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USMMA Historic District Property Maintenance and Repair Manual

Volume 3 – Wood Elements

Sunny E. Adams and Adam D. Smith

June 2018

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Cover Photo: Closeup of peeling paint on a Wiley Hall door lintel that should be corrected at United States Merchant Marine Academy (ERDC-CERL, 2015).

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Volume 3 – Wood Elements

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Abstract

The U.S. Merchant Marine Academy is located in Kings Point, New York. The Academy is listed on the National Register of Historic Places (#14000538). The historic district contains contributing mansions constructed during the Gold Coast Era and the Academy buildings constructed in 1942 to 1969. All buildings require regular planned maintenance and repair. The most notable cause of historic building element failure and/or decay is not the fact the historic building is old, but rather it is caused by an incorrect or inappropriate repair and/or basic neglect of the historic building fabric. This document is a maintenance manual compiled with as-is conditions of construction materials of buildings at the Academy. The *Secretary of the Interior's Standards for the Treatment of Historic Properties* on preservation, rehabilitation, and repair per material are discussed to provide the Academy a guide to maintain these historic buildings. Materials included in this report are concrete, wood, brick, metal, roofing materials, stucco, and mechanical system elements. All mentioned repair procedures are from the U.S. General Services Administration (GSA): Historic Preservation Technical Procedures and/or the National Park Service's series of Preservation Briefs. This report satisfies Section 110 of the National Historic Preservation Act (NHPA) of 1966, as amended.

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Preface

This study was conducted for the U.S. Department of Transportation Maritime Administration (MARAD) under Project Number 450153, “Historic Preservation Plan for U.S. Merchant Marine Academy.” The technical monitor was Barbara Voulgaris, Federal Preservation Officer, U.S. Department of Transportation, MARAD.

The work was performed by the Land and Heritage Conservation Branch (CNC) of the Installations Division (CN), U.S. Army Engineer Research and Development Center – Construction Engineering Research Laboratory (ERDC-CERL). At the time of publication, Dr. Michael Hargrave was Chief, CEERD-CNC; and Ms. Michelle Hanson was Chief, CEERD-CN. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti, and the Director was Dr. Lance D. Hansen.

COL Bryan S. Green was the Commander of ERDC, and Dr. David W. Pittman was the Director.

Foreword

ERDC-CERL's effort to put together a guide to proper maintenance and repair of the historic elements at the U.S. Merchant Marine Academy has been divided into multiple volumes for ease of use by installation personnel.

This is Volume 3 of 8, and it covers guidance for proper maintenance and repair of historic wood elements at USMMA.

Please see Volume 1 for an overview of the project and the USMMA's historic context, an explanation of the Secretary of the Interior's Standards and their application, and overviews and lists of immediate concerns for the USMMA's historic exteriors and interiors.

ADAM D. SMITH
Project Manager

1 Wood Elements

NOTE: Maintenance manuals such as those produced as part of this report are a general guide for the historic materials used throughout the USMMA. Do not assume that because a particular building or a particular material on a building is not mentioned in these manuals that the material in need of maintenance or repair does not need to follow the Standards.

1.1 Wood millwork

Visually, exterior wood trim (millwork) frames areas of wood siding or shingles, and it serves as the transition between decorative elements such as doors, windows, cornices, and porches. Functionally, it provides protection at the perimeter and corners of openings and creates a weather-tight building enclosure. Exterior wood trim frames windows and doors, and it serves as the transition to adjoining wall surfaces. In addition to wood trim, there are numerous types of wood ornaments applied to buildings, including porch posts and columns, brackets, balustrades, and other decorative details. Historically, wood trim and ornament profiles, details, and sizes varied with building styles. Wood trim and ornament details are considered to be architecturally significant features.

Typical exterior woodwork concerns include lack of regular maintenance, peeling paint, rot or deterioration, infestation, and loose, cracked or missing elements. Whatever the causes of deterioration, careful analysis that is supplemented by testing is vital to the success of any wood millwork repair project. Repair of wood millwork may consist of either patching the historic material or filling in with new material worked to match the historic material. If replacement is necessary, duplication of historic materials and detailing should be exact as possible to assure a repair that is functionally and aesthetically acceptable.

1.1.1 Immediate concerns for wood millwork

Deterioration of wood can be caused by environmental factors, inferior materials, poor workmanship, inherent structural design defects, and inadequate maintenance.

Any work done on these elements should be sympathetic to the significant qualities of the historic property.

Any exposed end grain of wood members should not be left untreated. End-grain wood is the wood that shows the growth of rings of the tree. This area has a tendency to absorb paint, so it must be primed prior to painting; if it is not primed, the porous wood grain will soak up the paint and alter the paint color. End-grain wood is commonly found at the ends of boards, but it is also found in the wood knots of boards. Unfinished wood grain is rough and needs to be sanded before paint or primer is applied. Painting the wood end grains ensures the wood is sealed to prevent future deterioration or decay.

The wood millwork elements are evaluated as follows (see Figure 1–Figure 6):

- The wood is structurally intact and performing its intended purpose.
- The wood is to be stripped and painted according to the Standards.
- The deteriorated or damaged wood members need to be repaired according to the standards.
- The wood is cleaned in order to maintain the historic appearance.
- Any repairs to the wood are made after cleaning the surface gently, if necessary.
- The decision to replace should be based on an extensive evaluation of all wood; replacement in substitute materials is not acceptable.
- Replace in-kind any entire wood feature that is too deteriorated to repair.

Figure 1. Wood trim should be maintained, and paint reapplied as needed (ERDC-CERL, 2105).

Figure 2. Wood trim should be maintained, and paint reapplied as needed to prevent the wood from deteriorating (ERDC-CERL, 2015).

Figure 3. Wood railings should be maintained and paint reapplied as needed to prevent the wood from deteriorating (ERDC-CERL, 2015).

Figure 4. The wood rafters on the pergolas should be maintained, and paint reapplied as needed, including the end grain, to prevent the wood from deteriorating.

Figure 5. Wood rafters, wood columns, and wood beams like these on Quarters D should be periodically checked for damage (USMMA, 2013).

Figure 6. Wood bracket on pent roof over front entrance at the American Merchant Marine Museum (Barstow Mansion) (ERDC-CERL, 2013).

1.1.2 Guidelines, briefs, bulletins, and sources for wood millwork

In addition to the information contained in this manual, the authors have compiled the following federal resource publications (reproduced here for convenience, with links for online access given in References) to inform managers about standards, guidelines, and procedures for understanding architecture, and caring for, preserving, and rehabilitating historic buildings with emphasis on historic wood millwork (see subsections 1.1.2.1–1.1.2.5).

1.1.2.1 Exterior paint problems on woodwork (Weeks and Look 1982 – Preservation Brief #10)

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Some of the web versions of the Preservation Briefs differ somewhat from the printed versions. Many illustrations are new and in color; Captions are simplified and some complex charts are omitted. To order hard copies of the Briefs, see [Printed Publications](#)®.

PRESERVATION BRIEFS

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Exterior Paint Problems on Historic Woodwork

Kay D. Weeks and David W. Look, AIA

- [Purposes of Exterior Paint](#)
- [Treating Paint Problems](#)
- [Justification for Paint Removal](#)
- [Paint Removal Precautions](#)
- [Repainting Historic Buildings for Cosmetic Reasons](#)
- [Conditions/Recommended Treatments](#)
- [Selecting the Safest Method to Remove Paint](#)
- [General Paint Type Recommendations](#)
- [Summary and References](#)
- [Reading List](#)
- [Download the PDF](#) ^{PDF}

Peeling paint on historic wood siding. Photo: ©John Leeke, 2002.

A cautionary approach to paint removal is included in the guidelines to the *Secretary of the Interior Standards for Rehabilitation*. Removing paints down to bare wood surfaces using harsh methods can permanently damage those surfaces; therefore such methods are not recommended. Also, total removal obliterates evidence of the historical paints and their sequence and architectural context.

This Brief expands on that advice for the architect, building manager, contractor, or homeowner by identifying and describing common types of paint surface conditions and failures, then recommending appropriate treatments for preparing exterior wood surfaces for repainting to assure the best adhesion and greatest durability of the new paint.

Although the Brief focuses on responsible methods of "paint removal," several paint surface conditions will be described which do not require any paint removal, and still others which can be successfully handled by limited paint removal. In all cases, the information is intended to address the concerns related to exterior wood. It will also be generally assumed that, because houses built before 1950 involve one or more layers of lead-based paint, the majority of conditions warranting paint removal will mean dealing with this toxic substance along with the dangers of the paint removal tools and chemical strippers themselves.

Purposes of Exterior Paint

Paint applied to exterior wood must withstand yearly extremes of both temperature and humidity. While never expected to be more than a temporary physical shield—requiring reapplication every 5 to 8 years—its importance should not be minimized. Because one of the

main causes of wood deterioration is moisture penetration, a primary purpose for painting wood is to exclude such moisture, thereby slowing deterioration not only of a building's exterior siding and decorative features but, ultimately, its underlying structural members. Another important purpose for painting wood is, of course, to define and accent architectural features and to improve appearance.

Treating Paint Problems in Historic Buildings

Exterior paint is constantly deteriorating through the processes of weathering, but in a program of regular maintenance—assuming all other building systems are functioning properly—surfaces can be cleaned, lightly scraped, and hand sanded in preparation for a new finish coat. Unfortunately, these are ideal conditions. More often, complex maintenance problems are inherited by owners of historic buildings, including areas of paint that have failed beyond the point of mere cleaning, scraping, and hand sanding (although much so-called "paint failure" is attributable to interior or exterior moisture problems or surface preparation and application mistakes with previous coats).

Although paint problems are by no means unique to historic buildings, treating multiple layers of hardened, brittle paint on complex, ornamental—and possibly fragile—exterior wood surfaces necessarily requires an extremely cautious approach. In the case of recent construction, this level of concern is not needed because the wood is generally less detailed and, in addition, retention of the sequence of paint layers as a partial record of the building's history is not an issue.

When historic buildings are involved, however, a special set of problems arises—varying in complexity depending upon their age, architectural style, historical importance, and physical soundness of the wood—which must be carefully evaluated so that decisions can be made that are sensitive to the longevity of the resource.

Justification for Paint Removal

At the outset of this Brief, it must be emphasized that removing paint from historic buildings—with the exception of cleaning, light scraping, and hand sanding as part of routine maintenance—should be avoided unless absolutely essential. ***Once conditions warranting removal have been identified the general approach should be to remove paint to the next sound layer using the gentlest means possible, then to repaint.*** Practically speaking as well, paint can adhere just as effectively to existing paint as to bare wood, providing the previous coats of paint are also adhering uniformly and tightly to the wood and the surface is properly prepared for repainting—cleaned of dirt and chalk and dulled by sanding.

But, if painted exterior wood surfaces display continuous patterns of deep cracks or if they are extensively blistering and peeling so that bare wood is visible, then the old paint should be completely removed before repainting. The only other justification for removing all previous layers of paint is if doors, shutters, or windows have literally been "painted shut," or if new wood is being pieced-in adjacent to old painted wood and a smooth transition is desired.

Paint Removal Precautions

Because paint removal is a difficult and painstaking process, a number of costly, regrettable experiences have occurred—and continue to occur—for both the historic building and the building owner. Historic buildings have been set on fire with blow torches; wood irreversibly scarred by sandblasting or by harsh mechanical devices such as rotary sanders and rotary wire strippers; and layers of historic paint inadvertently and unnecessarily removed. In addition, property owners, using techniques that substitute speed for safety, have been injured by toxic lead vapors or dust from the paint they were trying to remove or by misuse of the paint removers themselves.

Owners of historic properties considering paint removal should also be aware of the amount of time and labor involved. While removing damaged layers of paint from a door or porch railing might be readily accomplished within a reasonable period of time by one or two people, removing paint from larger areas of a building can, without professional assistance, easily become unmanageable and produce less than satisfactory results. The amount of work involved in any paint removal project must therefore be analyzed on a case-by-case basis. Hiring qualified professionals will often be a cost-effective decision due to the expense of materials, the special equipment required, and the amount of time involved. Further, paint removal companies experienced in dealing with the inherent health and safety dangers of paint removal should have purchased such protective devices as are needed to mitigate any dangers and should also be aware of State or local environmental and/or health regulations for hazardous waste disposal.

The paint on this exterior decorative feature is sound.
Photo: NPS files.

When the protective and decorative paint finish was removed and an inappropriate clear finish applied, the exterior character of the building was altered. Photo: NPS files.

All in all, paint removal is a messy, expensive, and potentially dangerous aspect of rehabilitating or restoring historic buildings and should not be undertaken without careful thought concerning first, its necessity, and second, which of the available recommended methods is the safest and most appropriate for the job at hand.

Repainting Historic Buildings for Cosmetic Reasons

If existing exterior paint on wood siding, eaves, window sills, sash, and shutters, doors, and decorative features shows no evidence of paint deterioration such as chalking, blistering, peeling, or cracking, then there is no physical reason to repaint, much less remove paint! Nor is color fading, of itself, sufficient justification to repaint a historic building.

The decision to repaint may not be based altogether on paint failure. Where there is a new owner, or even where ownership has remained constant through the years, taste in colors often changes. Therefore, if repainting is primarily to alter a building's primary and accent colors, a technical factor of paint accumulation should be taken into consideration.

When paint builds up to a thickness of approximately 1/16" (approximately 16 to 30 layers), one or more extra coats of paint may be enough to trigger cracking and peeling in limited or even widespread areas of the building's surface. This results because excessively thick paint is less able to withstand the shrinkage or pull of an additional coat as it dries and is also less able to tolerate thermal stresses. Thick paint invariably fails at the weakest point of adhesion—the oldest layers next to the wood. Cracking and peeling follow. Therefore, if there are no signs of paint failure, it may be somewhat risky to add still another layer of unneeded paint simply for color's sake (extreme changes in color may also require more than one coat to provide proper hiding power and full color). When paint appears to be nearing the critical thickness, a change of accent colors (that is, just to limited portions of the trim) might be an acceptable compromise without chancing cracking and peeling of paint on wooden siding.

When the paint on the wood window sills became too thick, it was removed and the window repainted. Photo: NPS files.

If the decision to repaint is nonetheless made, the "new" color or colors should, at a minimum, be appropriate to the style and setting of the building. On the other hand, where the intent is to restore or accurately reproduce the colors originally used or those from a significant period in the building's evolution, they should be based on the results of a paint analysis.

Identification of Exterior Paint Surface Conditions/Recommended Treatments

It is assumed that a preliminary check will already have been made to determine, first, that the painted exterior surfaces are indeed wood—and not stucco, metal, or other wood substitutes—and second, that the wood has not decayed so that repainting would be superfluous. For example, if any area of bare wood such as window sills has been exposed for a long period of time to standing water, wood rot is a strong possibility. Repair or replacement of deteriorated wood should take place before repainting. After these two basic issues have been resolved, the surface condition identification process may commence.

The historic building will undoubtedly exhibit a variety of exterior paint surface conditions. For example, paint on the wooden siding and doors may be adhering firmly; paint on the eaves peeling; and paint on the porch balusters and window sills cracking and alligatoring. The accurate identification of each paint problem is therefore the first step in planning an appropriate overall solution.

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 top 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. It is precisely because conditions will vary at different points on the building that a careful inspection is critical. Each item of painted exterior woodwork (i.e., siding, doors, windows, eaves, shutters, and decorative elements) should be examined early in the planning phase and surface conditions noted.

The problem evidenced here by mossy growth and deteriorated wood must be resolved and the wood allowed to dry out before the wood is repainted. Photo: NPS files.

CLASS I Exterior Surface Conditions Generally Requiring No Paint Removal Dirt, Soot, Pollution, Cobwebs, Insect Cocoons, etc.

Cause of Condition

Environmental "grime" or organic matter that tends to cling to painted exterior surfaces and, in particular, protected

surfaces such as eaves, do not constitute a paint problem unless painted over rather than removed prior to repainting. If not removed, the surface deposits can be a barrier to proper adhesion and cause peeling.

Recommended Treatment

Most surface matter can be loosened by a strong, direct stream of water from the nozzle of a garden hose. Stubborn dirt and soot will need to be scrubbed off using 1/2 cup of household detergent in a gallon of water with a medium soft bristle brush. The cleaned surface should then be rinsed thoroughly, and permitted to dry before further inspection to determine if repainting is necessary. Quite often, cleaning provides a satisfactory enough result to postpone repainting.

Mildew**Cause of Condition**

Mildew is caused by fungi feeding on nutrients contained in the paint film or on dirt adhering to any surface. Because moisture is the single most important factor in its growth, mildew tends to thrive in areas where dampness and lack of sunshine are problems such as window sills, under eaves, around gutters and downspouts, on the north side of buildings, or in shaded areas near shrubbery. It may sometimes be difficult to distinguish mildew from dirt, but there is a simple test to differentiate: if a drop of household bleach is placed on the suspected surface, mildew will immediately turn white whereas dirt will continue to look like dirt.

Recommended Treatment

Because mildew can only exist in shady, warm, moist areas, attention should be given to altering the environment that is conducive to fungal growth. The area in question may be shaded by trees which need to be pruned back to allow sunlight to strike the building; or may lack rain gutters or proper drainage at the base of the building. If the shady or moist conditions can be altered, the mildew is less likely to reappear. A recommend solution for removing mildew consists of one cup non-ammoniated detergent, one quart household bleach, and one gallon water. When the surface is scrubbed with this solution using a medium soft brush, the mildew should disappear; however, for particularly stubborn spots, an additional quart of bleach may be added. After the area is mildew-free, it should then be rinsed with a direct stream of water from the nozzle of a garden hose, and permitted to dry thoroughly. When repainting, specially formulated "mildew-resistant" primer and finish coats should be used.

Excessive Chalking**Cause of Condition**

Chalking—or powdering of the paint surface—is caused by the gradual disintegration of the resin in the paint film. (The amount of chalking is determined both by the formulation of the paint and the amount of ultraviolet light to which the paint is exposed.) In moderation, chalking is the ideal way for a paint to "age," because the chalk, when rinsed by rainwater, carries discoloration and dirt away with it and thus provides an ideal surface for repainting. In excess, however, it is not desirable because the chalk can wash down onto a surface of a different color beneath the painted area and cause streaking as well as rapid disintegration of the paint film itself. Also, if a paint contains too much pigment for the amount of binder (as the old white lead carbonate/oil paints often did), excessive chalking can result.

Recommended Treatment

The chalk should be cleaned off with a solution of 1/2 cup household detergent to one gallon water, using a medium soft bristle brush. After scrubbing to remove the chalk, the surface should be rinsed with a direct stream of water from the nozzle of a garden hose, allowed to dry thoroughly, (but not long enough for the chalking process to recur) and repainted, using a non-chalking paint.

Staining**Cause of Condition**

Staining of paint coatings usually results from excess moisture reacting with materials within the wood substrate. There are two common types of staining, neither of which requires paint removal. The most prevalent type of stain is due to the oxidation or rusting of iron nails or metal (iron, steel, or copper) anchorage devices. A second type of stain is caused by a chemical reaction between moisture and natural extractives in certain woods (red cedar or redwood) which results in a surface deposit of colored matter. This is most apt to occur in new replacement wood within the first 10-15 years.

Recommended Treatment

In both cases, the source of the stain should first be located and the moisture problem corrected.

When stains are caused by rusting of the heads of nails used to attach shingles or siding to an exterior wall or by rusting or oxidizing iron, steel, or copper anchorage devices adjacent to a painted surface, the metal objects themselves should be hand sanded and coated with a rust-inhibitive primer followed by two finish coats. (Exposed nail heads should ideally be countersunk, spot primed, and the holes filled with a high quality wood filler except where exposure of the nail head was part of the original construction system or the wood is too fragile to withstand the countersinking procedure.)

Discoloration due to color extractives in replacement wood can usually be cleaned with a solution of equal parts denatured alcohol and water. After the affected area has been rinsed and permitted to dry, a "stainblocking primer" especially developed for preventing this type of stain should be applied (two primer coats are recommended for severe cases of bleeding prior to the finish coat). Each primer coat should be allowed to dry at least 48 hours.

CLASS II Exterior Surface Conditions Generally Requiring Limited Paint Removal

Crazing

Cause of Condition

Crazing—fine, jagged interconnected breaks in the top layer of paint—results when paint that is several layers thick becomes excessively hard and brittle with age and is consequently no longer able to expand and contract with the wood in response to changes in temperature and humidity. As the wood swells, the bond between paint layers is broken and hairline cracks appear. Although somewhat more difficult to detect as opposed to other more obvious paint problems, it is well worth the time to scrutinize all surfaces for crazing. If not corrected, exterior moisture will enter the crazed surface, resulting in further swelling of the wood and, eventually, deep cracking and alligating, a Class III condition which requires total paint removal.

Crazing—or surface cracking—is an exterior surface condition which can be successfully treated by sanding and painting. Photo: Courtesy, National Decorating Products Association.

Recommended Treatment

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

Intercoat Peeling

Here, a latex top coat was applied directly over old oil paint, resulting in intercoat peeling. The latex was unable to adhere. If latex is used over oil, an oil-base primer should be applied first. Photo: Mary L. Oehrlein, AIA.

Cause of Condition

Intercoat peeling can be the result of improper surface preparation prior to the last repainting. This most often occurs in protected areas such as eaves and covered porches because 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 since, 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 hand or mechanically sanded, then repainted.

Where peeling was the result of using incompatible paints, the peeling top coat should be scraped and hand or mechanically sanded. 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

Cause of Condition

Solvent blistering, the result of a less common application error, is not caused by moisture, but by the action of ambient heat on paint solvent or thinners in the paint film. If solventrich 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, a blister should be cut open. 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, hand or mechanically 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

Cause of Condition

Another error in application that can easily be avoided is wrinkling. This 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 hand or mechanical sanding to provide as even a surface as possible, then repainted following manufacturer's application instructions.

Wrinkled layers can generally be removed by scraping and sanding as opposed to total paint removal. Photo: Courtesy, National Decorating Products Association.

CLASS III Exterior Surface Conditions Generally Requiring Total Paint Removal

If surface conditions are such that the majority of paint will have to be removed prior to repainting, it is suggested that a small sample of intact paint be left 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**Cause of Condition**

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

Extensively deteriorated paint needs to be removed to bare wood, then primed and repainted. Photo: NPS files.

Cracking/Alligatoring**Cause of Condition**

Cracking and alligatoring are advanced stages of crazing. Once the bond between layers has been broken due to 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, hand or mechanically sanded to the next sound layer, then repainted. However, if cracking and/or alligatoring have progressed to bare wood and the paint has begun to flake, it will need to 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.

Selecting the Appropriate/Safest Method to Remove Paint

After having presented the "hierarchy" of exterior paint surface conditions—from a mild condition such as mildew which simply requires cleaning prior to 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 building should be selected from the many available methods.

The treatments recommended—based upon field testing as well as onsite monitoring of Department of Interior grant-in-aid and certification of rehabilitation projects—are therefore those which 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. By applying these criteria, it will be seen that no paint removal method is without its drawbacks and all recommendations are qualified in varying degrees.

Methods for Removing Paint

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 building. Methods for paint removal can be divided into three categories (frequently, however, a combination of the three methods is used). Each method 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 have been identified that require limited paint removal such as crazing, intercoat peeling, solvent blistering, and wrinkling, 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—where the damaged paint is weak and already sufficiently loosened from the wood surface—scraping and hand sanding may be all that is needed prior to 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 1-5/16, 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; however, both of these tools, 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 (due to 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 it must be discarded and this process repeated until all layers adhere uniformly.

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

Summary of Abrasive Methods (Manual)

- **Recommended:** Putty knife, paint scraper, sandpaper, sanding block, sanding sponge.
- **Applicable areas of building:** All areas. For use on: Class I, Class II, and Class III conditions.
- **Health/Safety factors:** Take precautions against lead dust, eye damage; dispose of lead paint residue properly.

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 need to be employed; however, it should be noted 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: Designed as a finishing or smoothing tool—not for the removal of multiple layers of paint—the orbital sander is thus recommended when limited paint removal is required prior to repainting. Because it 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 3x7 inches to 4x9 inches and sandpaper is attached either by clamps or sliding clips. A medium grit, open-coat aluminum oxide sandpaper should be used; fine sandpaper clogs up so quickly that it is ineffective for smoothing paint.

Belt sander: A second type of power tool—the belt sander—can also be used for removing limited layers of paint but, in this case, 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 (also with a medium grit sandpaper) should be limited to flat surfaces and only skilled operators should be permitted to operate it within a historic preservation project.

Not Recommended

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 thus to be used exclusively for removing corrosion and paint from metals.

Waterblasting: Waterblasting above 600 p.s.i. 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. A detergent solution, a medium soft bristle brush, and a garden hose for purposes of rinsing, is the gentlest method involving water and is recommended when cleaning exterior surfaces prior to repainting.

Sandblasting: Finally—and undoubtedly 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 potentially the most damaging of all possibilities, even if a contractor promises that blast pressure can be controlled so that the paint is removed without harming the historic exterior woodwork. (For Additional Information, See Preservation Briefs 6, “Dangers of Abrasive Cleaning to Historic Buildings”.)

Summary of Abrasive Methods (Mechanical)

- **Recommended:** Orbital sander, belt sander (skilled operator only).
- **Applicable areas of building:** Flat surfaces, i.e., siding, eaves, doors, window sills.
- **For use on:** Class II and Class III conditions.
- **Health/Safety factors:** Take precautions against lead dust and eye damage; dispose of lead paint residue properly.
- **Not Recommended:** Rotary drill attachments, high pressure waterblasting, sandblasting.

Thermal Methods

Where exterior surface conditions have been identified that warrant total paint removal such as peeling, cracking, or alligatoring, 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 building 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

A heat plate was used on the cornice to remove paint. Photo: NPS files.

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, it is recommended that this implement be used with a single circuit and that a fire extinguisher always be kept close at hand.

Electric heat gun: The electric heat gun (electric hot-air gun) looks like a hand-held hairdryer with a heavy-duty metal case. It has an electrical resistance coil that typically heats 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. It can be used to best advantage when a paneled door was originally varnished, then painted a number of times. In this case, the paint will come off quite easily, often leaving an almost pristine varnished surface behind. Like the heat plate, the heat gun works best on a heavy paint buildup. (It is, however, not very successful on only one or two layers of paint or on surfaces that have only been varnished. The varnish simply becomes sticky and the wood scorches.)

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. Its use is thus more limited than the heat plate, and most successfully used 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, fretwork, or "gingerbread."

The nozzle on the electric heat gun permits hot air to be aimed into cavities on solid decorative surfaces, such as this carriage house door. After the paint has been sufficiently softened, it can be carefully removed with a scraper. Photo: NPS files.

Not Recommended

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, at temperatures between 3200 and 3800 degrees Fahrenheit the open flame is not only capable of burning a careless operator and causing 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, leadbase paints will vaporize at high temperatures, releasing toxic fumes that can be unknowingly inhaled. Therefore, because both the heat plate and the heat gun are generally safer to use—that is, the risks are much more controllable—the blow torch should definitely be avoided!

Summary of Thermal Methods

- **Recommended:** Electric heat plate, electric heat gun.
- **Applicable areas of building:** Electric heat plate—flat surfaces such as siding, eaves, sash, sills, doors. Electric heat gun—solid decorative molding, balusters, fretwork, or "gingerbread."
- **For use on:** Class III conditions.
- **Health/Safety factors:** Take precautions against eye damage and fire. Dispose of lead paint residue properly.
- **Not Recommended:** Blow torch.

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, including:

- 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;
- 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 can involve potential health and safety hazards, no wholehearted recommendations can be made from that standpoint. 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 are capable of softening several layers of paint at a time so that the resulting "sludge"—which should be remembered 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.

However, whether liquid or semi-paste, 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 is recommended 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 needs to be mentioned here because it can actually cause the most 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 prior to repainting or refinishing. Now, it is more difficult to find commercially prepared caustic solutions in hardware and paint stores for homeowner 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, assurances should be given by these companies 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.

Summary of Chemical Methods

- **Recommended, with extreme caution:** Solvent-base strippers, caustic strippers.
- **Applicable areas of buildings:** decorative features, window muntins, doors, exterior shutters, columns, balusters, and railings.
- **For use on:** Class III Conditions.
- **Health/Safety factors:** Take precautions against inhaling toxic vapors; fire; eye damage; and chemical poisoning from skin contact. Dispose of lead residue properly.

General Paint Type Recommendations

Decorative features were painted with a traditional oil-based paint as a part of the rehabilitation. Photo: NPS files.

Based on the assumption 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, it is recommended that for CLASS I and CLASS II paint surface conditions, a top coat of high quality oil paint be applied when repainting. The reason for recommending oil rather than latex paints is that a coat of latex paint applied directly over old oil paint is more apt to fail. The considerations are twofold. First, because oil paints continue to harden with age, the old surface is sensitive to the added stress of shrinkage which occurs as a new coat of paint dries. Oil paints shrink less upon drying than latex paints and thus do not have as great a tendency to pull the old paint loose. Second, when exterior oil paints age, the binder releases pigment particles, causing a chalky surface. Although for best results, the chalk (or dirt, etc.) should always be cleaned off prior to repainting, a coat of new oil paint is more able to penetrate a chalky residue and adhere than is latex paint. Therefore, unless it is possible to thoroughly clean a heavily chalked surface, oil paints—on balance—give better adhesion.

