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10
Guideline on the Rehabilitation of Walls, Windows, and Roofs

The research forming the basis for this report was conducted pursuant to a contract with the U. S. Department of Housing and Urban Development (HUD). The statements and conclusions contained herein are those of the contractor and do not necessarily reflect the views of the U. S. Government in general or HUD in particular.

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- U.S. Conference of Mayors
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- National Trust for Historic Preservation
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- National Housing Rehabilitation Association
- National Home Improvement Council
- Building Code Action
- Council of American Building Officials
- National Conference of States on Building Codes and Standards
- National Fire Protection Association
- American Institute of Architects

FOREWORD

Our purpose in publishing the rehabilitation guideline series is to encourage the rehabilitation and conservation of our older building stock. By making our existing stock safe, sound, and functional, we can very significantly aid in achieving our national housing goals and revitalizing our urban areas. We are emphasizing and encouraging rehabilitation and conservation because they represent the most cost-effective way to add to and maintain our Nation's housing supply.

For some time, we have known that building codes which were established (primarily) for new construction actually served to impede rehabilitation projects. These new guidelines were developed so State and local officials could voluntarily adopt and use them in conjunction with existing codes in the inspection and approval of rehabilitated properties.

The guideline describes typical procedures for rehabilitating walls, windows, and roofs, which are the most common building components that pose special problems and require careful treatment in building rehabilitation. I believe that this addition to the guideline series will prove useful to many who are involved in the building rehabilitation process.

Samuel R. Pierce, Jr.
Secretary
U.S. Department of Housing
and Urban Development

The Rehabilitation Guideline Series

The *Rehabilitation Guidelines* were prepared by the National Institute of Building Sciences for the Department of Housing and Urban Development in response to the requirements of Section 903 of the Housing and Community Development Amendments of 1978.

As Congress intended, the *Rehabilitation Guidelines* are not a code, nor are they written in code language. Rather, they are designed for voluntary adoption and use by States and communities as a means to upgrade and preserve the nation's building stock, while maintaining reasonable standards for health and safety. The term "rehabilitation", as used in the guidelines, includes any set of activities related to the general view of existing buildings as a resource to be conserved, rehabilitated, or reused.

The initial edition of the *Rehabilitation Guidelines* is published in eight separate volumes. The first four guidelines are designed for use by building officials, members of the executive and legislative branches of government, and related commissions and organizations involved in developing or implementing building regulations. These guidelines cover the following topics:

1. The *Guideline for Setting and Adopting Standards for Building Rehabilitation* provides an introduction and background to the building regulations that affect rehabilitation. It describes methods for identifying regulatory problems in a community, and recommends ways to amend, modify, or supplement existing regulations to encourage rehabilitation.

2. The *Guideline for Municipal Approval of Building Rehabilitation* examines the inherent differences between regulating new construction and regulating rehabilitation, and presents specific recommendations for dealing with rehabilitation within municipal building departments.

3. The *Statutory Guideline for Building Rehabilitation* contains enabling legislation that can be directly adopted by communities to provide the legal basis for promoting rehabilitation through more effective regulation.

4. The *Guideline for Managing Official Liability Associated with Building Rehabilitation* addresses the liability of code officials involved with the administration and enforcement of rehabilitation, and provides recommendations for minimizing liability problems.

The remaining four guidelines are technical in nature, and are intended for use by code officials, inspectors, designers, and builders. The cover the following topics:

5. The *Egress Guideline for Residential Rehabilitation* lists design alternatives for the components of egress that are regulated by current codes such as number and arrangement of exits, corridors, and stairs, travel distance, dead-end travel, and exit capacity and width.

6. The *Electrical Guideline for Residential Rehabilitation* outlines procedures for conducting inspections of electrical systems in existing buildings, and presents solutions to common problems associated with electrical rehabilitation such as eliminating hazardous conditions, grounding, undersized service, number of receptacle outlets, and incompatible materials.

The *Plumbing DWV Guideline for Residential Rehabilitation* presents criteria and methods for inspecting and testing existing drain, waste, and vent (DWV) systems, relocating fixtures, adding new fixtures to existing DWV systems, extending existing DWV systems, and installing new DWV systems in existing buildings.

8. The *Guideline of Fire Ratings of Archaic Materials and Assemblies* contains the fire ratings of building materials and assemblies that are no longer listed in current building codes or related reference standards. Introductory material discusses flame spread, the effects of penetrations, and methods for determining the ratings of assemblies not listed in the guideline.

Because of the value to the building rehabilitation community provided by the initial eight *Rehabilitation Guidelines* published in 1980, two additional guidelines were developed as the *Rehabilitation Guidelines, 1982*. As with

Guidelines 4 through 8, Guidelines 9 and 10 are technical in nature and are intended for use by those involved in the building rehabilitation process. These guidelines cover the following topics:

9. The *Guideline for Structural Assessment* addresses the methods and approaches used to evaluate structural systems in existing buildings. This guideline describes the assessment of common building structural systems such as masonry bearing walls, and simple wood, steel and concrete frames.

10. The *Guideline on the Rehabilitation of Walls, Windows, and Roofs* describes typical methods and procedures and appropriate cautions attendant to rehabilitating many common examples of these building components for many existing structures.

The *Rehabilitation Guidelines*-or copies of specific guidelines-are available from HUD USER, P.O. Box 280, Germantown, Maryland 20767. Phone (301) 251-5154.

Contact HUD USER for cost and ordering information.

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Acknowledgments

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Introduction

During the past few years there has been a growing trend toward rehabilitating existing buildings. This is due to increased public awareness of and interest in the merits of preserving significant buildings and to lower total costs of rehabilitation compared with much new construction. The Tax Reform Act of 1976 and the Economic Recovery Tax Act of 1981 increased rehabilitation by creating new economic investment incentives.

Much of the rehabilitation work has centered around designated historic buildings. For this work to qualify for tax advantages it must conform to standards established by The Secretary of the Department of the Interior. The U.S. Department of the Interior has prepared a series of "Preservation Briefs." A complete listing of the Briefs and their authors is given in Appendix 2. While some of the information in the "Briefs" relates primarily to designated historic structures, most of the information is applicable to the rehabilitation of most existing buildings.

As part of HUD's goal of providing for housing and urban development through building rehabilitation as well as new construction, the material presented in the "Preservation Briefs" has been incorporated into this Guideline for the Rehabilitation of Walls, Windows and Roofs. Some portions of the "Briefs" have been removed, such as material relating to the history of building materials. In other cases, several "Briefs" have been combined into a single topic. The material presented in this Guideline, should be of value to owners, design professionals, contractors and others involved with the rehabilitation of existing buildings; however, rehabilitation-related functions, needs, and requirements are usually complex and require the sound judgment of qualified design professionals.

Inasmuch as the information in this Guideline is limited to the content of the Preservation Briefs identified in Appendix 2, there are some existing exterior materials, such as stucco, and alternative replacement materials, such as prefinished exterior plywood that are not addressed. Also some detailed information on exterior painting and conditions such as some types of masonry cracking and lintel damage are not included. Those with an interest in materials, conditions and methods not discussed should seek available resource material from other sources. A recently published Preservation Brief on exterior painting is identified in the Bibliography.

Because the "Preservation Briefs" were originally developed for use in connection with designated historic buildings, there is a strong emphasis on retention of esthetic qualities as well as on preservation of structural integrity. While the emphasis on esthetic qualities has been reduced somewhat from that contained in the "Preservation Briefs," it still will be found throughout this Guideline. Whether or not a building is designated as "historic," its valuable inherent esthetic qualities should be recognized during design and preserved during the construction phase of rehabilitation.

Building owners interested in obtaining the tax benefits available for rehabilitation work should consult with the appropriate State Historic Preservation Officer during the early stages of project planning. See Appendix 4 for a listing of regional Historic Preservation Offices of the National Park Service. In addition, owners and architects may wish to read the complete "Preservation Brief" concerning each item of proposed work.

Building Code Requirements

The wall, window, and roof components of existing buildings are subject to the building code requirements for new construction only when rehabilitation work is major in scope (triggering the "25-50% Rule" or other provisions for this purpose included in most codes) or when there is a change in building use or occupancy classification. Otherwise, the requirements of building maintenance codes (usually issued as property maintenance, housing, or health codes) are likely to apply. In either case, typical code provisions are similar and focus on the following health and safety issues:

- Natural light. Habitable rooms should be provided with natural light by means of exterior glazed openings. The area required is normally a percentage of the floor area, usually 10 percent. Artificial illumination may be provided in lieu of this requirement in non-residential buildings.

- Ventilation. Habitable rooms should be provided with operable exterior openings. The area of these openings is normally percentage of the floor area, usually 5 percent. A mechanical ventilation system may be provided in lieu of this requirement.

- Egress. For dwelling units, every sleeping room below the fourth floor should have at least one operable window or exterior door for emergency egress or rescue. Most codes require that egress windows have a minimum net clear opening of 5.7 square feet, with a clear height of at least 24 inches and a clear width of at least 20 inches, and a sill height not more than 44 inches above the floor.

- Accident safety. Replacement glazing should be tempered, wire, or laminated glass or approved plastic material if located in areas subject to human impact such as glass doors, glazing immediately adjacent to such doors, glazing adjacent to any surface normally used as a walking surface, sliding glass doors, and storm doors.

- Structural safety. Roofs and walls should be capable of resisting the forces and loads specified in the codes under which they were constructed or specified in retroactive regulations which have since been imposed (see Rehabilitation Guideline Number 9 for Structural Assessment).

Because most existing buildings meet these very basic health and safety requirements, it is unlikely that code requirements will pose a significant problem to the rehabilitation of walls, windows, and roofs. However, the rehabilitator should make certain that these requirements are not violated during the rehabilitation process (such as the replacement of a movable sash with a fixed window in an exterior opening that is required to function as a means of egress), and that whenever there are existing code violations they be remedied during the rehabilitation process.

1 Masonry

1.1 General

The rehabilitation of exterior masonry walls can have a direct effect on their physical integrity and on their appearance. Appropriate treatment can restore a deteriorated wall, adding years to its useful life. Inappropriate treatment can hasten deterioration of walls, even those which are otherwise in sound condition. Appropriate and inappropriate treatments are described herein.

The most common treatments to exterior masonry walls are cleaning, repointing, and coating. In some instances, rehabilitation includes repair or replacement of deteriorated masonry units or rebuilding sections of a wall.

Masonry, for the purposes of this guideline, includes brick, stone, and terra-cotta. Construction of concrete masonry units (concrete blocks) is not included in this guideline; although many of the treatments for other types of masonry are equally applicable to concrete masonry construction.

1.2 Cleaning

Cleaning probably is the most common treatment given to existing masonry walls. It is imperative that cleaning be done in the manner which will have the least potential for causing damage to the building while providing the desired level of cleanliness.

WHY CLEAN?

The reasons for cleaning any building must be considered carefully before arriving at a decision to clean.

- Is the cleaning being done to improve the appearance of the building or to make it look new? The so-called "dirt" actually may be weathered masonry, not accumulated deposits; a portion of the masonry itself thus will be removed if a "clean" appearance is desired.

- Is there any evidence that dirt and pollutants are having a harmful effect on the masonry? Improper cleaning can accelerate the deteriorating effect of pollutants.

- Is the cleaning an effort to "get your project started" and improve public relations? Cleaning may help a local group with short term fund raising, yet if improperly done, can cause long term damage to the building.

These concerns may lead to the conclusion that cleaning may not be desirable until further study is made of the building, its environment and alternative cleaning methods.

TYPES OF CLEANING

Cleaning methods generally are divided into three major groups: water, chemical, and mechanical (abrasive). Water methods soften the dirt and rinse the deposits from the surface. Chemical cleaners react with the dirt and/or masonry to hasten the removal process; the deposits, reaction products and excess chemicals then are rinsed away with water. Mechanical methods include grit blasting (usually sand blasting), grinders, and sanding discs, which remove the dirt, and part of the masonry surface as well, by abrasion and are usually followed by a water rinse.

WHAT IS THE DIRT?

The general nature and source of dirt on a building must be determined in order to remove it in the most effective, yet least harmful, manner. Soot and smoke, for example, may require a different method of cleaning than oil stains or bird droppings.

Other common cleaning problems include stains from oxidizing metals such as ferrous or copper, and organic matter such as the tendrils left on the masonry after removal or plant growth such as ivy. The source of dirt, such as coal soot, may no longer be a factor in planning for longer term maintenance, or it may be a continuing concern. Efflorescence, soluble salts deposited on the surface of the masonry, is another common problem. (See Figure 1.) These salts usually originate in the masonry or migrate from the ground below; they also may result from air pollution or from improper cleaning techniques. The salts may be in the masonry units, either the facing masonry units or the backup units, or in trim materials, such as caps, copings, sills, lintels and keystones. Also, they could be from any of the basic mortar materials, cement, lime, sand and water. In addition, there are other miscellaneous sources of salts, such as admixtures, calcium chloride, or the atmosphere.

Figure 1

If the proposed cleaning is to remove paint, it is important in each case to learn whether or not exposed brick is historically appropriate. Many buildings were painted at the time of construction or shortly thereafter; retention of the paint, therefore, may be more appropriate historically than exposing the brick. Even in cases where unpainted masonry is appropriate, the retention of the paint may be more practical than removal in terms of long range preservation of the masonry. In some cases, however, removal of the paint may be desirable. For example, the old paint layers may have built up to such an extent that removal is necessary prior to repainting. In the case of a historic building, however, it is essential that research on the paint type, color, and layering be completed for the entire building before removal.

WHAT IS THE CONSTRUCTION OF THE BUILDING?

The construction of the building must be considered in developing a cleaning program because inappropriate cleaning can have a corrosive effect on both the masonry and on other building materials. Improper cleaning products can cause damaging chemical reactions with the masonry itself.

