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Buying Time: Mothballing Forest Service Facilities





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Contents

Introduction	1
Options for Unoccupied Forest Service Facilities	2
Mothballing a Facility	3
Documentation	3
Stabilization	4
Controlling Infestations	5
Controlling Moisture	6
Mothballing	7
Ventilation	7
Windows and Doors	8
Exterior	8
Plumbing and Utilities	9
Building Site and Adjacent Features	9
Building Security	9
Monitoring and Maintenance	10
Conclusions	13
References	14



Introduction

Uncertainties about the future need for unused Forest Service buildings may encourage facility managers to hold onto structures that are not currently needed. Buildings that are not needed now, but might be needed in a few years should be “mothballed”—prepared so that they will not deteriorate. Mothballing buys time and maintains options for the buildings and their improvements (figure 1).

Highlights...

- Some Forest Service facilities are not currently needed, but could be needed a few years into the future.
- Such facilities can be mothballed to prevent them from deteriorating while they are unused.
- This report includes information on mothballing buildings and includes references with more detailed information on particular topics related to mothballing.



Figure 1—The Bonita Work Center bunkhouse, Lolo National Forest, MT, is mothballed.



Options for Unoccupied Forest Service Facilities

Because facility managers are not allowed to abandon Government improvements on Government-owned land, managers need to know the steps they can take to preserve future options.

The best way to keep a building from deteriorating is to keep it occupied. Options for keeping the facility occupied include leasing the building to an agency or organization other than the U.S. Department of Agriculture, Forest Service. In certain situations, a facility may be rented as a recreational cabin under the Federal Lands Recreation Enhancement Act (figure 2).

Whether vacant or occupied, a facility's maintenance fees will still be assessed by the Forest Service (Cost Pool 09). Finding some way to keep the building occupied not only helps to maintain it, but can provide a financial benefit

through rental fees, payment of other fees, or payment of the working capital fund (WCF) on the facility.

If the facility will remain vacant until it is needed, the facility should be mothballed to prevent deterioration or damage by vandalism. This report offers some general guidelines for temporary facility closures. The primary focus is on techniques that apply to all types of facilities, regardless of their formal status as historically significant.

Historically significant facilities that are eligible for listing in the National Register of Historic Places require special considerations for mothballing. The National Park Service's (NPS) Preservation Brief No. 31 "Mothballing Historic Buildings" (Park 1993) is an excellent source of information on mothballing historic buildings. Many of the techniques discussed in that preservation brief represent important commonsense measures that could be applied to any building. This report includes many suggestions from NPS Preservation Brief No. 31.



Figure 2—Hogback Homestead Cabin for rent at Rock Creek, MT, Lolo National Forest.



Mothballing a Facility

The work of temporarily closing a building or other structure includes four major tasks:

1. **Documentation**—Determining and recording current conditions
2. **Stabilization**—Performing work to prevent deterioration while the building is not being used
3. **Mothballing**—Shutting systems down and securing the building for storage
4. **Monitoring**—Making sure that stabilization and mothballing protect the building while it is not being used

Taken together, these steps represent the best way to prevent the deterioration that can occur quickly when buildings are empty.

Mothballing structures that have fallen into a state of disrepair (for instance, some historic facilities) can be very expensive. In contrast, temporarily closing a newer, well-maintained building can be much less expensive.

Determining how long the structure will be unoccupied is important. Then you can determine the type of work to be done and the level of maintenance you can expect. If the closure is only going to be for a year or two, some buildings can simply be closed up, the doors and windows secured, and the heating set to just above freezing. Forest Service maintenance and facility managers have closed many buildings and rental facilities seasonally, so they have lots of experience with this type of facility closure.

If the facility is to be mothballed for more than 2 years, more costly measures must be taken. However, the cost of stabilizing current structures, implementing procedures to protect the building, and periodically monitoring the building's condition, can be money well spent when the building is brought back into service.

Documentation

The first step in the process of mothballing is to get a clear sense of the facility's current condition. Knowing the condition will help you set the priorities for the work that needs to be done. The structure's most current facility condition assessment survey provides a starting point for documentation. An extensive condition assessment survey should provide a clear view of the building's needs.

For buildings 50 years old or older, the starting point should be any documentation required for the Forest Service's Heritage Program. Mothballing historic structures eligible for the National Register of Historic Places will require additional documentation. The Missoula Technology and Development Center (MTDC) "Facility Toolbox" <<http://www.fs.fed.us/eng/toolbox/>> (figure 3) has information on the special requirements for historically significant facilities. Also, NPS Preservation Brief No. 31 (Park 1993) details special considerations for documentation and minimal stabilization work for historic buildings.

