BED BUG MANUAL

NUMBER 1

PestWest®
ENVIRONMENTAL

CONTENTS

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INTRODUCTION

In recent years, pest control companies have reported an increase in the number of bed bug, *Cimex lectularius* treatments (Boase, 2001, Boase, 2004).

Recent numerous and high-profile law suits have intensified the spotlight on bed bug control. A number of interim reports of bed bug resistance to technical insecticides (Boase, 2006 & 2007) have also provoked concern.

CLASSIFICATION

Bed bugs belong to the Family Cimicidae, within the Order Hemiptera – the true bugs.

There are thought to be 91 species of Cimicidae, grouped into 23 Genera. A selection of these is listed below.

Order: Hemiptera

Suborder: Heteroptera

Family: Cimicidae

Genus: Cimex

- *Cimex lectularius* (Bed bug)
- *Cimex hemipterus* (*C. rotundatus*) (Tropical bed bug)
- *Cimex pilosellus* (Bat bug)
- *Cimex adjunctus* (Bat bug)

Genus: Leptocimex

- *Leptocimex boueti* (Bat bug)

Genus: Haematosiphon

- *Haematosiphon inodora* (Poultry bug)

Genus: Oeciacus

- *Oeciacus vicarius* (Swallow bug)

ORIGIN, HISTORY & DISTRIBUTION

The evolution of obligate haematophagy (feeding only on blood) in the ectoparasitic *Cimex lectularius* seems to have originated and progressed from phytophagous (plant feeding) bugs that would predate by chance or accident, to predatory bugs feeding on invertebrates associated with nesting mammals or birds, to bugs that feed on the vertebrate host itself. The common flower bug, *Anthocoris nemorum*, which predates other insects and is occasionally herbivorous, is an example of a close relative to *Cimex lectularius. Anthocoris nemorum* will also pierce human skin and suck blood.

In terms of bed bugs evolving to feed on humans, it has been hypothesised that bed bugs made the switch from bats to man, when man was cave dwelling in pre-history.

The ecology of humans provides an excellent host-reservoir for bed bugs. People live communally within enclosed spaces, sleep at predictable times and places, posses a high body temperature and rich blood supply, and relatively hairless with a thin epidermis..

Cimex lectularius is cosmopolitan in distribution and is therefore a worldwide problem.

Bed bugs were first recorded in the US in 1583 (Usinger, 1966). In 1939 approximately four million people in Greater London were subject to bed bug infestations (Usinger, 1966). Bed bug infestations declined from 1939 onwards, most likely due to the introduction of residual insecticides. One survey showed that the number of bed bug treatments remained approximately stationary from the late 1960's to the early 1970's (Busvine, 1980).

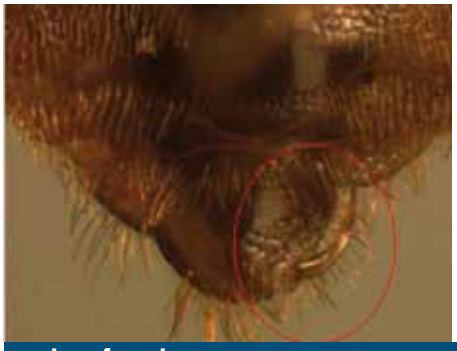
Bed bug nymphs after recent blood meal

Adult fully replete or engorged

Nymph

Adult

Adult



male v. female

It is a requirement that insects are to be identified before a pesticide treatment can take place.

This section provides descriptions, pictures and a key to facilitate identification of bed bugs.

Egg

Bed bug eggs are approximately 1mm long and 0.5mm wide, with an egg-cap (the operculum). Unhatched eggs are pearl colored and opaque before hatching, becoming translucent when hatched.

Nymph

Nymphs are small versions of the adult form, with a thinner cuticle, which displays the colour of partly digested blood. The bed bugs increase in size from 1.3 – 5.0mm as they pass through 5 instars.

Adult

Adult bed bugs are mahogany-brown, oval, dorso-ventrally flattened, wingless insects, which are approximately 5-7 mm in length and possess piercing mouthparts. When unfed, adults are pale, yellow-brown in color, but after a full blood meal, they take on a darker mahogany-brown color. Three pairs of walking legs are present, slender but well developed, with efficient tarsal claws for clinging on to the host during feeding.

