(Revised in May 2023)

Code of Practice
for
Rodent Management

October 2022

By

Pest Control Advisory Section

Food and environmental Hygiene Department

Contents

1. Introduction

Rodents have been closely associated with humans, they cause damage of our properties and risk of our health for many centuries. There are three important commensal rodent species distributed worldwide, namely *Rattus norvegicus* (Sewer Rat), *Rattus rattus* (Roof Rat) and *Mus musculus* (House Mouse). All these rodent species can be found in Hong Kong.

Rodents are implicated in the spread of several diseases that are of great public health importance. They serve as reservoirs of infectious diseases or carriers of transmittable diseases. Important diseases such as plague, hantaviral infection, rickettsial diseases and leptospirosis are transmitted by rodents or their ectoparasites. The University of Hong Kong also reported that there is a type of virus, called "rat Hepatitis E virus", which is believed to have transmitted from rats to a few immunocompromised persons in Hong Kong since 2018, although the exact route(s) of virus transmission (e.g. direct transmission or faecal-oral route) from commensal rodents to human is yet to be confirmed.

Rodents, apart from spreading several rodent borne diseases to human, also cause nuisance. Their gnawing behavior causes economic damage to structural and household items. Both rats and mice are known to cause damage through gnawing of insulation, PVC ducting, wood works, plastics, and even soft metal. Rodents may also cause structural damage and undermine buildings, floors, and flowerbeds through their extensive burrowing. Gnawing through electrical wires is common, and potentially highly hazardous, and has been linked to both power and telecommunications blackouts, and even building and vehicle fires. In addition, the short oestreus cycle and gestation period enable the rodent to proliferate rapidly. Thus, rodents can increase their population rapidly when no rodent control measure is present. Ineffective control of rodents can therefore threaten lives and cause severe damage to local economy.

In addition to the above mentioned, society's expectations as to what constitutes safe and humane rodent control has changed dramatically in the past decades. For example, the prohibition of the use of rodent sticky traps in Australia, and restrictions placed on their use in Tasmania. Similarly, cage traps now require daily inspection in Victoria, Australia.

As a consequence of these expectations and the fact that animal welfare is a continually evolving concern, there is an obvious need to define best practice rodent management procedures for Codes of Practices for Rodent Management in Hong Kong.

Successful control of rodents relies on concerted efforts of relevant stakeholders including

pest control operators in both public and private sectors, management of venues such as residential and commercial buildings, creational facilities, markets, restaurants, etc. This Code of Practice aims at providing relevant stakeholders, particularly property managements, with necessary technical information to facilitate and better their rodent prevention and control work.

2. Strategy of Rodent Management

Integrated Pest Management (IPM) approach should be adopted when dealing with rodent infestation problem. All available rodent management strategies and not simply rely on the use of rodenticides, having good sanitation in conjunction with effective rodent preventive measure provides better control than by using poisonous baits and cage traps alone. Relying on rodenticides alone does not guarantee that the infestation will always be eradicated and, if employed by default, may omit other control measures with a greater likelihood of success. It is obvious that the growth of rodent population heavily depends on the availability of food, harbourage, and dispersal routes. When these survival criteria are limited in the environment, rodent population can hardly proliferate. However, rodent population is dynamic and will rebound swiftly whenever the environment is suitable for their survival. Improvements to environmental factors should always be implemented to provide an effective long-term control effect.

In addition, each site is different and will require a different set of measures, either to prevent rodent infestation or to remove an infestation. A considered management measure may present a low risk at one site, but a higher risk at another. It is important to develop a specific strategy for individual site by conducting thorough inspection to apprehend rodent activities.

3. Control Strategy

The main concept of control strategy should be IPM, that is, to implement all possible effective control measures with the lowest risk first. All methods must be considered before an effective solution is achieved. However, it is not necessary that all methods in the tool box are implemented sequentially, or at all. The success of the control strategy is to find out the best combination of control measures with the least hazard to the environment.

3.1 Rodent proofing

Rodent proofing is a series of physical control measures to prevent the dispersal of rodents, e.g. intrusion into buildings, dispersal within building. It is generally regarded as a long-term solution to rodent problems and are usually without adverse impacts. Such measures should always be implemented at the first priority and is essential in successful rodent control strategy.

3.2 Removal of food sources

Preventing rodent's access to food and water in the environment will greatly increase on the success of a rodent control program and should always be implemented over the times. The effect is more significant that lack of food sources will help to deter rodents from a site, and it will encourage them to take up any baits that are introduced.

3.3 Removal of harbourage

In order to discourage rodent infestations, all debris, rubbish, old machinery, disused articles and equipment, should be removed or cleared timely. Vegetation around buildings should be cleared whenever possible. On the other hand, a buffer zone immediate surrounds of buildings by concreted or paved to prevent rodent burrowing should always be implemented as far as possible.

3.4 Direct control – Trapping

Traps could be a choice when the use of rodenticides is not feasible. Care must be taken to ensure traps do not pose a risk to non-target species, especially when placing traps outside of buildings.

When selecting lethal-traps, only those traps providing instant kill which meeting the humane standard should be considered. In contrary, when selecting live-capture traps, all set traps should be inspected at least daily. Besides, captured live rodents should also be killed in a humane way only.