Figure 2

Other building materials also may be affected by the cleaning process; some chemicals, for example, may have a corrosive effect on paint and glass. Totally unseen items, such as iron cramps or ties which hold the masonry to the structural frame, also may be subject to corrosion from the use of chemicals or even from plain water. If these items rust, for example, the accompanying increase in volume can spall the masonry. (See Figure 2.)

Previous treatments of the building and its surroundings also should be evaluated, if known. Earlier waterproofing applications may make cleaning difficult. Repairs may have been stained to match the building, and cleaning may make these differences apparent. Salts or other snow removal chemicals used near the building may have dissolved and been absorbed into the masonry, causing potentially serious problems of spalling or efflorescence. Techniques for overcoming each of these problems should be considered prior to the selection of a cleaning method.

TESTING

Several potentially useful cleaning methods should be tested prior to selecting the one for use on the building. The simplest and least harmful methods should be included--as well as those that are more complicated. All too often, simple methods, such as a low pressure water wash, are not even considered, yet they frequently are effective, safe, and least expensive.

The level of cleanliness desired also should be determined before selecting a cleaning method. Obviously, the intent of cleaning is to remove most of the dirt. A "brand new" appearance, however, may be inappropriate for an older building, and may require an overly harsh cleaning method. It may be wise, therefore, to determine a lower level of acceptable cleaning. The precise amount of residual dirt considered acceptable would depend upon the type of masonry and local conditions.

Cleaning tests should be made regardless of the basic cleaning method selected. These tests should include a variety of chemical concentrations, water pressures, and so forth. A single building may have several types of masonry, and similar materials may have different surface finishes; each of these differing areas should be tested separately. Once tentatively acceptable test areas have been approved, the same cleaning methods should be used on larger areas using the actual production techniques. These larger areas should be at least a meter square and should include all variations of the masonry.

When feasible, test areas should be allowed to weather for an extended period prior to final evaluation. Some detrimental effects, such as the haze on the test patch shown in Figure 3, do not appear for some time. A waiting period of a full year is not unreasonable, so that the masonry and test area can be exposed to a full range of seasons. For a building which has been standing for many years, such a delay is insignificant when compared with the potential for damage and disfigurement resulting from inappropriate cleaning.

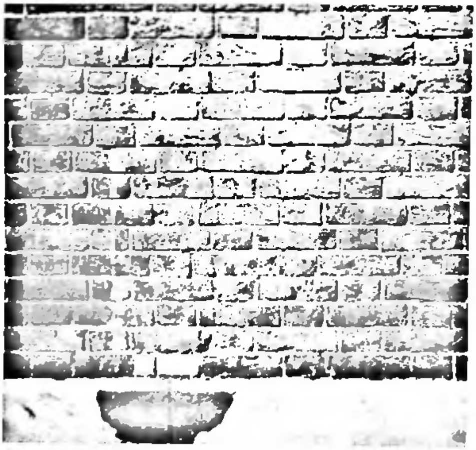


Figure 3 (Photo: Lee H. Nelson)

POTENTIAL PROBLEMS OF CLEANING

Water Cleaning

Water cleaning methods include: 1) low pressure wash over an extended period, 2) moderate to high pressure wash, and 3) steam. Any of these water based cleaning methods may also include the use of non-ionic detergents. Bristle brushes frequently are used to supplement the water wash. All joints, including mortar and sealants, must be sound in order to minimize water penetration to the interior.

Porous masonry may absorb excess amounts of water during the cleaning process and cause damage within the wall or on interior surfaces. Normally, however, water penetrates only part way through even moderately absorbant masonry materials.

Excess water also can bring soluble salts from within the masonry to the surface, forming efflorescences; in dry climates, the water may evaporate inside the masonry, leaving the salts slightly in back of the surface. Efflorescence usually can be traced to a source other than a single water wash.

Another source of surface visual disfigurement is chemicals such as iron and copper in the water supply; even "soft" water may contain deleterious amounts of these chemicals.

Water methods cannot be used during period of cold weather because water within the masonry can freeze, causing spalling and cracking.

A wall may take more than a week to become sufficiently dry to avoid damage due to freezing after water cleaning. Therefore, no water cleaning should be permitted for several weeks prior to the first average frost date, or even earlier if local forecasts predict cold weather.

Chemical Cleaning

Since most chemical cleaners are water based, they have many of the potential problems of plain water. Users should also be careful to avoid potential environmental damage due to chcmical runoff on to adjacent plant life and earth. Winds may carry chemical spray on to nearby automobiles and buildings and cause possible damage.

Chemical cleaners, used inappropriately, can cause other problems as well. Manufacturer's recommendations should be carefully followed when using chemical cleaning. Some types of masonry are subject to direct attack by cleaning chemicals; marble and limestone are dissolved easily by acidic cleaners, even in dilute forms. Similarly, glazed terra-cotta is susceptible to etching by acids, especially fluoride-based acids.

Brick buildings are susceptible to the formation of an efflorescence like "white scum" resulting from the use of hydrochloric (muriatic) acid, which is, unfortunately, widely used on these structures. Although this "white scum" may look like efflorescence, it is technically a silicic acid scum. It is a condition which can be reduced by fully saturating the wall before application and thoroughly rinsing the acid solution, but it can be avoided by not using hydrochloric acid for cleaning. It is generally a film of material that is insoluble in acid solutions except for hydroflouric acid, which is very dangerous and not recommended for this particular use.

Another problem may be a change in the color of the masonry caused by the chemicals, not by removal of dirt; the cleaner also may leave a hazy residue, as shown in Figure 3, in spite of heavy rinsing. Chemicals can react with components of mortar, stone, or brick to release soluble salts which can form efflorescence.

Mechanical Cleaning

Grit blasters, grinders, and sanding discs all operate by abrading the dirt off the surface of the masonry, rather than reacting with the dirt and masonry as in water and chemical methods. Since the abrasives do not differentiate between the dirt and the masonry, some erosion of the masonry surface is inevitable with mechanical methods, especially blasting. See Figures 4 and 5. Although a skilled operator can minimize this erosion, some erosion will still take place. In the case of brick, glazed terra-cotta, soft stone, detailed carvings, or polished surfaces, even minimal erosion is unacceptable. Brick, a fired product, is hardest on the outside where the temperatures were highest; the loss of this "skin" of the brick exposes the softer inner portion to more rapid deterioration. Abrasion of intricate details causes a rounding of sharp corners and other loss of delicate features, while abrasion of polished surfaces removes the polished quality of those surfaces. Mechanical methods, therefore, should never be used on brick, soft stone, terra cotta, or carved or polished surfaces; extreme caution should be exercised in using them on other masonry.

Figure 4


Figure 5

Grit blasting, unfortunately, still is widely used in spite of these serious effects. In most cases, blasting will leave minute pits on the surface of the masonry. This additional roughness actually increases water retention on the surface, facilitates the collection of dirt and increases the area on which pollutants can react.

Mortar joints, especially those with lime mortar, also can be eroded by mechanical cleaning. In some cases, the damage may be visual, such as loss of joint detail or increased joint shadows. Joints constitute a significant portion of the masonry surface (up to 20% in a brick wall) so this change should not be considered insignificant. Usually, however, abrasive cleaning causes physical damage by eroding the mortar joints permitting increased water penetration, and eventually requiring complete repointing.

Although softer than the harder grit materials like sand, cornhusks and nutshells are sometimes used as grit materials. These materials, although less abrasive, can cause extensive damage.

WHEN IS ABRASIVE CLEANING PERMISSIBLE?

For the most part, with the exception of cleaning cast iron, abrasive cleaning is destructive to historic building materials. In a limited number of special cases, it may be appropriate, if supervised by a skilled conservator, to use a delicate abrasive technique, such as low pressure (100 psi or less) wet grit cleaning. This type of cleaning involves injecting a small amount of grit into a stream of low pressure water. It may be appropriate for small areas of stone masonry (i.e., rough cut limestone, sandstone, or unpolished granite) where milder cleaning methods have not been totally successful in removing harmful deposits of dirt and pollutants. Such areas may include stone window sills, the tops of cornices or column capitals, or other detailed areas of the facade. This is still an abrasive technique, and without proper caution in handling, it can be just as harmful to the building surface as any other abrasive cleaning method. Thus, the decision to use this type of "wet grit" process should be made only after testing and consultation with an experienced building conservator to assure that the gentelest combination of materials and techniques have been used. Rember that it is very difficult and possibly very costly to provide the necessary controls and or supervision to insure that abrasive cleaning techniques do not cause harm to buildings, especially historic buildings.

1.3 Repointing

All buildings and building materials are in a constant process of deterioration, as shown in Figure 6. Repointing is the process of removing deteriorated mortar and replacing it with new mortar, renewing the points and preventing further deterioration to the building. Properly done, repointing restores the visual and physical integrity of the masonry. Improperly done, repointing not only detracts from the appearance of the building, but may, in fact, cause physical damage to the masonry units themselves.

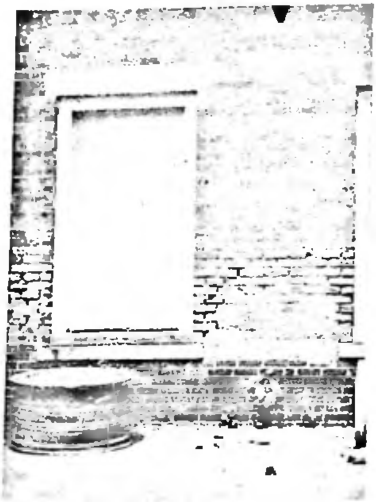


Figure 6 (Photo: Baird M. Smith)

IDENTIFYING THE PROBLEM

The decision to repoint is most often related to some obvious sign of deterioration such as disintegrating mortar, cracks in mortar joints, loose bricks, damp walls, or damaged plaster-work. It is, however, erroneous to assume that repointing alone will solve all these problems. Therefore, the true cause of the deterioration should be determined before beginning any repointing work. Leaking roofs or gutters, clogged or missing weepholes, faulty flashings, differential settlement of the building, capillary action causing rising damp, or extreme weather exposure should all be recognized as causes of deterioration and should be dealt with immediately.

SCHEDULING

In scheduling, seasonal aspects need to be considered first. Generally speaking, repointing should only be undertaken when the wall temperatures are between 40 degrees and 95 degrees (F) to prevent freezing or excessive evaporation of the water in the mortar.

The relationship of repointing to other proposed work on the building must also be recognized. For example, if paint removal or cleaning are anticipated and if the mortar joints are basically in sound condition and only need selective repointing, it is generally better to postpone repointing until after completion of these activities. However, if the mortar has badly eroded, thus allowing moisture to penetrate deeply into the wall, repointing should be accomplished before cleaning.

VISUAL EXAMINATION

All repointing work should be preceded by an analysis of the mortar and by an examination of the masonry units and the techniques used in the original construction of the wall. For most projects, a simple visual analysis of the mortar is sufficient to allow an appropriate match for the new mortar and avoid damage to the masonry units. The exact physical and chemical properties of the mortar are not of major significance as long as the new mortar:

- matches the original mortar in color, texture, and detailing;
- is softer (measured in compressive strength) than the masonry units;
- is as soft, or softer (measured in compressive strength) than the original mortar.

If the mortar mix used in the original construction of a building is known, it is preferable to use the same mix in repointing operations.

A simple method of analyzing the original mortar to aid in developing an appropriate repointing mortar for many restoration jobs and most rehabilitation work is as follows:

) Remove three or four unweathered samples of the mortar to be matched from several locations on the building (set the largest sample aside--this will be used later for comparison with the repointing mortar).

.) Break the remaining samples apart until they are separated. There should be a good handful of the material.

3) Carefully blow away the powdery material (the lime or cement matrix which bound the mortar together).

4) With a low power (10 power) magnifying glass, examine the remaining sand and other materials.

5) Note and record the wide range of color as well as the varying sizes of the individual grains of sand.

Original sand colors may range from white to grey to yellow within a given mortar sample. Furthermore, the varying sizes of the grains of sand or other materials such as shell play an important role in the texture of the repointing mortar. When specifying sand for repointing mortar, consideration may need to be given to obtaining sand from several sources and grain sizes in the sample. The role of the sand in the overall appearance of their replacement mortar should not be underestimated!

Pointing styles and the methods of producing them should be examined. See Figure 7. It is important to look at both the horizontal and the vertical joints to determine the order in which they were tooled and whether they were the same style. Some late-19th- and 20th-century buildings, for example, have horizontal joints that were tooled while the vertical joints were finished flush and stained to match the bricks, thus creating the illusion of horizontal bands. It is significant to note that pointing styles often differed from one facade to another. Front walls often received greater attention to mortar detailing than side and rear walls.

Figure 7 (Photo: Calder Loth)

The masonry units also should be examined so that any replacements will visually match the originals. It is also important that the replacement units approximate the physical characteristics of the adjacent units to avoid development of areas which have different thermal and moisture movement characteristics from the main body of the wall. Similarly, salvaged bricks must be used with caution; many of the units may be under-fired bricks from the interior portions of the wall, and they may deteriorate rapidly under exposure to weather.

PROPERTIES OF MORTAR

It is a common error to assume that hardness or high strength is a measure of durability. Stresses within a wall caused by expansion, contraction, moisture migration, or settlement must be accommodated in some manner; in a masonry wall, these stresses should be relieved by the mortar rather than by the masonry units. A mortar that is stronger or harder than the bricks or stone will not "give," thus causing the stresses to be relieved through the masonry units, resulting in cracking and spalling. Stresses can also break the bond between the mortar and the masonry, permitting water to penetrate the resulting hairline cracks.

Sand

Sand is the largest constituent of mortar and the principal material that gives mortar its characteristic color and texture. Particles of sand generally have either rounded edges, such as found in beach or river sand, or sharp, angular edges, found in crushed or manufactured sand. For repointing mortar, rounded or natural sand is preferred for two reasons. First, it is usually similar to the sand in the original mortar, thus providing a better visual match. Second, it has better "working" qualities or plasticity and can thus be forced into the joint more easily, forming a good contact with the existing mortar and the surface of the bricks or stones.

