

Code of Practice for Rodent Management

Pest Control Advisory Section
Food and Environmental Hygiene Department
Hong Kong Special Administrative Region

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1. Introduction

Rodents have been closely associated with humans for many centuries, they cause damage to our properties and risk to our health. There are three commensal rodent species distributed worldwide, namely *Rattus norvegicus* (Sewer Rat), *Rattus rattus* (Roof Rat) and *Mus musculus* (House Mouse), which can also 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 rodent-related diseases such as plague, hantavirus infection, rickettsial diseases and leptospirosis are transmitted by rodents or their ectoparasites. The University of Hong Kong also reported on the first human infection of rat hepatitis E virus (rat HEV) in 2018. Rat HEV is believed to be originated from rats, though the exact route(s) of transmission (e.g. direct transmission or faecal-oral route) is yet to be confirmed.

Rodents, apart from transmitting diseases to human, also cause nuisance. Their gnawing behaviour causes economic damage to structural and household items. They 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 flower beds through their extensive burrowing. Gnawing of electrical wires is not uncommon, which could lead to power or telecommunications blackouts and even cause fires of building and vehicle that would lead to casualties.

Rodents can proliferate quickly; their population can increase rapidly if no rodent control measure is put in force at an early stage. Ineffective control of rodents not only threaten human lives but also cause severe damage to local economy. 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, recreational facilities, markets, food premises) as well as the general public to maintain a good hygienic condition to discourage proliferation of rodents. 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. Applying appropriate rodent control strategies, implementing good sanitation practice in conjunction with adopting effective rodent proofing measures provide better rodent control effects than by using poison baiting and / or trapping alone. Relying on rodenticides alone may only provide transient control, and there is no guarantee that the infestation can be contained; its indiscriminate use may however disregard other control measures which, when used in a combined way, could give a more promising and long-lasting result. Rodent's survival heavily depends on three conditions provided by the environment, namely the availabilities of food, harbourage and dispersal route. As long as these survival conditions are provided in the environment, they can quickly proliferate; on the contrary, if such survival conditions are eliminated from the environment, rodent can hardly thrive. Therefore, improvements in environmental conditions and hygiene should always be put on top of the work list to accomplish a long term effect.

It should also be noted that each individual site is unique and is environmentally different from the others. The same rodent management programme that is effective at one site may not have the same effectiveness at another site. Thus, it is important to develop a specific control strategy / programme for individual site by conducting thorough inspection to apprehend the nature and seriousness of rodent infestation.

3. Control Strategy

IPM should be practiced in all control strategies / programmes, which means that control measures which are effective and pose the least harm / hazard to the environment should always be implemented first. All methods must be carefully considered before an effective solution is come up with. However, it is not necessary that all available methods must be implemented concurrently or sequentially. A good control strategy should consist of the best combination of feasible control measures which have to be reviewed regularly during the process for timely adjustment to cope with the changes in infestation situation.

3.1 Rodent proofing

Rodent proofing is a series of physical measures / modifications added to an environment 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 problem and usually has no adverse impacts to the environment. Such measures should always be implemented at an early stage of control.

3.2 Removal of food sources

The lack of food sources can discourage the stay of rodents at a site while at the same time increase the chance of their feeding of poison baits that are applied at the site. Preventing rodent's access to food and water in the environment can therefore greatly increase the effectiveness of a rodent control programme and should be implemented all the time.

3.3 Removal of harbourages

In order to discourage rodent infestations, all rubbish, old machinery, disused articles, equipment or any other materials that could be encroached by rodents as harbourages should be removed or cleared timely. Vegetation around buildings should be cleared whenever possible. A buffer zone paved with concrete or small boulders should be set up in immediate surrounding of buildings as far as possible to prevent rodent burrowing.

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 they are placed outside buildings.

When selecting lethal traps, only those that effect an instant kill of rodent in a humane way should be considered. When live-capture traps are used, all traps should be inspected at least daily, and captured live rodents should be killed in a humane way.

3.5 Direct control – Poison baiting

The use of rodenticides may present potential risks to people, non-target animals and the environment. As such, rodenticides should only be used after all environmental factors of the concerned 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 tamper-resistant bait

boxes that are locked and secured in place. In situations where rodenticides are being deployed, special care must be taken to ensure that the poison baits and the bait boxes will not contaminate any kind of food or fresh water sources. Further guidance on poison baiting strategies can be found in Section 6 and Section 7 of this Code of Practice.

4 Integrated Rodent Management

Integrated Rodent Management implies a combined approach to rodent management that relies on a good understanding of the biology / ecology of rodent, in particular, those factors which favour its development, and makes good use of non-chemical approaches which modify the environment to render it less suitable for rodent proliferation. Rodenticides have to be used in judicious and environmentally friendly ways. Actions should be carefully planned and supported by a thorough and comprehensive site inspection.

4.1 On-site inspection

A thorough on-site inspection is essential in identifying the species of rodent causing the infestation, the extent of the infestation and the existence of basic survival conditions (e.g. food and water sources, harbourages) for the rodent. Outcome of the inspection would provide essential information for devising an effective monitoring or disinfestation plan.

