

PRESERVATION TREATMENTS

Protection and Stabilization (Mothballing)

Although seemingly less durable when compared to masonry or iron, wooden lighthouses can last almost indefinitely if they are properly protected and stabilized. To properly protect and stabilize a historic wooden lighthouse, a thorough inspection and diagnosis should be performed using the inspection chart in the preceding section as a guide. Use the results of the inspection to develop a protection and stabilization plan. The following recommended protection and stabilization guidelines for vacant historic masonry lighthouses are minimum treatment requirements to prevent any further damage from occurring.

Weatherization

When a wooden lighthouse is mothballed, the exterior envelop should be completely weathertight. Moisture penetrating into wooden walls can be exceedingly detrimental to the integrity of the structure. Moisture within the wooden elements of a wall may cause various types of damage. High moisture content may literally “push” paint off the face of the wooden component, encourage fungal growth that will cause the wood to decay and rot, or attract termites and other wood eating insects that will cause rapid deterioration of the wooden components.

To prevent moisture penetration, be sure the following infiltration points are weathertight or functioning properly:

- **Lantern glass:** Lantern glass, frames, and roofs must be weathertight before mothballing (see Figure 5). Refer to the **Lantern** section for more information concerning the weatherproofing of the lantern components.
- **Built-in guttering systems:** All rainwater guttering systems (lantern roofs, or other tower roof forms) should be cleaned and checked for holes. Water entering the structure will cause premature deterioration of internal structural components. For more information refer to the discussion on roofing in the **Lantern** section.
- **Gallery decks:** In most wooden lighthouses gallery decks are wood covered in sheet metal. These decks are generally laid directly on top of

the wooden wall structure. The decking should be sloped away from the lighthouse to shed the water away from the structure. If the decking material is not weathertight, moisture can enter the interior cavity of the wall. Refer to the **Lantern** section for more information concerning the weatherproofing of gallery decks.



Figure 5. Storm glass with holes should be replaced as soon as possible to minimize water infiltration. If immediate replacement is not an option, the storm glass can be temporarily patched.



Figure 6. An acceptable temporary lantern glass repair made using a small piece of sheet metal and caulking.



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Figure 7. Ponding is occurring on this gallery deck near the base of the lantern parapet wall. This ponding has led to an active leak that occurs even during light rain conditions. A condition such as this should be remedied before the mothballing period.



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Figure 8. View of a wood-framed lighthouse roof; the arrow indicates where a large hole (approximately 2 by 4 inches) is present in the built-in gutter system. Water entering this hole has caused extensive damage to the interior wood framing members and wood interior wall paneling.

- **Door and window frames:** The joints along the perimeter of door and windows where a wood or metal frame is fitted into a wall opening should be caulked to prevent moisture from entering the walls. Both door and window sills



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Figure 9. If the exterior of the wooden tower has been covered with another sheathing material like this corrugated metal, all joints in the exterior sheathing should be made completely weathertight; at this particular lighthouse, deterioration of interior wood framing members was caused by moisture infiltration.



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Figure 10. This door sill has a positive slope to ensure proper drainage; the joint where the door surround meets the shingles should be checked for gaps and recaulked if necessary.

should have a positive slope to ensure water is drained away from the door or window opening. See the **Windows** and **Doors** sections for the proper caulk for this application.

- **Loose or open joints:** If the seams between siding boards are open or if the putty in those joints is loose, moisture can penetrate. In order to prevent this infiltration, all putty that is in disrepair must be removed and the affected seams sealed with caulking. For more information on various types of caulking available, refer to the **Windows** section.
- **Protective coatings:** Lighthouses were historically painted as a protective measure and for identification as a daymark. As part of a mothballing treatment, the exterior coating should be checked for loose and flaking paint. Any deteriorating areas should be scraped and

repainted to match the existing color. Ultimately, as part of a mothballing treatment the entire lighthouse should have all loose and flaking paint removed and a new coating applied according to the manufacturer's specifications. This action will result in a coating system that will require minimal service during the mothballed period. In lieu of a total repainting, spot painting can be an effective alternative. The removal of loose and flaking paint followed by spot priming and painting areas of bare wood will greatly increase the effective life span of a wooden lighthouse. For more information refer to the discussion on repainting under the **Repair** treatment in this section.



Figure 11. Open joints like those between these skirt boards must be properly primed, painted, and filled before mothballing the lighthouse.

Stabilization

When mothballing a wooden lighthouse, all possible structural repairs should be made before the official beginning of the “mothballed” period. If budget constraints prevent repairs, structural stabilization is the next option. Temporary wood shoring of window and door openings, installation of interior or exterior shoring, or bracing are all stabilization methods. A structural engineer or historical architect should be consulted for a proper stabilization treatment plan. The stabilization treatment utilized should not permanently damage features that define historic character. The treatment should also be easily reversible so that when the budget allows, the structure can be properly repaired.