Lime or Portland Cement

The two commonly used binders for mortar are lime and portland cement. Of the two, lime produces a mortar that meets nearly all the requirements for a good mortar for older buildings, while portland cement produces a mortar that does not perform as well. High lime mortar is soft, porous, and changes little in volume during temperature fluctuations. In addition, lime mortar is slightly water soluble and thus is able to re-seal any hairline cracks that may develop during the life of the mortar. This process, known as autogeneous curing, is due to the fact that hydrated lime can completely harden only by the process of being changed to limestone by the action of atmospheric carbon dioxide in the presence of water. Portland cement, on the other hand, can be extremely hard, is resistant to movement of water, shrinks upon setting, and undergoes relatively large thermal movements. The use of a high lime mortar, therefore, is recommended for nearly all repointing projects. However, the addition of 5 percent white portland cement for up to 20 percent of the lime may improve the workability or plasticity without adversely affecting the desirable qualities of the lime mortar.

Additives

Additives introduced in recent years generally are unnecessary and may, in fact, have detrimental effects. Antifreeze compounds are not recommended, as they are not very effective with high lime mortars and may introduce salts which will later cause efflorescence. The use of air-entraining additives to resist frost action and enhance plasticity, are also discouraged, since the air has a detrimental effect on both bond and strength of the mortar. In areas of extreme exposure requiring high-strength mortars, air-entrainment may be desirable. Bonding agents that increase the bond of the new mortar to the old should also be avoided. If the joint is properly prepared, there will be a good bond between the new mortar and the adjacent surfaces; chemical agents do not significantly improve this bond and are not a substitute for proper joint preparation.

MATERIAL SPECIFICATIONS

Materials specified for use in repointing mortar should conform to standard specifications of the American Society for Testing Materials (ASTM) or comparable federal specifications.

Sand should conform to ASTM C-144 to assure proper gradation and freedom from impurities. Sand color, size, and texture should match the original as closely as practicable to provide the proper color match without other additives. Samples of sand proposed for use should be submitted for approval prior to beginning work.

Lime should conform to ASTM C-207, Type S, Special Hydrated Lime for Masonry Purposes. This lime is designed to assure high plasticity and water retention with a safe degree of strength. The use of quicklime, which must be slaked and soaked, does not provide better results.

Cement should conform to ASTM C-150, Type I (white non-staining) portland cement. It should not have more than 0.60 percent alkali to help avoid efflorescence.

Water should be potable--clean and free from acids, alkalies, or deleterious amounts of organic materials.

MATCHING COLOR AND TEXTURE OF MORTAR

In matching the repointing mortar, the new mortar should match the unweathered interior portions of the existing mortar. The simplest way to check the match is to make a small sample of the proposed mix and allow it to cure; this sample is then broken open and the broken surface is compared with the broken surface of the largest "saved" sample of original mortar.

If it is not possible to obtain a proper color match through the use of natural materials, it may be necessary to use a mortar pigment. Pigments are available as separate ingredients or already mixed with mortar; the premixed mortars normally are not suited for use on repointing projects because of their high portland cement content. Also, premixed mortars usually contain high limestone content which, unlike hydrated lime, is not a cementing agent and will not provide autogeneous curing of a lime mortar. Only chemically pure mineral oxides, which are alkali-proof and sun-fast, should be used to prevent bleaching and fading.

MORTAR MIX

As mentioned earlier, repointing mortar must have appropriate physical and visual characteristics. Specifying materials proportions for a particular job thus can become a perplexing task. The following guidelines can assist in developing an acceptable mortar. They should be considered as a starting point for testing, not as final specifications.

- Materials proportions should be given in comparable volumes, such as "4 parts of lime to 12 parts of sand," rather than measurements such as "2 bags of lime to 6 cubic feet of sand." This will avoid confusion on the jobsite when substitution of packaging sizes occurs.

- For many jobs, a mix in the proportions of 3 parts of lime to 1/2 part of portland cement to 7 to 8 parts of sand will prove durable without excessive hardness. Adjustments may be made to provide the desired visual characteristics as long as they do not alter the physical properties substantially.

- For surfaces of extreme exposure, such as parapet walls, or surfaces below grade, a more weather resistant mortar may be desirable. A mix in the proportions of 3 parts of lime to 2 parts of portland cement to 9 or 10 parts of sand will give greater weather resistance. Again, adjustments may be necessary.

- For buildings originally constructed with portland cement mortar, use the same mortar mix as used in the original construction, if known, otherwise use a mortar mix similar to type N.

EXECUTION OF THE WORK

Test panels

The best way to evaluate the acceptability of a proposed mason's technique is through preparation of a test panel. The area of the panel should be carefully selected to include all types of masonry, joint styles, and types of problems to be encountered on the job. Usually a 3-foot square area located in an inconspicuous, yet readily accessible, place is sufficient; orientation to the sun and continuing accessibility throughout the course of the project also should be considered.

Joint Preparation

Old mortar should generally be removed to a minimum depth of 2 1/2 times the width of the joint to ensure an adequate bond and to prevent mortar "popouts." For most joints, this will require removal of the mortar to a depth of approximately 1/2 inch to 1 inch. Any loose or disintegrated mortar beyond this minimum depth should be removed. Only hand tools, including striking hammers, "no-bounce" hammers, and a variety of masonry chisels, should be used for removal of the mortar. The use of power tools such as saws with carbide blades or impact hammers for the removal of mortar almost always result in damage to the masonry units by breaking the edges and by overcutting on the head, or vertical, joints as illustrated in Figure 8. Damage to the brick or stone not only affects their visual character as shown in Figure 9, but can also lead to accelerated weather damage. Where horizontal joints are uniform and fairly wide, it may be possible to use a saw to assist the removal of mortar; however, final preparation of the joint should be done by hand.

Figure 8 (Photo: John Myers)

Figure 9 (Photo: Lee H. Nelson)

Test panels are quite helpful, but they cannot adequately assess the potential effect of using a saw since such panels are not prepared under actual working conditions. If there is any chance of damaging the masonry, hand-methods should be used exclusively. Although slower, these methods are easier to control and less likely to cause irreversible damage to the bricks. Mortar should be removed cleanly from the bricks, leaving square corners at the back of the cut. Before filling, the joints should be rinsed with a jet of water to remove all loose particles and dust. At the time of filling, the joints should be damp but with no standing water present.

Mortar Preparation

Mortar should be mixed carefully to obtain uniformity of visual and physical characteristics. The mortar should be pre-hydrated. Dry ingredients should be measured by volume. To pre-hydrate mortar, thoroughly mix all ingredients dry. Then mix again, adding only enough water to produce a damp, workable mix, which will retain its form when pressed into a ball. After keeping mortar in this dampened condition for one to two hours, add sufficient water to bring it to the proper consistency; that is, somewhat dryer than conventional masonry mortar. The total volume of water necessary may vary from batch to batch, depending on weather conditions. Mortar should be used within 30 minutes of final mixing. Adding more water after the initial mix is prepared, should not be permitted.

Re-temperting of the mortar should be permitted only when necessary because of evaporation rather than setting of the mortar. Weather conditions and whether or not the mortar is in direct sunlight should be considered in determining the need for re-tempering. Because repointing operations proceed at a slower pace, the mortar should be mixed in smaller batches than typical for new masonry construction.

Filling the Joint

Where existing mortar has been removed to a depth of greater than 1 inch, these deeper areas should be filled first, compacting the new mortar in several layers. The back of the entire joint should be filled successively by applying approximately 1/4 inch of mortar, packing it well into the back corners. This application may extend for several feet. As soon as the mortar has reached thumb-print hardness, another 1/4 inch layer of mortar--approximately the same thickness--may be applied. Several layers will be needed to fill the joint flush with the outer surface of the brick. It is important to allow each layer time to harden before the next layer is applied; most of the mortar shrinkage occurs during the hardening process, and layering thus minimizes overall shrinkage.

The rate of hardening can be controlled by dampening the masonry before beginning to fill the joint, but free water or excessive dampness in the joint should be avoided.

When the final layer or mortar is thumb-print hard, the joint should be tooled to match the adjacent original joints. Proper timing of the tooling is important for uniform color and appearance. If tooled when too soft, the color will be lighter than expected, and hairline cracks may occur; if tooled when too hard, there may be dark streaks called "tool burning," and good closure of the mortar against the masonry units will not be achieved.

If the old bricks or stones have worn, rounded edges, it is usually best to recess the final mortar slightly from the face of the masonry. (See Figure 10) This treatment will help avoid a joint visually wider than the actual joint width; it will also avoid creation of a large, thin featheredge which is easily damaged, thus admitting water.

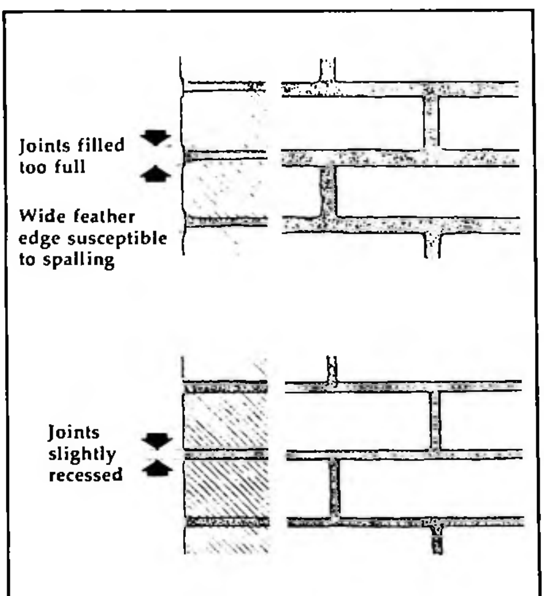


Figure 10

After tooling, it is frequently necessary to remove excess mortar from the edge of the joint by brushing with a stiff bristle brush. This step should be taken after the mortar has dried but before it is fully hardened (1-2 hours). Excess hardened mortar usually can be removed with a wooden paddle or, if necessary, a chisel.

"Aging" the Mortar

Even with the best efforts at matching the existing mortar color, texture, and materials, there usually will be a visible difference between the old work and the new, partly because the new mortar has been matched to the unweathered portions of the original mortar. If the mortars have been properly matched, the best treatment for surface color differences is to let the mortars age naturally.

Efforts to stain the new mortar to produce a color match should, in most cases, be avoided. Although such a process may provide an initial match, the old and new mortars may weather at different rates, leading to visual differences after a few seasons.

Cleaning

If repointing work is carefully executed, there will be little need for cleaning other than the small amount of mortar brushed from the edge of the joint following tooling, as described earlier.

Further cleaning is best accomplished with plain water and bristle brushes. Chemicals, if necessary, should be selected with extreme caution. Improper cleaning can lead to deterioration of the masonry units, deterioration of the mortar, mortar smear, and efflorescence.

New mortar joints are especially susceptible to damage because they do not become fully cured for several months. Chemical cleaners, particularly acids, should be used only once and should be flushed freely with plain water to remove all traces of the chemicals.

Several precautions should be taken prior to cleaning repointed mortar joints. First, the mortar should be fully hardened before cleaning; 30 days is usually sufficient, depending on weather and exposure. Only stiff natural bristle brushes should be used, except on glazed or polished surfaces; here, only soft cloths should be used.

New construction "bloom" or efflorescence occasionally appears within the first few months of repointing and usually disappears through the normal process of weathering. If the efflorescence is not removed by natural processes, the safest way to remove it is by dry brushing with stiff natural or nylon bristle brushes and water.

SCRUB COATS

A variety of new and purportedly useful techniques for mortar rehabilitation have been introduced over the past few years. These techniques are identified under a variety of names such as slurr coats, slurry coating, mask-and-grout, and scrub coats. These techniques involve brushing a thinned, low-aggregate coating of mortar over the entire masonry surface. In some instances, the surfaces of the masonry units themselves are protected by covering with tape, leaving only the mortar joints exposed. In other instances, the mortar is applied to the bricks or stones as well as to the joints; the mortar then is rubbed from the masonry units after it has dried.

These techniques have become increasingly appealing as they are quick and inexpensive compared to traditional repointing costs and they do not require the same level of skilled labor. Their greatest attraction lies in repointing large masonry surfaces, such as highrise buildings.

These techniques are of limited usefulness in most rehabilitation projects. While a certain amount of crack sealing in the mortar is achieved, the actual results are primarily cosmetic. The lifespan of the coating usually is limited. Since there is little joint preparation, the bond between the existing mortar and the scrub coat frequently is poor, leading to early failure of the new mortar.

While of some limited value in specific instances, these techniques should not be considered as substitutes for better quality repointing work.

1.4 Coatings

PROBLEMS OF WATER REPELLENT AND WATERPROOF COATINGS

Is Waterproofing Necessary?

Coatings frequently are applied to masonry buildings without concern of the requirement for, or the consequences of the coating. If the building has survived for year without coatings, why are they needed now? Water penetration to the interior usually is not caused by porous masonry but by deteriorated gutters and downspouts, deteriorated mortar, capillary moisture from the ground (rising damp), condensation, faulty caps, coping or flashing, or clogged or missing weepholes. Coatings will not solve these problems. The claim also is made that coatings keep dirt and pollutants from collecting on the surface of the building thus reducing the requirement for future cleaning. While this at times may be true, at other times the coatings actually retain the dirt more than uncoated masonry. More important, however, is the fact that these coatings can cause greater deterioration of the masonry than that caused by pollution.

Types of Coatings

Masonry coatings are of two types: waterproof coatings and water repellent coatings. Waterproof coatings seal the surface from liquid water and from water vapor; they usually are opaque, such as bituminous coatings and some paints. Water repellents keep liquid water from penetrating the surface but allow water vapor to enter and leave through the "pores" of the masonry. They usually are transparent, although they may change the reflective property of the masonry, thus changing the appearance.