The following should be noted, located and quantified as far as possible during the inspection:

- Live rodents;
- Rodent droppings: shape, size and freshness;
- Tracks (footprints) or smear;
- Burrows or holes in and around both natural and fabricated settings, and in both indoors and outdoors;
- Gnawing marks;
- Area for commuting or harbouraging of rodent;
- Loss or damage of food or other stored food items;
- Smells, sounds and previous observations; and
- Nesting materials.

Photos of some rodent signs are provided in Annex 1.

4.2 Tools for on-site inspection

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

- Torch (including an ultraviolet torch which can emit 'black-light');
- 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
- Extension pole for mirror/camera to reach hard-to-access place.

4.3 Rodent proofing

In conducting a thorough on-site inspection, methods of rodent exclusion should be considered, which include, but not limited to, the following:

- Removal of overgrown vegetation, possible harbouraging materials 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;
- Places which are vulnerable to rodent intrusion should be cleared of their food, shelters and breeding environment.

4.3.1 Removal of harbourage

Keeping a high standard of environmental sanitation and eliminating or minimising rodent harbourages are always of the greatest value in preventing rodent infestation.

Harbourage reduction can be achieved by, but not limited to, the following aspects:

- Removal of rubbish, disused articles and clutter;
- Tidying up equipment piles and relocating or clearing long-term stored goods and boxes regularly;
- Sealing voids and excavations;
- Trimming surrounding bushland, long-grassy fields and vegetation in flower beds

regularly;

- Keeping outbuildings and sheds well maintained;
- Checking and ensuring service voids are inaccessible to rodent;
- Clearing or flushing drains, gutters, sewers and septic tanks regularly;
- Filling or covering disinfested rat holes, potential rat holes and any other small openings with rodent-proof material(s) (e.g. fine concrete, cement mortar, 20 gauge galvanised steel sheet or barbed wire ball etc.); and
- Proper maintenance of flower beds and planting high-rise vegetation to expose soil surface to discourage burrowing of rodents and allow easy inspection and removal of refuse.

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 routes of entry.

Installing physical barriers including, but not limited to, the following:

- Replacing broken or missing gratings with the ones that meet rodent-proof standard (i.e. spacing between bars of grating no larger than 6 mm);
- Screening ventilation grids and other similar openings either with 24 gauge expanded galvanised steel or with 22 Standard Wire Gauge (SWG) galvanized steel woven wire cloth with mesh size not bigger than 6 mm;
- Repairing or replacing worn door and / or door frame to limit the door clearance to not more than 6 mm when it is closed;
- Protecting wooden doors and door frame at the bottom by fitting a 20 gauge galvanised steel 'kicking-plate' of at least 300 mm high on the outside, with maximum door clearance of 6 mm;
- Fixing a similar metal plate to the door frames to form a continuous band of metal;
- Sealing all openings and passings for pipes, wires, and ducts through walls;
- Spacing between vertical pipes should be at least 100 mm, so as the spacing between pipe and adjoining wall; and
- Installing at vertical pipe a circular/inverted funnel shaped rat guard (Fig. 1) made of 20

gauge galvanised steel sheet, projecting about 230 mm from the vertical pipe and with diameter of at least 550 mm (assuming diameter of the pipe is less than 90 mm); the gap between the rat guard and the pipe should not be larger than 6 mm. Make sure there is no projection or any other structure nearby to serve as foot step for rodents to jump over the rat guard.