If however, a latex top coat is going to be applied over several layers of old oil paint, an oil primer should be applied first (the oil primer creates a flat, porous surface to which the latex can adhere). After the primer has thoroughly dried, a latex top coat may be applied. In the long run, changing paint types is more time consuming and expensive. An application of a new oil-type top coat on the old oil paint is, thus, the preferred course of action.

If CLASS III conditions have necessitated total paint removal, there are two options, both of which assure protection of the exterior wood: (1) an oil primer may be applied followed by an oil-type top coat, preferably by the same manufacturer; or (2) an oil primer may be applied followed by a latex top coat, again using the same brand of paint. It should also be noted 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.

Summary and References

The recommendations outlined in this Brief are cautious because at present there is no completely safe and effective method of removing old paint from exterior woodwork. This has necessarily eliminated descriptions of several methods still in a developmental or experimental stage, which can therefore neither be recommended nor precluded from future recommendation. With the ever-increasing number of buildings being rehabilitated, however, paint removal technology should be stimulated and, in consequence, existing methods refined and new methods developed which will respect both the historic wood and the health and safety of the operator.

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This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical

Preservation Services (TPS), National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

September 1982

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1.1.2.2 Removing paint from wood surfaces (GSA 2017a)

Supplemental Guidelines For Removing Paint From Interior And Exterior Wood Surfaces

Procedure code:

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Source:

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Division:

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This standard identifies the causes of paint failure on wood surfaces and provides basic guidelines for deciding to what extent deteriorated paint layers should be removed. This procedure should be used in conjunction with "Chemically Removing Paint from Wood Features", and "Removing Paint from Wood Features Using Thermal Methods".

General

- Exterior surfaces are painted both for aesthetics and for protection. Paint protects the wood substrate from ultraviolet degradation due to sunlight exposure and rotting due to excess moisture.
- Interior wood surfaces are usually painted for decorative reasons rather than for protection.
- Causes for premature paint failure:
 - Excess moisture in wood causes the wood to swell, breaking the bond between the wood and the paint.
 - Poor surface preparation interferes with the bond between the new paint layer(s) and the substrate.
 - The wrong type of paint used in the wrong way and/or in the wrong place.

Types of Paint Failure

Peeling/Flaking:

Paint may peel for a number of reasons:

- When applied over damp wood, (usually only a problem when water blasting has been used to remove loose paint)
- If painting was begun too soon after heavy rains.

- NOTE: USE A MOISTURE METER TO DETERMINE THE AMOUNT OF MOISTURE IN THE WOOD. MAXIMUM MOISTURE CONTENT IS 14%.
- When excessive moisture inside the wall migrates to the outside. The moisture may come from poorly vented bathrooms, kitchens, and laundries, or leaky gutters and flashing, or broken plumbing; or lack of an adequate vapor barrier. When applied to a dirty or greasy surface. The paint will not adhere and will cause intercoat peeling. The new paint film will simply peel off leaving the bottom paint layers intact. This is especially a problem:
 - under roof eaves and other protected areas not readily washed by rain.
 - When sanding it.
 - When an incompatible top coat is used.
 - When the top coat is applied more than two weeks after the surface was painted with an oil-based primer. A soap-like material forms on the surface of the primer which needs to be scrubbed off with detergent and water before the top coat is applied. If the surface is not scrubbed clean, the top coat will peel.
- If the existing thickness of paint layers has reached or exceeded 16 mils and additional layers of paint have been added. Paint film thickness at 16 mils or more is said to have reached its saturation point. Additional layers of paint cause peeling for a number of reasons:
 - The thick paint layers are less permeable to water vapor. Since the moisture cannot evaporate, pressure builds up behind the paint and peeling or blisters result.
 - The individual layers of paint can no longer expand and contract at the same rate and the older, more brittle layers fail resulting in peeling and cracking.
- When exterior wooden elements have exposed end grain. Water absorbed in these areas causes the wood to swell, which loosens the bond between the wood and the paint.
 - Susceptible areas include the ends of clapboard where they meet door and window trim or corner boards, butt and miter joints of clapboard and other trim pieces, and porch floor boards.
- When water becomes trapped inside exterior hollow wooden elements such as columns or built-up fence newels, and adequate ventilation is not provided. Water vapor trapped inside can condense and settle at the base of the element, creating ideal conditions for rot.
- When the surface has not been adequately washed. This is especially a problem if latex paint is applied over calcimine paint which is water soluble.
- When protected areas are not readily washed by rain, causing dirt to accumulate on the surface. The dirt may have a tendency to attract and hold moisture against the building.
 - The prolonged presence of moisture, combined with the lack of sunlight, can cause the top layer of paint to expand and contract more frequently than the lower layers, often resulting in a breaking of the bond between the paint layers and the wood substrate.
 - Protected areas to watch include eaves, soffits, tops of walls, or areas protected by trees and other vegetation.
- If the species of wood used in construction is not suited dimensionally to provide the least amount of stress on the paint film, given the expansion and contraction rates associated with normal changes in relative humidity. For example, edge-grain, or quarter-sawn, softwoods are more dimensionally stable than flat sawn boards, warping and shrinking less. This places less stress on the paint film, thereby reducing the likelihood of cracking and peeling.

Blisters:

Blisters may occur for several reasons:

- If the paint was applied in direct sunlight. The paint film forms a skin before the thinners of the paint have had a chance to evaporate and a blister forms. Usually a sound layer of paint is visible when the blister is split open.
- When paint has reached its saturation point as described above, or when paint has been applied to a wet surface. Usually bare wood is visible when the blister is split open.

- If a primer containing zinc oxide, or a finish coat containing zinc oxide without a proper prime coat is used. Zinc oxide is hydrophilic, meaning it has a strong affinity for water and will readily absorb moisture.

Crazing and Cracking:

Crazing and cracking usually occur:

- When old, thick layers of paint can no longer expand and contract at the same rate as the wood substrate. Initially, only the top layers are affected. However, as water gets into these fine, hairline cracks, they eventually deepen and widen to form major cracks.

Alligatoring:

Alligatoring is an advanced stage of cracking where the deteriorated paint film takes on the appearance of alligator skin. It may occur:

- When a top coat is applied over a glossy paint surface that has not first been roughened to provide a proper "tooth" for the new paint film.

Wrinkling:

Wrinkling is when the top layer of paint moves, or dries, while the paint underneath is also still drying, and also still moving, but at a different rate. This may occur:

- When the top coat is applied too thickly or not fully brushed out, allowing the top of the paint film to dry before the bottom of the film dries.
- When the second coat is applied before the first coat has had a chance to dry.
- If the paint is applied in hotter weather than the manufacturer recommends. High temperatures cause the top of the paint film to dry too quickly, before the bottom of the film has had a chance to dry.

Mildew:

Mildew is likely to occur:

- On damp paint films.
- On crazed, cracked or peeling paint surfaces. Paint layers that are crazed and cracked are cracks.

Note: Painting over mildew without first killing it will not solve the problem. Mildew will just grow through the new paint. A sunny South or West facade is no guarantee that mildew will not grow.

Deciding When and How Much Paint to Remove

General:

It is important when making the decision to remove paint to determine why the paint is to be removed, because to do so is a time consuming and expensive job. (If the decision is made to remove all of the paint, samples of the existing paint layers should be taken to document and identify the paint colors used throughout the history of the building. A section of the existing paint film, located in an inconspicuous area, should be left alone and covered to allow for future study.)

- Paint should be removed when it has built up to the point of obscuring decorative details.
- Selective paint removal is also often done to expose a previous decorative finish such as graining or stenciling, or to restore a varnished or shellacked finish.
- The finish color and gloss should be consistent with the original finish treatment. Do not clear finish historic woodwork that was originally painted. Match new paint to historic paint color and gloss level as identified by qualified architectural conservator.

Peeling/Flaking:

- For wholesale peeling and/or paint which has reached its saturation point:
 - Remove all of the paint before repainting.
- For localized paint failure:
 - Remove only the affected layers of paint.
 - Sand the edges of the sound paint to provide a smooth transition between the old and the new.
 - Spot prime the area and repaint as required and as described in procedure "Epoxy Repair For Deterioration And Decay In Wooden Members", "Surface Preparation For Painting Wood" and "General Guidelines for Painting Exterior and Interior Surfaces".

Blisters:

For solvent blisters, or those where sound layers of paint are still visible under the blister:

- Remove only the failed layers of paint. It is usually not necessary to remove paint to the bare wood.
- Spot prime and repaint as required and as described in procedure "Epoxy Repair For Deterioration And Decay In Wooden Members", "Surface Preparation For Painting Wood" and "General Guidelines for Painting Exterior and Interior Surfaces".

For localized water blisters:

- Treat as for solvent blisters above if the surrounding paint is sound.
- For localized water blisters in conjunction with massive peeling of thick layers of paint:
 - Remove all of the paint.
 - Prime and repaint as required and as described in procedure "Epoxy Repair For Deterioration And Decay In Wooden Members", "Surface Preparation For Painting Wood" and "General Guidelines for Painting Exterior and Interior Surfaces".

Cracking and crazing:

- For surface crazing:
 - Sand the paint film only as necessary to remove the crazed layers of paint.
 - Repainting may or may not be necessary.
- For cracking that reveals bare wood or a dark varnished or shellacked surface:
 - Completely remove all paint.

- Prime and repaint as required and as described in procedure "Epoxy Repair For Deterioration And Decay In Wooden Members", "Surface Preparation For Painting Wood" and "General Guidelines for Painting Exterior and Interior Surfaces".

Wrinkling:

- For wrinkles in paint surfaces:
 - Sand the surface to the next unwrinkled layer.
 - Repaint as required and as described in procedure "Epoxy Repair For Deterioration And Decay In Wooden Members", "Surface Preparation For Painting Wood" and "General Guidelines for Painting Exterior and Interior Surfaces".

Alligatored:

- For paint that has alligatored to form deep cracks:
 - Completely remove all of the paint.

Prime and repaint as required and as described in procedure "Epoxy Repair For Deterioration And Decay In Wooden Members", "Surface Preparation For Painting Wood" and "General Guidelines for Painting Exterior and Interior Surfaces".

Mildew:

- For mildew growth:
 - Wash with a solution of bleach to kill the mildew. If the surface is also dirty, adding TSP if allowed by applicable law/regulation, or use appropriate substitute cleaner to the bleach solution will aid in the cleaning process.
- For mildew associated with cracks in the paint film or other type of paint deterioration:
 - Treat the paint film as directed above for complete paint removal and repaint as required and as described in procedure "Epoxy Repair For Deterioration And Decay In Wooden Members", "Surface Preparation For Painting Wood" and "General Guidelines for Painting Exterior and Interior Surfaces".

Paint Removal Techniques

- Paint removal is achieved through a variety of means:
 - Thermal methods, such as heat plates and heat guns; See procedure 06400-09-R, "Removing Paint from Wood Features Using Thermal Methods" for guidance.
 - Abrasive methods, such as by hand or with an orbital sander; See procedure "Surface Preparation For Painting Wood", "Procedures for Painting Wood Features" for guidance.
 - Chemical methods; See procedure "Chemically Removing Paint from Wood Features", "Chemically Removing Paint from Wood Features" for guidance.
 - Applications of the above methods should be reviewed in accordance with the Secretary of the Interior's "Standards for Rehabilitation Projects."

1.1.2.3 Replacing deteriorated woodwork (GSA 2017b)

U.S. General Services Administration

Replacing Deteriorated Woodwork

Procedure code:

6400155

Source:

National Capitol Region Specifications

Division:

Concrete

Section:

Architectural Woodwork

Last Modified:

02/24/2017

PART 1---GENERAL

1.01 SUMMARY

- A. This procedure includes guidance on wood restoration work including repairing existing woodwork by removing damaged or deteriorated material and replacing with new to match existing.
- B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
1. Safety Precautions
 2. Historic Structures Precautions
 3. Submittals
 4. Quality Assurance
 5. Delivery, Storage and Handling
 6. Project/Site Conditions
 7. Sequencing and Scheduling
 8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 REFERENCES

- A. AWI Quality Standard: Comply with applicable requirements of Architectural Woodwork Standards, published by the Architectural Woodwork Institute (www.AWI.net), except as otherwise indicated.

1.03 SYSTEM DESCRIPTION

- A. Performance Requirements: Submit written program for each phase of restoration process including protection of surrounding materials on building during operations. Describe in detail materials, methods and equipment to be used for each phase of restoration work.

1.04 QUALITY ASSURANCE

- A. Mock-Ups: Prior to start of wood restoration work, prepare the following sample panels in building where directed by RHPO. Obtain RHPO's acceptance of visual qualities before proceeding with the work. Retain acceptable panels in undisturbed condition, suitably marked, during construction as a standard for judging completed work.
1. Wood Repair: Prepare sample panels for each type of woodwork indicated to be patched, resurfaced, modified or replaced. Prepare mock-up panels on existing woodwork to demonstrate quality of materials and workmanship.

1.05 PROJECT/SITE CONDITIONS

- A. Existing Conditions:
1. Installer shall advise Contractor of temperature and humidity requirements for woodwork installation areas. Do not install woodwork until required temperature and relative humidity have been stabilized and will be maintained in installation areas.
 2. Maintain temperature and humidity in installation area as required to maintain moisture content of installed woodwork within a 1.0 percent tolerance of optimum moisture content, from date of installation through remainder of construction period. The fabricator of woodwork shall determine optimum moisture content and required temperature and humidity conditions.
 3. Determine that surfaces to which finishes are to be applied are even, smooth, sound, clean, dry and free from defects affecting proper application. Correct or report defective surfaces to Contracting Officer.

PART 2---PRODUCTS

2.01 MATERIALS

- A. New or Replacement Materials:
1. Wood Moisture Content: Provide kiln-dried lumber with an average moisture content range of 6% to 11% for interior work. Maintain temperature and relative humidity during fabrication, storage and finishing operations so that moisture content values for woodwork at time of installation do not exceed the above range.
 2. Replacement Wood: Match species, grade, grain pattern, and other special characteristics of existing woodwork.
- B. Clean, soft cloths

PART 3---EXECUTION

3.01 PREPARATION

A. Surface Preparation:

1. Condition woodwork to average prevailing humidity conditions in installation areas prior to installing.
2. Back prime woodwork on all surfaces which will be concealed with one coat of wood primer. Schedule delivery to allow time for application and drying of Back prime coat before installation of woodwork.
3. Remove miscellaneous hardware, nails, etc., from all existing woodwork as required to provide a first class installation of new or replacement woodwork.
4. Prior to installation of new architectural woodwork, examine shop fabricated work for completion, and complete work as required, including back priming and removal of packing.

3.02 ERECTION, INSTALLATION, APPLICATION

- A. Carefully remove at locations indicated any damaged or deteriorated woodwork. Unless indicated otherwise, replace the entire length of the existing damaged piece to the next butt joint.
- B. For partial replacement of existing pieces, use a neat, well-fitted level cut with grain aligned in transparent finished wood.
- C. Install new pieces as described below:
 1. Install the work plumb, level, true and straight with no distortions. Shim as required using concealed shims.
 2. Cut to fit unless specified to be shop-fabricated or shop-cut to exact size. Where woodwork abuts other finished work, scribe and cut for accurate fit. Before making cutouts, drill pilot holes at corners.
 3. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns, miter at corners, and comply with Quality Standards for joinery.
 4. Anchor woodwork to anchors or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fasteners heads are required, use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork, and matching final finish where transparent finish is indicated.
- D. Finish replacement woodwork to match adjacent woodwork surfaces. See 06400-05-R and 06400-10-R for guidance.

3.03 ADJUSTING/CLEANING

- A. Upon completion of this work, all floors, walls, and other adjacent surfaces that are stained, marred, or otherwise damaged by work under this section shall be cleaned and repaired and all work and the adjacent areas shall be left in a clean and perfect condition.
- B. All completed work shall be adequately protected from damage by subsequent building operations and effects of weather. Protection shall be by methods recommended by the manufacturer of installed materials and as approved by the RHPO.
- C. Repair damaged and defective woodwork wherever possible to eliminate defects functionally and visually; where not possible to repair properly, replace woodwork. Adjust joinery for uniform appearance.
- D. Clean woodwork: Dust and damp wipe woodwork with a soft cloth dampened in clean water; dry rub with soft cloth to maintain the polish, rubbing along the grain of the wood.
- E. Stain and Spot Removal:
 1. Stains may be cleaned by prompt damp wiping with cloth dampened in clear water or rubbing with cloth dampened in solvent. Dry the wood with a soft cloth.
 2. White spots may be removed by rubbing them with a small amount of linseed oil.

1.1.2.4 Repairing water-damaged woodwork (GSA 2015)

Repairing Water-Damaged Woodwork

Procedure code:

640011S

Source:

National Capitol Region Specifications

Division:

Concrete

Section:

Architectural Woodwork

Last Modified:

06/09/2015

PART 1---GENERAL

1.01 SUMMARY

- A. This procedure includes guidance on repairing woodwork stained from minor water damage.
- B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
 - 1. Safety Precautions
 - 2. Historic Structures Precautions
 - 3. Submittals
 - 4. Quality Assurance
 - 5. Delivery, Storage and Handling
 - 6. Project/Site Conditions
 - 7. Sequencing and Scheduling
 - 8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

PART 2---PRODUCTS

2.01 MATERIALS

- A. Wood stain
- B. Wood bleach: Solution of sodium perborate, hydrogen peroxide or proprietary mixture suitable for oak.
- C. Wood filler, colored to match wood
- D. Sandpaper: Extra fine grit
- E. Mild cleaner such as "Murphy's Oil Soap" or approved equal.

PART 3---EXECUTION

3.01 PREPARATION

- A. Surface Preparation:
 - 1. Mask all adjacent surfaces and protect other exposed surfaces in the work area.
 - 2. Fill any splits in existing wood and sand smooth prior to sealer application.

3.02 ERECTION, INSTALLATION, APPLICATION

- A. Select an inconspicuous area on which to test materials and application for each method type required. Test area must be approved by the Contracting Officer.
- B. After each test area has been prepared, receive approval from the Contracting Officer before commencing general application.
- C. Check area with a moisture meter to verify that wood does not have moisture on surface.
- D. Sand stained areas to bare wood.
- E. If bare wood is stained, apply wood bleach to remove stain. Minimize flow of bleach onto areas not stained. Allow to dry and sand wood lightly to remove chemical residue.
- F. Fill wood if required and apply stain of color to match existing.

3.03 ADJUSTING/CLEANING

- A. Wash woodwork with mild detergent and water.
- B. Dry immediately with clean cloth.
- C. . Finish to match historic finish.

1.1.2.5 Cleaning and refinishing of woodwork (GSA 2017c)

U.S. General Services Administration

Cleaning And Refinishing Of Woodwork

Procedure code:

640005S

Source:

National Capitol Region Specifications

Division:

Wood and Plastics

Section:

Architectural Woodwork

Last Modified:

07/28/2017

PART 1---GENERAL

1.01 SUMMARY

- A. This procedure includes guidance on cleaning and refinishing both shellacked and varnished woodwork.
- B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
 - 1. Safety Precautions
 - 2. Historic Structures Precautions
 - 3. Submittals
 - 4. Quality Assurance
 - 5. Delivery, Storage and Handling
 - 6. Project/Site Conditions
 - 7. Sequencing and Scheduling
 - 8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 SUBMITTALS

- A. Product Data: Submit product data for all materials selected that will be applied to existing woodwork.
- B. Operation and Maintenance Data: Submit a dust control procedure.

1.03 QUALITY ASSURANCE

- A. Field Samples: A sample area shall be restored and serve as a standard of quality in restoration of wood. The sample area will be restored by means of the approved process.
- B. Each sample area must receive the approval of the Contracting Officer before a general application is made.

PART 2---PRODUCTS

2.01 MATERIALS

- A. Wood Stain
- B. Floor Varnish
- C. Shellac
- D. Alcohol
- E. Paste Wax - Proprietary or job-mixed compound containing carnauba, beeswax, cadelilla, or ceresin mixed with turpentine.
- F. Floor Wax
- G. Wood Bleach: Solution of sodium perborate, hydrogen peroxide or proprietary mixture suitable for oak.
- H. Wood Filler
- I. Steel Wool
- J. Sandpaper: Extra Fine Grit.

PART 3---EXECUTION

3.01 PREPARATION

- A. Protection: Mask all adjacent surfaces and protect other exposed surfaces in the work area.
- B. Surface Preparation:
 - 1. Select an inconspicuous area on which to test materials and application for each method type required. Test area must be approved by the Contracting Officer. After each test area has been prepared, receive approval from the Contracting Officer before commencing general application.
 - 2. Fill any split in existing wood and sand smooth prior to sealer application.

3.02 ERECTION, INSTALLATION, APPLICATION

- A. General:
 - 1. Follow manufacturer's application instructions.
 - 2. Final appearance of woodwork must be uniform in all respects.
- B. Refinishing When Removal of Existing Shellac is Required:
 - 1. Coat wood with denatured alcohol. Apply with soft cloth. Scrape up residue as quickly as possible. Repeat application of alcohol until all shellac is removed.
 - 2. Sand smooth.
 - 3. Apply one coat of shellac with soft cloth.

4. Apply mixture of shellac and alcohol with soft cloth and allow to dry overnight.
 5. Apply liberal amount of paste wax with soft cloth and allow to dry.
 6. Buff wood lightly with steel wool.
 7. Buff wood with soft brush.
 8. Polish with soft cloth.
 9. Other processes may be used as long as final results conform to quality standards and give uniform appearance.
- C. Refinishing When Removal of Existing Wax is Required:
1. Rub wood with a soft cloth moistened in turpentine.
 2. Apply liberal amount of paste wax with soft cloth and allow to dry.
 3. Polish wood with soft cloth.
- D. Refinishing Wood Floor:
1. Remove existing finish by sanding two or three times until bare wood is exposed.
 2. Repair scratched or broken boards. Do not replace boards unless approved by the Contracting Officer.
 3. Clean area of dust and sawdust.
 4. Apply stain of same color as existing. Allow to dry overnight.
 5. Apply two coats of floor varnish.
 6. Apply two coats of floor wax.

3.04 ADJUSTING/CLEANING

- A. Wash woodwork with mild detergent and water.
- B. Dry immediately with clean cloth.
- C. Apply a liberal amount of paste wax and allow to dry.

1.1.3 Preservation and rehabilitation guidelines for wood millwork

According to *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, the proper procedure for preservation and rehabilitation is to respect the significance of the original materials and features, repair and retain them wherever possible, and replace them only when absolutely necessary (Grimmer 2017) .

The following recommendations for care of historic wood millwork are to be thoroughly read and understood before a treatment is specified. Table 1 (preservation) and Table 2 (rehabilitation) contain information excerpted from Grimmer 2017. Any related NPS or GSA guidelines should also be consulted to determine the appropriateness of any treatment.

Table 1. Preservation treatment for wood millwork (Grimmer 2017, 37–40).

Preservation Treatment for Wood Millwork	
RECOMMENDED	NOT RECOMMENDED
Identifying, retaining, and preserving wood features that are important in defining the overall historic character of the building (such as siding, cornices, brackets, window and door surrounds, and steps) and their paints, finishes, and colors.	Altering wood features which are important in defining the overall historic character of the building so that, as a result, the character is diminished. Replacing historic wood features instead of repairing or replacing only the deteriorated wood. Changing the type of finish, coating, or historic color of wood features
Stabilizing deteriorated or damaged wood as a preliminary measure, when necessary, prior to undertaking preservation work.	Failing to stabilize deteriorated or damaged wood until additional work is undertaken, thereby allowing further damage to occur to the historic building.
Protecting and maintaining wood features by ensuring that historic drainage features that divert rainwater from wood surfaces (such as roof overhangs, gutters, and downspouts) are intact and functioning properly. Finding and eliminating sources of moisture that may damage wood features, such as clogged gutters and downspouts, leaky roofs, or moisture-retaining soil that touches wood around the foundation.	Failing to identify and treat the causes of wood deterioration, such as faulty flashing, leaking gutters, cracks and holes in siding, deteriorated caulking in joints and seams, plant material growing too close to wood surfaces, or insect or fungal infestation.
Finding and eliminating sources of moisture that may damage wood features, such as clogged gutters and downspouts, leaky roofs, or moisture-retaining soil that touches wood around the foundation.	
Applying chemical preservatives or paint to wood features that are subject to weathering, such as exposed beam ends, outriggers, or rafter tails.	Using chemical preservatives (such as creosote) which, unless they were used historically, can change the appearance of wood features.
Implementing an integrated pest management plan to identify appropriate preventive measures to guard against insect damage, such as installing termite guards, fumigating, and treating with chemicals. Retaining coatings (such as paint) that protect the wood from moisture and ultraviolet light. Paint removal should be considered only when there is paint surface deterioration and as part of an overall maintenance program which involves repainting or applying other appropriate coatings	Stripping paint or other coatings from wood features without recoating.
Removing damaged or deteriorated paint to the next sound layer using the gentlest method possible (e.g., hand scraping and hand sanding) prior to repainting.	Using potentially-damaging paint-removal methods on wood surfaces, such as open-flame torches, orbital sanders, abrasive methods (including sandblasting, other media blasting, or high-pressure water), or caustic paint-removers. Removing paint that is firmly adhered to wood surfaces.
Using chemical strippers primarily to supplement other methods such as hand scraping, hand sanding, and thermal devices.	Failing to neutralize the wood thoroughly after using chemical paint removers so that new paint may not adhere. Removing paint from detachable wood features by soaking them in a caustic solution which can roughen the surface, split the wood, or result in staining from residual acid leaching out through the wood.
Using biodegradable or environmentally-safe cleaning or paint-removal products.	
Using paint-removal methods that employ a poultice to which paint adheres, when possible, to neatly and safely remove old lead paint.	Using a thermal device to remove paint from wood features without first checking for and removing any flammable debris behind them.
Using thermal devices (such as infrared heaters) carefully to remove paint when it is so deteriorated that total removal is necessary prior to repainting.	Using thermal devices without limiting the amount of time the wood feature is exposed to heat.

(Table continues on next page.)

RECOMMENDED	NOT RECOMMENDED
Using coatings that encapsulate lead paint, when possible, where the paint is not required to be removed to meet environmental regulations.	
Applying compatible paint coating systems to historically-painted wood following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting wood features.
Repainting historically-painted wood features with colors that are appropriate to the building or district.	Using paint colors on historically-painted wood features that are not appropriate to the building or district.
Protecting adjacent materials when working on wood features.	Failing to protect adjacent materials when working on wood features.
Evaluating the overall condition of the wood to determine whether more than protection and maintenance, such as repairs to wood features, will be necessary.	Failing to undertake adequate measures to ensure the protection of wood features.
Repairing wood by patching, splicing, consolidating, or otherwise reinforcing the wood using recognized preservation methods.	Removing wood that could be stabilized, repaired, and conserved, or using untested consolidants, improper repair techniques, or unskilled personnel, potentially causing further damage to historic materials.
<i>The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment Preservation, and should only be considered after protection, stabilization, and repair concerns have been addressed.</i>	
Limited Replacement in Kind	
Replacing in kind (i.e., with wood, but not necessarily the same species) extensively deteriorated or missing components of wood features when there are surviving prototypes, such as brackets, molding, or sections of siding, or when the replacement can be based on documentary or physical evidence. The new work should match the old in material, design, scale, color, and finish	Replacing an entire wood feature, such as a column or stairway, when limited replacement of deteriorated and missing components is appropriate.
	Using replacement material that does not match the historic wood feature.

Table 2. Rehabilitation treatment for wood millwork (Grimmer 2017, 89–92).

Rehabilitation Treatment for Wood Millwork	
RECOMMENDED	NOT RECOMMENDED
Identifying, retaining and preserving wood features that are important in defining the overall historic character of the building (such as siding, cornices, brackets, window and door surrounds, and steps) and their paints, finishes, and colors.	<p>Removing or substantially changing wood features which are important in defining the overall historic character of the building so that, as a result, the character is diminished.</p> <p>Removing a major portion of the historic wood from a façade instead of repairing or replacing only the deteriorated wood, then reconstructing the façade with new material to achieve a uniform or “improved” appearance.</p> <p>Changing the type of finish, coating, or historic color of wood features, thereby diminishing the historic character of the exterior.</p> <p>Failing to renew failing paint or other coatings that are historic finishes.</p> <p>Stripping historically-painted surfaces to bare wood and applying a clear finish rather than repainting.</p> <p>Stripping paint or other coatings to reveal bare wood, thereby exposing historically-coated surfaces to the effects of accelerated weathering.</p> <p>Removing wood siding (clapboards) or other covering (such as stucco) from log structures that were covered historically, which changes their historic character and exposes the logs to accelerated deterioration.</p>
Protecting and maintaining wood features by ensuring that historic drainage features that divert rainwater from wood surfaces (such as roof overhangs, gutters, and downspouts) are intact and functioning properly.	Failing to identify and treat the causes of wood deterioration, such as faulty flashing, leaking gutters, cracks and holes in siding, deteriorated caulking in joints and seams, plant material growing too close to wood surfaces, or insect or fungal infestation.
Applying chemical preservatives or paint to wood features that are subject to weathering, such as exposed beam ends, outriggers, or rafter tails.	Using chemical preservatives (such as creosote) which, unless they were used historically, can change the appearance of wood features.
Implementing an integrated pest management plan to identify appropriate preventive measures to guard against insect damage, such as installing termite guards, fumigating, and treating with chemicals.	
Retaining coatings (such as paint) that protect the wood from moisture and ultraviolet light. Paint removal should be considered only when there is paint surface deterioration and as part of an overall maintenance program which involves repainting or applying other appropriate coatings.	Stripping paint or other coatings from wood features without recoating.
Removing damaged or deteriorated paint to the next sound layer using the gentlest method possible (e.g., hand scraping and hand sanding) prior to repainting.	<p>Using potentially-damaging paint-removal methods on wood surfaces, such as open-flame torches, orbital sanders, abrasive methods (including sandblasting, other media blasting, or high-pressure water), or caustic paint-removers.</p> <p>Removing paint that is firmly adhered to wood surfaces.</p>
Using chemical strippers primarily to supplement other methods such as hand scraping, hand sanding, and thermal devices.	<p>Failing to neutralize the wood thoroughly after using chemical paint removers so that new paint may not adhere.</p> <p>Removing paint from detachable wood features by soaking them in a caustic solution, which may roughen the surface, split the wood, or result in staining from residual acids leaching out of the wood.</p>
Using biodegradable or environmentally-safe cleaning or paint-removal products.	