Waterproof Coatings

These coatings usually do not cause problems as long as they exclude all water from the masonry. If water does enter the wall, however, the coating can intensify the damage because the water will not be able to escape. During cold weather this water in the wall can freeze, causing serious mechanical disruption, such as spalling. In addition, the water eventually will get out by the path of least resistance. If this path is toward the interior, damage to interior finishes can result; if it is toward exterior cracks in the coating, it can lead to damage from the build-up of salts.

Water Repellent Coatings

These coatings also can cause serious damage, but by a somewhat different mechanism. Water frequently can enter even a coated wall through hairline cracks, or by other means, as a vapor and then condense. The coating then keeps the liquid water in the wall, rather than allowing it to escape. If this water then freezes, the accompanying expansion can cause spalling of the masonry units.

Further damage can be done by soluble salts. Salts frequently are present in the masonry. See 1.2 Cleaning herein for additional information on the source of these salts. Liquid water can dissolve these salts and carry them toward the surface. If the water is permitted to come to the surface, efflorescences appear upon evaporation. These are unsightly but usually are easily removed; they often are washed away by the simple action of the rain.

The presence of a water repellent coating prevents the water and dissolved salts from coming completely to the surface. The salts then are deposited slightly behind the surface of the masonry as the water evaporates through the pores. Over time, the salt crystals will grow and will develop substantial pressures which will spall the masonry, detaching it at the depth of crystal growth. Although it can occur in as little as six months, this build-up may take several years to cause problems.

Test patches for coatings generally do not allow an adequate evaluation of the treatment, because water may enter and leave through the surrounding untreated areas, thus flushing away the salt build-up. In addition, salt deposits may not cause visible damage for several years, well after the patch has been evaluated.

This is not to suggest that there is never a use for water repellents or waterproofing. Sandblasted brick, for example, may have become so porous that some type of coating is essential. Similarly, terra-cotta with spalling or serious cracking of the glaze will need treatment to prevent entry of excessive amounts of water. Generally, coatings are not necessary unless there are specific problems which they will help to solve. If the problem occurs on only a portion of the masonry, it probably is best to treat only the problem area, rather than the entire building.

2
Wood Frame Exterior Walls

2.1
Historic Character

The exterior character of a building is largely established by its "style" and by the degree of decorative detailing. It is also influenced by the choice of materials for the walls--by their dimensions, details, color and other surface characteristics. This is particularly true for wood sided, frame buildings. Since wood has always been present in abundance in America, it has been a dominant building cladding and structural material in many parts of the country. Early craftsmen could harvest the wood and create both structural and finish members with their hand tools. The variety of tools used and regional differences in style resulted in the richness and diversity of wood textures. Later, as technology progressed, weatherboards produced by local mills continued to reflect regional traditions in material, style and dimension.

Today, a number of communities are conserving the unique characteristics of their historic buildings and districts with architectural controls. One of the reasons for such regulation is that the appearance of a building may be visually altered by changes in scale, texture, color and detailing which are inappropriate. These changes may be the result of efforts to reduce maintenance, to make the building look more "modern," or to reduce energy consumption.

2.2 Energy Conservation

Walls are one of the primary areas of heat loss and heat gain. This heat transfer is the result both of conduction through the wall and infiltration. Reduction of this heat transfer is a desirable component goal of rehabilitation. The work must be done with care, however, to prevent both structural damage and alteration of visual character. Additional considerations are discussed in the HUD publication "Conserving Energy in Older Homes."

Air Infiltration

During winter in colder climates, substantial heat loss occurs because cold outside air infiltrates the building through loose windows, doors, and cracks in the outside shell of the building. Adding weatherstripping to doors and windows, and sealing cracks and open joints will substantially reduce this infiltration. Care should be taken not to reduce infiltration to the point where the building is completely sealed and moisture migration is prevented. Without some infiltration, condensation problems can occur throughout the building. Also, without air infiltration or some other means of ventilation indoor air contaminants may build up to unacceptable levels. Reducing air infiltration should have a high priority; the cost is low, little skill is required, and the benefits are substantial.

Wall Insulation

The improper installation of wall insulation in some older frame buildings can result in serious technical and preservation problems. Some types of insulation must be kept dry to function properly. Without a vapor barrier those types of insulation may become saturated, losing their thermal properties and, in some cases, actually increasing the heat loss through the wall.

Additionally, moisture (in vapor form) may condense into water droplets and begin serious deterioration of adjacent building materials such as sills, window frames, framing and bracing. See Figure 11. Correcting such problems are often costly as they may necessitate the dismantling of the exterior or interior wall surfaces. It should be clear that the improper addition of wall insulation has the potential for causing serious damage to building materials.

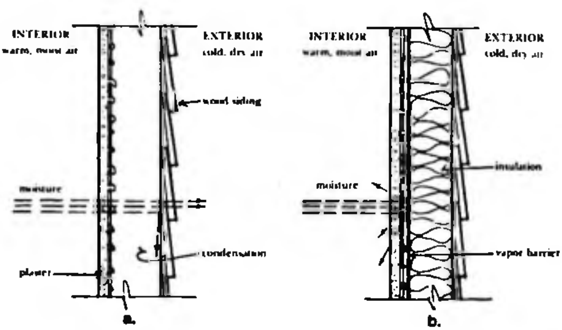


Figure 11

a. Typical wood frame wall where moist inside air freely migrates to the outside. Moisture may condense in the wall cavity and be absorbed into the adjacent materials and evaporate as the wall is heated by the sun.

b. Typical wall condition with insulation and a vapor barrier facing in (toward the heated side of the wall). The vapor barrier prevents moisture migration, thus keeping the insulation dry.

In spite of potential difficulties, adding wall insulation to frame buildings generally is considered desirable. The two approaches which have received widest acceptance are installation of batts, and blowing insulation into the wall cavity. In either of these approaches, a vapor barrier should always be installed on the inside face of the insulation.

The installation of batt insulation requires the removal of either the interior or exterior wall surface to permit access to the wall cavities. Though more costly than blowing, this technique assures that even small cavities can be filled with insulation. It also permits inspection of the structural system for hidden deterioration. Existing siding normally can be removed without damage, permitting re-installation of the original siding; this technique probably is desirable in cases in which the building is to remain occupied or in which there are decorative interior wall finishes. In other cases, it may be desirable to remove the interior finishes, thus keeping the weather surfaces intact. In either case, batt insulation with an integral vapor barrier can be installed; the vapor barrier should be on the interior of the insulation. If the insulation is installed from the interior, a polyethylene sheet can be applied as a vapor barrier after the insulation is installed. In exterior installations the polyethylene sheet vapor barrier can often be installed before the insulation.

The second possible approach involves blowing, pouring, or injecting insulation into the wall cavity. There are a variety of materials which can be considered for blown or poured insulation, including cellulose (with boric acid as the fire retardant), polystyrene beads, blown fiberglass, and expanded minerals. The installation procedure includes making a hole near the top of the wall cavity (from either the exterior or the interior), pouring or blowing the insulation into the cavity, and patching the hole. Cellulose is widely used because of its higher R factor and because it flows well into the various spaces within the cavity as it is blown in place.

There are two insulation types which are not recommended for wall insulation: cellulose which uses aluminum or ammonium sulfate as the fire retardant, and urea-formaldehyde foam. The cellulose treated with the sulfates reacts with moisture in the air and forms sulfuric acid which corrodes many metals and causes building stones to deteriorate.

Urea-formaldehyde foam insulations were widely used for several years; however, in February 1982 they were banned by the U.S. Consumer Product Safety Commission. Another major problem is that the injected foam insulating material often carries large quantities of moisture into the wall system. As the foam cures, this moisture must be absorbed into the adjacent materials. This process has caused interior and exterior paint to blister, and has caused water to actually puddle at the base of a wall, creating the possibility of serious deterioration to the building materials. In addition, the maximum shrinkage after curing (3%) has been tested and found to be as much as twice as high as advertised.

With blown or poured insulation, a vapor barrier cannot be installed simultaneously. An equivalent vapor barrier can be created by applying an impermeable paint layer to the interior wall surfaces. In addition, cracks in the painted surface, such as at baseboards and window trim, and other penetrations, such as electrical outlets, should be sealed to prevent entry of moist air into the wall cavity. Special attention should be given to rooms which are major sources of interior moisture, such as kitchens, bathrooms, and laundry areas.

Aluminum and vinyl sidings should not be considered an insulation. Energy savings resulting from the application of an alternate exterior siding material probably result primarily from the creation of an air space between old and new siding, reduced infiltration, the installation of some insulating material behind the siding or a combination of these factors.

There are numerous publications on energy retrofitting which explain techniques of determining cost-effectiveness based on utility costs, R-factors or materials, and initial cost of the treatment. It is recommended that a total energy analysis be conducted by a qualified professional for rehabilitation projects where energy use is an important factor.

2.3 Alternate Materials

There is a natural desire to reduce the labor and expense required to maintain a building. To this end, a number of products have been developed for installation over existing wood siding or as a replacement for existing wood siding. Two common products for this purpose include aluminum and vinyl siding. When used improperly, some of these products can cause technical problems. In addition, their application may cause significant and often undesirable, changes to the appearance of some buildings, as shown in Figure 12. These issues will be discussed in greater detail in this subsection.

Figure 12 (Photo: Laurie Robin Hammel)

Products and Installation

Horizontal lap sidings are the primary types of aluminum and vinyl products used on exterior facades of older buildings. Horizontal sidings are generally available in eight, five and four inch exposures to simulate clapboard widths. Trim pieces are produced to cover or replace existing details at corners, doors, windows and eaves. With both materials, the optional wood grain textures are exaggerated, and the typically available colors are generally light to minimize fading problems which are inherent in the darker shades.

The siding materials are advertised primarily by manufacturers. The installations, however, are often carried out by independent contractors or applicators which are not affiliated with the manufacturers. Since the manufacturer has no control over the quality of the installa-

.on, both the quality of the work and the ensitivity of the application vary significantly. Usually the manufacturer's warranties do not cover problems due to faulty installation. It is important that proper installation techniques be used to avoid sagging, bending, leaking, and other technical and appearance related problems.

Generally, application of the products is accomplished by nailing the siding panels, which are usually about 12 and 1/2 feet long, to the existing surface. Preparation consists of eliminating uneven areas, squaring up the starter strips and nailing furring strips where necessary to create a smooth and level surface. Usually there is little concern over damage or alteration to the existing exterior surface of the building, since it is expected to remain hidden for many years. In the standard installation, the siding panels are not nailed firmly to the surface, but are hung on nails, 16 inches on center, to allow for expansion. Trim pieces are used to aid in attachment and connection, and to cover or replace existing trim, but such pieces are usually quite different in size, shape, and location from original trim. For aluminum siding, sealant is recommended at all intersections where metal meets wood.

Removal of Features

Although it may be argued that an alternate siding application is reversible since it can be removed, there is frequently irreversible damage because decorative and other trim is often removed by applicators and discarded or destroyed. The installation process usually dictates that the existing surface be flat and free of "obstructions" so that the new siding will be smooth and even in appearance. Where projecting details appear, it is easier to pull them off or cut them back rather than to attempt the time consuming process to custom fit the siding. Aluminum and vinyl siding can be installed around existing trim, but the application requires more labor and, therefore, will be more expensive. In addition, there may be greater potential for water penetration at points where aluminum or vinyl meets existing trim.

Durability and Cost

The questions of durability and relative costs of new wood, aluminum or vinyl sidings compared to the maintenance cost of original materials are complex, to say the least.

Cost/benefit studies frequently are performed to assess the economic feasibility of various building treatments. Those considering the economic merits of maintaining existing wood siding or replacing it with a substitute material should perform such a study using the most accurate projections of cost, performance, value, useful life of the available options, and other important considerations.

Prevention of Inspection

Alternate siding materials are frequently applied to buildings in need of maintenance and repair. The result can be the concealing of the early warning signs of serious deterioration. Minor problems, concealed and uncorrected, can progress to the point where expensive, major repairs to the structure are necessary. It is recommended that the root cause of the need for repair to the exterior siding be identified and corrected. A cosmetic treatment to hide difficulties such as peeling paint, stains, rotted wood, or other deterioration is no substitute for proper care and maintenance. Difficulty often arises when owners perceive the replacement of sidings with new or alterative materials as the total solution to their required maintenance and forego other remedial action.

Moisture Problems

If a barrier, impermeable to moisture, is applied to the exterior or cold side of a wall, moisture can be trapped within the wall cavity and create conditions favorable to deterioration due to wood rotting or staining fungi. There are three techniques which will reduce the entry of moisture vapor and the accumulation of moisture within a wall that has an exterior (cold side) vapor barrier: 1) apply an interior (warm side) vapor barrier to keep moisture out of the wall, 2) condition the air in the interior space to reduce humidity, and 3) ventilate the wall cavity to remove excess moisture. Of course, other sources for moisture entry should be considered and eliminated if found to exist. When humidity and climatic conditions indicate a need, the added expense of such preventative measures should be considered as part of the installation of an alternative siding material over existing frame walls. Some manufacturers of alternate siding materials have attempted to prevent moisture problems by venting their products. Typical venting techniques include perforated foil, weep holes, ventilation louvers, vent tubes into the wall cavity, recommendations to omit caulking or a combination of these methods. The success of these efforts vary due to numerous variables affecting the moisture levels within any particular building. Ventilation holes should be large enough to avoid blockage by accumulations of dust and debris, insect activity and painting.

Another potential source of moisture problems results when leaking roofs, broken gutters and downspouts, or flashing problems are left unrepaired. Because of these conditions, quantities of water may be channeled into the wall behind the siding. In such cases the water admitted directly to the wall cavity can easily exceed the levels produced by moisture migration from the interior. Such excessive moisture levels within the wall can contribute to the deterioration of interior materials and finishes, such as plaster, drywall, or wallpaper, causing peeling, blistering, or staining. This moisture also causes rapid and extensive deterioration of exterior wall materials, insulation and structural members.

