, especially when used in dry conditions. Do not use ignitable fumigants when soil or vegetation in the area is extremely dry. Fumigating burrows in dry soil is also less effective because gases escape into the porous soil. Moist soil holds gases better because water fills the gaps between soil particles. Whenever possible, plan to fumigate after a soaking rain.

Do not use gas cartridges under or near buildings. Cartridges can cause personal injury. Wear a glove, at least on the hand handling the cartridge, when lighting. Stay up wind when possible and avoid breathing the fumes. Store gas cartridges in a secure and dry location.

We do not recommend using ignitable gas cartridges on pocket gophers due to inadequate evidence of efficacy.

Carbon Dioxide Fumigation

Carbon dioxide (CO_2) gas is naturally produced by the metabolic processes of our body. With every breath, we exhale CO_2 as a waste product. Room air contains 0.4 percent CO_2, but concentrations as low as 30 percent or higher can be lethal to animals. Research shows that rats become unconscious in 25 seconds when exposed to 100 percent CO_2.

Carbon dioxide offers many benefits as a fumigant. First, the gas is heavier than air so it naturally sinks into burrows. Second, it is non-flammable. Finally, it offers a greater margin of safety for the applicator than other fumigant gases, thereby avoiding restricted use designation.

Rat Ice

In 2017, the EPA registered carbon dioxide-based fumigants to control burrowing rodents. Rat Ice™ (EPA # 12455-148) uses pelleted dry ice to kill Norway, roof, and Polynesian rats in active burrows around industrial, commercial, public and residential areas. (Roof and Polynesian rats do not occur in Montana). It may also be used around homes, lawns, campgrounds, golf courses, public parks, and commercial nurseries.

Identify active burrows by sightings, visible runways, burrow holes and soft soil undermined with tunnels. Burrows often are 2 to 4 inches in diameter and will have smooth surfaces. The presence of excavated soil and trampled vegetation are also indicators of active burrows. Active burrows may be hidden by debris. All active burrows will have rat hairs present at the opening. Rats shed hundreds of hairs daily so a close look will reveal the presence of hair if the burrow is active.

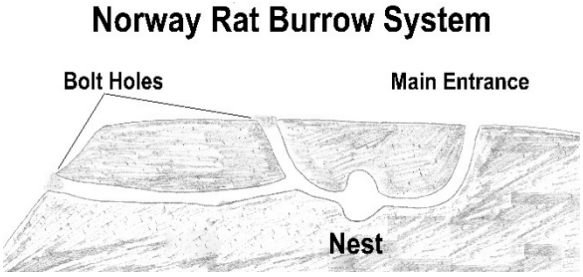

Figure 8. Idealized burrow system of the Norway rat.

Gas fumigant applications may be made only to burrows outside of buildings. Applicators must follow label restrictions when treating burrows near structures.

Bottled Carbon Dioxide

Liphatech, Inc. manufactures IGI Carbon Dioxide™ (EPA # 91274-1) that uses bottled CO_2 rather than pellets to dispense CO_2 into burrows. IGI Carbon Dioxide is labelled for use on burrowing rodents, such as pocket gophers, ground squirrels, rats, and voles including those burrowing near structures. Unfortunately, it is not registered for use on prairie dogs at this time.

The Vertebrate Pest Specialist welcomes comments from applicators on their experience with IGI Carbon Dioxide (contact info at the end of this document).

Aluminum Phosphide-Based Tablets/Pellets

Aluminum phosphide, better known for its use as a grain fumigant, is registered to control burrowing rodents. It is a restricted-use pesticide and may only be used by licensed personnel or individuals under their direct supervision. To obtain a pesticide license contact the Montana Department of Agriculture at the number listed at the end of this document.

Aluminum phosphide-based pesticides are formulated as tablets or pellets (Fig. 9). Tablets are five times larger than pellets.

Aluminum phosphide-based fumigants may be

applied to control woodchucks (woodchucks do not occur in Montana), yellowbelly marmots (rock chucks), prairie dogs (except Utah prairie dogs, *cynomys parvidens*), Norway rats, roof rats, mice, ground squirrels, voles, pocket gophers and chipmunks in underground burrow systems located in non-crop areas, crop areas or orchards.

Figure 9. Size comparisons of a tablet (left) and pellet (right).

Phosphine gas is highly toxic and capable of killing humans, vertebrate wildlife and even insects. Due to its lethality, applicators must follow many safety guidelines to ensure safe and effective use.

Some of these safety rules include:

1. Completion of a detailed, written Fumigant Management Plan (FMP) prior to application. An FMP template (not for use with prairie dogs) is available from the MDA at https://agr.mt.gov/Vertebrate-Pests or by contacting the Vertebrate Pest Specialist listed at the end of this document. Other FMP templates may be obtained from the pesticide manufacturer.

2. Prior to applying aluminum phosphide to rodent burrows, the applicator must provide the customer with a copy of the completed FMP.

3. Using aluminum phosphide-based fumigants is strictly prohibited for fumigating rodent burrows on single or multi-family residential properties and nursing homes, schools (except athletic fields), day care facilities and hospitals.

4. Strict prohibitions against applications to rodent burrow systems within 100 feet of a building that is or may be occupied by humans and/or domestic animals.

5. A phosphine gas monitor must be used for all applications to ensure that applicator exposure to phosphine gas does not exceed 0.3 ppm for the 8-hour Time Weighted Average (TWA) or the 15-minute Short Term Exposure Limit (STEL) of 1.0 ppm. If these limits are exceeded but below 15ppm, applicators may either vacate the treated area until gas levels are reduced or wear a properly fitted, full-face respirator capable of filtering phosphine gas. If gas levels exceed 15 ppm or are unknown, then the applicator must wear a NIOSH/MSMA self-contained breathing apparatus (SCBA).