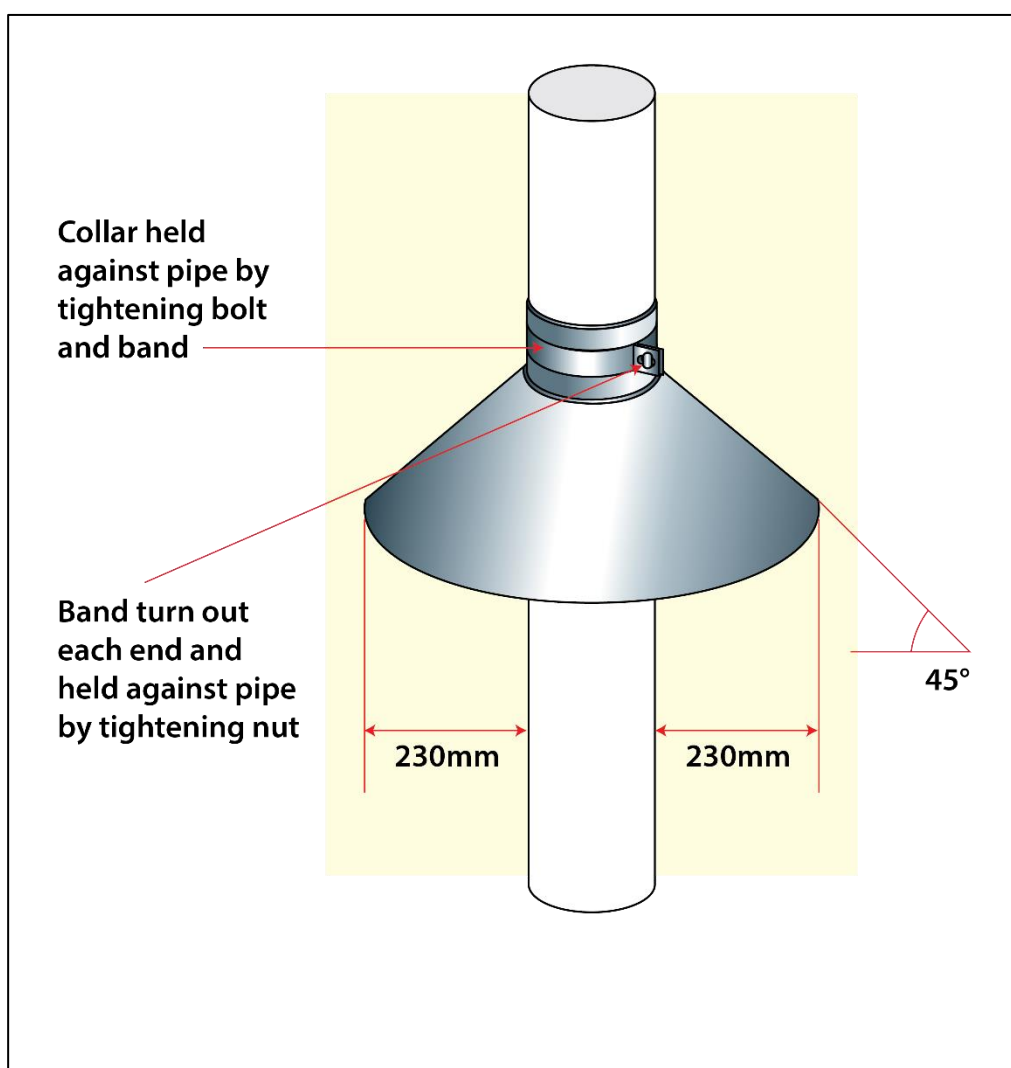


Fig. 1 Specifications of Rat Guard

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. The following methods should be considered during a thorough site inspection:

- Regular and frequent removal of rubbish, food waste and excess or expired stock;
- Using metal or plastic rubbish 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 attractants in the area with rodent activity (e.g. food bowls, BBQ sites, rubbish bins, birdfeeders, etc.); and
- Keeping food for human consumption in metal or glass containers with well fitted covers.

Photos of environments providing survival conditions to rodent and the suggested solutions are provided in Annex 2.

5. Rodent Control by Trapping

With an increased emphasis on integrated pest management, non-chemical tools for rodent management are becoming more important. There are several cost-effective and non-toxic methods available for monitoring and controlling rodents. When the use of rodenticides is considered undesirable, trapping would be the preferred method of killing and capturing rodents.

Trapping has several advantages. Its effect is immediate, the counts of trapped rodents can be readily tracked, there is flexibility in food choice for baiting the traps, it may facilitate the disinfestation without resorting to the use of rodenticides, and there will be no chemical residue left in the site thus causing no harm to the environment.

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

5.1 Lethal traps

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

- snap/break-back traps **for rats** should be baited daily but unset in the first 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 still trigger the trap.

When human activity and non-target animals are present at the site where traps are being laid, all traps should be placed in tamper-resistant boxes and the boxes should be firmly anchored by screws or cable ties/wires to the designated place.

5.2 Cage traps

Cage traps/Multiple-catch traps for rats and mice should be baited and set on the first day when they are laid. In general, wire cage traps found in the local market are designed for catching rats, but not mice.

5.3 Glue traps

Only when encountering heavy rodent infestation where other rodent control methods have been exhausted without satisfactory results may glue traps 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 glue trap in a lockable and tamper-resistant rodent station or dedicated rodent glue trap tunnel for complete protection against non-target animals. Frequent inspections should be arranged to each glue trap laid and any trapped rodent shall be handled immediately in a humane manner. The carcass should also be properly handled/disposed of as soon as possible. The use of glue traps should be suspended as soon as the situation of rodent infestation is alleviated.

5.4 Placement of traps

Rats and mice feel safe by moving close to vertical surface such as wall, rather than across open areas. Traps should therefore be placed at **right angle to the vertical surface** against which rodents are known or suspected to run. When snap traps are used, they 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. Similarly, when cage traps are used, they should also be placed at right angle to the vertical surface with the opening facing the vertical surface (Fig. 2). If they are set parallel to the vertical surface, they should be set back to back **in pair** (with opening facing the two ends).

Whenever possible, set rat cages firmly on ground. The position for traps should be carefully chosen, and traps should remain in the same position throughout the trapping period. For best results, traps for catching mice should be placed about 1 m apart. For rats, traps could be placed about 3-5 m apart, and the distance should be adjusted according to the actual environment as well as rodent infestation and activities.



Fig. 2 Setting a trap at right angle to the vertical surface

5.5 Number of traps

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**. Short-term trapping with large amount of traps could always yield better result than prolonged trapping with insufficient number of traps.

