

Heat Treatment for Bedbug Mitigation in Fire Sprinklered Properties



Bedbug control has become a growing trend in the pest control industry. One of the preferred methods for mitigation is to subject potentially infested rooms to high temperatures. If the places where bedbugs are harboring can be brought to around 122°F for as little as a minute, the heat will be sufficient to kill them. Accomplishing this often means bringing the ambient temperature in rooms being treated as high as 155°F to 160°F. This method has the benefit of being highly effective and of leaving no toxic residues behind but it creates some serious complications when applied to rooms protected with fire sprinklers. The National Pest Management Association (NPMA) has become increasingly aware of this concern and now recognizes that a room with ordinary fire sprinklers cannot be heated to any temperature above 100°F without consideration for the heat sensitive elements in the sprinkler system.

Temperature and Exposure Time Required to Kill All Bed Bug Stages	
Temperature	Exposure Time
113°F (45 C)	7 hours
118°F (48 C)	90 minutes
122°F (50 C)	< 1 minute

Throughout most of the United States, installation standards produced by the National Fire Protection Association (NFPA), *NFPA 13, Standard for the Installation of Sprinkler Systems*, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, have been adopted as regulatory law by reference through building and fire codes. These standards require that sprinklers designated as “ordinary temperature” (designed to operate between 135°F and 170°F) can only be exposed to maximum ambient temperatures of 100°F. Exposing an “ordinary temperature” sprinkler to temperatures in excess of 100°F during pest control procedures is inconsistent with both the requirements of the installation standards and the sprinkler’s product listing. This is a violation of the fire codes most commonly adopted by state and local jurisdictions.

This paper will address the special concerns regarding the fire sprinkler system that need to be taken into account and also discuss some ongoing research that the sprinkler industry is conducting to address this situation. It will discuss four strategies proposed within the pest control industry and suggests that the best practice when using the heat treatment method is to engage the services of a licensed professional sprinkler contractor to take care of the sprinkler system while the professional pest control contractor takes care of the bedbugs.

Fire Sprinkler Basics

It is worth taking a few moments to discuss the basics of how fire sprinklers operate. Fire sprinklers are heat sensitive devices that are connected through a series of pipes to a water supply. Each fire sprinkler individually reacts to a fire by opening when it is heated to a pre-designated temperature and discharging a calculated amount of water over a defined area.

The heat sensitive operating element in fire sprinklers can be either a glass bulb or a fusible solder link. The most commonly installed sprinklers are designated as “ordinary temperature” and are designed to activate when they reach a specific temperature somewhere between 135°F and 170°F. There are sprinklers rated for higher temperature for use in situations near hot objects (such as unit heaters or skylights that get direct sunlight), but, for the most part, the sprinklers that will typically be installed in homes, offices, apartments and hotels will be designed to operate at a specific temperature within the “ordinary temperature” range.

Automatic Sprinkler Temperature Ratings, Classifications, and Color Codes				
Maximum Ceiling Temperature ¹	Sprinkler Temperature Rating	Temperature Classification	Frame Color Code	Glass Bulb Color
100°F (38 C)	135-170°F (57-77 C)	Ordinary	Uncolored or black	Orange or Red
150°F (66 C)	175-225°F (79-107 C)	Intermediate	White	Yellow or Green
225°F (107 C)	250-300°F (121-149 C)	High	Blue	Blue
300°F (149 C)	325-375°F (163-191 C)	Extra High	Red	Purple
375°F (191 C)	400-475°F (204-246 C)	Extra Very High	Green	Black
475°F (246 C)	500-575°F (260-302 C)	Ultra High	Orange	Black
625°F (329 C)	600°F (343 C)	Ultra High	Orange	Black

¹ Ambient air temperature at sprinkler location

Glass bulb sprinklers operate on a basic principle of fluid expansion at high temperatures. As the fluid in the bulb warms up, it expands. A small bubble of air exists in the fluid within the bulb at room temperature. As the fluid gets warmer and expands, the bubble disappears. Once the bubble disappears, the fluid gets warmer and continues to expand. Eventually it breaks the glass bulb allowing the water seal to release and discharge water from the sprinkler.

