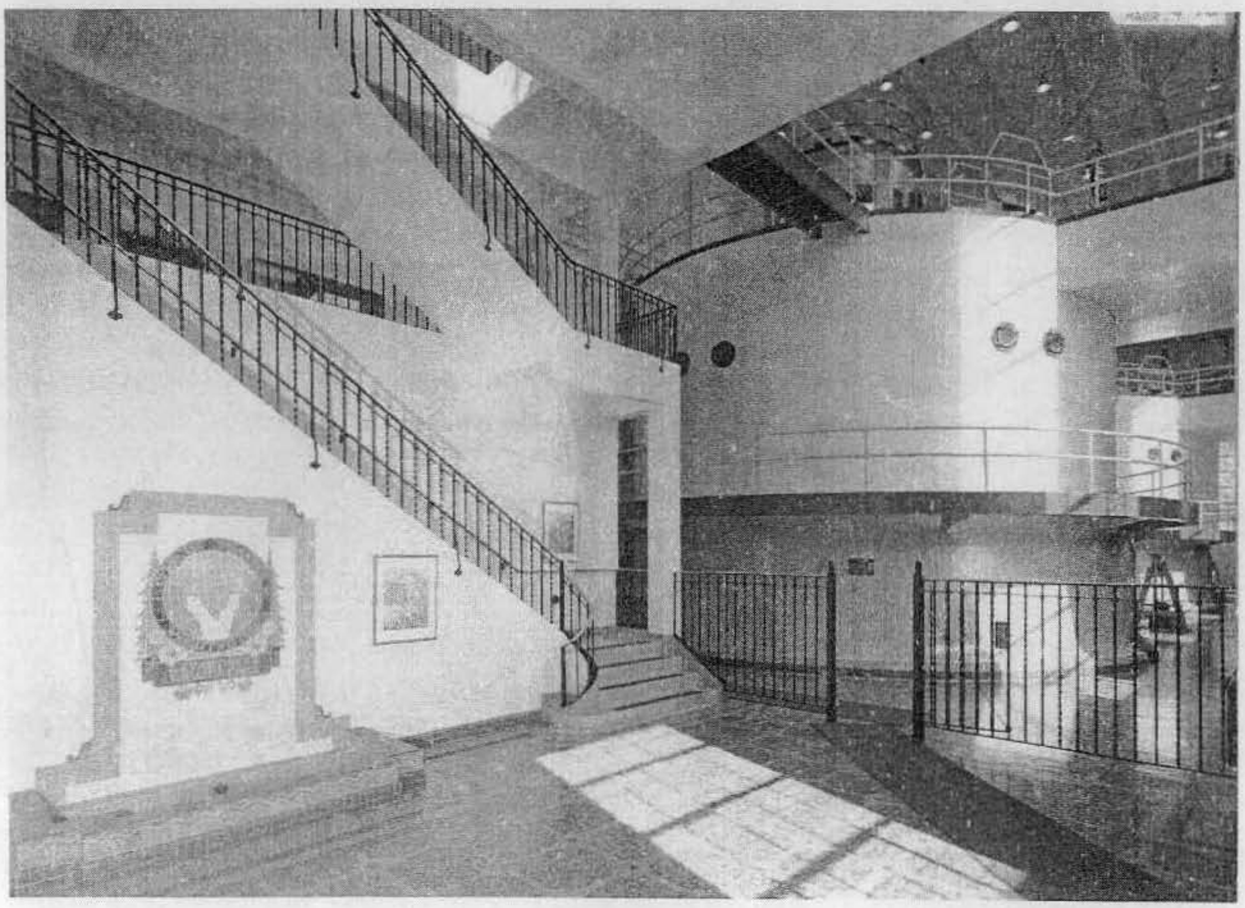
SKAGIT RIVER HYDROELECTRIC PROJECT

FERC No. 553

HISTORIC RESOURCES MITIGATION AND MANAGEMENT PLAN



City of Seattle
City Light Department

APRIL 1991

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FERC NO. 553

HISTORIC RESOURCES MITIGATION and MANAGEMENT PLAN

Submitted by:

City of Seattle
City Light Department

April 1991

Prepared and Submitted in Response to the Federal Energy Regulatory Commission's Request for Supplemental Environmental Information Dated October 31, 1988 and in Compliance with 36 CFR Part 800 and Section 106 of the National Historic Preservation Act

HOW TO USE THE PLAN

The new license for the Skagit Project brings some significant new requirements and responsibilities for the care and management of historic resources in the Skagit Project Area. This Historic Resource Mitigation and Management Plan (HRMMP) is designed to be of practical use to Seattle City Light's Skagit Area managers and crews in meeting the specialized demands and new requirements for the historic buildings, structures, and sites that comprise the Skagit Project historic district. It is the Skagit Area personnel who have the lead responsibility for the day-to-day care and protection of the historic resources. Their high standards of stewardship over the past 70 years have enabled the most significant elements of the area's history to survive in good condition today.

How to Determine Which Buildings and Resources are Covered by the Plan

Only some of the buildings and facilities in the Skagit Area-those which have been designated as "contributing to the character of the historic district"-are covered by the provisions of the HRMMP. To determine if a building or structure is a Contributing Resource (and therefore covered by the HRMMP), refer to Figure 1-2 on page 1-5 of the Introduction, or the more detailed listings in Section 3.4.

Project Planning and Review

Section 3, the main portion of the HRMMP, contains background information and policy direction to assist in the planning, review, and completion of projects and activities which involve maintenance or changes to Contributing Resources. A suggested sequence for proceeding is:

1. Get an Overview of the Resource. Each resource has a 2-page descriptive entry in Section 3.4. This includes short discussions of the significance of the resource, issues and concerns, and a listing of the notable and important features of the resource. A repair and maintenance database will be kept at the Skagit Area which will also contain information about individual resources.

2. Review the Background Information. Over the years a set of approaches and standards have been developed for the care and management of historic structures. Sections 3.1 and 3.2 contain definitions of accepted historic preservation treatments, and the full text of the preservation standards which have been modified to address certain unique aspects of the Skagit Project.

3. Determine the Category for the Particular Activity or Action. Section 3.3 describes and gives examples for the different actions: maintenance, repair-in-kind, alteration, demolition, relocation, reconstruction, and new construction.

4. Determine the Appropriate Level of Review. Charts 3-1 through 3-4 correlate proposed actions from No. 3 above with the applicable standards in No. 2 above, and indicate the appropriate review procedures for different activities. There are three different review processes, one of which will apply to any given action which would affect a Contributing Resource.

5. Determine the Appropriate Techniques and Materials to Use for Repair, Maintenance, and other Activities. Each resource has a list of character-defining features in Section 3.4. These are the particular aspects and features of the resources that are important to protect and which (depending on the activity) may require special handling, processes, or materials. The Preservation Briefs in Appendix A present some useful models for actions and repairs to historic structures. The Skagit Maintenance Guidelines in Appendix B will provide information on appropriate methods and materials for activities and actions.

Skagit Maintenance Guidelines

The Skagit Maintenance Guidelines will be developed in 1991. They will have a materials preservation focus and will emphasize appropriate methods for materials handling and repair. Preventive cyclical measures and procedures will be described and illustrated. The Guidelines will also contain a bibliography of recent information on preservation technology and the maintenance of historic structures.

If You Have Questions or Need Assistance

Please contact the Environmental Affairs Division if you would like additional information or some assistance with the HRMMP (for example, locating a specialist in the repair and restoration of historic tiling).

SUMMARY

The Historic Resources Mitigation and Management Plan (HRMMP) provides policy direction and review for historic architectural and engineering resources within the boundaries of the Skagit River Hydroelectric Project (Skagit Project) in Whatcom County, Washington. The HRMMP has been prepared by the City of Seattle, City Light Department (City) to meet the relicensing requirements of the Federal Energy Regulatory Commission (FERC) and Section 106 of the National Historic Preservation Act of 1966 as amended. In developing the HRMMP, the City has consulted with the Washington State Historic Preservation Officer (SHPO), and with the National Park Service (NPS) as an interested intervenor.

The management program outlined in the HRMMP will run for the term of the new license. The HRMMP applies to all historic buildings, structures, and features designated as Contributing Resources within the Skagit River Hydroelectric Project Historic District, recently determined eligible for listing in the National Register of Historic Places. Implementation of the HRMMP will be carried out largely by the City's Skagit Area personnel, and the plan has therefore been designed for maximum usability. Periodic reports on all HRMMP-implementing activities will be issued by the City under the terms of a Memorandum of Agreement executed with the SHPO and the NPS in 1991.

The City began identification and evaluation of the historic resource base at the Skagit Project in 1989. Survey and inventory of all architectural and engineering resources were completed to Level I standards of the Historic American Building Survey (HABS) and the Historic American Engineering Record (HAER). Based upon the findings of the survey/inventory, the City prepared a nomination to the National Register which extensively documents the history of the Skagit Project and its multiple components. The HRMMP describes the methodology and the end products of these efforts, and establishes a process for the periodic updating of the National Register listing.

The HRMMP supports the concept that the preservation and re-use of historic resources at the Skagit Project will now be integrated with the mission and programs of Seattle City Light. Protection of identified Contributing Resources is ensured through the guidelines, review procedures, and various mitigation measures contained in the HRMMP. A set of ten Skagit Project Preservation Standards is adopted as official design standards governing changes to historic buildings. Three levels of review procedures are established, each corresponding to the degree of intervention entailed by any proposed action.

The City will prepare a set of Skagit Maintenance Guidelines to encourage a maintenance and repair program that is sensitive to the character of designated structures within the historic district. For the Gorge Inn and Cambridge House in Newhalem, an Historic Structure Report will be compiled to assist the City in its decision-making on the fate of these two buildings. Ladder Creek Falls Gardens will be the subject of a detailed Historic Landscape Report, and the landscaping of Newhalem will be studied in a Cultural Landscape Inventory and Assessment.

An annual Historic Preservation Seminar Series for City and NPS personnel involved in the maintenance of historic resources will be jointly sponsored by the City and the NPS.

Ongoing interpretation and education programs at the Skagit Project will be enhanced through several new measures. A self-guided walking tour of the company town of Newhalem will be developed to supplement the popular Skagit Tours program. Existing exhibits at five key locations throughout the area will be assessed for visual quality and effectiveness, and exhibits at Newhalem Visitor Center, and Diablo and Ross Powerhouses will be revitalized. The City will publish a booklet for sale at Skagit incorporating the best of the photographic and graphic documentation produced during the HABS/HAER Survey/Inventory project. To preserve a valuable collection of 400 historic photographs depicting construction of the Skagit Project, the City will provide funds to the Seattle Engineering Department for the transfer of images on cellulose nitrate film to safety film.

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1.0 INTRODUCTION

The City of Seattle, City Light Department (City) owns and operates the Skagit River Hydroelectric Project (Skagit Project) on the upper Skagit River in Whatcom County, Washington. The Skagit Project is licensed by the Federal Energy Regulatory Commission (FERC) under license number 553. The original license for the Skagit Project, which includes Gorge, Diablo, and Ross dams and associated facilities and project area, expired in 1977. Since that time the City has been engaged in discussions with state and federal agencies, treaty tribes, and public groups in preparation for the relicensing of the Skagit Project. Twelve of these entities have participated formally as "intervenors." During these discussions, several areas of interest were identified. Among these was the area of cultural resources, including historic, archaeological, and traditional cultural properties.

In this document, the Historic Resources Mitigation and Management Plan (HRMMP), the City presents a program for the mitigation of impacts to and the long-term management of historic buildings, structures, and features in the Project Area. The HRMMP will form one chapter of the Skagit Project Cultural Resources Mitigation and Management Plan (CRMMP). The CRMMP will include two additional chapters: the Traditional Cultural Properties Mitigation Plan, and the Archaeological Resources Mitigation and Management Plan. The City will implement each of these component plans for the duration of the new license.

In the preparation of this HRMMP, the City conferred with interested intervenors and other knowledgeable parties, and considered the various issues and priorities expressed during the relicensing proceedings, including documentation needs, the resolution of current demolition proposals, the effects of continued maintenance and repair, the treatment of historic landscape features, and educational and interpretive needs.

1.1 BACKGROUND

The Skagit Project was built by the City Light Department in several stages during the period from 1918 to 1962. It operated originally under permit from the U. S. Department of Agriculture and after 1927 under license number 553 issued by the Federal Power Commission. Since the expiration of the original license in 1977, the City has operated the Skagit Project under an annually renewed license while conducting the studies and consultations necessary for the relicensing.

Under the provisions of Section 106 of the National Historic Preservation Act of 1966 as amended (NHPA), the FERC is required to consider the impact of its licensing action upon identified cultural resources of the Skagit Project listed in, or eligible for listing in, the National Register of Historic Places (National Register). Further, the FERC must afford the Advisory Council on Historic Preservation an opportunity to comment upon the proposed undertaking by following the procedures set forth in 36 CFR Part 800, "Protection of Historic and Cultural Properties."

The City as licensee has taken specific steps to enable the FERC to meet these compliance responsibilities under Section 106 and its implementing regulations, 36 CFR Part 800. In regard to historic resources, the City has: 1) completed an intensive survey and inventory of historic buildings, engineering facilities, and related features in the project area; 2) prepared and submitted to the Washington State Historic Preservation Officer (SHPO) a nomination to the National Register for "The Skagit River and Newhalem Creek Hydroelectric Projects;" 3) received a Determination of Eligibility from the SHPO; 4) assessed the impact of the relicensing upon eligible resources and made a Determination of Adverse Effect (*i.e.*, that relicensing of the Project could result in actions that would affect the historic properties); 5) consulted with the SHPO, the NPS as an interested intervenor in the relicensing, and other interested parties to seek ways of avoiding or reducing these adverse effects; and 6) reached an agreement on how the effects will be mitigated and executed a Memorandum of Agreement (MOA) with the SHPO and the NPS. In carrying out these steps for purposes of the relicensing, the City has met and exceeded applicable FERC staff guidelines set forth in the Hydroelectric Project Relicensing Handbook (April 1990).

The MOA, executed in 1991, calls for the development and implementation of a HRMMP, spells out its major components, and requires the City to report on all implementation activities on a regular basis. A Settlement Agreement concerning cultural resources among the City, the NPS, and the three intervening tribes (Upper Skagit Tribe, Sauk-Suiattle Tribe, and Swinomish Tribal Community) incorporates the HRMMP and the mitigation/management plans for archaeological resources and traditional cultural properties, and provides for their implementation under the new license for the Skagit Project.

The City meets the final requirements of consultation and mitigation of adverse effects under 36 CFR Part 800.5 by the development and implementation of this HRMMP, in consultation with the SHPO, the NPS as intervenor, and other interested parties. This document therefore completes the City's obligations for historic resources on behalf of the FERC under Section 106 of the NHPA.

1.2 HISTORIC OVERVIEW

The Skagit Project is a physically and historically linked system of dams, powerhouses, and company towns on the upper Skagit River in northcentral Washington. Built over a span of fifty years, beginning in 1918, the Skagit Project is the City of Seattle's premier symbol of the Progressive Era in American city government. Its development guaranteed the survival of the City's Lighting Department, strengthening its position in the fierce competition with private utilities, and influencing the public power movement in the 1920s and beyond. The Skagit Project illustrates the historical trend of developing more ambitious and remote hydroelectric sites in the decade of the 1920s. Its construction in the rugged terrain of the Skagit Gorge prompted innovative solutions to difficult engineering problems and required the establishment of two employee towns-Newhalem and Diablo. Inextricably connected with the vision of one man, James Delmage Ross, Seattle's Superintendent of Lighting for 28 years, the Skagit Project gained national renown as a showplace for the promotion of hydroelectricity and municipal ownership. In the 1920s and 1930s, thousands of tourists participated each summer in two-day rail and boat tours of the Skagit Project, including visits to special landscape attractions created by J. D. Ross.

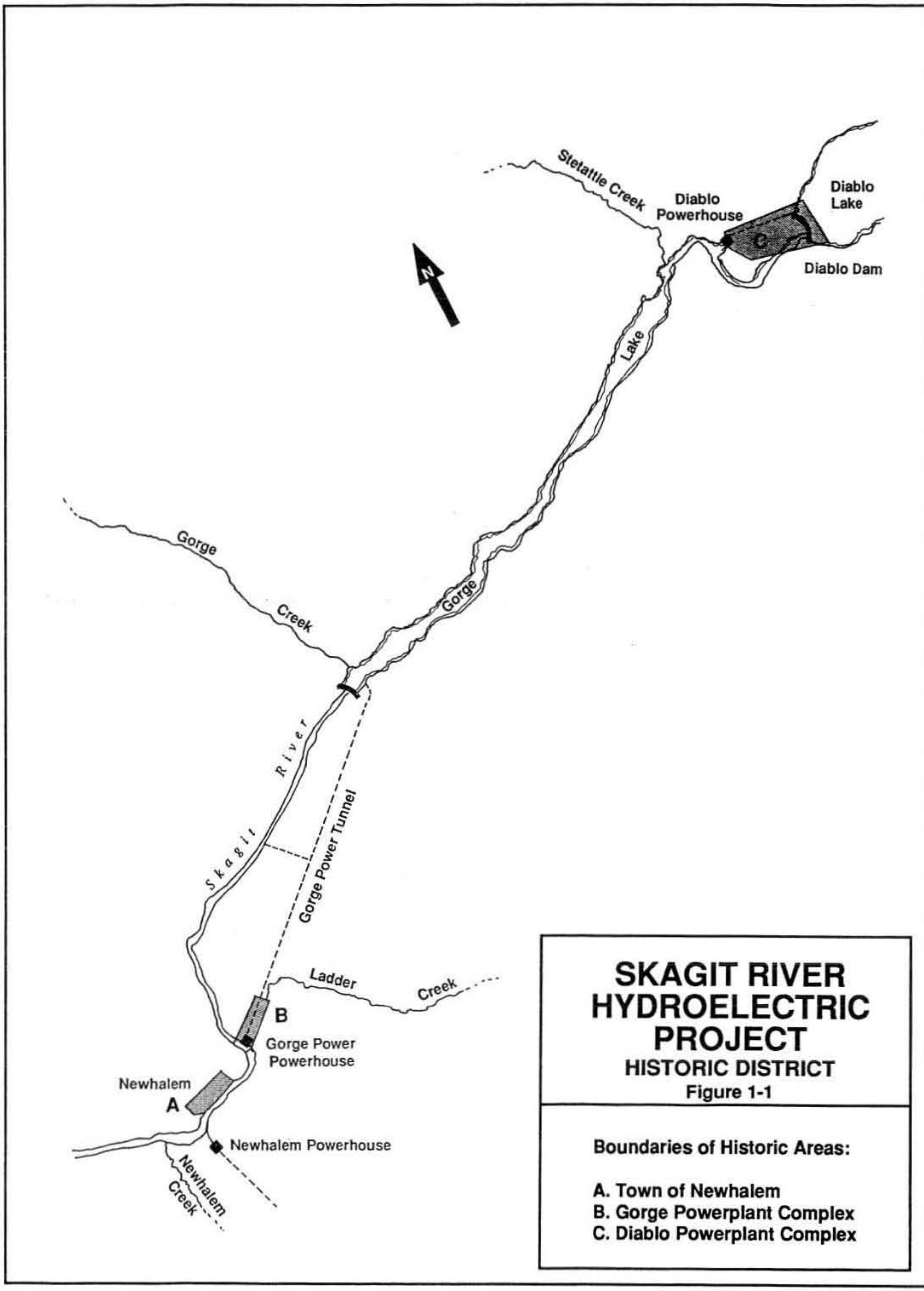
Today, the Skagit Project displays a wide range of historic resources dating from the early decades of its operation. Among the most remarkable are the still-functioning company towns of Newhalem and Diablo, unique examples on a national scale of municipally-owned, planned communities; Diablo Dam and Powerhouse, with aesthetic details designed to appeal to the visiting public; and Ladder Creek Falls Garden, a planned landscape and trail system that in its heyday featured tropical plants and a carefully orchestrated sound and light show.

As an indicator of their significance as examples of early 20th century hydroelectric power development in the west, many of the buildings, structures, and features of the Skagit Project have been collectively determined eligible for listing as an historic district (see Figure 1-1) in the National Register. The National Register is the nation's official inventory of properties worthy of preservation. It is a record of the physical evidence of the past, tangible reminders of historic American accomplishments in architecture, engineering, archaeology, and culture.

By virtue of their listing in the National Register, the historic resources of the Skagit Project require special management consideration. The HRMMP sets forth a program to meet this need and recognizes a long-term stewardship role for the City in the care and protection of these significant resources.

The historic district extends in a discontiguous fashion from Newhalem to Diablo and encompasses a wide variety of functional components. The resources that are at least 50 years of age, clearly illustrate the theme of municipal hydroelectric power and related development, and possess integrity of location, design, setting, materials, workmanship, feeling, and association, are included in the historic district as "Contributing Resources." (Conversely, those resources which do not meet these criteria are "Non-Contributing Resources.")

The HRMMP applies to all Contributing Resources, listed in their entirety in Figure 1-2. With the passage of time, additional buildings or structures may be added to the Contributing Resource category as they reach 50 years of age, or as new information comes to light. In general, when the HRMMP refers to historic resources, Contributing Resources are implied.



SKAGIT RIVER HYDROELECTRIC PROJECT
HISTORIC DISTRICT
Figure 1-1

Boundaries of Historic Areas:

A. Town of Newhalem
B. Gorge Powerplant Complex
C. Diablo Powerplant Complex

Figure 1-2. Contributing Resources in the Skagit River Hydroelectric Project Historic District in 1990

<u>Newhalem</u>	<u>Gorge</u>
New Cook's Bunkhouse #10	Gorge Powerhouse
Gorge Inn	Ladder Creek Falls Gardens
Cambridge House	Gorge Railroad Bridge
Silk Stocking Row Houses	Gravity Oil Tank House
Schoolteacher's House	
The Hotel (Bunkhouse #23)	
Commissary	
Pansy House (Bunkhouse #13)	<u>Diablo</u>
Tourist Dormitory (Bunkhouse #70)	Diablo Powerhouse
Garages	Incline Lift & Powerhouse
U.S.G.S. Stream Gauging Station and Cable Car	Incline Waiting Station
Old Number Six	Diablo Dam
Ross Crypt	Diablo Water Tower
	Hollywood House #2

1.3 SCOPE OF THE PLAN

The HRMMP is prompted by the relicensing of the Skagit Project and the anticipated indirect effects of continued operation upon the designated historic resources. Incremental change to project components has occurred in the past and is expected to continue in the future. Over the term of the new license, project elements will undergo routine maintenance and upgrading, and support facilities in Newhalem and Diablo may be affected by proposals for alteration, demolition, or new construction. Among proposals currently under consideration, some have the potential to erode and others to enhance the historic resource base.

Previously, the City's adherence to a strict policy of efficiency and utility in the management of its building stock at the Skagit Project has meant the inevitable loss of some historic resources and the irreversible alteration of others. Now, however, National Register designation of the historic district, and compliance with Section 106 in the relicensing process, require some revision of that policy to reflect the City's new stewardship responsibilities. The intent of the HRMMP is thus to set forth management standards, guidelines, and processes that express historic preservation values. **The HRMMP supports the concept that the preservation and**

re-use of historic resources at the Skagit Project will now be integrated with the mission and programs of Seattle City Light.

The methodology employed in the development of the HRMMP is founded upon the body of research produced in the documentation process. The historical facts, physical descriptions, and assessments of significance provided in the National Register registration form serve as basic background data. To clarify the potential impacts of continued operation and existing management constraints, extensive discussions were held with City personnel whose program areas directly affect the historic resources of the Skagit Project. Representatives from the SHPO's office, Cultural Resources Division of the Pacific Northwest Regional Office of the NPS, and North Cascades NPS Complex were consulted in the earliest stages and throughout the planning process. Their concerns and priorities have been considered in the formulation of this program, and through negotiation all major issues have been addressed to each party's satisfaction.

The structure of the HRMMP is based upon the three sequential objectives of cultural resource management: identification of resources and evaluation of significance, protection of significant resources, and public interpretation of the resource base. These concepts are developed in Chapters 2, 3, and 4. Within each chapter are descriptions of current programs which have met or continue to meet these management objectives, as well as new programs and principles designed to strengthen historic preservation goals. Cost estimates for the various mitigative measures specified throughout the text are presented in Tables 5-1 to 5-5 in Chapter 5.

The Historic Resources Mitigation and Management Plan was prepared by Florence K. Lentz and Shirley L. Courtois. The City's project manager was Richard Rutz.

2.0 IDENTIFICATION AND EVALUATION OF HISTORIC RESOURCES

The first step in any program of historic resource management is the identification, documentation and evaluation of the resource base. In 1989 and 1990 the City completed this process for the architectural and engineering resources of the Skagit Project. The work was accomplished to Level I standards of the Historic American Building Survey (HABS) and the Historic American Engineering Record (HAER) and hence far surpassed the minimum levels of documentation required by 36 CFR Part 800.4.

Under guidelines set forth in FERC's current Hydroelectric Project Relicensing Handbook, the HABS/HAER documentation prepared by the City constitutes a major mitigative measure that contributes toward the reduction of adverse impacts to historic resources over the term of the new license.

The HABS/HAER documentation was carried out on behalf of the City by the Cultural Resources Division of the Pacific Northwest Regional Office of the NPS-PNRO, whose professional historians, architects, and engineers followed the standards for inventory, documentation, and evaluation established by Section 110 of the NHPA. The project encompassed three components, each described in greater detail below: Architectural Survey and Documentation, Engineering Survey and Documentation, and Evaluation of National Register Eligibility and Documentation Needs. A final report encompassing all three products entitled "Historic American Building Survey/Historic American Engineering Record Survey for the Skagit River and Newhalem Creek Hydroelectric Projects" was submitted to the City by the NPS-PNRO in October 1990.

Copies of the report are on file at the NPS-PNRO, the SHPO, and at the Skagit Project. Duplicate sets of documentation materials have been submitted for permanent retention at the Library of Congress in Washington, D.C. and at the University of Washington, Special Collections and Preservation Division.

2.1 HABS SURVEY OF ARCHITECTURAL RESOURCES

During the spring and summer of 1989, qualified NPS architectural historians conducted an intensive survey of all City-owned housing and commercial, office, and institutional buildings in the communities of Newhalem and Diablo. All resources 40 years of age or older were considered for inclusion.

Historical data on the properties were collected from several repositories. Of greatest value were the Seattle City Light Archives and Library, the University of Washington Manuscripts Division and Pacific Northwest Collection, and the Seattle Public Library. Oral interviews with former and current City employees clarified specific information about the historic structures. Historic photos and architectural drawings provided additional data on the resources of Newhalem and Diablo.