5.6 Baits for traps

Rats are omnivorous animals consuming a great variety of food. *Rattus norvegicus* loves sweet and oily food. Baits of proven acceptability to *Rattus norvegicus* include bacon, peanut (groundnut) butter, sweet potato, fresh, smoked or dried fish, ground meat and bread; baits for *Rattus rattus* include nuts, meat, apple, carrot and bread; whereas *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 have dried out or spoiled should be replaced immediately by fresh ones.

Mixed baits, to a certain extent, can minimise 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 from place to place, food baits that work in a location do not mean they are also attractive to rodents in another location. Therefore, trials on different food baits should be conducted in trapping operation at individual location to find out the best combination of food baits.

5.7 Trapping period

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

5.8 Courtesy and warning to stakeholders

Whenever traps are laid, adequate warning must be courteously given to concerned stakeholders to avoid causing injuries to people and animals, including not to touch the set traps with bare hands, not to touch excreta of rodent and not to interfere with traps. Pest control operators have to ensure that such warning is delivered both verbally and by written (e.g. notice, letters).

5.9 Frequency of inspection

The recommended frequency of inspection for traps varies around the world, but generally to

be once or twice daily. When glue traps are used, the frequency of inspection should be further increased; internationally recommended inspection intervals range from hourly to once every 12-hour. If non-target animal is accidentally captured during rodent trapping operations, release the animal at a safe location. 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.

5.10 Handling captured rodents

When selecting lethal traps or killing a live rodent in cage, the most humane way which is available should be used. Killing by breaking upper cervical vertebrae of the animal is considered as the fastest and the most humane way, since damage to the upper cervical vertebrae can result in instant loss of consciousness of the animal.

Gassing with carbon dioxide (CO₂) may be a good alternative method to euthanise and kill rodent due to the ease in application and the possibility of euthanising and killing several rodents at the same time. Rodent could either be remained in the trap or be transferred from the trap to a thick cloth bag which is then tightly tied, and subsequently be placed in an impervious container or plastic sack to be filled with CO₂.

Only CO₂ delivered from a compressed gas cylinder should 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. Confirm its death after ten minutes and dislocate the upper cervical vertebrae of the unconscious rodent by a pair of tongs or a strong metal bar whenever necessary.

5.11 Other trapping device(s)

In addition to traditional trapping devices, there are also other automatic trapping devices with multiple-catch function available. These kinds of trapping devices are particularly useful in areas not frequently accessed by humans or in areas where traditional poison baiting is not suitable (e.g. cooked food centre).

Some multiple-catch devices could kill captured rodents and temporarily store them inside the devices for collection after a period of time. They might attract rodents by non-toxic food baits and the sensor on the device is activated when the rodent is trying to obtain the food bait. Some devices are equipped with a chamber filled with high concentration alcoholic based preservative solution for preserving captured rodents that die inside it, thereby suppressing the odour from the decaying rodents.

Before using any of these automated multiple-catch devices, it is important to read the instruction manuals provided by the manufacturer(s) thoroughly and follow their instructions strictly. Safety precautions as stated in the instruction manuals should also be strictly observed.

6. Rodent Control by Rodenticides

Only locally registered rodenticides / rodenticides approved by the AFCD should be used in Hong Kong. Always refer to the product labels and the 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 factors should be considered:

- Which rodent species is/are causing the problem (sewer rat, roof rat or house mouse)?
- How large is the rodent colony?
- Where are the rodents' harbourages and runways?
- Are there foodstuffs stored or manufactured nearby?
- Are non-target animals or children present around?
- Is there the possibility of secondary poisoning on the site (e.g. non-target animals feeding on poisoned rodents)?
- What are the relative risks of various baiting options?
- What is likely to be the most attractive (smell) and palatable (taste) rodent bait available, considering what the rodents are foraging on-site?

The first four of the above questions should be dealt with during the initial inspection and discussion with the client.

Where primary or secondary poisoning is a concern, non-toxic control strategies must be considered first (see Section 3) before rodenticide baiting is given a thought. If rodenticide baiting is really required to achieve the disinfestation, further consideration must be given to the baiting strategy (see Section 7). It should not be assumed that any of the first generation anticoagulant rodenticides, second generation anticoagulant rodenticides and pro-hormone rodenticides (cholecalciferol) would pose less risk from the perspective of primary or secondary poisoning.

The attractiveness of rodenticide baits to rodents may vary from colony to colony and may even change during the course of control programme in respect to the feeding habits of the target colony. Preferred rodenticide bait option(s) should be used but in situations where rodenticide bait is not taken, alternative measure(s) must be considered.

6.2 First generation and second generation anticoagulant rodenticides

Anticoagulants disrupt the mechanism that controls blood-clotting and cause fatal internal haemorrhage to develop. Their action is cumulative and most of them need to be ingested over a period of several days before they become effective. Their main advantage is that primary and secondary poisoning hazards to non-target species are greatly reduced and if accidental poisoning in human or animals does occur, an effective antidote, vitamin K, is available for cure. Nevertheless, accidental poisoning to non-target species (e.g. stray dogs) should still be avoided as far as possible. All necessary precautionary measures to protect the rodenticides from access of non-target animals should be taken during their application.

The first generation anticoagulant rodenticides (e.g. warfarin, diphacinone, coumatetralyl, etc.), which are also known as 'multiple-dose' rodenticides, is a group of anticoagulants that was developed before 1970. These compounds are more toxic to rodents when feeding occurs on several successive days rather than on one single day only.