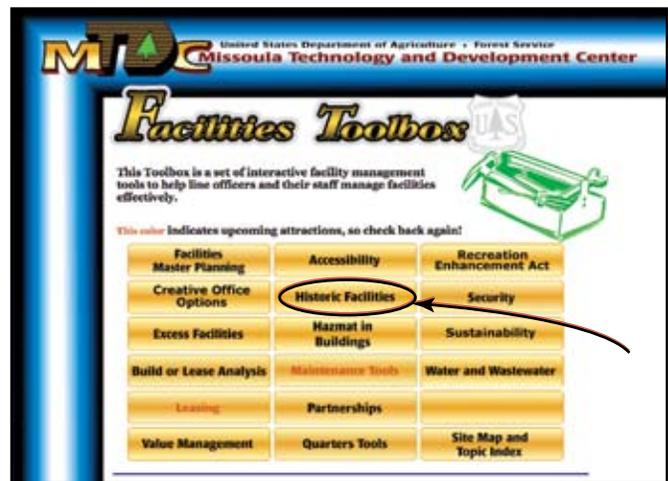


Figure 3—The "Facility Toolbox" Web site <<http://www.fs.fed.us/eng/toolbox/>> has information on historically significant facilities.



For any mothballing project, the initial documentation should provide information on the age and condition of the basic features of the building, including:

- Foundation
- Structural systems
- Exterior materials
- Roof and gutters
- Exterior porches and steps
- Interior finishes
- Staircases
- Plumbing
- Electrical systems
- Mechanical systems
- Special features such as chimneys
- Site drainage

The building's condition assessment survey may not have enough detailed information for this documentation, but if a survey has been conducted recently, it will have all, or most, of the information you need. If there is no current facilities condition assessment survey, refer to the MTDC report "So That's Why It's Always Cold in Here: A Guide for Conducting Facilities Condition Assessment Surveys" (Peacock and Snodgrass 2004).

Once you have a clear sense of the conditions of the facility's major features, priorities can be set for the work that needs to be done. For example, if the foundation and the roof are sound, you will have many years of service from the building. If there are major problems in either of these areas, you should probably attend to them first.

The initial documentation can also help confirm whether the facility is worth mothballing or whether the building should be demolished or sold. If, for example, the facility is less than 50 years old and in a state of disrepair or if the construction quality was poor, it may be more cost effective to sell or demolish the facility than to mothball it for future use. In such cases, mothballing may not keep management options open but may simply tie a manager's hands. Future costs may include not just mothballing, but also rehabilitation, maintenance, and updating to meet new building standards.

If, on the other hand, the facility condition assessment survey and current documentation support mothballing,

the documentation process will help to identify any initial stabilization the structure needs.

Stabilization

Stabilization of certain features may be needed before mothballing to slow deterioration of the building. "If either the roof or the foundation is in poor condition, you will need to stabilize it in some fashion before you can mothball the building" (Matthew 2009). Stabilization of the roof should take into account its structural ability to sustain snow loads in northern climates (figure 4). Structural stabilization should focus on bracing at the ridge and midpoints, particularly if the roof is sagging.



Figure 4—The Moose Creek Cookhouse on the Moose Creek Ranger District, Nez Perce National Forest, ID, relieved of a heavy snow load.

Ensuring that the building has an adequate roof with sufficient drainage is often mentioned as the single most important step to preventing deterioration in mothballed buildings. "A secure roof is the most important protection the building needs. Water should run off the roof and away from the building. Damaged or insufficient gutters can cause severe problems for wood corners and fascia boards" (Frazier Associates 2002). Repairing leaks, especially from faulty flashing, is an important part of mothballing. Also, roofs and gutters need to be maintained while the building is mothballed.

With historic facilities, there will be resistance to putting on a metal roof. A case can be made however for installing a metal roof, even on historic structures (Matthew 2009).



A metal roof may be justified as one way to comply with the requirement that historic buildings are not allowed to deteriorate. A metal roof can be a temporary installation while the building is mothballed and be replaced with a historic roof during restoration. A metal roof could even be put over an existing roof if the structure will support the weight.