(Table continues on next page.)

RECOMMENDED	NOT RECOMMENDED
Using paint-removal methods that employ a poultice to which paint adheres, when possible, to neatly and safely remove old lead paint.	
Using thermal devices (such as infrared heaters) carefully to remove paint when it is so deteriorated that total removal is necessary prior to repainting.	Using a thermal device to remove paint from wood features without first checking for and removing any flammable debris behind them. Using thermal devices without limiting the amount of time the wood feature is exposed to heat.
Using coatings that encapsulate lead paint, when possible, where the paint is not required to be removed to meet environmental regulations.	
Applying compatible paint coating systems to historically-painted wood following proper surface preparation.	Failing to follow manufacturers' product and application instructions when repainting wood features.
Repainting historically-painted wood features with colors that are appropriate to the building and district.	Using paint colors on historically-painted wood features that are not appropriate to the building or district.
Protecting adjacent materials when working on other wood features.	Failing to protect adjacent materials when working on wood features.
Evaluating the overall condition of the wood to determine whether more than protection and maintenance, such as repairs to wood features, will be necessary.	Failing to undertake adequate measures to ensure the protection of wood features.
Repairing wood by patching, splicing, consolidating, or otherwise reinforcing the wood using recognized conservation methods. Repair may include the limited replacement in kind or with a compatible substitute material of those extensively deteriorated or missing components of wood features when there are surviving prototypes, such as brackets, molding, or sections of siding.	Removing wood that could be stabilized, repaired, and conserved, or using untested consolidants and unskilled personnel, potentially causing further damage to historic materials. Replacing an entire wood feature, such as a cornice or balustrade, when repair of the wood and limited replacement of deteriorated or missing components is feasible.
Replacing in kind an entire wood feature that is too deteriorated to repair (if the overall form and detailing are still evident) using physical evidence as a model to reproduce the feature or when the replacement can be based on historic documentation. Examples of such wood features include a cornice, entablature, or a balustrade. If using wood is not feasible, then a compatible substitute material may be considered.	Removing a wood feature that is unrepairable and not replacing it, or replacing it with a new feature that does not match. Using substitute material for the replacement that does not convey the same appearance of the surviving components of the wood feature.
Replacing a deteriorated wood feature or wood siding on a <i>primary</i> or other <i>highly-visible</i> elevation with a new matching wood feature.	Replacing a deteriorated wood feature or wood siding on a <i>primary</i> or other <i>highly-visible</i> elevation with a composite substitute material.
<i>The following work is highlighted to indicate that it is specific to Rehabilitation projects and should only be considered after the preservation concerns have been addressed.</i>	
Designing the Replacement for Missing Historic Features	
Designing and installing a replacement masonry feature, such as a step or door pediment, when the historic feature is completely missing. It may be an accurate restoration based on documentary and physical evidence, but only when the historic feature to be replaced coexisted with the features currently on the building. Or, it may be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating an inaccurate appearance because the replacement for the missing masonry feature is based upon insufficient physical or historic documentation, is not a compatible design, or because the feature to be replaced did not coexist with the features currently on the building. Introducing a new wood feature that is incompatible in size, scale, material, or color.

1.1.4 Maintenance / management for wood millwork

All building materials deteriorate with age and exposure to the weather. Through routine inspection and cyclical maintenance, the useful life span of a building and its historic fabric will be greatly increased. Preventive maintenance involves regular inspection of those parts of the building that are most likely to develop problems. Having a checklist for each USMMA building is advised to help the USMMA CRM and maintenance department identify and keep an accurate record or inventory of the building's problems, to facilitate systematic repair and maintenance. Begin early in

project planning to ensure that design scopes, qualifications, and budgets address preservation compliance requirements.

Repair, renovation, and replacement of character-defining features to the USMMA historic district, such as historic wood millwork, **MUST** be coordinated with the NY SHPO. If a character-defining feature has been previously removed or replaced on the contributing building (prior to this report) and as future renovations occur, these features need to be replaced with elements that replicate the original character-defining features of that building. Historic photographs found in *Character-Defining Features of Contributing Buildings and Structures in the United States Merchant Marine Academy Historic District* report (Smith, Enscoe, and Tooker 2014) will help guide this process in coordination with the NY SHPO.

The ideal sequence for proper repainting of wood includes the following steps: cleaning surfaces, light scraping to remove loose and scaling paint, feathering edges, priming any bare wood, and applying two finish coats. In most instances, complete removal of paint prior to repainting is unnecessary and is not recommended. However, complete paint removal may be necessary wherever a heavy buildup of multiple layers of hardened brittle paint, surface crazing or alligatoring, or intercoat peeling or blistering have been observed.

With proper maintenance, an exterior wood element's life span is increased; however, improper maintenance can result in problems and deterioration from water, fungus, mold, and insects. The actual condition of unmaintained exterior wood is generally better than its appearance. In addition, a deteriorated component or area typically does not necessitate replacing or covering all exterior woodwork. In most instances, selective repair or replacement of damaged parts and implementation of a regular maintenance program is all that is required.

The following steps should be taken to manage the preservation of historic wood millwork:

- Conduct semi-annual inspections of all exterior wood elements to verify their condition and determine maintenance needs.
- Look for signs of deterioration, including excessive paint peeling, which might indicate a moisture problem.

- Avoid using power washers that can force water into wall cavities through crevices and damage decorative details.
- Maintain and repaint exterior woodwork on a regular basis.
- Hand scrape and sand wherever possible to avoid removing or damaging decorative details with power tools or burning.
- Repair smaller areas of deterioration by reinforcing or patching as required.
- Repair small cracks with an exterior wood filler, glue, or epoxy.
- Selectively replace deteriorated wood elements when they are beyond repair. The replacement pieces should be the same size, profile, and character as the original.

1.2 Wood doors

Original wood doors are important features on historic buildings. Their spacing contributes to the visual rhythm of the facade, while providing insight into the interior spaces and uses of the building. Their design, craftsmanship, and materials contribute to a property's historic value. Historic solid and paneled wood doors have good thermal properties and should be retained.

Major signs of wood door deterioration include moisture, dry rot, insect damage, splitting, and peeling paint. The causes of deterioration and careful analysis of the door deterioration (supplemented by testing) is vital to the success of any historic wood repair project. Repair of a wood door may consist of either patching the historic material or filling in with new material to match the historic material. If replacement is necessary, duplication of historic materials and details should be as exact as possible to ensure a repair that is functionally and aesthetically acceptable.

1.2.1 Immediate concerns for wood doors

Ensure that frames and doors have proper maintenance, regular painting or other finishing material, and that caulking and weatherstripping are applied as necessary. Wood doors that are repaired and properly maintained will have an extended service life, while also contributing to the historic character of the building. Improper maintenance can cause long-term de-

terioration of wood elements. If deterioration occurs, selective repair or replacement of damaged parts and implementation of a regular maintenance program is often all that is required to retain a historic door.

All the following actions should be taken to avoid deterioration of wood doors:

- Verify that doors fit properly in their frames and joints are tight.
- Verify that thresholds are installed properly.
- Remove thresholds that are deteriorated beyond rehabilitation -and replace with in-kind materials to inhibit water and insect damage.
- Remove damaged or peeling paint to expose the next sound layer by using the gentlest methods possible; then repaint or otherwise refinish the wood element (Figure 7).
- Repair damaged wood and treat as per preservation standards.
- Replace a severely damaged door, if needed, with an in-kind door; consult original plans for specifications (Figure 8).
- Inspect the wood to determine whether repainting is necessary or if cleaning is all that is required.
- Make repairs to wood after cleaning the surface gently, if necessary.
- Maintain undamaged wood doors and reapply paint or stain as needed to prevent the wood from deteriorating (Figure 9 and Figure 10).
- Note the reduced life expectancy of affected or related building materials and/or systems that are left untreated.

Figure 7. Detail of peeling paint above Wiley Hall doorway (ERDC-CERL, 2015).

Figure 8. Consult original plans for door replacement in-kind. Leaving a rotted door unchecked leads to insect and animal infestations and termite damage to other elements of the building (ERDC-CERL, 2015).

Figure 9. Undamaged wood doors, such as those here on Land Hall, should be maintained, and paint or stain reapplied as needed to prevent deterioration (ERDC-CERL, 2015).

Figure 10. Undamaged wood doors, for instance here on American Merchant Marine Museum (Barstow Mansion), should be maintained, and paint or stain reapplied as needed to prevent deterioration (ERDC-CERL, 2012).

1.2.2 Guidelines, briefs, bulletins, and sources for wood doors

In addition to the information contained in this manual, the authors have compiled the following federal resource publications (reproduced here for convenience, with links for online access given in References) to inform managers about standards, guidelines, and procedures for understanding architecture, and caring for, preserving, and rehabilitating historic buildings with emphasis on historic wood doors (see subsections 1.2.2.1–1.2.2.2).

1.2.2.1 Guidance for stripping and refinishing wood doors (GSA 2017d)

Stripping and Refinishing Stained and Varnished Wood Doors

Procedure code:

0821007S

Division:

Finishes

Section:

Wood Doors

Last Modified:

12/11/2017

Stripping and Refinishing Stained and Varnished Wood Doors

PART 1---GENERAL

1.1 SUMMARY

A. This procedure includes guidance on removing varnish build-up on wood doors and refinishing. This includes removing and storing all hardware from doors and reinstalling after the doors have been refinished.

B. Read "General Project Guidelines" along with this specification. These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO). The guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals
4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling
8. General Protection (Surface and Surrounding)

1.2 QUALITY ASSURANCE

A. The intent of refinishing is to restore the color, finish and overall surface uniformity of the historic doors, consistent with the original design intent. A like new appearance is neither expected nor desired.

B. Splotches, streaks, runs or other inconsistencies caused by improper application of finishing products will not be accepted.

C. Regulatory Requirements: Comply with municipal and Federal regulations governing the refinishing operations, chemical waste disposal and scaffolding.

1.3 SUBMITTALS

Samples:

A. Submit sample of wood stain and finish for approval of Contracting Officer.

B. Prepare a sample refinishing area for review of color and finish.

1.4 PROJECT/SITE CONDITIONS

Determine that surfaces to which finishes are to be applied are even, smooth, sound, clean, dry and free from defects affecting proper application. Correct or report defective surfaces to Contracting Officer.

1.5 CAUTIONS

A. Projects involving removal of coatings or use of hazardous chemicals are subject to employee safety and environmental laws governing lead paint disposal and use of volatile organic compounds (VOCs). Specified products may not be permitted or appropriate for all locations.

B. Products containing chemicals known to present health or environmental hazards should be used only as a last resort, where permissible, in accordance with manufacturer's directions and government requirements. Test milder formulations for effectiveness before proceeding to stronger alternatives.

C. Protect adjacent materials from damage or discoloration by cleaning run off. To avoid discoloring stone or driving stains deeper into porous stones, use the products and techniques described herein only for the combinations of dirt/stain and stone specified.

PART 2---PRODUCTS

2.1 MANUFACTURERS

A. Epifanes N.A., Inc.

B. Sherwin-Williams

C. Scotch-Brite (The 3M Company)

D. W.M. Barr & Co.

E. Samax Enterprises, Inc.

F. The Spic and Span Company

2.2 MATERIALS

NOTE: Chemical products are sometimes sold under a common name. This usually means that the substance is not as pure as the same chemical sold under its chemical name. The grade of purity of common name substances, however, is usually adequate for stain removal work, and these products should be purchased when available, as they tend to be less expensive. Common names are indicated below by an asterisk (*).

A. Commercial Stripper such as "KWIK Superfast Paint and Varnish Remover" (W. M. Barr & Co.) "Rock Miracle" (Samax Enterprises, Inc.) or approved equal.

B. Stain: Penetrating, permanent oil-based stain such as "Wood Classics Interior Oil Stain", "Decksapces Exterior Semi-

Transparent Oil Stain" (Sherwin-Williams) or approved equal, colored to match existing interior and exterior wood.

C. Varnish: tung-oil modified phenolic spar varnish such as "Epifanes High Gloss Clear Varnish" (Epifanes N.A., Inc.) or approved equal.

D. Solvent: Mineral spirits, turpentine or denatured alcohol.

E. Mineral Spirits:

1. A petroleum distillate that is used especially as a paint or varnish thinner.
2. Other chemical or common names include Benzine* (not Benzene); Naphtha*; Petroleum spirits*; Solvent naphtha*.
3. Potential Hazards: TOXIC AND FLAMMABLE.
4. Safety Precautions:
 - a. AVOID REPEATED OR PROLONGED SKIN CONTACT.
 - b. ALWAYS wear rubber gloves when handling mineral spirits.
 - c. If any chemical is splashed onto the skin, wash immediately with soap and water.
5. Available from construction specialties distributor, hardware store, paint store, or printer's supply distributor.

F. Turpentine:

1. Typically used as a solvent and thinner.
2. Potential Hazards: TOXIC AND FLAMMABLE.
3. Safety Precautions:
 - a. Work in a well ventilated area.
 - b. Observe safety rules as turpentine is flammable, and the fumes can trip an ionization smoke detection system.
 - c. Store soiled cloths in a metal safety container to guard against spontaneous combustion.
 - d. Available from hardware store or paint store.

G. Denatured Alcohol:

1. Other chemical or common names include Methylated spirit*.
2. Potential hazards: TOXIC AND FLAMMABLE.
3. Available from hardware store, paint store or printer's supply distributor.
4. Denatured alcohol should be a satisfactory substitute for ethyl alcohol for stain removing purposes.

H. Alternative solvent: A mixture of 75% toluene, 24% acetone and 1% butyl acetate.

I. Toluene (C₇H₈):

1. A liquid, aromatic hydrocarbon that resembles benzene but is less volatile, flammable and toxic, and is produced commercially from light oils from coke- oven gas and coal tar and from petroleum, and is used as a solvent, in organic synthesis and an antiknock agent for gasoline.
2. Other chemical or common names include Toluol.

3. Potential hazards: TOXIC AND FLAMMABLE.

4. Available from chemical supply house, hardware store, paint store or printer's supply distributor.

J. Acetone (C₃H₆O):

1. A volatile fragrant flammable liquid ketone used chiefly as a solvent and in organic synthesis.

2. Other chemical or common names include Dimethyl ketone; Propanone

3. Potential Hazards: VOLATILE AND FLAMMABLE SOLVENT

4. Available from chemical supply house or hardware store.

K. Detergent containing trisodium phosphate, such as "Spic and Span Multi-Surface and Floor Cleaner" (The Spic and Span Company), or approved equal.

L. Steel Wool: Grade 000 steel wool.

M. Aluminum oxide sandpaper - 220 grit.

N. Silicon carbide paper - 400 grit.

O. Bronze wool.

P. Sandpaper - 80 and 120 grit.

Q. Shellac burn-in sticks.

R. Tack rag.

S. Clean cotton cloths.

T. Soft, natural bristle brushes.

U. Mild soap.

V. Abrasive pad such as "Scotch-Brite" or approved equal.

PART 3---EXECUTION

3.1 PREPARATION

A. Protection:

1. Make sure work area is well-ventilated and wear protective clothing and rubber gloves.

2. Do not allow smoking in the work area.

3. Place a fire extinguisher for Class B fires at entrances for emergency use.

4. Change clothes as often as necessary to be effective in cleaning.

5. Daily, dispose of all used solutions, finishing products, solvent residue and soiled rags in sealed noncombustible containers to prevent a fire hazard.

6. Protect all surfaces adjacent to wood being refinished.

7. Maintain a healthy level of air circulation within the space being treated. Regularly employ and maintain exhaust fans or other air moving devices to the satisfaction of the Contracting officer's Representative.

8. Curtain off areas being treated from other trades and occupants to prevent fumes from reaching other parts of the

building.

9. Wear appropriate safety devices such as respirators fitted with the correct cartridge, gloves, and other protective clothing.

B. Surface Preparation:

1. Remove all non-original door louvers, panels and transom panels taking care not to damage the remainder of the door, frame or paneling.
2. Replace the non-original elements with new wood which matches the species of the original wood and which matches the detailing of the original millwork.
3. Hardware: Remove existing hardware, door numbers, and other applied elements, and store for reinstallation.
4. Make minor repairs to doors as required:
 - a. Fill holes exceeding 1 inch in diameter with matching Dutchmen. See "Dutchman Repair of Wood Floorboards" for guidance.
 - b. Fill smaller holes with patching compound tinted to match wood. See "Filling of Holes in Wood Veneer Paneling" for guidance.

3.2 ERECTION, INSTALLATION, APPLICATION

A. Strip the existing varnish finish:

1. Wet steel wool with solvent and rub over the doors to remove varnish build-up and smooth out checked surface.
2. Replace soiled steel wool frequently with clean and continue with wiping process until a smooth, even-colored surface is achieved.
 - a. Use no water on wood surface under any circumstances.
 - b. Work only one 4' square area at a time. Work area should be within a comfortable arms reach.
 - c. If solvent affects the stained color of the wood, discontinue use and use an alternative solvent mixture as listed in Section 2.02 Materials.
3. Allow surface to dry thoroughly; no less than 24 hours.

-OR-

1. Apply commercial stripper following manufacturer's instructions.
2. Wash the surface with acetone to remove stripper residue.
3. Lightly sand the surface with 220 grit aluminum oxide sandpaper as needed to remove carbon soiling and finish damage not removed by solvent application.
4. Wipe surface with a tack rag to remove traces of bronze wool, sand and dust prior to applying new finishes.

B. Remove shallow scratches:

1. Lightly sand, in the direction of the grain only, to remove shallow scratches, against the grain sanding, and finish damage not removed by stripper application.
2. Remove scratches using 80 grit sandpaper.
3. Finish using 120 grit sandpaper until smooth surface is attained.

4. Smooth surface sufficiently to ensure uniform stain absorption.

5. Wipe surface with a tack rag to remove traces of steel wool, sand, and dust prior to applying new finishes.

C. Apply the stain:

1. Color mix stain to match original finish.

2. Apply stain to bare wood surfaces using a soft cloth or bristle brush.

3. Allow stain to set as required for proper color match and maximum surface uniformity.

4. Wipe off excess stain by rubbing parallel to the grain with a soft dry cloth.

5. Allow surface to dry for at least 24 hours.

D. Fill deep scratches and gouges with shellac burn-in sticks tinted to match the wood stain.

E. Apply the finish coating:

1. Make sure that surface is clean, level and free of defects. Promptly report to Contractor Officer's Representative any unanticipated conditions which may affect the quality of the finish.

2. Apply 3 coats of varnish using a brush or sprayer to produce a uniform sheen and appearance. 3. Allow each coat to dry for at least 4 hours.

4. Lightly sand with #400 grit silicon carbide paper or rub with fine steel wool between coats.

5. Vacuum surface and wipe with a dry tack rag to remove all grit and dust prior to applying next finish coat.

6. After curing, lightly rub surface with fine steel wool to replicate original finish.

F. Clean hardware:

1. General:

- a. For bronze and stainless steel hardware (door knobs, escutcheon plates, hinges and closers), clean using a mild soap and water.

- b. For stubborn dirt and hard to clean areas, apply detergent with a Scotch-Brite abrasive pad or bristle brush. Rinse thoroughly and buff dry with soft cotton.

- c. Remove grease on closers and hinges with sponge and detergent.

- d. Scrape gently with a non-metallic spatula to remove paint drips.

- e. See also "Cleaning and Polishing Brass-Plate" and "Cleaning and Polishing Solid Brass" for guidance.

2. If required, carefully remove adhesive residue, paint and varnish drips from escutcheon plates using a paint stripper.

- a. Apply with soft cloths.

- b. If necessary, apply light pressure using a natural bristle brush.

3. If necessary, remove adhesive residue from door knobs using a mild solvent.

- a. Test an inconspicuous area to avoid damaging the finish.

- b. DO NOT APPLY SOLVENTS WHICH MAY REMOVE PATINA.

G. Repair locksets:

1. Repair inoperable locksets, reusing original knobs and escutcheons.
2. Where locksets are missing or irreparably damaged, furnish new locksets matching originals. Replicate existing escutcheons in color, sheen, overall configuration, and detailing.
 - a. Conceal existing cutouts, but do not cover portions of door not originally concealed.
 - b. Replicate original knob's finish.

H. Install new closers where missing or irreparably damaged. Furnish closers matching originals in form and finish as closely as possible.

I. Replace glazing as required.

J. Clean glazing as required:

1. Remove adhesive residues, paint splatters, and other soiling using soft cloths and detergent.
2. Use a mild solvent and Scotch Brite pad or bristle brush to remove stubborn residues.
3. Remove paint splatters with solvent or by scraping gently with a razor blade held at a shallow angle.
4. DO NOT USE TOOLS OR CLEANING PRODUCTS WHICH MAY ETCH THE GLASS.

K. Reinstall kickplates and other hardware as required.

L. Remove and repaint louvers to match original as required.

M. Refinish jambs and frames to match original as required.

3.3 ADJUSTING/CLEANING

A. Adjust door to assure proper operation. Replace or rehang doors which are hinge bound and do not swing or operate freely. Replace worn hinge pins with replicates.

B. Refinish or replace job-finished doors damaged during installation.

C. For guidance on the periodic cleaning of woodwork see "Biennial Cleaning and Stain Removal of Woodwork".

END OF SECTION

1.2.2.2 Guidance for replacing damaged wood doors (GSA 2017e)

Replacement Of Damaged Wood Doors

Procedure code:

821003S

Source:

National Capitol Region Specifications - Fed Trade Commiss

Division:

Doors and Windows

Section:

Wood Doors

Last Modified:

05/02/2017

REPLACEMENT OF DAMAGED WOOD DOORS

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on the removal and replacement of deteriorated or damaged wood doors with new to match original historic doors. It also includes the removal, storage and reinstallation of original door hardware.

B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precaution= s
3. Submittals

4. Quality Assurance

5. Delivery, Storage and Handling=

6. Project/Site Conditions

7. Sequencing and Scheduling

8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 REFERENCES

A. Architectural Woodwork Institute (AWI) www.awinet.org

1.03 System Description

A.

1. Architectural Woodwork Standards <http://www.awinet.org/>

2. Take all required field measurements and verify installation conditions for work.

1.04 SUBMITTALS

A. Shop Drawings:

1. Indicate general construction, jointing methods, hardware locations and cut-outs for glazing and vents.

2. Indicate opening identifying symbol (room number), sizes, door type and grade, and show elevation, swing, light and grill cut-out sizes, locations and undercuts.

B. Samples:

1. Submit sectional sample of door construction indicating grade and species.
2. Submit sample of stain and finish for approval of Contracting Officer.

1.05 PROJECT/SITE CONDITIONS:

A. Field Measurements: Take all required field measurements and verify installation conditions for work of this section.

PART 2---PRODUCTS

2.01 MATERIALS

A. Wood doors, premium grade, to match existing species face and edge grain.

2.02 FABRICATION

A. Moisture content shall be 12% maximum at time of fabrication for all wood material.

B. Fabricate doors in accordance with requirements of AWI Quality Standards to match existing in construction and quality.

C. Allowable Tolerances for Fabrications of Doors:

1. Size: Plus or minus 1/16" overall dimensions.
2. Maximum warp: 1/4"
3. Squareness: Length of diagonal measured on face of door from upper right corner to lower left corner

between length of diagonal measured on upper left corner to lower right corner - maximum difference of 1/4".

4. Factory finish thickness: Minimum 1 mil., cured.

5. Show-through (photographing): 1/100" deviation from true plane in any 3" span on door face.

D. Provide doors with minimum 1/2" thick edge strips (Door Stops); often found at 1 inch to 1 1/2 inch wide and 3/8 inch thick.

E. Make cut-outs and provide stops for glass in original locations using profiles matching the original.

F. Bevel strike edge of single acting doors 1/8" (3 mm) in 2" (51 mm).

G. Strike doors to receive hardware. Hardware locations to match its location on original doors.

PART 3---EXECUTION

3.01 PREPARATION

A. Protection: Remove all non-original door louvers, panels and transom panels taking care not to damage the remainder of the door, frame or paneling.

B. Replace the non-original elements with new wood which matches the species of the original wood and which matches the detailing of the original millwork.

3.02 ERECTION, INSTALLATION, APPLICATION

A. Carefully remove existing damaged and altered doors to be replaced and label with location.

B. Remove all hardware from doors and store. New non-compatible hardware should be discarded and replaced with hardware matching the original.

C. Remove all glazing and vents and restore to original condition.

D. Fitting and Machining:

1. Fit doors for width by planing; for height by sawing.

a. 3/8 inch maximum from bottom.

b. 1/8 inch maximum from top.

c. Bevel lock and hinge edges, 1/8" to 2".

2. Machine doors for Hardware.

3. Cut doors for glazing and vents. Cuts in replacement doors shall match size and location of openings cut in original doors.

4. Refinish all job site cut surfaces before final hanging of doors. See 08210-07-R for guidance on refinishing wood doors.

E. Install doors in accordance with requirements of AWI Standard and as indicated.

1. Clearances:

a. Allow maximum of 1/8" at jamb and head for fit doors.

b. Allow maximum of 3/16" over threshold or saddle.

c. Allow maximum of 3/8" over decorative floor coverings.

2. Install, using original hardware in original locations. Replace any damaged, incompatible, or missing hardware with that which is as close as possible to original.

3. Install original glazing and vents in original locations.

3.03 ADJUSTING/CLEANING

A. Replace or rehang doors which are hinge bound and do not swing or operate freely.

B. Refinish or replace job-finished doors damaged during installation.

1.2.3 Preservation and rehabilitation guidelines for wood doors

According to *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, the proper procedure for preservation and rehabilitation is to respect the significance of the original materials and features, repair and retain them wherever possible, and replace them only when absolutely necessary (Grimmer 2017) .

Please refer to Table 1 (preservation) and Table 2(rehabilitation) in the wood millwork section (see subsection 1.1.3) which contain information excerpted from Grimmer 2017 for care of historic wood doors. These are to be read and understood before treatment is specified. Any related NPS or GSA guidelines should also be consulted to determine the appropriateness of any treatment.

1.2.4 Maintenance / management guidelines for wood doors

All building materials deteriorate with age and exposure to the weather. Through routine inspection and cyclical maintenance, the useful life span of a building and its historic fabric will be greatly increased. Preventive maintenance involves regular inspection of those parts of the building that are most likely to develop problems. Having a checklist for each USMMA building is advised to help the USMMA CRM and maintenance department identify and keep an accurate record or inventory of the building's problems, to facilitate systematic repair and maintenance. Begin early in project planning to ensure that design scopes, qualifications, and budgets address preservation compliance requirements.

Repair, renovation, and replacement of character-defining features to the USMMA historic district, such as wood doors, **MUST** be coordinated with the New York State Historic Preservation Officer (NY SHPO). If a character-defining feature has been previously removed or replaced on the contributing building (prior to this report) and as future renovations occur, these features need to be replaced with elements that replicate the original character-defining features of that building (see Figure 11). Historic photographs found in *Character-Defining Features of Contributing Buildings and Structures in the United States Merchant Marine Academy Historic District* (Smith, Enscoe, and Adams 2014) will help guide this process in coordination with the NY SHPO.

Figure 11. Left is an example from a historic drawing (USMMA DPW) depicting the original wood doors and transom versus replacement metal doors and transom on the right (ERDC-CERL, 2013).

Replacement of doors is often proposed because of condition or poor functioning. However, peeling paint, broken glass, and high air infiltration are no indications that doors are beyond their useful lives. These concerns can be addressed through repair and repainting, and replacement is not recommended.

Wood doors that are repaired and properly maintained will have greatly extended service lives while also contributing to the historic character of the building. Original doors should be retained unless they are damaged beyond reasonable repair, and the frame and trim also should be retained as much as is practicable. Damage must be investigated and documented before replacement is considered. If security is a determining factor, steel core doors with wood exteriors can be utilized in place of all-wood doors.

The following actions should be taken to maintain historic wood doors:

- Clean surfaces regularly and remove loose paint prior to reapplication with specification-approved finish.
- Install and/or maintain caulk and weather-stripping prior to reapplication with specification-approved finish.