Figure 12. View of underside of a screwpile lighthouse. Although these bare wood surfaces are not directly exposed to rain, they are susceptible to mist and condensation moisture; and because there is no exposure to direct sunlight, the surfaces are seldom dry. For adequate protection during the mothballing period, these surfaces should be painted.

Ventilation

When the exterior has been made weathertight and secure, it is essential to provide adequate air exchange throughout the lighthouse. Once closed up, a lighthouse interior will still be affected by the temperature and humidity of the exterior. Without proper ventilation, moisture from condensation may occur and cause damage by wetting plaster, peeling paint, staining woodwork, warping floors, and in some cases even causing freeze-thaw damage to plaster. If moist conditions persist in a wooden lighthouse, structural damage can result from rot or returning insects attracted to moist conditions.

The average required minimum air exchange for most mothballed lighthouses is one to four air exchanges every hour; in the winter one or two air exchanges per hour. Twice this amount is typically required in the more humid summer months. In order to achieve this, almost every window opening will need to be fitted with some type of passive, louvered ventilation. Even this minimal exchange may permit mold and mildew in damp climates. Monitoring the lighthouse for several months during the initial

weatherization period and after the building has been fitted with ventilation louvers and mothballed will provide useful information on the effectiveness of the ventilation solution. Installation of window-mounted passive louver systems is covered in the **Windows** section.

Repair

Once a thorough inspection and diagnosis is performed, using the inspection chart on page 4 as a guide, a preservation treatment plan must be developed. The following are general guidelines for preservation repair and maintenance for wooden lighthouses.

Cleaning

The simple act of cleaning painted surfaces can effectively enhance the appearance and extend the life of the coating of historic wooden lighthouse components. In a marine environment a buildup of potentially damaging elements such as salts, bird guano, and in more urban locations, industrial pollutants, can cause premature deterioration of coatings on wooden lighthouses. Simple but effective regular cleaning will greatly extend the life of the wooden components. The following are general guidelines to follow when cleaning historic wooden lighthouse components:

- Clean surfaces only when necessary to remove buildup of salts, guano, mildew and industrial pollutants.
- Clean surfaces with the gentlest method possible, such as low pressure water and mild detergents and natural bristle brushes. Do not use high pressure water blasting. This treatment may damage the wood substrate by breaking through the paint layer and erode the wood or by passing through gaps and saturating interior finishes and exposed bare wood within the wall cavity.
- Do not use a cleaning method that involves water or liquid chemical solutions when there is any possibility of freezing temperatures.

Fire Protection

Fire is a threat to wooden lighthouses. For guidance on this issue, refer to “Fire Prevention and Protection Objectives” under **Related Activities** in Part VI.

Failing Paint

Paint is the primary defense used to protect wooden lighthouse building components from the harsh marine environment. Paint applied to exterior wood must withstand yearly extremes of both temperature and humidity. While being merely a temporary coating designed to last between five and eight years, paint is responsible for the exclusion of moisture for the wood substrate. Its role is pivotal because moisture penetration causes most of the wooden component failures in historic lighthouses.

The treatment of failing paint depends on the condition of the paint surface. Paint surface conditions can be grouped according to their relative severity: Class I conditions include minor blemishes or dirt collection and generally require no paint removal; Class II conditions include failure of the layer or layers of paint and generally require limited paint removal; and Class III conditions include substantial or multiple layer failure and generally require total paint removal.

A Guide to Paint Treatment Organized by Surface Condition Classification



Figure 13. This image shows a Class I paint condition: virtually no deterioration, only some soiling and possible salt buildup resulting from the open-water location of the lighthouse.

Class I: Generally no paint removal—dirt, soot, pollution, chalking, mildew etc., (see Figure 13).

Recommended Treatment: This condition presents a problem only if the surface is to be painted over. If not removed, the surface deposits can be a barrier to proper adhesion and cause peeling. Most surface matter can be loosened by a strong, direct stream of water from the nozzle of a garden-type hose. Stubborn dirt and soot will need to be scrubbed off using a 1/2 cup of household detergent in a gallon of water with a medium soft-bristle brush. (For the removal of mildew add 1 cup of bleach to the non-ammoniated detergent.) The cleaned surface should be thoroughly rinsed and permitted to dry before further inspection to determine if repainting is necessary.

Class II: Generally limited paint removal—crazing, intercoat peeling, solvent blistering, wrinkling (see Figure 14).

Crazing: Fine jagged interconnected breaks in the top layer of paint; results when paint that is several layers thick becomes hard and brittle with age and is no longer able to expand and contract with the wood.

Recommended Treatment: Crazing can be treated by sanding the surface by hand or mechanically, then repainting. Although hairline cracks may tend to show through the new paint, the surface will be protected from moisture penetration.