Vulnerability

Alternative replacement sidings are often marketed and purchased as maintenance saving alternatives; there are, however, certain types of damage to which these materials are susceptible. Aluminum siding scratches and dents easily, as a typical thickness is about .020 inches. Some vinyl sidings may melt when exposed to high temperatures; the siding shown in Figure 13 was damaged by a fire across the street. Some vinyl sidings may become brittle and susceptible to shattering in very cold weather, as shown in Figure 14. Durability should be considered by those responsible for a rehabilitation project.

Figure 13 (Photo: Linda J. Flint)

Figure 14 (Photo: Technical Preservation Services)

Typical repairs are made by cutting out the damaged area and splicing in a new piece of siding material, but new sections are often not an exact color match due to fading of the exposed surface and color variations in product runs.

If alternative replacement sidings are damaged it may be difficult or impossible to obtain an exact replacement as manufacturers may change product sizes, styles, or colors in response to market factors. At the time of a new installation of aluminum vinyl or other alternative replacement siding it is wise to obtain a few extra sections for use as replacement in the event of damage.

3 Wood Windows

3.1 General

The windows on many buildings are an important aspect of the architectural character of those buildings. At the same time, they are a major source of heat loss and heat gain. They also frequently require maintenance and repairs.

This Guideline is oriented to wood windows because they are, by far, the most common type of windows found in buildings undergoing rehabilitation. The primary emphasis is on the technical issues of repairing wood windows, including evaluation of their physical condition, techniques of repair, and design considerations when replacement is necessary. In addition, information is provided concerning energy conservation improvements to these windows. More detailed information concerning repair techniques is presented in Appendix 3 as an instructional instructional guide for the do-it-yourselfer. Although developed for smaller projects, most of the information in this section is equally applicable to 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.

3.2 Significance of Windows

Evaluating the architectural or historical significance of windows is the first step in planning for window treatments, and a general understanding of the function 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 treatment; for example, attempting to conserve energy by eliminating windows 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.

Many styles of windows are associated with specific building periods of architectural styles.

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 meet any of the following criteria: 1) are original, 2) reflect the original functional design and esthetic 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.

3.3 Repairs

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 complete, 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 usually the primary factor contributing to decay. Deterioration usually begins on horizontal surfaces and joints where water can collect and saturate the wood, as illustrated in Figure 15. All window units should be inspected for water penetration around the edges of the frame; seams should be caulked

Figure 15 (Photo: Baird M. Smith)

to eliminate this danger. This 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 in 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 new dripline or open a paint-filled dripline along the underside of the sill. This almost invisible treatment will insure proper water run-off, 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 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 end-grain 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.

To test wood for soundness, jab a small ice pick or awl into the 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.

3.4 Weatherization

As noted at the beginning of this section, windows are a major source of heat loss and heat gain. Any rehabilitation effort should include consideration of appropriate methods of reducing undesirable heat losses and gains. The major methods of accomplishing this objective are by double glazing the window, either with insulating glass or with a storm window, and by adding weatherstripping. In addition, various methods of exterior shielding can dramatically effect heat gain.

Weatherstripping

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. 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.

Storm Windows

Windows are a primary source of heat loss because they are both a poor thermal barrier (R factor of only 0.89) and often a source of air infiltration. Adding storm windows greatly improves these poor characteristics. If a building has existing storm windows (either wood or metal framed), they should be retained. Assure they are tight fitting and in good working condition. If storm windows have not been provided, it is recommended to add new metal framed windows on the exterior. This will result in a window assembly (window plus storm window) with an R factor of approximately 1.79 which outperforms a double paned window assembly (with an air space up to 1/2") that has an R factor of approximately 1.72. If the metal frames visually impair the appearance of the building, it may be necessary to paint them to match the original color of the frame. Some manufacturers provide a good range of factory applied colors.

Triple-track metal storm windows are recommended because they are readily available, in numerous sizes, and at a reasonable cost. Arched top storms are available for windows with special shapes.

Interior storm window installations can be as thermally effective as exterior storm windows; however, there is high potential for damage to the window and sill from condensation. With storm windows on the interior, the outer (original) sash will be cold in the winter, and hence moisture may condense there. This condensation often collects on the flat surface of the sash or window sill causing paint to blister and the wood to begin to deteriorate. 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. If interior storm windows are in place, the potential for moisture deterioration can be lessened by opening (or removing, depending on the type) the storm windows during the mild months allowing the window to dry thoroughly.

Rigid plastic sheets are used as interior storm windows by attaching them directly to the original sash. They are not quite as effective as the storm windows described previously because of the possibility of air infiltration. If the rigid plastic sheets are used, assure that they are installed with minimum damage to the sash, are removed periodically to allow the sash to dry, and that the original frame and sash are completely caulked and weatherstripped.

Awnings and Shading Devices

In the past, awnings and trees were used extensively to provide shade to keep buildings cooler in the ner. If awnings or trees are in place, keep them in good condition, and take advantage of their energy-saving contribution. Building owners may consider adding awnings or trees if the summer cooling load is substantial. If awnings are added, assure that they are installed without damaging the building or visually impairing its architectural character. If trees are added, select deciduous trees that provide shade in the summer, but, after dropping their leaves, would allow the sun to warm the building in the winter. When planting trees, assure that they are not closer than 10 feet to the building to avoid damage to the foundations. Adding either awnings or shade trees may be expensive, but in hot climates, the benefits can justify the costs.

3.5 Window Replacement

Although the retention of original or existing windows is always desirable, there is a point when the condition of a window may clearly indicate replacement. The decision process for selecting replacement windows should begin with an 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) types 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 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 availability and cost information.

4 Roofing

4.1 General

The roof of a building imparts much of the architectural character of the structure. It also sheds the rain, shades from the sun, and buffers the weather. A weather-tight roof is basic to the preservation of a structure, regardless of its age, size, or design. An energy efficient roof or attic space is equally basic to energy conservation within the building. This section will address both water protection and energy conservation aspects of roof areas.

4.2 Water Protection

The roof is a highly vulnerable element of a shelter which will inevitably fail. A leaking roof will permit the accelerated deterioration of other building materials and will cause general disintegration of the basic structure. Furthermore, there is an urgency involved in repairing a leaking roof since such repair costs will mount quickly. Although repairs are desirable as soon as a failure is discovered, temporary patching should be done carefully to prevent inadvertent damage to sound roofing materials and related features.

LOCATING THE PROBLEM

Failures of Surface Materials

When trouble occurs, it is important to contact a professional, either an architect, a reputable roofing contractor, or a craftsman familiar with the inherent characteristics of the particular roofing system involved. These people may be able to advise on immediate patching procedures and help plan more permanent repairs. A thorough examination of the roof should start with an appraisal of the existing condition and quality of the roofing material itself.

Wood: Some roofing materials have limited life expectancies because of normal organic decay and "wear." For example, the flat surfaces of wood shingles erode from exposure to rain and ultra-violet rays. Some species are more hardy than others, and heartwood, for example, is stronger and more durable than sapwood.

Asphalt Shingles: "Asphalt" or "composition" shingles are made of asphalt saturated organic felts which are embedded with mineral granules. They are perhaps the most widely used roofing material on older houses. Like wood, asphalt shingles have a relatively limited life span. The most common indication that asphalt shingles are nearing the end of useful service is the accumulation of mineral granules in gutters or at the base of the building. Because of their flexibility, older asphalt shingles are more susceptible to wind damage than most other roofing materials.

Membrane Roofing: "Built-up" roofing is found on many flat and low-slope roofs. This roofing consists of a series of organic felts embedded in hot mastic such as asphalt; gravel topping frequently is applied to protect the membrane from sunlight and from impact damage. These roofs, too, have a limited life span. Two common signs of imminent failure are blistering of the felts and cracking of the asphalt.

Metal: Sheet metals are likely to deteriorate from chemical action by pitting or streaking. This can be caused by airborn pollutants; acid rainwater; acids from lichen or moss; alkalis found in adjacent lime mortars or portland cement; or tannic acids from adjacent wood sheathings or shingles made of red cedar or oak.

Corrosion from "galvanic action" occurs when dissimilar metals, such as copper and iron, are used in direct contact. Corrosion may also occur even though the metals are physically separated; one of the metals will react chemically against the other in the presence of an electrolyte such as rainwater.

Iron rusts unless it is well-painted or plated. Historically this problem was avoided by use of tin plating or galvanizing, but this method is durable only as long as the coating remains intact. Once the plating is worn or damaged, the exposed iron will rust. Therefore, any iron-based roofing material needs to be undercoated, and its surface needs to be kept well-painted to prevent corrosion.

One cause of sheet metal deterioration is fatigue. Depending upon the size and the gauge of the metal sheets, wear and metal failure can occur at the joints or at any protrusions in the sheathing as a result of the metal's alternating movement caused by thermal changes. Lead will tear because of "creep," or the gravitational stress that causes the material to move down the roof slope.

Slate and Tile: Perhaps the most durable roofing materials are slate and tile. Seemingly indestructible, both vary in quality. Some slates are hard and tough without being brittle. Soft slates are more subject to erosion and to attack by airborne and rainwater chemicals, which cause the slates to wear at nail holes, to delaminate, or to break. See Figure 16. In winter, slate is very susceptible to breakage by ice or ice dams. Tiles will weather well, but tend to crack or break if hit, as by tree branches, or if they are walked on improperly. Like slates, tiles cannot support much weight. Low quality tiles that have been insufficiently fired during manufacture will craze and spall under the effects of freeze and thaw cycles on their porous surfaces.

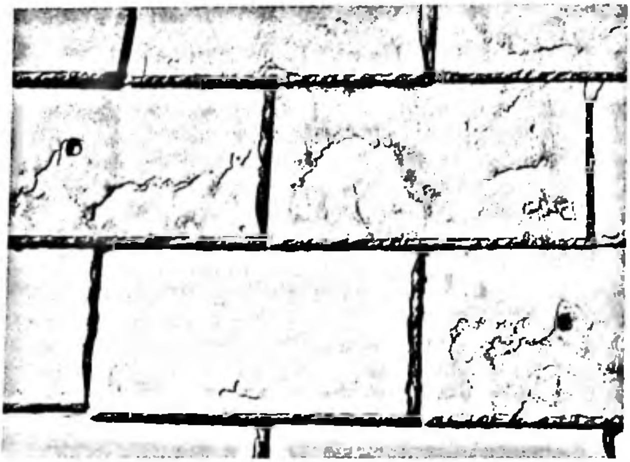


Figure 16 (Photo: Building Conservation Technology, Inc.)

Failures of Support Systems

Once the condition of the roofing material has been determined, the related features and support systems should be examined on the exterior and on the interior of the roof. The gutters and downspouts need periodic cleaning and maintenance since a variety of debris fill them, causing water to back up and seep under roofing units. Water will eventually cause fasteners, sheathing, and roofing structure to deteriorate. During winter, the daily freeze-thaw cycles can cause ice to develop under the roof surface. The pressure from this ice will dislodge the roofing material, especially slates, shingles, or tiles. Moreover, the buildup of ice dams above the gutters can trap enough moisture to rot the sheathing or the structural members.

Many larger buildings have built-in gutters set within the perimeter of the roof. The downspouts for these gutters may run within the walls of the building, or drainage may be through the roof surface or through a parapet to exterior downspouts. These systems can be effective if properly maintained; however, if the roof slope is inadequate for good runoff, or if the traps are allowed to clog, rainwater will form pools on the roof surface. Interior downspouts can collect debris and thus back up, perhaps leaking water into the surrounding walls. Exterior downspouts may fill with water, which in cold weather may freeze and crack the pipes. Conduits from the built-in gutter to the exterior downspout may also leak water into the surrounding roof structure or walls.

Failure of the flashing system is usually a major cause of roof deterioration. Flashing assemblies (materials and fasteners) should be carefully inspected for failure caused by either poor workmanship, thermal stress, or metal deterioration. With many roofing materials, the replacement of flashing on an existing roof is a major operation which may require taking up large sections of the roof surface. Therefore, the installation of top quality flashing material on a new or replaced roof should be a primary consideration. <u>Remember, some roofing and flashing materials are not compatible</u>. Copper flashing, for example, is subject to corrosion through contact with red cedar or the runoff from a cedar roof.

Roof fasteners and clips should also be made of a material compatible with all other materials used, or coated to prevent rust. For example, the tannic acid in oak will corrode iron nails. Some roofs such as slate and sheet metals may fail if nailed too rigidly.

If the roof structure appears sound and nothing indicates recent movement, the area to be examined most closely is the roof substrate--the sheathing or the battens. The danger spots are near the roof plates, under any exterior patches, at the intersections of the roof planes, and at vertical surfaces such as dormers. Water penetration, indicating a breach in the roofing surface or flashing, should be readily apparent, usually as a damp spot or stain. Probing with a small pen knife may reveal any rot which may indicate previously undetected damage to the roofing membrane. Insect infestation evident by small exit holes and frass (a sawdust-like debris) should also be noted. Condensation on the underside of the roofing is undesirable and indicates improper ventilation.

TEMPORARY STABILIZATION

It may be necessary to carry out an immediate and temporary stabilization to prevent further deterioration until research can determine whether the roof should be repaired or replaced, or until funding can be provided to do a proper job. A simple covering of exterior plywood or roll roofing might provide adequate protection, but any temporary covering should be applied with caution. One should be careful not to overload the roof structure or to damage materials which might be incorporated into a new roof at a later date.

REPAIR OR REPLACE

Understanding potential weaknesses of roofing material also requires knowledge of repair difficulties. Individual slates or tiles can be replaced normally without major disruption to the rest of the roof, as shown in Figures 16 and 17, but replacing the flashing on these roofs can require substantial removal of surrounding materials. If it is the substrate or a supporting member which has deteriorated, many materials such as slate and tile can be reused if removed carefully. Such problems should be evaluated at the outset of any project to determine if the roof can be effectively patched or if it should be completely replaced.

Figure 17

Will the repairs be effective? Maintenance costs tend to multiply once trouble starts. As the cost of labor escalates, repeated repairs could soon equal the cost of a new roof.

