

CONTROL OF BED BUGS IN RESIDENCES**Information For Pest Management Companies**

Amelia K. Shindelar and Dr. Stephen A. Kells
Department of Entomology
University of Minnesota

INTRODUCTION

Bed bugs have resurged to quickly become a very important pest of the 21st century, as they invade numerous urban areas including hostels, hotels and residences. Our society has had a “30-year vacation” from this pest, during which bed bugs were almost removed from North America as a result of mass treatments with older types of insecticides (DDT, Chlordane, Chlorpyrifos, etc.). However, through a combination of re-introduction to society; increased travel of people; and people underestimating the abilities of this insect, bed bugs have reemerged as a significant pest. Because of their unique hiding behavior, because they can feed without detection, and because of their ability to spread, inspection and control methods against bed bugs must be far more thorough and extensive than what we are used to with other pests (such as cockroaches, ants and rodents).

Bed bugs are in a group of parasites that live in the “nests” of their hosts, and the feeding behavior of these bugs makes them a particular problem. Associated with humans, the “nests” can include houses, hotels, and hostels; essentially any area in close proximity to where people sleep or rest. By living in close proximity to humans, they can wait and feed when the person is not likely to notice, and then they return to hiding to avoid detection. These pests typically bite people when they are sleeping, resting or



sitting for long periods. Hungry bugs will move out from their hiding places, in search of a blood meal when the person is distracted. In heavy infestations, these bugs may also move into folds of clothing or under sheets to find a feeding site. Once fed, bed bugs will return to their specialized behavior of hiding, and this behavior is what makes bed bugs truly unique compared to other parasites. Unless people are carefully looking for bed bugs hiding in cracks and crevices, these pests can be easily overlooked. Research reports of bed bugs spending up to 95% of their life cycle in hiding, provide an indication as to why bed bugs are so hard to eradicate from a site. This combination of bed bugs’ feeding behavior and their tendency to hide makes bed bugs an extremely difficult pest to control.

In addition to behavior that helps them go unnoticed, the bites inflicted by bed bugs can also go unnoticed, or can be mistaken for the bites of other pests. All people are not equally sensitive to bed bug bites, so while

some victims break out in rashes from the bites, other people may not display any symptoms. Even among people sleeping side by side, one person may show severe reactions while the other has no evidence of having been bitten at all. When a reaction does occur, the results of feeding can be mild (a simple red spot) to severe (rash or even hives).

Over time, people who did not originally react may develop a response to the bites, but it will depend on the person, the number of bugs, and the size of infestation. An individual's reaction to insect bites is an immune response and will depend on the ability of their body to detect and respond to inflicted bites. In a survey, Dr. Mike Potter (University of Kentucky) estimated that 1 in 4 people were not reactive to bed bug bites, and in senior citizens this estimate was 1 in 2 people not being reactive to bed bugs. Sometimes the immune system requires time to develop a response, resulting in the bites being detected only after multiple feedings. Cold medications containing antihistamines may reduce a person's response to insect bites. The reaction caused by feeding might be mistaken for other problems: fleas, mosquitoes and other biting insects, sensitization to detergents and soaps, and irritants (e.g., poison ivy) are some of the conditions victims of bed bugs thought they were dealing with.

When feeding is not readily detected, it can permit an infestation to exist for quite a time before the person (or establishment) realizes they have an infestation.

On the opposite side of the spectrum are individuals who do not have bed bug infestations but suffer from Ekbom Syndrome or Ekbom-like symptoms (also known as delusory-parasitosis) and thus believe they are dealing with an infestation when in reality there is none. A recent review of phone calls to the Minnesota Bed Bug *InformationLine* has shown that 1-2 % of people calling may have exhibited possible Ekbom (or Ekbom-like) symptoms. These have included symptoms such as thinking the insects are living in or on their bodies, being unable to find any insects for identification, and being unwilling to explore other potential explanations for the "bites" they are experiencing. The key point is that there is usually no current parasite activity detected, or there may be insects present that would be associated by the victim as causing direct injury to the person when in reality they are harmless. For more about this syndrome, please refer to:

<http://www.ent.uga.edu/pubs/delusory.pdf>, or other published documents by Dr. Nancy Hinkle (University of Georgia www.ent.uga.edu/personnel/faculty/hinkle.htm).