Intercoat peeling: Can be the result of improper surface preparation before the last repainting. This most often occurs in protected areas such as under covered lighthouse entry ways or under the “shadow” of an overhanging gallery deck. These surfaces do not receive a regular rinsing from rainfall, and salts from airborne pollutants thus accumulate on the surface. If not cleaned off, the new paint coat will not adhere properly and that layer will peel.

Another common cause of intercoat peeling is incompatibility between paint types. For example, if oil paint is applied over latex paint, peeling of the top coat can sometimes result when, upon aging, the oil paint becomes harder and less elastic than the latex paint. If latex paint is applied over old, chalking oil paint, peeling can also occur because the latex paint is unable to penetrate the chalky surface and adhere.

Recommended Treatment: First, where salts or impurities have caused the peeling, the affected area should be washed down thoroughly after scraping, then wiped dry. Finally, the surface should be sanded by hand or mechanically, then repainted. Where peeling was the result of using incompatible paints, the peeling top coat should be scraped and sanded (with an orbital sander only). Application of a high-quality oil-type exterior primer will provide a surface over which *either* an oil or a latex topcoat can be successfully used.

Solvent blistering: The result of a less common application error, caused not by moisture, but by the action of ambient heat on paint solvent or thinners in the paint film. If solvent-rich paint is applied in direct sunlight, the top surface can dry too quickly and, as a result, solvents become trapped beneath the dried paint film. When the solvent vaporizes, it forces its way through the paint film, resulting in surface blisters. This problem occurs more often with dark colored paints because darker colors absorb more heat than lighter ones. To distinguish between solvent blistering and blistering caused by moisture, cut

Figure 14. View of Class II paint condition: this example happens to be on the same lighthouse as the Class I condition shown in the previous image; multiple paint conditions can exist on the same lighthouse. In this example, only spot paint removal and repainting will be required to remedy the condition.



open a blister. If another layer of paint is visible, then solvent blistering is likely the problem whereas if bare wood is revealed, moisture is probably to blame. Solvent blisters are generally small.

Recommended Treatment: Solvent-blistered areas can be scraped, sanded to the next sound layer, then repainted. In order to prevent blistering of painted surfaces, paint should not be applied in direct sunlight.

Wrinkling: An error in application that occurs when the top layer of paint dries before the layer underneath. The top layer of paint actually moves as the paint underneath (a primer, for example) is drying. Specific causes of wrinkling include: (1) applying paint too thick; (2) applying a second coat before the first one dries; (3) inadequate brushing out; and (4) painting in temperatures higher than recommended by the manufacturer.

Recommended Treatment: The wrinkled layer can be removed by scraping followed by sanding (with an orbital sander only) to provide as even a surface as possible, then repainted following manufacturer's application instructions.

Class III: Exterior surface conditions generally requiring total paint removal—peeling, cracking/alligating (see Figure 15).

If surface conditions are such that most of the paint will have to be removed before repainting, leave a small sample of intact paint in an inconspicuous area either by covering the area with a metal plate, or by marking the area and identifying it in some way. (When repainting does take place, the sample should not be painted over). This will enable future investigators to have a record of the building's paint history.

Peeling: Exposing bare wood; most often caused by excess interior or exterior moisture that collects behind the paint film, thus impairing adhesion. Generally beginning as blisters, cracking and peeling occur as moisture causes the wood to swell, breaking the adhesion of the bottom layer.

Recommended Treatment: There is no sense in repainting before dealing with the moisture problems because new paint will simply fail. Therefore, the first step in treating peeling is to locate and remove the source or sources of moisture, not only because moisture will jeopardize the protective coating of paint but because, if left unattended, it can ultimately cause permanent damage to the wood. Excess interior moisture should be removed from the building through installation of exhaust fans and vents. Exterior moisture should be eliminated by correcting the following conditions before repainting: faulty flashing; leaking gutters; defective roof shingles; cracks and holes in siding and trim; deteriorated caulking in joints and seams; and shrubbery growing too close to painted wood. After the moisture problems have

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Figure 15. View of Class III paint condition: in this case the cracking, peeling, and alligatoring have been caused by excessive paint layer build up.

been solved, the wood must be permitted to dry out thoroughly. The damaged paint can then be scraped off with a putty knife, sanded, primed, and repainted.

Cracking/alligatoring: Advanced stages of crazing. Once the bond between layers has been broken because of intercoat paint failure, exterior moisture is able to penetrate the surface cracks, causing the wood to swell and deeper cracking to take place. This process continues until cracking, which forms parallel to grain, extends to bare wood. Ultimately, the cracking becomes an overall pattern of horizontal and vertical breaks in the paint layers that looks like reptile skin; hence, ‘alligatoring’. In advanced stages of cracking and alligatoring, the surfaces will also flake badly.

