

NATSOP-FOX004 NATIONAL STANDARD OPERATING PROCEDURE: FUMIGATION OF FOX DENS USING CARBON MONOXIDE

Voluntarily adopted by the Vertebrate Pest Committee 2013 with the Invasive Plants and Animals Committee endorsing minor updates September 2017.

BACKGROUND

The introduced European red fox (*Vulpes vulpes*) has a significant impact on native fauna and agricultural production. Fox control methods include lethal baiting, trapping, shooting, den fumigation, den destruction and exclusion fencing.

Fumigation of breeding, or natal dens with carbon monoxide (CO) gas is sometimes used to kill young cubs. Although den fumigation may locally reduce the number of foxes or problem animals, it is not effective as a general fox control method.

Carbon monoxide is a colourless, odourless gas that causes oxygen depletion leading to unconsciousness and rapid death without pain or discernible discomfort. The gas is generated by the incomplete combustion of carbon using sodium nitrate within a fumigant cartridge. CO is toxic to humans, therefore operators using the cartridges must take adequate precautions to safeguard against accidental exposure.

This National Standard Operating Procedure (NATSOP) is a guide only; it does not replace or override the legislation that applies in the relevant state or territory jurisdiction. The NATSOP should only be used subject to the applicable legal requirements (including OH&S) operating in the relevant jurisdiction.

APPLICATION

- Den fumigation should only be used in a strategic manner as part of a co-ordinated program designed to achieve sustained effective control.
- Den fumigation is best suited to localised fox problems such as active dens within lambing paddocks or near poultry. It is time-consuming and labour intensive and therefore an inefficient method for large-scale fox control in Australia.
- Fumigation should be carried out only when active dens containing young cubs older than 4 weeks of age can be located. This will usually be around August to October.
- Carbon monoxide fumigation appears to be a humane method of fox destruction provided that high enough concentrations of CO to bring about a rapid death can be introduced into the den; that cubs are sufficiently grown to be fully susceptible to the effects of CO; and, that animals are not exposed to high temperatures during combustion of the cartridges.
- Carbon monoxide is the only fumigant registered for foxes. Other fumigants, for example, chloropicrin (trichloronitromethane) and phosphine (aluminium phosphide) are not registered for use against foxes. Chloropicrin is considered to be highly inhumane and phosphine also causes significant suffering therefore they must not be used for fox den fumigation.
- DEN-CO-FUME® carbon monoxide cartridges are the only prescribed means for the generation of CO as a fumigant. Exhaust from idling internal combustion engines does not produce adequate CO concentrations and older engines produce sulphur and nitrogen oxides that cause severe irritation before death. Also, the exhaust gases produced may be unacceptably hot.
- Fumigation can take place in adverse weather conditions as generation of CO by combustion of the cartridges is not affected by wet and windy weather conditions. However, fumigation should be avoided in dry, hot, windy weather when there is a high fire risk.
- Fumigants must be used according to instructions on approved labels and guidelines issued by relevant state authorities for vertebrate pest control.

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ANIMAL WELFARE CONSIDERATIONS

Impact on target animals

- When inhaled, carbon monoxide binds to haemoglobin in the red blood cells with an affinity 250 times that of oxygen. This results in reduced oxygen-carrying capacity and altered delivery of oxygen to cells. Hypoxia – the reduction of oxygen supply to the tissues – eventually leads to unconsciousness and death.
- Death occurs rapidly at CO concentrations of 4 to 6%. Carbon monoxide concentrations greater than 2% are sufficient to cause loss of consciousness within minutes. Failure of the respiratory centre then occurs followed by death from cardiac arrest.
- Hypoxia induced by CO is insidious. Animals do not appear to experience distress as unconsciousness is induced without pain or discomfort.
- With den fumigation, the time to unconsciousness and death depends on factors such as CO concentration (influenced by size of den, porosity of the soil in the den, full or incomplete combustion of the cartridge) and animal age.
- Neonatal animals are relatively resistant to hypoxia. Physiological mechanisms exist to protect the animal from cerebral damage when oxygen is limited in the uterus and during birth. Because inhalation of CO causes hypoxia, neonatal animals may therefore take longer to become unconscious and die than adult animals. To ensure that death is rapid, fumigation should only be performed when cubs are relatively well grown (ie greater than 4 weeks of age). At this stage cubs will be starting to eat solid food, evidenced by the presence of animal materials at the entrance to the den (eg small carcasses, feathers, bones). If the cubs are less than 4 weeks of age there will usually be no evidence of fresh and partially eaten animal material. Fresh earth at the den entrance indicates it has recently been cleaned out by the vixen and may contain newborn cubs. Fumigation of dens containing neonatal cubs is less effective and is considered to be inhumane.
- There is a risk of foxes experiencing burns to skin and fur if they come into contact with cartridges whilst they are still hot. Use of the DEN-CO-FUME® portable fumigator will help to overcome this risk and is therefore recommended.
- Because the recommended time for den fumigation is when the cubs are greater than 4 weeks of age, it is less likely that the vixen will also be killed. She will usually only be in the den for prolonged periods of time during the first 3 weeks after the birth of the cubs.