Taking into consideration the complexity of this pest, control of bed bugs in residential areas requires a very thorough process of:

- Identification and inspection;
- Non-chemical and chemical control methods; and
- Follow-up methods including regular inspections for new infestations.



The methods below describe a system of **eliminating** the insects completely from an infested location. Without complete elimination and a system to quickly respond to new infestations, bed bug infestations will continue, and the site will pose a risk for becoming a reservoir site introducing bed bugs to other areas. Control methods for a single residence can take from 4 hours to repeated applications over 2 - 4 days spanning 3 weeks depending on the extent of the infestation and type of treatment. In addition, after feeding some bed bugs may move farther away from the feeding site, to quieter areas (including smoke detectors or fire sprinklers). Therefore, all activities against this bug must be extensive and carefully done.

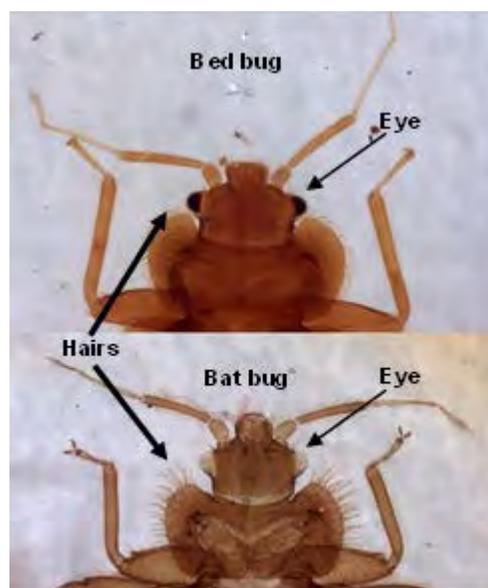
IDENTIFICATION

During an inspection or when you have received a sample, the first step is to make sure you are indeed dealing with bed bugs. Bed bugs are flattened, brown, wingless insect approximately $\frac{1}{4}$ to $\frac{3}{8}$ inch long (5 - 9 mm). After the bug has taken a blood meal, it's color changes from brown to purplish-red. The size and shape also changes, making it appear like a different insect. After a blood meal adult bed bugs become cigar shaped and have a darker color.



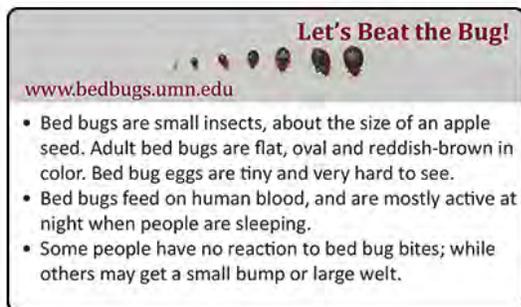
Young bed bugs are nearly colorless and much smaller ($\frac{1}{16}$ " or 1.6 mm), but resemble the adult in general shape. You may also find caste skins, which the bed bug sheds as it grows. After a blood meal, bed

bugs deposit fecal spots (composed of digested blood) in areas adjacent to the feeding site or back at their hiding places. These spots are not a dust, and cannot be brushed away. The liquid fecal matter is frequently absorbed into the surface material, leaving a distinctive mark.



If you do not have experience identifying bed bugs, contact an entomologist to help you as there are a number of insects that are in the same family as bed bugs and are often mistaken for bed bugs. It is very important to get a proper identification as treatment will vary depending on the type of insect. Bat bugs or swallow bugs are frequently mistaken for bed bugs. Bat (or swallow) bugs have very long hairs along the edge of the pronotum (the plate just behind the head). These hairs will be long enough to project beyond the eye (or at least longer than the eye is wide). When in doubt, have a specialist examine the sample. These other species of bed bugs live in attics (and eaves) associated with bats and birds, but have been known to also infest human habitats. If the insect is a bat bug or swallow bug, inspection and control measures should include areas where these animals may be found.