Recommended Treatment: If cracking and alligatoring are present only in the top layers, they can probably be scraped, sanded to the next sound layer, then repainted. If cracking and/or alligatoring have progressed to bare wood, however, and the paint has begun to flake, it should be totally removed. Methods include scraping or paint removal with the electric heat plate, electric heat gun, or chemical strippers, depending on the particular area involved. Bare wood should be primed within 48 hours, then repainted.

Paint Removal: Selecting the Appropriate/Safest Method

Having presented the “hierarchy” of exterior paint surface conditions—from a mild condition such as mildewing which simply requires cleaning before repainting to serious conditions such as peeling and alligatoring which require total paint removal—one important thought bears repeating: if a paint problem has been identified that warrants either limited or total paint removal, the gentlest method possible for the particular wooden element of the historic lighthouse should be selected from the many available methods.

The treatments recommended take three overriding issues into consideration (1) the continued protection and preservation of the historic exterior woodwork; (2) the retention of the sequence of historic paint layers; and (3) the health and safety of those individuals performing the paint removal. No paint removal method is without its drawbacks, and all recommendations are qualified in varying degrees.

Methods for Removing Paint

WARNING: *Many of these techniques are potentially dangerous and should be carried out only by experienced and qualified workers using proper eye protection and protective clothing, and observing other workplace safety conditions. Before selecting a process, test panels should be prepared to determine the relative effectiveness of various techniques. The cleaning process will most likely expose additional coating defects, cracks, and deterioration that may not have been obvious before.*

After a particular exterior paint surface condition has been identified, the next step in planning for repainting—if paint removal is required—is selecting an appropriate method for such removal. The method or methods selected should be suitable for the specific paint problem as well as the particular wooden element of the

lighthouse. Methods for paint removal can be divided into three categories (frequently, however, a combination of the three methods is used).

Each method of paint removal is defined below, then discussed further and specific recommendations made:

Abrasive: “Abrading” the painted surface by manual and/or mechanical means such as scraping and sanding. Generally used for surface preparation and limited paint removal.

Thermal: Softening and raising the paint layers by applying heat followed by scraping and sanding. Generally used for total paint removal.

Chemical: Softening of the paint layers with chemical strippers followed by scraping and sanding. Generally used for total paint removal.

Abrasive methods (manual)

If conditions such as crazing, intercoat peeling, solvent blistering, and wrinkling require limited paint removal, scraping and hand sanding should be the first methods employed before using mechanical means. Even in the case of more serious conditions such as peeling (here the damaged paint is weak and already sufficiently loosened from the wood surface), scraping and hand sanding may be all that is needed before repainting.

Recommended abrasive methods (manual):

- **Putty knife/paint scraper:** Scraping is usually accomplished with either a putty knife or a paint scraper, or both. Putty knives range in width from one to six inches and have a beveled edge. A putty knife is used in a pushing motion going under the paint and working from an area of loose paint toward the edge where the paint is still firmly adhered and, in effect, “beveling” the remaining layers so that as smooth a transition as possible is made between damaged and undamaged areas. Paint scrapers are commonly available in 1 1/2-, 2 1/2-, and 3 1/2-inch widths and have replaceable blades. In addition, profiled scrapers can be made specifically for use on moldings. As opposed to the putty knife, the paint scraper is used in a pulling motion and works by raking the damaged areas of paint away.

The obvious goal in using the putty knife or the paint scraper is to selectively remove the affected layer or layers of paint; both of these tools, however, particularly the paint scraper with its hooked edge, must be used with care to properly prepare the surface and to avoid gouging the wood.

- **Sandpaper/sanding block/sanding sponge:** After manually removing the damaged layer or layers by scraping, the uneven surface (caused by the almost inevitable removal of varying numbers of paint layers in a given area) will need to be smoothed or ‘feathered out’ prior to repainting. As stated before, hand sanding, as opposed to harsher mechanical sanding is recommended if the area is relatively limited. A coarse-grit, open-coat flint sandpaper—the least expensive kind—is useful for this purpose because, as the sandpaper clogs with paint, new sheets are used until all layers adhere uniformly. Blocks made of

wood or hard rubber and covered with sandpaper are useful for hand sanding flat surfaces. Sanding sponges—rectangular sponges with an abrasive aggregate on their surfaces that conforms to curves and irregular surfaces—are also available for detail work that requires reaching into grooves. All sanding should follow the grain of the wood.

Abrasive methods (mechanical)

If hand sanding for purposes of surface preparation has not been productive or if the affected area is too large to consider hand sanding by itself, mechanical abrasive methods, i.e., power-operated tools, may be needed; it should be noted, however, that the majority of tools available for paint removal can cause damage to fragile wood and must be used with great care.