- Lubricate operable hinges and hardware periodically to extend their life and inhibit corrosion.
- Repair missing hardware or doors with salvage or in-kind material.
- Replace non-original doors and hardware with salvage of in-kind, specification-approved units that are then painted or stained to match original.
- Restore, repair, and reuse original remaining material, including wood frames, surrounds, and thresholds, as much as is practicable.

1.3 Wood windows

The wood and glass in old windows is generally very sturdy and repairable, and these features can last for generations if properly protected and maintained (Figure 12). Windows should be considered significant to a building if they are original, reflect the original design intent for the building, reflect period or regional styles or building practices, reflect changes to the building resulting from major periods or events, and/or they exemplify exceptional craftsmanship or design. Once an evaluation of the significance of the wood window has been completed, it is possible to proceed with planning appropriate treatments, beginning with an investigation of the physical condition of the window (excerpt from Myers 1981 – Preservation Brief #9).

1.3.1 Immediate concerns for wood windows

Many factors such as poor design, moisture, vandalism, insect attack, and lack of maintenance can contribute to window deterioration, but moisture is the primary contributing factor in wood window decay. The sill should be examined to ensure that it slopes downward away from the building and allows water to drain off. Generally, the actions necessary to return a window to “like new” condition fall into three categories: (1) routine maintenance procedures, (2) structural stabilization, and (3) parts replacement.

Whatever the causes of deterioration, a careful analysis of the deterioration, supplemented by testing, is vital to the success of any wood window repair project. Repair of historic wood windows may consist of either patching the historic material or filling in with new material worked to

match the historic material (Figure 14). If replacement is necessary, duplication of historic materials and detailing should be as exact as possible to ensure a repair that is functionally and aesthetically acceptable.

Wood window elements are evaluated as follows:

- All windows should be inspected to see if water is entering around the edges of the frame and, if so, the joints or seams should be caulked to eliminate this danger.
- Glazing putty should be checked for cracked, loose, or missing sections.
- Paint failure is seen in paint blistering, cracking, flaking, and peeling, and these conditions usually identify points of water penetration, moisture saturation, and potential deterioration (Figure 13).
- There is a condition with long-term impact (beyond 5 years).

Figure 12. Undamaged original windows should be maintained, and paint reapplied as needed to prevent the wood from deteriorating and water from infiltrating (ERDC-CERL, 2015).

Figure 13. Peeling paint on wood needs to be scraped and sanded according to the guidelines and then repainted in-kind to inhibit water and insect damage (ERDC-CERL, 2015).

Figure 14. Damaged wood should be replaced with compatible and in-kind material to the original (ERDC-CERL, 2015).

1.3.2 Guidelines, briefs, bulletins, and sources for wood windows

In addition to the information contained in this manual, the authors have compiled the following federal resource publications (reproduced here for convenience, with links for online access given in References) to inform managers about standards, guidelines, and procedures for understanding architecture, and caring for, preserving, and rehabilitating historic buildings with emphasis on historic wood windows (see subsections 1.3.2.1–1.3.2.9).

1.3.2.1 Repairing historic wood windows (Myers 1981 – Preservation Brief #9)

Technical Preservation Services

National Park Service
U.S. Department of the Interior

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PRESERVATION BRIEFS

9

The Repair of Historic Wooden Windows

John H. Myers

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Historic six-over-six windows--preserved. Photo: NPS files.

The windows on many historic buildings are an important aspect of the architectural character of those buildings. Their design, craftsmanship, or other qualities may make them worthy of preservation. This is self-evident for ornamental windows, but it can be equally true for warehouses or factories where the windows may be the most dominant visual element of an otherwise plain building. Evaluating the significance of these windows and planning for their repair or replacement can be a complex process involving both objective and subjective considerations. *The Secretary of the Interior's Standards for Rehabilitation* and the accompanying guidelines, call for respecting the significance of original materials and features, repairing and retaining them wherever possible, and when necessary, replacing them in kind. This Brief is based on the issues of significance and repair which are implicit in the standards, but the primary emphasis is on the technical issues of planning for the repair of windows including evaluation of their physical condition, techniques of repair, and design considerations when replacement is necessary.

Much of the technical section presents repair techniques as an instructional guide for the do-it-yourselfer. The information will be useful, however, for the architect, contractor, or developer on large-scale projects. It presents a methodology for approaching the evaluation and repair of existing windows, and considerations for replacement, from which the professional can develop alternatives and specify appropriate materials and procedures.

Architectural or Historical Significance

Evaluating the architectural or historical significance of windows is the first step in planning for window treatments, and a general understanding of the function and history of windows is vital to making a proper evaluation. As a part of this evaluation, one must consider four basic window functions: admitting light to the interior spaces, providing fresh air and ventilation to the interior, providing a visual link to the outside world, and enhancing the appearance of a building. No single factor can be disregarded when planning window treatments; for example, attempting to conserve energy by closing

up or reducing the size of window openings may result in the use of *more* energy by increasing electric lighting loads and decreasing passive solar heat gains.

Historically, the first windows in early American houses were casement windows; that is, they were hinged at the side and opened outward. In the beginning of the eighteenth century single- and double-hung windows were introduced. Subsequently many styles of these vertical sliding sash windows have come to be associated with specific building periods or architectural styles, and this is an important consideration in determining the significance of windows, especially on a local or regional basis. Site-specific, regionally oriented architectural comparisons should be made to determine the significance of windows in question. Although such comparisons may focus on specific window types and their details, the ultimate determination of significance should be made within the context of the whole building, wherein the windows are one architectural element.

After all of the factors have been evaluated, **windows should be considered significant to a building if they:**

1. are original,
2. reflect the original design intent for the building,
3. reflect period or regional styles or building practices,
4. reflect changes to the building resulting from major periods or events, or
5. are examples of exceptional craftsmanship or design.

Once this evaluation of significance has been completed, it is possible to proceed with planning appropriate treatments, beginning with an investigation of the physical condition of the windows.

Physical Evaluation

The key to successful planning for window treatments is a careful evaluation of existing physical conditions on a unit-by-unit basis. A graphic or photographic system may be devised to record existing conditions and illustrate the scope of any necessary repairs. Another effective tool is a window schedule which lists all of the parts of each window unit. Spaces by each part allow notes on existing conditions and repair instructions. When such a schedule is completed, it indicates the precise tasks to be performed in the repair of each unit and becomes a part of the specifications. **In any evaluation, one should note at a minimum:**

1. window location
2. condition of the paint
3. condition of the frame and sill
4. condition of the sash (rails, stiles and muntins)
5. glazing problems
6. hardware, and
7. the overall condition of the window (excellent, fair, poor, and so forth)

Many factors such as poor design, moisture, vandalism, insect attack, and lack of maintenance can contribute to window deterioration, but moisture is the primary contributing factor in wooden window decay. All window units should be inspected to see if water is entering around the edges of the frame and, if so, the joints or seams should be caulked to eliminate this danger. The glazing putty should be checked for cracked, loose, or missing sections which allow water to saturate the wood, especially at the joints. The back putty on the interior side of the pane should also be inspected, because it creates a seal which prevents condensation from running down into the joinery. The sill should be examined to insure that it slopes downward away from the building and allows water to drain off. In addition, it may be advisable to cut a dripline along the underside of the sill. This almost invisible treatment will insure proper water runoff, particularly if the bottom of the sill is flat. Any conditions, including poor original design, which permit water to come in contact with the wood or to puddle on the sill must be corrected as they contribute to deterioration of the window.

One clue to the location of areas of excessive moisture is the condition of the paint; therefore, each window should be examined for areas of paint failure. Since

Windows are frequently important visual focal points, especially on simple facades such as this mill building. Replacement of the multi-pane windows with larger panes could dramatically alter the appearance of the building. Photo: NPS files.

excessive moisture is detrimental to the paint bond, areas of paint blistering, cracking, flaking, and peeling usually identify points of water penetration, moisture saturation, and potential deterioration. Failure of the paint should not, however, be mistakenly interpreted as a sign that the wood is in poor condition and hence, irreparable. Wood is frequently in sound physical condition beneath unsightly paint. After noting areas of paint failure, the next step is to inspect the condition of the wood, particularly at the points identified during the paint examination.

Each window should be examined for operational soundness beginning with the lower portions of the frame and sash. Exterior rainwater and interior condensation can flow downward along the window, entering and collecting at points where the flow is blocked. The sill, joints between the sill and jamb, corners of the bottom rails and muntin joints are typical points where water collects and deterioration begins. The operation of the window (continuous opening and closing over the years and seasonal temperature changes) weakens the joints, causing movement and slight separation. This process makes the joints more vulnerable to water which is readily absorbed into the endgrain of the wood. If severe deterioration exists in these areas, it will usually be apparent on visual inspection, but other less severely deteriorated areas of the wood may be tested by two traditional methods using a small ice pick.

Deterioration of poorly maintained windows usually begins on horizontal surfaces and at joints, where water can collect and saturate the wood. Photo: NPS files.

An ice pick or an awl may be used to test wood for soundness. The technique is simply to jab the pick into a wetted wood surface at an angle and pry up a small section of the wood. Sound wood will separate in long fibrous splinters, but decayed wood will lift up in short irregular pieces due to the breakdown of fiber strength.

Another method of testing for soundness consists of pushing a sharp object into the wood, perpendicular to the surface. If deterioration has begun from the hidden side of a member and the core is badly decayed, the visible surface may appear to be sound wood. Pressure on the probe can force it through an apparently sound skin to penetrate deeply into decayed wood. This technique is especially useful for checking sills where visual access to the underside is restricted.

Following the inspection and analysis of the results, the scope of the necessary repairs will be evident and a plan for the rehabilitation can be formulated. **Generally the actions necessary to return a window to "like new" condition will fall into three broad categories:**

1. **routine maintenance procedures,**
2. **structural stabilization, and**
3. **parts replacement.**

These categories will be discussed in the following sections and will be referred to respectively as **Repair Class I**, **Repair Class II**, and **Repair Class III**. Each successive repair class represents an increasing level of difficulty, expense, and work time. Note that most of the points mentioned in Repair Class I are routine maintenance items and should be provided in a regular maintenance program for any building. The neglect of these routine items can contribute to many common window problems.

Before undertaking any of the repairs mentioned in the following sections all sources of moisture penetration should be identified and eliminated, and all existing decay fungi destroyed in order to arrest the deterioration process. Many commercially available fungicides and wood preservatives are toxic, so it is extremely important to follow the manufacturer's recommendations for application, and store all chemical materials away from children and animals. After fungicidal and preservative treatment the windows may be stabilized, retained, and restored with every expectation for a long service life.

Repair Class I: Routine Maintenance

Repairs to wooden windows are usually labor intensive and relatively uncomplicated. On small scale projects this allows the do-it-yourselfer to save money by repairing all or part of the windows. On larger projects it presents the opportunity for time and money which might otherwise be spent on the removal and replacement of existing windows, to be spent on repairs, subsequently saving all or part of the material cost of new window units. Regardless of the actual costs, or who performs the work, the evaluation process described earlier will provide the knowledge from which to specify

an appropriate work program, establish the work element priorities, and identify the level of skill needed by the labor force.

The routine maintenance required to upgrade a window to "like new" condition normally includes the following steps:

1. some degree of interior and exterior paint removal,
2. removal and repair of sash (including reglazing where necessary),
3. repairs to the frame,
4. weatherstripping and reinstallation of the sash, and
5. repainting.

These operations are illustrated for a typical double-hung wooden window, but they may be adapted to other window types and styles as applicable.

Historic windows have usually acquired many layers of paint over time. Removal of excess layers or peeling and flaking paint will facilitate operation of the window and restore the clarity of the original detailing. Some degree of paint removal is also necessary as a first step in the proper surface preparation for subsequent refinishing (if paint color analysis is desired, it should be conducted prior to the onset of the paint removal). There are several safe and effective techniques for removing paint from wood, depending on the amount of paint to be removed.

Paint removal should begin on the interior frames, being careful to remove the paint from the interior stop and the parting bead, particularly along the seam where these stops meet the jamb. This can be accomplished by running a utility knife along the length of the seam, breaking the paint bond. It will then be much easier to remove the stop, the parting bead and the sash. The interior stop may be initially loosened from the sash side to avoid visible scarring of the wood and then gradually pried loose using a pair of putty knives, working up and down the stop in small increments. With the stop removed, the lower or interior sash may be withdrawn. The sash cords should be detached from the sides of the sash and their ends may be pinned with a nail or tied in a knot to prevent them from falling into the weight pocket.

Removal of the upper sash on double-hung units is similar but the parting bead which holds it in place is set into a groove in the center of the stile and is thinner and more delicate than the interior stop. After removing any paint along the seam, the parting bead should be carefully pried out and worked free in the same manner as the interior stop. The upper sash can be removed in the same manner as the lower one and both sash taken to a convenient work area (in order to remove the sash the interior stop and parting bead need only be removed from one side of the window). Window openings can be covered with polyethylene sheets or plywood sheathing while the sash are out for repair.

The sash can be stripped of paint using appropriate techniques, but if any heat treatment is used, the glass should be removed or protected from the sudden temperature change which can cause breakage. An overlay of aluminum foil on gypsum board or asbestos can protect the glass from such rapid temperature change. It is important to protect the glass because it may be historic and often adds character to the window. Deteriorated putty should be removed manually, taking care not to damage the wood along the rabbet. If the glass is to be removed, the glazing points which hold the glass in place can be extracted and the panes numbered and removed for cleaning and reuse in the same openings. With the glass panes out, the remaining putty can be removed and the sash can be sanded, patched, and primed with a preservative primer. Hardened putty in the rabbets may be softened by heating with a soldering iron at the point of removal. Putty remaining on the glass may be softened by soaking the panes in linseed oil, and then removed with less risk of breaking the glass. Before reinstalling the glass, a bead of glazing compound or linseed oil putty should be laid around the rabbet to cushion and seal the glass. Glazing compound should only be used on wood which has been brushed with linseed oil and primed with an oil based primer or paint. The pane is then pressed into place and the glazing points are pushed into the wood around the perimeter of the pane.

The final glazing compound or putty is applied and beveled to complete the seal. The sash can be refinished as desired on the inside and painted on the outside as soon as a "skin" has formed on the putty, usually in 2 or 3 days. Exterior paint should cover the beveled glazing compound or putty and lap over onto the glass slightly to complete a weather-tight seal. After the proper curing times have elapsed for paint and putty, the sash will be ready for reinstallation.

After removing paint from the seam between the interior stop and the jamb, the stop can be pried out and gradually worked loose using a pair of putty knives as shown. Photo: NPS files.

This historic double-hung window has many layers of paint, some cracked and missing putty, slight separation at the joints, broken sash cords, and one cracked pane. Photo: NPS files.

Sash can be removed and repaired in a convenient work area. Paint is being removed from this sash with a hot air gun. Photo: NPS files.

While the sash are out of the frame, the condition of the wood in the jamb and sill can be evaluated. Repair and refinishing of the frame may proceed concurrently with repairs to the sash, taking advantage of the curing times for the paints and putty used on the sash. One of the most common work items is the replacement of the sash cords with new rope cords or with chains. The weight pocket is frequently accessible through a door on the face of the frame near the sill, but if no door exists, the trim on the interior face may be removed for access. Sash weights may be increased for easier window operation by elderly or handicapped persons. Additional repairs to the frame and sash may include consolidation or replacement of deteriorated wood. Techniques for these repairs are discussed in the following sections.

The operations just discussed summarize the efforts necessary to restore a window with minor deterioration to "like new" condition. The techniques can be applied by an unskilled person with minimal training and experience. To demonstrate the practicality of this approach, and photograph it, a Technical Preservation Services staff member repaired a wooden double-hung, two over two window which had been in service over ninety years. The wood was structurally sound but the window had one broken pane, many layers of paint, broken sash cords and inadequate, worn-out weatherstripping. The staff member found that the frame could be stripped of paint and the sash removed quite easily. Paint, putty and glass removal required about one hour for each sash, and the reglazing of both sash was accomplished in about one hour. Weatherstripping of the sash and frame, replacement of the sash cords and reinstallation of the sash, parting bead, and stop required an hour and a half. These times refer only to individual operations; the entire process took several days due to the drying and curing times for putty, primer, and paint; however, work on other window units could have been in progress during these lag times.

Following the relatively simple repairs, the window is weathertight, like new in appearance, and serviceable for many years to come. Photo: NPS files.

Repair Class II: Stabilization

The preceding description of a window repair job focused on a unit which was operationally sound. Many windows will show some additional degree of physical deterioration, especially in the vulnerable areas mentioned earlier, but even badly damaged windows can be repaired using simple processes. Partially decayed wood can be waterproofed, patched, built-up, or consolidated and then painted to achieve a sound condition, good appearance, and greatly extended life. Three techniques for repairing partially decayed or weathered wood are discussed in this section, and all three can be accomplished using products available at most hardware stores.

One established technique for repairing wood which is split, checked or shows signs of rot, is to:

1. dry the wood,
2. treat decayed areas with a fungicide,
3. waterproof with two or three applications of boiled linseed oil (applications every 24 hours),
4. fill cracks and holes with putty, and
5. after a "skin" forms on the putty, paint the surface.

Care should be taken with the use of fungicide which is toxic. Follow the manufacturers' directions and use only on areas which will be painted. When using any technique of building up or patching a flat surface, the finished surface should be sloped slightly to carry water away from the window and not allow it to puddle. Caulking of the joints between the sill and the jamb will help reduce further water penetration.

This illustrates a two-part epoxy patching compound used to fill the surface of a weathered sill and rebuild the missing edge. When the epoxy cures, it can be sanded smooth and painted to achieve a durable and waterproof repair. Photo: NPS files.

When sills or other members exhibit surface weathering they may also be built-up using wood putties or homemade mixtures such as sawdust and resorcinol glue, or whiting and varnish. These mixtures can be built up in successive layers, then sanded, primed, and painted. The same caution about proper slope for flat surfaces applies to this technique.

Wood may also be strengthened and stabilized by consolidation, using semirigid epoxies which saturate the porous decayed wood and then harden. The surface of the consolidated wood can then be filled with a semirigid epoxy patching compound, sanded and painted. Epoxy patching compounds can be used to build up missing sections or decayed ends of members. Profiles can be duplicated using hand molds, which are created by pressing a ball of patching compound over a sound section of the profile which has been rubbed with butcher's wax. This can be a very efficient technique where there are many typical repairs to be done. The process has been widely used and

proven in marine applications; and proprietary products are available at hardware and marine supply stores. Although epoxy materials may be comparatively expensive, they hold the promise of being among the most durable and long lasting materials available for wood repair. More information on epoxies can be found in the publication "Epoxies for Wood Repairs in Historic Buildings," cited in the bibliography.

Any of the three techniques discussed can stabilize and restore the appearance of the window unit. There are times, however, when the degree of deterioration is so advanced that stabilization is impractical, and the only way to retain some of the original fabric is to replace damaged parts.

Repair Class III: Splices and Parts Replacement

When parts of the frame or sash are so badly deteriorated that they cannot be stabilized there are methods which permit the retention of some of the existing or original fabric. These methods involve replacing the deteriorated parts with new matching pieces, or splicing new wood into existing members. The techniques require more skill and are more expensive than any of the previously discussed alternatives. It is necessary to remove the sash and/or the affected parts of the frame and have a carpenter or woodworking mill reproduce the damaged or missing parts. Most millwork firms can duplicate parts, such as muntins, bottom rails, or sills, which can then be incorporated into the existing window, but it may be necessary to shop around because there are several factors controlling the practicality of this approach. Some woodworking mills do not like to repair old sash because nails or other foreign objects in the sash can damage expensive knives (which cost far more than their profits on small repair jobs); others do not have cutting knives to duplicate muntin profiles. Some firms prefer to concentrate on larger jobs with more profit potential, and some may not have a craftsman who can duplicate the parts. A little searching should locate a firm which will do the job, and at a reasonable price. If such a firm does not exist locally, there are firms which undertake this kind of repair and ship nationwide. It is possible, however, for the advanced do-it-yourselfer or craftsman with a table saw to duplicate moulding profiles using techniques discussed by Gordie Whittington in "Simplified Methods for Reproducing Wood Mouldings," *Bulletin of the Association for Preservation Technology*, Vol. III, No. 4, 1971, or illustrated more recently in *The Old House*, Time-Life Books, Alexandria, Virginia, 1979.

The repairs discussed in this section involve window frames which may be in very deteriorated condition, possibly requiring removal; therefore, caution is in order. The actual construction of wooden window frames and sash is not complicated. Pegged mortise and tenon units can be disassembled easily, if the units are out of the building. The installation or connection of some frames to the surrounding structure, especially masonry walls, can complicate the work immeasurably, and may even require dismantling of the wall. **It may be useful, therefore, to take the following approach to frame repair:**

1. conduct regular maintenance of sound frames to achieve the longest life possible,
2. make necessary repairs in place, wherever possible, using stabilization and splicing techniques, and
3. if removal is necessary, thoroughly investigate the structural detailing and seek appropriate professional consultation.

Another alternative may be considered if parts replacement is required, and that is sash replacement. If extensive replacement of parts is necessary and the job becomes prohibitively expensive it may be more practical to purchase new sash which can be installed into the existing frames. Such sash are available as exact custom reproductions, reasonable facsimiles (custom windows with similar profiles), and contemporary wooden sash which are similar in appearance. There are companies which still manufacture high quality wooden sash which would duplicate most historic sash. A few calls to local building suppliers may provide a source of appropriate replacement sash, but if not, check with local historical associations, the state historic preservation office, or preservation related magazines and supply catalogs for information.

If a rehabilitation project has a large number of windows such as a commercial building or an industrial complex, there may be less of a problem arriving at a solution. Once the evaluation of the windows is completed and the scope of the work is known, there may be a potential economy of scale. Woodworking mills may be interested in the work from a large project; new sash in volume may be considerably less expensive per unit; crews can be assembled and trained on site to perform all of the window repairs; and a few extensive repairs can be absorbed (without undue burden) into the total budget for a large number of sound windows. While it may be expensive for the average historic home owner to pay seventy dollars or more for a mill to grind a custom knife to duplicate four or five bad muntins, that cost becomes negligible on large commercial projects which may have several hundred windows.

Most windows should not require the extensive repairs discussed in this section. The ones which do are usually in buildings which have been abandoned for long periods or have totally lacked maintenance for years. It is necessary to thoroughly investigate the alternatives for windows which do require extensive repairs to arrive at a solution which retains historic significance and is also economically feasible. Even for projects requiring repairs identified in this section, if the percentage

of parts replacement per window is low, or the number of windows requiring repair is small, repair can still be a cost effective solution.

Weatherization

A window which is repaired should be made as energy efficient as possible by the use of appropriate weatherstripping to reduce air infiltration. A wide variety of products are available to assist in this task. Felt may be fastened to the top, bottom, and meeting rails, but may have the disadvantage of absorbing and holding moisture, particularly at the bottom rail. Rolled vinyl strips may also be tacked into place in appropriate locations to reduce infiltration. Metal strips or new plastic spring strips may be used on the rails and, if space permits, in the channels between the sash and jamb. Weatherstripping is a historic treatment, but old weatherstripping (felt) is not likely to perform very satisfactorily. Appropriate contemporary weatherstripping should be considered an integral part of the repair process for windows. The use of sash locks installed on the meeting rail will insure that the sash are kept tightly closed so that the weatherstripping will function more effectively to reduce infiltration. Although such locks will not always be historically accurate, they will usually be viewed as an acceptable contemporary modification in the interest of improved thermal performance.

Many styles of storm windows are available to improve the thermal performance of existing windows. The use of exterior storm windows should be investigated whenever feasible because they are thermally efficient, cost-effective, reversible, and allow the retention of original windows (see "Preservation Briefs: 3"). Storm window frames may be made of wood, aluminum, vinyl, or plastic; however, the use of unfinished aluminum storms should be avoided. The visual impact of storms may be minimized by selecting colors which match existing trim color. Arched top storms are available for windows with special shapes. Although interior storm windows appear to offer an attractive option for achieving double glazing with minimal visual impact, the potential for damaging condensation problems must be addressed. Moisture which becomes trapped between the layers of glazing can condense on the colder, outer prime window, potentially leading to deterioration. The correct approach to using interior storms is to create a seal on the interior storm while allowing some ventilation around the prime window. In actual practice, the creation of such a durable, airtight seal is difficult.

Window Replacement

Although the retention of original or existing windows is always desirable and this Brief is intended to encourage that goal, there is a point when the condition of a window may clearly indicate replacement. The decision process for selecting replacement windows should not begin with a survey of contemporary window products which are available as replacements, but should begin with a look at the windows which are being replaced. **Attempt to understand the contribution of the window(s) to the appearance of the facade including:**

1. the pattern of the openings and their size;
2. proportions of the frame and sash;
3. configuration of window panes;
4. muntin profiles;
5. type of wood;
6. paint color;
7. characteristics of the glass; and
8. associated details such as arched tops, hoods, or other decorative elements.

Develop an understanding of how the window reflects the period, style, or regional characteristics of the building, or represents technological development.

Armed with an awareness of the significance of the existing window, begin to search for a replacement which retains as much of the character of the historic window as possible. There are many sources of suitable new windows. Continue looking until an acceptable replacement can be found. Check building supply firms, local woodworking mills, carpenters, preservation oriented magazines, or catalogs or suppliers of old building materials, for product information. Local historical associations and state historic preservation offices may be good sources of information on products which have been used successfully in preservation projects.

Consider energy efficiency as one of the factors for replacements, but do not let it dominate the issue. Energy conservation is no excuse for the wholesale destruction of historic windows which can be made thermally efficient by historically and aesthetically acceptable means. In fact, a historic wooden window with a high quality storm window added should thermally outperform a new double-glazed metal window which does not have thermal breaks (insulation between the inner and outer frames intended to break the path of heat flow). This occurs because the wood has far better insulating value than the

metal, and in addition many historic windows have high ratios of wood to glass, thus reducing the area of highest heat transfer. One measure of heat transfer is the U-value, the number of Btu's per hour transferred through a square foot of material. When comparing thermal performance, the lower the U-value the better the performance. According to ASHRAE 1977 Fundamentals, the U-values for single glazed wooden windows range from 0.88 to 0.99. The addition of a storm window should reduce these figures to a range of 0.44 to 0.49. A non-thermal break, double-glazed metal window has a U-value of about 0.6.

Summary and References

Technical Preservation Services recommends the retention and repair of original windows whenever possible. We believe that the repair and weatherization of existing wooden windows is more practical than most people realize, and that many windows are unfortunately replaced because of a lack of awareness of techniques for evaluation, repair, and weatherization. Wooden windows which are repaired and properly maintained will have greatly extended service lives while contributing to the historic character of the building. Thus, an important element of a building's significance will have been preserved for the future.

This publication has been prepared pursuant to the National Historic Preservation Act of 1966, as amended, which directs the Secretary of the Interior to develop and make available information concerning historic properties. Technical Preservation Services (TPS), National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

1981

Reading List

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1.3.2.2 Protecting woodwork against decay (Feist 1984 - Preservation Tech Note 4)

PROTECTING WOODWORK AGAINST DECAY WITHOUT CHEMICAL PRESERVATIVES

The survival of millions of historic wooden windows is a testament to their long useful life. Faced with windows that are beyond repair, however, many owners are reluctant to install wooden replacement windows, in part due to the belief that without constant maintenance the windows will quickly decay. Studies undertaken by the Forest Products Laboratory (FPL), U.S. Department of Agriculture, have convincingly shown that when wooden elements in windows are treated with a water repellent very little decay will occur in the new windows even if many years of maintenance neglect follow. This important finding was an outgrowth of a research project to determine alternatives to potentially toxic chemical wood preservatives.

Problem

When old wooden windows in historic buildings have to be repaired or replaced, it is always advisable to incorporate treatments that will extend the useful life of the new wood. Application of a water-repellent chemical preservative, such as pentachlorophenol, to new wood prior to painting traditionally has been recommended. The toxicity of some formulations, however, pose potential health problems. A treatment to prolong the useful life of the new wood—and therefore the windows—is needed which avoids certain potential health hazards.

Solution

A 20-year test on wooden windows by the FPL in Madison, Wisconsin, has concluded that there is a safer alternative to traditional water-repellent chemical preservatives for treating wood in order to prevent decay. It was found that the easiest way to prevent decay in woodwork items such as frames and sash is the application of small amounts of wax to the surface. The wax, *in the absence of chemical preservatives*, protects the wood from excessive moisture and provides good long-term protection to window units and other wood exposed above ground.

Twenty years ago, test window units at FPL were dipped for 3 minutes in either a solution of water-repellent with a chemical preservative or a water-repellent without chemical preservatives. Some units were left untreated as comparison controls. After only 6 years' exposure on an outdoor test in Madison, the untreated samples were so badly decayed that they fell apart as they were being removed. Figure 1 shows where three of the control (untreated) window units were installed. Figure 2 shows a portion of the untreated window frame and the extensive decay.

A close-up view of the window unit treated with a water-repellent chemical preservative shows how well this unit was protected against decay for 20 years (see figure 3). All test units were painted originally but never repainted. Most paint

PRESERVATION Tech Notes

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D.C.