Solder link sprinklers operate on a basic principle of solder properties. The types of solders used in sprinkler systems change sharply from solids to liquids when they are heated to their operating temperatures. When the solder melts, the parts that are held together by the solder separate or collapse allowing the seal closing the nozzle to open and discharge water from the sprinkler.

Sprinklers that have a temperature rating of 135°F to 170°F cannot be exposed to ambient temperatures above the maximum ceiling temperature identified in the table above; 100°F. Excursions above the maximum permissible ceiling temperature risk weakening the sprinkler to the point where it may unintentionally activate sometime in the future.

Glass bulb sprinklers heated below their rated temperature may reach the point where the bubble collapses and disappears. If any additional heating takes place, the glass bulb will be subjected to stress as the fluid expands. Even if the sprinkler is then allowed to cool down before it operates, the glass may develop tiny fractures that cannot be seen by the naked eye. These fractures may grow over time and cause the sprinkler to open unintentionally in the future. Also, as the sprinkler cools and the fluid contracts, it allows the bubble to reform. The bubble snaps back into existence almost instantaneously, causing a shock wave in the bulb that may weaken the bulb; eventually causing it to fail and open the sprinkler unintentionally in the future.

Solder link sprinklers function differently from glass bulb sprinklers but are still not intended to be subjected to temperatures near their rated temperature. The solder in the link will flow or creep at temperatures lower than the rated temperatures and any cycling of temperatures near the rated temperature of the sprinkler will cause fatigue in the solder joint. Any fatigue will weaken the solder link, which could cause the sprinkler to operate unintentionally at some time in the future.

Since fire sprinklers automatically discharge water when they operate, it is important that the treatment method for killing bedbugs should not compromise the sprinklers causing them to discharge water unintentionally at some time in the future. Building owners may suffer water damage events if sprinkler systems are not properly cared for during heat based bedbug mitigation.

Sprinkler Protection Strategies

The NPMA's *Best Management Practices for Bed Bugs* advises pest control contractors to safeguard fire sprinklers during heat treatments but does not provide guidance on methods.

11.3.3.7.6. Potential heat damage to certain materials, including the risk of activating automatic fire suppression systems (sprinklers). Care should be taken to safeguard these materials and systems.

Four typical strategies for safeguarding sprinklers during heat-based bedbug mitigation have been identified in the pest management industry:

- Monitoring the Temperature at Sprinkler Locations
- Protecting Sprinklers from Elevated Temperatures
- Disabling Sprinkler Systems
- Removing/Replacing Sprinklers

Monitoring the Temperature at Sprinkler Locations

This strategy involves placing sensors near each sprinkler and monitoring the temperature to confirm that it does not exceed the permissible maximum ceiling temperature. This is limited in usefulness with “ordinary temperature” sprinklers as their maximum permitted ceiling temperature, 100°F, is well below the minimum temperature required to kill bedbugs, 113°F. There is, however, some merit to this strategy when “intermediate temperature” sprinklers with a maximum permitted ceiling temperature of 150°F are involved.

Following this procedure, any sprinklers that have been exposed to temperatures above the permissible maximum ceiling temperature should be replaced with new sprinklers by a qualified professional. *(Sprinkler removal/replacement procedures are discussed below in Removing/Replacing Sprinklers.)*

Protecting Sprinklers from Elevated Temperatures

Another strategy is to insulate sprinklers from the elevated temperatures associated with bedbug mitigation; possibly with an insulated cover containing something cold to help keep the temperature of the sprinkler below the permissible maximum ceiling temperature. This suggestion has some merit and deserves further investigation. There are some clear potential advantages to such a procedure because it keeps the sprinkler system outside of the area being treated in service and limits the scope of the “Impairment Procedures” required when any part of a sprinkler system is taken out of service. *(Impairment procedures are discussed below in Disabling Sprinkler Systems.)*

There are a number of protection strategies currently in use during heat-based bedbug mitigation ranging from commercially produced insulating devices (with or without cooling inserts) to covering sprinklers with Styrofoam cups containing dry-ice. While most of these might successfully keep the sprinklers from being heated, the practice of using dry ice that might come into contact with sprinklers carries the potential to damage the sprinklers. The damage may not be apparent immediately, but the

sprinklers could operate without a fire sometime after the treatment, or the sprinklers might be damaged to the point where they will not operate, even under fire conditions.