For assistance with identification and client education a bed bug identification card is available from the University of Minnesota.



For more information on this card please visit www.bedbugs.umn.edu/bed-bug-identification-card, email bedbugs@umn.edu, or call 612-624-2200

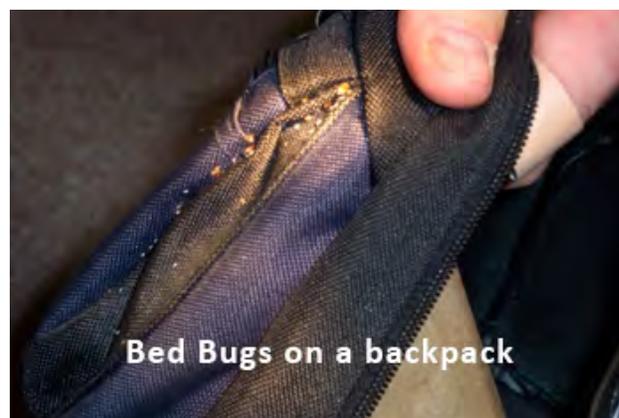
INSPECTIONS



When a bed bug infestation is suspected, a very thorough inspection is required. You must be prepared to look for large and small bugs, fecal spotting, and cast skins. Often the first response is to look around the bed, but other locations can be just as important. Here are some important questions to ask:

- Has someone in the family been on a trip that required luggage? Do they regularly carry other bags (backpacks, etc.) that they may place under (or beside) chairs or seats?
- Where is luggage, (or baggage, backpacks, etc.) typically placed when returning to the residence?

- Where is the luggage stored after emptying?
- Does the affected person sleep or rest for extended time on a couch (or another area) in the residence?
- Where are dirty clothes and bed linens placed, or stored?
- Who else visits the residence with bags, a coat, or other items? (This question has been important for seniors residences and apartments when determining source infestations)
- Where has the person visited in the past 6 months – place or places where they may have sat or rested for a time period? *This is a “long shot” question, but it has in the past revealed a key societal connection, and may be critical for prevention methods.*



Answers to the above questions will help determine the potential extent of the infestation and where inspections should **start**. Keep in mind, though, that these questions should not limit where you look!

While bed bugs are most commonly found in bedrooms, infestations also frequently occur in other rooms, including: bathrooms; living rooms; and laundry rooms.

Necessary tools:

- a quality flashlight,
- thin blade spatula (a cake icing spatula is suitable),

- screwdrivers and wrenches for dismantling items (e.g., the bed and cover plates to electrical receptacles)
- 10x magnifying glass,
- inspection mirror,
- carpet adhesive,
- garbage bags (for quickly containing infested items),
- clear packing tape (for samples and sealing infested articles in bags),
- staple gun with ¼” staples, and
- a vacuum cleaner that can use filter bags.

Usually, there will be one (to several) primary infestation sites associated with where people rest (sleep, sit for extended periods, etc.). Bed bugs are extremely flat and small (1/16th to 3/8 inch or 6 to 8 mm long) so the person inspecting must look along (and in) edges and cracks, folds and seams. It is important to not overlook any cracks or crevices during the inspection. For example; holes drilled in wooden elements for screws are often overlooked, as are labels and stickers placed on mattresses and other furniture. To give you an idea of the tight places bed bugs can fit into, bed bugs have been found along picture frames, between the glass and frame itself. During an inspection, start at the places the person has identified as a resting site, and move out from these areas.

If at any time a bed bug is found: discontinue inspection and plan to initiate control activity! Do not continue with the inspection alone, as bed bugs will move from their hiding places once disturbed. Further inspections must be accompanied by control measures, or at least a vacuum to capture any bed bugs found during your inspection.



Needles and sharps hazard!