3.5 Direct control – Poisonous baiting

The use of rodenticides presents the potential risk to people, non-target animals and the

environment and, rodenticides have been found in the dead bodies of stray dogs occasionally. As such, rodenticides should be used after when all environmental factors on sites have been fully considered.

All rodenticides are poisonous and must be used strictly in accordance with the product label as approved by Agriculture, Fisheries and Conservation Department (AFCD). Where necessary and practicable, rodenticides should be contained within locked, tamper-resistant bait stations that are secured in place.

In situations where rodenticides are being employed, special attention must be taken to ensure that the bait and the bait stations do not contaminate any kind of fresh water sources.

Additional guidance on poison baiting strategies can be found in later part of this Code of Practice.

4 Integrated Rodent Management

Integrated Rodent Management implies a combination approach to rodent management that relies on an understanding of the ecology of rodent, in particular, those factors which favour its development, and makes use of non-chemical approaches that modifies the environment less suited to rodent proliferation. Rodenticides have to be used in judicious and environment sensitive ways. Actions should be further determined and supported with a thorough and comprehensive site inspection.

4.1 On-site inspection

A thorough on-site inspection is essential in identifying the area and extent of the rodent problem in the environment that the issue has been reported or detected.

Identifying the species of rodent, areas affected by the rodent(s), and any food and/or water sources will be essential indicators for any proposed monitoring or treatment plan.

This can be achieved by locating and quantifying the following during the inspection:

- Any live rodents observed; and
- Droppings: shape, size and colour (Annex 1);
- Tracking (footprints), or smear (Annex 1);
- Burrows or holes in and around both natural and fabricated areas, internal and external (Annex 1);
- Gnawing marks (Annex 1);
- Whether rodents are using the area for transit or harbourage, or if there is loss of food or spoilage of food stuffs and other stored items;
- Smells, sounds, and previous observations; and
- Nesting materials.

4.2 Tools used during the on-site inspection

The following list of tools and equipment are useful for carrying out an effective inspection:

- Torch (including a 'black-light' ultraviolet torch);
- Ladder;
- Appropriate protective clothing and equipment (e.g. overalls, a pair of goggles, rubber gloves, safety helmet, knee/elbow pads);
- Non-toxic tracking powder/boards;
- Mirror/camera; and
- Remote mirror/camera extension arm for reaching difficult to access areas.

4.3 Exclusion

Methods of exclusion can include, but are not limited to, the below methods:

- Removal of overgrown vegetation and possible harbourage material and disused articles;
- Building physical barriers by installing screens with metal mesh capping, wire mesh,

door sweeps and weather seals to exclude rodents from area of ingress;

- Clearing areas which will expose to rodents or destroying their food, shelter and breeding environment.

All of these methods should be considered in a thorough on-site inspection.

4.3.1 Removal of harbourage

Keeping a high standard of environmental sanitation and rodent harbourage is either eliminated or kept to the minimum, such will always prove of the greatest value in preventing rodent infestation.

Harbourage reduction can include, but is not limited to:

- Removal of rubbish, disused articles and clutter;
- Tidying equipment piles and rotation or removal of long-term stored goods and boxes regularly;
- Sealing voids and excavations made by rodents;
- Regularly trimming surrounding bushland, long-grassed fields, and vegetation in flowerbeds;
- Keeping outbuildings and sheds well maintained;
- Ensuring service voids are accessible;
- Regularly clearing or flushing drains, gutters, sewers and septic tanks; and
- Filling or covering rat-holes, potential rat-holes and any other small openings with rodent proofed material (e.g. fine concrete, cement mortar, 20-gauge sheet or barbed wire ball etc.).

4.3.2 Physical barrier

There are many ways by which rodents may enter buildings, and a very thorough search is necessary to locate all possible means of entry.

Building physical barrier can include, but is not limited to:

- Replacing broken or missing gratings with rodent proofed screens (spacing between grating is no larger than 6 mm);
- Screening ventilation grids and other similar openings either with 6 mm mesh, 24-gauge, expanded metal or with galvanized steel woven wire cloth of 22 S.W.G. at about seven meshes to the inch (25.4 mm);
- Repairing or renewing space beneath doorways result from worn steps;
- Protecting wooden doors at the bottom by fitting a 20-gauge metal 'kicking-plate', at least 300 mm high, on the outside (maximum clearance of 6 mm);
- Fixing a similar metal plate to the door frames to form a continuous band of metal;
- Sealing all opening and passings for pipes, wires, and ducts through walls;
- Spacing vertical pipes at least 100 mm apart, and with at least 100 mm between pipes and wall; and
- Installing rat guard (Fig. 1) made of 20-gauge metal and diameter of at least 550 mm around vertical pipe (space between the rat guard and the pipe should not be larger than 6 mm).