WINDOWS NUMBER 4

Replacement Wooden Frames and Sash: Protecting Woodwork Against Decay

William C. Feist

Forest Products Laboratory
U.S. Department of Agriculture

Deteriorated architectural features should be repaired rather than replaced wherever possible. In the event replacement is necessary, the new material should match the material being replaced in composition, design, color, texture, and other visual qualities.

Figure 1. View of the test panels showing untreated control window frames in the foreground. Note the dismembered frame at the far right, and long crevices along the sills of the other two—all results of decay. Treated window units can be seen in the background. Photo: Courtesy of the Forest Products Laboratory

was gone from exposed surfaces after 10 to 12 years' exposure. The water-repellent with a chemical preservative treatment was very effective in protecting the window unit long after all the paint had weathered away.

But the most surprising result in the 20-year test was that shown in Figure 4. Window units treated with a simple water repellent (1.5 percent paraffin wax in mineral spirits plus 10 percent exterior varnish resin *with no chemical preservatives*) performed as well as did the water-repellent preservative (which contained both wax and a chemical preservative). This showed that a non-chemical water repellent like paraffin wax with a small amount of resin, such as exterior varnish, was capable of providing protection to wood exposed above ground to the elements for 20 years in a northern climate.

A water-repellent treatment alone can provide excellent decay resistance to outdoor painted woodwork without the addition of a chemical preservative. This can represent a saving of money and resources and judicious avoidance of chemical preservatives in items such as windows, sheds, porch and fence rails, and other above-ground wood products.

The water-repellent treatment is easily done before or after construction and before painting. A simple formula, easily prepared, is:

Exterior varnish	3 cups
Paraffin wax	1 ounce
Mineral spirits	Add to
or paint thinner	make 1
or turpentine	gallon

Treatment is best done by dipping the wood for 1 to 3 minutes in the solution. If dipping is inconvenient, liberal brush application can be made—paying particular attention to heavy treatment of all board ends and joints. The treated surface can be painted after 2 or 3 days of warm weather. In fact, paint should last longer over the treated surface than over untreated wood.

Figure 2. Close-up view of decayed, untreated window frame. Frame fell apart after 6 years' exposure. Photo: Courtesy of the Forest Products Laboratory

Figure 3. Close-up view of the window unit treated with water-repellent chemical preservative after 20 years' exposure. Condition of millwork is very good. Photo: Courtesy of the Forest Products Laboratory

Conclusion

The field test conducted by the Forest Products Laboratory showed that there are safer treatments for protecting woodwork in northern climates than many commonly used. The combination of pretreating and painting provides good long-term protection against decay. Of equal interest, the test showed that there are effective ways to prevent decay in wooden window elements even where the windows are exposed to long periods of maintenance neglect.

In the southeastern states and in the Pacific Northwest where there is a high decay potential due to the combination of higher moisture and moderate to warm temperatures, it is still recommended that wooden windows be treated with both a water-repellent and a chemical preservative. A number of newer, less toxic chemical preservatives are now commonly available and will provide similar long-term protection.

Figure 4. Close-up view of window unit treated with a paraffin-wax water-repellent *without* a chemical preservative. After 20 years' exposure, firm wood resists penetration by the knife blade. Photo: Courtesy of the Forest Products Laboratory

This PRESERVATION TECH NOTE was prepared by the National Park Service in cooperation with the Center for Architectural Conservation, Georgia Institute of Technology. Charles E. Fisher, Preservation Assistance Division, National Park Service, serves as Technical Coordinator for the TECH NOTES. Substantial portions of the text have been reprinted from "Protecting Woodwork Without Preservatives," by William C. Feist, Chemist. We wish to thank the Forest Products Laboratory, Forest Service, U.S. Department of Agriculture for their permission to reprint this material. Special thanks also go to the following people who contributed to the production of this TECH NOTE: John H. Myers, Center for Architectural Conservation, and Preservation Assistance Division staff, particularly Kay D. Weeks, Martha A. Gutrick and Mae Simon.

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ISSN: 0741-9023

PTN-4

January 1984

1.3.2.3 Replacing wood sash and frame (Parrott 1984 – Preservation Tech Notes: Windows 6)

LAWRENCE-WENTWORTH HOUSE

Lowell, Massachusetts

The Lawrence-Wentworth House, originally the home of one of Lowell's antebellum mill owners, has had numerous alterations and changes in use since its construction in 1831. Its original Greek Revival street facade was altered sometime after the Civil War to such an extent that it appears more Victorian than Greek Revival.

Beginning at the turn of the century, the single family residence was converted to a boarding house, a succession of commercial uses, and finally to offices for a social service organization. Sometime during this series of changes, the Victorian double-hung wooden sash on the first floor were replaced with mill finish aluminum jalousies as shown in the above photograph of the rear facade. The Victorian wooden sash, consisting of a two-over-two (2/2) light configuration, survived on the second floor.

After experiencing several years of sizable increases in energy costs, coupled with the inherently poor thermal performance of the jalousie sash on the first floor, the owner, Unitas, Inc., a service organization to Lowell's Hispanic community, came to the Lowell Historic Preservation Commission requesting assistance in replacing these visually obtrusive and thermally inadequate windows.

Design Problem

The Victorian 2/2 sash on the second floor were still in serviceable condition and were already fitted with storm windows. Consideration was therefore given to the installation of 2/2 replacement sash and frames on the first floor that would match the visual qualities of the remaining historic windows and at the same time incorporate the energy efficiency features of double glazing and weather stripping. Another important goal was to reduce cost without altering the appearance of the windows or affecting their performance.

Design Solution

Studies have shown that when treated with a water repellent coating, and properly fabricated and installed, new wood windows will provide long service. Since the exterior wood siding, trim, upper floor windows and painted masonry would all require periodic repainting, this maintenance consideration was not a major factor in the decision to install wooden replacement windows.

A full-scale measured drawing was made of an existing second floor window as a guide in detailing the replacement window. This investigation revealed that the single-glazed 2/2 sash were 1-3/8" thick, and that the entire width of the box frame was exposed on the exterior.

In reaching the decision to install wooden windows, the important techni-

PRESERVATION Tech Notes

NATIONAL PARK SERVICE
U.S. DEPARTMENT OF THE INTERIOR
WASHINGTON, D.C.

WINDOWS NUMBER 6

Replacement Wooden Sash and Frames With Insulating Glass and Integral Muntins

Charles Parrott

Lowell Historic Preservation Commission
U.S. Department of the Interior

Replacement of missing architectural features or insensitive later replacements should be based on accurate duplication of features, substantiated by historic, physical, or pictorial evidence. The composition, design, color, texture and other visual qualities of the historic feature should be matched.

cal issue was the treatment of the vertical muntin in both the upper and lower sash. The narrow appearance of the $\frac{3}{4}$ " muntin in the historic sash presented some problems, since insulating glass was preferred for the new windows and required a wider muntin for proper installation. The alternative of using new single glazed wooden windows, with a separate interior or exterior storm unit added, was less desirable in this case since such windows would be more troublesome to open.

The selected replacement sash were designed to have two individual lights of insulating glass in each sash with an integral (as opposed to a "fake" or applied) muntin. Based on the experience gained by the Lowell Historic Preservation Commission in previous projects, the muntin of the new sash was made only 1" wide, closely matching the appearance of the historic $\frac{3}{4}$ " wide vertical muntins remaining in the upper floor windows (see figure 1). This slight change in muntin width is hardly noticeable. The results might have been different if the old and new sash had existed side by side; if the number of panes had been greater and the panes themselves been smaller; or if the historic muntins had been thinner.

The new sash were made $1\frac{3}{4}$ " thick, an increase of $\frac{3}{8}$ " over the historic sash, in order to allow a sufficiently deep rabbet in which to set the $\frac{7}{16}$ " insulating glass and to provide added support for the double weight of the glass.

Fabrication and Installation

Along with full scale working drawings for the new window, written specifications for both sash and frame fabrication and installation were prepared. These documents were sent to several window shops and installation contractors to obtain separate quotations for fabrication and installation.

The ten new windows were to be delivered fully primed and assembled. Of the ten windows, six were detailed for masonry openings and four for frame openings. No more than two windows were the same size, and there were seven different sizes in all. Only the six principal windows, averaging 21 square feet each, were of 2/2 configuration. Replacements for the four smaller jalousie windows, positioned in less prominent rear or side locations, away from the front of the building, were designed in 1/1 light configuration, but were otherwise identical to the larger windows.

Two types of a commercially-available rigid metal weather stripping, formed

Figure 1. The wooden replacement windows had two individual lights of insulating glass in each sash with an integral (as opposed to "fake") muntin. Drawing: Penelope S. Watson

from rolled zinc sheets, were installed in preference to a less permanent vinyl, foamed plastic, or spring-metal weather stripping. At the heads, jambs and sills, the weather stripping consists of a continuous flange over which fit the grooved rails and stiles. At the meeting rail, the weather stripping consists of two interlocking hooks (see figure 2). The weather stripping protrudes only a short distance above and below the meeting rails along the jambs and is almost totally concealed when the windows are shut. It is extremely durable and is virtually unaffected by corrosion or chemical decomposition.

The sealed insulating glass units, installed in the fabricator's shop, were first caulked with a thin bead of non-hardening water-based (containing no oil) sealant. The sealant was applied at the corner of the glass unit so as not to touch the butyl compound used to seal the edge of the insulating glass (see figure 3). The water-based sealant serves as an important barrier between the separate butyl-seal on the insulating glass and the standard oil-based glazing compound as used in the actual glazing. The oil-based glazing compound was chosen in preference to the standard wood molding strips to provide a cheaper, more flexible and more weather-resistant

glazing. It also matches the historic glazing treatment.

The historic windows in the Lawrence-Wentworth House were balanced in standard fashion with sash weights and pulleys. Since many were missing on the first floor, less costly spiral tube balances were specified for the new windows (see figure 1). The spiral tube balances were attached at their top to the face of the jamb near the top of the window. The longer balance tube for the lower sash, therefore, is visible above the closed lower sash inside the building, just as the sash cord is exposed on a weight balanced sash. The tube balances, however, are not seen from the exterior and their use permitted a more energy efficient window frame. The empty boxes, which would have held the sash weights, were filled with insulation; air infiltration was further reduced since there were no pulley mortises in the frame.

The spiral balances also allowed the use of a less expensive L-shaped, shop-fabricated frame, and the look of the historic box frame was accomplished with masonry-anchored nailers, steel framing clips, and flat interior casing stock (see figure 1).

The new wooden frame was thus identical in appearance to the historic frame on the building. The width of the historic frame was reproduced along with the wooden brick molding used to trim the exterior of the masonry openings (see figure 4).

Figure 2. Several types of zinc weather stripping were used. Drawing: Penelope S. Watson

Project Costs

The ten windows were fabricated to specification, including such features as wood preservative treatment and sash locks, for \$2520 (\$13.40 per square foot).

The installation work, undertaken in 1983, included preparation of the window openings; installation of the windows and interior stops; and the attachment of exterior brick molding and all interior trim, which had been selected from flat or molded stock. Priming unprimed elements and caulking were also included in the installation work, which totaled \$1800 (\$9.52 per square foot).

Total cost of the ten windows less finish painting, which was done as part of the general exterior repainting, was \$4320 (\$22.92 per square foot). Wooden frame half screens mounted on the interior and set in aluminum tracks were also furnished and installed for a total of \$490 for the ten windows.

Project Evaluation

The window work on the Lawrence-Wentworth House shows the practicality of replacing windows on a selective basis. In replacing only the first floor windows, significant cost savings were achieved and the 2/2 Victorian windows on the second floor were saved. This project clearly shows that energy conservation and other cost-reducing measures can be achieved in replacement windows that reproduce the visual qualities of the historic windows. The use of spiral balances and insulating glass, the increase in the sash thickness, modifications to the box frames, and the slight widening of the integral wood muntin were accomplished in a sensitive way in keeping with the Secretary of the Interior's "Standards for Rehabilitation." This approach has limitations, especially when dealing with very thin historic muntins, where to accommodate the weight of insulating glass and for suitable glazing, the width of the muntin would have to be increased substantially. In many cases, however, involving two- and four-light sash, this application can be adopted without perceptibly increasing the width of the muntin or diminishing the historic character of the window.

Figure 3. Glazing detail shows how the non-hardening water-based glazing sealant was used to separate the butyl compound (used to seal the insulating glass) from the oil-based glazing compound. Drawing: Penelope S. Watson

Figure 4. The new wooden windows on the first floor with insulating glass installed closely matched the historic windows which were preserved on the upper floor. Photo: Charles Parrott

PROJECT DATA

Building:

Lawrence-Wentworth House
48 Lawrence Street
Lowell, Massachusetts

Owner:

Unitas Inc.
48 Lawrence Street
Lowell, Massachusetts

Project date: Early 1983

Design Staff:

Lowell Historic Preservation
Commission
204 Middle Street
Lowell, Massachusetts

Fabrication:

The Window Shop
250 Chandler Street
Worcester, Massachusetts

Materials:

Weather Stripping-
Southern Metal Products
3950 Swinner Road
Memphis, Tennessee
Sash Balances-
Caldwell Manufacturing Company
64 Commercial Street
Rochester, New York
Sealed Insulating Glass-
Economy Glass Corp.
315 Columbus Avenue
Boston, Massachusetts

Project Costs:

The fabrication cost, including priming, of the 10 windows (7 different sizes) was \$2520 (\$13.40 per square foot); installation cost was \$1800 (\$9.52 per square foot); total cost was \$4320 (\$22.92 per square foot).

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PTN-6

January 1984

1.3.2.4 Rehabilitating wood windows (GSA 2017f)

Rehabilitating Wood Windows

Procedure code:

861001S

Source:

The Old Custom House/New York, Ny - Gsa/Pbs, 1991

Division:

Doors and Windows

Section:

Wood Windows

Last Modified:

07/05/2017

PART 1---GENERAL

1.01 SUMMARY

- A. This procedure includes guidance for the rehabilitation of wood windows. Outlined are the steps one might go through to complete repairs. Each step is cross-referenced to one or more procedures which covers the particular problem. The cross-referenced procedures should be reviewed prior to beginning window repairs and should be followed along with recommendations from the Regional Historic Preservation Officer (RHPO).
- B. The steps in the repair of deteriorated sash include but are not limited to the following:
 - 1. Examination, survey and condition assessment of windows.
 - 2. Removal of existing sash, trim, etc.
 - 3. Repair of deteriorated wood through the use of epoxies, dutchmen and/or the replacement with new wood to match the existing appearance.
 - 4. Painting/refinishing sash and trim.
 - 5. Installation of repaired sash.
- C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
 - 1. Safety Precautions
 - 2. Historic Structures Precautions
 - 3. Submittals
 - 4. Quality Assurance
 - 5. Delivery, Storage and Handling
 - 6. Project/Site Conditions
 - 7. Sequencing and Scheduling

8. General Protection (Surface and Surrounding)

These guidelines should be reviewed before performing this procedure and should be followed, when applicable, along with recommendations from the RHPO.

- D. For general information on the repair of wood windows see 08610-01-S, "Preservation Briefs: 9 - The Repair of Historic Wooden Windows."

1.02 SUBMITTALS

- A. Shop drawings for each type of window, including 1/4-inch scale wall elevations, typical unit elevations at 3/4- inch scale, glazing details, and full-size details of typical composite members, include window rehabilitation, wood and hardware replacement, reglazing details and weatherstripping.
- B. The RHPO reserves the right to require additional samples that show fabrication techniques and construction and design of hardware and accessories.

1.03 SEQUENCING AND SCHEDULING

- A. Rehabilitation of windows shall be completed before doing any interior restoration/rehabilitation work to insure weather-tight integrity of interior spaces.

PART 2---PRODUCTS

2.01 MATERIALS

NOTE: See specific procedures for materials and equipment requirements, and their manufacturers and sources.

PART 3---EXECUTION

3.01 EXAMINATION

- A. Conduct a window-by-window survey to determine existing conditions and identify the specific work needs of each window.
- B. For each window type, the survey should include color photographs which show design details for comparison to new work, and existing conditions.
1. Full frame views, both interior and exterior.
 2. Close-up views of typical details, both interior and exterior.

3.02 ERECTION, INSTALLATION, APPLICATION

- A. Carefully remove window stops, sash and trim as required. Remove only those features which cannot be repaired on-site. All disassembled parts should be indelibly marked or stamped on hidden parts so they can be returned to their exact location.
1. See 06440-03-R, "Closing Open Joints in Wood Wall Ornament"

- B. Replace rotted window sills as required.
 - 1. See 08610-04-R, "Replacing a Wood Window Sill"
- C. Repair, replace, or rebuild all rotted or deteriorated wood features. These can include but are not limited to stiles, rails, muntins, joints, frame, trim. New work shall match existing profiles or shapes in every respect and shall be flush with existing adjacent surfaces.
 - 1. See 06300-01-R, "Epoxy Repair for Deterioration and Decay in Wooden Members"
 - 2. See 08611-01-R, "Sealing Leaky Wood Double-Hung Windows"
 - 3. See 06440-01-R, "Repairing Cracks and Checks in Wood Wall Ornament"
 - 4. See 06440-03-R, "Closing Open Joints in Wood Wall Ornament"
 - 5. See 06440-04-R, "Repairing Scratches, Gouges and Dents in Wood Wall Ornament"
 - 6. See 09560-03-R, "Dutchman Repair of Wood Floor Boards"
- D. Remove paint from both interior (where applicable) and exterior surfaces.
 - 1. See 06400-07-R, "Chemically Removing Paint From Wood Features"
 - 2. See 06400-02-S, "Supplemental Guidelines for Removing Paint from Interior and Exterior Wood Surfaces"
 - 3. See 06400-09-R, "Removing Paint From Wood Features Using Thermal Methods"
- E. Remove all deteriorated glazing putty and broken glass. Replace glass and reglaze with a flexible elastomeric glazing compound. Clean the existing historic glass. See 08800-01-R, "Replacing Broken Glass in Wood and Metal Windows"
- F. Reinstall windows. Inspect pull chains and weights at all double hung windows and adjust, clean or replace as required to ensure proper operation. Lubricate all working parts to assure smooth operation.
 - 1. See 08760-01-R, "Repairing Double-Hung Window Sash Weights and Cords/Chains"
 - 2. See 08712-01-R, "Resetting a Hinge Mortise"
- G. Provide weatherstripping as required.
 - 1. See 08500-01-R, "Installing Weatherstripping on Metal Double-Hung Windows"
- H. Refinish both interior and exterior sides of sash, frame and trim with appropriate paint, stain or natural finish as specified.
 - 1. See 06300-01-S, "Primers and Paints for Wood"
 - 2. See 06300-02-R, "Surface Preparation for Painting Wood"
 - 3. See 06400-10-R, "Refinishing Interior Wood"
 - 4. See 06310-01-S, "Preparing a Non-toxic Water-repellent Preservative"
 - 5. See 06310-01-P, "Applying a Water-repellent Preservative to Wood"
 - 6. See 09900-07-S, "General Guidelines for Painting Exterior and Interior Surfaces"
 - 7. See 06300-03-R, "Applying a Semi-Transparent or Opaque Stain to Wood"
- I. Hardware:
 - 1. All window hardware shall be removed, marked for proper room number and location, boxed or packaged, and collected in a central location for the Contractor who shall polish all the hardware before reinstallation.
 - 2. All hardware to be removed before paint stripping, cleaned to bare metal and repaired to its original condition.
 - 3. Where hardware is missing or damaged, provide new hardware of same design and material as original hardware.

3.03 PROTECTION

- A. Begin and maintain protection and other precautions required through the remainder of construction period to ensure that newly rehabilitated window units will not be damaged throughout the remainder of any restoration or rehabilitation work.

1.3.2.5 Restoring sash and frame (GSA 2017g)

Restoring Wood Window Sash And Frames

Procedure code:

861006S

Source:

Internet - Castle Hill Window Restoration

Division:

Doors and Windows

Section:

Wood Windows

Last Modified:

02/02/2015

RESTORING WOOD WINDOW SASH AND FRAMES

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on restoring the appearance of wood window sash and frames and preserving the wood. This includes removing the existing paint by hand, removing deteriorated glazing compound, treating weathered wood surfaces with wood preservative, reglazing as needed, priming and repainting.

B. The choice to fully restore wood windows can be an expensive investment, but the choice will likely reduce future maintenance costs and extend the life of the original windows.

C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions

3. Submittals
4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling
8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. DAP Corporation www.dap.com

B: The Sherwin Williams Co. www.sherwin-williams.com

C: Benjamin Moore www.benjaminmoore.com

2.02 MATERIALS

As the state of coatings technology is in a constant state of flux, it is vital that proper research into product manufacturers be made. What used to be viewed to as the individual components □□□ primer□□□ and □□□ stain□□□ are now referred to as a □□□ coating system□□□ and are usually specified together for reasons concerning performance. We must adhere to a certain set of guides and carefully follow instructions to get the best coating system performance and maintain the manufacturer□□□s warranty. Therefore, it has become vitally important on special portions of a project to utilize products which are found within the catalog of a single manufacturer, allowing us to attain traceable and warrantable results.

In any case, we must understand the existing coatings on the surface to be refinished. If a surface is treated as if it was coated with varnish and it turns out to be shellac, polyurethane, or a natural rubbed wax finish, damage that could have been avoided may occur. Extreme caution is advised, and testing on hidden areas of a finished surface is advised.

As time goes on and the materials used on our projects change because of scientific studies, it is important to realize that we once thought lead, mercury, PCB□□□s and asbestos were safe products for everyday use. It is possible that some chemical we use today might be placed in the category of less-than-desirable materials in the future. When considering any coating project, it is incumbent upon the planner of the project to make sure they are fully aware of the history of previous materials used on a particular surface, understand the properties of adhesion and reactivity that may be exhibited between differing chemical compounds involved, and be prepared to fully record the coating materials they choose to use in the future. An area that is protected, such as a painted space behind a baseboard or a piece of trim where the original coatings might be seen in the future, should be carefully protected, recorded and remain undisturbed so that those layers can be studied in the future when new technology might lead to a better understanding of its qualities.

A. 80 to 120 grit sandpaper

B. Primer chosen for compatibility with the coating system (see introductory paragraphs to this section, above). The individual manufacturer will specify coating thicknesses, drying times under particular environmental conditions (temperature, humidity, direct sunlight, etc), and these details must be adhered to without fail.

C. Pure steam-distilled turpentine. For the usage specified below (E), turpentine is preferred over mineral spirits, despite its higher cost.

D Boiled Linseed Oil. (This is a prepared product and does not need to be heated in the field). Users are cautioned that most latex-based products in use today will not perform well when they come in contact with fresh Linseed Oil. Utilize this product only when using more traditional coatings such as Alkyd-or thinner-based primers and paints, and always adhere to the manufacturer's guidelines. Allow sufficient drying time before applying any coating to a surface treated with Linseed Oil.

E. Wood Preservative: A mixed solution consisting of 60% boiled linseed oil and 40% turpentine. NOTE: WITH WOOD THAT IS VISIBLY DRYED-OUT AND DISPLAYS OPEN SPLITS IN ITS SURFACE, A GREATER PERCENTAGE OF LINSEED OIL IS ADVISABLE (such as 70% Linseed, 30% Turpentine).

F. Caulking Compound (a durable, flexible caulk that bonds well with the chosen coating system and the components it will come in contact with, such as DAP's RELY-ON Latex Caulk).

G. Glazing Compound such as "DAP 33" (DAP), or approved equal.

H. Top coat (paint) chosen for compatibility with the desired coating system

2.03 EQUIPMENT

A. Hand-held sheet Orbital Sanders (NO ROTARY DISK SANDERS or BELT SANDERS)

B. Stiff bristle brushes

C. Paint brushes

D. Putty knife

E. Triangular scraper

F. Appropriate personal protective equipment such as a NIOSH /OSHA rated dust mask certified for use with the materials present, gloves, eye protection, etc.

PART 3---EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Determine the type of wood used and understand its properties. Pine for instance is much softer than oak. Therefore, special care should be taken on the pine elements so as not to damage or obscure any detail.

3.03 ERECTION, INSTALLATION, APPLICATION

A. Remove paint from sash, frame, and sill by hand.

1. Carefully sand the surface by hand using 80 to 120 grit sandpaper. Hand-held orbital sanders may be used on large, flat surfaces, but disk or belt-sanders should be avoided. Follow the grain of the wood, and be sure not to remove details or profiles on edging. NOTE: THIS EQUIPMENT SHOULD BE USED BY EXPERIENCED OPERATORS ONLY. For alternative methods in removing paint from wood features, see 06400-07-R and 06400-09-R.

CAUTION: PAINT ON OLDER SURFACES MAY CONTAIN LEAD. FOLLOW EPA REGULATIONS AND SAFETY GUIDELINES INCLUDING THOSE REQUIRED FOR THE IDENTIFICATION, REMOVAL AND DISPOSAL OF LEAD-BASED PAINT.

2. Reset all exposed nail heads and treat with a rust-inhibiting primer that is compatible with the chosen coating system. If utilizing an Alkyd-based primer, the product Penatrol may be added to aid in preventing the oxidation of old nail heads.

B. Remove deteriorated glazing compound and glazing.

CAUTION: PUTTY ON OLDER SURFACES MAY CONTAIN LEAD OR ASBESTOS. FOLLOW EPA REGULATIONS AND SAFETY GUIDELINES INCLUDING THOSE REQUIRED FOR THE IDENTIFICATION, REMOVAL AND DISPOSAL OF THESE MATERIALS.

C. Brush apply the chosen, compatible wood preservative to all bare wood surfaces.

D. Caulk seam cracks and crevices in the surface with the caulking compound. Depending on the caulk chosen, time may have to be allowed to allow for preservative drying time.

E. Sand smooth the transitions between muntin/mullion and any original glazing that remains.

F. Replace glazing and apply the glazing compound smooth and evenly to the surface.

F. Apply final coats of paint to match the desired color and thickness. If glazing compound is exposed it should also be coated once it has dried.

1.3.2.6 Sealing leaky windows (GSA 2015b)

Sealing Leaky Wood Double-Hung Windows

Procedure code:

861101S

Source:

Hspg Prepared For Nps - Sero

Division:

Doors and Windows

Section:

Wood Double-Hung Windows

Last Modified:

02/02/2015

SEALING LEAKY WOOD DOUBLE-HUNG WINDOWS

PART 1---GENERAL

1.01 SUMMARY

A. This procedure includes guidance on sealing leaky windows and includes caulking gaps between the wall and the frame, filling cracks in the wood, repainting and replacing loose window putty.

B. Peeling paint, the absence of putty, and open sash joints are signs of moisture infiltration into the window sash. The wood should be properly sealed against moisture to prevent deterioration in wood.

C. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:

1. Safety Precautions
2. Historic Structures Precautions
3. Submittals

4. Quality Assurance
5. Delivery, Storage and Handling
6. Project/Site Conditions
7. Sequencing and Scheduling
8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

PART 2---PRODUCTS

2.01 MATERIALS

A. Caulking Compound (in order of recommended usage):

1. Polyurethanes - easily workable; paintable; 15-20 year life span; limited availability.
2. Polysulfides - slow drying; can be sanded and painted; highly elastic; limited availability.
3. Butyls - paintable but cannot be sanded; 7-10 year life span.
4. Silicones - some can be painted but generally not sanded.
5. Acrylic Latex - for exterior work, their use is best left to tight, narrow joints; short life span especially when compared to polysulfides and polyurethanes.

B. Polyethylene foam backer rod such as "Ethafoam" SB brand backer rod (available at builder's supply houses or concrete materials suppliers), or approved equal.

C. Boiled linseed oil

D. Wood filler (there are four basic types):

1. Water-mix Wood Putty: Easy to tint and fairly resilient, but has poor moisture resistance.
2. Solvent-based Wood Filler: Not tintable, but has many color choices. A solvent is needed to clean any excess or spills. It is difficult to sand, but has good adhesion and moisture resistance. It also has a problem with shrinkage.
3. Acrylic Latex Wood Filler: Better than water-based in adhesion, moisture resistance, and flexibility. Apply the filler in layers to avoid shrinkage.
4. Two-part Polyester Filler: Similar to auto body filler. It has excellent adherence and moisture resistance with minimal shrinkage. It stains easily, but is time consuming to prepare.

E. Wood water-repellent preservative (see 06310-01-P, Section 2.02 Materials, and 06310-01-S)

F. Paint (see 06300-01-S)

G. Linseed oil putty or other approved product that is complementary to the coating system.

H. Clean, potable water

2.02 EQUIPMENT

A. Wire brush

B. Natural bristle brushes for oil-based paints: Precondition by soaking in raw linseed oil for 24 hours.

Use nylon bristle brushes for water-based paint. Do not use the same brush for both types of paint.

C. Putty knife

D. Caulking gun

PART 3---EXECUTION

3.01 EXAMINATION

A. Inspect windows periodically, at least yearly. Check for ease of operation, presence and operation of all hardware, and cracked or missing putty and glazing.

3.02 ERECTION, INSTALLATION, APPLICATION

A. Recaulk Gaps Between Window Frame and Wall:

1. Renail any loose boards in the window frame.
2. Using a wire brush and putty knife, remove any loose dirt and debris that may have collected in the gap.
3. For gaps 3/8 inch or wider, insert a closed-cell polyurethane backer rod.
4. Push the backer rod into the joint to fill up the space behind the caulking.
5. Fill gap with a flexible caulking or sealant. Apply with a caulking gun until flush with the surface.
6. If an oil-based caulk is used, allow the caulk to dry for at least 48 hours and then paint. Paint will extend the life of oil-based caulk.