Recommended abrasive methods (mechanical):

- **Orbital sander/random orbit sander:** Designed as finishing or smoothing tools, not for the removal of multiple layers of paint, these sanders are recommended when limited paint removal is required before repainting. The orbital sander sands in a small diameter circular motion (some models can also be switched to a back-and-forth vibrating action); this tool is particularly effective for “feathering” areas where paint has first been scraped. The abrasive surface varies from about 3 by 7 inches to 4 by 9 inches and sandpaper is attached either by clamps or sliding clips. The random orbit sander does just what its name implies, it sands in a circular motion with a random movement of its axis. This type of sander tends to leave a smoother finish than the orbital sander. The abrasive surface is round and ranges in diameter from 5 to 6 inches and is attached with either a pressure sensitive adhesive backing or a hook and loop fastening system. A majority of commercially available random orbit sanders come equipped with dust pickup connections which is a plus when sanding lead-based paint. For either sander a medium grit, open-coat aluminum oxide sandpaper should be used; fine sandpaper clogs up so quickly that it is ineffective for smoothing paint.

Abrasive methods not to use:

- **Rotary drill attachments:** Rotary drill attachments such as the rotary sanding disc and the rotary wire stripper should be avoided. The disc sander—usually a disc of sandpaper about 5 inches in diameter secured to a rubber-based attachment which is in turn connected to an electric drill or other motorized housing—can easily leave visible circular depressions in the wood which are difficult to hide, even with repainting. The rotary wire stripper—clusters of metals wires similarly attached to an electric drill type unit—can actually shred a wooden surface and is used only for removing corrosion and paint from metals.
- **Belt sander:** The abrasive surface is a continuous belt of sandpaper that travels at high speeds and consequently offers much less control than the orbital sander. Because of the potential for more damage to the paint or the wood, use of the belt sander can create deep gouges in the wood if not used properly.
- **Waterblasting:** Waterblasting above 600 psi to remove paint is not recommended because it can force water into the woodwork rather than cleaning loose paint and grime from the surface; at worst, high pressure waterblasting causes the water to penetrate exterior sheathing and damages interior finishes. The gentlest method involving water uses a detergent solution, a medium soft bristle brush, and a garden hose for purposes of rinsing, and is recommended when cleaning exterior surfaces before repainting.
- **Sandblasting:** Finally—and most vehemently “not recommended”—sandblasting painted exterior woodwork will indeed remove paint, but at the same time can scar wooden elements beyond recognition. As with rotary wire strippers, sandblasting erodes the soft porous fibers (spring wood) faster than the hard, dense fibers (summer wood), leaving a pitted surface with ridges and valleys. Sandblasting will also erode projecting areas of carvings and moldings before it removes paint from concave areas. Hence, this abrasive method is the most damaging of all possibilities, even though a contractor might promise that blast pressure can be controlled so that the paint is removed without harming the historic exterior woodwork. For additional information, see NPS *Preservation Briefs 6: Dangers of Abrasive Cleaning to Historic Buildings*.

Thermal methods

Where exterior surface conditions such as peeling, cracking, or alligatoring have been identified that warrant total paint removal, two thermal devices—the electric heat plate and the electric heat gun—have proven to be quite successful for use on different wooden elements of the historic building. One thermal method, the blow torch, is not recommended because it can scorch the wood or even burn the lighthouse down!

Recommended thermal methods:

- **Electric heat plate:** The electric heat plate operates between 500 and 800 degrees Fahrenheit (not hot enough to vaporize lead paint), using about 15 amps of power. The plate is held close to the painted exterior surface until the layers of paint begin to soften and blister, then moved to an adjacent location on the wood while the softened paint is scraped off with a putty knife. It should be noted that the heat plate is most successful when the paint is very thick. With practice, the operator can successfully move the heat plate evenly across a flat surface such as wooden siding or a window sill or door in a continuous motion, thus lessening the risk of scorching the wood in an attempt to reheat the edge of the paint sufficiently for effective removal. Since the electric heat plate's coil is "red hot", extreme caution should be taken to avoid igniting clothing or burning the skin. If an extension cord is used, it should be a heavy-duty cord (with 3-prong grounded plugs). A heat plate could overload a circuit or, even worse, cause an electrical fire; therefore, the implement should be used with a single circuit and a fire extinguisher always kept close at hand.
- **Electric heat gun:** The electric heat gun (electric hot-air gun) looks like a hand-held hair dryer with a heavy-duty metal case. It has an electrical resistance coil that typically heats to between 500 and 750 degrees Fahrenheit and, again, uses about 15 amps of power, which requires a heavy-duty extension cord. (There are some heat guns that operate at higher temperatures, but they should not be purchased for removing old paint because of the danger of lead paint vapors.) The temperature is controlled by a vent on the side of the heat gun. When the vent is closed, the heat increases. A fan forces a stream of hot air against the painted woodwork, causing a blister to form. At that point, the softened paint can be peeled back with a putty knife.