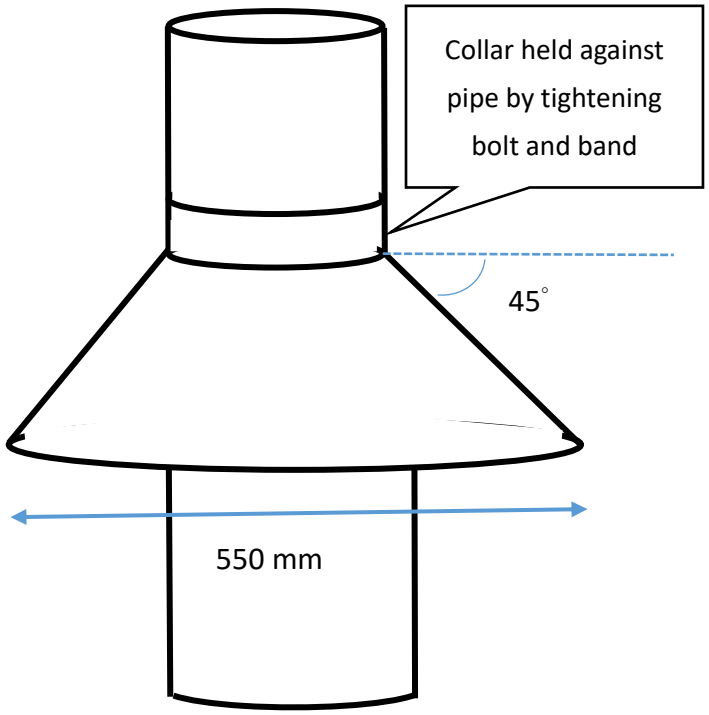


Fig. 1 Specification of Rat Guard

4.3.3 Removal of food and water

Attention should be paid to the storage and disposal of anything which could be taken by rodents as food. This may include:

- Regular and frequent removal of rubbish, food waste, and excess or out of date stock;
- Using metal or plastic dust-bins or receptacles with well fitted covers;
- Regular cleaning of food production zones at the end of each shift and/or production run;
- Adoption of a 'first in, first out' ('FIFO') approach to the storage and handling of both raw materials and finished products in food manufacturing facilities;
- Containment and good storage practices of all food and water sources that are an attractant to the area of activity. (e.g. food bowls, BBQ's, rubbish bins, birdfeeders etc.); and
- Keeping food for human consumption in metal or glass containers with well fitted covers.

All of these methods should be considered in a thorough site inspection. A list of commonly used rodent proofing measures are listed in Annex 2.

5. Rodent Control by Using Traps

With an increasing focus on integrated pest management, non-chemical tools for rodent management are becoming more important. There are several cost-effective non-toxic approaches available to monitor and control rodents. Traps are the preferred method of killing and capturing rodents in situations where the use of rodenticides is considered undesirable.

Trapping has several advantages, in that rodents can be easily removed from the site without leaving chemical residues, success is immediately evident, counts of trapped rodents can be readily tracked, flexibility in food choice for baiting the traps, and in many instances may facilitate the eradication of an infestation without resorting to the use of rodenticides.

The location of traps should be noted and recorded on a site map to facilitate follow-up actions.

5.1 Lethal traps

The advantage for using lethal traps is that the traps can provide instant kill for rodents. For ideal results, traps are placed in rodent runways and:

- Snap/Break-back traps **for rats** should be baited daily but unset for a few days before setting them.
- Snap/Break-back traps **for mice** should always be baited and set on the first day that they are laid. As newly weaned mice are extremely light in weight, it is important to set these traps finely so that the least touch on the treadle can trigger the trap.

When human activity and non-target animals present on the site for traps being laid, all traps should be placed in tamper-resistant stations and the stations should be firmly anchored by screws or cables/wires.

5.2 Wire cage traps

Wire cage traps/Multiple-catch traps for rats and mice should be baited and set on the first day that they are laid. In general, wire cage traps found in the local markets are not designed for trapping mice. The size of the cage/multiple-catch traps must be smaller than 331 mm in length, 181 mm in width or 156 mm in height.

5.3 Sticky traps/Glue traps

Only when countering heavy rodent infestation where other rodent control methods have been exhausted without satisfactory results, sticky traps/glue traps may be considered as a tool to supplement the rodent control programme. They should not be set outdoor or in areas with possible activities of other non-target animals, e.g. birds, cats and reptiles, etc. Consideration may be given to enclosing the sticky trap/glue trap in a lockable, temper-resistant rodent station or dedicated rodent sticky trap/glue trap tunnel for complete protection against non-target animals. Frequent inspections should be arranged to each sticky trap/glue trap laid and any trapped rodent shall be handled of immediately in a

humane manner. The carcass should be properly handled as soon as possible. The use of sticky traps/glue traps should be suspended as soon as the situation of rodent infestation is alleviated. (added in May 2023)

5.4 Positioning the traps

Rats and mice feel safe by moving close to vertical surface such as wall, rather than across open areas. Snap traps should therefore be placed at **right angle to the vertical surface** against which rodents are known or suspected to run. Traps should extend from a vertical surface at a right angle, with the trigger end nearly touching the vertical surface. If traps are set **parallel to the vertical surface**, set them **in pairs**, with the triggers situated to intercept rodents coming from either direction.