Foundations that are weakened by poor drainage, poor design, neglect, or age will need underpinning or bracing. Regional differences in climate, moisture, and construction designs influence the types of stabilization efforts, particularly for foundations, roofs, decks, patios, and other exterior portions of the structure. “If the building is in a southern or humid climate and termites or other insects are a particular problem, the foundation and floor framing should be inspected to ensure that there are no major structural weaknesses” (Park 1993).

If there are known structural problems with the facility, they must be attended to first. A structural engineer or specialist should direct the stabilization efforts to make sure that the existing structure can accommodate any reinforcements, additions, or bracing.

Controlling Infestations

The types and number of pests are influenced by a host of factors related to the building condition, the climate, and the region of the country where the facility is located (figure 5). The full range of pests and instructions on excluding them is beyond the scope of this report. Some of the possible pests include “squirrels, raccoons, bats, mice, rats, snakes, termites, moths, beetles, ants, bees, wasps, pigeons, and other birds” (Park 1993). These invaders can damage the building’s structure or, in the case of mouse, pigeon, and bat droppings, pose a health hazard. “If the property is infested with animals or insects, it is important to get them out and to seal off their access to the building” (Park 1993).

Excluding rodents receives a great deal of attention because of the threats they pose to both the condition of buildings and to human health. MTDC has compiled information from Forest Service and the Bureau of Land Management (BLM) field personnel on techniques they have found helpful in “Controlling Rodents in Forest Service Facilities: Reports from the Field” (Snodgrass 2004). Also, the “National Park Service Rodent-Exclusion Manual”



Figure 5—Insect infestations that have not been controlled before mothballing can quickly become apparent on windowsills and floors.

(Hoddenbach and others 2005) offers a comprehensive approach to building inspections, preventing and controlling rodent infestations, and sanitation treatments, as well as monitoring and evaluation after treatment.

Even if animals or insects are kept out of a building, they can still cause extensive damage to the exterior. Birds and animals peck and chew surfaces on buildings, causing damage and sometimes creating new entry points for other animals and insects (figure 6), particularly if buildings are unoccupied.

Several approaches can be used to discourage this type of damage. MTDC has identified a habanero pepper coating that can protect Forest Service buildings, signs, wiring and fencing from damage by porcupines, horses, rodents, and possibly woodpeckers (Snodgrass 2005).



Figure 6—Birds or other animals can peck or chew the exterior of buildings, damaging a building that has been mothballed.



Preventing woodpeckers from damaging buildings is an issue whether the building is in the city or in a rural area. Another report by MTDC identified some long- and short-term methods to discourage woodpecker damage. These methods include providing nest boxes, developing alternative nest sites, net coverings, and harassment (Jasumback and others 2000).

The U.S. General Services Administration (1998) has prepared an evaluation of the pros and cons of a range of bird control methods <<http://w3.gsa.gov/web/p/HPTP.NSF/gstagov>AllProceduresDisplay/1029601S>>. This document evaluates bird deterrent systems, including lethal and nonlethal systems.

Controlling Moisture

Preventing moisture from penetrating the exterior of buildings is essential when buildings are stabilized for mothballing. “Leaks from deteriorated or damaged roofing, from around windows and doors, or through deteriorated materials, as well as ground moisture from improper site run-off or rising damp at foundations, can cause long-term damage to interior finishes and structural systems” (Park 1993). While buildings need some moisture for human comfort and for the building’s longevity, the challenge is to prevent unwanted moisture from damaging the building.

The NPS Preservation Brief No. 39 “Holding the Line: Controlling Unwanted Moisture in Historic Buildings” (Park 1996) is a detailed resource for identifying and responding to moisture problems. The brief explains: “There is never a single answer to a moisture problem. Diagnosis and treatment will always differ depending on where the building is located, climatic and soil conditions, ground water effects, and local traditions in building construction.”

When stabilizing a building for mothballing, identifying signs of moisture is the first step in devising management options.

Although stabilizing a building with moisture problems can seem daunting, most issues can be dealt with through basic repairs, roofing, grade changes, or ventilation treatments.

For high-value historic structures that use older construction techniques, “It is usually advantageous to eliminate one potential source of moisture at a time. Simultaneous treatments may set up a new dynamic in the building with its own set of moisture problems” (Park 1996). Newer buildings have different construction techniques that are better suited to working on several moisture issues at a time.