One problem with covering the sprinklers with any kind of insulated cover is that the cover or its attachment might touch a critical part of the sprinkler and move it out of alignment. The tolerances of each of the moving parts of a solder link sprinkler are critical and any movement could either cause the sprinkler to operate when there is no fire or prevent the sprinkler from operating when there is a fire. For this reason, installation and maintenance standards for sprinklers do not permit attaching or suspending anything directly from any part of the sprinkler system.

Another problem with covering the sprinklers concerns situations where the insulating devices contain dry-ice. Dry-ice has a temperature of -110°F or lower. Temperatures that low can potentially damage the sprinkler since fire sprinklers are typically only rated for temperatures down to -40°F. Lastly, covering a sprinkler still does not guarantee that it will remain below its maximum allowable temperature throughout the heating process. Monitoring the temperature inside the insulated sprinkler cover is the only way to confirm that the sprinkler has not been exposed to temperatures above the permissible maximum ceiling temperature.

Following this procedure, all covering materials must be removed to ensure proper operation of the fire sprinkler system and any sprinklers that have been exposed to temperatures above the permissible maximum ceiling temperature should be replaced with new sprinklers by a qualified professional. *(Sprinkler removal/replacement procedures are discussed below in Removing/Replacing Sprinklers.)*

Disabling Sprinkler Systems

This strategy reduces the potential for water damage if a sprinkler operates during the heat treatment, but does not prevent sprinklers from being subjected to heat above the permissible maximum ceiling temperature. The act of turning off the water supply needs to be performed by an appropriately trained, qualified professional for the following reasons:

1. In many jurisdictions, consumer protection laws are written such that a person needs to be a licensed sprinkler contractor in order to service any part of a fire protection system.
2. When a sprinkler system, as a whole or in part, is shut down for any reason, building and fire codes require a series of steps called “Impairment Procedures” to be performed. These procedures typically include notifying the fire department, fire alarm monitoring service, and any other authorities having jurisdiction that the system is going to be out of service for a significant period of time. These procedures can also include evacuation of the building, the establishment of an approved fire watch (trained people with access to fire extinguishers and communication devices that patrol the building and deal with incipient fires), and/or changes or restrictions to the activities occurring within the building to mitigate the potential for fire to

start. Typically, only people within the fire protection community really understand how to legally comply with system impairment procedures.

3. Disabling the system without protecting the sprinklers is not a recommended practice as this does not address the issue with exposing sprinklers to elevated temperatures above their rating. *(Protecting sprinklers in place during heat-based bedbug mitigation is discussed above in Protecting Sprinklers from Elevated Temperatures.)*

Removing/Replacing Sprinklers

It becomes clear that the last strategy, removing the sprinklers in rooms that are going to be heated for the treatment of bedbugs, is a viable option. However, before sprinklers can be removed from their fittings, the water supply needs to be turned off and the system needs to be drained so that water does not discharge from the sprinkler system as soon as the sprinkler is removed. As noted previously, the act of turning off the water supply and removing the sprinklers needs to be performed by an appropriately qualified professional as required by local regulations. Typically, this will be a professional sprinkler contractor.

1. In many jurisdictions, consumer protection laws are written such that a person needs to be a licensed sprinkler contractor in order to service any part of a fire protection system.
2. As noted previously, when a sprinkler system is shut down, for any reason, "Impairment Procedures" need to be performed. In the case of shutting down the system or part of the system in order to remove sprinklers, this will likely involve both a fire watch and/or significant changes or limitations to the activities occurring within the building to mitigate the potential for fire to start. The scope of impairment procedures required is usually determined by the authority having jurisdiction.
3. Fire sprinklers are manufactured with critical tolerances on key components. Sprinkler wrenches that are unique to the model of the sprinkler are required both to remove existing sprinklers and to install new sprinklers to replace them. Typically, only trained sprinkler fitters can remove a sprinkler properly and are often the only people with the appropriate equipment and training to remove or replace sprinklers.
4. NFPA installation and maintenance standards do not permit that a sprinkler to be removed from its fitting and re-installed due to concerns that the sprinkler might be damaged during removal even by a trained professional. In jurisdictions where the latest editions of NFPA 13 or NFPA 25 are enforced, sprinklers *cannot* be reinstalled; they must be replaced with new sprinklers. The new sprinklers must be the correct type of sprinkler for the application and must be installed

with appropriate wrenches. In many jurisdictions consumer protection regulations only permit licensed professionals to perform this work. Even in the absence of licensing regulations, fire sprinkler contractors are typically the best qualified professionals for this activity.