Although the heat gun is heavier and more tiring to use than the heat plate, it is particularly effective for removing paint from detail work because the nozzle can be directed at curved and intricate surfaces. It thus is more limited than the heat plate, and is most successful in conjunction with the heat plate. For example, it takes about two to three hours to strip a paneled door with a heat gun, but if used in combination with a heat plate for the large, flat area, the time can usually be cut in half. Although a heat gun seldom scorches wood, it can cause fires (like the blow torch) if aimed at the dusty cavity between the exterior sheathing and siding and interior lath and plaster. A fire may smolder for hours before flames break through to the surface. Therefore, this thermal device is best suited for use on solid decorative elements, such as molding, balusters, and handrails.

Thermal methods not to use:

- **Blow torch:** Blow torches, such as hand-held propane or butane torches, were widely used in the past for paint removal because other thermal devices were not available. With this technique, the flame is directed toward the paint until it begins to bubble and loosen from the surface. Then the paint is scraped off with a putty knife. Although this is a relatively fast process, the open flame, at temperatures between 3200 and 3800 degrees Fahrenheit, can not only burn a careless operator and cause severe damage to eyes or skin, it can easily scorch or ignite the wood. The other fire hazard is more insidious. Most frame buildings have an air space between the exterior sheathing and siding and interior lath and plaster. This cavity usually has an accumulation of dust which is also easily ignited by the open flame of a blow torch. Finally, lead-base paints will vaporize at high temperatures, releasing toxic fumes that can be unknowingly inhaled.

Chemical methods

With the availability of effective thermal methods for total paint removal, the need for chemical methods, in the context of preparing historic exterior woodwork for repainting, becomes quite limited. Solvent-base or caustic strippers may, however, play a supplemental role in a number of situations:

- removing paint residue from intricate decorative features, or in cracks or hard-to-reach areas if a heat gun has not been completely effective;
- removing paint on window muntins because heat devices can easily break the glass;
- removing varnish on exterior doors after all layers of paint have been removed by a heat plate/heat gun if the original varnish finish is being restored; or
- removing paint from detachable wooden elements such as exterior shutters, balusters, columns, and doors by dip-stripping when other methods are too laborious.

Recommended chemical methods (use with extreme caution):

Because all chemical paint removers have potential health and safety hazards, only qualified recommendations can be made. Commonly known as ‘paint removers’ or ‘strippers’, both solvent-base or caustic products are commercially available that, when poured, brushed, or sprayed on painted exterior woodwork, soften several layers of paint at a time so that the resulting ‘sludge’—which is nothing less than the sequence of historic paint layers—can be removed with a putty knife. Detachable wood elements such as exterior shutters can also be ‘dip-stripped’.

- **Solvent-base strippers:** The formulas tend to vary, but generally consist of combinations of organic solvents such as methylene chloride, isopropanol, toluol, xylol, and methanol; thickeners such as methyl cellulose; and various additives such as paraffin wax used to prevent the volatile solvents from evaporating before they have time to soak through multiple layers of paint. Thus, while some solvent-base strippers are quite thin and therefore unsuitable for use on vertical surfaces, others, called ‘semi-paste’ strippers, are formulated for use on vertical surfaces or the underside of horizontal surfaces.

Whether liquid or semi-paste, however, there are two important points to stress when using any solvent-base stripper: first, the vapors from the organic chemicals can be highly toxic if inhaled; skin contact is equally dangerous because the solvents can be absorbed; second, many solvent-base strippers are flammable. Even though application out-of-doors may somewhat mitigate health and safety hazards, a respirator with special filters for organic solvents should be worn and, of course, solvent-base strippers should never be used around open flames, lighted cigarettes, or with steel wool around electrical outlets.

Although appearing to be the simplest for exterior use, a particular type of solvent-base stripper should be mentioned here because it can actually cause more problems. Known as ‘water-rinsable’, such products have a high proportion of methylene chloride together with emulsifiers. Although the dissolved paint can be rinsed off with water with a minimum of scraping, this ultimately creates more of a problem in cleaning up and properly disposing of the sludge. In addition, these strippers can leave a gummy residue on the wood that requires removal with solvents. Finally, water-rinsable strippers tend to raise the grain of the wood more than regular strippers.

On balance, then, the regular strippers would seem to work just as well for exterior purposes and are perhaps even better from the standpoint of proper lead sludge disposal because they must be hand scraped as opposed to rinsed off. (A coffee can with a wire stretched across the top is one effective way to collect the sludge; when the putty knife is run across the wire, the sludge simply falls into the can. Then, when the can is filled, the wire is removed, the can capped, and the lead paint sludge disposed of according to local health regulations.)

- **Caustic strippers:** Until the advent of solvent-base strippers, caustic strippers were used exclusively when a chemical method was deemed appropriate for total paint removal before repainting or refinishing. Now, commercially prepared caustic solutions are more difficult to find in hardware and paint stores for

home-owner use with the exception of lye (caustic soda) because solvent-base strippers packaged in small quantities tend to dominate the market.