The more durable the surface is initially, the easier it will be to maintain. Some roofing materials such as slate are expensive to install, but if top quality slate and flashing are used, it will last 40-60 years with minimal maintenance. Although the installation cost of the roof will be high, low maintenance needs will make the lifetime cost of the roof less expensive.

REPLACING THE ROOFING MATERIAL

Professional advice may be needed to assess the various aspects of replacing a roof. With some exceptions, most historic roofing materials are available today. Special roofing materials, such as tile or embossed metal shingles, can be produced by manufacturers of related products that are only used elsewhere. Care should be taken to vent creating an appearance which is nappropriate to the design of the building. So called "Early American" or "handsplit" wood shingles, for example, are a 20th-century invention and bear no resemblance to the hand-made materials used on early American buildings.

ALTERNATIVE MATERIALS

The use of the original roofing materials on a structure may be restricted by building codes or by the availability of the materials, in which case an appropriate alternative will have to be found.

Cost and ease of maintenance may dictate the substitution of a material different in appearance from the original. The practical problems (wind, weather, and roof pitch) should be weighed against esthetic considerations of scale, texture, and color. Sometimes the effect of the alternative material will be minimal, but on roofs with a high degree of visibility and patterning or texture, the substitution may seriously alter the architectural character of the building.

If the roof is flat and is not visible from the ground, there may well be good reasons to substitute modern membrane materials for the original materials. If the roof is readily visible, the alternative material should match as closely as possible the scale, texture, and coloration of the historic roofing material.

Asphalt shingles or ceramic tiles are common substitute materials intended to duplicate the appearance of wood shingles, slates, or tiles. Esthetic considerations, however, may make original-type materials desirable. In some cases, accurate comparisons of long-term costs will show that the substitute materials will be more expensive than replacement with original-type materials.

Lead-coated copper, terne-coated steel, and aluminum/zinc-coated steel can successfully replace tin, terne plate, zinc, or lead. Copper-coated steel is a less expensive (and less durable) substitute for sheet copper.

4.3 Energy Conservation

Heat rising through the attic roof is a major source of heat loss, and reducing this heat loss should be one of the highest priorities in a rehabilitation project. The most logical time to undertake this work is in conjunction with any necessary roofing work. Adding insulation in accessible attic spaces is very effective in saving energy and is generally accomplished at a reasonable cost, requiring little skill to install. The most common attic insulations include blankets of fiberglass and mineral wool, blown-in cellulose (treated with boric acid only), blowing wool, vermiculite, and blown fiberglass. If the attic is unheated (not used for habitation), then the insulation is placed between the floor joists with the vapor barrier facing down. If flooring is present, or if the attic is heated, the insulation is generally placed between the roof rafters with the vapor barrier facing in. All should be installed according to the manufacturer's recommendations. If the attic has some insulation, add more (but without a vapor barrier) to reach the total depth recommended.

Problems occur if the attic space is not properly ventilated. This lack of ventilation will cause the insulation to become wet from condensation, reducing its thermal effectiveness. The attic is adequately ventilated when the net area of ventilation (free area of a louver or vent) equals approximately 1/300 of the attic floor area.

If the attic floor is inaccessible, or if it is impossible to add insulation along the roof rafters, consider attaching insulation to the ceilings of the rooms immediately below the attic. Some insulations are manufactured specifically for these cases and include a durable surface which becomes the new ceiling.

4.4 Maintenance

Although a new roof can be an object of beauty, it will not be protective for long without proper maintenance. At least twice a year, the roof should be inspected. All changes should be recorded and reported. Guidelines should be established for any foot traffic that may be required for the maintenance of the roof. Many roofing materials should not be walked on at all. For some--slate, asbestos, and clay tile--a self-supporting ladder might be hung over the ridge of the roof, or planks might be spanned across the roof surface. Such items should be specifically designed and kept in a storage space accessible to the roof. If exterior work ever requires hanging scaffolding, use caution to insure that the anchors do not penetrate, break, or wear the roofing surface, gutters, or flashing.

Any roofing system should be recognized as a membrane that is designed to be self-sustaining, but that can be easily damaged in intrusions such as pedestrian traffic or fallen tree branches. Certain items should be checked at specific times. For example, gutters tend to accumulate leaves and debris during the spring and fall and after heavy rain. Hidden gutter screening both at downspouts and over the full length of the gutter could help keep them clean. The surface materials should be checked after a storm as well. Periodic checking of the underside of the roof from the attic after a storm or winter freezing may give early warning of any leaks. Generally, damage from water or ice is less likely on a roof that has good flashing on the outside and is well ventilated and insulated on the inside. Decorative features, such as the cupola shown in Figure 18, require extra maintenance because they are more exposed to the weather and because their delicate features are susceptible to damage.

Figure 18 (Photo: National Trust for Historic Preservation)

Appendix 1
The Secretary of the Interior's Standards for Rehabilitation and Revised Guidelines for Rehabilitating Historic Buildings 1982, Draft

"The Secretary of the Interior's Standards for Historic Preservation Projects" was initially prepared by W. Brown Morton III and Gary L. Hume and published in 1979. In response to the National Historic Preservation Act Amendments of 1980 the Guidelines have now been revised and expanded. This revision represents the collective efforts of the professional staff of Technical Preservation Services under the direction of Gary L. Hume. After the review and comment period, the revised "Secretary of the Interior's Standards for Rehabilitation and Revised Guidelines for Rehabilitating Historic Buildings (1982)" will be printed and distributed.

Preservation Assistance Division
National Park Service
U.S. Department of the Interior
Washington, D.C.

The Secretary of the Interior is responsible for establishing standards for all programs under Departmental authority and for advising Federal agencies on the preservation of historic properties listed or eligible for listing in the National Register of Historic Places. In fulfillment of this responsibility, the Secretary of the Interior's Standards for Historic Preservation Projects have been developed and published in the Code of Federal Regulations (36 CFR 67 and 68). The Standards for Rehabilitation (36 CFR 67) are a part of these project standards addressing the most prevalent preservation treatment: Rehabilitation.

The National Park Service believes that standards that make a strong commitment to responsible preservation practices are essential. The following standards provide a sound pragmatic framework that address design issues and technical preservation issues; allow for both traditional and contemporary techniques for treating historic properties; and support continuing as well as innovative uses for those properties.

The "Standards for Rehabilitation" are used by the Secretary of the Interior when determining if a rehabilitation project qualifies as a "certified rehabilitation" pursuant to the Tax Reform Act of 1976, the Revenue Act of 1978, and the Economic Recovery Tax Act of 1981, as amended. The following is the definition of the term "Rehabilitation," included in the Code of Federal Regulations, cited above:

"Rehabilitation means the process of returning a property to a state of utility, through repair or alteration, which makes possible an efficient contemporary use while preserving those portions and features of the property which are significant to its historic, architectural, and cultural values."

STANDARDS FOR REHABILITATION

1. Every reasonable effort shall be made to provide a compatible use for a property which required minimal alteration of the building, structure, or site and its environment, or to use a property for its originally intended purpose.

2. The distinguishing original qualities or character of a building, structure, or site and its environment shall not be destroyed. The removal or alteration of any historic material or distinctive architectural features should be avoided when possible.

3. All buildings, structures, and sites shall be recognized as products of their own time. Alterations that have no historical basis and which seek to create an earlier appearance shall be discouraged.

4. Changes which may have taken place in the course of time are evidence of the history and development of a building, structure, or site and its environment. These changes may have acquired significance in their own right, and this significance shall be recognized and respected.

5. Distinctive stylistic features or examples of skilled craftsmanship which characterize a building, structure, or site shall be treated with sensitivity.

6. Deteriorated architectural features shall 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. Repair or replacement of missing architectural features should be based on accurate duplications of features, substantiated by historic, physical, or pictorial evidence rather than on conjectural designs or the availability of

different architectural elements from other buildings or structures.

7. The surface cleaning of structures shall be undertaken with the gentlest means possible. Sandblasting and other cleaning methods that will damage the historic building materials shall not be undertaken.

8. Every reasonable effort shall be made to protect and preserve archeological resources affected by, or adjacent to any project.

9. Contemporary design for alterations and additions to existing properties shall not be discouraged when such alterations and additions do not destroy significant historical, architectural or cultural material, and such design is compatible with the size, scale, color, material, and character of the property, neighborhood or environment.

10. Wherever possible, new additions or alterations to structures shall be done in such a manner that if such additions or alterations were to be removed in the future, the essential form and integrity of the structure would be unimpaired.

GUIDELINES FOR APPLYING THE STANDARDS

The following guidelines are intended to help property owners formulate the application of the Secretary of the Interior's "Standards for Rehabilitation" by providing general technical and design recommendations for each component of a historic property: Environment, Site, Structural Systems, Exterior and Interior Features and Finishes, Storefronts, Signs, New Construction, Mechanical Systems, and Safety and Code Requirements. The guidelines pertain to buildings of all occupancy and construction types, sizes and materials. They apply to new additions as well as new adjacent construction.

Those techniques, treatments, and methods that are consistent with the Secretary's "Standards for Rehabilitation" are listed in the "recommended" column on the left. Not all recommendations listed under a treatment will apply to each project proposal. Rehabilitation treatments, materials, and methods which may adversely affect a building's historic materials and architectural and historic qualities are listed in the "not recommended" column on the right. Every effort will be made to update and expand the guidelines as additional techniques and treatments become known.

Specific information on rehabilitation and preservation technology may be obtained by writing to the Preservation Assistance Division, National Park Service, Department of the Interior, Washington, D.C. 20240, or the appropriate National Park Service Regional Office or State Historic Preservation Office. Advice should also be sought from qualified professionals, including architects, architectural historians, and archeologists skilled in the preservation, restoration and rehabilitation of historic properties.

THE ENVIRONMENT

Recommended	Not Recommended
Retaining and preserving the size, scale, mass, color, materials, and relationship of buildings and landscape features in the historic district, the neighborhood, or the rural setting.	Introducing new construction into historic districts that is visually incompatible in terms of size, scale, mass, color, and materials.
Retaining landscape features such as parks, gardens, street lights, signs, benches, walkways, streets, alleys, and building setbacks that have traditionally linked buildings to their environment.	Destroying the relationship of buildings and their environment by widening existing streets, changing paving material, or by introducing inappropriately located new streets and parking lots that are incompatible with the historic character of the historic district.
Retaining the relationship between structures and open space.	Placing additions or new buildings in a manner that would destroy a significant open space or relationship between buildings and open space.
Using new street lights, walkways, fencing, signs, benches, and plant materials that are compatible with the historic character of the district or neighborhood in size, scale, material, and color.	Introducing new street lights, walkways, fencing, signs, benches, and plant materials that are out of scale or otherwise inappropriate to the historic character. An example of the latter would be to introduce cypress trees where boxwood had been the primary historic planting.

Recommended	Not Recommended
Placing onsite parking facilities in the rear of historic properties if there are no significant plantings or gardens.	Placing onsite parking facilities directly adjacent to historic buildings where automobiles can cause damage to the buildings and/or obscure the setting.
	Removing lawns or plant materials to place onsite parking facilities in the front of historic buildings.
	Placing driveways, such as circular driveways, in front of historic buildings where they never existed.
Using the same as existing species or compatible plant materials to screen onsite parking to minimize the impact on the historic character.	

BUILDING SITE

Identifying plants, trees, fencing, walkways, out-buildings, and other elements that might be an important part of the property's history and development.

Recommended	Not Recommended
Basing decisions for new site work on actual knowledge of the past appearance of the property found in photographs, drawings, newspapers, and tax records. If changes are made they should be carefully evaluated in light of the past appearance of the site.	
Retaining plants, trees, fencing, walkways, street lights, signs, and benches that reflect the property's history and development, unless plant materials and trees in close proximity to the building are causing deterioration of the historic fabric.	Making changes to the appearance of the site by removing old plants, trees, fencing, walkways, outbuildings, and other elements before evaluating their importance in the property's history and development.
Retaining plant materials, trees, and landscape features, especially those which perform passive solar energy functions such as sun shading or wind breaks.	
Providing proper site and roof drainage to assure that water does not splash against building or foundation walls, nor drain toward the building.	
	Demolishing buildings or parts of a building in a complex of related historic structures, thus destroying distinguishing historic building materials and altering the historic character of the complex.

Recommended	Not Recommended
Installing solar collectors which are free standing rather than attached to buildings when such free standing collectors do not destroy the historic character of the building site.	Installing free standing solar collectors and solar greenhouses that destroy or damage historic landscape or archeological features; obscure significant building features; or are visually incompatible with the size, scale, mass, color, materials, and setting of the building.
Archeological features	
Preserving in place known archeological material whenever possible.	Leaving known archeological material unprotected and subject to vandalism, looting, and destruction by natural elements such as erosion.
Planning and carrying out all investigations utilizing professional archeologists.	
Conducting archeological investigations in accordance with an appropriate research plan which is based on such factors as significance of the archeological property, usefulness of the data, and anticipated damage to the archeological material.	
When preservation in place is not feasible, designing and implementing a data recovery plan for the affected material.	

Recommended	Not Recommended
Minimizing disturbance of terrain around the structure, thus reducing the possibility of destroying unknown archeological materials.	Introducing heavy machinery or equipment into areas where their presence may disturb archeological materials.
Evaluating and recovering important data from previously unknown archeological material discovered during disturbance of the terrain.	

BUILDING: STRUCTURAL SYSTEMS

Recognizing the special problems inherent in the structural systems of historic buildings, especially where there are visible signs of cracking, deflection, or failure.	Disturbing existing foundations with new excavations that undermine the structural stability of the building.
Examining and evaluating the condition of a structure in a manner that minimizes loss of historic fabric through use of non-destructive techniques such as X-ray photography.	Utilizing destructive probing techniques which damage or destroy distinguishing historic building material.
Undertaking stabilization and repair of weakened structural members and systems.	Leaving known structural problems untreated that will cause continuing deterioration and will shorten the life of the structure.
Correcting structural deficiencies without losing decorative features or altering historic spaces.	
Supplementing existing structural systems when damaged or inadequate.	