The HABS Survey resulted in a number of valuable products. Forty properties are fully documented on two-page inventory forms developed by the Cultural Resources Division of the NPS-PNRO in consultation with National Register staff and the SHPO. Incorporated in each form are the basic data required for documenting and evaluating historic properties. Each form includes general location information and a site map; a brief description of the property (historic and present) including a floor plan sketch; a short history of the property, including construction date, architects or engineers (if known); and a bibliography of source materials. The forms also include 35 mm black-and-white photos of the resources documenting their 1989 appearance and, when available, reductions of historic drawings depicting elevations. In addition, the inventory forms provide a preliminary assessment of National Register eligibility and a statement of significance for those determined eligible.

2.2 HAER SURVEY OF ENGINEERING RESOURCES

In the summer of 1989, comprehensive HABS/HAER level photodocumentation of the engineering facilities of the Skagit Project was completed. In the same season, a qualified HAER historian intensively surveyed and inventoried all of the major dams, hydraulic and power-generating facilities, and supporting transportation and maintenance facilities of the Skagit Project.

In preparation for documenting the technical history of the Skagit Project's development, the HAER historian reviewed the City's archives and photo collection, visited other local repositories, and interviewed City employees. Historic views and images that best represented the overall development and various construction phases of the Skagit Project were selected for archival reproduction. The HAER historian further prepared an inventory of historic engineering drawings which served as a foundation for the work of a team of HAER architects the following year.

In a second phase of documentation in the summer of 1990, a HAER team of five architecture students produced a record set of measured drawings of the historic dams and powerhouses at the Skagit Project. The HAER survey resulted in Level I documentation which included: a narrative overview of the technical history of the Skagit Project coupled with an annotated bibliography; photodocumentation consisting of large format record photos and reproductions of historic photos, all in accordance with HABS/HAER Photographic Specifications (June 1989); 15 ink-on-mylar measured drawings; and an inventory of historic engineering drawings and photos pertaining to the hydroelectric facilities of the Skagit Project.

2.3 NATIONAL REGISTER NOMINATION

Upon completion of the inventory process, architectural historians from the NPS-PNRO prepared a detailed National Register nomination of the Skagit Project's historic resources. Because of functional and historical links to the Skagit Project, the facilities of the Newhalem Creek Hydroelectric Project are evaluated within the same National Register document. The resulting nomination is thus entitled, "Skagit River and Newhalem Creek Hydroelectric Projects."

Background data from the HABS/HAER Survey form the basis for the National Register nomination. Documentation from a previously listed multiple-resource nomination for "Hydroelectric Power Plants in Washington State, 1890-1938" was also incorporated into this more focused treatment of the Skagit and Newhalem Creek facilities. Because of the physical proximity and obvious functional connections between the dams, powerhouses and company towns and their many associated features, the nomination for the Skagit and Newhalem Projects is structured around the concept of a "discontiguous historic district." The district boundaries are not continuous from Newhalem to Diablo but instead define smaller nodes or clusters of resources in several locations.

The registration form includes a descriptive overview of the Skagit Project in 1989, as well as a thorough accounting of changes which have occurred over time. Each Contributing Resource and Non-Contributing Resource is described in detail and the rationale for each designation explained. The character-defining features of each resource are noted in narrative fashion. A statement of significance, or assessment of historical import, documents the significance of the Skagit Project in terms of the published criteria for National Register listing. The requirement for physical "integrity," or authenticity of a property's historic identity, is applied to the varied resources of the Skagit Project both individually and collectively.

"The Skagit River and Newhalem Creek Hydroelectric Projects" registration form is a document that is valuable above and beyond its most obvious function as an evaluation device. It is in itself the most comprehensive history of the Skagit Project yet compiled and the only one that covers in detail the evolution of the towns of Diablo and Newhalem. It will likely remain for many years the standard reference on the history of Seattle City Light on the Skagit. In the implementation of the HRMMP, the Skagit Project nomination will serve as the basic reference tool.

A formal Determination of Eligibility for the "The Skagit River and Newhalem Creek Hydroelectric Projects" was issued by the SHPO in November 1990. The SHPO concurred with the recommendations of the NPS-PNRO and the City on the list of Contributing Resources, and the HRMMP addresses these resources.

2.4 PERIODIC UPDATING OF NATIONAL REGISTER LISTING

Some resources of the Skagit Project may fail to qualify for listing simply because they are not 50 years old. As these resources reach the 50-year-old requirement, there will be a need to expand the National Register nomination by designating these properties as Contributing Resources. Some of these resources, such as Ross Dam and Powerhouse, and certain Diablo, Hollywood, and Newhalem housing, will become 50 years old within the next ten to fifteen years. Similarly, as new information comes to light, other resources such as the Stetattle Creek Bridge may be determined eligible by virtue of significance established by the new information.

As part of this HRMMP, beginning in 1999 and every ten years thereafter, the City will undertake an update of "The Skagit River and Newhalem Creek Hydroelectric Projects" National

Register nomination (see also the schedule in Tables 5-2 to 5-5). The update will be done by a qualified architectural historian and will result, as necessary, in a formal amendment to the historic district designation. In developing the documentation for these amendments, the City will consult with the NPS-PNRO and the SHPO. Any update activity will be reported by the City as provided in the MOA.

3.0 PROTECTION OF HISTORIC RESOURCES

The goal of historic resource management is to promote the longevity of the historic properties and resource base. Having completed the identification and evaluation of historic properties at the Skagit Project, the City will now implement a program of resource protection. This chapter presents the framework for such a program.

Every historic resource requires individualized care. Some of the Skagit Project's historic structures, such as the powerhouses and dams, were designed to endure for decades into the future. Others, like the bunkhouses and the Gorge Inn in Newhalem, are more fragile in nature. Much of the historic operating equipment in the powerhouses must undergo continual updating to the latest technological standard. Still other engineering features, such as Old Number Six and the Incline Lift in Diablo, are retained essentially as built.

Despite their variations, each resource now designated as contributing to the character of the historic district calls for special consideration in matters of maintenance, use, and ultimate disposition. Without such special consideration, individual resources will incrementally lose their character-defining features and the historic integrity of the district as a whole will erode.

3.1 TREATMENT DEFINITIONS

There are a wide variety of treatments that are suitable for historic resources and will lead to protection of their character-defining features. Some of these techniques, defined below for clarity, are already in use at the Skagit Project.

PROTECTION. Applying measures that will defend a property from loss, deterioration, or injury.

Protecting a property implies that it will receive additional treatments in the future. Protection often means boarded up windows and doorways, plastic sheeting on the roof, or other ways of keeping out the weather. Protection is acknowledged to be a temporary treatment and must be connected to a long-term solution.

STABILIZATION. Applying measures to reestablish the structural stability of an unsafe or deteriorated property while maintaining the essential form as it exists at present.

This treatment remedies severe deterioration through the repair or reinforcement of roof, wall, or foundation systems.

PRESERVATION. Applying measures to sustain the existing form, integrity, and material of an historic resource. It can include stabilization as well as ongoing maintenance.

Skagit maintenance crews practice preservation when they paint the original lapped and shingled siding of houses on Silk Stocking Row, retool existing generation equipment at Gorge Powerhouse, and maintain the historic light standards on Diablo Dam.

REHABILITATION. Returning a property to a state of utility through repair which makes possible an efficient contemporary use while preserving its character-defining features.

This treatment extends the life of a resource by enabling continued viable use. The term may be applied to the proposed update of internal systems at Diablo Powerhouse, and the proposed conversion of the New Cook's Bunkhouse at Newhalem to a research laboratory.

RESTORATION. Accurately recovering the form and details of a property and its setting as it appeared at a particular period of time by means of the removal of later work or the replacement of missing earlier work.

There are no examples of pure restoration at the Skagit Project, although several candidates exist. Restoration makes possible continued use and generally offers the most visible interpretive opportunities.

RECONSTRUCTION. Reproducing by new construction the exact form and detail of a vanished structure as it appeared at a specific period of time.

Since reconstruction is always new construction, it can be a very expensive technique. No matter how expertly carried out, reconstruction still results in something that is not historic. In certain instances, it may be an appropriate technique when carried out in conjunction with an interpretive master plan.

3.2 SKAGIT PROJECT PRESERVATION STANDARDS

Future actions which affect the Contributing Resources of the Skagit Project historic district will be guided by the "Skagit Project Preservation Standards" set forth below. These guidelines have been adapted to the special circumstances of the Skagit Project from the Secretary of the Interior's Standards for Historic Preservation Projects. Adopted as part of this HRMMP, the standards apply to historic buildings of all construction types, materials, and sizes, and include interiors and exteriors. Related landscape features, building site and environment, and attached or adjacent new construction are also addressed.

The adopted Skagit Project Preservation Standards are to be applied to specific projects in a reasonable manner, taking into consideration economic and technical feasibility, the requirements of the new license and the various resource plans (*i.e.*, the Wildlife Habitation Protection and Management Plan, *etc.*), and the overall mission of Seattle City Light.

Retention and protection of character-defining features is the underlying principle which governs the Skagit Project Preservation Standards. These standards recognize, however, that change is inherent in working engineering facilities. Through the application of these standards, the City will endeavor to maintain the historic integrity of the entire district, while retaining the flexibility to upgrade its operating equipment as required by law and by technological advancements.

<u>Skagit Project Preservation Standards</u>

1. An historic resource shall be used for its original purpose or be placed in a new use that requires minimal change to the defining characteristics of the resource and its site and environment.

2. The historic character of a resource shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a resource shall be avoided when possible.

3. Each historic resource shall be recognized as a physical record of its time, place, and use. Changes which seek to create an earlier appearance but have no historical basis shall be avoided.

4. Changes which have taken place to a resource over the course of time may have acquired significance in their own right, and shall be retained and preserved.

5. Distinctive stylistic features and finishes and examples of skilled craftsmanship which characterize a resource shall be treated with sensitivity.

6. Deteriorated architectural features shall be repaired rather than replaced wherever possible. When replacement is necessary, the new material should match the old in design, color, texture, and other visual qualities. Replacement of missing features shall be substantiated by documented, physical, or pictorial evidence.

7. Replacement of outmoded, deteriorated, or defective engineering equipment shall avoid unnecessary alteration or removal of character-defining features.

8. Chemical or physical treatments that cause damage to historic materials shall not be used. The surface cleaning of structures, when appropriate, shall be undertaken using the most gentle means possible.

9. New additions, exterior alterations, and related new construction shall not destroy historic materials that characterize a resource. The new work shall be differentiated from the old and shall be compatible with size, scale, material, and character of the resource and its environment.

10. All actions shall seek to maintain and preserve the overall integrity of the historic district.

3.3 ACTIONS AND REVIEW PROCEDURES

3.3.1 Actions

Various actions, both direct and indirect, will affect the historic resources of the Skagit Project over the term of the license. Maintenance and repair, alteration, demolition and relocation, and reconstruction and new construction within the historic district are all likely to occur.

A basic premise of historic resource management is that actions involving the least degree of intervention are always preferable. Protection and maintenance are the first steps in this hierarchy. Repair and replacement-in-kind are preferable to alteration, which may change or diminish a resource's historic character. Sensitive alteration, in turn, can extend a property's useful life without loss of integrity. Relocation may save a building but will reduce its significance by removing it from its historic context. Demolition, in principle, is always the most radical and least desirable alternative. Reconstruction of a vanished resource is considered new construction, and because it poses problems of authenticity, is less frequently attempted today than in the past.

In planning actions that will affect the designated Contributing Resources of the Skagit Project, the City will take into full consideration these basic principles. Further, all actions will be evaluated in light of the Skagit Project Preservation Standards.

3.3.2 Review Procedures

The procedural review of proposed actions that will affect historic resources will continue to take place largely within the context of the City's project and budget review processes. National Register designation of the historic district, however, does require certain adjustments to these procedures. First, Skagit Area personnel will have improved access to technical information and guidelines for sound preservation decision-making. Second, the role of City Light's Environmental Affairs Division in obtaining technical assistance for Skagit Area personnel on historic preservation issues will be increased. Third, the review of historic resource projects under the State Environmental Policy Act (SEPA) will expand.

One important new component of protection procedures will be the Annual Project Review Meeting. At this meeting, Skagit Area managers will apprise Environmental Affairs of all proposed projects for the coming year which might impact historic resources. The kinds of actions which will be addressed include: all proposed alterations (both Capital Improvement Projects (CIP) and non-CIP activities), demolitions, relocations, reconstructions, and new construction. Each proposed action will then be discussed in light of the Skagit Project Preservation Standards. To assist in answering questions or issues of concern regarding appropriate preservation technique, Environmental Affairs will seek advice from professionals with expertise in specialized areas of historic preservation and will convey this technical advice to Skagit Area staff.

Review procedures set forth in the HRMMP correspond to the degree of intervention entailed by the proposed action. Roughly three categories of review will occur:

- **Level One Review - for all Maintenance and Repair-in-kind.** This level of review will take place at the Skagit Area. Existing procedures for prioritizing, scheduling, and supervising projects will remain in effect. Added is the responsibility of Skagit Area staff to apply the Skagit Project Preservation Standards and to consult the technical reference materials in Appendix A of this HRMMP. Project planners will further consult the Skagit Maintenance Guidelines outlined in Section 3.5 that, when completed, will become Appendix B of the HRMMP. Maintenance and repair records will be kept at the Skagit Area for all historic resources.

- **Level Two Review - for all Alteration.** This level of review will occur at the Skagit Area with technical assistance provided by Environmental Affairs. Through the mechanism of the Annual Project Review Meeting, Skagit Area staff and Environmental Affairs will jointly discuss proposed alterations to Contributing Resources and apply the Skagit Project Preservation Standards. Environmental Affairs will obtain and convey any necessary technical advice from professionals in historic preservation. For non-CIP alterations, this consultation process concludes the review procedure. At the conclusion of the project, Environmental Affairs will include a description of the work in its periodic report under the terms of the MOA.

- **Level Three Review - for CIP Alteration, Demolition, Relocation, Reconstruction, and New Construction within the historic district.** This level of review will occur both within the City through the existing CIP contracting and SEPA processes, as well as outside the department, when mandated by SEPA and NHPA rules and regulations. On the basis of project proposals put forward by Skagit Area staff at the Annual Project Review Meeting, Environmental Affairs will conduct all legally required reviews under SEPA for actions impacting designated Contributing Resources through consultation with the SHPO. In instances where further federal licensing or federal funding is required, appropriate consultations under Section 106 of the NHPA will be initiated by Environmental Affairs.

Charts 3-1 through 3-4 correlate proposed actions with applicable Skagit Project Preservation Standards and appropriate review procedures. When planning work on a Contributing Resource, City project planners should refer to the appropriate action chart and check the specific resource description given below in Section 3.4.

Chart 3-1

ACTION: MAINTENANCE AND REPAIR-IN-KIND

Maintenance is taking care of what is already there. Repair-in-kind involves keeping as much of the original or existing material as possible. When deterioration is severe, repair-in-kind means the limited replacement of deteriorated materials with like materials.

The following tasks are examples of Maintenance and Repair-in-kind: removing vegetation, cleaning an exterior surface, rust removal, caulking, painting, replacing window panes, piecing-in siding that matches the original, reinforcing wood flooring, patching concrete.

APPLICABLE STANDARDS:

2. The historic character of a resource shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a resource shall be avoided when possible.

5. Distinctive stylistic features and finishes and examples of skilled craftsmanship which characterize a resource shall be treated with sensitivity.

6. Deteriorated architectural features shall be repaired rather than replaced wherever possible. When replacement is necessary, the new material should match the old in design, color, texture, and other visual qualities. Replacement of missing features shall be substantiated by documented, physical, or pictorial evidence.

8. Chemical or physical treatments that cause damage to historic materials shall not be used. The surface cleaning of structures, when appropriate, shall be undertaken using the gentlest means possible.

10. All actions shall seek to maintain and preserve the overall integrity of the historic district.

PROCEDURES: LEVEL ONE REVIEW

►1◄ Skagit Area staff refer to Section 3.4 for character-defining features and issues of concern specific to individual resource.

►2◄ Skagit Area staff apply Skagit Project Preservation Standards.

►3◄ Proposed work is considered in light of Skagit Maintenance Guidelines (when completed) and pertinent reference material in Appendix A. Environmental Affairs may be consulted for additional assistance.

►4◄ Work proceeds in accordance with standards and guidelines.

►5◄ Work is recorded in a maintenance and repair data base at Skagit.

Chart 3-2

ACTION: ALTERATION

Alteration encompasses a very wide range of changes, including replacements, removals, and additions. Alteration changes the way a resource looks or functions by modifying its materials, massing, spatial configuration, detailing, or its relationship to its environment.

The following tasks are examples of Alteration: replacing generators, raising a dam, upgrading transformers, demolishing a wing, adding a porch, updating systems, inserting new structural openings, replacing a wooden sash with PVC or metal sash, painting surfaces not originally painted, replacing wood shingle roofs with metal, or replacing wood shingle or drop siding with lapped siding.

APPLICABLE STANDARDS:

1. A historic resource shall be used for its original purpose or be placed in a new use that requires minimal change to the defining characteristics of the resource and its site and environment.

2. The historic character of a resource shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a resource shall be avoided when possible.

3. Each historic resource shall be recognized as a physical record of its time, place, and use. Changes which seek to create an earlier appearance but have no historical basis shall be avoided.

4. Changes which have taken place to a resource over the course of time may have acquired significance in their own right, and shall be retained and preserved.

5. Distinctive stylistic features and finishes and examples of skilled craftsmanship which characterize a resource shall be treated with sensitivity.

7. Replacement of outmoded, deteriorated, or defective engineering equipment shall avoid unnecessary alteration or removal of character-defining features.

9. New additions, exterior alterations, and related new construction shall not destroy historic materials that characterize a resource. The new work shall be differentiated from the old and shall be compatible with size, scale, material, and character of the resource and its environment.

10. All actions shall seek to maintain and preserve the overall integrity of the historic district.

PROCEDURES:

<u>NON-CIP PROJECTS</u> - LEVEL TWO REVIEW

►1◄ Skagit Area and Environmental Affairs discuss proposed non-CIP alteration at Annual Project Review Meeting.

(continued on p. 3-8)

Chart 3-2 (continued from p. 3-7)

►2◄ Environmental Affairs assists Skagit Area personnel in applying Skagit Project Preservation Standards, seeking outside expertise on technical issues whenever advisable.

►3◄ Work proceeds in accordance with standards and guidelines.

►4◄ Environmental Affairs includes project descriptions in periodic reports to agencies and FERC under terms of the MOA.

<u>CIP PROJECTS</u> - LEVEL THREE REVIEW

►1◄ Skagit Area and Environmental Affairs discuss proposed CIP alteration at Annual Project Review Meeting and apply Skagit Project Preservation Standards.

►2◄ Environmental Affairs and/or Engineering Division red-flags CIP Project as having probable impact on a historic resource.

►3◄ Environmental Affairs conducts SEPA or Section 106 review as required, establishing necessary mitigation measures.

►4◄ Engineering Division, Financing Division, and Purchasing Department as appropriate ensure that historic status is reflected in all bid and construction contract documents.

►5◄ Contract administrators ensure adherence to specified preservation constraints.

►6◄ Environmental Affairs includes a project review in its report to agencies and FERC under terms of the MOA.

Chart 3-3

ACTION: DEMOLITION AND RELOCATION

Demolition is the razing of an entire historic resource. Relocation changes the physical context of a resource. It includes both the moving of a resource off Seattle City Light property, as well as the resiting of a resource to another location within Skagit Project Area boundaries.

Examples of Demolition and Relocation could include: selling and removing Newhalem housing to private property in Marblemount or taking out a bunkhouse.

APPLICABLE STANDARDS:

1. A historic resource shall be used for its original purpose or be placed in a new use that requires minimal change to the defining characteristics of the resource and its site and environment.

10. All actions shall seek to maintain and preserve the overall integrity of the historic district.

PROCEDURES: LEVEL THREE REVIEW

►1◄ Skagit Area and Environmental Affairs discuss proposed demolition/relocation at Annual Project Review Meeting.

►2◄ Using a qualified historical architect Environmental Affairs initiates an Historic Structure Report and/or Needs Assessment documenting a range of alternative options.

►3◄ Environmental Affairs conducts the required SEPA review, establishing necessary mitigation measures.

►4◄ Work proceeds in accordance with mitigation measures.

►5◄ Environmental Affairs includes description of project outcome in its periodic report to agencies and FERC under terms of the MOA.

Chart 3-4

ACTION: NEW CONSTRUCTION AND RECONSTRUCTION

New construction adjacent to a historic resource or within a complex of historic resources modifies the historic character of the resource's environment. New construction includes historically-based reconstruction of buildings no longer extant.

Examples of New Construction and Reconstruction include: putting up new garages between the houses of Silk Stocking Row, re-installing the five-globe light standards on Newhalem's Main Street, placing new structures atop dams or adjacent to powerhouses, and rebuilding the Gorge Inn after demolishing the original.

APPLICABLE STANDARDS:

9. New additions, exterior alterations, and related new construction shall not destroy historic materials that characterize a resource. The new work shall be differentiated from the old and shall be compatible with size, scale, material, and character of the resource and its environment.

10. All actions shall seek to maintain and preserve the overall integrity of the historic district.

PROCEDURES: LEVEL THREE REVIEW

►1◄ Skagit Area and Environmental Affairs discuss proposed new construction at Annual Project Review Meeting.

►2◄ Environmental Affairs and/or Engineering Division red-flags CIP Project as having probable impact on an adjacent historic resource.

►3◄ Environmental Affairs conducts SEPA or Section 106 review as required, establishing necessary mitigation measures.

►4◄ Engineering Division, Financing Division, and Purchasing Department as appropriate ensure that historic status of adjacent resource is reflected in all bid and construction contract documents.

►5◄ Contract administrators ensure adherence to specified preservation constraints.

►6◄ Environmental Affairs includes a project review in its report to agencies and FERC under terms of the MOA.

3.4 DESCRIPTION OF BUILDINGS, STRUCTURES AND SITES

This section deals individually with the buildings, structures and sites that have been identified as Contributing Resources in the Skagit Project historic district. A separate entry, containing basic information, is provided for each resource. The information in this section serves as a guide for project planning when used in conjunction with the review procedures outlined in Section 3.3.

3.4.1 Character-Defining Features

Every Contributing Resource in the Skagit Project has **character-defining features**. These are features that reflect the significance of the property and the characteristics that must be protected if the property is to retain its significance. A resource with its character-defining features intact is said to have **integrity**.

Different types of resources will have different types of features. For example, seemingly small elements, such as the number of panes in a window sash, are important as features of the wood buildings in Newhalem, whereas the size and scale of the concrete mass is a distinguishing characteristic of a dam.

Each resource has its own particular features that define its individual character. However, buildings constructed at the same time, in the same place, of the same materials, for the same purpose—such as the bunkhouses in Newhalem—will have shared features that also define them as a group.

Size, shape and materials are all basic to establishing character. The type of plan, the number of stories and the roof form contribute to a building's massing. This characteristic massing can be altered—by the addition of a porch—for example, which could compromise this distinguishing feature of the building and contribute to the loss of its integrity.

Materials are especially important in defining character. The surface texture, malleability, light reflecting/absorbing quality and other attributes distinguish one material from another. When a different material is substituted during repair or replacement, the change can alter the resource and affect its integrity. The substitution, beginning in the 1950s, of metal roofs for the original wood shingle roofs of Newhalem buildings is a dramatic example of the effect of a change in materials.

For buildings in the Skagit Project the massing, the siding or surface finish, the style of doors and windows, details of trim and other design elements all add up to make each building a distinct object. Managing the historic resource means being able to identify and protect these character-defining features.

3.4.2 Features of Newhalem

Because there is a concentration of resources in Newhalem, the town serves as a clear illustration of the concept of character-defining features. The historic resources that remain within the community date from two periods: the earliest phase of the construction camp (early 1920s) and the period when Newhalem served as a base for tourists participating in the Skagit Tours (1930s). The style of architecture employed was simple, functional and unpretentious. The earliest buildings, intended to house or provide services for construction crews, were considered to be temporary structures. All but one bunkhouse and all the cottages were demolished early in the Skagit Project's history. However, the need for more permanent buildings was soon perceived, and the houses on Silk Stocking Row were built. In addition, some of the earliest buildings were improved to ensure their continued use.

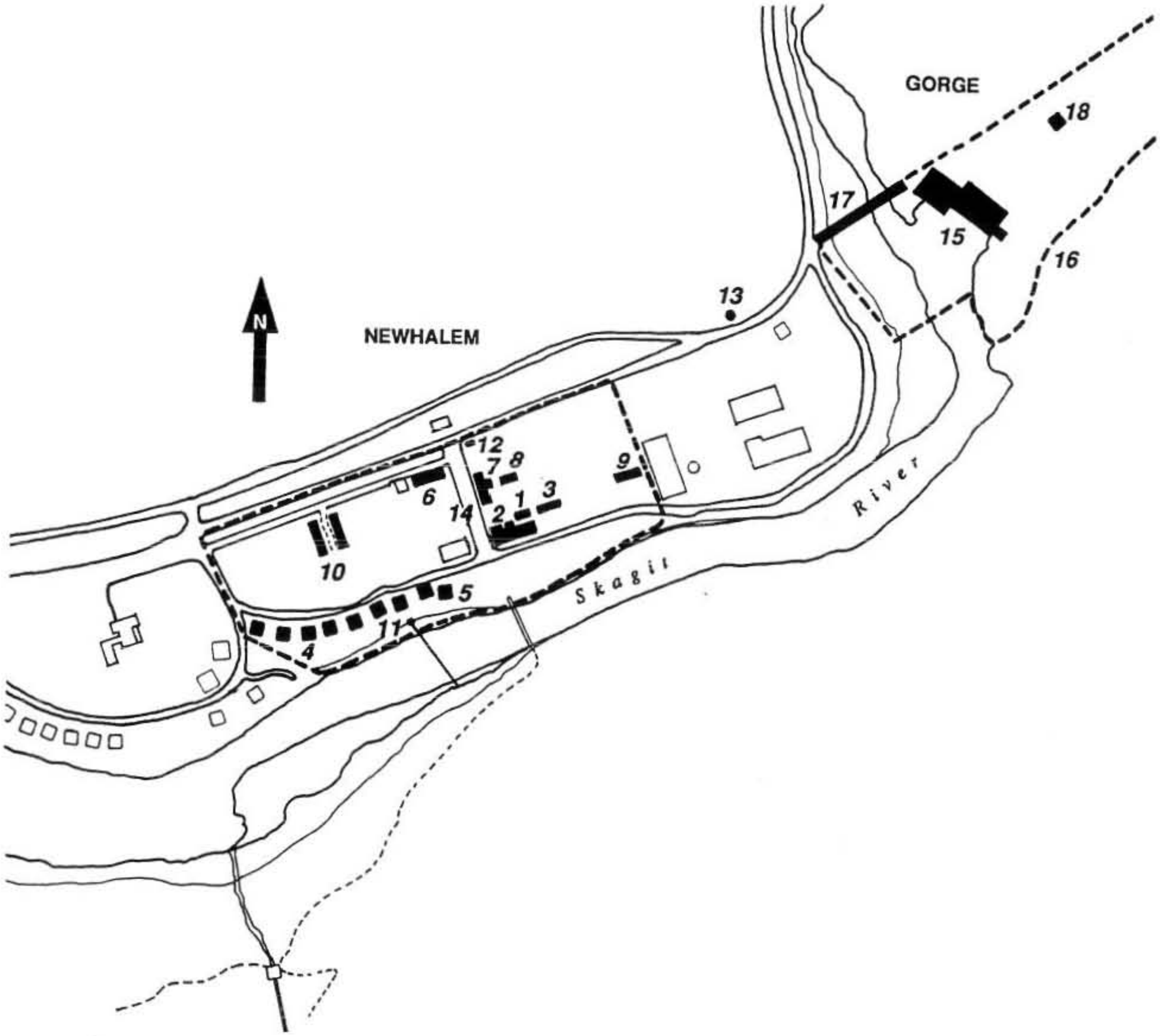
The mess hall or cook house (later called Gorge Inn) was originally a relatively simple though large structure, with walls of vertical board-and-batten and a Malthoid roof covering secured with battens. By the late 1920s, along with the Commissary, it received an exterior sheathing and roof of wood shingles. Early additions to the cook house provided more space for a bakery and for meat butchering and locker areas. In this way, some of the original features of these buildings were, at an early period, covered with new materials which themselves became the historic character-defining features.