B. Fill holes and cracks with linseed oil and fill with putty (see 06440-04-R for guidance).

C. Examine condition of paint.

1. If paint has minor cracking or peeling, remove loose paint with a wire brush and putty knife and repaint.
2. If paint deterioration is extensive:
 - a. Remove all paint from window (see 06400-07-R and 06400-09-R for guidance).
 - b. Liberally apply a wood preservative to the wood (see 06310-01-P for guidance).
 - c. Allow to dry for 24 hours.
 - d. Apply a primer that is tinted darker than the final coat, with its choice based on compatibility with the preservative and the desired coating system.
 - e. Apply final layers of coating system as per manufacturers specifications and allow to dry before installation (see 06300-01-S, 06300-02-R and 09900-07-S for guidance).

D. Replace Window Putty:

1. Remove loose or cracked putty using a putty knife.

2. Using a wire brush, remove loose dirt and debris from within the putty channel.
3. Brush exposed areas with a preservative (such as a linseed oil mixture) that will not conflict with the chosen coating system. This preservative will be absorbed into the wood and prevent the new putty from drying too quickly and cracking.
4. Apply fresh window putty and smooth out with a putty knife.

1.3.2.7 Guidelines for fabrication and installation (GSA 2016a)

General Guidelines For The Fabrication And Installation Of Wood Windows

Procedure code:

861002S

Source:

Federal Building/Usps, Spokane, Wa - Gsa/Pbs

Division:

Doors and Windows

Section:

Wood Windows

Last Modified:

07/13/2016

PREFACE: Windows are an important design element contributing to a building's architectural character. For historic buildings, state historic preservation officers generally apply the Secretary of Interior Standards for Rehabilitation which require that original material be repaired and retained where possible. Condition surveys are typically required to determine if windows are too deteriorated to save, before replacements will be considered. Replacement windows should match the color, size and configuration of the original windows and the material.

PART 1---GENERAL**1.01 SUMMARY**

- A. This procedure includes general information relating to the fabrication and installation of wood windows and includes the following window types:
 - 1. Double-Hung Window Units.
 - 2. Casement Window Units.
 - 3. Decorative Window Units.
 - 4. Hopper Window Units.
 - 5. Non-Operative (Fixed) Window Units.
 - 6. Single-Hung Window Units.
- B. See 01100-07-S for general project guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
 - 1. Safety Precautions
 - 2. Historic Structures Precautions
 - 3. Submittals
 - 4. Quality Assurance
 - 5. Delivery, Storage and Handling
 - 6. Project/Site Conditions
 - 7. Sequencing and Scheduling
 - 8. General Protection (Surface and Surrounding)

9. These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM),
100 Barr Drive, West Conshohocken, PA 19428
(610) 832-9585
(610) 832-9555.
- B. American National Standards Institute, Inc. (ANSI),
1430 Broadway, New York, NY 10018.
Flat Glass Marketing Association (FGMA),
National Wood Window and Door Association (NWWDA),

1.03 SYSTEM DESCRIPTION

- A. Performance Grade Classification: Provide wood windows that comply with requirements of NWWDA I.S. 2 for performance grade 40.
- B. Performance Grade Classification: Provide wood windows that comply with requirements of NWWDA I.S. 2 for performance grade 60.
- C. Standards: Performance requirements for structural performance, air infiltration, and water penetration for wood windows are those specified in NWWDA I.S. "Industry Standard for Wood Window Units".
- D. Testing: Manufacturer's stock units of each grade of required wood window shall have been tested by a recognized testing laboratory or agency, in accordance with ASTM E330 for structural performance. Test samples shall comply with requirements in NWWDA I.S. 2 for test sample sizes and methods.
- E. Performance Requirements (Grade 60 Windows): Each required window unit shall comply with the following performance requirements:
 - A. Air Infiltration: Not more than 0.10 cfm per sq. ft. of overall frame area at an inward test pressure of 1.57 lbf per sq. ft.
 - B. Water Penetration: No water penetration as defined in the test method at an inward test pressure of 6.24 lbf per sq. ft.
 - C. Structural Performance: No glass breakage, damage to hardware, or permanent deformation that would impair operation of the unit or residual deflection greater than 0.4 percent of the span at a positive (inward) and negative (outward) test pressure of 60 lbf per sq. ft.
 - D. Forced Entry Resistance: Windows shall comply with requirements for Grade 40 level of resistance to forced entry when tested in accordance with ASTM F588.

1.04 SUBMITTALS

- A. Product Data: Submit product data for each type of wood window specified, including standard construction details, dimensions of individual components, profiles, finishes, hardware, and accessories.
- B. Shop Drawings: Submit shop drawings for each type of window specified, including 1/4-inch scale wall elevations, typical unit elevations at 3/4-inch scale, glazing details, and fill-size details of typical composite members.

1.05 QUALITY ASSURANCE

- A. Wood Window Standard: Comply with provisions of NWWDA I.S. 2 for standards of performance and fabrication workmanship for wood windows.
- B. Glazing Standards: Comply with recommendations of the Flat Glass Marketing Association (FGMA) "Glazing Manual" and "Sealant Manual" except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this section or referenced standards.

- C. Safety Glass Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide the type of products indicated which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for category II materials.
- D. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers at least one component pane of units with the appropriate certification label of inspecting and testing organization indicated below.
 - A. Insulating Glass Certification Council (IGCC)
 - B. Associated Laboratories, Inc. (ALI)
- E. Single Source Responsibility: Provide wood windows produced by a single fabricator who is capable of indicating prior successful production of units similar to those required.

1.06 PROJECT/SITE CONDITIONS

- A. Field Measurements:
 - A. Check actual window openings in construction work by accurate field measurement before fabrication of custom window units. Show recorded measurements on final shop drawings.
 - B. Coordinate fabrication with construction progress to avoid delay. Where necessary, proceed with fabrication without measurements, and coordinate tolerances to ensure proper fit of window units.

1.07 WARRANTY

- A. Submit a written warranty signed by the Manufacturer, agreeing to repair or replace wood window units that fail in materials or workmanship within the specified warranty period.
 - A. Failures include, but are not limited to, structural failures, including excessive deflection, excessive leakage, air infiltration, failure of weatherstripping, faulty operation of window sash or hardware, and deterioration of metals, finishes, and other materials beyond normal weathering.
 - B. Warranty period for wood windows is 3 years after the date of substantial completion.
 - C. This warranty shall be in addition to and not a limitation of other rights the Government may have against the Contractor under the Contract Documents.

PART 2---PRODUCTS

2.01 MANUFACTURERS

- A. Pella Corp.
102 Main Street
Pella, IA 0219
515/628-1000
- B. Andersen Corporation
100 Fourth Avenue North
Bayport, MN 55003
612/439-5150

2.02 MATERIALS

- A. General: Comply with requirements of NWWDA I.S. 2.
- B. Wood: Clear Ponderosa Pine or other suitable fine-grained lumber that has been kiln-dried to a moisture content of 6 to 12 percent at time of fabrication and is free of visible finger-joints, blue stain, knots, pitch-pockets and surface checks larger than 1/8-inch deep by 2-inches wide.
 - 1. Lumber shall be water-repellent preservative treated after machining in accordance with NWWDA I.S. 4.
- C. Aluminum Cladding: Provide manufacturer's standard aluminum formed sheet or extruded cladding mechanically bonded to exterior wood sash and frame members.
 - 1. Trim members: Aluminum clad wood trim.
 - 2. Finish: Provide factory-applied baked-on enamel finish.

- 3. Color: Custom color as selected by the Architect from the manufacturer's standard color range.
- D. Anchors, Clips, and Accessories: Fabricate anchors, clips and window accessories of aluminum, non-magnetic stainless steel, or hot-dip zinc coated steel complying with ASTM A123; provide strength sufficient to withstand design pressure indicated.
- E. Fasteners: Comply with NWWDA I.S. 2 for fabrication and with manufacturer's recommendations and standard industry practices for type and size of installation fasteners.
 - A. Use zinc-coated or nonferrous nails and screws for window fabrication and installation.
 - B. Use brass screws for hardware and accessory installation.
- F. Hardware: Provide the manufacturer's standard hardware, necessary to properly operate, tightly close, and securely lock windows. Do not use aluminum in frictional contact with other metals.
 - A. Provide solid bronze hardware, with plated steel or brass/bronze operating bars and rods.
- G. Compression Weatherstripping: Provide compressible weatherstripping, designed for permanently resilient sealing under bumper or wiper action, completely concealed when sash is closed.
- H. Glass and Glazing Materials: Provide the manufacturer's standard clear sealed insulating safety glazing material that complies with ANSI Z97.1.
 - A. Insulating glass unit shall have metal spacers, sealed between the panes, behind each muntin bar.
- I. Glazing Seal: Provide the manufacturer's standard extruded vinyl or butyl glazing gasket providing weathertight seal.
- J. Sliding Weatherstripping: Provide woven pile weatherstripping of polypropylene, wool, or nylon pile, with resin-impregnated backing fabric, and aluminum backing strip; comply with AAMA 701.2.

2.03 EQUIPMENT

- A. General: Comply with minimum operating requirements of NWWDA I.S. 2.
- B. Casement Windows: Provide units containing side-hinged swing-out sash, with the following equipment and hardware:
 - 1. Hook or cam-type latch and lever, for operation without screen removal.
 - 2. For sash more than 48 inches high, provide 3 extension hinges and 2-point latching mechanism.
- C. Double-Hung Windows: Provide units containing 2 balanced, vertically-sliding sash with the following equipment and hardware. 2 pair concealed counterbalancing mechanism.
 - 1. Latch at meeting rail.
 - 2. Lift handle on the lower rail.
- D. Hopper Windows: Provide units containing bottom-hinged (hopper) sash with the following equipment and hardware:
 - 1. 2 balance support arms and pivots with friction shoes.
 - 2. Cam latch or other latching hardware with lever handle or pull. Provide latch with eye for pole operation for operable sash located more than 6 feet above the floor.

2.04 FABRICATION

- A. General: Except to the extent that more stringent requirements are indicated, provide the manufacturer's standard fabrication of units. Comply with indicated standards. Include a complete system for assembly of components and anchorage of window units.
 - 1. Comply with requirements of referenced standards for moisture content of lumber at time of fabrication and for relative humidity conditions in the installation areas.
- B. Fabricate windows to produce units that are re-glazable without dismantling sash framing. Provide openings and mortises precut, where possible, to receive hardware and other items.
- C. Each window unit includes sash, frame, stops, sill (including undersill or nosing), and moldings, integral mullions and muntins, hardware, and accessories
- D. Provide weatherstripping at perimeter of each operating sash.
 - 1. Provide weatherstripping at perimeter of each operating sash.
 - a. For double/single-hung sash, provide weatherstripping only at horizontal rails of operable sash.
 - 2. Provide glazing stops, nailed or snap-on, coordinated with glass selection and glazing system indicated

3. Preglazed Window Units: Preglaze window units at the shop before delivery.
- E. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to the project site, to the maximum extent possible. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
- F. Wood Finish: Provide the following finish on exposed wood in units:
 1. Shop-Primed Units: Provide the fabricator's standard shop prime coat on exterior wood surfaces only.

PART 3---EXECUTION

3.01 EXAMINATION

- A. Inspect openings before beginning installation. Verify that the rough or masonry opening is correct and the sill plate is level. Do not proceed with installation of window units until unsatisfactory conditions have been corrected.
 1. Masonry surfaces shall be visibly dry, and free of excess mortar, sand, and other construction debris.
 2. Wood frame walls shall be dry, clean, sound and well-nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in the opening and within 3 inches of the opening.

3.02 ERECTION, INSTALLATION, APPLICATION

- A. Comply with manufacturer's instructions and recommendations for installation of window units, hardware, operators, accessories, and other window components.
- B. Set units plumb, level, true to line, without warp or rack of frames or sash. Provide proper support and anchor securely in place.
- C. Set sill members in a bed of compound or with joint fillers or gaskets as indicated, to provide weathertight construction. Coordinate window installation with wall flashings and other built-in components.

3.03 ADJUSTING/CLEANING

- A. Adjust operating sash and hardware to provide a tight fit at contact points and weatherstripping, and to provide smooth operation and a weathertight closure. Lubricate hardware and moving parts.
- B. Clean interior and exterior surfaces promptly after installation of windows. Take care to avoid damage to protective coatings and finishes. Remove excess glazing and sealants, dirt, and other substances.
- C. Clean glass of preglazed window units promptly after installation. Wash and polish glass on both faces not more than 4 days prior to date scheduled for final inspection. Comply with manufacturer's recommendations for final cleaning and maintenance.
- D. Remove and replace glass that is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents, and vandalism.

3.04 PROTECTION

- A. Institute and maintain protection and other precautions required through remainder of construction period to ensure that, except for normal weathering, window units
- B. will be without damage or deterioration at the time of substantial completion.

1.3.2.8 Unsticking a window (GSA 2016b)

Unsticking a Wood Double-Hung Window Sash

Procedure code:

861003S

Source:

Hspg Prepared For Nps - Sero

Division:

Doors and Windows

Section:

Wood Windows

Last Modified:

08/16/2016

PART 1---GENERAL

1.01 SUMMARY

- A. This procedure includes guidance and procedures required to inspect and loosen a wood sash.
- B. A wood window sash can bind or stick for many reasons including: window nailed shut; accumulation of paint and/or dirt; humidity causing wood expansion; bowed members; weatherstripping too tight; or building settlement. NOTE: Some sash were fixed, installed without operable parts such as single hung sash.
- C. See "General Project Guidelines" for general Project Guidelines to be reviewed along with this procedure. These guidelines cover the following sections:
 - 1. Safety Precautions
 - 2. Historic Structures Precautions
 - 3. Submittals
 - 4. Quality Assurance
 - 5. Delivery, Storage and Handling
 - 6. Project/Site Conditions
 - 7. Sequencing and Scheduling
 - 8. General Protection (Surface and Surrounding)

These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO).

1.02 SYSTEM DESCRIPTION

- A. A window sash in proper working order is freely sliding, has balancing and moving apparatus in working order, and has operable sash lock(s) to deter air infiltration. In addition, operable sash often have weatherstripping and adjustable interior stops to allow for seasonal swelling and shrinkage.

PART 2---PRODUCTS

2.01 MATERIALS

- A. Replacement stock is available for stop and parting beads. Be sure replacement is an exact duplicate of the original. Milling a new piece may be required.

2.02 EQUIPMENT

- A. A device for cutting paint seals such as "Window Zipper" (Red Devil), or approved equal; available at hardware stores.
- B. A rubber mallet and block of wood for jamb and stop straightening
- C. Utility knife for cutting paint seals
- D. Paint scraper
- E. Wide putty knife or "window zipper" to break paint seal
- F. Screwdriver and screws to tighten jamb into place
- G. Hand soap or household paraffin for waxing the stop and parting beads
- H. Flat steel pry bar to loosen sash from outside
 - I. Carpenter's nippers to remove nails
- J. 1" chisel to scrape paint in channel
- K. Sandpaper
- L. Planer
- M. Nail to secure sash cord/chain
- N. Soap and water

PART 3---EXECUTION

3.01 EXAMINATION

- A. Determine if sash is an operable design and not fixed.

3.02 ERECTION, INSTALLATION, APPLICATION

- A. The sash may be nailed shut:
 - 1. Check around general area of sash for the presence of any nails.
 - 2. If sash is nailed shut with finish nails, drive them completely through with nailset.
 - 3. If large headed nails were used, pull them out with carpenter's nippers being careful not to damage wood.
- B. The sash may be painted shut:
 - 1. Break the paint seal between the stops and the sash.
 - 2. Use a "window zipper" or a wide putty knife with a rubber mallet.
 - 3. Do this on the inside and outside of the window.
 - 4. CAREFULLY insert a heavy screwdriver between the sash rail and jamb at groove for sash cord. TAKE CARE NOT TO MAR OR DAMAGE FINISH AND/OR SASH.
 - 5. Work at both sides of jambs to loosen sash.
 - 6. If window still will not open, use a pry bar on the outside of the sash. TAKE CARE TO PROTECT THE SASH AND SILL FROM DENTS WITH A WIDE PUTTY KNIFE OR WOOD BLOCKING. INTENSE PRESSURE ON A SMALL AREA SUCH AS THAT FROM A SMALL SCREWDRIVER OR FLAT PRYBAR CAN GOUGE OR DENT THE WOOD.
- C. If the window has been opened but is difficult to move:
 - 1. Remove any dirt from the channel, stops, weatherstripping and parting bead.
 - 2. Remove any globs of dried paint from the stops and parting bead with a 1" chisel and sand edges after paint is removed.
 - 3. Lubricate stops and parting bead with hand soap or household paraffin.
- D. If sash still binds, determine the point of friction:
 - 1. If the friction occurs along the jamb; with a hammer, tap a wood block approximately 6" long 5 or 6 times against the back of channel to force the jamb back into place. If this allows the sash to move more freely, screw the jamb into the jack stud behind at 3" intervals around the point of friction.

2. If the friction occurs with the stop, use the same procedure as above, but with less force and do not drive screws into the stop.
- E. Problems such as humidity, paint build-up, or weatherstripping applied too tightly require more aggressive repair:
1. If the window is easily operable during dry times of the year but will not work properly during humid times, then humidity is to blame. Repair should not be attempted until the time of year with highest humidity. See section 1.02 A; If the window has adjustable interior stops, it may be desirable to refurbish and restore them to use.
 - a. The sash must be carefully planed and should be done only once.
 - b. Take off as little of the sash surface as possible to make the window operable during all times of the year.
 - c. Remove the sash as described below with the problem of paint build-up.
 2. If the sash binds because of the build-up of layers of paint, remove the paint. To remove the paint properly, first remove the sash:
 - a. Remove the stop; break the paint seal between the inside stop and the window frame. Pry the stop away from the frame with a stiff putty knife, small pry bar, or wide chisel.
 - b. Pull one side of sash out to expose the sash cord/chain.
 - c. Remove cord/chain from both sides of sash. Temporarily secure the end of cord/chain with a nail through the cord/chain and across the pulley hole so that it will not fall into the pocket. Lift out the sash.
 - d. Remove loose paint from all members by sanding, and repaint.
 - e. Reinstall parting bead and sash.
 - f. When reinstalling inner stop, check position in relation to the sash one nail at a time so that sash will fit snugly in place and will not bind or rattle.
 3. To remove the upper sash - lower the sash; remove the parting bead from the top down; at midpoint, raise the sash and continue. Follow the same procedure as above.
 - a. If weatherstripping applied too tightly is suspected to be the problem, removal and reinstallation of weatherstripping will be required.

1.3.2.9 Replacing broken glass (GSA 2016c)

Replacing Broken Glass in Wood and Metal Windows

Procedure code:

880001S

Division:

Doors and Windows

Section:

Glass & Glazing

Last Modified:

08/17/2016

PART 1---GENERAL

1.01 SUMMARY

- A. This specification provides guidance on replacing cracked, broken or missing panes of glass, replacing cracked or missing window putty and cleaning glazing in standard windows and doors.
- B. Repairs that involve art glass, stained glass, leaded glass, beveled glass or plate glass require special skills, and should only be attempted by or under the guidance of a trained conservator.
- C. Broken or cracked glass panes and missing or cracked window putty may be the result of weather, neglect, or vandalism. In any case, it is a matter that requires immediate attention.
- D. For temporary repairs to broken glass until a permanent replacement can be performed, see "Temporary Patching of Chips and Cracks in Window Glazing".
- E. Read "General Project Guidelines" along with this specification. These guidelines should be reviewed prior to performing this procedure and should be followed, when applicable, along with recommendations from the Regional Historic Preservation Officer (RHPO). The guidelines cover the following sections:
 - 1. Safety Precautions
 - 2. Historic Structures Precautions
 - 3. Submittals
 - 4. Quality Assurance
 - 5. Delivery, Storage and Handling
 - 6. Project/Site Conditions
 - 7. Sequencing and Scheduling
 - 8. General Protection (Surface and Surrounding)

1.02 SYSTEM DESCRIPTION

A window glass is in proper condition when it is set securely and tightly into the window frame, is properly caulked, and is not scratched, cracked, or broken.

1.03 SEQUENCING AND SCHEDULING

Coordination of Work: The coordination of glass repair or replacement with other proposed projects must be considered. For example, if work on other window elements is anticipated (involving but not limited to the frame, sash, trim, lintel, sill, or hardware, paint removal, cleaning, or repairing), it best to postpone any glazing work until last.

PART 2---PRODUCTS

2.01 MANUFACTURERS

A. Due to industry standardization, there will be little difference between new glass from different manufacturers in the U.S. However, there are different types of glass, and the type of glass used for a particular project is usually an engineering, architectural, building code or safety regulation compliance issue. Some manufacturers include:

1. AGC Glass Company

Alpharetta, GA

1-800-251-0441

2. Cardinal Glass Industries

3. Environmental Glass, Inc.

Redford, MI

734-261-1930

4. Guardian Glass Company

Auburn Hills, MI

248-340-1800

5. Pilkington North America

1-800-221-0444

6. PPG IdeaScapes

1-888-774-4332

7. Saint-Gobain Glass

8. Viracon, Inc.

Owatonna, MN

1-800-533-2080

B. Manufacturers of the sealants suggested in the following section are:

1. Bostik, Inc.

Wauwatosa, WI

1-800-726-7845

2. Dow Corning Corporation

Auburn, MI

989-496-7875

3. Percola Corporation

Harleysville, PA

1-800-523-6688

2.02 MATERIALS

A. Linseed oil putty (for wood windows)

B. Glazing compound or elastomeric sealant (for metal windows):

1. One-component advanced urethane sealant such as:

- a. 2000 Primary Sealant (Bostik, Inc.)
- b. DynaTrol I-XL (Pecora Corporation)
- c. Approved equal

-OR-

1. One-part non-acid-curing silicone glazing sealant such as:

- a. 790 Silicon Building Sealant (Dow Corning)
- b. 864 NST Silicone (Pecora Corporation)
- c. Approved equal

2. Any glazing sealant being used should comply with the following requirements:

- a. Must be compatible with other materials with which they will come into contact.
- b. Must be suitable for applications indicated and conditions at time of installation.
- c. Colors: Provide color of exposed sealants as selected by the RHPO from manufacturer's standard colors.
- d. Hardness and Flexibility: Consult the manufacturer to determine if the sealant meets the actual hardness or flexibility parameters needed for this particular installation and use.
- e. Sealants and materials used with laminated glass are to be 100% solids, containing no solvents.

C. Materials for Removing Glazing Compound:

1. Mineral Spirits:

- a. A petroleum distillate that is used especially as a paint or varnish thinner. It was developed as an inexpensive replacement for the vegetable-based turpentine, and is a light version of kerosene. It comes in three grades, and cost rises as refining quality increases.
- b. Other chemical or common names include Benzine (not Benzene); Naphtha; Petroleum spirits; White spirit; Varisol; Solvent naphtha; Stoddard solvent.

c. Potential Hazards: TOXIC AND FLAMMABLE.

d. Safety Precautions:

- Work in a well ventilated area.
- ALWAYS wear proper Personal Protection Equipment, especially rubber gloves, safety glasses/goggles and a properly rated respirator, when handling any solvent such as mineral spirits.
- AVOID REPEATED OR PROLONGED SKIN CONTACT. If any chemical is splashed onto the skin, wash immediately with soap and water.
- Available from construction specialties distributors, hardware store, paint store, or printer's supply distributor.

-OR-

2. Linseed oil or thinned primer

D. Replacement Glass that Matches Existing Glass:

1. Glass comes in a variety of thicknesses and types. For this application, we will be discussing standard flat glass, often called "float glass" because of the process used to create sheets. It can be cut with specialty hand-tools (glass cutters with a steel or diamond tip). This material will usually come in thicknesses of:
 - a. 3/32" (2.5mm) (formerly referred to as single-strength glass, not to be confused with single-pane glass in windows and doors)
 - b. 1/8" (3.2mm), which was formerly referred to as double-strength glass, not to be confused with double-pane or insulated units.
2. Although you will probably not be using safety glass, it is important to understand its uses, properties, and the corresponding weight of each type. It will most frequently come in one of the following types for windows
 - a. Tempered glass, which will usually come in 1/8" (3.2mm) thickness, and can be identified by a small safety rating and manufacturer symbol etched into a corner of the surface, with slightly rounded edges all around the piece. . It will weigh the same as a piece of non-tempered glass of the same dimensions. This type needs to be custom-ordered from a factory and made to exact size. As it has been heat or chemically treated, it will shatter if you attempt to cut it.
 - b. Laminated glass, which is most commonly encountered as two sheets of 3/32" (2.5mm) glass layered together like a sandwich, with a clear sheet of Polyvinyl or another modern plastic in between. This particular type would be referred to as 5.38mm laminated glass, and weighs over twice the amount of an individual single-thickness sheet of glass (which on a sash window, or other application where balancing weights are installed, will have a significant impact). It can only be cut to size in a professional glass shop.
 - c. Wired glass, which is infrequently seen except in areas requiring fire-resistance, such as in fire doors or fire-rated partitions (such as entries to boiler rooms or exit stairwells). It is quite thick (1/4" or greater), and the weight is correspondingly larger. It is not as widely used today as safety glass because new methods have supplanted many of its previous uses, and personal contact with it can still cause serious injury.

E. Glazier's points

1. The three most common types of points are:
 - a. The triangular point
 - b. The diamond point
 - c. The "push point", which is the easiest for the casual user to install.
2. These are usually formed from the metal zinc.

F. Neoprene setting blocks and shims

G. Clean, potable water

H. Ammonia

I. Paper towels or rags

2.03 EQUIPMENT

For Replacing a Window Pane:

- A. Goggles and gloves for protection when removing broken glass
- B. Hammer and chisel
- C. Soldering iron wrapped in foil, to help warm and remove old glazing compound
- D. Needle-nose pliers, end-cutters, and chisels for maneuvering glazier's points
- E. Sandpaper
- F. Very fine 0000 steel wool
- G. Paint brush to apply primer
- H. Glass cutter and straight edge
- I. Putty knife or glazier's tool for smoothing glazing compound

PART 3---EXECUTION

3.01 EXAMINATION

- A. Check for cracked, broken, chipped, or otherwise damaged glass.
- B. Inspect glazing putty on both sides of pane for cracked, loose, or missing sections which allow water to attack the window components, especially at the joints.
- C. Examine the condition of the window components for rot, corrosion, loose connections, etc.
 1. Note if the glass rattles or moves in the glazing system.
 2. Note if the glass stops are intact.
- D. Inspect all surfaces which are to receive glass and/or glazing sealant. Take special note of any defects or condition which will interfere with, or prevent a satisfactory installation. Correct all defects prior to installation of new glass.
- E. Verify the glass type in each window type prior to the installation of new glass.

3.02 PREPARATION

- A. Prior to reglazing, remove all oil, dirt, rust and other materials from the glass and the metal framing members using solvents such as toluol or xylol.
- B. After removing loose material from a steel window frame, neutralize rust with one of the commonly available products on the market such as Loctite "Extend Rust Neutralizer".
- C. Clean and prime all glazing rabbets prior to glazing. See "Rehabilitating Wood Windows" and/or "Cleaning and Painting Steel Windows" for guidance.
- D. Store removed glass in a safe and clean place during construction, so that it will not be damaged or need to be recleaned of corrosive contaminants.

3.03 ERECTION, INSTALLATION, APPLICATION

NOTE: IT IS IMPORTANT TO WEAR PROPER PERSONAL PROTECTION EQUIPMENT, INCLUDING SAFETY GLASSES/GOGGLES AND HEAVY GLOVES WHEN WORKING WITH GLASS.

- A. After the intended pieces of glass are removed, remove the glazing compound / putty left behind using any or all of the following methods:
 - 1. A hammer and glazing chisel (at the risk of damage to adjacent glazing) or a triangular/tear-drop scraper.
 - 2. A soldering iron wrapped in aluminum foil can be used to soften the putty to ease removal.
 - 3. Mineral spirits. CAUTION: Consult the MSDS for handling cautions and PPE requirements.
 - 4. Linseed oil (if the originally putty is linseed oil-based, which most legacy putties are). CAUTION: Consult the MSDS for handling cautions and PPE requirements.
- B. Remove glazier's points using needle-nose pliers and end-cutters. Discard.
- C. Special Procedures for Wood Windows:
 - 1. Thoroughly clean the sash of any remaining compound and sand rabbets smooth. Be alert for leftover glazing brads in the rabbets of the wooden glazing bars.
 - 2. Apply linseed oil or thinned oil-based primer to rabbets to prevent wood from absorbing oil from new putty.
 - a. If primer is used, it should be applied in two coats, 24 hours apart.
 - b. Verify that new putty is compatible with linseed oil before attempting this step.
- D. Special Procedures for Metal Windows:
 - 1. While the glass is out, clean/repair/replace, prime and paint the metal frame, the mullions, muntins, sash, and other window components prior to glass reinstallation.
 - 2. Apply glazing compound to the rabbets of the window sash.
 - 3. Metal windows use special fasteners, some of which are propriety designs. Therefore, the existing glazing clips, glazing beads, and other fasteners should be cleaned and reused whenever possible. Where existing metal glazing clips are missing, you will need to supply and install new wire (metal) glazing clips to match existing. Architectural salvage operations are a good source for these items. However, the clips may need to be specially fabricated.
- E. To replace damaged panes, new glass will need to be cut 1/8" smaller in length and width than the existing opening. There are several online videos readily accessible that explain this process.