Recommended	Not Recommended
Maintaining the soundness of the structural system through providing proper ventilation and vapor barriers, as necessary, when installing insulation.	Discontinuing ventilation in such areas as basements, crawl spaces, and attics without providing for dehumidification or evacuation fans.
Replacing historically important structural members only when necessary.	
	Removing rather than repairing historically important features which are structurally deficient.
Upgrading structures as necessary to repair fire damage or to meet building code requirements in a manner which minimizes loss of historic fabric (such as reusing and reinforcing historic floor framing systems).	Upgrading structures in a manner that changes the historic appearance (such as strapping channels to the exterior of a building or removing a decorative cornice).
	Removing sections of the interior of the building, its structural system and roof to create an atrium.
Minimizing cutouts or holes in structural members when installing new mechanical or electrical equipment.	Installing equipment and electrical systems which result in numerous cuts, splices, or alterations to the building's historic structural system.
	Installing equipment or mechanical systems which overloads the historic structural system, thus necessitating a major intervention such as the insertion of a new structural system.

Recommended	Not Recommended
	Utilizing modern treatments or products that will accelerate the deterioration of historic structural materials, such as the installation of urea-formaldehyde foam insulation in frame walls.

BUILDING: EXTERIOR FEATURES

Masonry: Brick, stone, adobe, terra cotta, concrete, stucco and mortar

Recommended	Not Recommended
Retaining and preserving distinguishing architectural features.	Removing architectural features such as cornices, window architraves, and doorway pediments that are an essential part of a building's distinguishing appearance and that illustrate the continuity of growth and change.
Repairing or replacing, where necessary, deteriorated material with new material that matches the old as closely as possible.	Applying new material which is inappropriate or was unavilable when the building was constructed, such as artifical brick siding, artificial stone or brick veneer.
Retaining historic masonry units and mortar without the application of new or non-historic surface treatments.	Applying waterproof or water-repellent coatings. Coatings are frequently unnecessary, expensive, may change the appearance of the historic masonry, and may accelerate deterioration.

Recommended	Not Recommended
Repointing only those mortar joints where there is evidence of moisture problems or where sufficient mortar is missing to allow water to stand in the mortar joint.	Repointing mortar joints that do not need repointing. Using electric saws and hammers to remove mortar can seriously damage the adjacent masonry.
Duplicating old mortar in strength, composition, color, and texture.	Repointing with mortar of high Portland cement content can often create a bond that is stronger than the building material. This can cause damage as a result of the differing coefficient of expansion and the differing porosity of the material and the mortar.
Duplicating old mortar in joint size, method of applications, and joint profile.	Repointing with mortar joints of a differing size or joint profile, texture or color.
Cleaning masonry only when necessary to halt deterioration or heavy soiling and always with the gentlest method possible such as low pressure water and detergents, using natural bristle brushes.	Sandblasting, including dry and wet grit and other abrasives, brick or stone surfaces; this method of cleaning erodes the surface of the material and can accelerate deterioration.
	Cleaning with chemical products that would have an adverse effect on masonry materials, i.e., acid on limestone or marble.

Recommended	Not Recommended
Repairing stucco with a stucco mixture that duplicates the original as closely as possible in strength, appearance and texture.	
Using mud plaster as a surface coating over unfired, unstabilized adobe because the mud plaster will bond to the adobe.	Applying cement stucco to unfired, unstabilized adobe. Because the cement stucco will not bond, moisture can be entrapped between materials which will cause accelerated deterioration of the adobe.
Repointing unfired, unstabilized adobe with mud mortar because it is compatible with the adobe masonry units in strength.	Repointing unfired, unstabilized adobe with lime mortar or Portland cement mortar. Either will cause the adobe to disintegrate.
Preserving the historic painted surface, including early signs. Brick or stone surfaces may have been painted or whitewashed for practical and aesthetic reasons.	Removing paint from historically painted surfaces. Conversely, do not paint masonry surfaces that were historically unpainted.
Conducting an onsite inspection of painted masonry surfaces to determine the degree of deterioration prior to removing any paint.	
Removing damaged/deteriorated paint to the next sound layer using the gentlest method possible (i.e., handscraping) then repainting.	Using destructive methods of removing paint such as sandblasting, applying caustic solutions, or waterblasting.
Applying compatible paint coating systems following proper surface preparation.	

Recommended	Not Recommended
Using substitute materials to replace severely deteriorated masonry materials only when replacement in kind is not feasible. For example, suitable replacement materials for glazed architectural terra-cotta may include stone, pre-cast concrete, or fiberglass.	
	Resurfacing historic building materials with more energy efficient but incompatible materials, such as covering historic masonry with exterior insulation.
	Installing passive solar devices such as attached glass "trombe" walls on primary facades or where visible from the public right-of-way.
<u>Wood: Clapboard, weather-board, shingles, and other wooden siding, and decorative elements</u>	
Retaining and preserving distinguishing architectural features.	Removing architectural features such as siding, cornices, brackets, window architraves, and door way pediments that are an essential part of a building's distinguising appearance and that illustrate the continuity of growth and change.

Recommended	Not Recommended
Repairing or replacing, where necessary, deteriorated material with new material that matches the old as closely as possible.	Resurfacing frame buildings with new material that is inappropriate or was unavilable when the building was constructed such as artificial stone, brick veneer, asbestos or asphalt shingles, and plastic or aluminum siding. The incorrect installation of such material can result in the loss of distinguishing architectural details, and can also contribute to the deterioration of the structure from moisture and insects.
Conducting an onsite inspection of painted wood surfaces to determine the degree of deterioration prior to removing any paint.	
Removing damaged/deteriorated paint to the next sound layer using the gentlest method possible (i.e., handscraping and handsanding), then repainting.	Stripping paint to bare wood, thus obliterating evidence of the historic paint layers and exposing the woodwork to the effects of accelerated weathering.
Using an electric hot-air gun on decorative architectural elements and an electric heat plate on flat surfaces when total paint removal is necessary prior to repainting.	Using destructive methods to remove paint such as a propane/butane torch, sandblasting or waterblasting. These methods can irreversibly damage historic woodwork.

Recommended	Not Recommended
Using chemicals when total paint removal is necessary (caustic or solvent-base strippers), primarily to supplement other methods such as hand scraping and sanding and the electric heat-plate and electric hot-air gun. Detachable wooden elements such as shutters, doors, and columns may, with the proper safeguards, be chemically dip-stripped.	Allowing detachable wooden elements to soak too long in a caustic solution so that the wood grain is raised and the surface roughened. Also, the wood must be thoroughly rinsed and neutralized after chemical dip- stripping or new paint will not adhere.
	Stripping historically painted surfaces to bare wood, then applying clear finishes or stains in order to create a contemporary "natural look."
Applying compatible paint coating systems following proper surface preparation. Generally, oil-base paints should be applied over layers of old oil paint because water-thinned paints may not adhere. If the paint has deteriorated and requires removal to bare wood, either oil-base or water-thinned coatings sys-tems can be successfully used.	
Applying preservatives to wooden elements that are exposed to decay hazards; selecting preservatives which do not change the appearance of signifi-cant wooden architectural fea-tures.	Using preservatives such as creosote which may change the appearance of significant wooden architectural features.

Recommended	Not Recommended
Utilizing passive solar devices and weatherization measures which do not alter or destroy the distinguishing features of the building.	Installing passive solar devices such as attached glass "trombe" walls on primary facades, or where visible from the public right-of-way.

Architectural Metals: Cast iron, steel, pressed tin, aluminum, and zinc

Recommended	Not Recommended
Retaining and preserving distinguishing architectural features.	Removing architectural features such as columns, capitals, and window hoods that are an essential part of a building's distinguishing appearance and that illustrate the continuity of growth and change.
Repairing or replacing, where necessary, deteriorated material with new material that matches the old as closely as possible.	
Cleaning, when necessary, with the appropriate method. Metals should be cleaned by methods that do not damage or discolor the surface or its finish.	Exposing metals which were intended to be protected from the environment. Do not use cleaning methods which alter the color, texture, and finish of the metal.
Removing paint build-up and corrosion on cast iron using mechanical methods such as low pressure dry grit blasting when handscraping and wire brushing have proven ineffective. Apply rust-inhibiting primers immediately after cleaning where newly cleaned metals are subject to corrosion, such as cast iron and steel.	

Recommended	Not Recommended
Cleaning soft metals such as lead, tin, copper, terneplate, and zinc by appropriate chemicals because their finishes can be easily abraded by blasting methods.	
Selecting paint coating systems that are compatible with the particular metal involved.	
Using substitute materials to replace severely deteriorated metal features when replacement in kind is not feasible. For example, a suitable replacement material for cast iron decorative elements such as column capitals may be fiberglass.	

Roofs and Roofing

Recommended	Not Recommended
Preserving or retaining architectural features that give the roof its distinguishing appearance, such as dormer windows, cupolas, cornices, brackets, chimneys, cresting, and weathervanes.	Stripping the roof of its distinguishing architectural features.
Preserving the historic roof shape.	Changing the configuration or historic roof shape by adding inappropriate features such as dormer windows, vents, or skylights.

Recommended	Not Recommended
Retaining the historic roofing material.	Applying new roofing material that is inappropriate to the style and period of the building and neighborhood.
Repainting of replacing deteriorated roof coverings with new material that matches the old in composition, size, shape, color, and texture.	Replacing deteriorated roof coverings with new materials that differ to such an extent from the old in composition, size, shape, color, and texture that the distinguishing appearance of the building is altered or destroyed.
Providing a sound roof covering, adequate ventilation and flashing, and proper drainage so that the building is maintained in an essentially dry condition.	
Placing television antennae and mechanical equipment, such as air conditioning equipment, in an inconspicuous location.	Placing television antennae and mechanical equipment, such as air conditioning equipment, where they can be seen from the street.

Windows and Doors

Recognizing that windows are an extremely important element in the overall historic character of a building, and should be retained and preserved. In marginally contributing buildings in historic districts, the window size, glazing pattern, and configuration may be the only distinguishing features of the building.

Recommended	Not Recommended
Retaining and preserving distinguishing features related to windows and doors.	Removing distinguishing architectural features such as frames, doors, sash, glass, sills, pediments, architraves, lintels, and hardware.
	Changing the number, location, size or glazing pattern of windows, doors, and other openings.
Replacing missing or irreparable sash on primary facades with new sash that match the historic window in material, size, general muntin and mullion proportion and configuration, and reflective qualities.	Replacing historic sash with new sash that are incompatible in size, configuration, and reflective qualities or which alter the setback relationship between window and wall.
	Obscuring historic window trim with metal or other material.
	Replacing windows and doors on primary facades with historically incompatible materials such as anodized aluminum, or mirrored or tinted glass.
	Changing the historical appearance of windows and doors through application of inappropriate finishes and paint colors for sash, doors, and frames.

Recommended	Not Recommended
Improving the thermal performance of existing windows and doors through adding or replacing weather-stripping and adding storm windows and doors which are compatible with the historic character of the building and which do not damage window or door frames.	Installing on primary facades new decorative elements, such as shutters, screens, blinds, window grills, and awnings which are historically inappropriate.
	Installing new exterior storm windows and doors which are inappropriate in size or color, which are inoperable, or which require removal of original windows and doors.
Installing interior storm windows with air-tight gaskets, ventilating holes, and/or removable clips to insure proper maintenance and to avoid condensation damage to historic windows.	Installing interior storm windows that allow moisture to accumulate and damage the window.
	Replacing historic multi-paned sash with new thermal sash utilizing snap-in muntins.
	Installing heating/air conditioning units in the window frames when the sash and frames may be damaged. Window installations should be considered only when all other viable heating/cooling systems would result in significant damage to historic materials.

Recommended	Not Recommended
	Removing carriage or garage doors and replacing them with a formal architectural doorway such as a panelled door with fanlight and sidelights.
Providing a setback in the design of new dropped ceilings so that the exterior form and appearance of historic windows are unchanged when it is necessary to lower the height of a ceiling.	
	Inserting new floors or furred-down ceilings which cut across the glazed areas of windows.
Utilizing the inherent energy conserving features of a building by maintaining windows and louvered blinds in good operable condition for natural ventilation.	Using dark or reflective glazing, or exterior shading devices which obscure historic window details or which alter or destroy the distinguishing features of a building.
Improving thermal efficiency with weather-stripping, storm windows, caulking, interior shades, and, if historically appropriate, blinds and awnings.	

Storefronts

Retaining and preserving historic storefronts including windows, sash, doors, transoms, signs, and decorative features where such features contribute to the historic character of the building.

Recommended	Not Recommended
Repairing and replacing, where necessary, deteriorated material that matches the old as closely as possible.	Using materials that were unavailable when the storefront was constructed, such as vinyl and aluminum siding, anodized aluminum, mirrored or tinted glass, artificial stone, and brick veneer. Changing the entrance location of a historic storefront. "Earlying up" a historic storefront using stock "lumberyard colonial" detailing such as coach lanterns, mansard overhangings, wood shakes, nonoperable shutters, and non-historic small paned windows.
Retaining the commercial appearance of the building where historic storefronts no longer exist or are too deteriorated to save through: 1) contemporary design which is compatible with the scale, design, materials, color, and texture of the historic buildings; or 2) an accurate restoration of the storefront based on historical research and physical evidence.	Introducing a new storefront or new design element on the ground floor, such as a recessed arcade which alters the building's relationship with the street or setting or which causes destruction of historic building materials. Removing historic materials from a historic storefront to create a recessed arcade.