Because the remaining historic resources in Newhalem date from a relatively short period, they have many features in common. The use of the same materials, similar shapes, forms and details creates a uniformity of design, providing a harmonious and cohesive visual effect. Almost all of the buildings, with the exception of the Gorge Inn, have rectangular plans and are either one story or one-and-a-half stories. All have gable roofs (except for one gambrel roof on Silk Stocking Row). Siding is either lapped horizontal cedar or cedar shingles laid in a characteristic pattern of alternating wide and narrow courses. Sometimes these two sidings are combined, as in the 1930s bunkhouses. A characteristic window type is a single-hung wood sash with nine lights. Double-hung wood sash with six-over-one lights was originally common in Silk Stocking Row houses. Window and door surrounds are plain milled boards. Doors are of a simple paneled variety, with stiles and rails forming the divisions and no raised panels. Over-doors have small shed or gable roofs supported by simple undecorated braces. All of these features, repeated throughout the town, contribute to the visual cohesiveness.

3.4.3 Contributing Resources

The following pages contain information on the individual Contributing Resources of the Skagit Project. The resources are presented in three geographic groupings: Newhalem (Figure 3-1), Gorge (Figure 3-1) and Diablo (Figure 3-2). At the end of the first group there is a discussion of two elements of the town of Newhalem. These elements, Main Street and landscaping, are not individually classified as contributing, but they are an integral part of the Newhalem community and contribute to the historic ambiance that still exists there.

The information for each Contributing Resource includes a list of character—defining features, a brief statement of significance, and a photograph. The discussion following this page addresses current issues of special concern, and in most cases, presents an action or procedure applicable to the particular situation. Where the action to be undertaken is a further study, the resolution of the problem after completion of the study will be contained in the City's periodic report as provided under the MOA. Additional actions in the future will also be documented in the continuing maintenance records that will become part of the Skagit Maintenance Guidelines.



HISTORIC DISTRICT

NEWHALEM - GORGE AREA

Figure 3-1

---- Historic District Boundary

Contributing Resources

NEWHALEM

1. New Cook's (Bunkhouse #10)
2. Gorge Inn
3. Cambridge House
4. Eight Silk Stocking Row Houses
5. Schoolteacher's House
6. The Hotel (Bunkhouse #23)
7. Commissary
8. Pansy House (Bunkhouse #13)
9. Tourist Dormitory (Bunkhouse #70)
10. Garages
11. U.S.G.S. Stream Gauging Station & Cable Car
12. Old Number Six Locomotive
13. Ross Crypt
14. Main Street
15. Gorge Powerhouse
16. Ladder Creek Falls Trail & Gardens
17. Gorge Railroad Bridge
18. Gravity Oil Tank House

1. NEW COOK'S BUNKHOUSE #10

Character-Defining Features

ca. 1934

- rectangular plan, 1½ stories
- gable roof, shed dormers
- exposed purlin & rafter ends
- plain fascia boards
- lapped wood siding
- coursed wood shingles in gable ends
- 9-light single-sash wood windows
- paneled & glazed wood doors
- plain board window/door surrounds
- gable-roofed over-door with plain braces

Significance

One of two bunkhouses built for Seattle City Light employees in the mid-1930s, during the second phase of the town's development. Except for metal roof covering, it retains original features, including siding, windows, doors, and interior configuration and millwork.

NEW COOK'S BUNKHOUSE #10

Issues/Actions 1990

The building is in good condition and is currently used for storage.

Under Seattle City Light's relicensing agreement for a Wildlife Program, the bunkhouse is scheduled to be converted to a scientific research facility. This conversion would include extensive interior remodeling to install a wet lab and to upgrade wiring, heating, insulation and plumbing.

This conversion is an excellent example of the treatment of Rehabilitation, in which the useful life of a historic property is continued by adapting the building to serve a contemporary function. The rehabilitation of the bunkhouse affords Seattle City Light the opportunity to apply the Skagit Project Preservation Standards and procedures in an initial project involving major alterations.

In planning the conversion to a research facility, care should be taken that the interior adaptation does not adversely affect the exterior features of the building. Original building fabric, including windows, doors and over-doors, should be retained and repaired as needed. If new elements are required, replacements should match the original in size, design, texture, and, where possible, materials.

The contract for the design of the adaptation should specify that the work be done by an experienced historical rehabilitation architect and require adherence to the Skagit Project Preservation Standards. Appropriate staff from North Cascades Park will review plans and drawings to ensure that the design meets their needs, and knowledgeable staff from the Cultural Resources Division of the NPS-PNRO will review plans and drawings to advise on adherence to the Skagit Project Preservation Standards.

2. GORGE INN

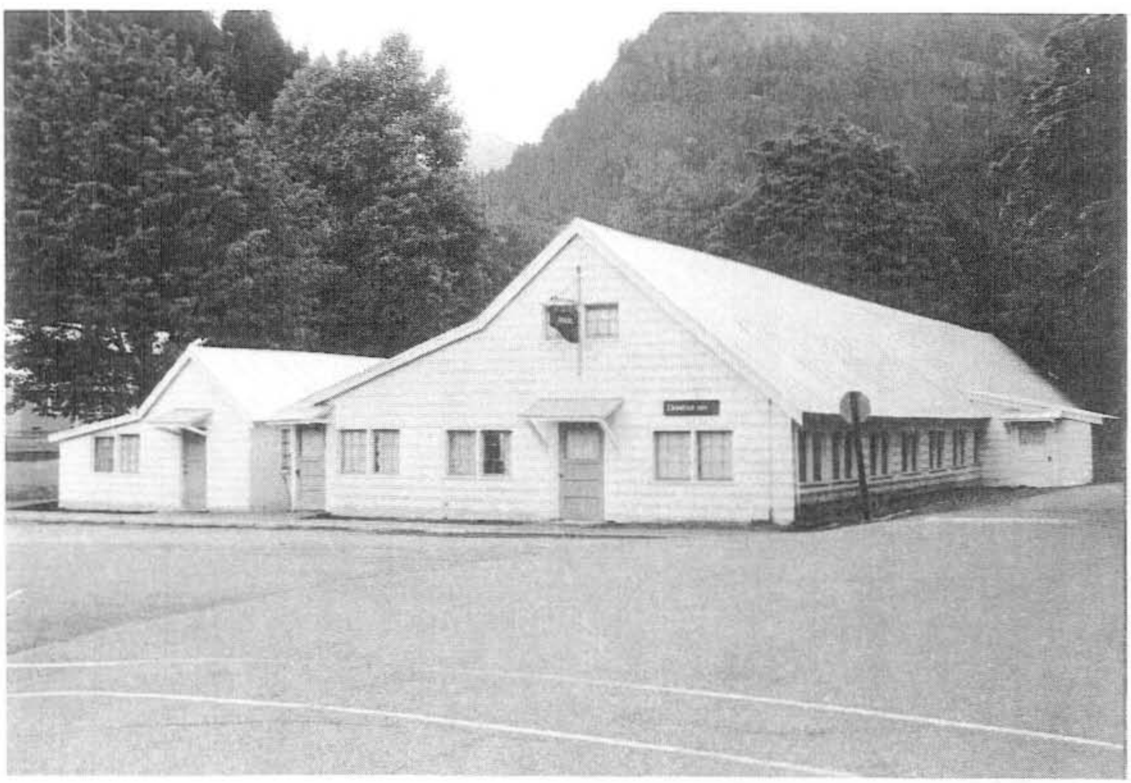
Character-Defining Features

1920

- irregular plan, 1 story
- multiple gable, hip & shed roofs
- exposed rafter ends
- plain fascia boards
- coursed wood shingle siding
- plain board window/door surrounds
- 9-light single-sash wood windows
- paneled & glazed wood doors
- shed-roofed over-doors with plain braces
- anchors SE corner of Main Street

Significance

One of the principal buildings in Newhalem and one of three remaining buildings located on Main Street that date from the first year of construction (1920). The Gorge Inn also played a significant role, serving as the tourists' dining hall, during the heyday of the Skagit Tours in the 1930s.



GORGE INN

Issues/Actions 1990

The Gorge Inn has not been used on a regular basis since before 1980. The electrical and heating systems are not operating, and there is evidence of roof deterioration and leakage. Because of the accumulation of grease residue above the cooking area, the kitchen is believed to be a fire hazard.

The structure rests on its original wood pier foundation. Currently, the general condition of the building is fair, but it is suffering continuing deterioration. Of particular concern is the damage caused by snow accumulation in the open space between the main hall and the addition to the north. The building will continue to receive only minimal maintenance while a decision on its future is pending.

The future of the Gorge Inn is presently indeterminate. There is currently no identifiable use for the building, although it has been considered as an alternative location for an environmental learning center. A number of other options have been discussed, but no specific use has been agreed upon. The future protection of the Gorge Inn depends upon finding a viable new function that the building can serve.

Because of its historical importance and in light of its worsening condition, the City will have an Historic Structure Report prepared by a qualified historical architect. The report will concentrate on an analysis of the structural condition and will include alternative re-use proposals and cost estimates. Depending on the data compiled in the report, the City can weigh such alternatives as preservation through stabilization, rehabilitation for an adaptive re-use, restoration for an interpretive and educational use, or demolition.

3. CAMBRIDGE HOUSE

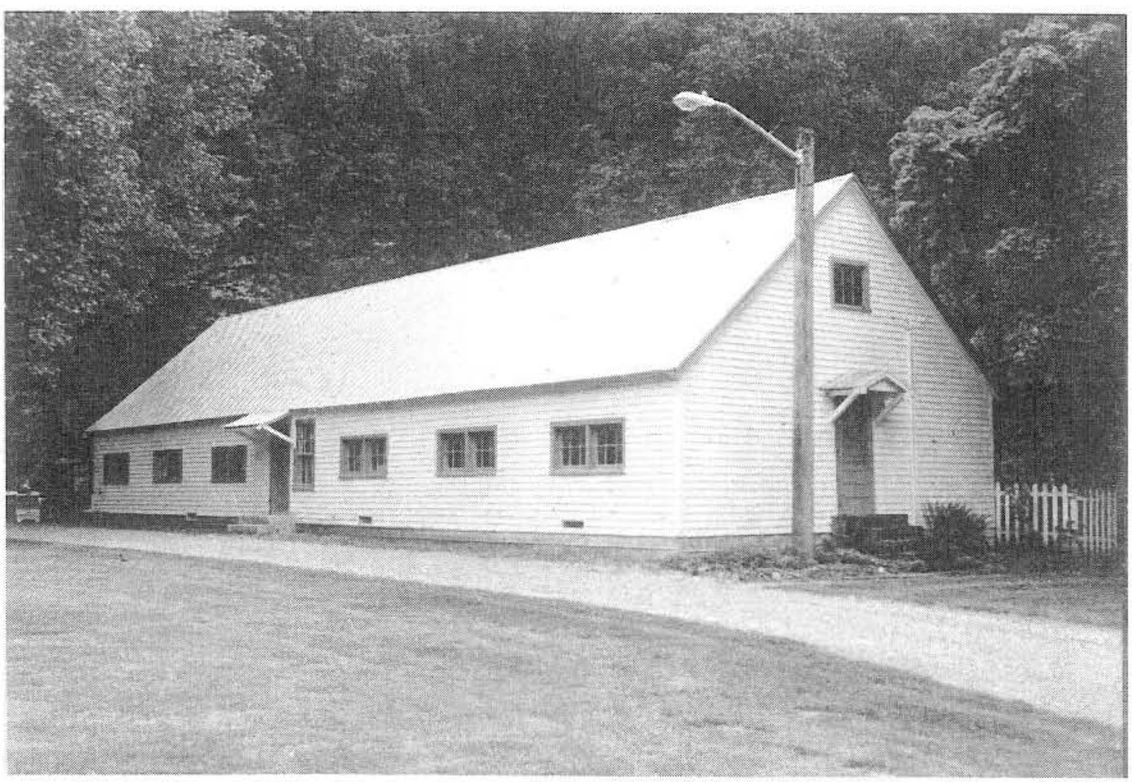
Character-Defining Features

1921

- rectangular plan, 1 story
- gable roof
- exposed rafter ends
- plain fascia boards
- lapped wood siding
- 4-light & 6-light single-sash wood windows
- paneled & glazed wood doors
- plain board window/door surrounds
- shed-roofed & gable-roofed over-doors with plain braces

Significance

One of the oldest buildings in Newhalem and sole remaining example of the original eighteen bunkhouses built in the first years of the camp's development.



CAMBRIDGE HOUSE

Issues/Actions 1990

The building is currently used as a library. However, this function is scheduled to be transferred to the present Administration Building in the near future, leaving the Cambridge House vacant.

Currently, no new use has been identified and demolition has been proposed.

The structure rests on its original wood pier foundation. The general condition of the building is fair, although there is some evidence of settling and other deterioration.

Because of its historical importance and in light of its condition, the City will have an Historic Structure Report prepared by a qualified historical architect. The report will concentrate on an analysis of the structural condition and will include alternative re-use proposals and cost estimates. Relying on the data compiled in the report, the City can weigh such alternatives as preservation through stabilization, rehabilitation for an adaptive re-use, and demolition.

4. SILK STOCKING ROW HOUSES

Character-Defining Features

1921-1923

- rectangular plans, 1½ stories
- gable or complex gable or gambrel roofs
- concrete chimneys
- exposed purlin & rafter ends
- plain fascia boards
- wood shingle or lapped wood siding or combination
- original paneled & glazed wood doors
- original wood window/door surrounds
- projecting or recessed porches
- boxed wood railings with plain wood balusters
- sited as row of detached houses aligned on a gentle S curve
- rear elevations face street; front elevations oriented to river

Significance

First group of permanent houses built for supervisors and operators in Newhalem's early period of development.

SILK STOCKING ROW HOUSES

Issues/Actions 1990

As landlord, Seattle City Light maintains and repairs the houses for renter occupants. Substantial refurbishing is done when houses are vacated. The buildings are all in good condition and well maintained.

All the houses now have standing seam metal roof coverings in place of the original wood shingle roofing.

Recent alterations have included the replacement of original multi-paned, double-hung, wood-sash windows with PVC-sash windows that incorporate flat strips sandwiched between double glazing to simulate muntins. This has resulted in some loss of visual quality (three dimensional character, shadow lines) of the original wood muntins. Some original exterior wood doors have been replaced with metal doors that have glazing in a non-historic configuration.

Future maintenance and repairs should adhere to the Skagit Maintenance Guidelines (when they are developed). In the interim, apply the Skagit Project Preservation Standards, paying special attention to Standards #2, 5, 6, and 8.

Concrete driveways and pads have been provided in anticipation of the future construction of garages. This proposal for new construction is a major alteration to the historic setting of the Silk Stocking Row Houses. Skagit Project Preservation Standards #9 and 10 are applicable in this case. Because the new construction would impact Contributing Resources, a SEPA review would be required.

5. SCHOOLTEACHER'S HOUSE

Character-Defining Features

1939

- rectangular plan, 1½ stories
- gable roof
- exposed rafter ends
- lapped wood siding
- hip roofed porch
- boxed wood posts
- simple wood railings
- orientation to river; relationship to Silk Stocking Row houses

Significance

Similar to family housing built in 1938-39 that came to be known as "Poverty Row." Only house of this type and period remaining in Newhalem, since all Poverty Row houses have been removed.

SCHOOLTEACHER'S HOUSE

Issues/Actions 1990

As landlord, Seattle City Light maintains and repairs the house for renter occupants. The building is in good condition and well maintained.

The original wood shingle roof covering has been replaced with a standing seam metal roof. Other alterations are similar to those that have affected the Silk Stocking Row houses.

Future maintenance and repairs should adhere to the Skagit Maintenance Guidelines when they are developed. In the interim, apply the Skagit Project Preservation Standards, paying special attention to Standards #2, 5, 6 and 8.

6. THE HOTEL (BUNKHOUSE #23)

Character-Defining Features

1920

- rectangular plan, 1 story
- gable roof
- exposed rafter ends
- lapped wood siding
- important siting at NW corner of Hwy 20 and Main Street intersection

Significance

One of three remaining buildings located on Main Street that date from the first year of Newhalem's construction (1920). Although built as a bunkhouse for Skagit workers, it accommodated overnight visitors to the Skagit Project beginning in the mid-1920s and continues to do so to this day.

THE HOTEL (BUNKHOUSE #23)

Issues/Actions 1990

The Hotel is in good condition and is well maintained. It is in continuous use as lodging for Seattle City Light staff or other overnight visitors.

In recent years the Hotel has been refurbished in stages by the Skagit Project maintenance crew. No further work on the building is anticipated at this time.

The building's original massing has been changed by the addition of a full-width porch with a gable roof of lower pitch at the east facade. The original 9-light, single-hung, wood-sash windows have been replaced with metal sash sliding windows, and the original wood doors have been replaced with metal raised panel doors. The original wood shingle roof covering has been replaced with a metal standing seam roof. The recent installation of a concrete foundation has stabilized the structure, and rewiring and the addition of insulation has made the building more habitable.

While all of these measures have prevented the loss or deterioration of the building, the alterations have diminished or eliminated many of its original character-defining features and contributed to a loss of integrity.

Despite this loss, the Hotel remains an important resource because of its prominent location on Main Street at its juncture with Highway 20 and because of its continuous use as lodging at the Skagit Project from the time of its construction in 1920 until the present day.

Continuing maintenance and repair of the Hotel should adhere to the Skagit Project Preservation Standards and follow the procedures outlined in Section 3.3. Future work may offer the opportunity to restore character-defining features that have been removed or altered.

7. COMMISSARY

Character-Defining Features

1920

- original rectangular plan, 1 story
- original gable roof
- coursed wood shingle siding
- 9-light wood-sash windows (2 remaining)
- siting parallel to Main Street

Significance

One of the principal buildings in Newhalem and one of three remaining buildings located on Main Street that date from the first year of the camp's construction (1920). It served and still serves as the company store for Skagit personnel.

COMMISSARY

Issues/Actions 1990

The building has been in continuous use as a general store since its construction in the first year of the camp's existence. It still serves City employees living in the Skagit area and also caters to tourists during the summer season. It is in good condition and is well maintained.

Some of the alterations that have changed the building's outward appearance took place during the historic period, and some are of more recent vintage. When the Commissary was constructed in 1920 the walls were sheathed with vertical board-and-batten. Later in the 1920s this surface was covered with wood shingles applied in a characteristic pattern of alternating wide and narrow courses. This cladding remains on the north and east elevations but has recently been removed from the south end of the west facade. Drop siding of indeterminate date is located on the north end of the west facade. Newer lapped wood siding covers the south elevation and the sound end of the west facade.

A 1950s addition to the east has altered the building's massing, changing the rectangular plan to a T-shaped plan. The lateral gable roof is now covered with standing seam metal roofing, which extends as a shed roof forming a new open porch the length of the west facade. Square metal porch posts support this new roof. In addition, only two of the original 9-light wood-sash windows are still in place.

Although the building rests on its original wood pier foundation, recent stabilization has included the installation of some concrete blocks. This work and the other changes have prevented the loss or deterioration of the building, but some of the alterations have diminished or eliminated some of the original or early character-defining features.

Despite some loss of integrity, the Commissary remains an important resource because of its conspicuous location facing Main Street and its continuous historic use as a general store for the Skagit Project.

Continuing maintenance and repair of the Commissary should adhere to the Skagit Project Preservation Standards and follow the procedures outlined in Section 3.3. Special attention should be paid to Standard #4. The 1920s shingle siding is a character-defining feature and should be retained. When opportunity permits, it should be restored to the areas where it has been removed. Future work may also offer the opportunity to restore other character-defining features that have been removed or altered.

8. PANSY HOUSE (BUNKHOUSE #13)

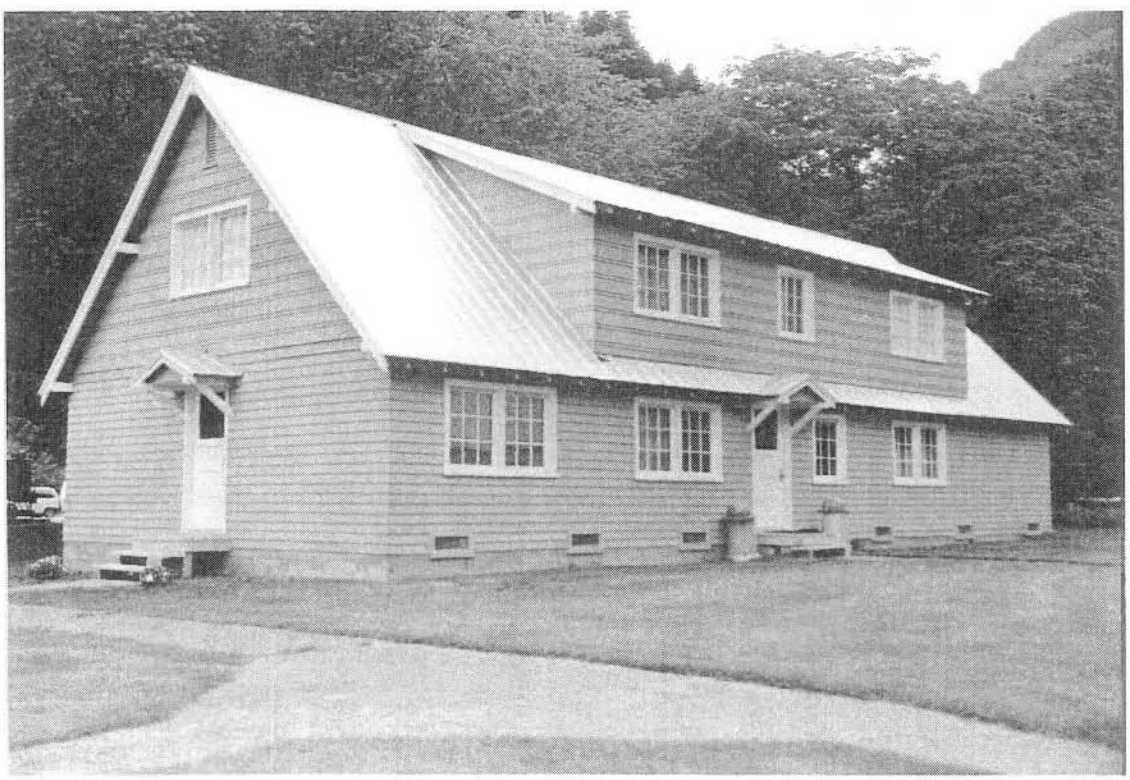
Character-Defining Features

ca. 1934

- rectangular plan, 1½ stories
- gable roof, shed dormers
- exposed purlin & rafter ends
- plain fascia boards
- lapped wood siding
- coursed wood shingles on gable ends & dormers
- 9-light single-sash wood windows
- plain board window & door surrounds
- paneled & glazed wood doors
- gable-roofed over-doors with plain braces

Significance

One of two bunkhouses built for Seattle City Light employees in the mid-1930s, during the second phase of Newhalem's development. Except for metal roof covering, it retains original features, including siding, windows, doors, and interior configuration and millwork.



TOURIST DORMITORY (BUNKHOUSE #70)

Issues/Actions 1990

This one remaining tourist dormitory has a permanent foundation, is in good condition, and has been recently refurbished without a loss of integrity. It is currently unoccupied, but a future use is being considered, perhaps in connection with a summer camp.

The continuing maintenance program should adhere to applicable Skagit Project Preservation standards and follow procedures for maintenance and in-kind repair outlined in Section 3.3.

10. GARAGES #1-22

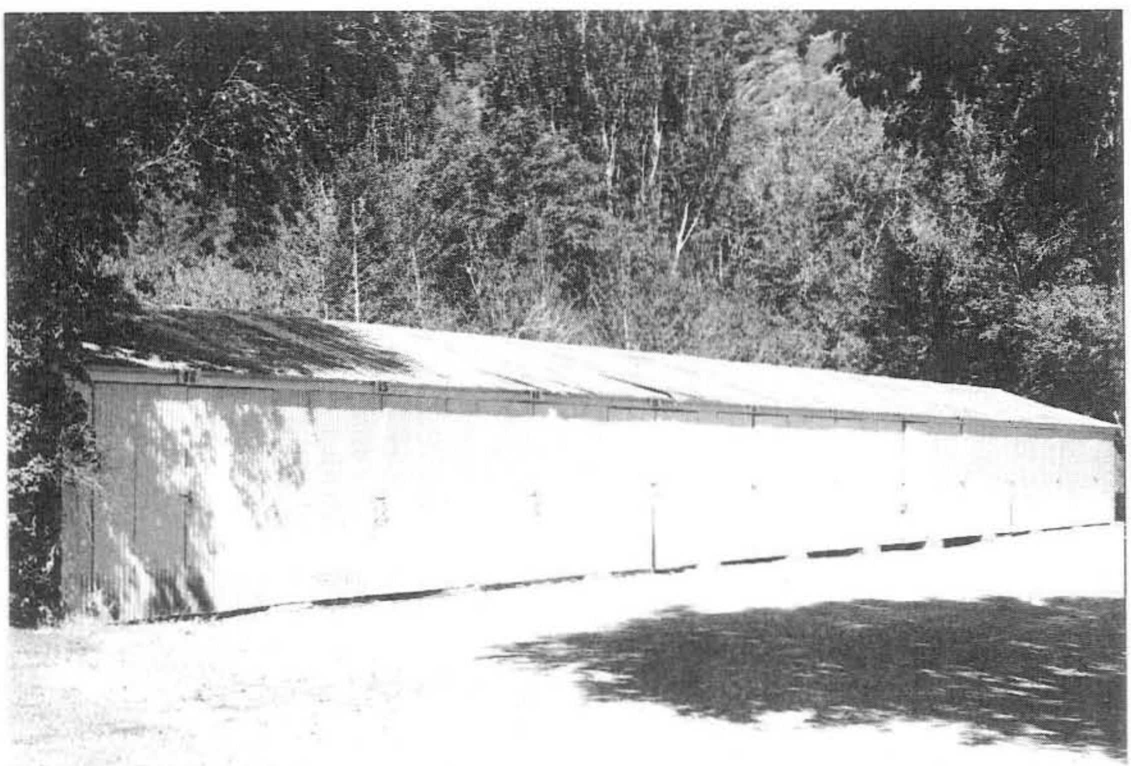
Character-Defining Features

ca. 1939

- long narrow rectangular plan, 1 story
- gable roof
- corrugated metal siding
- coursed wood shingles on gable ends & dormers
- paired hinged doors
- siting in relation to highway

Significance

The garages are representative of the shift in transportation links with downriver urban centers, as employees came to rely more on private automobiles and less on the railroad for access to outside services and activities. Within the context of a historic district, the buildings contribute to an understanding of Newhalem as an example of company town planning and development.