When cage traps are used, they should also be placed similarly at right angles with the open of the trap facing the vertical surface or if set **parallel to the vertical surface**, they should be set back to back **in pairs**. Whenever possible, setting rat cages firmly on ground. The position for traps should be carefully chosen, and traps should remain in the same position throughout each trapping period. For best results, traps should be placed **1 m apart for mice** and **1-2 m apart for rats**.

5.5 Number of traps to be used

For best results, a thorough inspection is needed to ascertain the locations of rodent harbourage and movement. Base on the result of the inspection, as many traps as possible and reasonable should be laid. It is suggested that **at least six traps should be laid for one or two rodents**.

5.6 Baits for traps

Rats are omnivorous, consuming a great variety of food. *Rattus norvegicus* loves sweet and oily food. Baits of proven acceptability include bacon, peanut (groundnut) butter, sweet potato, fresh, smoked or dried fish, ground meat or bread for *Rattus norvegicus* and nuts, meat, apple, carrots or bread for *Rattus rattus*. Mice, *Mus musculus*, always prefer cereal grains and seeds. Other baits proved to give good results might also be used for trapping.

Fresh baits should be used as far as possible. Baits that dry out or spoil should be replaced immediately by fresh ones.

Mixed baits, in a certain extent, can minimize the impacts of environmental factors, human practices or variations in rodent behavior on the efficiency of traps during the rodent trapping exercises. As food preference of rodents varies from time to time and place to place, the best combination of food baits for a particular location needs to be tested. However, the list of food baits preferred in a location does not guarantee similar attractiveness to rodents in another location. Trials on different food baits should be conducted in any trapping operation at individual location to find out the preferred combination of food baits.

5.7 Trapping period

With both rats and mice, it is better to carry out repeated trapping programme with a large number of traps laid for a few days, rather than distribute scattered traps over a wide area for a longer period. For a trapping programme, traps should be laid for at least five consecutive nights.

5.8 Courtesy and warning to occupiers

Whenever traps are laid, adequate warning must be courteously given to responsible occupiers – both to avoid injuries to people and animals, touching laid traps with bare hands, touching excreta of rodent and to advise against interference with traps. Pest control operator is responsible for taking appropriate action to see that this is done both verbally and with the issue of whatever forms, notices and letters are available for this purpose.

5.9 Frequency of inspection

The common recommended frequency of inspection for traps varies around the world, with intervals of between daily to twice-daily. If non-target animal is accidentally captured during rodent trapping operations, release the animal at a safe location. When sticky traps/glue traps are used, the frequency of inspection should be increased. Internationally recommended inspection interval range from hourly to every 12-hour. If the captured non-

target animal is or suspected to be injured, contact Society for the Prevention of Cruelty to Animals (SPCA) at their emergency hotline 2711 1000 for assistance. (added in May 2023)

5.10 Handling captured rodents

When selecting lethal traps or killing a live rodent in cage, the most humane ways available should be used. Killing method by breaking upper cervical vertebrate is considered the most efficient and humane way, since damage to the upper cervical vertebrae is more likely to result in immediate loss of consciousness.

Gassing with carbon dioxide (CO_2) may be an alternative method to kill rodent euthanasia due to the minimal handling required and the possibility of euthanizing several rodents at the same time. Rodents should either be removed from the trap or placed into a container to be filled with CO_2, or remain in holding traps, which are then enclosed within an impervious container or plastic sack.

Only CO_2 delivered from a compressed gas cylinder must be used. Gas flow should be delivered using a gradual-fill method and must be maintained for several minutes. The rodent(s) must be left in the gas-filled container for a minimum of ten minutes for effective euthanasia to occur. Death must be confirmed after ten minutes and dislocate upper cervical vertebrate of unconscious rodent by tong or a strong metal bar whenever necessary.

6. Rodent Control by Using Rodenticides

Only registered rodenticides should be used. Always refer to AFCD-approved product labels and for full directions of use and precautions provided by the manufacturer.

6.1 Selecting a rodenticide

When selecting a rodenticide for use in and around buildings, several criteria should be considered:

- Which rodent species are present (Norway rat, roof rat or house mouse)?

- How large is the rodent population?
- Where are the rodents' harbourages and runways?
- Are there foodstuffs stored or manufactured nearby?
- Are non-target animals or children at risk?
- What is the possibility of secondary poisoning on the site, such as animals eating poisoned rodents?
- What is the relative toxicity of the various baiting options?
- What is likely to be the most attractive (smell) and palatable (taste) rodent bait available, considering what the rodents are consuming on-site?

The first four criteria should be dealt with during the initial inspection and discussion with the client.

Where either primary or secondary toxicity is a concern, non-toxic eradication strategies must be considered first (refer to the Risk Management in Section 3) before rodenticide baiting is considered. If rodenticide baiting is required to achieve eradication, further consideration must be given to the baiting strategy (see Section 7). It should not be assumed that first-generation anti-coagulant rodenticides, second-generation anti-coagulant rodenticides, or pro-hormone rodenticides (cholecalciferol) pose any less risk than each other from the perspective or primary or secondary poisoning risk.

The attractiveness of rodenticide baits will vary from population to population and may even change during the course of the year in response to the feeding habits of the population being targeted. Preferred rodenticide bait option should be used but, in situations where rodenticide bait is not taken, alternative measures must be considered.