Be very careful of wood splinters, sharp metal fragments, and concealed items.

Look with your eyes and use the spatula only.

DO NOT use your hands!

Inspections of the bed (or resting areas) have to be detailed, as this habitat is very complex. The bed consists of: linens; blankets; mattress; box spring; headboard and frame. Although the favored resting areas consist of the region near the head and shoulders of the person (mattress, box spring and behind the headboard) **do not** superficially inspect these areas and assume the job is done. Start with the linens concentrating on the folds and seams of sheets and blankets (particularly fitted sheets). As items are inspected, remove them from the bed and place them centrally on the floor.

Next on the mattress:

1. Start with the piping (the edge reinforcement on the bed) and look along all stitching lines.
2. Look along the sides of the mattress, and then the field (top and bottom, again following all stitch lines will help you methodically and quickly cover the mattress). Once you have inspected all the sides of the mattress which are accessible, move the mattress to be able to inspect the other sides.
3. Finally, pay attention to any labels, tags, buttons and other decorations that may be on the mattress.



With the mattress out of the way, move on to the box spring:

1. Again begin with the edge, looking along stitch lines.
2. Look where the frame and box spring contact - if you lift the box spring on edge quickly look along the bed frame before bed bugs have a chance to scatter.
3. Look under the plastic edge guards (best is to remove them for inspection and refasten with the staple gun).
4. Gradually remove the dust cover ("ticking") from the back of the box spring while looking under any folds and where the mattress fabric fastens to the frame.
5. Look in any depressions, countersunk screws and under any staples that are not flush with the frame.
6. Finally, inspect all joints, cracks and corners of the box spring's frame.



With the box spring clear, move to the frame:

1. Starting with the frame rails, inspect along the rails and the following features: end caps, joints, welds, holes, seams, cracks, and countersunk areas (bed bugs will hide on metal and wood frames).
2. Inspect along any cross-bracing, again paying attention to the above features.
3. Inspect the legs (don't forget the casters, if present).
4. Move to the head- and foot-boards, again look along all surfaces and pay attention to the features previously mentioned.



With the frame moved away, begin in the surrounding area:

1. Look in the area where the bed contacted the floor (carpeting depressions, or hardwood).
2. Move to the baseboards, inspecting top and bottom of the baseboard (including imperfections, cracks and crevices, peeling wallpaper and drywall cracks, in and under phone jacks and other plugs). If the baseboards are made of carpeting and are fastened to the wall with glue, carefully remove the carpeting - inspecting the carpet and glue lines. Carpeting can later be replaced with adhesive, but use adhesive sparingly. Obtain permission to remove this and other fixed elements in the room.

- Using the spatula, carefully “scoop” debris from under the baseboard. Angle the spatula so the leading edge rests on the floor and the trailing edge scrapes along the baseboard underside. This method will often crush bugs, so pay attention to blood spots or insect parts (you may have to send the parts to an entomologist for identification, as other insects might be present).

Having finished with the bed (or resting area), move out to the next item of furniture and begin the same methodical and thorough inspection.

For drawers and bedside tables: start with an exterior inspection (top, sides, and bottom), then move to the drawers (remove them and begin with top, sides and bottom). Again, pay attention to: cracks and crevices, imperfections, joints, screws and corners.



Don't forget to move furniture away from the wall, inspecting the back and bottom sides of the item.

For upholstered furniture, the same detailed search is required as mentioned with the bed. Do not overlook any detail and pay special attention to: zippers; skirting; fabric seams; and the crevices under the cushions.

Other items such as drapes, pictures, stuffed animals, and toys must be inspected also.

For electronic items, such as phones, radios and TVs: inspect all holes, corners, cracks and edges.

Using canine inspections has become a common approach in the pest control industry, and a well-trained canine and handler team can be very effective during a bed bug inspection. Canines and their handlers can cover a lot of area quickly and can often find low level infestations much easier than a visual inspection. If a canine inspection is going to be used there are a number of important considerations. The canine and handler team should be trained and certified in the detection of bed bugs. The area to be inspected should be free of distractions, such as pets or strong scents. Also, keep in mind that a canine cannot inspect all areas of a room, anything above the reach of the canine, i.e. pictures hung on the wall, should be inspected by a technician.