GARAGES #1-22

Issues/Actions 1990

These utilitarian service buildings, built as automobile shelters and still used for storage, are in fair condition. They will continue to be maintained and utilized for the foreseeable future.

If at some future time there is no longer a use for the structures, a proposition to demolish them could arise. Since the garages are now classified as Contributing Resources within a National Register historic district, a proposal to demolish would necessitate a review under SEPA rules.

11. U.S.G.S. STREAM GAUGING STATION & CABLE CAR

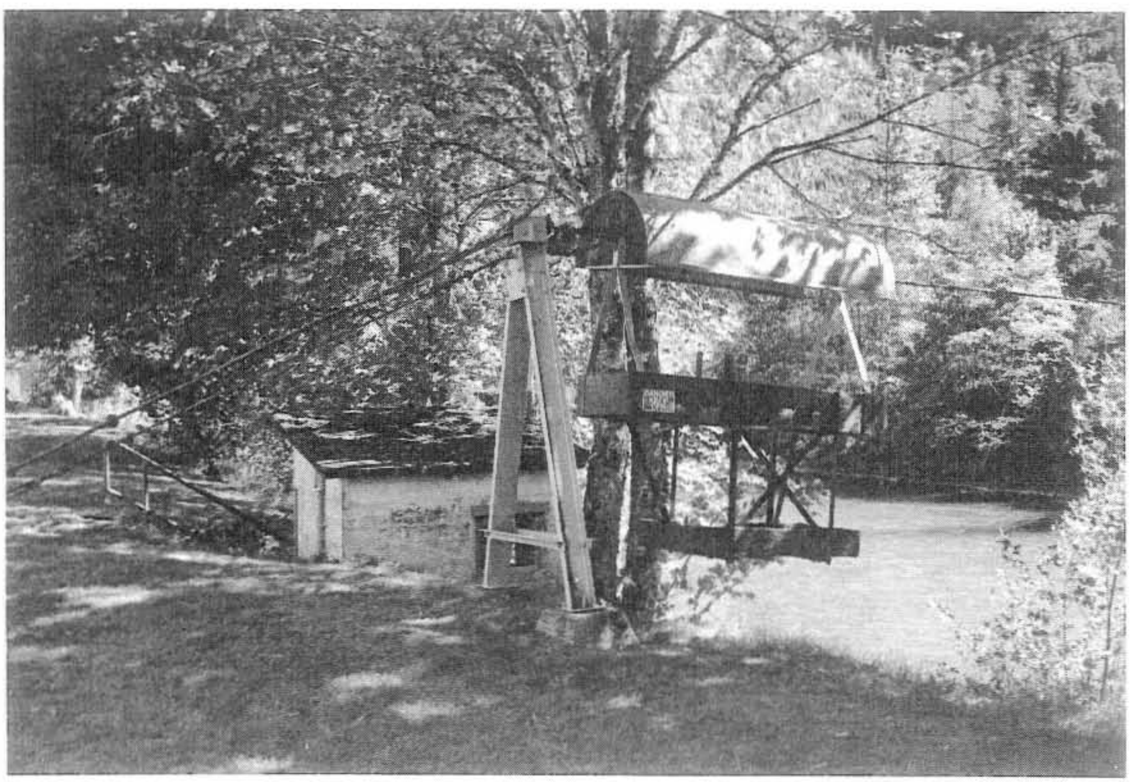
Character-Defining Features

1909/1923

- reinforced concrete gauging station
- rectangular plan, block form
- concrete surface texture
- paneled & glazed wood door
- siting on river bank
- siting of cable car support
- wood & metal cable car members

Significance

The site and its features are significant for their historic association with the Skagit Project, since the data gathered by the U.S.G.S. were critical for the development of hydroelectric power by Seattle City Light in the early decades of the twentieth century.



OLD NUMBER SIX LOCOMOTIVE

Issues/Actions 1990

The locomotive was returned from the town of Concrete, where it had been operated as part of a tourist excursion train, to its present site in Newhalem in 1986. It presently serves as a permanent exhibit, located alongside Highway 20 near Main Street.

There is no anticipated change to the locomotive's location or present function as an exhibit. However, in the future there may be proposals to relocate the locomotive or again put it to use as part of an excursion train. Since Old Number Six is now a Contributing Resource and is so closely associated with the history of the Skagit Project, it should remain at its present location and attempts to relocate it outside the Skagit Project area should be avoided. Its continued maintenance should adhere to applicable Skagit Project Preservation Standards.

13. ROSS CRYPT

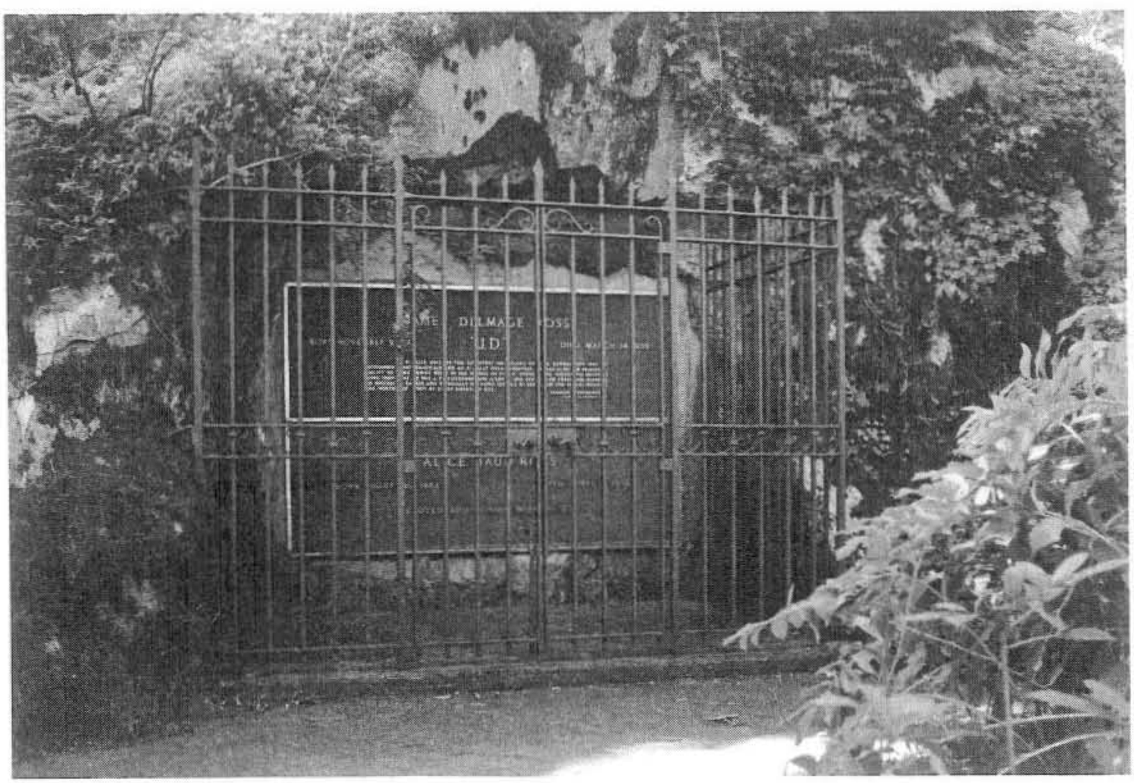
Character-Defining Features

1939

- brass plaque - J. D. Ross
- brass plaque - A. M. Ross
- wrought-iron gates
- recessed niche in rock face
- semi-circular path & associated plantings

Significance

The crypt is significant as the burial place of J. D. Ross, Seattle's Superintendent of Lighting (1911-1939), developer of the Skagit River Hydroelectric Project and its most zealous promoter.



ROSS CRYPT

Issues/Actions 1990

The design of the crypt, integrated into the natural environment and augmented by an informally planted approach, is representative of the landscape aesthetic J. D. Ross envisioned for the entire Skagit Project.

The two brass plaques, though somewhat sheltered in the recessed niche, are exposed to the elements. They were recently refurbished using abrasive cleaning methods that removed any acquired patina. The raised letters and outer border are exposed brass, and the background surface and decorative border have been painted. While the paint protects the brass surface from the effects of exposure to weather, this treatment has compromised the integrity of the historic resource.

Future maintenance should follow the Maintenance Guidelines when they are developed. In the interim, apply the Skagit Project Preservation Standards, paying particular attention to Standard #8. For the care and cleaning of special materials, the technical assistance of specialists in historic materials conservation should be requested through Environmental Affairs.

14. MAIN STREET

Main Street itself is not classified as a Contributing Resource, but is an important part of the historic setting of the town of Newhalem.

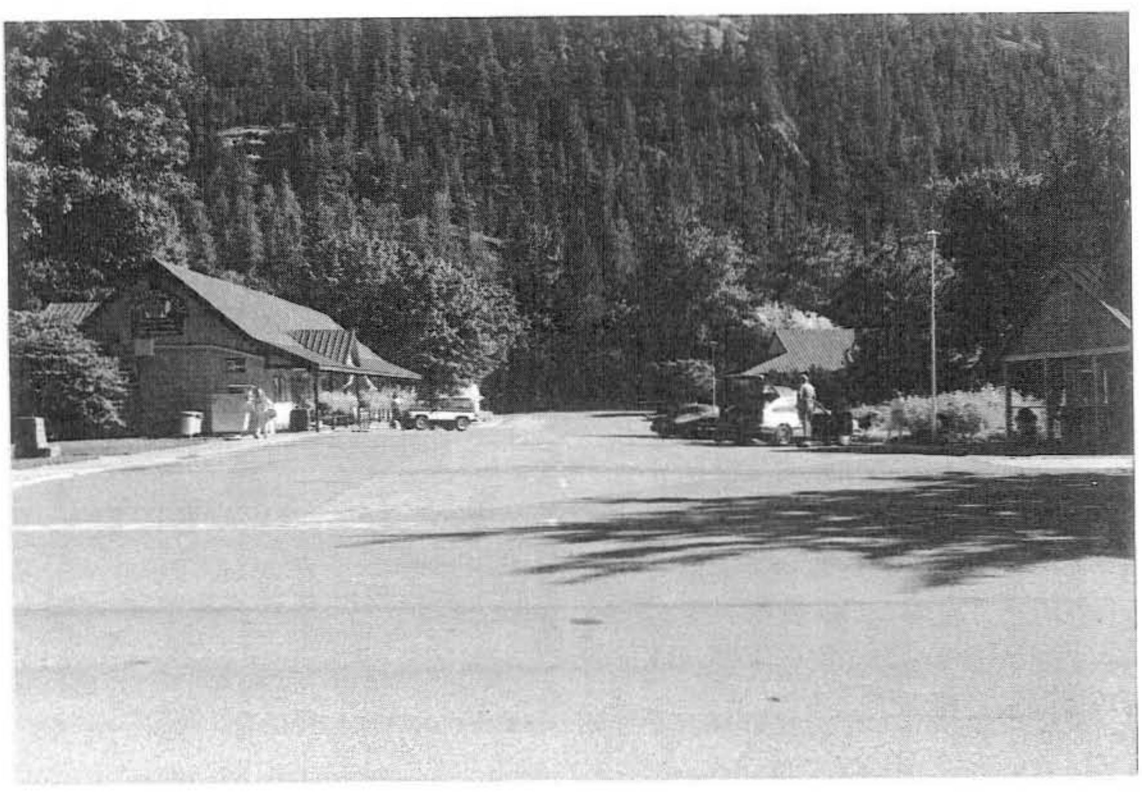
Special Characteristics 1939

Main Street was a central feature of the original layout for the camp at Newhalem. Principal buildings were located along both sides of the street. Several of these original 1920 structures have been demolished, but three-the Hotel, the Commissary and the Gorge Inn-remain.

The qualities which lend historic ambience to Main Street are: the broad width of the roadway, flanked by pedestrian walkways; the alignment perpendicular to the highway; the southern termination at the suspension bridge over the Skagit River; and the relationship of the remaining historic buildings to the street.

Importance

Primary street in Newhalem camp's original layout and later important as entryway for tourists during the heyday of the Skagit Tours in the 1930s.



MAIN STREET

Directions 1990

Main Street still serves its original function as the town's central spine, fronting the historic Gorge Inn and Hotel, serving the major public buildings (Commissary, Currier Hall) and providing access to Silk Stocking Row housing. It also serves as the main parking area for visiting tourists, with angle parking stalls along both sides of the street.

Proposed improvements include the rehabilitation of modern sidewalks and curbs, elimination of a high spot in the roadbed in front of the Hotel, and possible installation of replicas of the five-globe light standards erected by J. D. Ross in 1928 and removed in the 1950s.

These proposed improvements have the potential to impact the historic setting of the district. Care should be taken that the new work is designed to be compatible with the historic character of Newhalem camp, and does not create a false sense of historical development. Technical assistance should be requested if replication of the original light standards is undertaken.

Main Street itself is not a Contributing Resource, and thus is not subject to the higher review standards applicable to such resources.

GENERAL LANDSCAPING

The landscaping of the Skagit Project area is not classified as a Contributing Resource but forms an important element of the historic setting, particularly in the town of Newhalem.

Special Characteristics

During the 1930s, especially under the direction of J. D. Ross, a myriad of plant material was brought to Newhalem and Diablo to beautify the site in keeping with Ross' intention to make the Skagit a showplace. A principal focus was the gardens at Ladder Creek Falls, but trees, shrubs and flowers were planted throughout the area. The practice of enhancing the sites frequented by tourists with shrubs and flower beds is still carried on today.

On entering Newhalem on Highway 20, a visitor is immediately struck by the difference between the natural forest environment of the North Cascades and the manipulated natural elements of the town itself. The character of an established urban-or suburban-environment is immediately evident.

Recognizable elements of the historic landscape include the allée of trees along the former railroad right-of-way east of Main Street, remaining trees that stood among the demolished housing in the historic district north of Silk Stocking Row, and the yards and lawns along the riverbank.

Importance

Several elements of the landscaping of the Skagit Project are significant because of their association with J. D. Ross and with the development of Newhalem and Diablo from construction camps to tourist towns to permanent communities.

Direction 1990

Although there was apparently no overall plan for the landscaping in the Skagit Project area, correspondence and other documented evidence exists to suggest the intentions of J. D. Ross. There are currently some suggestions to return the area to its "natural" state, which would be inconsistent both with the character of the historic district and with the current occupation.

In order to better understand and interpret the Newhalem townsite and its historical context, a Cultural Landscape Inventory and Assessment will be prepared. This assessment will identify design concepts and plant materials that were historically used in Newhalem and will discuss their significance in defining the site's visual character.

GENERAL LANDSCAPING (continued)

Examples of such patterns would be the use of foundation plantings to ease transitions between the built and natural environment and rows of trees to define and enhance circulation routes. The assessment will provide guidelines for maintaining these patterns or visual character as the town continues to evolve. The assessment will also recognize that the landscaping is not a Contributing Resource within the district, and is not subject to the higher review standards applicable to such resources.

15. GORGE POWERHOUSE

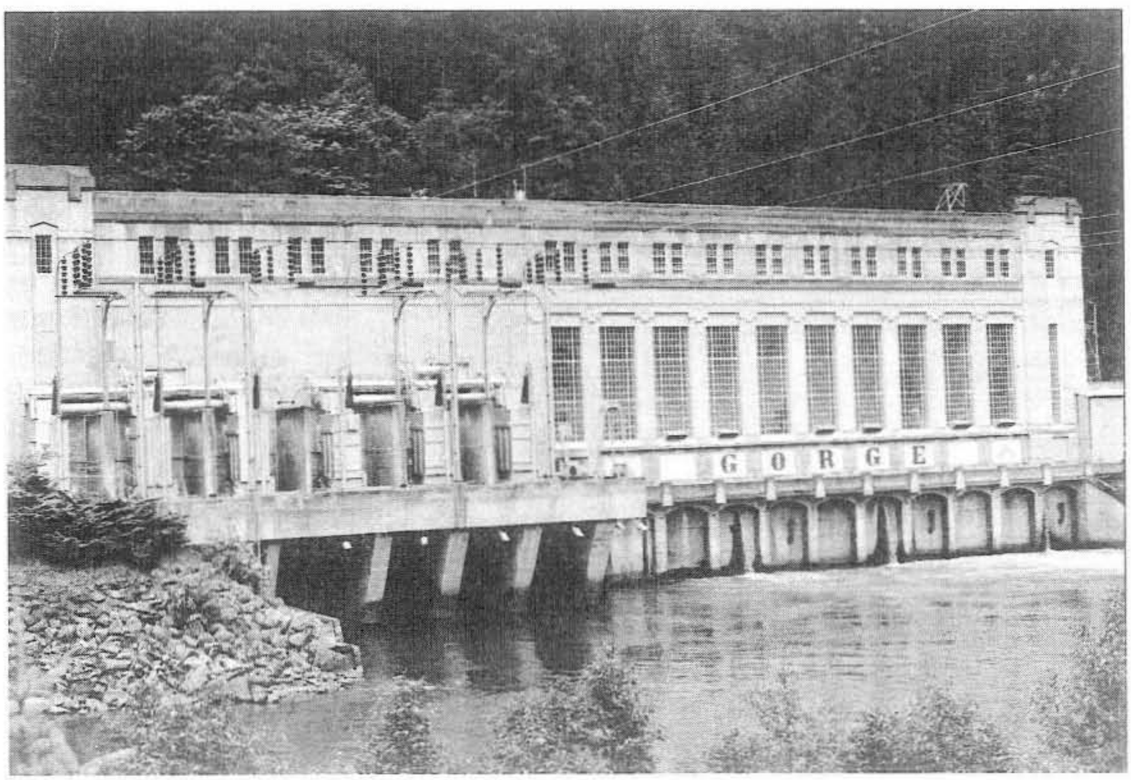
Character-Defining Features

1924

- rectangular plan, 1 story, 60 ft. high volume
- reinforced concrete shell
- exterior surface articulation and decorative details
- industrial steel sash windows
- interior spatial relationships
- prominent siting with unobstructed view from across river

Significance

The first of the three major power plants constructed on the Skagit River and representative of hydroelectric technology in the 1920s. The building is a prominent visual feature, terminating the east-west axis of the town of Newhalem.



GORGE POWERHOUSE

Issues/Actions 1990

The Gorge Powerhouse has excellent integrity; the 1949 addition on the north is sympathetic to the design of the original 1924 building. The generating equipment has been updated in the past and will continue to be improved as new technology and regulations dictate changes.

A proposal to add a second power tunnel at Gorge in the mid-1990s would require a license amendment. This process would include a full Section 106 (NHPA) review.

An interpretive display of historic photographs and artifacts has recently been installed in the visitors' gallery at Gorge Powerhouse. A discussion of the need for comprehensive planning and integration of interpretive exhibits throughout the Skagit Project is contained in Section 4.2 of this document.

16. LADDER CREEK FALLS TRAIL AND GARDENS

Character-Defining Features

1928-41

- layout of pathways
- viewing areas
- stone steps
- concrete steps at falls viewpoint
- ponds and pools
- fountains
- rustic wood bridges
- rustic wood benches
- colored lighting system
- historic plant material

Significance

A personal creation of J. D. Ross, who used the unique combination of gardens, sound and light as a promotional tool to draw the public to the Skagit.

LADDER CREEK FALLS TRAIL AND GARDENS

Issues/Actions 1990

The gardens were at their zenith in the late 1930s but declined after the Skagit Tours were interrupted by World War II. Post-war refurbishing and later attempts at recreating the lighting system make it unclear what parts of the gardens retain integrity.

The gardens continue to attract visitors and they are highlighted in Seattle City Light's promotional brochure for the Skagit Tours. Skagit Project personnel have expressed interest in seeing the gardens returned, at least in part, to their former glory.

Before any decision on the future of Ladder Creek Falls Gardens is made, a Historic Landscape Report will be prepared by a qualified historical landscape architect. This report will describe current conditions, analyze and evaluate landscape components, and present preliminary design options for the future treatment of the gardens and the Ladder Creek trail.

17. GORGE RAILROAD BRIDGE

Character-Defining Features

ca. 1935

- Pratt iron trusses
- concrete center pier and abutments

Significance

The present bridge, a replacement for the earlier railroad bridge, is significant for its association with the Skagit Project during the second period of development of the town of Newhalem.

GORGE RAILROAD BRIDGE

Issues/Actions 1990

The present bridge replaced the original railroad bridge at the same location and was installed to accommodate service automobiles and trucks carrying materials for the powerhouse. It is in good condition and is well maintained.

Continuing maintenance should follow the Skagit Maintenance Guidelines when they are developed. In the interim, apply the Skagit Project Preservation Standards.

18. GRAVITY OIL TANK HOUSE

Character-Defining Features

1928

- reinforced concrete structure
- rectangular plan, block form
- concrete surface texture

Significance

Important for its historical association with the operation of the Gorge Powerhouse and with the Skagit Tours.

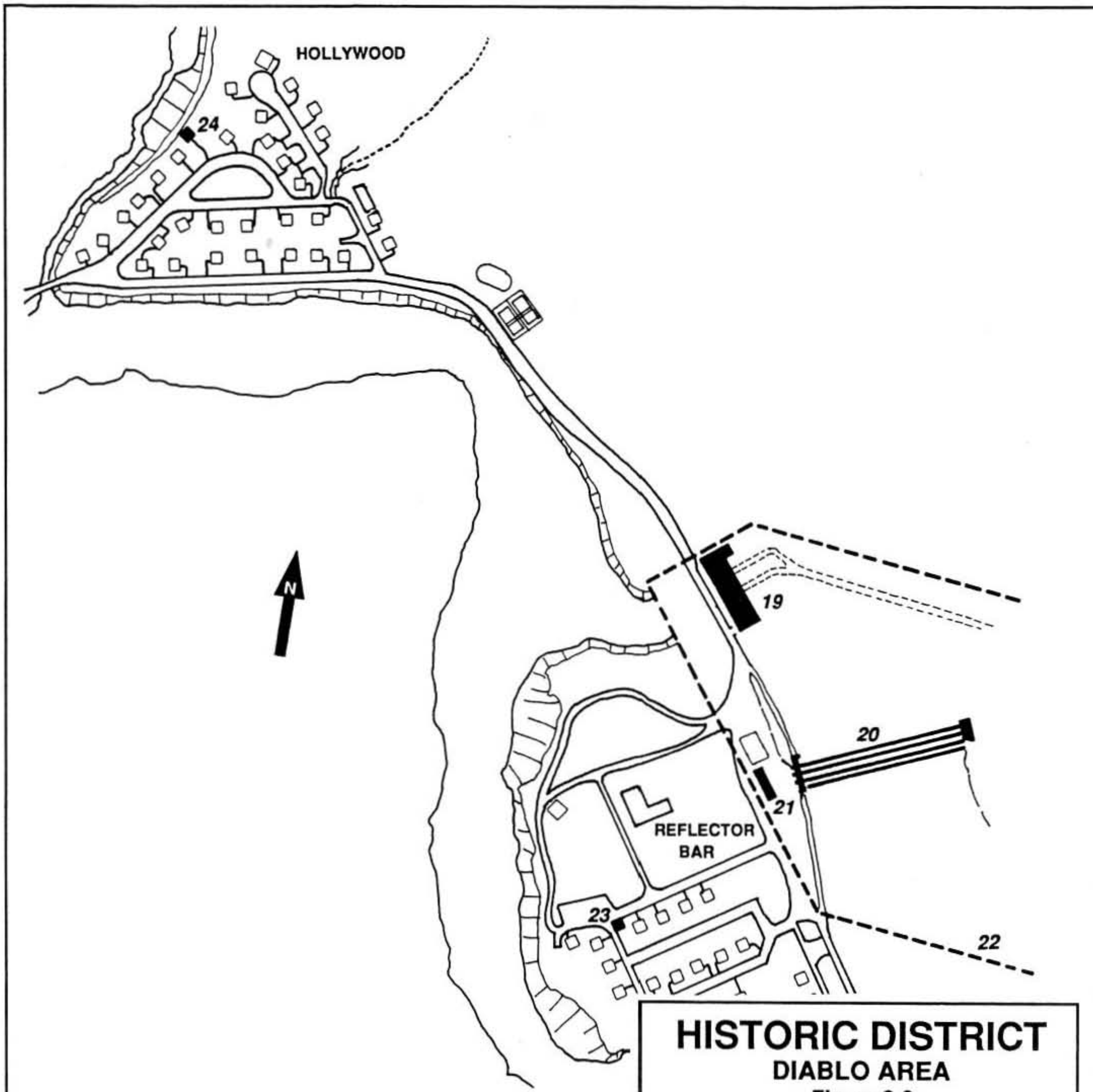
GRAVITY OIL TANK HOUSE

Issues/Actions 1990

The structure was used to store oil for the gravity oil lubrication system for the equipment in Gorge Powerhouse until the mid-1980s. During the 1930s it also housed the recording equipment necessary to provide amplified music throughout the Ladder Creek Falls area while visitors were touring the gardens.

Oil tanks were removed in the mid-1980s. The building is now used for storage. It is in good condition.

No changes are anticipated for the foreseeable future. Continuing maintenance should follow the Skagit Maintenance Guidelines when they are developed. In the interim, apply the Skagit Project Preservation Standards.