1. NOTE: Proper Personal Protection Equipment, especially eye and hand protection, is absolutely necessary when cutting glass.
2. Practice cutting on an unusable piece of glass first.
3. Make sure the working surface is perfectly clean and do not press too hard with the glass cutter. NOTE: Old window glass can be quite thin, and may also contain impurities and irregular internal tensions. Pressure from the wheel cutter on even a tiny piece of dirt can cause the glass to split or "run" in an unintended direction.
4. When cutting straight pieces, use a straight edge as a guide.
 - a. Score the piece with one firm, even stroke of a sharp glass cutter. If it is a carbide steel cutter, dipping it in kerosene or mineral spirits will improve the cutting action, while lengthening the life of the cutting wheel. If using a diamond cutter lubricant should not be used.
 - b. Once glass is scored, there are several methods of breaking it along the score line. Here are three:

F. Method 1:

1. Place the glass with the scored facing up and lined up with the edge of a workbench.
2. Holding the "waste" piece beyond the score with a gloved hand, lift the overhanging edge about 1" above the workbench (the other end will remain on the workbench).
3. Next, bring the glass down sharply against the table edge, and the glass should snap along the score. When trying this for the first time, do so gently to start, and then each time increase the speed of the drop and the downward pressure until you become practiced at gauging the right balance for a clean break along the score.

G. Method 2:

1. Score the glass as above.
2. Next, turn the piece over so the score faces downward and the mark is placed about an inch off the edge of the workbench.
3. On the top (or un-scored site), carefully tap along the score with the ball end of the glass cutter to "run" the break from one end of the pane to the other, while supporting the scrap part of the pane to be cut off (which is off the table) with your gloved hand.
4. It is recommended to place a large plastic trash can under the edge of the workbench to contain the small shards that are being ejected by the tapping.

H. Method 3:

1. Use plastic glass-cutter's pliers to snap the glass along the score.
2. Requires practice to achieve quality results.

I. Cutting Curves:

1. Requires practice to achieve quality results.
2. It is recommended to place a large plastic trash can under the edge of the workbench to contain the small shards that are being ejected by the tapping.
3. Make a template out of thick cardboard or masonite board to guide the glass cutter. The template should be slightly smaller than the desired piece to allow for half the width of the glasscutter, usually about 1/8" in each dimension.

4. Practice on a scrap piece of glass- Score the piece with a sharp glass cutter following the edge of the template. A diamond cutter is preferred for complex shapes. Do not try to score the piece freehand.
5. Score lines from the initial curved score line off at a tangent to facilitate the removal of extra scrap glass.
6. Turn the piece of glass over and place it on the workbench with some of the newly scored marks on the bottom, overhanging the edge of the workbench by about an inch.
7. While supporting the overhanging piece with your free hand, use the ball end of the cutter and tap the top of the glass along the main score, starting in the middle and working toward both ends gradually.
8. Next, tap the tangential lines made for the scrap parts.
9. The score-line should fracture along the curve.
 - a. Even practiced professionals can find this difficult.
 - b. Gradual curves may be broken off in one piece.
 - c. For extreme curves, it is best to cut and remove one small section of glass at a time.
10. For pieces with complex cuts, consult a trained conservator or stained glass craftsman.
- J. Apply a small bead of glazing compound on the glazing bar rabbet as bedding putty, to cushion the new glass, and then install the glass with spacing evenly distributed on all sides. Be sure the compound is properly chosen to work with the window material (wood, steel, etc.).
- K. Replace glazier's points 4" to 6" apart around the perimeter, and tap them halfway in. If using a glazing point driver (which is similar to a stapler), be sure not to unduly stress the glass with too much downward pressure.
- L. Form glazing compound into a 3/8" diameter rope and press around perimeter of new glass.
- M. Using a putty knife, triangulate the surface of the compound. Hold the knife at a 45 degree angle and align compound with the muntin on the interior.
- N. Allow the compound to dry for a week, and then paint accordingly with 1/16" of paint extending onto the surface of the glass to act as a moisture seal.

3.04 ADJUSTING/CLEANING

- A. After the installation of the frame is complete, remove all non-permanent labels from the glass.
- B. After glazing compound has cured (and been sealed with paint in the case of traditional putties), wash the glass on both sides with a mild solution of soapy water. NOTE: ALKALINE OR ABRASIVE AGENTS ARE NEVER TO BE USED TO CLEAN GLASS. CARE SHALL BE TAKEN DURING CLEANING TO AVOID SCRATCHING OF GLASS SURFACES THAT WOULD OCCUR IF USING GRITTY MATERIALS OR DRY CLOTHS.
- C. Thoroughly rinse away any soap residue with clean, clear water. If desired, at this point a glass cleaning solution containing alcohol or ammonia may be used on the glass (unless the frame has been finished with shellac).
- D. Dry both sides of glass with a soft, dry cotton cloth.
- E. The use of newspapers is an effective traditional method for buffing the surface of glass after work is complete.
- F. Clean any excess glazing compound or spills from frames, sash and adjacent surfaces promptly after installation.

1.3.3 Preservation and rehabilitation guidelines for historic wood windows

According to *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, the proper procedure for preservation and rehabilitation is to respect the significance of the original materials and features, repair and retain them wherever possible, and replace them only when absolutely necessary (Grimmer 2017) .

The following recommendations for care of historic wood windows are to be thoroughly read and understood before a treatment is specified. Table 3 (preservation) and Table 4 (rehabilitation) contain information excerpted from Grimmer 2017. Any related NPS or GSA guidelines should also be consulted to determine the appropriateness of any treatment.

Table 3. Preservation treatment for windows (Grimmer 2017, 46–48).

Preservation Treatment for Windows	
RECOMMENDED	NOT RECOMMENDED
Identifying, retaining, and preserving windows and their functional and decorative features that are important to the overall historic character of the building. The window material and how the window operates (e.g., double hung, casement, awning, or hopper) are significant, as are its components (including sash, muntins, ogee lugs, glazing, pane configuration, sills, mullions, casings, or brick molds) and related features, such as shutters.	<p>Altering windows or window features which are important in defining the historic character of the building so that, as a result, the character is diminished.</p> <p>Changing the appearance of windows that contribute to the historic character of the building by replacing materials, finishes, or colors which noticeably change the sash, depth of reveal, and muntin configuration; the reflectivity and color of the glazing; or the appearance of the frame.</p> <p>Obscuring historic wood window trim with metal or other material.</p>
Stabilizing deteriorated or damaged windows as a preliminary measure, when necessary, prior to undertaking preservation work.	Failing to stabilize deteriorated or damaged windows as a preliminary measure, when necessary, prior to undertaking preservation work.
Protecting and maintaining the wood or metal which comprises the window jamb, sash, and trim through appropriate surface treatments, such as cleaning, paint removal, and reapplication of the same protective coating systems.	Failing to protect and maintain materials on a cyclical basis so that deterioration of the window results.
Protecting windows against vandalism before work begins by covering them and by installing alarm systems that are keyed into local protection agencies.	Leaving windows unprotected and subject to vandalism before work begins, thereby also allowing the interior to be damaged if it can be accessed through unprotected windows.
Installing impact-resistant glazing, when necessary for security, so that it is compatible with the historic windows and does not damage them or negatively impact their character.	Installing impact-resistant glazing, when necessary for security, that is not compatible with the historic windows and damages them or negatively impacts their character.
Making windows weathertight by recaulking gaps in fixed joints and replacing or installing weatherstripping.	Replacing windows rather than maintaining the sash, frame, or glazing.
Protecting windows from chemical cleaners, paint, or abrasion during work on the exterior of the building.	Failing to protect historic windows from chemical cleaners, paint, or abrasion when work is being done on the exterior of the building.
Protecting and retaining historic glass when replacing putty or repairing other components of the window.	Failing to protect the historic glass when making repairs.
Sustaining the historic operability of windows by lubricating friction points and replacing broken components of the operating system (such as hinges, latches, sash chains or cords) or replacing deteriorated gaskets or insulating units.	<p>Failing to maintain windows and window components so that windows are inoperable, or sealing operable sash permanently.</p> <p>Failing to repair and reuse window hardware such as sash lifts, latches, and locks</p>
Adding storm windows with a matching or a one-over-one pane configuration that will not obscure the characteristics of the historic windows. Storm windows improve energy efficiency and are especially beneficial when installed over wood windows because they also protect them from accelerated deterioration.	
Protecting adjacent materials when working on windows.	Failing to protect adjacent materials when working on windows.
Evaluating the overall condition of windows to determine whether more than protection and maintenance, such as repairs to windows and window features, will be necessary.	Failing to undertake adequate measures to ensure the protection of windows.
Repairing window frames and sash by patching, splicing, consolidating, or otherwise reinforcing them using recognized preservation methods.	Removing window frames or sash that could be stabilized, repaired, and conserved, or using untested consolidants, improper repair techniques, or untrained personnel, potentially causing further damage to historic buildings.
Using corrosion-resistant roof fasteners (e.g., nails and clips) to repair a roof to help extend its longevity.	
<i>The following work is highlighted to indicate that it represents the greatest degree of intervention generally recommended within the treatment. Preservation, and should only be considered after protection, stabilization, and repair concerns have been addressed.</i>	
Limited Replacement in Kind	
Replacing in kind extensively deteriorated or missing components of windows when there are surviving prototypes, such as frames or sash, or when the replacement can be based on documentary or physical evidence. The new work should match the old in material, design, scale, color, and finish.	<p>Replacing an entire window when limited replacement of deteriorated or missing components is appropriate.</p> <p>Using replacement material that does not match the historic window.</p>

Table 4. Rehabilitation treatment for windows (Grimmer 2017, 102–109).

Rehabilitation Treatment for Windows	
RECOMMENDED	NOT RECOMMENDED
Identifying, retaining, and preserving windows and their functional and decorative features that are important to the overall character of the building. The window material and how the window operates (e.g., double hung, casement, awning, or hopper) are significant, as are its components (including sash, muntins, ogee lugs, glazing, pane configuration, sills, mullions, casings, or brick molds) and related features, such as shutters.	<p>Removing or substantially changing windows or window features which are important in defining the overall historic character of the building so that, as a result, the character is diminished.</p> <p>Changing the appearance of windows that contribute to the historic character of the building by replacing materials, finishes, or colors which noticeably change the sash, depth of the reveal, and muntin configurations; the reflectivity and color of the glazing; or the appearance of the frame.</p> <p>Obscuring historic wood window trim with metal or other material.</p> <p>Replacing windows solely because of peeling paint, broken glass, stuck sash, or high air infiltration. These conditions, in themselves, do not indicate that windows are beyond repair.</p>
Protecting and maintaining the wood or metal which comprises the window jamb, sash, and trim through appropriate treatments, such as cleaning, paint removal, and reapplication of protective coating systems.	Failing to protect and maintain window materials on a cyclical basis so that deterioration of the window results.
Protecting windows against vandalism before work begins by covering them and by installing alarm systems that are keyed into local protection agencies.	Leaving windows unprotected and subject to vandalism before work begins, thereby also allowing the interior to be damaged if it can be accessed through unprotected windows.
Making windows weathertight by recaulking gaps in fixed joints and replacing or installing weatherstripping.	
Protecting windows from chemical cleaners, paint, or abrasion during work on the exterior of the building.	Failing to protect historic windows from chemical cleaners, paint, or abrasion when work is being done on the exterior of the building.
Protecting and retaining historic glass when replacing putty or repairing other components of the window.	Failing to protect the historic glass when making window repairs.
Sustaining the historic operability of windows by lubricating friction points and replacing broken components of the operating system (such as hinges, latches, sash chains or cords) and replacing deteriorated gaskets or insulating units.	<p>Failing to maintain windows and window components so that windows are inoperable, or sealing operable sash permanently.</p> <p>Failing to repair and reuse window hardware such as sash lifts, latches, and locks.</p>
Adding storm windows with a matching or a one-over-one pane configuration that will not obscure the characteristics of the historic windows. Storm windows improve energy efficiency and are especially beneficial when installed over wood windows because they also protect them from accelerated deterioration.	
Adding interior storm windows as an alternative to exterior storm windows when appropriate.	
Installing sash locks, window guards, removable storm windows, and other reversible treatments to meet safety, security, or energy conservation requirements.	
Evaluating the overall condition of the windows to determine whether more than protection and maintenance, such as repairs to windows and window features, will be necessary.	Failing to undertake adequate measures to ensure the protection of window features.
Repairing window frames and sash by patching, splicing, consolidating, or otherwise reinforcing them using recognized preservation methods. Repair may include the limited replacement in kind or with a compatible substitute material of those extensively deteriorated, broken, or missing components of features when there are surviving prototypes, such as sash, sills, hardware, or shutters.	<p>Removing window features that could be stabilized, repaired, or conserved using untested consolidants, improper repair techniques, or unskilled personnel, potentially causing further damage to the historic materials.</p> <p>Replacing an entire window when repair of the window and limited replacement of deteriorated or missing components are feasible.</p>

(Table continues on next page.)

RECOMMENDED	NOT RECOMMENDED
Removing glazing putty that has failed and applying new putty; or, if glass is broken, carefully removing all putty, replacing the glass, and reputtying.	
Installing new glass to replace broken glass which has the same visual characteristics as the historic glass.	
Replacing in kind an entire window that is too deteriorated to repair (if the overall form and detailing are still evident) using the physical evidence as a model to reproduce the feature or when the replacement can be based on historic documentation. If using the same kind of material is not feasible, then a compatible substitute material may be considered.	Removing a character-defining window that is unrepairable or is not needed for the new use and blocking up the opening, or replacing it with a new window that does not match. Using substitute material for the replacement that does not convey the same appearance of the surviving components of the window or that is physically incompatible.
Modifying a historic single-glazed sash to accommodate insulated glass when it will not jeopardize the soundness of the sash or significantly alter its appearance.	Modifying a historic single-glazed sash to accommodate insulated glass when it will jeopardize the soundness of the sash or significantly alter its appearance.
Using low-e glass with the least visible tint in new or replacement windows.	Using low-e glass with a dark tint in new or replacement windows, thereby negatively impacting the historic character of the building.
Using window grids rather than true divided lights on windows on the upper floors of high-rise buildings if they will not be noticeable.	Using window grids rather than true divided lights on windows in low-rise buildings or on lower floors of high-rise buildings where they will be noticeable, resulting in a change to the historic character of the building.
Ensuring that spacer bars in between double panes of glass are the same color as the window sash.	Using spacer bars in between double panes of glass that are not the same color as the window sash.
Replacing all of the components in a glazing system if they have failed because of faulty design or materials that have deteriorated with new material that will improve the window performance without noticeably changing the historic appearance.	Replacing all of the components in a glazing system with new material that will noticeably change the historic appearance.
Replacing incompatible, non-historic windows with new windows that are compatible with the historic character of the building; or reinstating windows in openings that have been filled in.	
<i>The following work is highlighted to indicate that it is specific to Rehabilitation projects and should only be considered after the preservation concerns have been addressed.</i>	
Designing the Replacement for Missing Historic Features	
Designing and installing a new window or its components, such as frames, sash, and glazing, when the historic feature is completely missing. It may be an accurate restoration based on documentary and physical evidence, but only when the historic feature to be replaced coexisted with the features currently on the building. Or, it may be a new design that is compatible with the size, scale, material, and color of the historic building.	Creating an inaccurate appearance because the replacement for the missing window is based upon insufficient physical or historic documentation, is not a compatible design, or because the feature to be replaced did not coexist with the features currently on the building. Installing replacement windows made from other materials that are not the same as the material of the original windows if they would have a noticeably different appearance from the remaining historic windows.

(Table continues on next page.)

RECOMMENDED	NOT RECOMMENDED
Alterations and Additions for a New Use	
Adding new window openings on rear or other secondary, less-visible elevations, if required by a new use. The new openings and the windows in them should be compatible with the overall design of the building but, in most cases, not duplicate the historic fenestration.	Changing the number, location, size, or glazing pattern of windows on primary or highly-visible elevations which will alter the historic character of the building. Cutting new openings on character-defining elevations or cutting new openings that damage or destroy significant features. Adding balconies at existing window openings or new window openings on primary or other highly-visible elevations where balconies never existed and, therefore, would be incompatible with the historic character of the building.
Replacing windows that are too deteriorated to repair using the same sash and pane configuration, but with new windows that operate differently, if necessary, to accommodate a new use. Any change must have minimal visual impact. Examples could include replacing hopper or awning windows with casement windows, or adding a realigned and enlarged operable portion of industrial steel windows to meet life-safety codes.	Replacing a window that contributes to the historic character of the building with a new window that is different in design (such as glass divisions or muntin profiles), dimensions, materials (wood, metal, or glass), finish or color, or location that will have a noticeably different appearance from the historic windows, which may negatively impact the character of the building.
Installing impact-resistant glazing, when necessary for security, so that it is compatible with the historic windows and does not damage them or negatively impact their character.	Installing impact-resistant glazing, when necessary for security, that is incompatible with the historic windows and that damages them or negatively impacts their character.
Using compatible window treatments (such as frosted glass, appropriate shades or blinds, or shutters) to retain the historic character of the building when it is necessary to conceal mechanical equipment, for example, that the new use requires be placed in a location behind a window or windows on a primary or highly-visible elevation.	Removing a character-defining window to conceal mechanical equipment or to provide privacy for a new use of the building by blocking up the opening.

1.3.4 Maintenance / management for wood windows

Repair, renovation, and replacement of character-defining features to the USMMA historic district, such as wood windows, **MUST** be coordinated with the NY SHPO. If a character-defining feature has been previously removed or replaced on the contributing building, prior to this report, and as future renovations occur, these features need to be replaced with elements that replicate the original character-defining features of that building (see Figure 15). Historic photographs found in *Character-Defining Features of Contributing Buildings and Structures in the United States Merchant Marine Academy Historic District* report (Smith, Enscoe, and Adams 2014) will help guide this process in coordination with the NY SHPO. Figure 15 is an example of how to utilize that report in consultation and managing the historic resources.

Figure 15. Example of reference from a historic photograph (left, *Arts and Decoration*, 1919) to the current replacement window (right, ERDC-CERL, 2013).

Evaluating the architectural or historic significance of windows is the first step in planning for window treatments, and a general understanding of the function and history of windows is vital to making a proper evaluation. As part of this evaluation, one must consider four basic window functions: admitting light to the interior spaces, providing fresh air and ventilation to the interior, providing a visual link to the outside world, and enhancing the appearance of a building.

The key to successful planning for window treatments is a careful evaluation of existing physical conditions on a unit-by-unit basis. In any evaluation, it should be noted at a minimum to indicate the following: window location, condition of the paint, condition of the frame and sill, condition of the sash (rails, stiles, and muntins), glazing problems, hardware, and the overall condition of the window (excellent, fair, poor, and so forth).

The replacement of windows is often proposed because of condition or poor functioning. However, situations such as peeling paint, broken glass, stuck sashes, and high air infiltration are no indication that windows are beyond their useful lives. These concerns can be addressed through repair and repainting, and replacement is not recommended.

Wood windows that are repaired and properly maintained will have greatly extended service lives, while also contributing to the historic character of the building. The rehabilitation of original wood window sashes is required, unless they are damaged. Damage must be investigated and documented before replacement is considered.

1.4 Wood siding

Wood siding will occasionally need to be repaired or replaced. The type of wood siding found on some of the USMMA buildings is clapboard siding, which is installed in horizontal courses (rows) from the bottom up. Clapboards are made from several different types of wood including, pine, fir, and cedar. Signs of wood siding deterioration include horizontal cracks or splits along the grain lines, rot around the nails, water penetration, and insect damage. Whatever the causes of deterioration, careful analysis, supplemented by testing is vital to the success of any historic wood repair project. Repair of historic wood may consist of either patching the historic material or filling in with new material worked to match the historic material. If replacement is necessary, duplication of historic materials and detailing should be exact as possible to assure a repair that is functionally and aesthetically acceptable.

Any work done on these wood elements should be sympathetic to the significant qualities of the historic property.

1.4.1 Immediate concerns for wood siding

Deterioration of wood can be caused by environmental factors, inferior materials, poor workmanship, inherent structural design defects, and inadequate maintenance.

Wood siding elements are evaluated by assessing the following points (see some examples in Figure 16):

- The wood siding is structurally intact and performing its intended purpose.
- Wood siding is to be stripped and painted according to the standards.
- Deteriorated or damaged wood members are to be repaired according to the standards.
- Wood siding needs to be cleaned to maintain its historic appearance.
- Repairs to wood siding need to be made after gently cleaning the surface, if necessary.

- Replacement decisions should be based on an extensive evaluation of all wood options; replacement in substitute materials is not acceptable.
- Replacement in-kind of an entire wood feature only if it is too deteriorated to repair.

Figure 16. Cracked wood siding on dormer on Quarters B (ERDC-CERL, 2015).

1.4.2 Guidelines, briefs, bulletins, and sources for wood siding

In addition to the information contained in this manual, the authors have compiled the following federal resource publications (reproduced here for convenience, with links for online access given in References) to inform managers about standards, guidelines, and procedures for understanding architecture, and caring for, preserving, and rehabilitating historic buildings with emphasis on historic wood (see subsections 1.4.2.1 and 1.4.2.2).

1.4.2.1 Exterior paint problems (Weeks and Look 1982 - Preservation Brief #10)

Technical Preservation Services

National Park Service
U.S. Department of the Interior

[Home](#) > [How to Preserve](#) > [Preservation Briefs](#) > 10 Paint Problems

Some of the web versions of the Preservation Briefs differ somewhat from the printed versions. Many illustrations are new and in color; Captions are simplified and some complex charts are omitted. To order hard copies of the Briefs, see [Printed Publications](#)®.

PRESERVATION BRIEFS

10

Exterior Paint Problems on Historic Woodwork

Kay D. Weeks and David W. Look, AIA

[Purposes of Exterior Paint](#)
[Treating Paint Problems](#)
[Justification for Paint Removal](#)
[Paint Removal Precautions](#)
[Repainting Historic Buildings for Cosmetic Reasons](#)
[Conditions/Recommended Treatments](#)
[Selecting the Safest Method to Remove Paint](#)
[General Paint Type Recommendations](#)
[Summary and References](#)
[Reading List](#)
[Download the PDF](#)th

Peeling paint on historic wood siding. Photo: © John Leeke, 2002.

A cautionary approach to paint removal is included in the guidelines to the *Secretary of the Interior Standards for Rehabilitation*. Removing paints down to bare wood surfaces using harsh methods can permanently damage those surfaces; therefore such methods are not recommended. Also, total removal obliterates evidence of the historical paints and their sequence and architectural context.

This Brief expands on that advice for the architect, building manager, contractor, or homeowner by identifying and describing common types of paint surface conditions and failures, then recommending appropriate treatments for preparing exterior wood surfaces for repainting to assure the best adhesion and greatest durability of the new paint.

Although the Brief focuses on responsible methods of "paint removal," several paint surface conditions will be described which do not require any paint removal, and still others which can be successfully handled by limited paint removal. In all cases, the information is intended to address the concerns related to exterior wood. It will also be generally assumed that, because houses built before 1950 involve one or more layers of lead-based paint, the majority of conditions warranting paint removal will mean dealing with this toxic substance along with the dangers of the paint removal tools and chemical strippers themselves.

Purposes of Exterior Paint

Paint applied to exterior wood must withstand yearly extremes of both temperature and humidity. While never expected to be more than a temporary physical shield—requiring reapplication every 5 to 8 years—its importance should not be minimized. Because one of the

main causes of wood deterioration is moisture penetration, a primary purpose for painting wood is to exclude such moisture, thereby slowing deterioration not only of a building's exterior siding and decorative features but, ultimately, its underlying structural members. Another important purpose for painting wood is, of course, to define and accent architectural features and to improve appearance.

Treating Paint Problems in Historic Buildings

Exterior paint is constantly deteriorating through the processes of weathering, but in a program of regular maintenance—assuming all other building systems are functioning properly—surfaces can be cleaned, lightly scraped, and hand sanded in preparation for a new finish coat. Unfortunately, these are ideal conditions. More often, complex maintenance problems are inherited by owners of historic buildings, including areas of paint that have failed beyond the point of mere cleaning, scraping, and hand sanding (although much so-called "paint failure" is attributable to interior or exterior moisture problems or surface preparation and application mistakes with previous coats).

Although paint problems are by no means unique to historic buildings, treating multiple layers of hardened, brittle paint on complex, ornamental—and possibly fragile—exterior wood surfaces necessarily requires an extremely cautious approach. In the case of recent construction, this level of concern is not needed because the wood is generally less detailed and, in addition, retention of the sequence of paint layers as a partial record of the building's history is not an issue.

When historic buildings are involved, however, a special set of problems arises—varying in complexity depending upon their age, architectural style, historical importance, and physical soundness of the wood—which must be carefully evaluated so that decisions can be made that are sensitive to the longevity of the resource.

Justification for Paint Removal

At the outset of this Brief, it must be emphasized that removing paint from historic buildings—with the exception of cleaning, light scraping, and hand sanding as part of routine maintenance—should be avoided unless absolutely essential. ***Once conditions warranting removal have been identified the general approach should be to remove paint to the next sound layer using the gentlest means possible, then to repaint.*** Practically speaking as well, paint can adhere just as effectively to existing paint as to bare wood, providing the previous coats of paint are also adhering uniformly and tightly to the wood and the surface is properly prepared for repainting—cleaned of dirt and chalk and dulled by sanding.

But, if painted exterior wood surfaces display continuous patterns of deep cracks or if they are extensively blistering and peeling so that bare wood is visible, then the old paint should be completely removed before repainting. The only other justification for removing all previous layers of paint is if doors, shutters, or windows have literally been "painted shut," or if new wood is being pieced-in adjacent to old painted wood and a smooth transition is desired.

Paint Removal Precautions

Because paint removal is a difficult and painstaking process, a number of costly, regrettable experiences have occurred—and continue to occur—for both the historic building and the building owner. Historic buildings have been set on fire with blow torches; wood irreversibly scarred by sandblasting or by harsh mechanical devices such as rotary sanders and rotary wire strippers; and layers of historic paint inadvertently and unnecessarily removed. In addition, property owners, using techniques that substitute speed for safety, have been injured by toxic lead vapors or dust from the paint they were trying to remove or by misuse of the paint removers themselves.

Owners of historic properties considering paint removal should also be aware of the amount of time and labor involved. While removing damaged layers of paint from a door or porch railing might be readily accomplished within a reasonable period of time by one or two people, removing paint from larger areas of a building can, without professional assistance, easily become unmanageable and produce less than satisfactory results. The amount of work involved in any paint removal project must therefore be analyzed on a case-by-case basis. Hiring qualified professionals will often be a cost-effective decision due to the expense of materials, the special equipment required, and the amount of time involved. Further, paint removal companies experienced in dealing with the inherent health and safety dangers of paint removal should have purchased such protective devices as are needed to mitigate any dangers and should also be aware of State or local environmental and/or health regulations for hazardous waste disposal.

The paint on this exterior decorative feature is sound. Photo: NPS files.

When the protective and decorative paint finish was removed and an inappropriate clear finish applied, the exterior character of the building was altered. Photo: NPS files.

All in all, paint removal is a messy, expensive, and potentially dangerous aspect of rehabilitating or restoring historic buildings and should not be undertaken without careful thought concerning first, its necessity, and second, which of the available recommended methods is the safest and most appropriate for the job at hand.

Repainting Historic Buildings for Cosmetic Reasons

If existing exterior paint on wood siding, eaves, window sills, sash, and shutters, doors, and decorative features shows no evidence of paint deterioration such as chalking, blistering, peeling, or cracking, then there is no physical reason to repaint, much less remove paint! Nor is color fading, of itself, sufficient justification to repaint a historic building.

The decision to repaint may not be based altogether on paint failure. Where there is a new owner, or even where ownership has remained constant through the years, taste in colors often changes. Therefore, if repainting is primarily to alter a building's primary and accent colors, a technical factor of paint accumulation should be taken into consideration.

When paint builds up to a thickness of approximately 1/16" (approximately 16 to 30 layers), one or more extra coats of paint may be enough to trigger cracking and peeling in limited or even widespread areas of the building's surface. This results because excessively thick paint is less able to withstand the shrinkage or pull of an additional coat as it dries and is also less able to tolerate thermal stresses. Thick paint invariably fails at the weakest point of adhesion—the oldest layers next to the wood. Cracking and peeling follow. Therefore, if there are no signs of paint failure, it may be somewhat risky to add still another layer of unneeded paint simply for color's sake (extreme changes in color may also require more than one coat to provide proper hiding power and full color). When paint appears to be nearing the critical thickness, a change of accent colors (that is, just to limited portions of the trim) might be an acceptable compromise without chancing cracking and peeling of paint on wooden siding.

If the decision to repaint is nonetheless made, the "new" color or colors should, at a minimum, be appropriate to the style and setting of the building. On the other hand, where the intent is to restore or accurately reproduce the colors originally used or those from a significant period in the building's evolution, they should be based on the results of a paint analysis.

When the paint on the wood windows became too thick, it was removed and the window repainted. Photo: NPS files.