CONTROL PROCEDURES

When using any insecticide, obey the label and follow all directions.

Furthermore, the control methods described herein assume that the commercial insecticides available will be used by licensed personnel from a Professional Pest Management Provider.

DO NOT use other pesticide products off-label (Especially pesticides meant for Garden or Agricultural use)

DO NOT use products that appear “homemade”, “custom formulated”, or were purchased from a non-licensed vendor.

The following control procedures represent “best practices” for controlling bed bugs developed as a result of many years of experience in the Pest Management Industry. These practices were developed in response to complaints about repeated control failures

resulting from attempts to control bed bugs using only insecticides.

Work Efficiently

Control procedures against bed bugs require much moving of furniture, equipment and other items. Plan how you will treat the room so you only move each item once. This will save considerable time and effort. Designate a “clean area” and apply non-chemical and chemical measures to that area (see below). After setting up a clean area, all items receiving treatment can be placed into this clean area. As the clean area fills up, adjacent sections of the room will become available and you can expand the clean area to provide more room for treated items. Depending on the room and its contents, expanding a clean area two or three times usually provides enough space for all the contents.

MAINSTREAM PRACTICES

Thermal Treatments

If items can be isolated and contained so that bed bugs cannot move away from the area, bugs can be controlled by **dry heat**, or by **freezing** infested articles. The key point of thermal treatments is to make sure the bugs are exposed to a **critical temperature** for a specified time, **and** to make sure that you consider the **insulative qualities** of the infested item. **Critical temperatures are necessary at the core (or inside) of the infested item, and it may take some time for critical temperatures to reach the center of these items.** Temperatures may damage certain articles, so careful monitoring of surface and core temperatures is very important.

For a whole-room heat treatment, or container heat treatment, bed bugs should be exposed to 118°F (48°C) for 72 minutes or 122°F (50°C) for less than 1 minute, these time/temp targets should be considered a

minimum control condition for heat treatments. However, care should be taken to avoid conditions above 145°F (63 °C), as damage to certain items may occur. To safely achieve these temperatures and reduce risk of damage, only use equipment that has been specifically designed for insect control, and follow manufacturer’s instructions, and training guidelines.

For effective freezing conditions, hold items at 0°F (-18°C) for 72 hours. For homeowner recommendations we suggest 96 hours to provide an extra 24 hour “safety factor” given the potential variability of freezers. As you decrease the temperature, you will be able to shorten the time of exposure. If you wish to “flash freeze” articles (shorten the time of exposure, by using really low temperatures) the target temperature should be at least -22°F (-30°C); at this temperature the eggs instantly freeze.

When conducting thermal treatments, the key is to minimize insulative qualities, allowing critical temperatures to quickly reach the core of each article. Piling cushions or clothes together increases the time for critical temperatures to reach the core. Keep stacked items to a minimum, and try to promote circulation of air around and between items.

Regardless of the method used, proper equipment for monitoring temperatures should be used. Thermocouples and electronic thermometers are available from scientific supply stores or heating and ventilation suppliers. Thermocouples are wires with a temperature sensor on the end. You can place several wires within infested articles to ensure critical temperatures are reached.