HISTORIC DISTRICT
DIABLO AREA
Figure 3-2

---- Historic District Boundary

Contributing Resources

DIABLO

19. Diablo Powerhouse
20. Incline Lift & Powerhouse
21. Incline Waiting Station
22. Diablo Dam
23. Diablo Water Tower
24. Hollywood House #2 (Bldg H-6)

19. DIABLO POWERHOUSE

Character-Defining Features

Building:

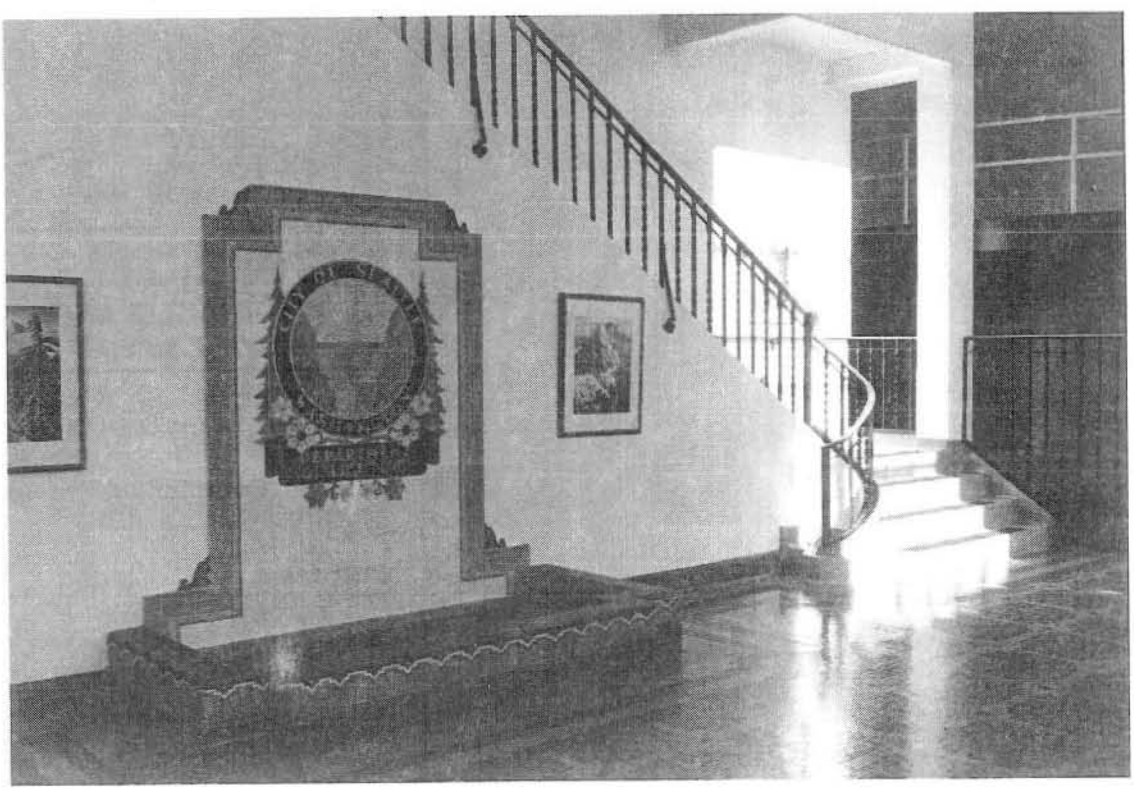
- rectangular plan, 1 story, 60 ft. high volume
- reinforced concrete shell
- exterior surface articulation
- parapet
- industrial steel sash windows
- spatial arrangement of interior 3-level lobby
- wrought-iron fences & railings; aluminum handrails
- terrazzo and intricately patterned tile floors
- glazed tile fish pond

Equipment:

- visible external features that characterize 1930s design, including:
  - pedestal & circular external encasement of generators
  - metal pipe railings
  - porthole windows
- spatial relationships of main generators, house units, spare exciter, *etc.* in open 60 ft. high space

Significance

Most advanced technology and most powerful generating equipment at the time of construction. Intended by J. D. Ross to be the showplace of the public tours of the Skagit Project.



DIABLO POWERHOUSE

Issues/Actions 1990

The Diablo Powerhouse building has excellent integrity and is well maintained. The generating equipment has been updated in the past and will continue to be improved as new technology and regulations dictate changes.

The Diablo Powerhouse holds a unique position in the Skagit Project. It was specifically designed to showcase the generating equipment for the visiting public and was a special destination of the Skagit Tours. Particular attention was paid to interior amenities, especially the visitors' lobby and viewing platforms with their distinctive features. The generators were intentionally raised on pedestals to ensure the most impressive display of their size and power. Details such as porthole windows and pipe railings are characteristic of the Moderne style of the 1930s. All of these significant features are extant and retain remarkable integrity.

The major rehabilitation that is currently proposed includes station service modifications, modernization of ancillary operating systems, installation of static exciters, and many other improvements. Certain of these proposed changes have the potential to impact character-defining features of Diablo Powerhouse. For example, the replacement of the exciters for generators 31 and 32 may affect the exterior appearance of the generators. Care should be taken that significant features, such as the brass handrails at the upper level, are retained.

For all aspects of the rehabilitation, which may occur over a period of time, the City will apply the Skagit Project Preservation Standards and ensure that character-defining features are protected. In addition, the entire proposed rehabilitation will be reviewed through the SEPA process.

20. INCLINE LIFT & POWERHOUSE

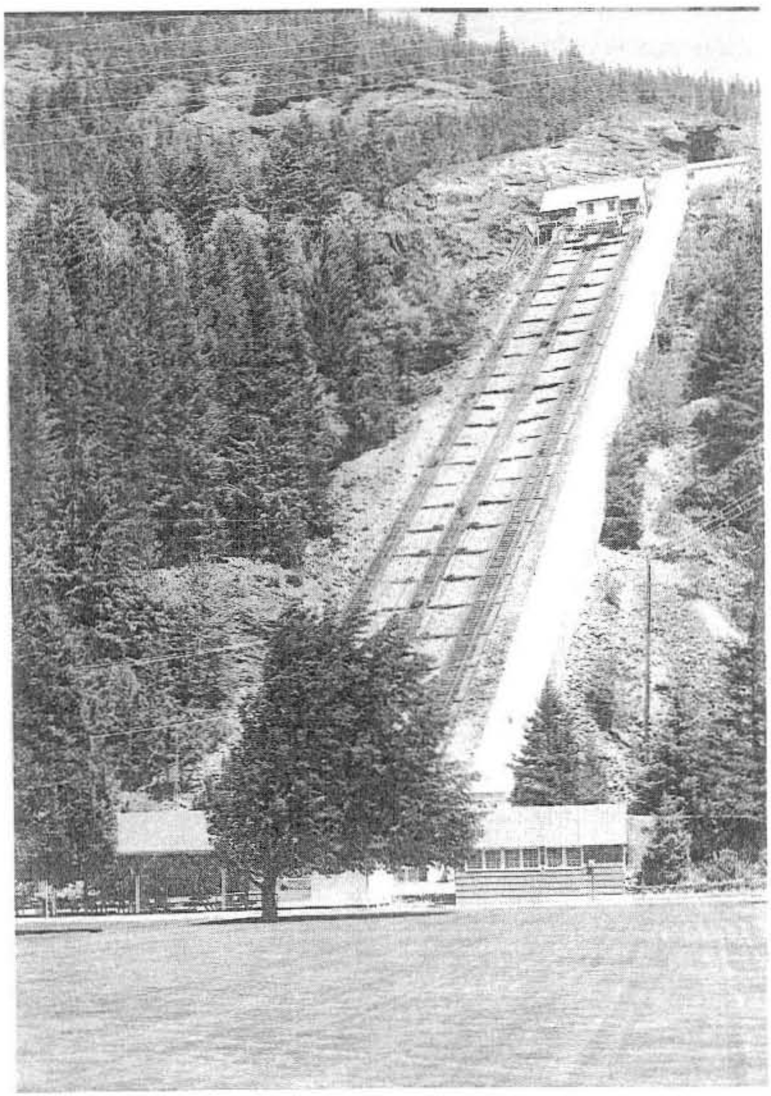
Character-Defining Features

1939

- original tracks
- 60 ft. steel platform with supporting trucks
- 1 story powerhouse
- gable roof with overhangs at stairways

Significance

Integral to the transportation system construction of the Skagit Project, lifting loaded railway cars 313 feet to transport materials and equipment for both Diablo and Ross dams. The Incline Lift has also figured prominently in the Skagit Tours throughout their history, transporting visitors to the same elevation as the top of Diablo Dam.



INCLINE LIFT & POWERHOUSE

Issues/Actions 1990

After operating continuously for over 60 years, the Incline Lift became inoperative in August 1990 due to problems in the electrical system.

A decision on the future of the Incline Lift will be based on the consideration of many factors, including cost, operability, liability and recreational value. Since the Incline Lift is now listed as a Contributing Resource in the National Register district, a consideration of its historic significance must also be a factor in any decision.

Two alternative treatments would ensure the protection of this historic resource.

A. Preservation

The Incline Lift and its Powerhouse would receive on-going maintenance to sustain existing form, integrity and materials. Although not in active use, the lift and all of its features would remain in place and be visible as an integral part of the historic Skagit Project.

B. Rehabilitation

The Incline Lift would be repaired and returned to operation, with all of its character-defining features treated in accordance with the Skagit Project Preservation Standards. The continued operation of the lift would ensure its on-going maintenance as a distinctive historic resource.

Either of these options would protect the historic resource and would be an acceptable treatment.

As of February 1991, the City plans tentatively to rehabilitate the Incline Lift by replacing the inoperative lift machinery in the powerhouse. No modification of character-defining features would be necessary.

21. INCLINE WAITING STATION

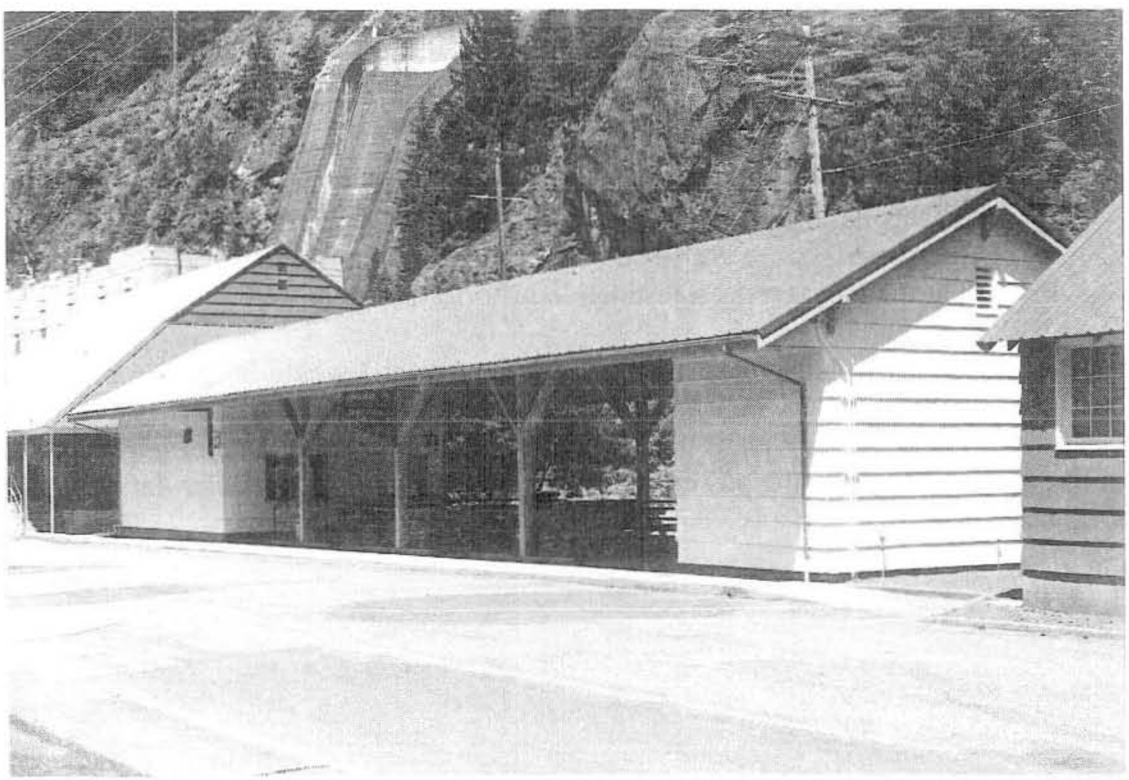
Character-Defining Features

1934

- rectangular plan, 1 story
- gable roof
- visible wood posts, beams & rafters of central open area

Significance

An integral part of the Skagit Railway system, the waiting station was built specifically for visitors during the height of promotional activities for the Skagit Project.



INCLINE WAITING STATION

Issues/Actions 1990

The waiting station is in good condition and is well maintained.

Changes to the building apparently began in the 1950s when the Skagit Tours resumed after an interruption caused by World War II. These changes include the replacement of the wood shingle roof covering with metal roofing, covering of original lapped wood siding with wood shingles, replacement of lattice screens with slatted screens at restroom entries, and covering or replacement of original windows. All of these alterations have diminished or eliminated some original character-defining features and contributed to some loss of integrity.

Despite these alterations, the Incline Waiting Station remains an important historic resource because of its location at the base of the Incline Lift, its association with the historic Skagit Tours, and its continued use for tours during the summer season.

Continuing maintenance and repair of the Incline Waiting Station should adhere to the Skagit Project Preservation Standards and follow the procedures outlined in Section 3.3. Future work may offer the opportunity to restore character-defining features that have been removed or altered.

An interpretive display is proposed to be developed for this area (see Chapter 4 of the HRMMP). In the design and construction of this display, the City will pay particular attention to Skagit Project Preservation Standards #2 and #9.

22. DIABLO DAM

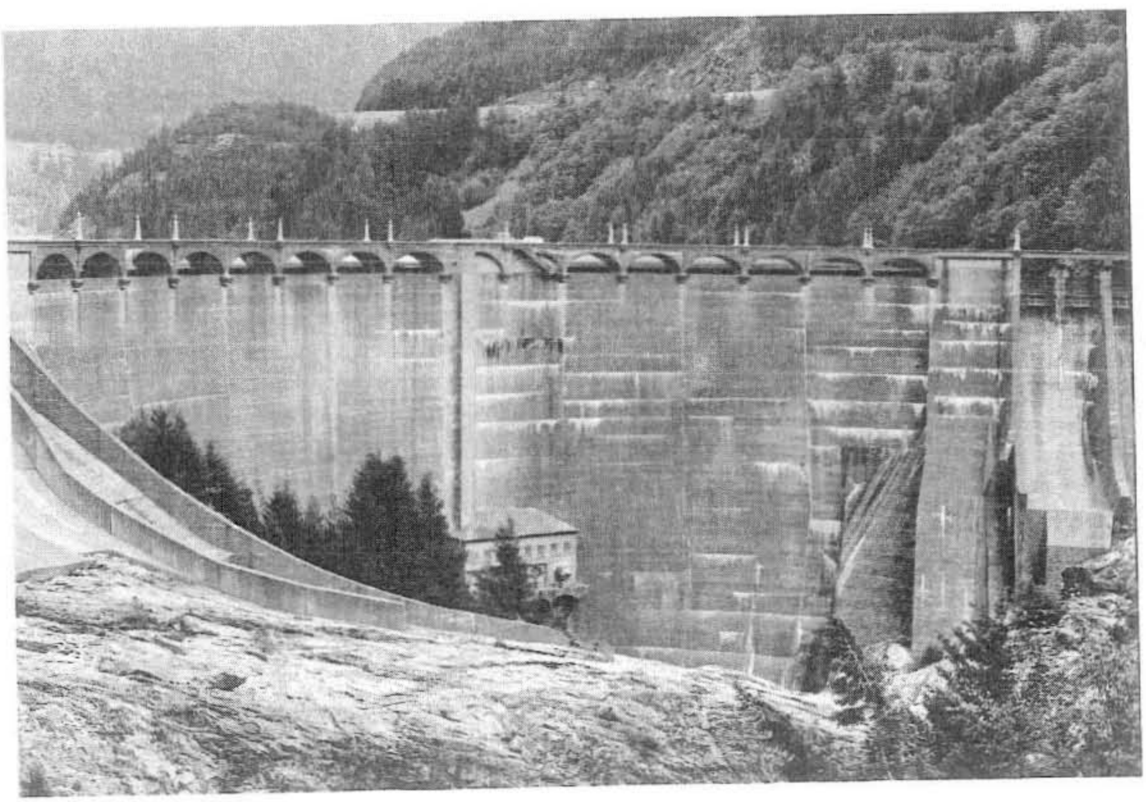
Character-Defining Features

1935

- single arch concrete dam
- gravity abutments
- reinforced concrete slab bridge
- supporting arches
- concrete railings & decorative details
- light standards
- valve house with supporting brackets

Significance

A historically significant example of a constant-angle single arch dam. When completed, Diablo Dam was, briefly, the highest thin arch dam in the world.



DIABLO DAM

Issues/Actions 1990

The Diablo Dam has excellent integrity and is well maintained. Various mechanical elements of the dam have been updated in the past, and improvements will continue in the future as developing technology and new regulations dictate changes. There are no major changes anticipated at this time.

Continuing maintenance and repair should follow the Skagit Maintenance Guidelines when they are prepared. Any future work on the dam or its components should adhere to the Skagit Project Preservations Standards and follow procedures outlined in Section 3.3. Care should be taken to preserve those visible features that define the 1920s design aesthetic.

23. DIABLO WATER TOWER

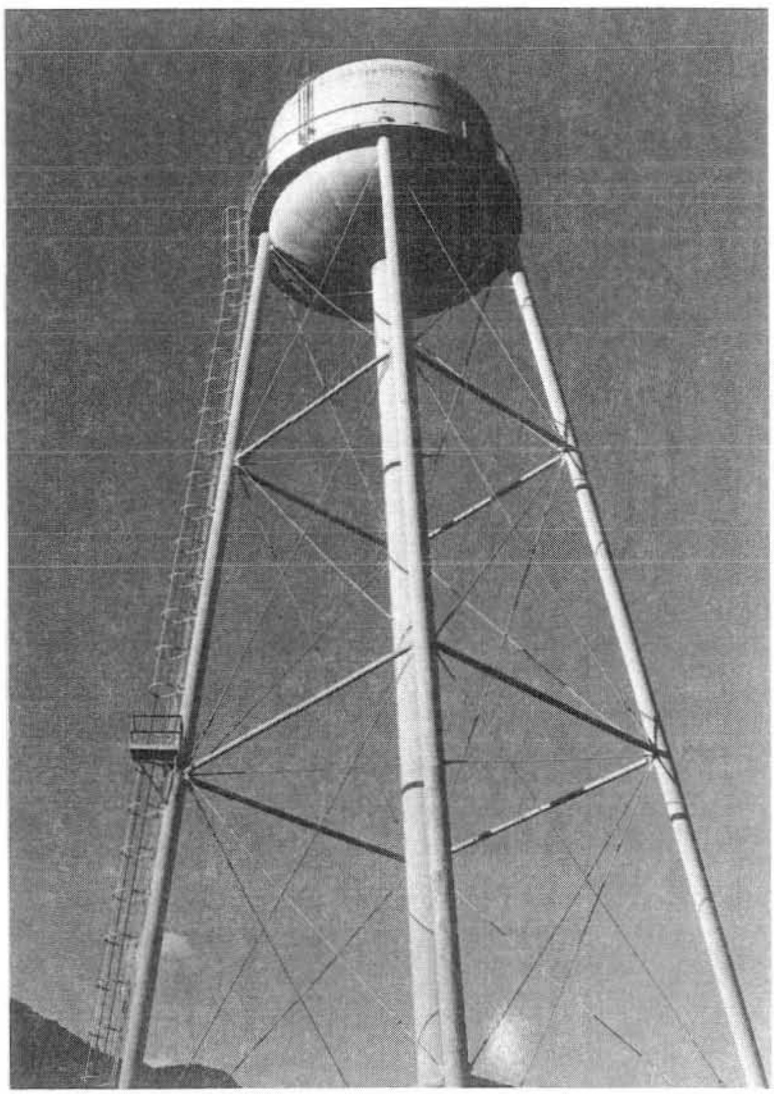
Character-Defining Features

1934

- raised concrete piers
- diagonally braced steel support structure
- circular storage tank

Significance

An integral part of the infrastructure of the company town of Diablo.



DIABLO WATER TOWER

Issues/Actions 1990

The structure still serves its original function of water storage for the town of Diablo. It is virtually unaltered, is in good condition, and is well maintained.

There are no changes anticipated in the foreseeable future. Continuing maintenance should follow the Skagit Maintenance Guidelines when they are developed. In the interim, apply the Skagit Project Preservation Standards.

24. HOLLYWOOD HOUSE #2 (BLDG H-6)

Character-Defining Features

1935

- L-shaped plan, 1½ stories
- gable roof
- brick chimney
- plain fascia boards
- lapped wood siding; vertical board-and-batten with decorative edging
- entry porch
- square wood porch posts with brackets
- paneled & glazed wood door
- double-hung wood sash windows
- plain narrow window surrounds
- stone steps & stoop
- stone foundation

Significance

One of two extant buildings dating to the first period of planned development of Hollywood; reflects the traditional U.S. Forest Service "rustic" design ethic.

HOLLYWOOD HOUSE #2 (BLDG H-6)

Issues/Actions 1990

The U.S. Forest Service offered design assistance when permanent housing was established at Hollywood in 1937. This building, one of five houses constructed, and remnants of the Lodge reflect the Forest Service's architectural style of this era.

The building is in good condition and is well maintained. There are no changes anticipated in the foreseeable future.

Continuing maintenance and repair of the house should adhere to the Skagit Project Preservation Standards and follow the procedures outlined in Section 3.3.

3.5 TRAINING IN PRESERVATION TECHNIQUES

City personnel charged with the maintenance of historic resources at Skagit are faced with a wide range of technical issues. The dual nature of the resources—power-generating engineering facilities, and architectural support facilities—is reflected in the diversity of materials and structures that require care. Further, department policy to date has dictated different management goals for different buildings. No single maintenance approach has been applied to all buildings and resources.

While the standards, objectives, and techniques of maintenance will continue to vary from powerhouse to bunkhouse, a common denominator now unites the effort. National Register listing of the historic district implies the need to preserve the historic character of the resources and to prevent the erosion of that character over the term of the new license and beyond. To introduce this historic preservation ethic into the ongoing maintenance and repair activities at Skagit, the City will undertake a two-pronged program.

The first component of the program will be the development of Skagit Maintenance Guidelines, applicable to the care of Contributing Resources within the historic district. To meet the needs of both the historic resources and the Skagit Area personnel, the development of these Guidelines will begin within a year of the adoption of this HRMMP (see Tables 5-2 to 5-5). To ensure the quality and usefulness of the final product, an experienced historical architect with professional standing in the field of historic preservation will be retained. This professional will consult initially with the full range of Skagit personnel involved in maintenance of dam and powerhouse complexes and company towns. Further discussions will be held with regional and national specialists in the pertinent fields of preservation technology, so that state-of-the-art solutions to maintenance problems may be presented in the guidelines.

The Skagit Maintenance Guidelines will have a materials preservation focus emphasizing appropriate methods of protecting, cleaning, repairing, and stabilizing historic concrete, metals, and wood. Preventative cyclical maintenance measures and procedures for repair will be set forth and illustrated by drawings and photos. The guidelines will provide a bibliography of recent works on preservation technology and historic structures maintenance. Upon completion, the guidelines will be incorporated into this Plan as Appendix B and will be used as a tool in the planning of maintenance and repair projects. Models for the Skagit Maintenance Guidelines can be found in the various historic structures preservation guides published by the NPS for its parks within the Pacific Northwest Region, as well as in the "Coast Defense Resources Management Plan" prepared for the Washington State Parks and Recreation Commission by the office of the SHPO.

As an adjunct to the Skagit Maintenance Guidelines, the City will provide a computer, software and training to the Skagit Area for a historic resources maintenance and repair record-keeping system. The program will allow a continuity of treatment for any given resource from one year to the next and from one maintenance worker to another. The computerized maintenance program will be reviewed periodically to ensure that it is meeting the needs of the Skagit Area personnel.

A second component of the program will be a continuing education or Historic Preservation Seminar Series jointly supported and funded by the City and the NPS. The seminars will be held annually or biennially for the benefit of all City and NPS personnel. The series will take the form of preservation maintenance workshops cooperatively planned with NPS-North Cascades staff and held alternately at selected NPS and Seattle City Light locations. The City will provide funding for the Historic Preservation Seminar Series during odd-numbered license years (the first year following acceptance of the new license by the City will be license year one), while funding in even-numbered license years will be provided by the NPS (subject to continuing appropriations authorization) (see Tables 5-2 to 5-5).

Topics presented will cover a wide range of preservation issues. Early sessions will focus on the implications of National Register historic district listing, and the use of the HRMMP. Subsequent sessions will offer up-to-date technical information on historic materials maintenance and repair. Subjects will be jointly selected on the basis of interest and need by Skagit personnel, City Light's Environmental Affairs Division, and the NPS-PNRO. Environmental Affairs will then consult with staff from the office of the SHPO and the NPS-PNRO, who will assist in scheduling expert speakers through contacts with the NPS Preservation Assistance Division, the Association for Preservation Technology, the Society for Industrial Archaeology and other pertinent organizations.

4.0 INTERPRETATION AND EDUCATION

When historic resources have been identified and evaluated, and a protection program put in place, the next step in cultural resource management is to provide for interpretation and education. Interpretation communicates the significance and value of the historic resource to the general public. In various forms, interpretation and education enlist the public's understanding and appreciation of the historic resources and contribute to their preservation and management.

Interpretation can take many forms, including tours, exhibits, displays, and publications of various types. The City has already undertaken many of these interpretive measures, the most notable being the popular Skagit Tours, which began in the 1920s and are themselves an important component of the Skagit Project's history.

Coordination with other interested or affected parties is an important component of interpretation at the Skagit Project. The pre-history, pioneer homesteading, early mining activity, and the development of hydroelectric power are all part of the story of the Upper Skagit. As the federal land management agency in the area, the NPS has had an interest in interpreting these themes in the region. There has been continuing cooperation between the NPS and Seattle City Light in operating the Visitor Information Center at Newhalem. When the new Henry Jackson Memorial Visitor Center opens, there will be an even greater need to cooperate on interpretive measures.

4.1 SKAGIT TOURS

4.1.1 Existing Tour Program

The genesis of the Skagit Tours goes back to the very early days of the project when J. D. Ross brought Seattle politicians and influential businessmen to the area beginning in 1918. Ross used these visits to promote support for development of the project, at first with key opinion-makers and later with the general public. By the summer of 1927 hundreds of Seattle citizens were visiting the upper Skagit River site to inspect the giant hydroelectric project under development.