Impact on non-target animals

- Fumigation of fox dens is one of the most target-specific means of fox destruction and will have no significant impact on non-target species if used correctly.
- The cartridges must only be used in dens where there is evidence of occupation by foxes e.g. presence of fox tracks, prey remains and distinctive odour. If a den appears to be empty or possibly occupied by a non-target species, fumigation must not be performed.
- There appears to be no significant risk of secondary poisoning if carcasses of gassed animals are consumed by non-target predatory or scavenger species.

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HEALTH AND SAFETY CONSIDERATIONS

- Operators must strictly follow the directions on the approved label when using carbon monoxide cartridges. They must not be used for any other purpose than the destruction of foxes in natal dens.
- The cartridges must not be used in situations where the operator is in a confined space. Never enter a confined den that has been recently fumigated.
- CO may be explosive at concentrations exceeding 10%.
- Carbon monoxide is extremely hazardous to humans as it is highly toxic and difficult to detect. Exposure from inhalation of combustion products can cause fatal poisoning. Non-fatal poisoning may result in permanent nervous system damage.
- If combustion products are inhaled remove patient from contaminated area. Lay patient down and keep warm and rested. Early signs of toxicosis are headache, dizziness and weakness. If patient is not breathing, apply artificial respiration and perform cardiopulmonary resuscitation (CPR) if necessary. Transport patient to a hospital or doctor without delay.
- Do not touch burning cartridges; they are capable of causing severe burns.
- Once ignited the cartridge will burn vigorously for several minutes, creating a risk of fire in surrounding vegetation. This can be minimised by ensuring that the cartridges are inserted and lighted in-situ. Alternatively, and preferably, the Den-Co-Fume® Fumigator can be used.
- The ingredients in the cartridge are harmless until ignited. Precautions must be taken to prevent unintentional ignition during storage, transport and use.
- For further information refer to the Material Safety Data Sheet (MSDS), available from the supplier.

EQUIPMENT REQUIRED

DEN-CO-FUME® carbon monoxide fumigant cartridges

- The cartridges consist of a cardboard tube containing carbon in the form of charcoal (35%) and sodium nitrate (65%). Once ignited by a fuse, the active components burn for 2 to 4 minutes to produce carbon monoxide according to the following equation:
$$4C + 2NaNO_3 \rightarrow 3CO + Na_2CO_3 + N_2$$
- One cartridge will produce up to 3% carbon monoxide in a den volume of 1000 litres (1 m³). The concentration will be higher in smaller dens.
- For a typical fox den with only one entrance, one cartridge will be sufficient. If dens are quite old and large with multiple entrances or, they are located in enlarged rabbit warrens, two or more cartridges placed at opposite ends may be necessary.
- Cartridges must be stored in a cool, dry, well-ventilated area away from any source of ignition (e.g. sparks, naked flames etc).

DEN-CO-FUME® fumigator

- Cartridges may be placed directly inside the den or they may be burnt inside a DEN-CO-FUME® fumigator. This is a portable steel combustion chamber with a flexible steel pipe that can be used for fumigation when access to the den is restricted or where there is an unacceptably high risk of fire.

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- Use of the chamber is recommended for the following reasons:
 - prevents exposure of foxes to unacceptably high temperatures, especially in smaller dens where the distance from the end of the cartridge to the animal is less. – reduces the risk of fire in surrounding vegetation.
 - allows monitoring of cartridge combustion. If the cartridge fails to burn completely, another cartridge can be used to ensure that the desired concentration of CO is reached
 - allow fumigation of den when access is restricted.
- Refer to the 'instructions for use' for more details.