The second generation anticoagulant rodenticides were developed to control rodents that had developed resistance to the first generation anticoagulant rodenticides. Examples include brodifacoum, bromadiolone, difethialone, difenacoum and flocoumafen. They only require a single feeding of a lethal dosage to achieve a killing effect which occurs after 3 to 5

days. This delayed effect greatly reduces the risk of bait aversion within a rodent colony and maximises the effect of control of rodent infestation.

6.3 Rodenticide formulations

Different rodenticide formulations are available in local market. Selection of rodenticide formulation can be based on:

- the conditions of the application site (e.g. whether the site is dry or wet); and
- the dietary requirements and/or feeding preferences of the target rodent colony.

Block baits, scrap baits and soft baits are some of the commonly used formulations of rodenticides. Some formulations, such as block bait, have certain degree of water resistance, which are suitable for combating rodent infestations inside sewer systems. Despite their water-proof nature, the wax base of the food bait may however decrease its acceptability to rodent. Clearing of food sources in the environment is therefore important to counteract such problem. Cereal baits are also commonly used formulation in rodent control, but they are more easily affected by weather conditions, such as rainfall and humidity.

7. Poison Baiting Strategies

In general, the site conditions, the food sources available in the environment and the target rodent species will affect the choice of rodenticide and formulation. Brodifacoum and bromadiolone are the two second generation rodenticides commonly used by local pest control operators. They are ready-to-use baits that come in the forms of scrap bait, block bait, etc. Scrap bait containing 0.005% brodifacoum / bromadiolone, if packed in thin plastic bags, should be punched with a number of holes before being applied at target sites. Each bag of bait should weigh not more than 15 g. The thin plastic bag could prevent the baits from scattering around in the application site and provide some protection to the baits against moisture. It is not recommended to mix ready-to-use rodenticides, e.g. brodifacoum, with other food bait(s) with an aim to enhance the attractiveness of the rodenticides to rodent as it might also increase its attractiveness to other non-target animals, leading to their accidental intake of the rodenticides. It is also not advisable to hang the bait packs above ground, but if it is unavoidable (e.g. due to regular street washing that might spoil the rodenticides), the bait packs should not be hung at a height greater than 5 cm above ground and such should only be done in places that are not frequently visited by human or other non-target animals. In case bait boxes are used for holding rodenticides, they should

always be set according to the instruction as stated on the product label.

7.1 Use of bait boxes

Utilise lockable and tamper-resistant bait boxes to secure the safe use of rodenticides. Well-designed bait boxes could help achieve effective rodent management; they should possess the following features:

- Protect rodenticides from moisture and dust;
- Provide sense of security to rodents when feeding inside the bait box;
- Help keep non-target species, including pets, wildlife and children, away from rodenticides;
- Help prevent accidental spillage of rodenticides; and
- Allow easy access, checking and replenishment of the rodenticides by pest control operators.

Besides, one may consider using different designs of bait box according to the environmental conditions.

7.2 Block control (area control)

The principle of block control is to disinfest rodents within the same 'block', which 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.) that restrict movement of rodents, concurrently. This is to ensure the entire territory of a rodent colony is covered in the same operation, which would be advantageous in reducing / slowing down the speed of rebound of population of the rodent colony. Pulsed baiting is the major method to combat rodent infestation within the defined blocks.

7.2.1 Pulsed baiting

Pulsed baiting refers to the application of small quantities of bait at approximately weekly intervals. It is used to eliminate the existing infestations of rats and mice. Single dose anticoagulants (i.e. second generation anticoagulants) are suggested for pulsed baiting as very frequent inspection is generally not required. Rodenticides are placed in bait boxes and/or placed directly in rodent burrows.

For the best result, poison baits would need to be inspected regularly, particularly for the first

two weeks, and baits that have been consumed, contaminated or spoiled should be replaced duly. When poison baits are applied appropriately, it usually requires at least three to four pulses (rounds) of baiting to bring the rat or mouse number down to a considerable level, although heavy infestation may require longer treatment to achieve an effective control. Treatment should be discontinued when an effective control has been achieved and all poison baits should be removed from the application sites.

7.2.2 Burrow / Hole baiting

Rodenticide baits should be placed deep into burrows to avoid access by non-target species. It is suggested to leave the burrow open to allow the rodents to enter / exit as usual. After baiting for one to two weeks, cover the hole with tested material, such as crumpled paper, leaves, or other light debris, to assess rodent activity. If the tested material remains untouched overnight, the rat hole could be considered as an inactive one and such rat hole could be sealed with appropriate rodent-proof material(s).

7.2.3 Surface baiting

All rodenticide baits must be placed in lockable and tamper-resistant bait boxes which should be secured to prevent removal or dislodgement and / or access to the boxes by unauthorised persons or non-target species. Sufficient number of warning notices should be displayed at appropriate locations to alert the concerned stakeholders.

7.3 Monitoring

In general, the use of non-toxic baits and / or traps as monitoring tools is recommended to facilitate early detection of newly formed rodent infestation.