Most commercial dip stripping companies, however, continue to use variations of the caustic bath process because it is still the cheapest method available for removing paint. Generally, dip stripping should be left to professional companies because caustic solutions can dissolve skin and permanently damage eyes as well as present serious disposal problems in large quantities.

If exterior shutters or other detachable elements are being sent out for stripping in a caustic solution, it is wise to see samples of the company's finished work. While some companies do a first-rate job, others can leave a residue of paint in carvings and grooves. Wooden elements may also be soaked too long so that the wood grain is raised and roughened, requiring extensive hand sanding later. In addition, these companies should give assurances that caustic paint removers will be neutralized with a mild acid solution or at least thoroughly rinsed with water after dipping (a caustic residue makes the wood feel slippery). If this is not done, the lye residue will cause new paint to fail.

Painting

Assuming that the exterior wood has been painted with oil paint many times in the past and the existing top coat is therefore also an oil paint, a top coat of high quality oil paint should be applied when repainting *Class I* and *Class II* paint surface conditions. There are two reasons for recommending oil rather than latex paints: 1) a coat of latex paint applied directly over old oil paint is more apt to fail because of different rates of shrinkage; 2) oil paints withstand the harsh conditions of a marine environment better than latex.

- If Class III conditions have necessitated total paint removal, an oil-based primer/top coat system should be applied to ensure the maximum protection of the wood. For the best results the primer and top coat should be manufactured by the same company. Note also that primers were never intended to withstand the effects of weathering; therefore, the top coat should be applied as soon as possible after the primer has dried.
- To ensure that the maximum life expectancy of the paint is achieved, follow the manufacturer's specifications and guidelines that are included with the product (either directly on the label or as included literature).
- All paint on wood surfaces should be applied with good quality natural bristle brushes. All brushing should be done with the grain of the

wood. Brush painting ensures the best coverage and in turn the most durable finish.

Repair of Damaged/Deteriorated Wooden Components

Exterior wood trim on historic lighthouses often performs the dual function of weather protection and decoration. Moldings, siding, and trim not only create visual interest with highlights and shadows, but also have practical value. In addition to covering joints and protecting the wood end grain, they direct rainwater from one component to the next and eventually to the ground.

General Guidelines for Wood Repair

Identify, retain, and preserve wood features that are important in defining the overall historic character of the building, such as siding, cornices, brackets, window architraves, and doorway pediments, and their paints, finishes, and colors.

- During the inspection of the historic wooden lighthouse, identify character-defining features of the wooden components such as the species of wood, grain pattern, dimensions, millwork, shaping, joining, and finishing techniques, and means of fastening.
- Historically, the wood species was chosen for its inherent qualities. Oak, fir, and pine, all common building lumber, exhibit varying strength and resistance to decay. When

choosing a wood species for repair or replacement, these factors should be considered.

- The use of lumber treated to resist decay is only appropriate for hidden structural components.
- Determine if a wood element functions as a structural, decorative, or finish material. This information will dictate the priority of treatment, e.g., a structural beam or column will take precedence over applied trim that serves no other function than decoration.
- Do not remove or radically change wood features that are important in defining the overall historic character of the building, or provide weather protection for the lighthouse.
- Do not radically change the type of finish or its color or accent scheme so that the historic character of the exterior is diminished or the daymark characteristics of the lighthouse are altered.
- Do not remove all paint layers without retaining samples for analysis and documentation. In the case of a lighthouse where total paint removal is required, if possible leave a patch of undisturbed paint in a protected area such as on a wall under a covered entry or behind a shutter. The location of the sample should be identified in the project record and kept in the lighthouse maintenance file.
- For all exterior wood repairs galvanized or stainless steel fasteners (nails, screws, and bolts) must be used in order to prevent the premature failure of the repair by fasteners that rusted and failed. When used, finish nails should be countersunk and the depression filled with wood filler applied over the nailheads.
- Do not replace an entire wood feature, such as a cornice or wall, when repair of the wood and limited replacement of deteriorated or missing parts are appropriate.
- Damaged or missing trim elements that maintain the exterior weathertight envelope must be repaired as soon as possible.
- For the replacement part, do not use substitute material that does not have the appearance of the surviving parts of the wood feature or that is physically or chemically incompatible.
- Do not remove an entire wood feature that is beyond repair and not replace it, or replace it

with a new feature that does not have the same appearance.

- Do not replace milled lumber with plywood. Plywood is both historically inappropriate and visually distinct from historic wood.