Other equipment

- shovel or mattock
- small amount of sand for preparing sand pads
- first aid kit

PROCEDURES

Assessment of den suitability

- Fumigation must only be used in natal dens which have evidence of current fox activity. This can be determined by:
 - the presence of small fox (cub) footprints in the immediate vicinity of the den and also inside the den.
 - the presence of partially consumed, fresh animal carcasses for example, rabbits and birds at the den entrance.
 - a distinctive odour sometimes with large numbers of flies present.
 - trails and flattened vegetation characteristic of cub 'play areas'.

Establish sand pads

- To confirm the existence of cubs in the den, a sand pad (1m² area of raked earth or sand) can be established outside of the den to detect footprints. Although, in doing this, there is a risk of disturbing the den and the vixen removing the cubs.

Fumigation of dens

Do NOT inhale smoke coming from the cartridge or fumigator

- Dens are treated only when the existence of cubs (>4 weeks old) is confirmed.
- Make sure all den entrances are located and if only one cartridge is to be used, block off all but one of these entrances.
- If using the cartridges on their own:
 - use a shovel handle or flexible hose to probe the den to establish that no animals are within 2 metres of the entrance. Flames from the ignited cartridge will extend for up to 30cm and heat will be intense for around 1 metre in a direct radiant path from the combustion point.
 - place the cartridge well into the entrance of the den, light the fuse, confirm the cartridge has ignited, and then seal the entrance to the den with earth. If smoke emerges from any other entrances attempt to seal these with earth also. Do not disturb the den after fumigation.
- If using the cartridges with the fumigator:
 - ensure there are no animals near to the entrance of the den.

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place the end of the pipe into the den and seal the den opening with earth.

– place the cartridge in the fumigator, light the fuse and close the door. If smoke emerges from any other entrances attempt to seal these with earth also. After the cartridge has completely burned (wait for around 10 minutes), remove the pipe outlet from the den and quickly re-seal the entrance. Leave the den sealed.

- Refer to the specific instructions for use with each product for more details.

Procedural notes

Supplier of the DEN-CO-FUME® carbon monoxide fumigant cartridges and DEN-CO-FUME® fumigator is Animal Control Technologies of Australia, Somerton Victoria. See their website: <http://www.animalcontrol.com.au/>

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REFERENCES

1. American Veterinary Medical Association (2007). *AVMA Guidelines on Euthanasia (formerly The Report of the AVMA Panel on Euthanasia)*.
2. American Veterinary Medical Association (2001). *2000 Report of the AVMA Panel on Euthanasia*. Journal of the American Veterinary Medical Association 218, 669-696.
3. Animal Control Technologies Australia (ACTA) (1995). *Den-Co-Fume® carbon monoxide fumigant cartridge for the control of foxes in natal dens*. Information update #13. Victoria.
4. Bureau of Resource Sciences (1995). *Evaluation of carbon monoxide cartridges for the fumigation of fox natal dens* (unpublished report). Bureau of Resource Sciences, Canberra.
5. Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART) (2001). *Euthanasia of animals used for scientific purposes*. ANZCCART, Glen Osmond, South Australia.
6. Hart S, Marks CA and Staples L (1996). Den-Co-Fume – Humane control of foxes (*Vulpes vulpes*) in natal dens. In: Fisher PM & Marks CA (Eds.) *Humaneness and Vertebrate Pest Control*. Pp 58-61. Department of Natural Resources and Environment, Victoria.
7. Marks CA (1996). Research directions for humane burrow fumigation and 1080 predator baiting. In: Fisher PM & Marks CA (Eds.) *Humaneness and Vertebrate Pest Control*. Pp 50-57. Department of Natural Resources and Environment, Victoria.
8. Ross J, Page RJC, Nadian AK and Langton SD (1998). The development of a carbon monoxide producing cartridge for rabbit control. *Wildlife Research* 25:305-314.
9. Saunders G, Coman B, Kinnear J and Braysher M (1995). *Managing vertebrate pests: foxes*. Australian Government Publishing Service, Canberra.
10. UFAW (1988). *Humane killing of animals* (4th Ed). Universities Federation for Animal Welfare, Potters Bar, England.

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