There are three general options for removing/replacing sprinklers. Which option is selected depends on the stakeholders' tolerances for system impairments and the likelihood of needing to repeat heat-based bedbug mitigation treatments in the future. It should be noted that taking the sprinklers in a single room out of service for any significant length of time can trigger impairment procedures for the entire building; making it very desirable in many cases to avoid or reduce impairments. It should also be noted that it may be considered prudent in some types of occupancies to anticipate the future need for repeated bedbug treatments and design initial mitigation strategies accordingly.

Option 1. Remove existing "ordinary temperature" sprinklers prior to heat treatment, plug pipe outlets during treatment, and replace with new "ordinary temperature" sprinklers after treatment is complete. This option ensures the greatest protection against accidental discharge during treatment but increases the time that the system must be turned off with a greater potential for required impairment procedures.

Option 2. Remove existing "ordinary temperature" sprinklers prior to heat treatment, replace with "intermediate temperature" sprinklers during heat treatment, and replace with new "ordinary temperature" sprinklers afterwards. This option maintains the ability to keep the sprinklers in service during most of the process and reduces the need for potential impairment procedures.

Option 3. Remove existing "ordinary temperature" sprinklers prior to heat treatment, replace with new "intermediate temperature" sprinklers, and monitor ceiling temperatures at every sprinkler during heat treatment, replace all sprinklers exposed to temperatures above 150°F. Depending on the occupancy, it may be permissible to leave the "intermediate temperature" sprinklers in place which could be beneficial if a potential for additional heat treatments is anticipated in the future.

Conclusions

NFSA's recommendation to the pest control industry is to consult a sprinkler contractor to assist in selecting and implementing the best strategy for safeguarding fire sprinklers whenever whole room/building heat treatment is used as a mitigation method for bedbugs.

The procedure currently available that will have the least potential to damage the sprinkler system is to take the sprinkler system out of service (using the legally required Impairment Procedures), remove the sprinklers from the rooms that will be heated, plug the pipe outlets, install new replacement sprinklers when the heating procedure is complete, and return the system to service (following the legally required

Impairment Procedures). Typically a professional fire sprinkler contractor is best qualified to perform this series of tasks correctly.

When it is desirable to keep the sprinkler system in service during heat treatment in order to avoid or reduce potential impairment procedures, “ordinary temperature” sprinklers may be replaced with “intermediate temperature” sprinklers during heat-based bedbug mitigation to minimize the potential for accidental discharge during heat treatment and reduce the potential to expose sprinklers to adverse temperatures. If the ceiling temperatures are monitored at each sprinkler location to verify that they have not exceeded their permissible maximum ceiling temperature (150°F), it may be possible to leave the new intermediate sprinklers in place after treatment is complete. As always, a professional fire sprinkler contractor is best qualified to perform this work on the sprinkler system.

The time and effort that the National Pest Management Association has invested in working on this issue so far is appreciated. Both the pest management industry and the fire sprinkler industry want to work together to protect the public from both pests and fires.

About the Author

Bob Upson, M.S.F.P.E. is the Manager of Engineering Services for the National Fire Sprinkler Association (NFSA), based in Patterson, NY. A graduate of the Fire Protection Engineering program of Worcester Polytechnic Institute, he has been a staff member at the NFSA since 2013. Prior to coming to the NFSA, he retired from the fire service in Connecticut where he served as a Staff Captain and as a Fire Marshal. The author encourages a dialog on this subject and can be reached via e-mail at upson@nfsa.org.

The National Fire Sprinkler Association is a trade association for the fire sprinkler industry representing all facets of the industry including manufacturers of sprinklers, suppliers and manufacturers of allied products and services; contractors (union and non-union); engineers, architects, insurance officials, fire marshals and building officials. Our mission is, "To protect lives and property from fire through the widespread acceptance of the fire sprinkler concept" in all buildings from homes to high-rise. More information about fire sprinklers can be found on our website at www.nfsa.org.

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