6.2 First- and second-generation anticoagulants

Anticoagulants disrupt the mechanism that controls blood-clotting and cause fatal internal haemorrhages to develop. Their action is cumulative and most of them need to be ingested over a period of several days to be effective. The main advantage is primary and secondary poisoning hazards to non-target species are generally reduced and if accidental poisoning of human or animals does occur, an effective antidote, vitamin K, is available. Even so, accidentally poisoning to non-target species (e.g. stray dogs) are occasionally reported locally, the utmost care should be taken in their application.

First-generation anticoagulant rodenticides (e.g. warfarin, diphacinone and coumatetralyl) also called 'multiple-dose' rodenticides, are a group of anticoagulants that were developed before 1970. These compounds are much more toxic to rodents when feeding occurs on several successive days rather than on one day only.

The second-generation anticoagulants rodenticides were developed to control rodents that had developed resistance to first generation anticoagulant rodenticides. Examples of them are including brodifacoum, bromadiolone, difethialone, difenacoum and flocoumafen.

Second-generation anticoagulants rodenticides are able to achieve a lethal dose after only a single feeding, although a delayed action still occurs, with death occurring 3-5 days after ingestion. This delayed effect greatly reduces the risk of bait aversion within a population and maximises effective control of rodent infestations.

6.3 Rodenticide formulations

Different rodenticide formulations are available in commercial markets. The choice of which rodenticide formulation to be used can be informed and determined by:

- The nature of the site (e.g. whether a loose grain or pellet formulation can be used or if a securable formulation is required); and
- The dietary requirements and/or feeding preferences of the rodent population present.

Rodenticide block baits, pellets and soft baits are the most commonly used formulations since they can be secured inside lockable, tamper-resistant bait stations and have certain degree of water resistant, and then could be used to combat rodent infestation inside sewer system. Although block baits, pellets and soft baits have certain degree of weather proof, food and flavors preserved in wax base may decrease the acceptability to rodent, thus clearance of food sources is the way to encounter the adverse effect. Cereal baits are also commonly used formulation in local rodent control industries, however, they are more easily affected by weather conditions, such as rainfall and humidity.

7. Poison Baiting Strategies

Brodifacoum and Bromadiolone are the two second generation rodenticides commonly used by local pest control operators, both of them are a ready-to-use bait in form of small pellets or wax blocks. Pellets/blocks containing 0.005% brodifacoum/bromadiolone should be packed in thin PVC bags punched with a number of holes before laying them at target sites whereas each bag of bait pellets should weigh not more than 15 g. Each bait pack is sufficient for killing two to three rats. The thin PVC bag could prevent the bait pellets/blocks from being scattered and provide some protection from moisture. It is not recommended to mix ready-to-use rodenticides, e.g. brodifacoum with any other food sources with an aim to enhance the attractiveness of the rodenticides to rodent as it might also increase the attractiveness to other non-target animals causing accidental uptake by non-target animals. In general, it is not advisable to hang bait pack above ground but if hanging bait pack above ground is unavoidable (due to regular street washing that might spoil the rodenticides), the bait pack should not be hanged at a height greater than 5 cm above ground and only do so in places not frequently visited by human or other non-target animals. In addition, the site conditions, available food sources and the rodent species targeted will often determine the choice of rodenticide and bait formulation to be used (e.g. pellets, block, soft bait). In case rodent bait stations are used for containing rodenticides, they should always be placed in compliance with the product label instructions.

7.1 Use of bait boxes

Utilising lockable, tamper-resistant bait boxes to secure safe use of rodenticides.

Well designed bait boxes fulfil several functions in effective rodent management, they should:

- Protect bait from moisture and dust; and
- Allow rodents to feel more secure; and
- Help keep non-target species, including pets, wildlife and children, away from rodenticides; and
- Help prevent accidental spillage; and
- Offer pest control operators easy access, making it simpler to determine the amount of bait consumed, and need of refill.

7.2 Block control (area control)

The principle of block control is to determine a "block" where it could be a building block, an individual floor of a building and/or an area surrounded by physical barriers (such as lanes, roads, streets, etc.). The advantage of block control is that a large area is able to be divided into smaller blocks and rodent disinfestation could be eliminated phase by phase. If the entire territory of a colony of rodent is covered in the operation, it would largely slow-down re-invasion of rodent from nearby. Pulse baiting will be the major methods to combat rodent infestation within the defined blocks.

7.2.1 Pulse baiting

Pulse baiting are used to remove existing infestations of rats and mice. Single dose anticoagulants (second generation of anticoagulants) is suggested for pulse baiting as frequent inspection generally is not required. Rodenticides are placed in bait boxes and/or placed directly in rodent burrows.

For the best result, poison baits need to be inspected regularly, particularly in the first ten working days (first two weeks) and any bait that has been consumed, together with any contaminated or spoiled bait should be replaced on time.

Baiting is performed for at least 2 weeks (3 to 4 pulses), and it is usually necessary to reduce rat or mouse numbers to a low level. Although heavy infestations may require longer treatments to achieve complete eradication.