Signs of Moisture Damage

Identifying the type of moisture damage and discovering its source or sources usually involves the human senses of sight, smell, hearing, touch, and taste combined with intuition. Some of the more common signs of visible as well as hidden moisture damage include:

- Presence of standing water, mold, fungus, or mildew
- Wet stains, eroding surfaces, or efflorescence (salt deposits) on interior and exterior surfaces
- Flaking paint and plaster, peeling wallpaper, or moisture blisters on finished surfaces
- Dank, musty smells in areas of high humidity or poorly ventilated spaces
- Rust and corrosion stains on metal elements, such as anchorage systems and protruding roof nails in the attic
- Cupped, warped, cracked, or rotted wood
- Spalled, cracked masonry or eroded mortar joints
- Faulty roofs and gutters including missing roofing slates, tiles, or shingles and poor condition of flashing or gutters
- Condensation on window and wall surfaces
- Ice dams in gutters and on roofs or moisture in attics

—“*Holding the Line: Controlling Unwanted Moisture in Historic Buildings*” (Park 1996).

Successfully dealing with moisture problems requires ongoing maintenance and monitoring. Those charged with monitoring the site, whether they are employees or contractors, need to be familiar with the site, the building, its mechanical systems, and previous moisture treatments.



Mothballing

The goal of mothballing is not to fix the building, but to keep it from deteriorating while it is not being used. Once the building has been stabilized, turn your attention to specific areas that need to be dealt with when mothballing the building, including:

- Ventilation
- Windows and doors
- Chimneys
- Exterior
- Plumbing and radiators
- Building site and adjacent features
- Building security

Ventilation

Adequate air exchange reduces unwanted moisture from condensation. The goal is to provide a minimum of one to four exchanges every hour. The exact number varies by season with one to two exchanges per hour needed in winter and two to four in summer (Park 1993).

Determining the exact number of air exchanges for a particular building and identifying how to achieve them depend on the type of building, its age and condition, its fixtures, and the climate. While each case must be evaluated individually, the NPS has identified some rules of thumb. These rules (table 1) illustrate the factors that combine to influence decisions about ventilation.

The ventilation system should be designed so that air can enter at ground level and leave at roof level. Cross ventilation in the attic as well as louvered window inserts can help achieve this type of air exchange (figures 7a and 7b).

If possible, chimneys should remain open. They can help air flow from lower levels to upper areas of the building. If the building has power, fans can be put in the chimney to encourage this airflow.



Figure 7a—Louvered window ventilation inserts on the Bonita Work Center bunkhouse, Lolo National Forest, MT (outside view).



Figure 7b—Louvered window ventilation inserts on the Bonita Work Center bunkhouse, Lolo National Forest, MT (inside view).

Louvers should be constructed so that wind and weather can't enter. As a general rule, if the angles of the louvers are such that you cannot look through them, snow and rain are less likely to blow in. Also, in humid areas such as the Southeast, louvered window vents should be made of treated material to prevent deterioration.

Table 1—Ventilation rules of thumb —Adapted from “Mothballing Historic Buildings” (Park 1993).

Climate	Type of Structure	Ventilation Type
Hot and arid	Adobe structures	May need no additional ventilation if the structure has been well weatherized and no moisture is penetrating the interior.
Arid or temperate	Frame buildings with cracks and fissures	May have three to four natural air exchanges per hour and may need no additional ventilation once secured.
Humid	Masonry buildings	Will need almost every window opening to be fitted with some type of passive louvered ventilation. This is the most difficult situation.



The condition of doors and other closures affects how tightly the building seals and how well air enters and leaves. Furniture, equipment, or trash left in the building impedes airflow.

Floor coverings are an especially important consideration for ventilation. Linoleum or carpets (particularly rubber-backed carpets) restrict airflow from subfloor spaces, which can contribute to decay of floor timbers. Similarly, linoleum creates an impermeable layer that blocks the movement of air through the building.

At the least, fitted floor coverings should be rolled back from external walls (figure 8). Also any garbage, furniture, or other equipment should be removed. Keeping cupboards and drawers open also helps improve airflow (figure 9).



Figure 8—Pulling back carpets from floors can encourage airflow in the building.



Figure 9—Leaving drawers and cupboards open can encourage airflow in the building.

Windows and Doors

Doors and other first floor entrances should be closed off and locked. If window vents are not needed for the building, first floor windows should be closed off as well.

All entrances except one door used for periodic access should be sealed. Heavy plywood can be used to block doors. These entrances also could be barricaded from the inside.

Exterior

Treatments to the exterior of the building should focus on protecting wood surfaces and preventing openings that can let in pests and moisture. Maintaining the building's exterior also increases the structure's security. Buildings that don't look like they have been abandoned might be less attractive targets for vandals.