If rodent number escalates, quickly revert to pulsed baiting. This may mean increasing the number of rodent baiting points on a temporary basis and / or increasing the amount of baits available at each baiting point.

7.4 Replacement of poison baits

If rodenticide baits are made with fresh, food grade ingredients, their palatability and attractiveness will deteriorate over time.

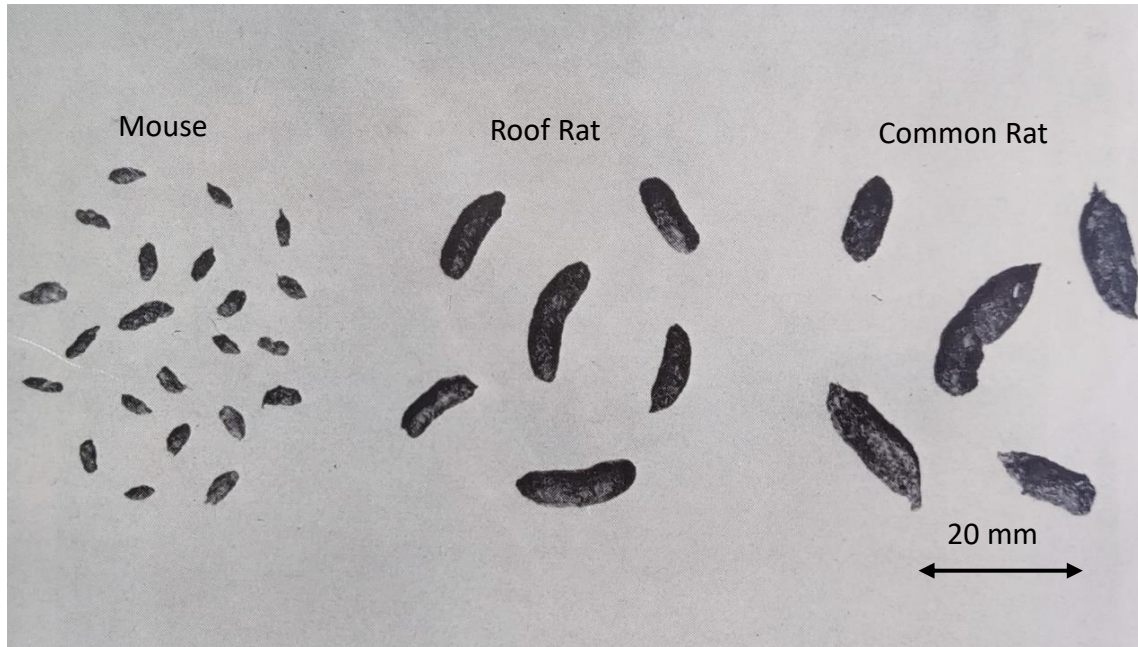
There is no standard guideline on the replacement frequency of baits, as their deterioration

varies with different formulations and ingredients of the baits as well as environmental conditions. For instance, in warm and damp environment, high humidity level may significantly shorten the life of rodent baits, leading to the need for a more frequent replacement; whereas in cool and dry location, bait effectiveness may be prolonged. Thus, there is no golden rule to define a standard timeline for bait replacement. It is therefore important that if rodenticides are being used to eliminate a rodent colony, fresh and palatable bait should be made continuously available to the rodents. Pest control operators should inspect bait at least weekly and critically assess if bait replacement is required. In the absence of any consumption or gnawing by rodents, other signs which indicate the need to replace the bait and to increase the frequency of inspection may include:

- the presence of mold;
- damage by cockroach, beetle, or other insects;
- damage by slug or snail;
- damage or submerged by water;
- discolouration or physical disintegration of the bait;
- exposure to or melted by heat;
- regular exposure to or tainted by contaminants at site (e.g. chemical spills, fumes).

It is noteworthy that the amount of active ingredient in rodenticide, particularly for anticoagulants, does not decrease significantly over time, whereas the deterioration of the food ingredients in the poison bait does have an effect on the palatability and attractiveness of the bait.

Annex 1
Photos of rodent signs



Droppings of three commensal rodents: *Mus musculus* (left), *Rattus rattus* (middle) and *Rattus norvegicus* (right).



Rat smears on pipe (left) and metal louvre (right).



Rodent footprints on soft soil and a rat hole at top left corner.



Rat holes on flower bed (left) and at road side (right).










Gnawing marks on a wooden door (left) and a plastic container (right).



Annex 2






Environments providing survival conditions to rodent and the suggested solutions



Item	Environment	Suggested solution
Flower bed and vegetation		
1	<p>Wall of flower bed too low or with protruding structure / uneven surface allows easy rodent access.</p> 	<ul style="list-style-type: none"> ● Wall of flower bed should be at least 1 m high with smooth external surface without any protrusion.  <ul style="list-style-type: none"> ● Cover soil surface with gravels to a thickness of 5 cm to 8 cm. 