The bed bug's head is short and broad, with a pair of prominent compound eyes, in front of which is a pair of clearly visible 4 - segmented antennae. The proboscis is slender and normally held closely along the ventral surface of the head and prothorax. Other key points for identification are the 3 - segmented proboscis lying in a ventral groove, ocelli being absent, and the tarsi being 3 - segmented. Bed bugs are very distinctive and can usually be identified immediately.

(Left) The sickle-shaped penis or paramere at the end of the males abdomen penetrates the cuticle of the female and introduces sperm. (Right) The cuticle paramere recepter (inverted v-shape) on the side of the female bed bug.

SIGNS OF BED BUG PRESENCE

Cast nymphal skins, hatched or unhatched eggs, strawyellow, dark brown or black marks (excrement spots, consisting mainly of excess water, with a little blood) and a sickly sweet / raspberry-like smell, are all signs that are used to identify bed bug presence. Other indicators are customer complaints and evidence of bites.

Key (Taken From Mallis, 1964)

A. Rostrum reaching to coxae of fore-legs

1. Front margin of pronotum deeply concave

a) Hairs on body not long. Man the usual host.

1) Pronotum with wing-like expansions, hairs fringing pronotum relatively straight. …*Cimex lectularius*

2) Pronotum not wing-like, hairs fringing pronotum curve backwards. …*Cimex hemipterus*

b) Body with long hairs, bats are the usual host.

1) In the United States – Eastern United States – *Cimex adjunctus*
Western United States – *Cimex pilosellus*

2. Front margin of pronotum much less concave, body with long hairs, swallows the usual host.

a) In the United States – *Oeciacus vicarius*

b) In Europe – *Oeciacus hirundinus*

B. Rostrum longer, reaching to coxae of hind legs, poultry the usual host. *Haematosiphon inodora.*

frass on mattress

Bed bugs have well defined resting sites (sometimes referred to as 'refugia') in which many individuals from all the different life stages are found. This harborage(s) is an essential part of the life cycle of the insect since it is in this area that the young bed bugs may pick up the internal microorganisms that are essential to their survival, some of which are also inherited transovarially. Bed bugs spend the majority of their time in these harborage(s), aggregated under the influence of a possible pheromone (which is exactly why targeted crack and crevice treatments are so crucial – see Control section).

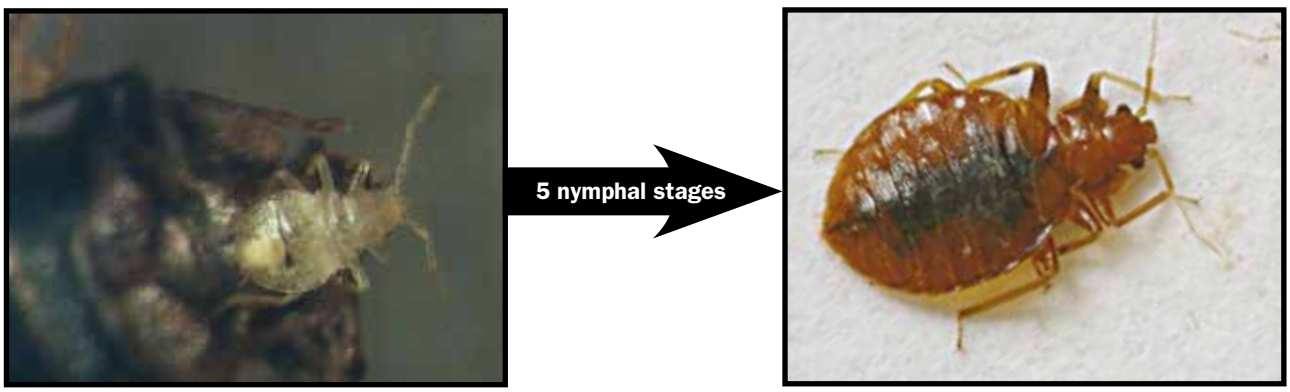
Alarm pheromones are also emitted in response to stress, causing bed bugs to scatter.