To mothball the building's exterior:

- Paint wood surfaces.
- Repair and stabilize severe rot problems.
- Block any unwanted openings.
- Maintain measures for pest control.
- Repair any loose masonry.

Older buildings may have lead-based paint. For example, lead-based paint was deteriorating at the Bonita Work Center bunkhouse (figure 10) when the bunkhouse was mothballed. In such cases, the facility manager's task should be to remove and secure the old paint and to repaint the structure. The tech tip "Lead-Based Paint: Planning Your Paint Removal



Figure 10—Damaged and flaking lead paint on the Bonita Work Center bunkhouse, Lolo National Forest, MT (outside view).



Project” (Beckley and Groenier 2007) can help facility managers address concerns about lead-based paint.

Plumbing and Utilities

The type and extent of plumbing and utility work required for mothballing depends on the systems left in service after the building is closed. The NPS recommends, “As long as these services will not constitute a fire hazard, it is advisable to retain those which will help protect the property” (Park 1993). Electricity, for example, can power ventilation fans and timed lights for security. Natural gas, water, and electricity may be used for heating.

If plumbing fixtures are not going to be kept in service, turn off the water supply and drain the pipes, toilets, water heaters, and any other water reservoirs. Disconnecting taps and plugging the plumbing to sinks and other fixtures are good practices. Removing toilets and plugging up the drains will discourage anyone from using them (figure 11).

Have the utility company turn off the natural gas lines if gas is not needed. The gas meter can be removed and gas lines can be plugged.

Oil furnaces require additional considerations. You may wish to fill the fuel tank with oil to keep it from rusting. Leaving the fuel tank full may not be practical. But if the tank is drained and left empty for more than a year, condensed moisture will cause rust, probably making the tank unusable.



Figure 11—Toilets were removed from bathroom stalls and the drains were plugged in the Bonita Work Center bunkhouse, Lolo National Forest, MT.

Building Site and Adjacent Features

The condition of the building site has implications both for maintaining the structure’s condition and for its security. Brush, debris, unkempt outbuildings, or improperly stored equipment can pose fire risks, particularly if the structure is in the wildland-urban interface.

Brush should be cleared so that the building can be seen by neighbors and from the street. Hidden buildings are tempting to vandals and encourage unauthorized entry and occupation.

Having a site that is open and visible also helps with personal safety. Employees are safer when they walk onto a site with good visibility.

Building Security

Looks do make a difference. A neat exterior sends the message that the building isn’t abandoned, that it receives regular maintenance, and that someone is likely to notice what happens at the site. Because security options requiring power are often impractical at remote mothballed buildings, appearance may be one of the best tools (besides locks) for securing the facility.

Specifics about appearance and security depend on geographic location, type of vegetation, and the nature of mothballing work needed for the facility. However, Frazier Associates (2002) offers some general observations about using appearance as a security measure:

- Use consistent materials to avoid a patchwork look.
- Paint plywood to make it less obvious that the building is closed up.
- Use colors that match the building.
- Maintain the grounds.

A sign explaining the mothballing project can help reinforce the message that the building isn’t abandoned. The sign can explain what is being done with the property, why it has been mothballed, and the options for further use. The sign should be dated so the reader knows the information is current. The sign can help people know that the Forest Service has not simply walked away from the building, that it isn’t abandoned, and that it is not ripe for vandalism.

Another potential security measure that does not require electrical power is keeping watch on the property. Neighbors, law enforcement officers, and employees at nearby sites may be able to observe activity at the mothballed facility.



Monitoring and Maintenance

Once the building has been mothballed, routine visits will help you detect vandalism or other problems, such as leaks or weather-related damage.

The frequency of visits depends on the building's location, the availability of personnel, and budgets. More frequent visits might save money by detecting problems early and allowing corrective action before problems become larger and more costly to correct.

If the building is in an area served by regular police or fire departments, they should be notified that the property is being mothballed. Provide information such as:

- When the building is going to be vacant
- When visits by Forest Service employees are scheduled
- How long the building may be mothballed

If possible, schedule a building walk-through with fire or law enforcement officers so they can become familiar with the layout of the building and surrounding area. This information can help them plan ahead so they know how to respond to emergencies.

A mothballing checklist helps ensure that monitoring and maintenance duties have not been overlooked. This checklist also serves as a framework for maintenance that needs to be performed while the building is mothballed.