2	<p>Weep hole of flower bed could be encroached by rodent as rat holes.</p> 	<ul style="list-style-type: none"> ● Screen weep holes with grating of aperture not greater than 6 mm.
3	<p>Soil surface covered by low rise dense vegetation is vulnerable to rodent intrusion and make detection of rodent infestation difficult.</p> 	<ul style="list-style-type: none"> ● High rise vegetation exposing the soil surface is preferable. 
4	<p>Boulders or other ornamental structure may provide sheltered void for burrowing of rodents.</p>  	<ul style="list-style-type: none"> ● 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 suspected rat holes and take prompt rodent control action whenever rodent sign is confirmed.




5	<p>Extensive root system of tree (e.g. banyan) creates natural harbourage for easy burrowing of rodents.</p> 	<ul style="list-style-type: none"> ● 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 at roots by suitable materials. ● Regular inspections to identify suspected rat holes and take prompt rodent control action whenever rodent sign is confirmed.
Animal / Bird cages		
6	<p>The landscape structure of animal/bird cages is very susceptible to intrusion and harbouraging of rodents. The soft soil surface is easy for burrowing. The presence of boulders and other concrete structure provide sheltered voids for burrowing of rodents.</p> 	<ul style="list-style-type: none"> ● Construct the landscape foundation with concrete and cover with shallow soil layer to prevent burrowing 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 suspected rat holes and take prompt rodent control actions whenever rodent sign is confirmed.

<p>7</p>	<p>Unattended animal/bird feed provides rodents with handy food source.</p> 	<ul style="list-style-type: none"> ● Residue of animal/bird feed must be removed promptly after feeding and should not be left unattended. ● For feeding of bird, consider hanging container with feed at a height of more than 1 m above ground to avoid access of rodents. ● Put feeding container at a height of more than 1 m and stay far away from surrounding objects/facilities.
<p>8</p>	<p>Dense vegetation around animal/bird cage provides harbouraging places for rodents with easy access into the animal/bird cages for food.</p> 	<ul style="list-style-type: none"> ● Avoid planting of dense vegetation around animal/bird cages. ● Fencing of animal/bird cages should be rodent-proofed either with 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm. ● A buffer zone of at least 30 cm constructed by rodent-proof material, such as concrete, is suggested to be set up outside animal/bird cages. ● Screen opening/drain holes connected to animal/bird cages with 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm.




9	<p>Drain hole provides rodents with entrance for intrusion into animal/bird cages for food and/or harbourages.</p> 	<ul style="list-style-type: none"> ● Screen opening/drain holes with 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm. 
10	<p>Soil surface around pond/pool provides rodent with burrowing ground.</p>  	<ul style="list-style-type: none"> ● Pave the surrounding areas of pond/pool with concrete. ● If surface channel is unavoidable, install 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm underneath the gratings. ● Avoid setting boulders or other ornamental structure in immediate surroundings of pond/pool.
11	<p>Broken wall of animal/bird cage allows easy intrusion of rodents.</p> 	<ul style="list-style-type: none"> ● Regular inspections to surroundings of animal/bird cages to identify defective structure for prompt follow up actions.








Others		
12	<p>Ventilation louvres on door/wall of switch room/plant room provide rodents with access to interior for harbourages.</p> 	<ul style="list-style-type: none"> ● Install 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm behind the ventilation louvers (on inner side of the door/wall).
13	<p>Void underneath raised container office provides rodents with harbourages and also leads to accumulation of refuse which may serve as food source for rodents.</p> 	<ul style="list-style-type: none"> ● Fitting a 20 gauge metal plate to cover the void to prevent access of rodents.

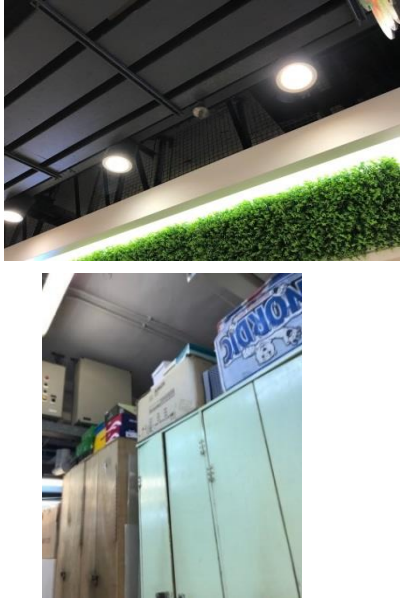



<p>14</p>	<p>Improper storage of construction materials and waste invites rodent infestation and provides harbourages for rodents.</p> 	<ul style="list-style-type: none"> ● Construction materials and waste should be properly stored in rodent-proofed environment. Hoarding boards should be closely placed to one another to avoid leaving any gap greater than 6 mm which allows passage of rodents. ● Construction materials and waste should not be stored/located in close proximity to flower bed or refuse collection facilities. ● Construction materials and waste should be removed or moved regularly to avoid prolonged storage.
<p>15</p>	<p>Refuse collection bins in close proximity to flower bed or vegetation allow easy access to food sources.</p> 	<ul style="list-style-type: none"> ● Refuse collection bins should be kept at minimal number and set at considerable distance from flower beds, vegetation and other potential rodent harbouraging places, e.g. switch rooms.