Life cycle and Bionomics

Bed bugs exhibit incomplete or gradual metamorphosis, from egg, through 5 nymphal stages, to adult. Female bed bugs place eggs throughout their life, an unusual feature in non-social insects. They generally produce around 2 to 3 per day and since they can live for many weeks, indeed months, each female could produce around 400 - 500 eggs during their lifetime. The eggs are deposited all around the environment in which the bed bug is living. The length of time spent in the five nymphal stages is greatly dependent upon the food resources available (each nymphal instar requires a blood meal for further development), temperature and relative humidity.

The importance of this data is that the temperature dependent life cycle can be manipulated to aid control. In particular, increasing room temperature to 78^{0}F can stimulate eggs to hatch after 5 – 6 days and vulnerable 1st instar nymphs will quickly come into contact with fresh insecticide deposits as they emerge from their many harbourages such as bed frames and headboards. It is often thought that higher temperatures will reduce the residuality of insecticides, but at these moderate temperatures this is not the case.

Lower temperatures mean that the time to hatching could be elongated and insecticide deposits are likely to be less effective. Delayed hatching of eggs could also give the false impression that an infestation has been eradicated, only for the bed bugs to reappear in time, especially as the unhatched eggs could remain viable for 3 months and adults can also survive for more than a year without a blood meal. If temperatures were to drop below 55°F, bed bugs become unable to complete their life cycle, although many properties are heated so bed bugs are a year-round problem.



Under ideal conditions, the life cycle from egg to adult can be as short as 3 weeks.

Cimex lectularius bionomics – Eggs	
Temperature (°C °F)	Egg hatching time (days)
13°C 55.4°F	49
15°C 59°F	34
18°C 64.4°F	21
22°C 71.6°F	12
27°C 80.6°F	5 - 6

Cimex lectularius bionomics – Egg to Adult	
Temperature (°C)	Complete cycle (weeks)
13°C 55.4°F	Not completed
15°C 59°F	34
18°C 64.4°F	18
22°C 71.6°F	8
27°C 80.6°F	4.5

Public health significance

The close association of bed bugs with human beings means that they can cause substantial nuisance through their blood-feeding habit. They feed at night on sleeping human hosts. If the infestation is high there can be a risk of anaemia being suffered by infants, although this is rare.

The nuisance and itching caused by the bites (known as cimicosis) and the possibility of secondary infection is more common. Bats, chickens and other domesticated animals may also be attacked.

Both male and female, adult and nymphal bed bugs take blood meals and so are equally important as nuisance pests. There is no evidence of bed bugs being involved in the transmission of infections or diseases to humans, and they are therefore not considered to be disease vectors.

Reaction to bites is variable. Some people show little or no reaction whereas others may suffer allergic or other severe reactions and sleepless nights. The biting nuisance is not to be underestimated, especially considering recent high profile litigation, damage to reputation and associated economic losses.

Adult bed bug feeding & excreting excess water ingested

Bed bug eggs

FEEDING, HOST LOCATION AND ASSOCIATIONS

As already stated, nymphal, adult, male and female bed bugs all require blood meals to develop and reproduce successfully. Bed bugs will feed mainly at night when the human host is sleeping, although they may also feed in the daytime if conditions are favorable. On average, a bed bug will feed once every 7 days, although higher temperatures can stimulate more frequent feeding – another added bonus of manipulating the temperature dependent biology is that more frequent attempts to feed are likely to bring bed bugs into contact with insecticide deposits.

Bed bugs generally take 5 – 10 minutes to complete a blood meal and the quantity of blood taken can be many times the weight of the bug.

Bed bugs feed on exposed areas of skin, with most bites typically being found on the abdomen, but also the neck, arms, legs and feet. Multiple lesions are found, often arranged in a linear pattern and sometimes clustered. The lesions are varied in appearance, often recognizable as raised reddened swellings, similar to flea bites, although with no central red area.

Bed bugs are thought to locate their host by random searching, followed by orientation to heat, CO_2 and host odors from perspiration and other secretions. These stimuli and possibly aggregation substances could be utilized if successful bed bug traps are to be developed.

Although bed bugs are closely associated and usually most successful when feeding on humans, they can also survive and complete their life cycle on bat, bird, mouse and rabbit blood. Other domesticated and zoo animals may also be attacked (Usinger, 1966).

Dispersal

To prevent the spread of bed bugs throughout a domestic property, it is recommended that the client should continue to sleep in the same room until the infestation is eradicated. For hotels and similar premises, this is not an option for obvious reasons, and is discussed in a later section.