Recommended	Not Recommended
Designing contemporary replacement storefronts which: 1) utilize materials appropriate to the building; 2) maintain the historic planar relationship of the storefront to the facade; 3) are visually compatible with the style and distinguishing architectural features of the building; and 4) keep the treatment of secondary design elements, such as graphics or awnings, as simple as possible.	
Entrances, porches, and steps	
Retaining and preserving porches and steps that are appropriate to the building and its historical development. Porches, even when added at a later date, often contribute to the building's distinctive appearance and should be retained.	Removing or altering porches and steps that are appropriate to the building and its historical development.
Repairing or replacing, where necessary, deteriorated architectural features of wood, iron, cast iron, terra cotta, tile, and brick.	Stripping porches and steps of original material and architectural features, such as hand rails, balusters, columns, brackets, and roof decoration or wood, iron, cast iron, terra cotta, tile and brick.
Retaining a sense of openness when enclosing porches by using large sheets of glass within the existing bays. The enclosure wall should also be recessed behind existing scrollwork, posts, and balustrades.	Enclosing porches and steps in a manner that destroys their intended appearance. The sense of openness can be lost by using solid materials such as wood, stucco, and masonry.

Recommended	Not Recommended
Considering the inherent energy conserving characteristics of historic porches and double vestibule entrances.	
	Enclosing porches located on primary facades or those visible from the public right-of-way to create passive solar collectors or air lock vestibules. Such enclosures can destroy the distinguishing appearance of the building.
Signs	
Retaining and preserving existing signs where they contribute to the historic character of the building.	
Repairing and replacing, where necessary, deteriorated material with new material that matches the old as closely as possible.	
Designing new signs that are visually compatible with the distinguishing architectural features of the historic building.	Designing and installing new signs that are visually incompatible with the historic building in size, scale, color, or lighting and graphic components.
Designing new signs that fit flush with the existing features of the facade, such as the fascia board or cornice.	Using new backlit fluorescent signs; large applied signs with distinctive corporate logos; and other signs that obscure distinguishing architectural detailing.

Recommended	Not Recommended
Painting or etching new signs directly onto display windows.	Using new signs that project over the sidewalk unless they are a characteristic feature of the district.
Designing new signs for businesses in a residential structure in a smaller scale than those for commercial buildings.	

Exterior Finishes

Discovering the historic paint colors and finishes of the building and neighborhood and repainting with those colors to illustrate the distinctive character of the building and neighborhood.	Repainting with colors that cannot be documented through research and investigation to be appropriate to the building and neighborhood.
Removing damaged/deteriorated paint to the next sound layer using the gentlest method possible (i.e., handscraping and handsanding), then repainting.	Stripping paint to bare wood, thus obliterating evidence of the historic paint layers and exposing the woodwork to the effects of accelerated weathering.
Applying compatible paint coating systems following proper surface preparation. Generally, oil-base paints should be applied over layers of old oil paint because water-thinned paints may not adhere. If the paint has deteriorated and requires removal to bare wood, either oil-base or water-thinned coatings systems can be successfully used.	

Recommended	Not Recommended
BUILDING: INTERIOR FEATURES	
Retaining historic materials and architectural features, such as stairs, elevators, hand rails, balusters, ornamental columns, cornices, baseboards, doors, doorways, windows, mantels, paneling, lighting fixtures, hardware, parquet or mosaic flooring.	Removing historic materials and architectural features. Replacing distinguishing features, such as interior doors and transoms for code compliance, without investigating alternative fire protection measures or possible code variances.
Retaining historic plaster.	Removing plaster to expose brick to give the wall an appearance it never had.
Retaining the historic floor plan of a building, the relationship and size or rooms, corridors, and other spaces.	Altering the historic floor plan of a building by demolishing principal walls, partitions, and stairways.
Repairing or replacing, where necessary, deteriorated historic material with new material that matches the old as closely as possible. Substitute materials may be acceptable when finished or coated in a manner similar to the replaced historic feature.	Installing new decorative material and sheet materials which destroy distinguishing architectural features or was unavailable when the building was constructed, such as vinyl plastic or imitation wood wall and floor coverings. Creating new interiors which will alter or destroy architecturally significant spaces by cutting through floors, lowering ceilings, or adding or removing walls.

Recommended	Not Recommended
	Inserting new floors within a structure which will alter or destroy the fenestration and which will destroy significant interior spaces or decorative detailing.
Enclosing, where required by code, an interior stairway in such a way as to retain its character. In many cases glazed fire rated walls may be used.	Enclosing an interior stairway with ordinary fire rated construction so that the stairwell space or any distinctive architectural features are destroyed.
Placing new code required stairways or elevators in secondary and service areas of the historic building.	
Utilizing historic architectural elements such as interior shutters and transoms for their inherent enery conserving features.	
<u>Interior Finishes</u>	
Discovering and retaining the historic paint colors, finishes, wallpapers, and other decorative motifs whenever possible.	Changing the texture and patina of exposed wooden architectural features (including structural members) and masonry surfaces through sandblasting or use of other abrasive techniques to remove paint, discoloration and plaster, except in certain industrial or warehouse buildings where the interior masonry or plaster surfaces do not have distinguishing design, detailing, tooling, or finish; and where wooden architectural features are not finished, molded, beaded, or worked by hand.

Recommended	Not Recommended
NEW ADDITIONS AND ADJACENT NEW CONSTRUCTION	
Designing new additions in a manner that makes clear what is historic and what is new.	Replicating the form, style, and detailing of the historic building in the new addition.
	Imitating an earlier style or period of architecture in new additions, especially those that have a completely contemporary function such as a drive-in bank or garage.
Designing new additions and adjacent new construction using contemporary design solutions. New additions should respect the historic building in terms of design (i.e., size, scale, mass, color, stylistic elements, and the relationship of solids to voids), materials, workmanship, location, and setting. For example, if the historic building has a repetitive pattern of tall, narrow windows, such a design motif may be utilized in the new addition.	Designing new additions which alter or destroy the historic character of the building, including its design, materials, workmanship, location, or setting.

Recommended	Not Recommended
Placing adjacent new construction and connecting additions so that they are set back from the facade; preserving distinguishing architectural features; and making them visually compatible with the historic character of the building.	
Placing code-required stairways and elevators within the historic buildings if they do not alter or destroy significant interior spaces or decorative detail. If not possible, then these new additions should be placed on secondary facades.	
Placing new additions such as balconies and greenhouses on secondary facades.	Designing new additions such as multi-story greenhouse additions which cover or obscure primary facades and change the planar quality of the structure.
Designing roof top additions that are not conspicuous when viewing the primary facades.	
Placing solar collectors on secondary roofs or roofs of non-historic adjacent buildings.	Placing solar collectors on roofs which are visible from the public right-of-way when such collectors change the historic roofline and/or obscure the relationship of the roof to existing roof features such as dormers, skylights, and chimneys.

Recommended	Not Recommended
MECHANICAL SYSTEMS: HEATING, AIR CONDITIONING, ELECTRICAL, PLUMBING, FIRE PROTECTION	
Retaining and preserving where possible, early mechanical systems, including plumbing fixtures, lighting fixtures, and switch plates.	Removing early mechanical systems which are a distinguishing feature of the building and reflect the history of building technology.
Installing new mechanical systems when essential and limiting installation to areas and spaces that require the least alteration to the building's plan and least damage to historic building materials.	Causing unnecessary damage to the plan, materials, and appearance of the building when installing mechanical systems.
	Attaching exterior electrical and telephone cables to the principal elevations of the building.
Installing the vertical runs of ducts, pipes, and cables in closets, service rooms, and wall cavities.	Installing vertical runs of ducts, pipes, and cables in places where they will be visually obtrusive.
	Concealing mechanical equipment in walls or ceilings in a manner that requires the removal of historic building material.
	Installing "dropped" acoustical ceilings to hide mechanical equipment when this destroys the proportions of the rooms.

Recommended	Not Recommended
Installing thermal installation in attics and in unheated cellars and crawl-spaces to conserve energy.	Reducing energy consumption in a building by applying urea formaldehyde foam or any other thermal insulation with a water content into wall cavities.
Providing adequate ventilation of attics, crawlspaces, and cellars to prevent moisture problems.	

SAFETY AND CODE REQUIREMENTS

Complying with health, safety and seismic code requirements in such a manner that distinguishing architectural features and spaces are preserved.

Working with local code officials to investigate alternative life safety measures that do not require additions to historic buildings.

Providing seismic reinforcing to a historic building in a manner that minimizes damage to the structure and its distinguishing architectural features.

Investigating alternative measures which allow variances for historic properties under some local codes.

Installing non-obstrusive fire suppression systems instead of applying fire resistant coverings to distinctive architectural features and where local building codes permit such installation.

Recommended	Not Recommended
Applying fire retardant coatings instead of fire resistant coverings if the coatings do not obscure distinguishing architectural features and where local building codes permit such application.	
Upgrading stairways and elevators to meet health and safety codes in a manner that preserves and retains their distinctive features.	Making changes to stairways and elevators in a manner that alters or destroys their distinctive architectural features and adjacent spaces.
Adding new stairways and elevators to meet health and safety codes in a manner that preserves adjacent distinctive architectural features and spaces.	Altering or destroying distinctive architectural features and spaces when adding new code required stairways and elevators.

Appendix 2
"Preservation Briefs" incorporated in this *Guideline*

Preservation Briefs: 1 The Cleaning and Waterproof Coating of Masonry Buildings. Robert C. Mack. November 1975.

Preservation Briefs: 2 Repointing Mortar Joints in Historic Brick Buildings. Robert C. Mack, de Teel Patterson Tiller, and James S. Askins. September 1980.

Preservation Briefs: 3 Conserving Energy in Historic Buildings. Baird M. Smith. April 1978.

Preservation Briefs: 4 Roofing for Historic Buildings. Sarah M. Sweetser. February 1978.

Preservation Briefs: 6 Dangers of Abrasive Cleaning to Historic Buildings. Anne E. Grimmer. June 1979.

Preservation Briefs: 7 The Preservation of Historic Glazed Architectural Terra-Cotta. de Teel Patterson Tiller. June 1979.

Preservation Briefs: 8 Aluminum and Vinyl Sidings on Historic Buildings. John H. Myers. August 1979.

Preservation Briefs: 9 The Repair of Historic Wooden Windows. John H. Myers. 1981.

Appendix 3
Wood Window Repair Techniques

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 normally are required for a typical double-hung window, but they may be adapted to other window types and styles as applicable.

Older 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.

There are several safe and effective techniques for removing paint from wood, depending on the amount of paint to be removed.

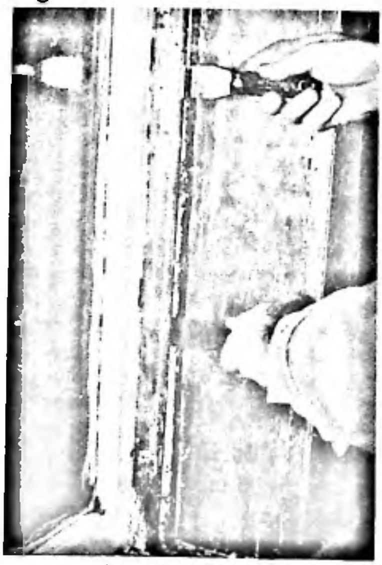
Paint removal should begin on the interior frames, being careful to remove the paint from the interior stop and the parting bead, particularly along the seam where these stops meet the jamb. This can be accomplished by running a utility knife along the length of the seam, breaking the paint bond. It 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

Figure A-1

The following series of photographs of the repair of a historic double-hung window use a unit which is structurally sound but has many layers of paint, some cracked and missing putty, slight separation at the joints, broken sash cords, and one cracked pane. Photo: John H. Myers

Figure A-2



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. To avoid visible scarring of the wood, the sash can be raised and the stop pried loose initially from the outer side. Photo: John H. Myers 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 pried 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.

Figure A-3

Sash can be removed and repaired in a convenient work area. Paint is being removed from this sash with a hot air gun while an asbestos sheet protects the glass from sudden temperature change. Photo: John H. Myers

Figure A-4

Reglazing or replacement of the putty requires that the existing putty be removed manually, the glazing points be extracted, the glass removed, and the back putty scraped out. To reglaze, a bed of putty is laid around the perimeter of the rabbet, the pane is pressed into place, glazing points are inserted to hold the pane (shown), and a final seal of putty is beveled around the edge of the glass. Photo: John H. Myers

The sash can be stripped of paint using appropriate techniques, such as chemical strippers or heat. 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 of cement asbestos board can protect the glass from such rapid temperature change. 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

Figure A-5

A common repair is the replacement of broken sash cords with new cords (shown) or with chains. The weight pocket is often accessible through a removable plate in the jamb, or by removing the interior trim. Photo: John H. Myers

Figure A-6

Following the relatively simple repairs, the window is weathertight, like new in appearance, and serviceable for many years to come. Both the historic material and the detailing and craftsmanship of this original window have been preserved. Photo: John H. Myers 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 weathertight seal. After the proper curing times have elapsed for paint and putty, the sash will be ready for reinstallation.

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.

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.

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 semi-rigid epoxies which saturate the porous decayed wood and then harden. The surface of the consolidated wood can then be filled with a semi-rigid 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. Proprietary epoxy 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.

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 the 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.

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 sash.

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.

Appendix 4
Regional Historic Preservation Offices of the National Park Service

National Historic Preservation Programs Western Regional Office National Park Service 450 Golden Gate Ave. Box 36063 San Francisco, CA 94102 (415) 556-7741	Arizona, California, Hawaii, Idaho, Nevada, Oregon, Washington, American Samoa, and Guam
Division of Cultural Resources Rocky Mountain Regional Office National Park Service 635 Parfet St. P. O. Box 25287 Denver, CO 80225 (303) 234-2560	Colorado, Illinois, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, Wisconsin, Wyoming
Office of Cultural Programs Mid-Atlantic Regional Office National Park Service 143 S. Third St. Philadelphia, PA 19106 (215) 597-2283	Connecticut, Delaware, District of Columbia, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia
Preservation Services Division Southeast Regional Office National Park Service 75 Spring St. SW, Room 1140 Atlanta, GA 30303 (404) 221-5180	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Puerto Rico, and the Virgin Islands
Cultural Resources Division Alaska Regional Office National Park Service 540 W. 5th Ave. Anchorage, AK 99501	Alaska

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