16	<p>Decaying remains of tree may develop as an ideal harbourage of rodent.</p> 	<ul style="list-style-type: none"> ● Remains of tree should be removed completely soonest possible. ● If immediate removal of remains is impossible, tree hole on ground could be sealed with small boulders or other suitable rodent-proof material as a temporary measure.
17	<p>Piping/ducting providing free runways for rodents at ceiling and between ceiling and floor areas.</p>  	<ul style="list-style-type: none"> ● Install rat guard made with rodent-proof material at vertical pipe leading to ceilings (See Fig. 1 on P.7). ● Wrap pipes/ducts with barbed wire at intervals to block rodent dispersal.




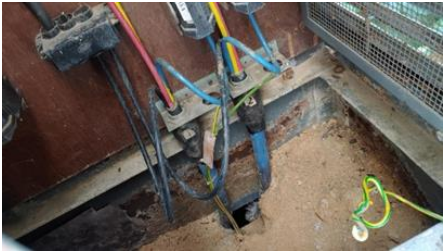

<p>18</p>	<p>Improper installation of rat guard.</p> <ul style="list-style-type: none"> Side branches of piping allow rodent by-pass the rat guard.  <ul style="list-style-type: none"> Rat guards are too close to the platform underneath.   <ul style="list-style-type: none"> The size of rat guard is too small to block the route of rodent. 	<ul style="list-style-type: none"> Rat guard should be installed at a proper location of at least 1 m above the nearest object. It should also be installed at a position that results in a maximum blockage of rodent activities.
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19	<p>Gap between rat guard and pipe is not sealed properly.</p> 	<ul style="list-style-type: none"> ● Gap between the rat guard and the vertical pipe/duct should not be bigger than 6 mm or else should be sealed with rodent-proof material.
20	<p>False ceilings provide rodents with concealed runways and harbourages.</p> 	<ul style="list-style-type: none"> ● Avoid installing false ceilings in markets and cooked food markets inside building complex.
21	<p>Vertical pillars allow rodent commuting between ceiling and floor.</p> 	<ul style="list-style-type: none"> ● A clear zone of at least 1 m high should be maintained between the ceiling and the nearest articles around the pillar. ● Rat guards should be installed on pipes/ducts.

<p>22</p>	<p>Rodent could access through door gaps wider than 6 mm.</p> 	<ul style="list-style-type: none"> ● Install 20 gauge galvanised steel kicking plate up to 30 cm high from the bottom and fit to the ground with door gap not greater than 6 mm. 
<p>23</p>	<p>Easy access of rodents through louvers on doors of refuse collection rooms, store rooms, service rooms, etc.</p> 	<ul style="list-style-type: none"> ● Install 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm. ● Threshold clearance should not be greater than 6 mm. 
<p>24</p>	<p>Passings of ducts / pipes through wall provide free runways for rodents from room to room or stall to stall.</p> 	<ul style="list-style-type: none"> ● Block up all holes or voids by galvanised wire netting / ball especially those passings between rooms or between floors. ● Seal all cable trunks properly on both ends with galvanised wire netting / ball or any other rodent proofing materials.
<p>25</p>	<p>Surface channels provide rodents with concealed runways for dispersion.</p> 	<ul style="list-style-type: none"> ● Install wire meshes of aperture not more than 6 mm at the surface channel to prevent access of rodents. 

<p>26</p>	<p>Articles accumulated on top of stalls provide rodents with harbourages as well as easy access to ceiling area for further dispersal.</p> 	<ul style="list-style-type: none"> ● A clear zone of at least 1 m vertical distance should be maintained between the lowest ceiling pipes/ducts and the nearest articles below them to prevent rodents from jumping between the ceiling pipes/ducts and nearby articles.
<p>27</p>	<p>Service rooms could become harbourages of rodents and provide them with access to markets for food.</p> 	<ul style="list-style-type: none"> ● Install 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm.
<p>28</p>	<p>Drain openings could be accessed by rodents.</p> 	<ul style="list-style-type: none"> ● Install 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm underneath the gratings. ● Use gratings with gaps not greater than 6 mm. 

29	<p>Accumulation of articles around food stalls.</p> 	<ul style="list-style-type: none"> ● Promptly remove disused articles.
30	<p>Weep holes not protected by grating.</p> 	<ul style="list-style-type: none"> ● Plug with crumpled wire netting or equip with gratings with aperture not more than 6 mm 
31	<p>Drain hole at the bottom of refuse collection bin allows easy access to food inside.</p> 	<ul style="list-style-type: none"> ● Plug with crumpled wire netting or gratings with aperture not more than 6 mm.

32	<p>Drain pipes are not screened by metal meshes.</p> 	<ul style="list-style-type: none"> ● Screen pipes with 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm. 
33	<p>Underground facilities that provide access point for rodent.</p>  	<ul style="list-style-type: none"> ● Install rodent-proof screens at all possible access points of rodent, such as 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm.
34	<p>Underground piping/wiring found in metre room providing entry points for rodent.</p> 	<ul style="list-style-type: none"> ● Install rodent-proof screens to all possible access points of rodent such as 24 gauge expanded galvanised steel or 22 SWG galvanised steel woven wire cloth with mesh size not bigger than 6 mm.