The presence of a sleeping person in the room also provides a stimulus for bed bugs, likely to lead to more frequent foraging and therefore contact with insecticide deposits.

It is thought that bed bugs disperse via travel, in suitcases, back-packs and also second hand furniture. Areas with a frequent change-over of residents, such as student and institution accommodation, multioccupancy housing with migrant workers or travellers, seem to be at a higher risk.

Resistance

Recent reports have shown that bed bug field strains taken from different locations exhibit resistance to Pyrethroids. It is crucial, however, that resistance is not used as an excuse for treatment failure.

Experience seems to show that control failure is generally down to other factors, such as poor or superficial inspection treatment methods or a lack of understanding of bed bug biology. Some authorities experiencing call – backs to bed bug treatments have simply changed their working practice to be more thorough.

After implementing this new strategy, no call – backs were observed. Some authorities commented that their successful bed bug treatments were due to the excellence and skill of their pest control staff. Resistance is also not a new issue – bed bug resistance to DDT in the 1950's was overcome with new insecticides. If resistance does appear to be a problem, it can be overcome with alternative insecticides like insect growth regulators, non-chemical control such as laundering, vacuuming and extreme temperature treatments and a targeted Integrated Pest Management strategy, outlined in the following sections.

BED BUG CONTROL

All insect control should follow the Integrated Pest Management (IPM) template and bed bug control is no exception. The IPM strategy outlined here incorporates inspection, monitoring, recording, chemical and non-chemical treatment guidelines.

Suggested inspection routine

A thorough visual inspection should be conducted. Use of a flashlight and hand lens may prove useful. The following key areas should be inspected:

- Mattress, including under buttons and along seams.
- Divan base – remove the material covering the base and also check hollow caster legs.
- Bed frame.
- Bed headboard.
- Bedside furniture, checking drawers in tables and cupboards.
- Other furniture, along seams and buttons.
- Furniture should also be turned over and the underside examined. (Note: we've seen infestations on attachment screw heads).
- Electrical fittings and appliances, such as telephones, clock radios, televisions.
- Underneath carpet edges and along the straight edges.
- Floor-board seams.
- Under loose wallpaper.
- Door frame.
- Picture frames, wall mirrors, blinds, curtains and curtain rods, books, behind electrical conduit, cracks and seams in the ceiling and ceiling mouldings.
- Lounges in common rooms of Youth Hostel etc.
- Housekeeping rooms
- No space within a structure should be over looked as a potential bed bug harborage.

Inspection Notes

PICTURES OF KEY INSPECTION AREAS

Fluorescence is an optical phenomenon (photon bounce) wherein a material emits light in response to some external stimulus. Normally, the fluorescent light that is emitted is of a specific color or group of colors that is released when the material is bombarded with light in some other part of the color spectrum.

Biological materials (containing carbon and hydrogen) have a characteristic fluorescent property that facilitates identification under UV examination. Protein, including protein crystals, can fluoresce without any dyes or markers if it contains the appropriate amino acids in high enough concentrations and is excited with the correct wavelength of light. Two or more amino acids bonded together are called a peptide. A chain of many amino acids is referred to as a polypeptide. The complete product, either one or more chains of amino acids, is called a protein. There is unequal sharing of electrons in a peptide bond. The O and the N are negative and the H is positive. The large number of charged atoms in a polypeptide chain facilitates hydrogen bonding within the molecule, causing it to fold into a specific 3-dimensional shape. The 3-dimensional shape is important in the activity of a protein.

Proteins contain three aromatic amino acid residues (tryptophan, tyrosine, phenylalanine) which may contribute to their intrinsic fluorescence. The fluorescence of a folded protein is a mixture of the fluorescence from individual aromatic residues. Protein fluorescence is generally excited at 280 nm or at longer wavelengths, usually at 295 nm. Most of the emissions are due to excitation of tryptophan residues, with a few emissions due to tyrosine and phenylalanine. The fluorescence of the aromatic residues varies in a somewhat unpredictable manner in various proteins. Comparing to the unfolded state, the quantum yield may be either increased or decreased by the folding. Accordingly, a folded protein can have either greater or less fluorescence than the unfolded form. The intensity of fluorescence is not very informative in itself. The magnitude of intensity, however, can serve as a probe of perturbations of the folded state. The wavelength of the emitted light is a better indication of the environment of the fluorophore. Tryptophan residues that are exposed to water, have maximal fluorescence at a wavelength of about 340-350 nm, whereas totally buried residues fluoresce at about 330 nm.