Treatment is discontinued when effective control has been achieved and all poison baits should be removed, unless a maintenance treatment is to be undertaken (see below). This strategy will ensure that after the dominant rodents have been eliminated, bait is still available for the less dominant individuals.

7.2.2 Burrow/hole baiting

Rodenticide baits can be placed deep into burrows to avoid access by non-target species. It is recommended to leave the burrow open to allow the rodents to enter/exit with regularity. After 2-3 weeks, seal the hole with crumpled paper, leaves, or other light debris as a means to assess the level of rodent activity.

7.2.3 Surface baiting

All rodenticide baits must be placed in lockable, tamper-resistant bait stations and secured to prevent removal or dislodgement and/or access to the stations by unauthorized persons or non-target species. Bait packs are to be evenly distributed in the target area and the application rate is about 15kg/ha. Sufficient number of warning notices should be displayed to aware the attention to people who living nearby.

7.3 Monitoring

In general situation, the use of non-toxic monitoring baits and/or traps is recommended to monitor for the early presence of rodents.

Where the prevention of rodent infestation is considered essential to maintaining the integrity of safe food production or the prevention of risks to human health, permanent placement of rodenticides may be granted.

If rodent number escalates, revert to pulse baiting. This may mean increasing the number of rodent bait stations on a temporary basis and/or increasing the bait available in each station.

7.4 Replacement of poisonous baits

If rodenticide baits are made with fresh, food grade ingredients, they will diminish in palatability and attractiveness over time.

There are no formal guidelines for the routine replacement of baits, as their deterioration will vary under different environmental conditions. For instance, in warm, damp environments, high humidity levels may significantly shorten the life of rodent baits leading to a requirement for more frequent replacement. Whereas in cool, dry locations field effectiveness may be prolonged. Thus, there is no golden rule to define a standardised timeline of bait replacement.

It is critical therefore, that if rodenticides are being used to eliminate a rodent population that fresh and palatable bait is made continuously available to the rodents. Pest control operators should inspect bait placement at least weekly and subjectively assess if the bait requires replacement. In the absence of any consumption or gnawing by rodents, other signs that the bait requires replacement and increase the frequency of inspection may

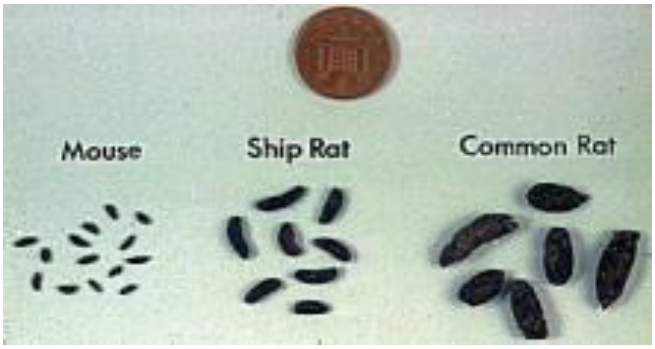
include:

- The presence of mould; or
- Cockroach, beetle, or other insect-related damage; or
- Slug or snail damage; or
- Evidence of water submersion or damage; or
- Discolouration or physical disintegration of the bait; or
- Evidence of heat exposure or melting; or
- Regular exposure or contamination from on-site sources (e.g. chemical spills, fumes).

It is useful to note that the level of active ingredient, particularly with anticoagulants, does not decrease significantly over time. It is the deterioration of the food ingredients that affects the palatability and attractiveness of the bait.

.

Annex 1



The three common rodent droppings of *Rattus norvegicus* (right), *Rattus rattus* (centre) and *Mus musculus* (left).

Examples of rat smears found on the pipe and on the metal louver.

Examples of rodent footprints on soft soil and a rat hole found in top right corner.

Examples of rat holes found in flower bed and at road side.

Examples of gnawing marks found on a wooden door and a plastic container.

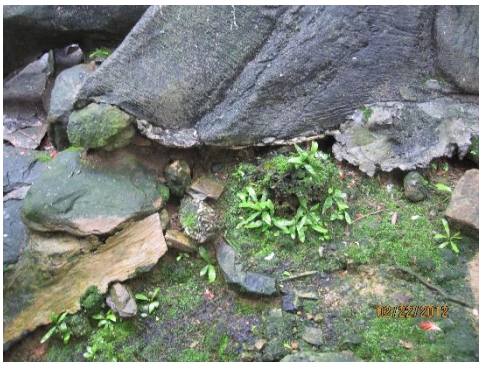
Annex 2

Rodent problems commonly observed locally

Item	Problem found	Possible improvement works
Flower bed and vegetation		
1	Wall of flower bed too low or with protruding structure/uneven surface. 	● Wall of flower bed should be at least 1 m high with smooth external surface without any protrusion.  ● Cover soil surface with gravels to a thickness between 5 cm to 8 cm. 
2	Weep hole of flower bed could be encroached by rodent as rat holes.	● Screen weep holes with grating of aperture not greater than 6 mm.