The two-day tours, with continually increasing numbers of sites to visit as project construction advanced, eventually brought thousands of people to the Skagit every summer. In the 1930s dormitories were built to lodge the influx of up to 500 overnight visitors. Ladder Creek Falls Gardens were developed as a special attraction of the tours. A visit to Diablo Powerhouse and Dam and the boat ride on Diablo Lake were considered highlights. Meals were served at the old cook house in Newhalem, which became known as the Gorge Inn.

The popular tours continued until 1941 when the project, considered a vital wartime-associated industry, was closed to outsiders. In 1954 one-day excursions to the Skagit were resumed and, with the exception of one year (1955), they have continued on a seasonal basis to the present day.

Originally instituted as a tool for gaining public and political support during the construction and financing of the project, the tours outlived their original purpose. But they have remained a popular attraction for Seattle citizens and their out-of-town visitors. Since the 1970s the City has attempted to make the tours self-supporting and is currently considering options to improve the financial stability of their operation.

Today, two types of tours are offered. The four-hour Traditional Tour includes a slide presentation, a ride on the Incline Lift, a boat ride on Diablo Lake to Ross Powerhouse, and a meal in the dining hall at the Visitor Center (the former school) in Diablo. The 90-minute Diablo Tour includes the presentation of Skagit Project history, a ride on the Incline Lift and walk across Diablo Dam, and a visit to the interior of Diablo Powerhouse. These tours are quite popular, and reservations for the Traditional Tour are sold out early in the season. The shorter Diablo Tour accommodates drop-in visitors without reservations.

The college students who are hired as tour guides each summer are issued a Skagit Tour Guide Manual that contains the text of the presentations delivered at various points in the tours. In addition, considerable background information is provided in the manual to acquaint the guides with the Skagit Project's history, geology and technical statistics.

The next time the manual is revised, it will incorporate material from the HABS/HAER and National Register documentation that will provide additional pertinent information. The presentation text should be revised to reflect the fact that the Skagit Project-including Diablo Dam and Powerhouse, Gorge Powerhouse, Ladder Creek Falls Gardens, a large group of buildings in Newhalem, and other structures-is now listed as a historic district in the National Register of Historic Places. At present, little mention is made in the manual of the role played by the camps at Newhalem and Diablo in the development of the Skagit Project. These communities are rare-perhaps unique-examples of municipally owned company towns in the United States. Information on their evolution from construction camps to tourist towns to permanent communities should be incorporated into the background material in the manual.

4.1.2 Newhalem Walking Tour

The Skagit Tours begin and end in Diablo. In the guides' commentary some mention is made of the early history of Reflector Bar and Hollywood. But, both tour participants and casual visitors traveling the North Cascades Highway may be unaware of the historic importance of Newhalem camp and its continuance today as a company town. Motorists stop in Newhalem to avail themselves of services (restroom at the Visitor Information Center and refreshments at the Commissary). They may find their way to the Trail of the Cedars across the river or to Ladder Creek Falls. However, they are given little opportunity to understand and appreciate the significance of the town itself.

A need remains to interpret the Newhalem story as part of the comprehensive package of Skagit Tours. Since there is a desire to keep the organized group tours centered in Diablo, where facilities specifically intended for large groups are located, the Newhalem element can be handled in an informal manner. To serve this need, the City will devise a self-guided walking tour of the Newhalem/Gorge area and prepare an accompanying explanatory brochure (see also Tables 5-1 to 5-5). The brochure will include a map of the tour route and brief statements on the history and significance of buildings and sites along the way. This self-guided tour will include the important buildings along Main Street, a view of Silk Stocking Row, the Newhalem Creek Powerhouse, Ladder Creek Falls Gardens, Gorge Powerhouse, and Ross Crypt. The development of the walking tour and the brochure should be coordinated with the long-range Interpretive Exhibits Program discussed below.

4.2 EXHIBITS AND DISPLAYS

4.2.1 Existing Exhibits Program

Seattle City Light has developed a variety of interpretive displays at five key locations throughout the Skagit Project. The exhibits provide pictorial detail on the history of the project, the technology of hydroelectricity, and the natural history of the North Cascades region. For off-season visitors, and summer visitors not participating in the official Skagit Tour, the exhibit and display program offers on-site interpretation not otherwise available.

The **Newhalem Visitor Information Center**, jointly staffed by the NPS and Seattle City Light, primarily serves the motorist entering the Skagit Project area on Highway 20 from the urban Puget Sound region to the west. It is open to the public from spring through autumn. The existing exhibit gives a brief overview of the region, with information available on hiking, camping, and other recreational activities in the area. In addition to a large relief map of the North Cascades, the small reception area contains a model of the Davis roadhouse, some framed scenic views, and a few historic photos.

Gorge Powerhouse, at the east end of Newhalem, offers a well-designed exhibit on the walls of the T-shaped visitors' lobby overlooking the generating room. This display serves off-highway visitors to Gorge and is not a component of the Skagit Tour. Its subject is the historical development of Gorge Dam and Powerhouse. Historic photographs, chronologically arranged, clearly depict the story of this dramatic construction effort. An electrical bolt stencil forms a border along the upper wall, and a blue-and-beige color scheme ties the whole display together. The Gorge exhibit was professionally developed by Seattle City Light's own Graphic Arts Design Unit, and its quality is reflected in its visual clarity, focused storyline, and cohesive design.

The **Skagit Museum** in Diablo is housed in the visitor center, a facility which serves jointly as the employee cookhouse, and the Skagit Tour reception area and dining room. The museum occupies a large room where during the summer months tour participants gather to check-in and view the "Glee Davis Skagit Historical Exhibit." Installed some 20 years ago, the exhibit covers a variety of subjects including the story of early homesteading on the Skagit, the development by Seattle City Light, and applications of early electrical technology. Free-standing display cases framed in heavy timber contain historic photo backdrops on masonite, and artifacts belonging to

Glee Davis, Superintendent J. D. Ross, and Seattle City Light. A large table-top relief map of the Skagit Project, with keyed site locations that light up, orients visitors to the area.

At **Diablo Powerhouse**, a photo exhibit hangs on the walls of the tri-level visitor lobby. This display serves tourists participating in the Diablo Tour of Diablo Dam and Powerhouse in the summer season. The exhibit is not "designed", per se, but consists of large framed photos of scenic attractions and of the construction of Diablo.

Skagit Tour crowds visit **Ross Powerhouse** during the summer, where two small displays are available for public viewing. In the visitor lobby, photos of boats, tugs, and trains used on the Skagit are currently displayed. In the generating room where visitors congregate to view the equipment, free-standing moveable display boards with photos and diagrams depict Ross Dam and Powerhouse and the principles of hydroelectricity.

4.2.2 Exhibit Revitalization

The five exhibits at Skagit vary considerably in quality, age, design, and theme. The exhibit program would benefit from a more clearly defined common theme: the presence of Seattle City Light in the region, and the associated sub-themes of dam and powerhouse construction, hydroelectric technology, design and function of the municipal company towns, and J. D. Ross' vision of the Skagit. Inherent in the group as a whole is the opportunity to tell the entire story of the Skagit's development, with each of the five locations focusing upon a site-specific aspect of that story. The larger spaces and "gateway" locations of the visitor centers at Newhalem and Diablo lend themselves as well to interpreting the broader context of the Skagit Project. Those exhibits would thus continue to serve as a means of orienting the tourist who may not take the time to visit the powerhouses or dams.

In conjunction with the need for a comprehensive interpretive approach, is the need to coordinate exhibit plans with the NPS to ensure that other thematic elements of the North Cascades story-prehistory, mining, homesteading, recreation, and natural history-are included. No less important is the advisability of linking all five exhibit locations at Skagit through a common design scheme.

Within five years of the receipt of the new license (see Tables 5-1 to 5-5), the City will carry out an internal re-evaluation and revitalization of exhibits at Skagit. Seattle City Light's Graphic Arts Design Unit, Community Relations, and Skagit Project personnel will collaborate in formulating a long-range Interpretive Exhibits Program. At a minimum, the Program will set out an overall thematic approach, identify site-specific themes for each of the five locations, and describe a unified design approach.

In developing the Interpretive Exhibits Program, Seattle City Light will take into consideration such factors as the spatial constraints of the five exhibit locations; visitation patterns as influenced by the seasons, by the Skagit Tours, and by access to Highway 20; the availability of historic photos, HAER drawings, National Register documentation, and artifacts; and coordination with North Cascades NPS Complex to avoid unnecessary duplication of interpretive themes.

In implementing the Program, first priority will go to the redesign of the Newhalem Visitor Information Center exhibit. The present center is expected to be vacated by the NPS upon completion of the new Henry Jackson Memorial Visitor Center. Whether or not the existing facility in Newhalem is then expanded or simply refurbished, a new exhibit design will be installed. It will include, among other informational materials, a low-maintenance video disk that presents the visitor with an overview of all the things to see and do at Skagit. New visual displays will depict the story of the Skagit Project, with special emphasis on the development of Newhalem as a construction camp, municipal company town, and early-day tourist center.

Revitalization of the exhibits at Diablo and Ross Powerhouses will be the second priority of the Interpretive Exhibits Program implementation. Both exhibits will be revamped to focus most strongly on the physical evolution and operation of the dams and powerhouses and any related technical and/or historical themes.

Third priority will be the development of a new exhibit at the Incline Waiting Station in Diablo. The storyline of this new display will emphasize the evolution of Diablo as a construction camp and municipal company town.

4.3 PUBLICATIONS

One publication on the history of Seattle City Light at Skagit is available for sale to the general public for under five dollars at the Commissary in Newhalem. Entitled Building the Skagit by Paul C. Pitzer (Portland: Galley Press, 1978), the 100-page booklet gives well-documented coverage of the region's early history, of Seattle City Light construction, of the influence of J. D. Ross, and the early Skagit Tours. It includes a balanced collection of historic photos as well as maps and footnotes.

There remains a need to make new information discovered through the HABS/HAER documentation process available to the public in a readable, accessible format. The City will undertake, in conjunction with the NPS-PNRO, the development of one or more new interpretive brochures incorporating this documentation (see Tables 5-1 to 5-5). The HAER drawings of the dams and powerhouses will be among the images chosen for inclusion in these publications.

4.4 PHOTOGRAPH PRESERVATION

Seattle City Light maintains a large and valuable collection of historic photos of the construction of the Skagit Project. A portion of this extensive record, however, is located at the Seattle Engineering Department. These photos-some 400 in number-are in the form of cellulose nitrate negatives which are fast deteriorating in recent years. Although Seattle City Light has made contact prints from these negatives, the images need to be transfered to safety film before their destruction is too far advanced. To date, the Department of Engineering has not been able to secure funding for this project.

To preserve this important collection, the City will undertake in the near future the photographic duplication of these negatives in cooperation with the Department of Engineering photo lab (see also Tables 5-1 to 5-5).

5.0 MITIGATION COST ESTIMATES

Table 5-1 indicates the cost of implementing the HRMMP, totalling $352,000. Tables 5-2 to 5-5 indicate the annual costs in 1990-91 and for the new license period.

Table 5-1. Costs of the HRMMP

Item	Periodic Costs	Costs (30 years)
HABS/HAER Documentation[1]		$ 70,000
National Register Update[2]	1999 - $ 2,000 2009 - $10,000 2019 - $ 4,000	16,000
Identification and Evaluation program subtotal		**$ 86,000**
Historic Structures Report for Gorge Inn and Cambridge House[3]		30,000
Historic Landscape Report for Ladder Creek Falls Gardens[4]		30,000
Newhalem Landscape Assessment[5]		6,000
Skagit Maintenance Guidelines[6]		40,000
Computer, software, and training for maintenance record-keeping[7]		6,000
Historic Preservation Seminar Series[8]		10,000
Protection program subtotal		**$122,000**
Newhalem Walking Tour Brochure[9]	$4,500 - year 1 $1,500/annually thereafter	48,000
Interpretive Exhibits Program[10]		10,000
Exhibit Rehabilitation		
Newhalem Visitor Center[11]		45,000
Diablo Powerhouse[12]		10,000
Ross Powerhouse[12]		10,000
Incline Waiting Station[13]		5,000
HABS/HAER Publication[14]		12,000
Historic Photo Conservation[15]		4,000
Interpretation and Education program subtotal		**$144,000**
TOTAL		**$352,000**

NOTES:

1. HABS/HAER documentation was completed in October, 1990. This figure represents mitigation and enhancement costs and excludes the cost of basic compliance with Section 106 of the National Historic Preservation Act.

2. National Register updates will occur at 10-year intervals beginning in 1999. Based on the resources expected to reach eligibility for listing, estimated costs per decade are: 1999 - $2,000; 2009 - $10,000; and 2019 - $4,000.

3. Cost estimate reflects a single Historic Structures Report document that addresses both buildings, produced by a private sector historical architect.

4. Cost estimate for Historic Landscape Report is based upon hiring two NPS-PNRO historic landscape architects/historians for a four-month period. Figure includes $5,000 for a private-sector horticultural specialist, and assumes donated services of SCL surveyors.

5. The Newhalem Landscape Assessment cost estimate is based upon hiring two NPS-PNRO historic landscape architects/historians for a one-month period.

6. Cost estimate for the Skagit Maintenance Guidelines is for a private sector historical architect.

7. The figure includes one 80386 computer + DOS at $3,500 and software, supplies, and training at $2,500.

8. Costs for the Historic Preservation Seminar Series assume that the expense of 15 of 30 annual seminars would be borne by NPS-PNRO in a cooperative series, as funds are appropriated and made available by Congress. Of 15 SCL-sponsored workshops, 3 would feature government preservation program speakers at no cost, and 12 would feature private sector professionals at $500 per session, for $6,000. Added to that are the costs of hand-out materials at $100 per session, for a total of $1,500. Consultant assistance for presentation and implementation of the HRMMP is estimated at $2,500.

9. Estimate includes one-time text preparation and design by NPS-PNRO at $3,000, and SCL in-house printing of two-color, double-fold brochure in annual quantities of 10,000 at $1,500 per run (or $45,000 over a 30-year period).

10. The Exhibits Assessment could be prepared by SCL Community Relations and Graphic Arts staff from existing budgets, or alternatively, contracted out to a free-lance exhibit design firm for approximately $10,000.

NOTES:

11. Cost estimate for rehabilitation of the Newhalem Visitor Center exhibits includes $25,000 for an interactive video disk, and $20,000 for display cabinets and exhibitry. Figure is based on in-house exhibit design and construction.

12. Estimates for both Diablo and Ross Powerhouse exhibits include construction of 3-4 free-standing display kiosks and exhibitry. Figures are based on in-house exhibit design and construction.

13. Estimate for new exhibit installation limited by constraints of the outdoor site at the incline lift waiting station. Figure based on in-house exhibit design and construction.

14. Estimate is based on design, production by NPS-PNRO, printing by the GPO. Costs include $6,000 for text and image assembly, $2,000 for formatting, $4,000 for one-time printing of 5,000 copies. Booklet to include 10 pages of text, 15 PMTs of HAER drawings, and 30 photos. This booklet could be offered for retail sale at Skagit for $2.40 each, resulting in break-even at $12,000.

15. Estimate based on labor provided by Seattle Engineering Department. Project includes transfer of all 400 nitrate negatives to safety film, plus duplicate set of 150 images of Skagit subjects only for transfer to SCL. Cost encompasses labor, safety film, contact prints, and 550 negatives, for a total cost of $6.60 per negative, or roughly $4,000.

Table 5-2. Schedule and Budget for the Historic Resources Mitigation and Management Plan. 1990-License Year 5

Program Item	Expenditures/year1/							
				License Year2/				
	TOTAL	1990-913/	19923/	1	2	3	4	5
HABS/HAER Documentation	$70,000	$70,000						
Update National Register Nomination	16,000							
Historic Structure Report for Gorge Inn & Cambridge House	30,000	30,000						
Ladder Creek Falls Trail Historic Landscape Rpt.	30,000		$30,000					
Newhalem Landscape Assessment	6,000		6,000					
Skagit Maintenance Guidelines	40,000	40,000						
Set up Computerized Records	6,000			$6,000				
Historic Preservation Seminars4/	10,000	1,500	1,000	500	4/	$500	4/	$500
Newhalem Walking Tour Brochure	48,000			4,500	$1,500	1,500	$1,500	1,500

Table 5-2 (cont.). Schedule and Budget for the Historic Resources Mitigation and Management Plan. 1990-License Year 5

Program Item	TOTAL	Expenditures/year[1]						
		1990-91[3]	1992[3]	License Year[2] 1	2	3	4	5
Interpretive Exhibits Assessment	10,000			5,000	5,000			
Exhibit Rehabilitation								
Newhalem Visitor Cntr	45,000					20,000	25,000	
Diablo Powerhouse	10,000						10,000	
Ross Powerhouse	10,000							10,000
Incline Lift Waiting Station	5,000							
HABS/HAER Publication	12,000				12,000			
Historic Photographs Conservation	4,000	4,000						
Historic Plan TOTAL	$352,000	$145,500	$37,000	$16,000	$18,500	$22,000	$36,500	$12,000

1/1990 dollars indexed for inflation.

2/License years are based on the date that the FERC order issuing a new license for the Project is accepted by the City.

3/Expenditures preceding conferral of license (projected to be conferred early in 1993 or late 1992).

4/National Park Service will cover costs in alternating years.

Table 5-3. Schedule and Budget for the Historic Resources Mitigation and Management Plan. License Years 6-14

Program Item	Expenditures/Year1/ License Year2/								
	6	7	8	9	10	11	12	13	14
HABS/HAER Documentation									
Update National Register Nomination		$2,000							
Historic Structure Report for Gorge Inn & Cambridge House									
Ladder Creek Falls Trail Historic Landscape Rpt.									
Newhalem Landscape Assessment									
Skagit Maintenance Guidelines									
Set up Computerized Records									
Historic Preservation Seminars3/	$500	500	3/	$500	3/	$500	3/	$500	3/
Newhalem Walking Tour Brochure	1,500	1,500	$1,500	1,500	$1,500	1,500	$1,500	1,500	$1,500

Table 5-3 (cont.). Schedule and Budget for the Historic Resources Mitigation and Management Plan. License Years 6-14

Program Item	Expenditures/Year1/ License Year2/ 6	7	8	9	10	11	12	13	14
Interpretive Exhibits Assessment									
Exhibit Rehabilitation									
Newhalem Visitor Cntr									
Diablo Powerhouse									
Ross Powerhouse									
Incline Lift Waiting Station	5,000								
HABS/HAER Publication									
Historic Photographs Conservation									
Historic Plan TOTAL	$6,500	$4,000	$1,500	$2,000	$1,500	$2,000	$1,500	$2,000	$1,500

1/1990 dollars indexed for inflation.

2/License years are based on the date that the FERC order issuing a new license for the Project is accepted by the City.

3/National Park Service will cover costs in alternating years.

Table 5-4. Schedule and Budget for the Historic Resources Mitigation and Management Plan. License Years 15-23

Program Item	Expenditures/Year[1] License Year[2]								
	15	16	17	18	19	20	21	22	23
HABS/HAER Documentation									
Update National Register Nomination			$10,000						
Historic Structure Report for Gorge Inn & Cambridge House									
Ladder Creek Falls Trail Historic Landscape Rpt.									
Newhalem Landscape Assessment									
Skagit Maintenance Guidelines									
Set up Computerized Records									
Historic Preservation Seminars[3]	$500	3/	500	3/	$500	3/	$500	3/	$500
Newhalem Walking Tour Brochure	1,500	$1,500	1,500	$1,500	1,500	$1,500	1,500	$1,500	1,500

Table 5-4 (cont.). Schedule and Budget for the Historic Resources Mitigation and Management Plan. License Years 15-23

Program Item	Expenditures/Year[1] License Year[2] 15	16	17	18	19	20	21	22	23
Interpretive Exhibits Assessment									
Exhibit Rehabilitation Newhalem Visitor Cntr Diablo Powerhouse Ross Powerhouse Incline Lift Waiting Station									
HABS/HAER Publication									
Historic Photographs Conservation									
Historic Plan TOTAL	$2,000	$1,500	$12,000	$1,500	$2,000	$1,500	$2,000	$1,500	$2,000

1/1990 dollars indexed for inflation.

2/License years are based on the date that the FERC order issuing a new license for the Project is accepted by the City.

3/National Park Service will cover costs in alternating years.

Table 5-5. Schedule and Budget for the Historic Resources Mitigation and Management Plan. License Years 24-30

Program Item	Expenditures/Year 1/ License Year 2/						
	24	25	26	27	28	29	30
HABS/HAER Documentation							
Update National Register Nomination				$4,000			
Historic Structure Report for Gorge Inn & Cambridge House							
Ladder Creek Falls Trail Historic Landscape Report							
Newhalem Landscape Assessment							
Skagit Maintenance Guidelines							
Set up Computerized Records							
Historic Preservation Seminars 3/	3/	$500	3/	500	3/	$500	3/
Newhalem Walking Tour Brochure	$1,500	1,500	$1,500	1,500	$1,500	1,500	$1,500

Table 5-5 (cont.). Schedule and Budget for the Historic Resources Mitigation and Management Plan. License Years 24-30

Program Item	Expenditures/Year[1] License Year[2] 24	25	26	27	28	29	30
Interpretive Exhibits Assessment							
Exhibit Rehabilitation Newhalem Visitor Center Diablo Powerhouse Ross Powerhouse Incline Lift Waiting Station							
HABS/HAER Publication							
Historic Photographs Conservation							
Historic Plan TOTAL	$1,500	$2,000	$1,500	$6,000	$1,500	$2,000	$1,500

[1]1990 dollars indexed for inflation.

[2]License years are based on the date that the FERC order issuing a new license for the Project is accepted by the City.

[3]National Park Service will cover costs in alternating years.

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APPENDIX A
Preservation Briefs

Contents:

3 PRESERVATION BRIEFS

Conserving Energy in Historic Buildings

Baird M. Smith, AIA

Technical Preservation Services Division

Office of Archeology and Historic Preservation/Heritage Conservation and Recreation Service

With the dwindling supply of energy resources and new efficiency demands placed on the existing building stock, many owners of historic buildings and their architects are assessing the ability of these buildings to conserve energy with an eye to improving thermal performance. This brief has been developed to assist those persons attempting energy conservation measures and weatherization improvements such as adding insulation and storm windows or caulking of exterior building joints. In historic buildings, many measures can result in the inappropriate alteration of important architectural features, or, perhaps even worse, cause serious damage to the historic building materials through unwanted chemical reactions or moisture-caused deterioration. This brief recommends measures that will achieve the greatest energy savings with the least alteration to the historic buildings, while using materials that do not cause damage and that represent sound economic investments.

Inherent Energy Saving Characteristics of Historic Buildings

Many historic buildings have energy-saving physical features and devices that contribute to good thermal performance. Studies by the Energy Research and Development Administration (see bibliography) show that the buildings with the poorest energy efficiency are actually those built between 1940 and 1975. Older buildings were found to use less energy for heating and cooling and hence probably require fewer weatherization improvements. They use less energy because they were built with a well-developed sense of physical comfort and because they maximized the natural sources of heating, lighting and ventilation. The historic building owner should understand these inherent energy-saving qualities.

Figure 1. This 1891 Courthouse and Post Office in Rochester, New York, has built-in energy conserving features such as, heavy masonry walls, operable windows, an interior skylighted atrium which provides light and ventilation, and roof-top ventilators which keep the building cooler in the summer. Also note the presence of awnings in this old photograph.

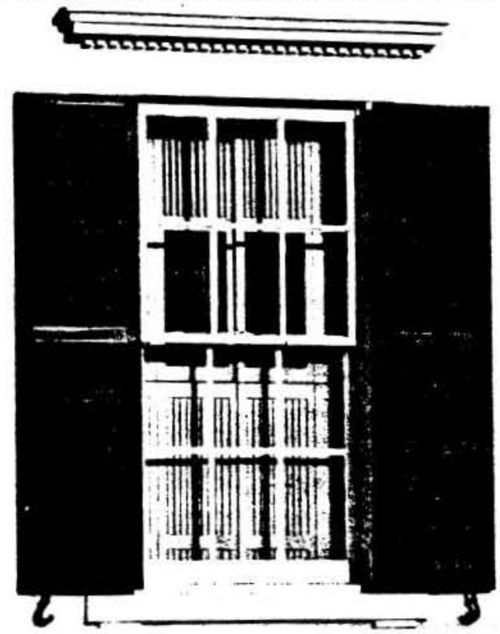


Figure 2. Shutters can be used to minimize the problem of summer heat gain by shading the windows. If operable shutters are in place, their use will help reduce the summer cooling load. (Photo: Baird Smith)

The most obvious (and almost universal) inherent energy saving characteristic was the use of *operable windows* to provide natural ventilation and light. In addition, historic commercial and public buildings often include interior light/ventilation courts, roof-top ventilators, clerestories or skylights (see figure 1). These features provide energy efficient fresh air and light, assuring that energy consuming mechanical devices may be needed only to supplement the natural energy sources. Any time the mechanical heating and air conditioning equipment can be turned off and the windows opened, energy will be saved.

Figure 3. Southern mansions typify climate conscious design. The wide roof overhangs, exterior porches, shade trees, heavy masonry walls (painted white), and living quarters on the second floor (to catch evening breezes and escape the radiant heat from the earth's surface) all are energy saving characteristics which provide reasonably comfortable living spaces without mechanical air conditioning. (Photo: Marcia Axtmann Smith)

Early builders and architects dealt with the poor thermal properties of windows in two ways. First, the number of windows in a building was kept to only those necessary to provide adequate light and ventilation. This differs from the approach in many modern buildings where the percentage of windows in a wall can be nearly 100%. Historic buildings, where the ratio of glass to wall is often less than 20%, are better energy conservers than most new buildings. Secondly, to minimize the heat gain or loss from windows, historic buildings often include interior or exterior shutters, interior venetian blinds, curtains and drapes, or exterior awnings (see figure 2). Thus, a historic window could remain an energy efficient component of a building.

There are other physical characteristics that enable historic buildings to be energy efficient. For instance, in the warmer climates of the United States, buildings were often built to minimize the heat gain from the summer sun. This was accomplished by introducing exterior balconies, porches, wide roof overhangs, awnings and shade trees. In addition, many of these buildings were designed with the living spaces on the second floor to catch breezes and to escape the radiant heat from the earth's surface. Also, exterior walls were often painted light colors to reflect the hot summer sun, resulting in cooler interior living spaces (see figure 3).