Lights of 400 nm or over are less likely to cause damage. Filters or goggles are required with 400 nm in order to more easily view the fluorescence. At this level, the amount of excitation causes bright light from surfaces surrounding the stain to illuminate and this illumination light needs to be blocked to reveal only the area actually fluorescing (Melles, 2002).

Using a bed bug detection KIT. These kits contain a specialty flashlight used in forensics in addition to the filter goggles/glasses, needle point forceps, specimen containers and interception monitors.

To maximize the benefit of your bed bug inspection system, it's important to know both what you're looking at and looking for. Proteins from blood feedings and excrement, caste skins, and eggs of bed bugs will fluoresce. Using the orange filter goggles in combination with the intense 455 nm UV light, you add vivid contrast and productivity to your inspection.

Our kit enables the user to add a new dimension to bed bug inspections to both intensify the inspection process and make good use of your time. This blue-light-emitting source is used to visualize latent signs and other physical infestation evidence. It is necessary for the examiner to wear orange goggles which are included within the kit.

Use your UV Bed Bug Detection Kit…

- Along and behind headboards.
- Along and under the mattress, box springs, and bed frame.
- Along base coves and wall utilities (heater-coolers, electrical covers, cable lines, computer lines, phone lines, etc.).
- Along and behind wall-hangings.
- Night stands and the undersides of drawers.
- Fabrics on furniture.
- Curtains and wall-hangings.
- Wall surfaces and textured ceilings.
- Appliances (clock-radios, HDTVs, phones, safes etc.).
- Coat hangers, shelves, under counter tops, behind toilets, shower areas, etc.).

PRE-TREATMENT ADVICE TO CLIENTS

Hotels, Guest Complaint Procedure

- Any report of bed bugs should be investigated and recorded.
- Any guest complaining of bed bugs should be immediately relocated, to avoid bites occurring again.
- Prior to relocation, belongings should be inspected for bed bugs (with consent of the owner) and laundered, to minimize the chance of the infestation spreading. Disposable linen bags can also be used.
- Medical assistance should be sought if there is a severe reaction to bed bug bites.
- A qualified pest management professional should inspect the area (which should be vacated until an inspection is organized) for bed bugs.
- Details of the inspection and action taken should be recorded.
- Ideally, the pest management professional should inspect the room before the client removes items. This is so the pest management professional can gauge the extent of the infestation.

Bed Bug infestation confirmed: action to take

- If a bed bug infestation is confirmed, the guest should be provided with advice on how to prevent infestation of their home.
- Guidance on the “Bed bug client checklist” should be followed.

CHECKLIST

Bed Bug Client Checklist

Client Responsibilities

- ☐ Loosen the carpet at wall / floor junction, but do not remove it from the room.
- ☐ Remove any wall-mounted items but do not take them out of the room.
- ☐ Remove plug and switch plate covers. Isolate the supply to the room to avoid electrocution.
- ☐ Remove linen from bed and base. These should be bagged and laundered (see laundering procedures in later section).
- ☐ Empty wardrobes and cupboards of items.
- ☐ Do not remove any items of furniture from the room. In most cases beds can be treated and do not need to be disposed of.
- ☐ If a mattress is torn and therefore difficult to treat, it can be disposed of. Discuss this with the pest management professional. The mattress should be rendered unusable, sealed and disposed of after being treated with insecticide.

After Treatment

- ☐ Replace all items removed from walls.
- ☐ Replace carpet.
- ☐ Re-assemble room.

Signed: _____

Date: _____

Bed Bug Client Checklist for PCO

Information for client

- ☐ Bed bug client checklist provided.
- ☐ Recommend, if possible, that rooms to be treated should be taken out of service for a minimum of 7-10 days (if relevant).
- ☐ Bed bug fact sheets provided, along with details of insecticides to be used.

Customer responsibilities completed

- ☐ Carpet loosened at wall / floor junction.
- ☐ All wall-mounted items removed.
- ☐ Plug and wall switch plate covers removed.
- ☐ Linen removed from bed and ensemble base.
- ☐ Items removed from wardrobes / cupboards.