		
3	Low rise dense vegetation covering the soil surface is vulnerable to rodent intrusion and make detection of rodent infestation difficult. 	● High rise vegetation exposing the soil surface is preferable. 
4	Boulders or other ornamental structure may provide sheltered void for burrowing of rodents. 	● Avoid setting boulders or other ornamental structure in flower bed. ● Surround the base of boulders or ornamental structure with pebbles or gravels. ● Regular inspections to identify any suspected rat holes and take prompt rodent control action whenever rodent sign confirmed.

		
5	Extensive root system of trees, e.g. banyan create natural harbourage for easy burrowing of rodents.  	● Avoid planting of banyan trees or bamboos. ● Expose the roots of the tree by removing vegetation nearby for easy inspection and removal of refuse. ● Plug holes/voids in-between roots by wire mesh ball or other feasible materials. ● Regular inspections to identify any suspected rat holes and take prompt rodent control action whenever rodent sign confirmed
Animal / Bird cages		
6	The landscape structure of animal/bird cages is very susceptible to intrusion and harbouraging of rodents. The soft soil surface is very receptacle burrowing. The	● Construct the landscape foundation with concrete and cover with shallow soil layer to prevent burrowing of rodents.

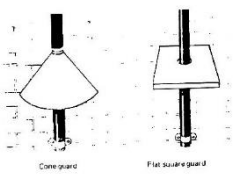
	presence of boulders and other concrete structure provide sheltered voids for borrowing of rodents.   	● Avoid setting boulders or other ornamental structure on soil surface. ● Surround the base of boulders or ornamental structure with pebbles or gravels. ● Regular inspection to identify any suspected rat holes and take prompt rodent control actions whenever rodent sign confirmed.
7	Unattended animal/bird feed privide rodents with handy food source. 	● Residue of animal/bird feed must be removed promptly after feeding and should not be left unattended. ● For feeding of bird, it may consider hanging up container with feed above ground level with a height not less than 1 m to avoid access of rodents. ● A rat guard with diameter not less than 550 mm should be fixed at the hanging material not less than 1 m from the feeding container.

8	Dense vegetation around animal/bird cage provide harbouraging places for rodents for easy access into the animal/bird cages for food.  	● Avoid planting of dense vegetation around animal/bird cages. ● Wire mesh of animal/bird cages should be rodent proofed either with 6 mm (1/4 in.) mesh, 24-gauge, expanded metal or with galvanized steel woven wire cloth of 22 S.W.G. at about seven meshes to the inch (25.4 mm). ● A buffer zone at least 30 cm made of rodent proof material, such as concrete, are suggested to be installed outside animal/bird cages ● Screen opening/drain holes with 6 mm (1/4 in.) mesh, 24-gauge, expanded metal or with galvanized steel woven wire cloth of 22 S.W.G. at about seven meshes to the inch (25.4 mm) should be installed to drain hole connected to animal/bird cages.
9	Drain hole provides rodents with entrance for intrusion into animal/bird cages for food or harbourages. 	● Screen opening/drain holes with 6 mm (1/4 in.) mesh, 24-gauge, expanded metal or with galvanized steel woven wire cloth of 22 S.W.G. at about seven meshes to the inch (25.4 mm). 

10	Soil surface around pond/pool provide rodent with borrowing gound.  	● Pave the surround areas of pond/pool with concrete. ● If surface channel is unavoidable, install 6 mm (1/4 in.) mesh, 24-gauge, expanded metal or with galvanized steel woven wire cloth of 22 S.W.G. at about seven meshes to the inch (25.4 mm) underneath the gratings. ● Avoid setting boulders or other ornamental structure in immediate surroundings of pond/pool.
11	Broken wall of animal/bird cage allows easy intrusion of rodents. 	● Regular inspections to surroundings of animal/bird cages to identify defective structure for prompt follow up actions.

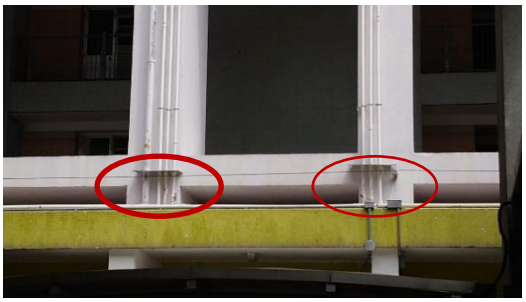
Others		
12	Ventilation louvres on door/wall of switch room/plant room provide rodents with access to the switch room/plant room for harbourages.  	● Install 6 mm (1/4 in.) mesh, 24-gauge, expanded metal or with galvanised steel woven wire cloth of 22 S.W.G. at about seven meshes to the inch (25.4 mm) behind the ventilation louver (inner side of the door/wall).
13	Void deployment of underneath raised container office block that provides rodents with harbourages and also accumulates refuse that serve as food source for rodents.	● Fitting a 20-guage metal plate to cover the void to prevent access of rodents.

		
14	Imporper storage of construction materials and waste invites rodent infestation and provide harbourages for rodents.  	● Construction materials and waste should be properly stored in rodent-proofed environment. Hoarding boards should be closely placed to avoid any gap of side greater than 6 mm allowing passage of rodents. ● Storage of construction materials and waste should not be located at close proximity to flower bed or refuse collection facilities. ● Construction materials and waste should be removed or moved regularly to avoid prolong storage.
15	Refuse collection bins in close proximity to flower bed or vegetation allow easy access to food sources.	● The number of refuse collection bins should be kept at minimal and set at locations with clear distance from flower beds and vegetation or other potential rodent harbourages, e.g. switch rooms.