Winter heat loss from buildings in the northern climates was reduced by using heavy masonry walls, minimizing the number and size of windows, and often using dark paint colors for the exterior walls. The heavy masonry walls used so typically in the late 19th century and early 20th century, exhibit characteristics that improve their thermal performance beyond that formerly recognized (see figure 4). It has been determined that walls of large mass and weight (thick brick or stone) have the advantage of *high thermal inertia*, also known as the "M factor." This inertia modifies the thermal resistance (R factor)* of the wall by lengthening the time scale of heat transmission. For instance, a wall with high thermal inertia, subjected to solar radiation for an hour, will absorb the heat at its outside surface, but transfer it to the interior over a period as long as 6 hours. Conversely, a wall having the same R factor, but low thermal inertia, will transfer the heat in perhaps 2 hours. High thermal inertia is the reason many older public and commercial buildings, without modern air conditioning, still feel cool on the inside throughout the summer. The heat from the midday sun does not penetrate the buildings until late afternoon and evening, when it is unoccupied.

Although these characteristics may not typify all historic buildings, the point is that historic buildings often have thermal properties that need little improvement. One must understand the inherent energy-saving qualities of a building, and assure, by re-opening the windows for instance, that the building functions as it was intended.

To reduce heating and cooling expenditures there are two broad courses of action that may be taken. First, begin **passive measures** to assure that a building and its existing components function as efficiently as possible without the necessity of making alterations or adding new materials. The second course of action is **preservation retrofitting**, which includes altering the building by making appropriate weatherization measures to improve thermal performance. Undertaking the passive measures and the preservation retrofitting recommended here could result in a 50% decrease in energy expenditures in historic buildings.

Passive Measures

The first passive measures to utilize are **operational controls**; that is, controlling *how* and *when* a building is used. These controls incorporate programmatic planning and scheduling efforts by the owner to minimize usage of energy-consuming equipment. A building owner should survey and quantify all aspects of energy usage, by evaluating the monies expended for electricity, gas, and fuel oil for a year, and by surveying how and when each room is used. This will identify ways of conserving energy by initiating operational controls such as:

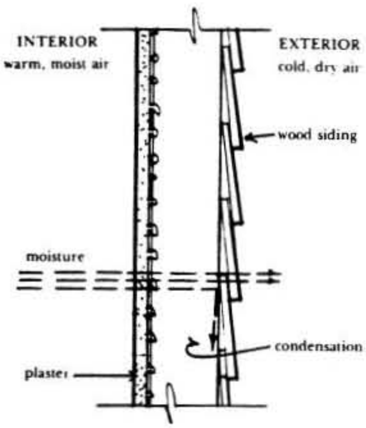
- lowering the thermostat in the winter, raising it in the summer
- controlling the temperature in those rooms actually used
- reducing the level of illumination and number of lights (maximize natural light)
- using operable windows, shutters, awnings and vents as originally intended to control interior environment (maximize fresh air)
- having mechanical equipment serviced regularly to ensure maximum efficiency
- cleaning radiators and forced air registers to ensure proper operation

Figure 4. Heavy masonry walls in office buildings dramatically reduce the need for summer cooling because the thermal inertia (M factor) of the massive wall increases its thermal resistance (R factor), thus delaying the heat transfer into the building until late afternoon when the office workers have gone home. (Photo: Baird Smith)

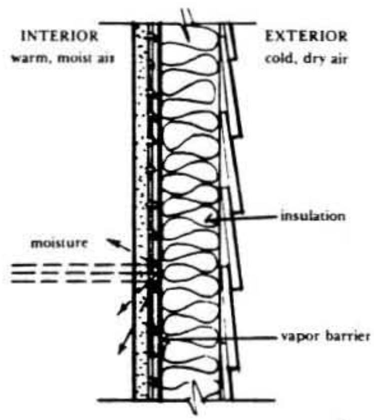
***R factor is the measure of the ability of insulation to decrease heat flow. The higher the factor, the better the thermal performance of the material.**

Figure 5. Moisture migration through walls and roofing occurs as a matter of course in northern winter climates. Problems occur if there is no vapor barrier because the moisture may saturate the insulation and greatly reduce its thermal performance, as well as creating the potential for deterioration of the adjacent materials.

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.



The passive measures outlined above can save as much as 30% of the energy used in a building. They should be the first undertakings to save energy in any existing building and are particularly appropriate for historic buildings because they do not necessitate building alterations or the introduction of new materials that may cause damage. Passive measures make energy sense, common sense, and preservation sense!

Preservation Retrofitting

In addition to passive measures, building owners may undertake certain retrofitting measures that will not jeopardize the historic character of the building and can be accomplished at a reasonable cost. Preservation retrofitting improves the thermal performance of the building, resulting in another 20%-30% reduction in energy.

When considering retrofitting measures, historic building owners should keep in mind that there are no permanent solutions. One can only meet the standards being applied today with today's materials and techniques. In the future, it is likely that the standards and the technologies will change and a whole new retrofitting plan may be necessary. Thus, owners of historic buildings should limit retrofitting measures to those that achieve reasonable energy savings, at reasonable costs, with the least intrusion or impact on the character of the building. Overzealous retrofitting, which introduces the risk of damage to historic building materials, should not be undertaken.

The preservation retrofitting measures presented here, were developed to address the three most common problems in historic structures caused by some retrofitting actions. The first problem concerns retrofitting actions that necessitated inappropriate building alterations, such as the wholesale removal of historic windows, or the addition of insulating

The Secretary of the Interior's Standards for Historic Preservation Projects

The Standards for Historic Preservation were developed for the Historic Preservation Fund Grants-in-Aid Program and authorized by the National Historic Preservation Act of 1966. The standards are also used for determining whether a rehabilitation project qualifies as a "certified rehabilitation" pursuant to Section 2124 of the Tax Reform Act of 1976. There are eight "General Standards" (listed below), and additional specific standards and guidelines for the various categories of historic preservation projects. Building owners and architects may obtain a copy of the entire document by writing the Technical Preservation Services Division, Heritage Conservation and Recreation Service, Washington, DC 20240.

General Standards

(Those shown in bold print are most applicable to preservation retrofitting.)

1. **Every reasonable effort shall be made to provide a compatible use for a property that requires 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, which 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 historical, 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 acquisition, protection, stabilization, preservation, rehabilitation, restoration, or reconstruction project.

aluminum siding, or installing dropped ceilings in significant interior spaces. To avoid such alterations, refer to the Secretary of the Interior's "Standards for Historic Preservation Projects" which provide the philosophical and practical basis for all preservation retrofitting measures.

The second problem area is to assure that retrofitting measures do not create moisture-related deterioration problems. One must recognize that large quantities of moisture are present on the interior of buildings.

In northern climates, the moisture may be a problem during the winter when it condenses on cold surfaces such as windows. As the moisture passes through the walls and roof it may condense within these materials, creating the potential for deterioration. The problem is avoided if a vapor barrier is added *facing in* (see figure 5).

In southern climates, insulation and vapor barriers are handled quite differently because moisture problems occur in the summer when the moist outside air is migrating to the interior of the building. In these cases, the insulation is installed with the vapor barrier *facing out* (opposite the treatment of northern climates). Expert advice should be sought to avoid moisture-related problems to insulation and building materials in southern climates.

The third problem area involves the avoidance of those materials that are chemically or physically incompatible with existing materials, or that are improperly installed. A serious problem exists with certain cellulose insulations that use ammonium or aluminum sulfate as a fire retardant, rather than boric acid which causes no problems. The sulfates react with moisture in the air forming sulfuric acid which can cause damage to most metals (including plumbing and wiring), building stones, brick and wood. In one instance, a metal building insulated with cellulose of this type collapsed when the sulfuric acid weakened the structural connections! To avoid problems such as these, refer to the recommendations provided here, and consult with local officials, such as a building inspector, the better business bureau, or a consumer protection agency.

Before a building owner or architect can plan retrofitting measures, some of the existing physical conditions of the building should be investigated. The basic building components (attic, roof, walls and basement) should be checked to determine the methods of construction used and the presence of insulation. Check the insulation for full coverage and whether there is a vapor barrier. This inspection will aid in determining the need for additional insulation, what type of insulation to use (batt, blown-in, or poured), and where to install it. In addition, sources of air infiltration should be checked at doors, windows, or where floor and ceiling systems meet the walls. Lastly, it is important to check the condition of the exterior wall materials, such as painted wooden siding or brick, and the condition of the roof, to determine the weather tightness of the building. A building owner must assure that rain and snow are kept out of the building before expending money for weatherization improvements.

Retrofitting Measures

The following listing includes the most common retrofitting measures; some measures are highly recommended for a preservation retrofitting plan, but, as will be explained, others are less beneficial or even harmful to the historic building:

- Air Infiltration
- Attic Insulation
- Storm Windows
- Basement and Crawl Space Insulation
- Duct and Pipe Insulation
- Awnings and Shading Devices
- Doors and Storm Doors
- Vestibules
- Replacement Windows
- Wall Insulation—Wood Frame
- Wall Insulation—Masonry Cavity Walls
- Wall Insulation—Installed on the Inside
- Wall Insulation—Installed on the Outside
- Waterproof Coatings for Masonry

The recommended measures to preservation retrofitting begin with those at the top of the list. The first ones are the simplest, least expensive, and offer the highest potential for saving energy. The remaining measures are not recommended for general use either because of potential technical and preservation problems, or because of the costs outweighing the anticipated energy savings. Specific solutions must be determined based on the facts and circumstances of the particular problem; therefore, advice from professionals experienced in historic preservation, such as, architects, engineers and mechanical contractors should be solicited.

Air Infiltration: 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 caulking of open cracks and 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 could occur throughout the building. Avoid caulking and weatherstripping materials that, when applied, introduce inappropriate colors or otherwise visually impair the architectural character of the building. Reducing air infiltration should be the first priority of a preservation retrofitting plan. The cost is low, little skill is required, and the benefits are substantial.

Attic Insulation: Heat rising through the attic and roof is a major source of heat loss, and reducing this heat loss should be one of the highest priorities in preservation retrofitting. 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. A weatherization manual entitled, "In the Bank . . . or Up the Chimney" (see the bibliography) provides detailed descriptions about a variety of installation methods used for attic insulation. The manual also recommends the amount of attic insulation used in various parts of the country. 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 saturated and lose 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. With adequate attic ventilation, the addition of attic insulation should be one of the highest priorities of a preservation retrofitting plan.

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. This option should not be considered if it causes irreparable damage to historic or architectural spaces or features; however, in other cases, it could be a recommended measure of a preservation retrofitting plan.

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 they are not in place, it is a recommended measure of a preservation retrofitting plan to add new metal framed windows on the exterior. This will result in a window assembly (historic window plus storm window) with an R factor of 1.79 which outperforms a double paned window assembly (with an air space up to ½") that only has an R factor of 1.72. When installing the storm windows, be careful not to damage the historic window frame. If the metal frames visually impair the appearance of the building, it may be necessary to paint them to match the color of the historic frame (see figure 6).

Triple-track metal storm windows are recommended because they are readily available, in numerous sizes, and at a reasonable cost. If a pre-assembled storm window is not available for a particular window size, and a custom-made storm window is required, the cost can be very high. In this case, compare the cost of manufacture and installation with the expected cost savings resulting from the increased thermal efficiency. Generally, custom-made storm windows, of either wood or metal frames, are not cost effective, and would not be recommended in a preservation retrofitting plan.

Interior storm window installations can be as thermally effective as exterior storm windows; however, there is high potential for damage to the historic window and sill from condensation. With storm windows on the interior, the outer sash (in this case the historic 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.

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

In most cases, interior storm windows of either metal frames or of plastic sheets are not recommended for preservation retrofitting because of the potential for damage to the historic window. 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 historic window to dry thoroughly.

Basement and Crawl Space Insulation: Substantial heat is lost through cold basements and crawl spaces. Adding insulation in these locations is an effective preservation retrofitting measure and should be a high priority action. It is complicated, however, because of the excessive moisture that is often present. One must be aware of this and assure that insulation is properly installed for the specific location. For instance, in crawl spaces and certain unheated basements, the insulation is generally placed between the first floor joists (the ceiling of the basement) with the **vapor barrier facing up**. Do not staple the insulation in place, because the staples often rust away. Use special anchors developed for insulation in moist areas such as these.

In heated basements, or where the basement contains the heating plant (furnace), or where there are exposed water and sewer pipes, insulation should be installed against foundation walls. Begin the insulation within the first floor joists, and proceed down the wall to a point at least 3 feet below the

Figure 6. The addition of triple track storm windows, as shown here, greatly improves the thermal performance of existing window assemblies, with a minimal impact on the appearance of the building. (Photo: Baird Smith)

exterior ground level if possible, with the **vapor barrier facing in**. Use either batt or rigid insulation.

Installing insulation in the basement or crawl space should be a high priority of a preservation retrofitting plan, as long as adequate provision is made to ventilate the unheated space, perhaps even by installing an exhaust fan.

Duct and Pipe Insulation: Wrapping insulation around heating and cooling ducts and hot water pipes, is a recommended preservation retrofitting measure. Use insulation which is intended for this use and install it according to manufacturer's recommendations. Note that air conditioning ducts will be cold in the summer, and hence moisture will condense there. Use insulation with the **vapor barrier facing out**, away from the duct. These measures are inexpensive and have little potential for damage to the historic building.

Awnings and Shading Devices: In the past, awnings and trees were used extensively to provide shade to keep buildings cooler in the summer. 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 (see figure 7). 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 no 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.

Doors and Storm Doors: Most historic wooden doors, if they are solid wood or paneled, have fairly good thermal properties and should not be replaced, especially if they are important architectural features. Assure that the frames and doors have proper maintenance, regular painting, and that caulking and weatherstripping is applied as necessary.

A storm door would improve the thermal performance of the historic door; however, recent studies indicate that installing a storm door is not normally cost effective in residential settings. The costs are high compared to the anticipated savings. Therefore, storm doors should only be added to buildings in cold climates, and added in such a way to minimize the visual impact on the building's appearance. The storm door design should be compatible with the architectural character of the building and may be painted to match the colors of the historic door.

Vestibules: Vestibules create a secondary air space at a doorway to reduce air infiltration occurring while the primary door is open. If a vestibule is in place, retain it. If not, adding a vestibule, either on the exterior or interior, should be carefully considered to determine the possible visual impact on the character of the building. The energy savings would be comparatively small compared to construction costs. Adding a vestibule should be considered in very cold climates, or where door use is very high, but in either case, the additional question of visual intrusion must be resolved before it is added. For most cases with historic buildings, adding a vestibule is not recommended.

Replacement Windows: Unfortunately, a common weatherization measure, especially in larger buildings, has been the replacement of historic windows with modern double paned windows. The intention was to improve the thermal performance of the existing windows and to reduce long-term maintenance costs. The evidence is clear that adding exterior storm windows is a viable alternative to replacing the historic windows and it is the recommended approach in preservation retrofitting. However, if the historic windows are severely deteriorated and their repair would be impractical, or economically infeasible, then replacement windows may be warranted. The new windows, of either wood or metal, should closely match the historic windows in size, number of panes, muntin shape, frame, color and reflective qualities of the glass.

Wall Insulation—Wood Frame: The addition of wall insulation in a wood frame building is generally not recommended as a preservation retrofitting measure because the costs are high, and the potential for damage to historic building materials is even higher. Also, wall insulation is not particularly effective for small frame buildings (one story) because the heat loss from the uninsulated walls is a relatively small percentage of the total, and part of that can be attributed to infiltration. If, however, the historic building is two or more stories, and is located in a cold climate, wall insulation may be considered if extreme care (as explained later) is exercised with its installation.

The installation of wall insulation in historic frame buildings can result in serious technical and preservation problems. As discussed before, insulation must be kept dry to function properly, and requires a vapor barrier and some provision for air movement. Introducing insulation in wall cavities, without a vapor barrier and some ventilation can be disastrous. The insulation would become saturated, losing its thermal properties, and in fact, actually increasing the heat loss through the wall. Additionally, the 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. The situation is greatly complicated, because correcting such problems could necessitate the complete (and costly) dismantling of the exterior or interior wall surfaces. It should be clear that adding wall insulation has the potential for causing serious damage to historic building materials.

If adding wall insulation to frame buildings is determined to be absolutely necessary, the first approach should be to consider the careful removal of the exterior siding so that it may later be reinstalled. Then introduce batt insulation with the **vapor barrier facing in** into the now accessible wall cavity. The first step in this approach is an investigation to determine if the siding can be removed without causing serious damage.

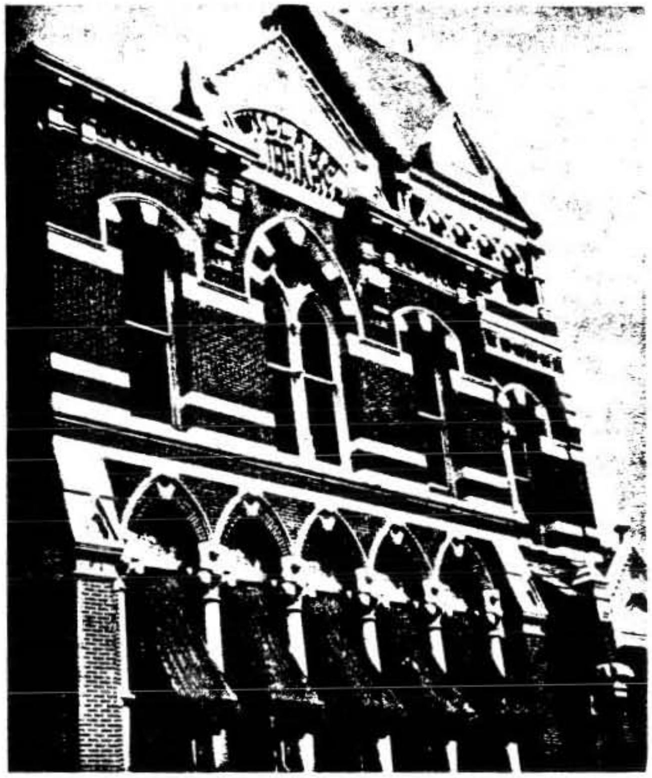


Figure 7. The awnings on the Willard Library in Evansville, Indiana, reduce heat gain in the summer and, when they are raised in the winter, radiant heat from the sun provides free supplementary heat. (Photo: Lee H. Nelson)

Figure 8. The white material seen between the wooden wall studs is urea-formaldehyde foam. It is injected into the wall cavity wet, and as it cures, large quantities of moisture are given off creating the potential for serious deterioration of adjacent materials and may cause paint to blister on interior and exterior wall surfaces. Additionally, foam can shrink as much as that shown here (about 7% by volume), thus reducing the predicted insulating performance. Until some of the technical problems are corrected, its use is not recommended in historic structures. (Photo: Baird Smith)

If it is feasible, introducing insulation in this fashion provides the best possible solution to insulating a wall, and provides an excellent opportunity to view most of the structural system for possible hidden structural problems or insect infestations. A building owner should not consider this approach if it would result in substantial damage to or loss of historic wooden siding. Most siding, however, would probably withstand this method if reasonable care is exercised.

The second possible approach for wall insulation involves injecting or blowing insulation into the wall cavity. The common insulations are the loose fill types that can be blown into the cavity, the poured types, or the injected types such as foam. Obviously a vapor barrier cannot be simultaneously blown into the space. However, an equivalent vapor barrier can be created by assuring that the interior wall surfaces are covered with an impermeable paint layer. Two layers of oil base paint or one layer of impermeable latex paint constitute an acceptable vapor barrier. Naturally, for this to work, the paint layer must cover all interior surfaces adjacent to the newly installed wall insulation. Special attention should be given to rooms that are major sources of interior moisture—the laundry room, the bathrooms and the kitchen.

In addition to providing a vapor barrier, make provisions for some air to circulate in the wall cavity to help ventilate the insulation and the wall materials. This can be accomplished in several ways. One method is to install small screened vents (about 2 inches in diameter) at the base of each stud cavity. If this option is taken, the vents should be as inconspicuous as possible. A second venting method can be used where the exterior siding is horizontally lapped. Assure that each piece of siding is separated from the other, allowing some air to pass between them. Successive exterior paint layers often seal the joint between each piece of siding. Break the paint seal (carefully insert a chisel and twist) between the sections of exterior siding to provide the necessary ventilation for the insulation and wall materials.

With provisions for a vapor barrier (interior paint layer) and wall ventilation (exterior vents) satisfied, the appropriate type of wall insulation may then be selected. There are three recommended types to consider: blown cellulose (with boric acid as the fire retardant), vermiculite, or perlite. Cellulose is the preferred wall insulation because of its higher R factor and its capability to flow well into the various spaces within a wall cavity.

There are two insulation types that are not recommended for wall insulation: urea-formaldehyde foams, and cellulose which uses aluminum or ammonium sulfate instead of boric acid as a fire retardant. 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 slowly disintegrate. This insulation is not appropriate for use in historic buildings.

Although urea-formaldehyde foams appear to have potential as retrofit materials (they flow into any wall cavity space and have a high R factor) their use is not recommended for preservation retrofitting until some serious problems are corrected. The major problem is that the injected material 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 caused water to actually puddle at the base of a wall, creating the likelihood of serious deterioration to the historic building materials. There are other problems that affect both historic buildings and other existing buildings. Foams are a two-part chemical installed by franchised contractors. To obtain the exact proportion of the two parts, the foam must be mixed and installed under controlled conditions of temperature and humidity. There are cases where the controls were not followed and the foam either cured improperly, not attaining the desired R factor, or the foam continued to emit a formaldehyde smell. In addition, the advertised maximum shrinkage after curing (3%) has been tested and found to be twice as high (see figure 8). Until this material is further developed and the risks eliminated, it is clearly not an appropriate material for preservation retrofitting.

Wall Insulation — Masonry Cavity Walls: Some owners of historic buildings with masonry cavity wall construction have attempted to introduce insulation into the cavity. This is not good practice because it ignores the fact that masonry cavity walls normally have acceptable thermal performance, needing no improvement. Additionally, introducing insulation into the cavity will most likely result in condensation problems and alter the intended function of the cavity. The air cavity acts as a vapor barrier in that moist air passing through the inner wythe of masonry meets the cold face of the outer wythe and condenses. Water droplets form and fall to the bottom of the wall cavity where they are channeled to the outside through weep holes. The air cavity also improves the thermal performance of the wall because it slows the transfer of heat or cold between the two wythes, causing the two wall masses to function independently with a thermal cushion between them.

Adding insulation to this cavity alters the vapor barrier and thermal cushion functions of the air space and will likely clog the weep holes, causing the moisture to puddle at the base of the wall. Also, the addition of insulation creates a situation where the moisture dew point (where moisture condenses) moves from the inner face of the outer wythe, into the outer wythe itself. Thus, during a freeze this condensation will freeze, causing spalling and severe deterioration. The evidence is clear that introducing insulation, of any type, into a masonry cavity wall is not recommended in a preservation retrofitting plan.

Wall Insulation—Installed on the Inside: Insulation could be added to a wall whether it be wooden or masonry, by attaching the insulation to furring strips mounted on the interior wall faces. Both rigid insulation, usually 1 or 2 inches thick, and batt insulation, generally 3½ inches thick, can be added in this fashion, with the **vapor barrier facing in.** Extra caution must be exercised if rigid plastic foam insulation is used because it can give off dense smoke and rapidly spreading flame when burned. Therefore, it must be installed with a fireproof covering, usually ½ inch gypsum wallboard. Insulation should not be installed on the inside if it necessitates relocation or destruction of important architectural decoration, such as cornices, chair rails, or window trims, or causes the destruction of historic plaster or other wall finishes. Insulation installed in this fashion would be expensive and could only be a recommended preservation retrofitting measure if it is a large building, located in a cold climate, and if the interior spaces and features have little or no architectural significance.

Wall Insulation—Installed on the Outside: There is a growing use of aluminum or vinyl siding installed directly over historic wooden sidings, supposedly to reduce long-term maintenance and to improve the thermal performance of the wall. From a preservation viewpoint, this is a poor practice for several reasons. New siding covers from view existing or potential deterioration problems or insect infestations. Additionally, installation often results in damage or alteration to existing decorative features such as beaded weatherboarding, window and door trim, corner boards, cornices, or roof trim. The cost of installing the artificial sidings, compared with the modest increase, if any, in the thermal performance of the wall does not add up to an effective energy-saving measure. The use of artificial siding is not recommended in a preservation retrofitting plan.

Good preservation practice would assure regular maintenance of the existing siding through periodic painting and caulking. Where deterioration is present, individual pieces of siding should be removed and replaced with matching new ones. Refer to the earlier sections of this brief for recommended retrofitting measures to improve the thermal performance of wood frame walls.

Waterproof Coatings for Masonry: Some owners of historic buildings use waterproof coatings on masonry believing it would improve the thermal performance of the wall by keeping it dry (dry masonry would have a better R factor than when wet). Application of waterproof coatings is not recommended because the coatings actually trap moisture within the masonry, and can cause spalling and severe deterioration during a freezing cycle.

In cases where exterior brick is painted, consider continued periodic painting and maintenance, since paints are an excellent preservation treatment for brick. When repainting, a building owner might consider choosing a light paint color in warm climates, or a dark color in cold climates, to gain some advantage over the summer heat gain or winter heat loss, whichever the case may be. These colors should match those used historically on the building or should match colors available historically.

Mechanical Equipment

A detailed treatise of recommended or not recommended heating or air conditioning equipment, or of alternative energy sources such as solar energy or wind power, is beyond the scope of this brief. The best advice concerning mechanical equipment in historic buildings is to assure that the existing equipment works as efficiently as possible. If the best professional advice recommends replacement of existing equipment, a building owner should keep the following considerations in mind. First, as technology advances in the coming years, the equipment installed now will be outdated rapidly relative to the life of the historic building. Therefore, it may be best to wait and watch, until new technologies (such as solar energy) become more feasible, efficient, and inexpensive. Secondly, do not install new equipment and ductwork in such a way that its installation, or possible later removal, will cause irreversible damage to significant historic building materials. The concept of complete invisibility, which necessitates hiding piping and ductwork within wall and floor systems, may not always be appropriate for historic buildings because of the damage that often results. Every effort should be made to select a mechanical system that will require the least intrusion into the historic fabric of the building and that can be updated or altered without major intervention into the wall and floor systems. These points should be considered when weighing the decision to replace a less than efficient exiting system with a costly new system, which may cause substantial damage to the historic building materials and in turn may prove inefficient in the future.

SUMMARY

The primary focus of this brief has been to describe ways to achieve the maximum energy savings in historic buildings without jeopardizing the architectural, cultural and historical qualities for which the properties have been recognized. This can be accomplished through undertaking the passive measures and the "recommended" preservation retrofitting. Secondly, this brief has emphasized the benefits of undertaking the retrofitting measures in phases so that the actual energy savings anticipated from each retrofitting measure can be realized. Thus, the "not recommended" retrofitting measures, with potential for damage or alteration of historic building materials, would not have to be undertaken, because the maximum feasible savings would have already been accomplished.