The mothballing checklist and the mothballing maintenance chart (both developed by the NPS) are good summaries of the types of treatments needed to keep buildings from deteriorating while they are vacant (adapted from Park 1993 and Eaton 2000).



Mothballing Checklist

Moisture

- Is the roof watertight?
- Do the gutters retain their proper pitch and are they clean?
- Are downspout joints intact?
- Are drains unobstructed?
- Are windows and doors and their frames in good condition?
- Are masonry walls in good condition to seal out moisture?
- Is wood siding in good condition?
- Is the site properly graded for water runoff?

Pests

- Have nests/pests been removed from the building's interior and eaves?
- Are adequate screens in place to guard against pests?
- Has the building been inspected and treated for termites, carpenter ants, rodents, etc.?
- If toxic droppings from bats and pigeons are present, has a special company been brought in for disposal?

Housekeeping

- Have the following been removed from the interior: trash, hazardous materials such as flammable liquids and poisons, plants, and canned goods that could freeze and burst?
- Has the interior been swept clean?
- Have furnishings been moved to a safe location?
- If furnishings remain in the building, are they properly protected from dust, pests, ultraviolet light, and other potentially harmful problems?

Security

- Have fire and police departments been notified that the building will be mothballed?
- Are smoke and fire detectors in working order?
- Are the exterior doors and windows securely fastened?
- Are plans in place to monitor the building regularly?
- Are keys to the building in a secure but accessible location?
- Are the grounds being kept from becoming overgrown?

Utilities

- Have utility companies disconnected/shut off or fully inspected water, gas, and electric lines?
- If the building will not be heated, have water pipes been drained and glycol added?
- If the electricity is to be left on, is the wiring in safe condition?

Ventilation

- Have steps been taken to ensure proper ventilation of the building?
- Have interior doors been left open for ventilation?
- Has the secured building been checked in the last 3 months for interior dampness or excessive humidity?

—Adapted from “Mothballing Historic Buildings” (Park 1993) and “Parrot Hall Architectural Conservation Assessment” (Eaton 2000).



Mothballing Maintenance Chart

1 to 3 Months—Periodic	Every 6 Months—Spring and Fall	Every 12 Months
<ul style="list-style-type: none">• Perform regular driveby surveillance• Check attic during storms, if possible• Walk around the structure monthly• Check entrances• Check window panes for breakage• Mow as required• Check for graffiti or vandalism• Enter every 3 months to air out• Check for musty air• Check for moisture damage• Check battery packs and monitoring equipment, if present• Check light bulbs, if any• Check for evidence of pests	<ul style="list-style-type: none">• Clean up site; prune and trim• Check gutter and downspout• Check crawl space for pests• Clean out storm drains	<ul style="list-style-type: none">• Inspect equipment and utilities• Check roof for loose or missing shingles• Inspect/treat for termites and other pests• Repair exterior materials: touch up paint• Remove bird droppings or other stains from exterior• Check and update the building documentation

—Adapted from “Mothballing Historic Buildings” (Park 1993) and “Parrot Hall Architectural Conservation Assessment” (Eaton 2000).



Conclusions

Keeping a building occupied is the best way to slow its deterioration. However, a facility may need to be mothballed to buy time and preserve options for future use. Mothballing projects are often time consuming and can be expensive. If a facility needs to be mothballed, resources are available to help you do the job.

This report provides an overview of the major considerations for mothballing facilities, regardless of their formal historical designation. The checklist and other

material presented here can help Forest Service employees who are planning mothballing projects. References cited in this report offer additional information on lead-based paint, pest control, moisture, ventilation, and other topics.

Deterioration can be held in check when buildings are mothballed properly. Facility managers need a solid plan, the resources for stabilization and mothballing, and the money and staff to monitor and maintain the building until it is put back into service. This expenditure of time and money can buy time so a building that is unneeded temporarily can again become useful to the agency and the public.





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Theron Miller has been a project leader at MTDC since 2006. Miller received his Ph.D. in forestry from the University of Montana in 1997 with an emphasis in natural resources social science. After graduating, he was a research and teaching professor at the University of Montana where his area of focus was applied social sciences directly related to management of natural resources on public lands. Miller's projects at MTDC have been in the safety and health, recreation, facilities, and fire and aviation management program areas.

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This report includes information on mothballing buildings that are not needed currently, but might be a few years in the future. References to more detailed information, including information on historic buildings, are included.

Keywords: historic buildings, maintenance



Additional single copies of “Buying Time: Mothballing Forest Service Facilities” may be ordered from:

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