As part of an effective treatment program, inspect wood surfaces and structural elements regularly for signs of moisture retention and insect or fungal attack. Peeling paint, spongy wood, discoloration, staining, and the presence of fungi are clear indicators of wood deterioration caused by elevated moisture content. (See the **Windows** section for inspection techniques for damaged and deteriorated wood.) Insect damage generally occurs on the interior of a wood member and may be hidden until the structural integrity is severely compromised. Sills and wood joints or members bearing on masonry are particularly susceptible to rot, because they are frequently subjected to moisture.

Wood structures are most commonly weakened when the original cross section of a structural member is reduced by portions cut out by alterations, fire, insect damage, or fungal rot. Rot on the original member must be removed before installing new material.

Deteriorated portions of wood can be effectively repaired using like-kind splices. Splicing of a wood member is required when a portion of the wood component, i.e., handrail, has been damaged or has deteriorated and only that portion needs to be removed and a new section attached in its place. The replacement member should match the existing members in species and grain orientation and in any existing shape or profile. The new member can even be made from matching salvaged stock. All deteriorated material should be removed and the end where the replacement member will be attached should be cut on a diagonal to increase the gluing surface area.



Figure 18. The wooden structural member that this bracket is attached to is extensively deteriorated. This condition is a prime example of deterioration that can be repaired by cutting back the rotted wood to a sound substrate, then fitting the void created with a wooden ‘dutchman’ or infill that matches as closely as possible the grain orientation and wood species as the existing member. Once the dutchman has been glued, and if needed, doweled in place, then the affected area should be properly primed and painted. This technique is affordable and incurs only minimal damage to the existing historic materials.

Then drill aligned holes in both members for reinforcing dowels.

A ‘dutchman’ is a fitted patch in a wood member that only has localized deterioration. To fit a dutchman, first probe the deteriorated area to determine size and the approximate depth of the deterioration. Second, cut a wood patch or ‘dutchman’ with its grain aligned with the existing members. The dutchman can be rectangular or diamond-shaped; a diamond shape is a little more difficult to fit but will provide more gluing surface and blend with the grain better when the wood is finished with varnish instead of paint. Be sure the dutchman is large enough to cover the affected area and thicker than the deterioration is deep. Slightly bevel all of the edges of the dutchman so that the widest face is the top. This will ensure a tight, cork-like fit. Next, trace the outline of the dutchman’s narrowest face on the existing member over the deterioration. Using the outline as a guide, carefully remove all of the deteriorated wood with a chisel. Test fit the dutchman and trim the

hole until the dutchman bottoms out and fills the affected area entirely; the dutchman should be slightly proud of the existing material. Glue and clamp the dutchman in place. Once the glue has cured, use a chisel or hand plane to make the dutchman flush with the surrounding material. Hand sanding can be used for the final leveling of the two surfaces.

Consolidation and Epoxy Repairs

Deteriorated features can be repaired using consolidation and epoxy techniques. This type of treatment is irreversible and should be used if other treatments are ineffective. (For more information on consolidants and epoxy treatments refer to the **Windows** section.)

Flashing and Joint Repairs

Maintain successful existing details of joints and flashing that keep water out of wood assemblies, and consider historic detail reconstruction before caulking. Replace missing wood features, especially those on the exterior, in a timely manner. Exterior wood components are usually designed, joined, and flashed to prevent water from penetrating joints. One missing element can compromise the entire system. The high-quality caulks that are available today can be used for short-term temporary repairs. Caulk, however, should not be regarded as a long-term repair for a condition where the original flashing or trim detail is missing or damaged.

When vertical elements are repaired, cut vertical replacement pieces on a diagonal to direct water from the joint. Horizontal joints tend to collect water. To minimize cracking and splitting, use predrilling and screws in old brittle wood rather than nails. Replace wood features using the same joining techniques as found in the original feature, e.g., if two members are joined with a mortise and tenon joint, the repair

should be joined using a mortise and tenon joint.

Structural Stabilization

Wood structural components that have experienced extensive deterioration will require stabilization to prevent failure and possible collapse of the lighthouse. Effective methods of stabilization include: installation of intermediary bracing and shoring that supports compromised members, and 'sistering' of wood or steel members to compromised members to help carry the load. All temporary treatments should be reversible and not incur further damage to the lighthouse. Before a permanent structural stabilization is performed, an engineer or historical architect should be consulted.

Limited Replacement In Kind

If repair by stabilization, consolidation, and conservation proves inadequate, the next level of intervention involves the limited replacement in kind of extensively deteriorated or missing parts of features when there are surviving prototypes (for example, wooden cornices, door pediments, window architraves, and wall coverings i.e., shingles or siding). The replacement material needs to match the old both physically and visually, i.e., 8- by 18-inch cedar shingles with 8- by 18-inch cedar shingles, etc. With the exception of hidden structural reinforcement and new mechanical system components, substitute materials are not appropriate in the preservation treatment. It is important that all new material be identified and properly documented for future research.

If prominent features are missing, then a rehabilitation or restoration treatment may be more appropriate.