Insecticide Applications

Insecticide applications are an effective method for controlling bed bug infestations if done thoroughly and accompanied by non-chemical methods, such as laundering and

vacuuming. When using insecticides to control bed bugs it is recommended that three types of insecticides are used:

- a residual product,
- a direct contact product, and
- a dust

These three types of insecticides, used according to their application label, allow for treatment of as many possible places where bed bugs may hide. For more information on different products, please consult your supplier of pest control products and Minnesota Department of Agriculture's booklet: *Bed Bugs & Insecticides: What You Should Know*

(download at:

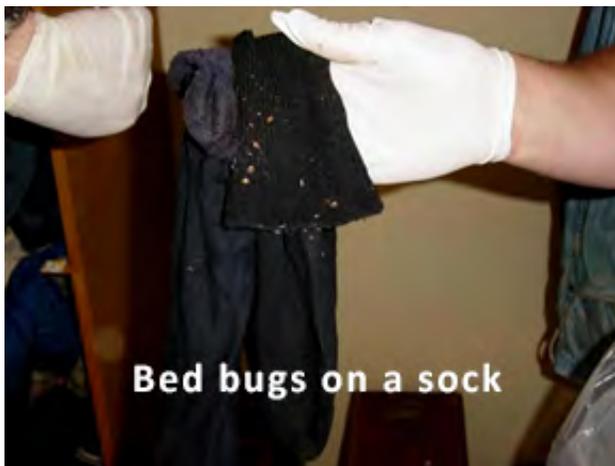
bedbugs.umn.edu/files/2013/08/FINAL-Bed-Bug-Guide-8.21.13.pdf)

ALWAYS read and fully understand insecticide labels before using these products and be prepared with alternative (non-chemical) methods if you have a specific site that is not addressed by any of the labels or formulations.

ADDITIONAL CONTROL METHODS NEEDED FOR CONTROL

Laundering

Clothes and linens can be washed and dried to remove infestations. Linens and dirty clothes by the bed should be contained in sealed plastic bags until they can be washed. Washing and drying should be done at the highest temperature that the fabric can withstand. If an item cannot be washed, place it in the dryer set to at least medium-high heat for 30 min. This will kill all stages of bed bugs and



then the item can be cleaned in the normal manner, i.e. dry cleaning or washing on cold.

A common question asked is: “what about all of the clothes in the closet and drawers?” The answer to this will depend on the size and location of the infestation. For example; a chest of drawers placed next to an infested bed should be suspect. The best practice is to have all items in an infested area treated; this includes all clothing and linens. If the resident finds this recommendation to be burdensome or stressful ask them to bag all of the items so they can be isolated and treated over time, as mentioned above 30 minutes in a clothes dryer set to medium-high heat will kill bed bugs. For additional information on laundering please see this factsheet: *Laundering Items to Kill Bed Bugs* www.bedbugs.umn.edu/bed-bug-control-in-residences/laundrying-bedbug-control

Vacuuming

Having a vacuum present during inspections and control efforts helps to quickly capture and contain any bugs that are found (make sure you get a couple for identification purposes). Use a vacuum fitted with a collection bag so you can seal the bag for disposal. Do not use a “wet/dry” vacuum

unless it has a bag fitted to collect bugs and debris. During control procedures, use the vacuum to collect any bugs found, vacuum the clean area, and also vacuum the crevices around baseboards, electronic items, and receptacles.

Use a plastic (non-conducting) crevice tool to prevent electric shock.

Steam

Using steam is a very effective method of killing all stages of bed bugs. Delivered correctly, steam will contact bugs on the surface and those hidden inside stitch seams. However, steaming is very labor intensive. Here are some key points to get the most out of this control method:

1. Use a commercial unit with a capacity of at least 1 gallon (or 4 liters). Avoid smaller (non-commercial) units because of the amount of steam delivered and the need to frequently cool and refill. Two units are preferable at a large site so at least one unit is in constant operation, while the other is being refilled and heated.
2. A unit that has a steam volume control is preferable because “dry” steam will reduce the drying time, yet provide flexibility for use of different attachments.
3. Employ a unit with a floor (or upholstery) attachment. Steam should be concentrated enough to penetrate the fabric, but given enough area so you don’t have to follow each stitch line. A single hole nozzle provides a jet of steam that is too concentrated. Bed bugs hit by a concentrated jet of steam may be blown across the room, and may walk away.
4. Use a non-contact (infrared) thermometer to monitor your progress. Immediately after the steam brush has passed, the surface temperature should be between 160 - 180° F. Below this temperature range and bed bugs will survive, above this range increases the risk of damage to the fabric and other materials.