Identification of Exterior Paint Surface Conditions/Recommended Treatments

It is assumed that a preliminary check will already have been made to determine, first, that the painted exterior surfaces are indeed wood—and not stucco, metal, or other wood substitutes—and second, that the wood has not decayed so that repainting would be superfluous. For example, if any area of bare wood such as window sills has been exposed for a long period of time to standing water, wood rot is a strong possibility. Repair or replacement of deteriorated wood should take place before repainting. After these two basic issues have been resolved, the surface condition identification process may commence.

The historic building will undoubtedly exhibit a variety of exterior paint surface conditions. For example, paint on the wooden siding and doors may be adhering firmly; paint on the eaves peeling; and paint on the porch balusters and window sills cracking and alligatoring. The accurate identification of each paint problem is therefore the first step in planning an appropriate overall solution.

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 top 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. It is precisely because conditions will vary at different points on the building that a careful inspection is critical. Each item of painted exterior woodwork (i.e., siding, doors, windows, eaves, shutters, and decorative elements) should be examined early in the planning phase and surface conditions noted.

CLASS I Exterior Surface Conditions Generally Requiring No Paint Removal Dirt, Soot, Pollution, Cobwebs, Insect Cocoons, etc.

Cause of Condition

Environmental "grime" or organic matter that tends to cling to painted exterior surfaces and, in particular, protected

The problem evidenced here by mossy growth and deteriorated wood must be resolved and the wood allowed to dry out before the wood is repainted. Photo: NPS files.

surfaces such as eaves, do not constitute a paint problem unless painted over rather than removed prior to repainting. If not removed, the surface deposits can be a barrier to proper adhesion and cause peeling.

Recommended Treatment

Most surface matter can be loosened by a strong, direct stream of water from the nozzle of a garden hose. Stubborn dirt and soot will need to be scrubbed off using 1/2 cup of household detergent in a gallon of water with a medium soft bristle brush. The cleaned surface should then be rinsed thoroughly, and permitted to dry before further inspection to determine if repainting is necessary. Quite often, cleaning provides a satisfactory enough result to postpone repainting.

Mildew**Cause of Condition**

Mildew is caused by fungi feeding on nutrients contained in the paint film or on dirt adhering to any surface. Because moisture is the single most important factor in its growth, mildew tends to thrive in areas where dampness and lack of sunshine are problems such as window sills, under eaves, around gutters and downspouts, on the north side of buildings, or in shaded areas near shrubbery. It may sometimes be difficult to distinguish mildew from dirt, but there is a simple test to differentiate: if a drop of household bleach is placed on the suspected surface, mildew will immediately turn white whereas dirt will continue to look like dirt.

Recommended Treatment

Because mildew can only exist in shady, warm, moist areas, attention should be given to altering the environment that is conducive to fungal growth. The area in question may be shaded by trees which need to be pruned back to allow sunlight to strike the building; or may lack rain gutters or proper drainage at the base of the building. If the shady or moist conditions can be altered, the mildew is less likely to reappear. A recommend solution for removing mildew consists of one cup non-ammoniated detergent, one quart household bleach, and one gallon water. When the surface is scrubbed with this solution using a medium soft brush, the mildew should disappear; however, for particularly stubborn spots, an additional quart of bleach may be added. After the area is mildew-free, it should then be rinsed with a direct stream of water from the nozzle of a garden hose, and permitted to dry thoroughly. When repainting, specially formulated "mildew-resistant" primer and finish coats should be used.

Excessive Chalking**Cause of Condition**

Chalking—or powdering of the paint surface—is caused by the gradual disintegration of the resin in the paint film. (The amount of chalking is determined both by the formulation of the paint and the amount of ultraviolet light to which the paint is exposed.) In moderation, chalking is the ideal way for a paint to "age," because the chalk, when rinsed by rainwater, carries discoloration and dirt away with it and thus provides an ideal surface for repainting. In excess, however, it is not desirable because the chalk can wash down onto a surface of a different color beneath the painted area and cause streaking as well as rapid disintegration of the paint film itself. Also, if a paint contains too much pigment for the amount of binder (as the old white lead carbonate/oil paints often did), excessive chalking can result.

Recommended Treatment

The chalk should be cleaned off with a solution of 1/2 cup household detergent to one gallon water, using a medium soft bristle brush. After scrubbing to remove the chalk, the surface should be rinsed with a direct stream of water from the nozzle of a garden hose, allowed to dry thoroughly, (but not long enough for the chalking process to recur) and repainted, using a non-chalking paint.

Staining**Cause of Condition**

Staining of paint coatings usually results from excess moisture reacting with materials within the wood substrate. There are two common types of staining, neither of which requires paint removal. The most prevalent type of stain is due to the oxidation or rusting of iron nails or metal (iron, steel, or copper) anchorage devices. A second type of stain is caused by a chemical reaction between moisture and natural extractives in certain woods (red cedar or redwood) which results in a surface deposit of colored matter. This is most apt to occur in new replacement wood within the first 10-15 years.

Recommended Treatment

In both cases, the source of the stain should first be located and the moisture problem corrected.

When stains are caused by rusting of the heads of nails used to attach shingles or siding to an exterior wall or by rusting or oxidizing iron, steel, or copper anchorage devices adjacent to a painted surface, the metal objects themselves should be hand sanded and coated with a rust-inhibitive primer followed by two finish coats. (Exposed nail heads should ideally be countersunk, spot primed, and the holes filled with a high quality wood filler except where exposure of the nail head was part of the original construction system or the wood is too fragile to withstand the countersinking procedure.)

Discoloration due to color extractives in replacement wood can usually be cleaned with a solution of equal parts denatured alcohol and water. After the affected area has been rinsed and permitted to dry, a "stainblocking primer" especially developed for preventing this type of stain should be applied (two primer coats are recommended for severe cases of bleeding prior to the finish coat). Each primer coat should be allowed to dry at least 48 hours.

CLASS II Exterior Surface Conditions Generally Requiring Limited Paint Removal

Crazing

Cause of Condition

Crazing—fine, jagged interconnected breaks in the top layer of paint—results when paint that is several layers thick becomes excessively hard and brittle with age and is consequently no longer able to expand and contract with the wood in response to changes in temperature and humidity. As the wood swells, the bond between paint layers is broken and hairline cracks appear. Although somewhat more difficult to detect as opposed to other more obvious paint problems, it is well worth the time to scrutinize all surfaces for crazing. If not corrected, exterior moisture will enter the crazed surface, resulting in further swelling of the wood and, eventually, deep cracking and alligatoring, a Class III condition which requires total paint removal.

Recommended Treatment

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

Crazing—or surface cracking—is an exterior surface condition which can be successfully treated by sanding and painting. Photo: Courtesy, National Decorating Products Association.

Intercoat Peeling

Here, a latex top coat was applied directly over old oil paint, resulting in intercoat peeling. The latex was unable to adhere. If latex is used over oil, an oil-base primer should be applied first. Photo: Mary L. Oehrlin, AIA.

Cause of Condition

Intercoat peeling can be the result of improper surface preparation prior to the last repainting. This most often occurs in protected areas such as eaves and covered porches because 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 since, 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 hand or mechanically sanded, then repainted.

Where peeling was the result of using incompatible paints, the peeling top coat should be scraped and hand or mechanically sanded. 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

Cause of Condition

Solvent blistering, the result of a less common application error, is not caused by moisture, but by the action of ambient heat on paint solvent or thinners in the paint film. If solventrich 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, a blister should be cut open. 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, hand or mechanically 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

Cause of Condition

Another error in application that can easily be avoided is wrinkling. This 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 hand or mechanical sanding to provide as even a surface as possible, then repainted following manufacturer's application instructions.

Wrinkled layers can generally be removed by scraping and sanding as opposed to total paint removal. Photo: Courtesy, National Decorating Products Association.

CLASS III Exterior Surface Conditions Generally Requiring Total Paint Removal

If surface conditions are such that the majority of paint will have to be removed prior to repainting, it is suggested that a small sample of intact paint be left 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**Cause of Condition**

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

Extensively deteriorated paint needs to be removed to bare wood, then primed and repainted. Photo: NPS files.

Cracking/Alligatoring**Cause of Condition**

Cracking and alligatoring are advanced stages of crazing. Once the bond between layers has been broken due to 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, hand or mechanically sanded to the next sound layer, then repainted. However, if cracking and/or alligatoring have progressed to bare wood and the paint has begun to flake, it will need to 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.

Selecting the Appropriate/Safest Method to Remove Paint

After having presented the "hierarchy" of exterior paint surface conditions—from a mild condition such as mildew which simply requires cleaning prior to 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 building should be selected from the many available methods.

The treatments recommended—based upon field testing as well as onsite monitoring of Department of Interior grant-in-aid and certification of rehabilitation projects—are therefore those which 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. By applying these criteria, it will be seen that no paint removal method is without its drawbacks and all recommendations are qualified in varying degrees.

Methods for Removing Paint

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 building. Methods for paint removal can be divided into three categories (frequently, however, a combination of the three methods is used). Each method 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 have been identified that require limited paint removal such as crazing, intercoat peeling, solvent blistering, and wrinkling, 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—where the damaged paint is weak and already sufficiently loosened from the wood surface—scraping and hand sanding may be all that is needed prior to 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 1-5/16, 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; however, both of these tools, 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 (due to 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 it must be discarded and this process repeated until all layers adhere uniformly.

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

Summary of Abrasive Methods (Manual)

- **Recommended:** Putty knife, paint scraper, sandpaper, sanding block, sanding sponge.
- **Applicable areas of building:** All areas. For use on: Class I, Class II, and Class III conditions.
- **Health/Safety factors:** Take precautions against lead dust, eye damage; dispose of lead paint residue properly.

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 need to be employed; however, it should be noted 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: Designed as a finishing or smoothing tool—not for the removal of multiple layers of paint—the orbital sander is thus recommended when limited paint removal is required prior to repainting. Because it 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 3x7 inches to 4x9 inches and sandpaper is attached either by clamps or sliding clips. A medium grit, open-coat aluminum oxide sandpaper should be used; fine sandpaper clogs up so quickly that it is ineffective for smoothing paint.

Belt sander: A second type of power tool—the belt sander—can also be used for removing limited layers of paint but, in this case, 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 (also with a medium grit sandpaper) should be limited to flat surfaces and only skilled operators should be permitted to operate it within a historic preservation project.

Not Recommended

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 thus to be used exclusively for removing corrosion and paint from metals.

Waterblasting: Waterblasting above 600 p.s.i. 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. A detergent solution, a medium soft bristle brush, and a garden hose for purposes of rinsing, is the gentlest method involving water and is recommended when cleaning exterior surfaces prior to repainting.

Sandblasting: Finally—and undoubtedly 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 potentially the most damaging of all possibilities, even if a contractor promises that blast pressure can be controlled so that the paint is removed without harming the historic exterior woodwork. (For Additional Information, See Preservation Briefs 6, "Dangers of Abrasive Cleaning to Historic Buildings".)

Summary of Abrasive Methods (Mechanical)

- **Recommended:** Orbital sander, belt sander (skilled operator only).
- **Applicable areas of building:** Flat surfaces, i.e., siding, eaves, doors, window sills.
- **For use on:** Class II and Class III conditions.
- **Health/Safety factors:** Take precautions against lead dust and eye damage; dispose of lead paint residue properly.
- **Not Recommended:** Rotary drill attachments, high pressure waterblasting, sandblasting.

Thermal Methods

Where exterior surface conditions have been identified that warrant total paint removal such as peeling, cracking, or alligatoring, 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 building 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

A heat plate was used on the cornice to remove paint. Photo: NPS files.

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, it is recommended that this implement be used with a single circuit and that a fire extinguisher always be kept close at hand.

Electric heat gun: The electric heat gun (electric hot-air gun) looks like a hand-held hairdryer with a heavy-duty metal case. It has an electrical resistance coil that typically heats 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. It can be used to best advantage when a paneled door was originally varnished, then painted a number of times. In this case, the paint will come off quite easily, often leaving an almost pristine varnished surface behind. Like the heat plate, the heat gun works best on a heavy paint buildup. (It is, however, not very successful on only one or two layers of paint or on surfaces that have only been varnished. The varnish simply becomes sticky and the wood scorches.)

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. Its use is thus more limited than the heat plate, and most successfully used 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, fretwork, or "gingerbread."

The nozzle on the electric heat gun permits hot air to be aimed into cavities on solid decorative surfaces, such as this carriage house door. After the paint has been sufficiently softened, it can be carefully removed with a scraper. Photo: NPS files.

Not Recommended

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, at temperatures between 3200 and 3800 degrees Fahrenheit the open flame is not only capable of burning a careless operator and causing 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, leadbase paints will vaporize at high temperatures, releasing toxic fumes that can be unknowingly inhaled. Therefore, because both the heat plate and the heat gun are generally safer to use—that is, the risks are much more controllable—the blow torch should definitely be avoided!

Summary of Thermal Methods

- **Recommended:** Electric heat plate, electric heat gun.
- **Applicable areas of building:** Electric heat plate—flat surfaces such as siding, eaves, sash, sills, doors. Electric heat gun—solid decorative molding, balusters, fretwork, or "gingerbread."
- **For use on:** Class III conditions.
- **Health/Safety factors:** Take precautions against eye damage and fire. Dispose of lead paint residue properly.
- **Not Recommended:** Blow torch.

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, including:

- 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;
- 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 can involve potential health and safety hazards, no wholehearted recommendations can be made from that standpoint. 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 are capable of softening several layers of paint at a time so that the resulting "sludge"—which should be remembered 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.

However, whether liquid or semi-paste, 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 is recommended 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 needs to be mentioned here because it can actually cause the most 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 prior to repainting or refinishing. Now, it is more difficult to find commercially prepared caustic solutions in hardware and paint stores for homeowner 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, assurances should be given by these companies 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.

Summary of Chemical Methods

- **Recommended, with extreme caution:** Solvent-base strippers, caustic strippers.
- **Applicable areas of buildings:** decorative features, window muntins, doors, exterior shutters, columns, balusters, and railings.
- **For use on:** Class III Conditions.
- **Health/Safety factors:** Take precautions against inhaling toxic vapors; fire; eye damage; and chemical poisoning from skin contact. Dispose of lead residue properly.

General Paint Type Recommendations

Decorative features were painted with a traditional oil-based paint as a part of the rehabilitation. Photo: NPS files.

Based on the assumption 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, it is recommended that for CLASS I and CLASS II paint surface conditions, a top coat of high quality oil paint be applied when repainting. The reason for recommending oil rather than latex paints is that a coat of latex paint applied directly over old oil paint is more apt to fail. The considerations are twofold. First, because oil paints continue to harden with age, the old surface is sensitive to the added stress of shrinkage which occurs as a new coat of paint dries. Oil paints shrink less upon drying than latex paints and thus do not have as great a tendency to pull the old paint loose. Second, when exterior oil paints age, the binder releases pigment particles, causing a chalky surface. Although for best results, the chalk (or dirt, etc.) should always be cleaned off prior to repainting, a coat of new oil paint is more able to penetrate a chalky residue and adhere than is latex paint. Therefore, unless it is possible to thoroughly clean a heavily chalked surface, oil paints—on balance—give better adhesion.

If however, a latex top coat is going to be applied over several layers of old oil paint, an oil primer should be applied first (the oil primer creates a flat, porous surface to which the latex can adhere). After the primer has thoroughly dried, a latex top coat may be applied. In the long run, changing paint types is more time consuming and expensive. An application of a new oil-type top coat on the old oil paint is, thus, the preferred course of action.

If CLASS III conditions have necessitated total paint removal, there are two options, both of which assure protection of the exterior wood: (1) an oil primer may be applied followed by an oil-type top coat, preferably by the same manufacturer; or (2) an oil primer may be applied followed by a latex top coat, again using the same brand of paint. It should also be noted 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.

Summary and References

The recommendations outlined in this Brief are cautious because at present there is no completely safe and effective method of removing old paint from exterior woodwork. This has necessarily eliminated descriptions of several methods still in a developmental or experimental stage, which can therefore neither be recommended nor precluded from future recommendation. With the ever-increasing number of buildings being rehabilitated, however, paint removal technology should be stimulated and, in consequence, existing methods refined and new methods developed which will respect both the historic wood and the health and safety of the operator.

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Preservation Services (TPS), National Park Service prepares standards, guidelines, and other educational materials on responsible historic preservation treatments for a broad public.

September 1982

Reading List

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1.4.2.2 Surface preparation for painting wood (GSA 2016d)

Surface Preparation for Painting Wood

Procedure code:

630002S

Division:

Wood and Plastics

Section:

Wood Treatment

Last Modified:

08/17/2016

PART 1---GENERAL**1.01 SUMMARY**

- A. This specification provides guidance on preparing wood surfaces for painting.
- B. Wood surfaces scheduled to be refinished with a transparent finish shall have existing coating stripped and sanded prior to application of new coatings.
- C. Wood surfaces scheduled to be finished with an opaque finish shall either be stripped or sanded as required to produce a smooth substrate for application of the new coatings.
- D. See also:
 - 1. "Primers and Paints for Wood"
 - 2. "General Guidelines for Painting Exterior and Interior Surfaces"
 - 3. "Supplemental Guidelines for Removing Paint from Interior and Exterior Wood Surfaces"
 - 4. "Chemically Removing Paint from Wood Features"
 - 5. "Removing Paint from Wood Features Using Thermal Methods"

PART 2---PRODUCTS**2.01 MANUFACTURERS**

- A. American International Tool
Cranston, RI
1-800-932-5872
- B. Benjamin Moore
Montvale, NJ
855-724-6802

C. PPG Architectural Coatings

1-800-441-9695

2.02 MATERIALS

NOTE: Chemical products are sometimes sold under a common name. This usually means that the substance is not as pure as the same chemical sold under its chemical name. The grade of purity of common name substances, however, is usually adequate for stain removal work, and these products should be purchased when available, as they tend to be less expensive. Common names are indicated below by an asterisk (*).

- A. Paste Wood Filler: Solvent-based, air-drying, paste-type wood filler for use on open-grain wood on interior wood surfaces such as "Benwood Wood Grain Filler 238" (Benjamin Moore) or approved equal.

B. Trisodium Phosphate (TSP):

CAUTION: TSP IS BANNED IN SOME STATES. REGULATORY INFORMATION AND INFORMATION ON ALTERNATIVE OR EQUIVALENT CHEMICALS MAY BE REQUESTED FROM THE ENVIRONMENTAL PROTECTION AGENCY (EPA) REGIONAL OFFICE AND/OR THE STATE OFFICE OF ENVIRONMENTAL QUALITY.

1. TSP is a strong base-type powdered cleaning chemical sold under several brand names.
2. Other chemical or common names include Sodium Orthophosphate; Tribasic sodium phosphate; Trisodium orthophosphate; TSP*; Phosphate of soda. Available from chemical supply house, grocery store, supermarket or hardware store.
3. Products sold as substitutes for TSP may contain soda ash (sodium carbonate) and/or zeolites.
 - a. However, sodium carbonate is not as strongly basic as trisodium phosphate, making it less effective in demanding applications.
 - b. Zeolites are used in laundry detergents and rapidly break down in water, claiming to be essentially nonpolluting.
4. Potential Hazards: CAUSTIC TO FLESH, DAMAGING TO THROAT IF INHALED.
5. Safety Precautions: Wear proper personal protective equipment, and avoid inhalation, contact with skin and eyes, and do not ingest.

-OR-

C. Non-ammoniated detergent such as "Tide"

-OR-

D. Liquid bleach containing 5% sodium hypochlorite (common household bleach)

E. Boiled linseed oil

F. Pure steam-distilled turpentine (must be clean and clear so that it will not adversely affect the texture or durability of the paint)

G. Caulking Compound (listed in order of recommended usage):

1. Polyurethanes
 - a. Easily workable
 - b. Paintable

- c. 15-20 year life span

- d. Limited availability

- 2. Polysulfides

- a. Slow-drying

- b. Can be sanded and painted

- c. Highly elastic

- d. Limited availability (most frequently used for marine repairs)

- 3. Butyls

- a. Paintable

- b. Cannot be sanded

- c. 7-10 year life span

- 4. Silicones

- a. Some can be painted

- b. Generally cannot be sanded

- 5. Acrylic Latex:

- a. Paintable

- b. 5-10 year lifespan

- H. Clean, potable water

2.02 EQUIPMENT

- A. Sanding blocks, sanding sponges, orbital sander, all with a variety of grits.

- B. HEPA-rated sanding vacuum.

- C. Stiff, natural and nylon bristle brushes

PART 3---EXECUTION

3.01 PREPARATION

- A. Protection: Spot-prime exposed ferrous metals such as exposed nails heads that could come in contact with surfaces that are to be painted over with water-based paints. Use a suitable corrosion-inhibiting primer capable of preventing flash rusting and compatible with the coating being used.

- B. Lead paint hazards

- 1. NOTE: SANDING DUST MAY CONTAIN LEAD; REGULATIONS PROVIDED BY THE EPA REGIONAL OFFICE AND/OR THE STATE OFFICE OF ENVIRONMENTAL QUALITY CONCERNING THE HANDLING OF LEAD-BASE PAINT MUST BE FOLLOWED.

- 2. NOTE: SURFACES SHOULD BE TESTED FOR LEAD CONTENT IN ADVANCE OF WORK. IF THE TEST IS POSITIVE AND YOU ARE NOT CERTIFIED TO HANDLE LEAD-ABATEMENT TASKS, IT IS ILLEGAL FOR YOU TO PERFORM FURTHER WORK.

- a. As of 2010, those who perform indoor or outdoor renovation, repair, and painting projects that disturb lead-based paint in various facilities that were built before 1978 must be certified through the EPA, trained, and follow specific work practices to prevent lead contamination.
 - b. Violators can be fined up to \$37,500 per occurrence, per day.
3. For further lead paint abatement information, consult resources produced by leading experts, including the EPA, HUD, NCPPT and the Building Research Council.

C. Surface Preparation:

1. Lightly sand all surfaces, either by hand or with a sheet orbital sander, using fine grade sandpaper.
 - a. Chemical paint removers often raise the wood grain. Any rough fibers of raised grain will need to be sanded smooth as they will otherwise weaken the paint film causing premature paint failure.
 - b. Thermal methods of paint removal often leave behind hard particles of paint residue. These will also need to be removed prior to repainting to ensure a smooth paint finish.
 - c. Other paint removal technologies include steam generators (like those used for wallpaper removal) and infrared paint stripping.
2. If only limited paint removal is required, feather edges of sound paint to provide a smooth transition between the old and the new paint. Use either hand methods or a sheet orbital sander.

NOTE: BELT SANDERS SHOULD ONLY BE USED BY EXPERIENCED PERSONNEL. THEY WORK VERY QUICKLY AND IT IS EASY TO DAMAGE THE WOOD SUBSTRATE IF THEY ARE NOT USED CAREFULLY.

- D. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer before application of putty or plastic wood filler to finish surface imperfections. Sand smooth when dried.

E. Fill all nail holes, voids, surface defects, etc. prior to refinishing.

1. Putty stop holes where nails are set and screws countersunk on all finished woodwork.
2. Use putty or spackle to repair voids, cracks, minor splits, and similar surface defects in finished woodwork that is to be painted or stain-varnish finished.

F. Recondition wood to ensure a tight bond between the new paint and the wood. Wood that is not reconditioned after paint removal may absorb too much of the binder in the paint, resulting in poor binding of the prime coat.

1. Mix 2 parts boiled linseed oil with 1 part pure steam-distilled turpentine.
2. Apply liberally with a brush and allow to dry.
3. Repeat as necessary until dry surface has a slight sheen.

G. If all paint has not been removed, wash the painted surfaces to remove all grease, dirt and mildew, and to ensure adequate adhesion of the prime coat.

1. Traditionally, a solution of 3 quarts warm water mixed with 2/3 cup trisodium phosphate (TSP) and 1/2 cup NON-AMMONIATED detergent has been used for this cleaning process. Before attempting this, be sure to read the TSP cautions in 2.02 B. above, and consider alternatives to TSP use.
2. To combat a mildew problem, add 1 quart of liquid bleach to solution. For stubborn mildew, straight bleach may be necessary.
3. Scrub surfaces with a medium bristle brush and rinse with clean, clear water. Make sure the surface is completely

rinsed before painting.

4. NOTE: WHEN TSP IS MIXED WITH WATER, IT FORMS FREE ALKALI. THIS FREE ALKALI WILL CAUSE OIL-BASED PAINTS TO BECOME SOAPY SO THAT THEY WILL NOT STICK TO THE SUBSTRATE. RINSE SUBSTRATE THOROUGHLY WITH CLEAN WATER BEFORE PROCEEDING.
 5. NOTE: DETERGENTS THAT CONTAIN SODIUM CARBONATES WILL ALSO PREVENT OIL-BASED PAINTS FROM STICKING TO SUBSTRATE AND SHOULD THEREFORE BE AVOIDED OR THOROUGHLY RINSED. CHECK LABELS FOR INGREDIENTS.
 6. CAUTION: DO NOT MIX AMMONIA WITH CHLORINE BLEACH. A POISONOUS GAS WILL RESULT! For the same reason, do not utilize bleach on bird droppings.
- H. Apply a water repellent or water repellent preservative (WRP) to all exterior items that are subject to extreme weather conditions, that are especially dry or that may have been consolidated.
1. These exterior items include windows, cornices, or other severely peeling or exposed wood features.
 2. See "Preparing a Non-Toxic Water-Repellent Preservative" and "Applying a Water-Repellent Preservative to Wood" for guidance on preparation and application.
 3. It is generally beneficial to apply a water repellent or a water repellent preservative to any unpainted wood that is to be repainted, but especially to exposed exterior wood.
- I. Caulk any end grain wood that will be subject to water infiltration and any places where wood trim pieces or door and window frames meet wall surfaces.
- J. Wood trim which has been removed, or new pieces to be installed, may be "back-primed," i.e. painted along the end grain for additional moisture-proofing. When transparent finish is required, backprime with spar varnish.

1.4.3 Preservation and rehabilitation guidelines for wood siding

According to *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*, the proper procedure for preservation and rehabilitation is to respect the significance of the original materials and features, repair and retain them wherever possible, and replace them only when absolutely necessary (Grimmer 2017) .

Please refer to Table 1 (preservation) and Table 2 (rehabilitation) in wood millwork (section 1.1), which contains information excerpted from Grimmer 2017 for care of wood siding. These are to be read and understood before treatment is specified. Any related NPS or GSA guidelines should also be consulted to determine the appropriateness of any treatment.

1.4.4 Maintenance / management for wood siding

All building materials deteriorate with age and exposure to the weather. Through routine inspection and cyclical maintenance, the useful life span of a building and its historic fabric will be greatly increased. Preventive maintenance involves regular inspection of those parts of the building that are most likely to develop problems. Having a checklist for each USMMA building is advised to help the USMMA CRM and maintenance department identify and keep an accurate record or inventory of the building's problems, to facilitate systematic repair and maintenance. Begin early in project planning to ensure that design scopes, qualifications, and budgets address preservation compliance requirements.

Repair, renovation, and replacement of character-defining features to the USMMA historic district, such as wood siding, **MUST** be coordinated with the NY SHPO. If a character-defining feature has been previously removed or replaced on the contributing building, prior to this report, and as future renovations occur, these features need to be replaced with elements that replicate the original character-defining features of that building. Historic photographs found in *Character-Defining Features of Contributing Buildings and Structures in the United States Merchant Marine Academy Historic District* report (Smith, Enscoe, and Adams 2014) will help guide this process in coordination with the NY SHPO.

The ideal sequence for proper repainting of wood includes the following steps: cleaning surfaces; light scraping to remove loose and scaling paint; feathering uneven edges; priming any bare wood; and applying two finish coats. In most instances, complete removal of paint prior to repainting is unnecessary and is not recommended. However, complete paint removal may be necessary wherever a heavy buildup of multiple layers of hardened brittle paint, surface crazing or alligatoring, or intercoat peeling or blistering have been observed.

If the wood siding needs to be replaced, each clapboard should be nailed to the structure about 1/2 inch up from the thicker, bottom butt edge. These nails should be driven in just above the thinner top edge of the piece below. The nails should be set between 8 and 12 inches apart.

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13. SUPPLEMENTARY NOTES					
14. ABSTRACT The U.S. Merchant Marine Academy is located in Kings Point, New York. The Academy is listed on the National Register of Historic Places (#14000538). The historic district contains contributing mansions constructed during the Gold Coast Era and the Academy buildings constructed in 1942 to 1969. All buildings require regular planned maintenance and repair. The most notable cause of historic building element failure and/or decay is not because the historic building is old, but rather it is caused by an incorrect or inappropriate repair and/or basic neglect of the historic building fabric. This document is a maintenance manual compiled with as-is conditions of building materials at the Academy. The <i>Secretary of the Interior's Standards for the Treatment of Historic Properties on Preservation, Rehabilitation, and Repair</i> are discussed per material. This 8-volume report includes an overview volume plus volumes on each of the following elements: concrete, wood, brick, metal, roofing, stucco, and mechanical systems. All mentioned repair procedures are from the U.S. General Services Administration (GSA): Historic Preservation Technical Procedures and/or the National Park Service's series of Preservation Briefs. This report satisfies Section 110 of the National Historic Preservation Act (NHPA) of 1966, as amended.					
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