Pest Control Manager: _____

Signed: _____

Date: _____

BED BUG FACT SHEET

Key features

Adult bed bugs are 4-8 mm in length, wingless and uniformly mahogany brown in color. They have long well-developed walking legs with efficient tarsal claws for clinging on to the host during feeding. Prominent antennae project from the head adjacent to the compound eyes.

Biology

Female bed bugs place eggs throughout their life, an unusual feature in insects. They generally produce around 2 to 3 per day and since they can live for many weeks, indeed months, each female could produce around 400 - 500 eggs during their lifetime. The eggs are deposited all around the environment in which the bed bug is living and are small and white or whitish/yellow about 1 mm long. The nymph that emerges from the egg after about 10 days at 22°C-72°F is a small version of the adult feeding also on the blood of vertebrates.

The length of time spent in the five nymphal stages is greatly dependent upon the food resources available, temperature and relative humidity. Bed bugs have well defined resting sites in which many individuals from all the different life stages are found. This harborage is an essential part of the life cycle of the insect since it is in this area that the young bed bugs pick up the internal gut microorganisms that are essential to their survival.

Distribution

Worldwide.

Significance

The close association of bed bugs with human beings means that they can cause substantial nuisance through their blood-feeding habit. They feed at night on the human hosts as they are sleeping. If the infestation is high there can be a risk of anaemia being suffered by the human hosts, although this is rare. The nuisance and itching caused by the bites (cimicosis) and the possibility of secondary infection is more common. Bats, chickens and other domesticated animals may also be attacked.

Management

A thorough inspection should be made to determine the extent and source of the infestation. Bed bugs may, for instance, have been introduced in second-hand furniture, where bugs may remain undetected for considerable periods until a suitable host appears. All harborages should be treated with a residual insecticide. A very thorough treatment is needed, as harborages are diverse and difficult to detect.

RECORD OF PEST COMPLAINTS

Name					
Unit Address					
Date	Nature of Pest Complaint	Location of Complaint	Reported by	Date of action	Reference Number

PEST CONTROL REPORT SHEET

Name	
Address	
Date	
Reference Number	
Report Number	

Initial Visit ☐ Routine Visit ☐ Follow-Up Visit ☐ Job/Call-Out ☐

Observations/ Comments	
Recommendations/ Treatment	
Action	
Pesticide(s) Used	
Quantity(ies) Used	

Customers Name: _____ Signed: _____

Technicians Name: _____ Signed: _____

RECORD OF PESTICIDE APPLICATION

Operator	
Date of Treatment	
Address/ Site of Application	
Areas to which applied	
Reason for Treatment	
Product Used	
Type of Application	
Quantity Used	
Dilution Rate	
Application Rate	
Reference Number	
Other Relevant Information	

INSECTICIDE APPLICATION

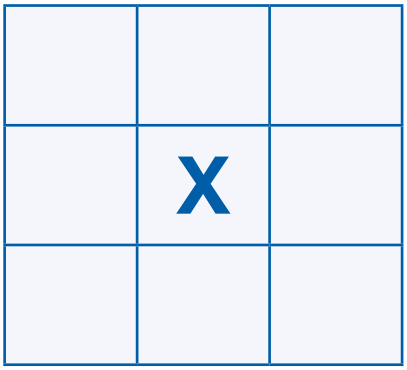
Use properly labeled insecticide with correctly calibrated and serviced spraying / dusting equipment.

- Flat fan and crack and crevice nozzles are recommended for broad spray treatments and crack and crevice treatments respectively.
- If the insecticide label allows it (read and understand the product label), treat mattresses, around buttons and along seams. Do not use insecticide on bedding.
- Treat the bed frame and headboard, including joints and grooves.
- Treat electrical goods such as telephones, clock radios and televisions with approved and labeled dust, if this can be done without damaging electrical components.
- Apply insecticide to the wall – floor junction, under carpet edges, where the carpet meets the skirting board and under the skirting board if accessible.
- Apply dust to the inside of all electrical junction boxes. Light switch covers can be removed and treated.
- Treat furniture framework – upholstered furniture can be treated with crack & crevice spray, similar to mattress treatments and dust can be applied to the hollow metal tubing of appropriate furniture.
- Treat items removed from the walls.
- If bed bugs are found in the guide tracks of wardrobes, arrange for these tracks to be pulled up. Treat this area and arrange for the tracks to be re-attached post-treatment.
- Inspect and treat housekeeping and storage rooms.