Always test the steam on a hidden area to confirm that treated fabric, dyes and wood finishes can withstand this temperature.



Apply steam to each item and object in the room as control procedures progress. Concentrate on areas and features that were mentioned in the inspection part of this fact sheet. Steam is particularly useful for carpeting, upholstery, the mattress / box spring, and deep cracks and crevices. Steam is useful for box springs because it can penetrate the fabric (and padding) and the many crevices that form during construction of a bed. Steam can also be useful on tubular steel frames, particularly when multiple holes are present.

Note that steam kills the bugs immediately, but does not provide important residual control necessary to ensure no bugs remain alive. As soon as the heat is removed, the area can be prone to re-infestation.

Also note that once finished, humidity will be rather high. To promote drying, a fan (dehumidifier or natural ventilation) should be used to prevent mold and mildew growth. Steam applications will prolong drying of insecticide applications, so reentry times by occupants should be adjusted accordingly.

After steam-treating each item, apply any additional treatments (where possible -- see below) and place item into the clean area (See the section about working efficiently).

Freezing

Putting infested items in a freezer can kill bed bugs if some particular conditions are met. Freezing causes ice to form inside the bed bug, causing death. There are some things to take into consideration to ensure that freezing is effective and does not cause damage to items you are freezing.

Most dry household items can be frozen, including:

- cloth items that you cannot (or do not want to) wash or launder
- modern books
- shoes
- jewelry
- pictures
- toys
- electronics without an LCD screen

There are a few items that require caution when attempting to freeze or that should not be frozen, these include:

- electronics with LCD panels
- historic artifacts or old books of considerable value
- items that cannot be replaced
- items that may be damaged if condensation occurs
- items that contain high moisture or liquids inside

When using a freezing as a control treatment, the temperature of the freezer is very important, as is the time of exposure. Please refer to “Thermal Treatments” above for time and temperature minimums.

DO NOT attempt to control bed bugs by putting infested items outside in cold temperature, it is unlikely that it will be cold enough for long enough to kill bed bugs. Sunlight, humidity, and temperature variations during the day increase the risk

that bed bugs will survive. DO NOT attempt to freeze bed bugs out of a residence by opening the windows and turning off the heat. There is a major risk that structural damage will occur and you will not kill the bed bugs.

Mattress Encasements

Mattress encasements which are labeled for bed bugs are recommended for areas prone to chronic infestations and can also be helpful in the course of a normal treatment. Mattress encasements prevent bed bugs from hiding in the complex habitat provided by the mattress and box spring, and simplify control measures. If insecticides are used (per label) to the mattress, covers can be used to contain this application and provide an additional barrier between the treated mattress and the person. Mattress encasements can also be used as a stand-alone treatment for mattresses and box springs. If installed appropriately, any bed bugs currently on or in the mattress will be trapped inside of the encasement where they will eventually starve and die. Bed bugs are known to live up to 18 months, thus when encasements are used as a treatment method they need to be left on the mattress and box spring for a minimum of 18 months.

FOLLOW UP INSPECTIONS AND TREATMENTS

Approximately two weeks post-inspection and treatment, another inspection of the premises is required to confirm that all bed bugs were eliminated. If insecticides were the main control method, a follow up treatment is highly recommended as insecticides may not kill bed bug eggs. This inspection must be as thorough as the preliminary inspection (described above), and if bugs are found again, control procedures must be repeated. From experience, most control failures encountered were a result of missed hiding

places. The presence of bed bugs in previously treated areas may be a result of these bugs moving from an untreated site (or sites) to areas closer to their food source. Attention to detail is critical for complete elimination and the follow up inspection is critical to ensuring that bed bugs have not survived control procedures.

Photo credits: Dr. Stephen Kells, Department of Entomology, University of Minnesota Extension Service

Sites of infestation Photos – Abell Pest Control, Inc. Etobicoke, Ontario, Canada