Applicators of aluminum phosphide must avoid harming threatened and endangered species. Before any use of aluminum phosphide, applicators must obtain a *Pesticide Use Bulletin for the Protection of Endangered Species* for their county by visiting https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins. The bulletin should be downloaded, printed, and kept with the pesticide label. If the fumigant will be used to control prairie dogs, applicators must contact the U.S. Fish and Wildlife Service [406-449-5225 (Helena) or 406-758-6868 (Kalispell)] and conduct a proper field survey in search of black-footed ferrets prior to application. Officials with the U.S. Fish and Wildlife Service will explain how to perform the survey.

Since phosphine gas collects in the sealed flask, open containers only in well-ventilated areas, such as outdoors. Hold the flask downwind, at arm's length with lid directed away from your

face when opening. Phosphine readily absorbs through the skin, especially when the skin is damp. Cotton or similar gloves that discourage hand sweating should be worn during application and thoroughly aired out in a well-ventilated area before reuse or disposal (Fig. 10). Do not wear rubber gloves or other impermeable gloves as they cause hands to sweat.

Figure 10. Cotton gloves with a aluminum phosphide container.

Other restrictions and regulations are explained in the aluminum phosphide labels. Be sure to read and follow the entire label, which consists of the container label, MSDS/SDS and the supplemental applicators manual.

In the presence of moisture these products release hydrogen phosphide (phosphine) gas. The rate of gas release varies depending on the temperature and amount of moisture present in the soil. Under average conditions gas release is slow, taking up to 24 hours (or more) to exhaust the application of tablets/pellets.

Place two to four tablets or 10 to 20 pellets in each active burrow. Use fewer tablets/pellets in smaller burrows under moist conditions and more tablets/pellets in larger burrows and dry conditions. Never exceed the maximum application amount. Cover the burrow opening with soil after packing the opening with crumpled newspaper to prevent soil from smothering the aluminum phosphide fumigant. A length of plastic pipe (1½ -1¾ in. dia.) may be used to help guide the tablets/pellets deep inside the burrow. When used correctly and in normal soil conditions, aluminum phosphide will control 80 to 95 percent of the treated prairie dog burrows.

Do not expose tablets or pellets to water or other liquid because this causes the immediate release of gas and may cause a fire. Never use phosphine gas during inclement weather. Store in a locked, dry, and well-ventilated area.

Alternative Fumigation Methods

Inventors have created devices that use carbon monoxide gas (CO) to kill burrowing rodents. The P.E.R.C.® Pressurized Exhaust Rodent Control (Fig. 11), the Cheetah**,** BurrowR$_x$, and the CO-Jack are devices marketed to control burrowing rodents.

Figure 11. P.E.R.C. fumigation equipment.

These devices are not regulated by the EPA, so pesticide licenses are not required for their use. Though not regulated, they should be used with care. Carbon monoxide is highly toxic and

capable of harming applicators and others exposed to the gas. We recommend working into the wind to reduce the likelihood of being exposed to CO. Likewise avoid fumigating burrows near structures (particularly occupied structures) to prevent poisoning inhabitants. We advise fumigating burrows away from structures at distances no closer than those recommended below; unless the manufacturer's instruction manual suggests a greater distance.

Minimum recommended distances from structures when using fumigants for control of burrowing rodents:

- 150 feet for pocket gophers,
- 100 feet for prairie dogs,
- 20 feet for ground squirrels, and
- 20 feet for rats.

Research on the P.E.R.C. device in California found it achieved 71 to 81 percent control on Belding's ground squirrels and 45 to 61 percent control on pocket gophers. The device has also been used in Colorado to control other burrowing rodents, such as prairie dogs, but efficacy results rely on anecdotal claims and not on controlled studies. Montana Department of Agriculture research using the Burrow Rx achieved 86% control of Richardson's ground squirrels with a 60 second injection time and 91% control of prairie dogs with a four-minute injection time. Unfortunately, only 32% of Columbian ground squirrels were controlled with an injection time of three minutes. If applicators wish to use carbon monoxide devices for the control of Columbian grounds squirrels, we suggest injection times start at four minutes but prepare to go higher.

Montana's Vertebrate Pest Specialist, welcomes comments from applicators who have used and/or are planning to use carbon monoxide delivery devices.

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DEPARTMENT SERVICES

Vertebrate pest control will be most effective where all affected landowners work together. The Montana Department of Agriculture Vertebrate Pest Specialist program will assist County Commissioners, Extension Agents, and landowners to establish a program suited to local and county needs. Field demonstrations are provided to inform landowners how, when, and where to control field rodents and other vertebrate pests. Interested individuals should contact the Montana Department of Agriculture.

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Additional printed information on the control of vertebrates is available from the Montana Department of Agriculture website http://agr.mt.gov/Topics/Vertebrate-Pests

MONTANA POISON CONTROL
(Emergencies)
1-800-222-1222

MONTANA DEPARTMENT of PUBLIC HEALTH & HUMAN SERVICES
Injury Prevention Program
1-406-444-4126
https://dphhs.mt.gov/

Disclaimer: Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement by the Montana Department of Agriculture is implied for those mentioned.

Credits

Fig. 1. Bureau of Land Management publication
Figs. 2-4, 6-8 & 10. Stephen M. Vantassel, Montana Department of Agriculture

Fig. 5. Stephen M. Vantassel, Wildlife Control Consultant, LLC.
Fig. 9. Degesch of America
Fig. 11. H & M Gopher Control