Block treatments

Block treatments are essential in good pest control. All rooms in contact with the infested room should be inspected and treated if necessary. This includes rooms adjacent, above and below the infested room.

It is a good pest control strategy to ‘work from the outside, in’. Find the extent and outer limit of the infestation and work inwards towards the focus to gain control.



X - Infested Room

INSECTICIDE TREATMENT PROGRAM

The suggested treatment program utilizes a mixture of insecticide groups and formulations, ensuring an integrated approach to control and resistance management.

PestWest does not endorse any insecticide that may be mentioned in this document. Product selection is the complete responsibility of the user.

Cimex lectularius suggested treatment regime	
TREATMENT 1 (initial treatment)	Residual Pyrethroid + IGR + Dust + Pyrroles
TREATMENT 2 (if the label permits, re-treat after 2 weeks, or depending on temperature and therefore egg hatch)	Residual Pyrethroid + IGR + Dust + Pyrroles
TREATMENT 3 (if the label permits, re-treat after 4 weeks, or depending on temperature and therefore egg hatch)	Residual Pyrethoid + IGR + Dust + Pyrroles

A comprehensive program ensures that the maximum number of insecticide groups and therefore modes of action are used against the bed bug. Modes of action include sodium channel modulators, and insect growth regulators. ULV based flushing agents are also available, which contain a synergist, piperonyl butoxide, which inhibits the insect detoxification mechanism. ULV flushing agents can excite bed bugs and flush them into other areas so they should be used with caution. This program also utilizes a number of different formulations.

Alternative control

Non-chemical control – Vacuuming

- Vacuum general area of the floor and use crack and crevice extension at wall / floor junction.
- Vacuum mattresses and other furniture, removing cushions and turning furniture upside down.
- Vacuum cleaners with HEPA filters are recommended to prevent the spread of potentially irritating debris through the exhaust.
- Dispose of the vacuum cleaner contents in a sealed bag as soon as possible, preferably by incineration. Approved insecticide dust can also be applied to the contents.
- Inspect all other potential bed bug refugia and vacuum if insects are present.
- Vacuum cleaners themselves could spread infestations. They should be 'treated' by soaking plastic parts in hot water. When not in use, the vacuum cleaner should be stored in a sealed bag.
- Vacuuming will not remove all bed bug eggs, so subsequent insecticide application is essential.

Extreme temperature treatments

There are commercially available extreme heat and cold treatments that can be used to treat bed bug infestations. These techniques certainly have their uses, especially where pesticide use may be undesirable or resistance is suspected. Tests have shown that bed bugs can be controlled successfully using extreme cold treatments, backed up with thorough vacuuming. It must be remembered, however, that extreme temperature treatments offer no residual effect. There is a heavy reliance on heat treatments and fumigation for bed bug control in the US, due to widespread pyrethroid resistance. Heat treatments consistently above 118 degrees (Kells 2010) for a time period have been proven successful in many applications, and as with any bed bug treatment protocol, paying attention to detail and following manufacturers recommendations is key.

Steam treatment

This technique can be used successfully, depending on the quality of the steam. This method can be particularly useful as it kills all life – stages of the bed bug, including the egg. The quality of steam is important. 'Dry' steam with less than 5% humidity, at 94ºC-201.2 ºF, applied at a high pressure is recommended.

Laundering procedures for bed bug management

The following table is an extract from work by Richard Naylor at the University of Sheffield, UK.

Post-treatment advice and risk minimization measures

- Repair any loose wallpaper.
- Repair any sources of moisture.
- Remove suitcases, day packs etc. from the bedroom (or house) inspect and/or treat thoroughly.
- After treatment, re-attach the cloth cover to the bottom of the divan base.
- After treatment, seal cracks and crevices.
- Covering the mattress with a plastic or allergy-proof cover may help prevent re-infestation by reducing the harbourages. Some covers will trap bed bugs, causing them to die of starvation.