	 	
16	Decaying remain of tree may develop as an ideal harbourage of rodent. 	● Remain of tree should be removed completely soonest possible. ● For temporary measure, tree hole found on ground should be sealed with small boulders or any other rodent proof material, e.g. cement.
17	Piping/ducting proving free runways for rodents at ceiling and between ceiling and floor areas.	● Install rat guards with materials with rodent proofs and the size not smaller than 55 cm at vertical pipes leading to ceilings.  Cone guard Flat square guard

	 	● Wrap pipes/ducts with barbed wire at intervals to discourage dispersal of rodents.
18	Improper installation of rat guard. 	● Rat guard should be installed in a proper location that at least 1 m above the nearest object. ● It should also be installed at a position that result at a maximum blockage of rodent activities.

Side branches of piping lets the rodent by-pass the rat guard.



Rat guards installed too near to platform underneath.

The size of rat guard is too small to screen

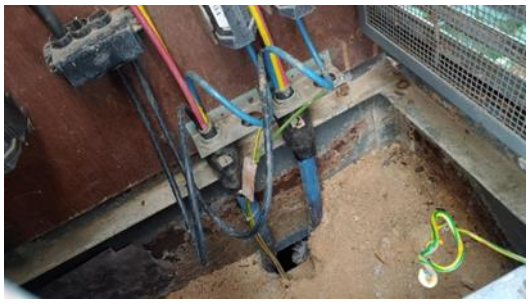
	rodent.	
19	Rat guard is not sealed properly. 	● Gap wider than 6 mm should not be allowed and should be sealed with rodent-proof materials.
20	False ceilings provide rodents with concealed runways and harbourages. 	● Remove false ceilings in markets and cooked food markets inside market complexes.
21	Vertical pillars could facilitate rodent communication between ceiling and floor areas.	● A clear zone of at least 1 m high should be maintained between the ceiling and the nearest articles surrounding the pillar. ● Rat guards should be installed on pipes/ducts.

		
22	Rodent could access through door gaps wider than 6 mm. 	Install 20 gauge metal kicking plates up to 30 cm high from the bottom and fit to the ground that the door gap not greater than 6 mm. 
23	Easy access of rodents through louvers on doors of refuse collection rooms, store rooms, service rooms, etc. 	• Install screens with 6 mm meshes, galvanized steel woven wire-cloths of 22 S.W.G. at about 6 mm meshes. • Threshold clearance should be lowered to less than 6 mm. 
24	Passings of ducts/pipes through wall provide free runways for rodents from room to room or stall to stall. 	• Block up all holes or voids by galvanised wire-nettings/balls especially those passings from room to room or from floor to floor. • Seal all chunks properly on both ends with galvanised wire-netting/balls or any other rodent proofing materials.

25	Surface channels provide rodents with concealed runways for dispersion. 	● Install wire meshes of apertures not less than 6 mm underneath the surface channel to prevent access of rodents. 
26	Articles accumulated on top of stalls provide rodents with harbourages as well as easy access to ceiling area for further dispersal.  	● A clear zone of at least 1 m vertical distance should be maintained between the lowest ceiling pipes/ducts and nearest articles to prevent rodents from jumping up and down the ceiling pipes/ducts and nearby articles.

27	Service rooms could become habourages of rodents which allow easy access to the markets for food. 	● Install screens with 6 mm meshes, galvanised steel woven wire-cloths of 22 S.W.G. at about 6 mm meshes.
28	Drain openings could be accessed by rodents. 	● Install screens with 6 mm meshes, galvanised steel woven wire-cloths of 22 S.W.G. at about 6 mm meshes. ● Install wire meshes of apertures not less than 6 mm underneath the surface channels to prevent access of rodents or replace gratings of surface channel with gaps smaller than 6 mm. 
29	Accumulation of articles around food stalls. 	● Promptly remove unused articles.

30	Weep holes not protected by grating. 	● Plug with crumpled wire netting or equip with gratings with aperture not more than 6 mm 
31	Drain hole at the bottom of refuse collection bin which allows easy access to food inside. 	● Plug with crumpled wire netting or gratings with aperture not more than 6 mm.
32	Drain pipes were not screened by metal meshes. 	● Pipes were screened by metal meshes. Screen with 6 mm mesh, 24 gauge, expanded metal or galvanised steel woven wire cloth of 22 S.W.G. 

33	Underground facilities that provide access point for rodent.  	● Install rodent proof meshes to all possible access points of rodent with 6 mm mesh, 24 gauge, expanded metal or galvanised steel woven wire cloth of 22 S.W.G. at about 6 mm meshes.
34	Underground piping/wiring find in meter room providing entry points for rodent. 	● Install rodent proof meshes to all possible access points of rodent with 6 mm mesh, 24 gauge, expanded metal or galvanised steel woven wire cloth of 22 S.W.G. at about 6 mm meshes.