Interception Monitors

The use (and misuse) of monitors is one tool in your tool box to help identify the level of an infestation. Passive monitors are only to be used if they have a preferable habitat and and minimal adhesive (see also alarm pheromone references) and most importantly used as at a point between the bug and the host. There are interlocking monitors available to make as large or small as the situation requires, but the rule of thumb is to use sufficient quantities per room.

Treatment Method	Temperature & Duration	Control Level
Washing machine (non-biological detergent) 3.2kg - 7lb	Cool – 30ºC / 86ºF – 30 minute wash	Did not kill egg stages
	Hot – 60ºC / 140ºF – 30 minute wash	Killed all life stages
Tumble Dry 3.2kg - 7lb	Cool dry – 30 minutes	Did not kill all stages
	Hot dry – 30 minutes – 40/45ºC / 104/113ºF	Killed all stages
Cold Soak 3.2kg - 7lb	Cold water – 30 minutes	Killed adults/nymphs only
	Cold soak – 24 hours	Killed adults/nymphs only
Dry cleaning (perchloroethylene)		Killed all life stages
Freezing 2.5kg - 5.5lb	2 hours at -17ºC / 62.6ºF (8 hours to get clothes and items to -17ºC / 62.6ºF, takes total 10 hours of treatment)	Killed all life stages

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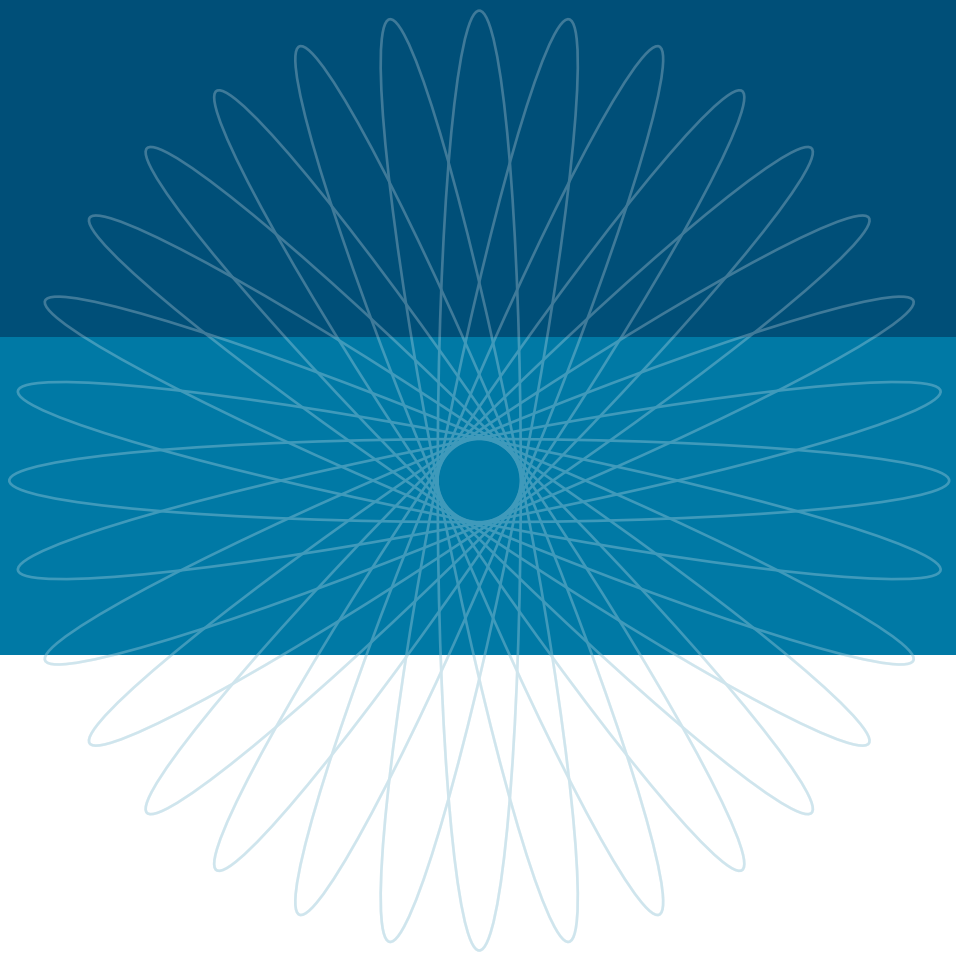

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