Lastly, and perhaps most important, we must recognize that the technologies of retrofitting and weatherization are relatively new. Unfortunately, most current research and product development is directed toward *new construction*. It is hoped that reports such as this, and the realization that fully 30% of all construction in the United States now involves work on existing buildings, will stimulate the development of new products that can be used with little hesitation in historic buildings. Until that time, owners of historic buildings can undertake the preservation retrofitting measures recommended here and greatly reduce the energy used for heating and cooling, without destroying those historic and architectural qualities that make the building worthy of preservation.

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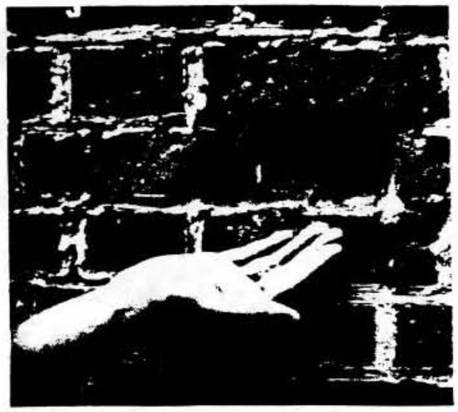
6 PRESERVATION BRIEFS



Dangers of Abrasive Cleaning to Historic Buildings

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National Park Service

> "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."—The Secretary of the Interior's "Standards for Historic Preservation Projects."

Abrasive cleaning methods are responsible for causing a great deal of damage to historic building materials. To prevent indiscriminate use of these potentially harmful techniques, this brief has been prepared to explain abrasive cleaning methods, how they can be physically and aesthetically destructive to historic building materials, and why they generally are not acceptable preservation treatments for historic structures. There are alternative, less harsh means of cleaning and removing paint and stains from historic buildings. However, careful testing should preceed general cleaning to assure that the method selected will not have an adverse effect on the building materials. A historic building is irreplaceable, and should be cleaned using only the "gentlest means possible" to best preserve it.

What is Abrasive Cleaning?

Abrasive cleaning methods include all techniques that physically abrade the building surface to remove soils, discolorations or coatings. Such techniques involve the use of certain *materials* which impact or abrade the surface under pressure, or abrasive *tools and equipment*. Sand, because it is readily available, is probably the most commonly used type of grit material. However, any of the following materials may be substituted for sand, and all can be classified as abrasive substances: ground slag or volcanic ash, crushed (pulverized) walnut or almond shells, rice husks, ground corncobs, ground coconut shells, crushed eggshells, silica flour, synthetic particles, glass beads and micro-balloons. Even *water* under pressure can be an abrasive substance. Tools and equipment that are abrasive to historic building materials include wire brushes, rotary wheels, power sanding disks and belt sanders.

The use of water in combination with grit may also be classified as an abrasive cleaning method. Depending on the manner in which it is applied, water *may* soften the impact of the grit, but water that is too highly pressurized can be very abrasive. There are basically two different methods which can be referred to as "wet grit," and it is important to differentiate between the two. One technique involves the addition of a stream of water to a regular sandblasting nozzle. This is done primarily to cut down dust, and has very little, if any, effect on reducing the aggressiveness, or cutting action of the grit particles. With the second technique, a very small amount of grit is added to a pressurized water stream. This method may be controlled by regulating the amount of grit fed into the water stream, as well as the pressure of the water.

Why Are Abrasive Cleaning Methods Used?

Usually, an abrasive cleaning method is selected as an expeditious means of quickly removing years of dirt accumulation, unsightly stains, or deteriorating building fabric or finishes, such as stucco or paint. The fact that sandblasting is one of the best known and most readily available building cleaning treatments is probably the major reason for its frequent use.

Many mid-19th century brick buildings were painted immediately or soon after completion to protect poor quality brick or to imitate another material, such as stone. Sometimes brick buildings were painted in an effort to produce what was considered a more harmonious relationship between a building and its natural surroundings. By the 1870s, brick buildings

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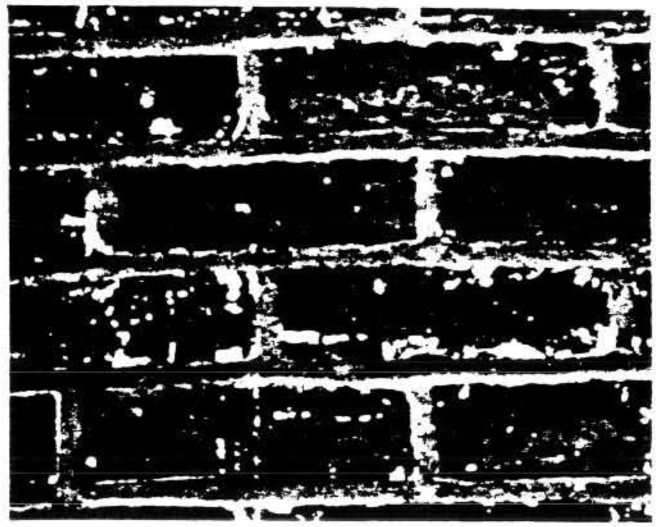
Abrasively Cleaned vs. Untouched Brick. *Two brick rowhouses with a common façade provide an excellent point of comparison when only one of the houses has been sandblasted. It is clear that abrasive blasting, by removing the outer surface, has left the brickwork on the left rough and pitted, while that on the right still exhibits an undamaged and relatively smooth surface. Note that the abrasive cleaning has also removed a considerable portion of the mortar from the joints of the brick on the left side, which will require repointing.*

were often left unpainted as mechanization in the brick industry brought a cheaper pressed brick and fashion decreed a sudden preference for dark colors. However, it was still customary to paint brick of poorer quality for the additional protection the paint afforded.

It is a common 20th-century misconception that all historic masonry buildings were initially unpainted. If the intent of a modern restoration is to return a building to its original appearance, removal of the paint not only may be historically inaccurate, but also harmful. Many older buildings were painted or stuccoed at some point to correct recurring maintenance problems caused by faulty construction techniques, to hide alterations, or in an attempt to solve moisture problems. If this is the case, removal of paint or stucco may cause these problems to reoccur.

Another reason for paint removal, particularly in rehabilitation projects, is to give the building a "new image" in response to contemporary design trends and to attract investors or tenants. Thus, it is necessary to consider the purpose of the intended cleaning. While it is clearly important to remove unsightly stains, heavy encrustations of dirt, peeling paint or other surface coatings, it may not be equally desirable to remove paint from a building which originally was painted. Many historic buildings which show only a slight amount of soil or discoloration are much better left as they are. A thin layer of soil is more often protective of the building fabric than it is harmful, and seldom detracts from the building's



Abrading the Surface without Removing the Paint. *Even though the entire outer surface layer of the brick has been sandblasted off, spots of paint still cling to the masonry. Sandblasting or other similarly abrasive methods are not always a successful means of removing paint.*

architectural and/or historic character. Too thorough cleaning of a historic building may not only sacrifice some of the building's character, but also, misguided cleaning efforts can cause a great deal of damage to historic building fabric. Unless there are stains, graffiti or dirt and pollution deposits which are destroying the building fabric, it is generally preferable to do as little cleaning as possible, or to repaint where necessary. It is important to remember that a historic building does not have to look as if it were newly constructed to be an attractive or successful restoration or rehabilitation project. For a more thorough explanation of the philosophy of cleaning historic buildings see Preservation Briefs: No. 1 "The Cleaning and Waterproof Coating of Masonry Buildings," by Robert C. Mack, AIA.

Problems of Abrasive Cleaning

The crux of the problem is that abrasive cleaning is just that—abrasive. An abrasively cleaned historic structure may be physically as well as aesthetically damaged. Abrasive methods "clean" by eroding dirt or paint, but at the same time they also tend to erode the surface of the building material. In this way, abrasive cleaning is destructive and causes irreversible harm to the historic building fabric. If the fabric is brick, abrasive methods remove the hard, outer protective surface, and therefore make the brick more susceptible to rapid weathering and deterioration. Grit blasting may also increase the water permeability of a brick wall. The impact of the grit particles tends to erode the bond between the mortar and the brick, leaving cracks or enlarging existing cracks where water can enter. Some types of stone develop a protective patina or "quarry crust" parallel to the worked surface (created by the movement of moisture towards the outer edge), which also may be damaged by abrasive cleaning. The rate at which the material subsequently weathers depends on the quality of the inner surface that is exposed.

Abrasive cleaning can destroy, or substantially diminish, decorative detailing on buildings such as a molded brickwork or architectural terra-cotta, ornamental carving on wood or stone, and evidence of historic craft techniques, such as tool marks and other surface textures. In addition, perfectly sound and/or "tooled" mortar joints can be worn away by abrasive techniques. This not only results in the loss of historic craft detailing but also requires repointing, a step involving considerable time, skill and expense, and which might not have been necessary had a gentler method been chosen. Erosion and pitting of the building material by abrasive cleaning creates a greater surface area on which dirt and pollutants collect. In this sense, the building fabric "attracts" more dirt, and will require more frequent cleaning in the future.

In addition to causing physical and aesthetic harm to the historic fabric, there are several adverse environmental effects of dry abrasive cleaning methods. Because of the friction caused by the abrasive medium hitting the building fabric, these techniques usually create a considerable amount of dust, which is unhealthy, particularly to the operators of the abrasive equipment. It further pollutes the environment around the job site, and deposits dust on neighboring buildings, parked vehicles and nearby trees and shrubbery. Some adjacent materials not intended for abrasive treatment such as wood or glass, may also be damaged because the equipment may be difficult to regulate.

Wet grit methods, while eliminating dust, deposit a messy slurry on the ground or other objects surrounding the base of the building. In colder climates where there is the threat of frost, any wet cleaning process applied to historic masonry structures must be done in warm weather, allowing ample time for the wall to dry out thoroughly before cold weather sets in. Water which remains and freezes in cracks and openings of the masonry surface eventually may lead to spalling. High-pressure wet cleaning may force an inordinate amount of water into the walls, affecting interior materials such as plaster or joist ends, as well as metal building components within the walls.

Variable Factors

The greatest problem in developing practical guidelines for cleaning any historic building is the large number of variable and unpredictable factors involved. Because these variables make each cleaning project unique, it is difficult to establish specific standards at this time. This is particularly true of abrasive cleaning methods because their inherent potential for causing damage is multiplied by the following factors:
- the type and condition of the material being cleaned;
- the size and sharpness of the grit particles or the mechanical equipment;
- the pressure with which the abrasive grit or equipment is applied to the building surface;
- the skill and care of the operator; and
- the constancy of the pressure on all surfaces during the cleaning process.

Micro-Abrasive Cleaning. *This small, pencil-sized micro-abrasive unit is used by some museum conservators to clean small objects. This particular micro-abrasive unit is operated within the confines of a box (approximately 2 cubic feet of space), but a similar and slightly larger unit may be used for cleaning larger pieces of sculpture, or areas of architectural detailing on a building. Even a pressure cleaning unit this small is capable of eroding a surface, and must be carefully controlled.*

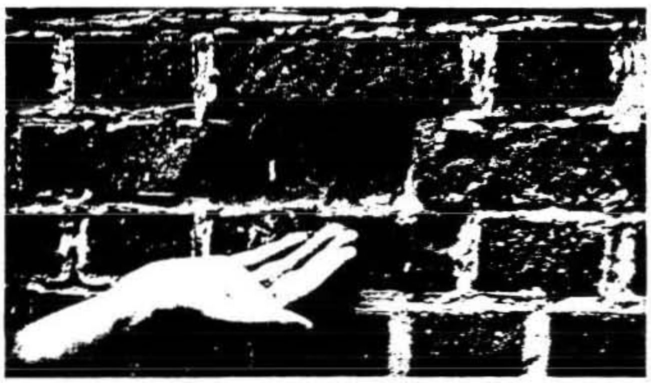
"Line Drop." *Even though the operator of the sandblasting equipment is standing on a ladder to reach the higher sections of the wall, it is still almost impossible to have total control over the pressure. The pressure of the sand hitting the lower portion of the wall will still be greater than that above, because of the "line drop" in the distance from the pressure source to the nozzle. (Hugh Miller)*

Pressure: The damaging effects of most of the variable factors involved in abrasive cleaning are self evident. However, the matter of pressure requires further explanation. In cleaning specifications, pressure is generally abbreviated as "psi" (pounds per square inch), which technically refers to the "tip" pressure, or the amount of pressure at the nozzle of the blasting apparatus. Sometimes "psig," or pressure at the gauge (which may be many feet away, at the other end of the hose), is used in place of "psi." These terms are often incorrectly used interchangeably.

Despite the apparent care taken by most architects and building cleaning contractors to prepare specifications for pressure cleaning which will not cause harm to the delicate fabric of a historic building, it is very difficult to ensure that the same amount of pressure is applied to all parts of the building. For example, if the operator of the pressure equipment stands on the ground while cleaning a two-story structure, the amount of force reaching the first story will be greater than that hitting the second story, even if the operator stands on scaffolding or in a cherry picker, because of the "line drop" in the distance from the pressure source to the nozzle. Although technically it may be possible to prepare cleaning specifications with tight controls that would eliminate all but a small margin of error, it may not be easy to find professional cleaning firms willing to work under such restrictive conditions. The fact is that many professional building cleaning firms do not really understand the extreme delicacy of historic building fabric, and how it differs from modern construction materials. Consequently, they may accept building cleaning projects for which they have no experience.

The amount of pressure used in any kind of cleaning treatment which involves pressure, whether it is dry or wet grit, chemicals or just plain water, is crucial to the outcome of the cleaning project. Unfortunately, no standards have been established for determining the correct pressure for cleaning each of the many historic building materials which would not cause harm. The considerable discrepancy between the way the building cleaning industry and architectural conservators define "high" and "low" pressure cleaning plays a significant role in the difficulty of creating standards.

Nonhistoric/Industrial: A representative of the building cleaning industry might consider "high" pressure *water* cleaning to be anything over 5,000 psi, or even as high as 10,000 to 15,000 psi! Water under this much pressure may be necessary to clean industrial structures or machinery, but would destroy most historic building materials. Industrial *chemical* cleaning commonly utilizes pressures between 1,000 and 2,500 psi.



Spalling Brick. *This soft, early 19th-century brick was sandblasted in the 1960s; consequently, severe spalling has resulted. Some bricks have almost totally disintegrated, and will eventually have to be replaced. (Robert S. Gamble)*

Historic: By contrast, conscientious dry or wet abrasive cleaning of a historic structure would be conducted within the range of 20 to 100 psi at a range of 3 to 12 inches. Cleaning at this low pressure requires the use of a very fine 00 or 0 mesh grit forced through a nozzle with a 1/4 inch opening. A similar, even more delicate method being adopted by architectural conservators uses a micro-abrasive grit on small, hard-to-clean areas of carved, cut or molded ornament on a building façade. Originally developed by museum conservators for cleaning sculpture, this technique may employ glass beads, micro-balloons, or another type of micro-abrasive gently powered at approximately 40 psi by a very small, almost pencil-like pressure instrument. Although a slightly larger pressure instrument may be used on historic buildings, this technique still has limited practical applicability on a large scale building cleaning project because of the cost and the relatively few technicians competent to handle the task. In general, architectural conservators have determined that only through very controlled conditions can most historic building material be abrasively cleaned of soil or paint without measurable damage to the surface or profile of the substrate.

Yet some professional cleaning companies which sepcialize in cleaning historic masonry buildings use chemicals and water at a pressure of approximately 1,500 psi, while other cleaning firms recommend lower pressures ranging from 200 to 800 psi for a similar project. An architectural conservator might decide, *after testing*, that some historic structures could be cleaned properly using a moderate pressure (200–600 psi), or even a high pressure (600–1800 psi) water rinse. However, cleaning historic buildings under such high pressure should be considered an exception rather than the rule, and would require *very careful* testing and supervision to assure that the historic surface materials could withstand the pressure without gouging, pitting or loosening.

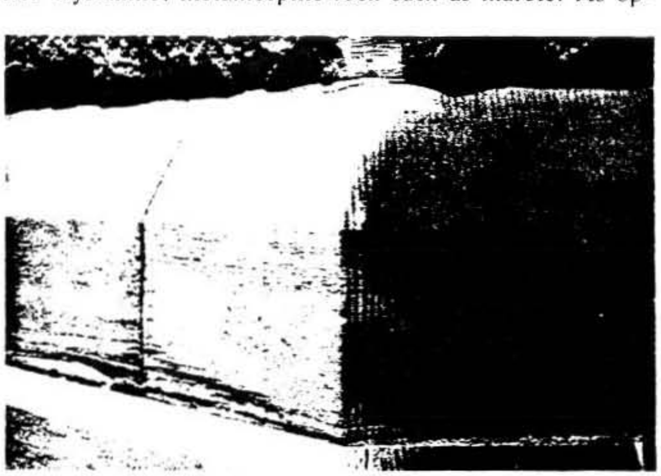
These differences in the amount of pressure used by commercial or industrial building cleaners and architectural conservators point to one of the main problems in using abrasive means to clean historic buildings: misunderstanding of the potentially fragile nature of historic building materials. There is no one cleaning formula or pressure suitable for all situations. Decisions regarding the proper cleaning process for historic structures can be made only after careful analysis of the building fabric, and testing.

How Building Materials React to Abrasive Cleaning Methods

Brick and Architectural Terra-Cotta: Abrasive blasting does not affect all building materials to the same degree. Such techniques quite logically cause greater damage to softer and more porous materials, such as brick or architectural terra-cotta. When these materials are cleaned abrasively, the hard, outer layer (closest to the heat of the kiln) is eroded, leaving the soft, inner core exposed and susceptible to accelerated weathering. Glazed architectural terra-cotta and ceramic veneer have a baked-on glaze which is also easily damaged by abrasive cleaning. Glazed ärchitectual terra-cotta was designed for easy maintenance, and generally can be cleaned using detergent and water; but chemicals or steam may be needed to remove more persistent stains. Large areas of brick or architectural terra-cotta which have been painted are best left painted, or repainted if necessary.

Plaster and Stucco: Plaster and stucco are types of masonry finish materials that are softer than brick or terra-cotta; if treated abrasively these materials will simply disintegrate. Indeed, when plaster or stucco is treated abrasively it is usually with the intention of removing the plaster or stucco from whatever base material or substrate it is covering. Obviously, such abrasive techniques should not be applied to clean sound plaster or stuccoed walls, or decorative plaster wall surfaces.

Building Stones: Building stones are cut from the three main categories of natural rock: dense, igneous rock such as granite; sandy, sedimentary rock such as limestone or sandstone; and crystalline, metamorphic rock such as marble. As op-



Abrasive Cleaning of Tooled Granite. *Even this carefully controlled "wet grit" blasting has erased vertical tooling marks in the cut granite blocks on the left. Not only has the tooling been destroyed, but the damaged stone surface is now more susceptible to accelerated weathering.*

posed to kiln-dried masonry materials such as brick and architectural terra-cotta, building stones are generally homogeneous in character at the time of a building's construction. However, as the stone is exposed to weathering and environmental pollutants, the surface may become friable, or may develop a protective skin or patina. These outer surfaces are very susceptible to damage by abrasive or improper chemical cleaning.

Building stones are frequently cut into ashlar blocks or "dressed" with tool marks that give the building surface a specific texture and contribute to its historic character as much as ornately carved decorative stonework. Such detailing is easily damaged by abrasive cleaning techniques; the pattern of tooling or cutting is erased, and the crisp lines of moldings or carving are worn or pitted.

Occasionally, it may be possible to clean small areas of rough-cut granite, limestone or sandstone having a heavy dirt encrustation by using the "wet grit" method, whereby a small amount of abrasive material is injected into a controlled, pressurized water stream. However, this technique requires very careful supervision in order to prevent damage to the stone. Polished or honed marble or granite should *never* be treated abrasively, as the abrasion would remove the finish in much the way glass would be etched or "frosted" by such a process. It is generally preferable to underclean, as too strong a cleaning procedure will erode the stone, exposing a new and increased surface area to collect atmospheric moisture and dirt. Removing paint, stains or graffiti from most types of stone may be accomplished by a chemical treatment carefully selected to best handle the removal of the particular type of paint or stain without damaging the stone. (See section on the "Gentlest Means Possible")

Abrasive Cleaning of Wood. *This wooden windowsill, molding and paneling have been sandblasted to remove layers of paint in the rehabilitation of this commercial building. Not only is some paint still embedded in cracks and crevices of the woodwork, but more importantly, grit blasting has actually eroded the summer wood, in effect raising the grain, and resulting in a rough surface.*

Wood: Most types of wood used for buildings are soft, fibrous and porous, and are particularly susceptible to damage by abrasive cleaning. Because the summer wood between the lines of the grain is softer than the grain itself, it will be worn away by abrasive blasting or power tools, leaving an uneven surface with the grain raised and often frayed or "fuzzy." Once this has occurred, it is almost impossible to achieve a smooth surface again except by extensive hand sanding, which is expensive and will quickly negate any costs saved earlier by sandblasting. Such harsh cleaning treatment also obliterates historic tool marks, fine carving and detailing, which precludes its use on any interior or exterior woodwork which has been hand planed, milled or carved.

Metals: Like stone, metals are another group of building materials which vary considerably in hardness and durability. Softer metals which are used architecturally, such as tin, zinc, lead, copper or aluminum, generally should not be cleaned abrasively as the process deforms and destroys the original surface texture and appearance, as well as the acquired patina. Much applied architectural metal work used on historic buildings—tin, zinc, lead and copper—is often quite thin and soft, and therefore susceptible to denting and pitting. Galvanized sheet metal is especially vulnerable, as abrasive treatment would wear away the protective galvanized layer.

In the late 19th and early 20th centuries, these metals were often cut, pressed or otherwise shaped from sheets of metal into a wide variety of practical uses such as roofs, gutters and flashing, and façade ornamentation such as cornices, friezes, dormers, panels, cupolas, oriel windows, etc. The architecture of the 1920s and 1930s made use of metals such as chrome, nickel alloys, aluminum and stainless steel in decorative exterior panels, window frames, and doorways. Harsh abrasive blasting would destroy the original surface finish of most of these metals, and would increase the possiblity of corrosion.

However, conservation specialists are now employing a sensitive technique of glass bead peening to clean some of the harder metals, in particular large bronze outdoor sculpture. Very fine (75–125 micron) glass beads are used at a low pressure of 60 to 80 psi. Because these glass beads are completely spherical, ther are no sharp edges to cut the surface of the metal. After cleaning, these statues undergo a lengthy process of polishing. Coatings are applied which protect the surface from corrosion, but they must be renewed every 3 to 5 years. A similarly delicate cleaning technique employing glass beads has been used in Europe to clean historic masonry structures without causing damage. But at this time the process has not been tested sufficiently in the United States to recommend it as a building conservation measure.

Sometimes a very fine *smooth* sand is used at a low pressure to clean or remove paint and corrosion from copper flashing and other metal building components. Restoration architects recently found that a mixture of crushed walnut shells and copper slag at a pressure of approximately 200 psi was the only way to remove corrosion successfully from a mid-19th century terne-coated iron roof. Metal cleaned in this manner must be painted immediately to prevent rapid recurrence of corrosion. It is thought that these methods "work harden" the surface by compressing the outer layer, and actually may be good for the surface of the metal. But the extremely complex nature and the time required by such processes make it very expensive and impractical for large-scale use at this time.

Cast and wrought iron architectural elements may be gently sandblasted or abrasively cleaned using a wire brush to remove layers of paint, rust and corrosion. Sandblasting was, in fact, developed originally as an efficient maintenance procedure for engineering and industrial structures and heavy machinery—iron and steel bridges, machine tool frames, engine frames, and railroad rolling stock—in order to clean and prepare them for repainting. Because iron is hard, its surface, which is naturally somewhat uneven, will not be noticeably damaged by controlled abrasion. Such treatment will, however, result in a small amount of pitting. But this slight abrasion creates a good surface for paint, since the iron must be repainted immediately to prevent corrosion. Any abrasive cleaning of metal building components will also remove the caulking from joints and around other openings. Such areas must be recaulked quickly to prevent moisture from entering and rusting the metal, or causing deterioration of other building fabric inside the structure.

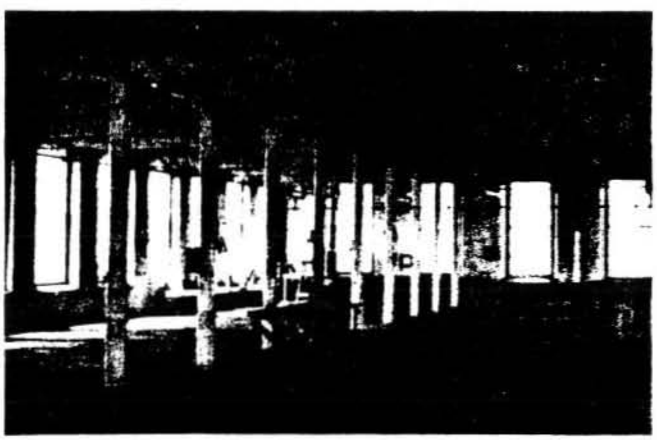
When is Abrasive Cleaning Permissible?

For the most part, abrasive cleaning is destructive to historic building materials. A limited number of special cases have been explained when it may be appropriate, if supervised by a skilled conservator, to use a delicate abrasive technique on some historic building materials. The type of "wet grit" cleaning which involves a small amount of grit injected into a stream of low pressure water may be used on 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 façade.

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 consultation with an experienced building conservator. Remember that *it is very time consuming and expensive to use any abrasive technique on a historic building in such a manner that it does not cause harm to the often fragile and friable building materials.*

At this time, and only under certain circumstances, abrasive cleaning methods may be used in the rehabilitation of interior spaces of warehouse or industrial buildings for contemporary uses.

Interior spaces of factories or warehouse structures in which the masonry or plaster surfaces do not have significant design, detailing, tooling or finish, and in which wooden architectural features are not finished, molded, beaded or worked by hand, may be cleaned abrasively in order to remove layers of paint and industrial discolorations such as smoke, soot, etc. It is expected after such treatment that brick surfaces will be rough and pitted, and wood will be somewhat frayed or "fuzzy" with raised wood grain. These nonsignificant surfaces will be damaged and have a roughened texture, but because they are interior elements, they will not be subject to further deterioration caused by weathering.



Permissible Abrasive Cleaning. *In accordance with the Secretary of the Interior's* Guidelines for Rehabilitation Projects, *it may be acceptable to use abrasive techniques to clean an industrial interior space such as that illustrated here, because the masonry surfaces* do not *have significant design, detailing, tooling or finish, and the wooden architectural features are not finished, molded, beaded or worked by hand.*

Historic Interiors that Should Not Be Cleaned Abrasively

Those instances (generally industrial and some commercial properties), when it may be acceptable to use an abrasive treatment on the interior of historic structures have been described. But for the majority of historic buildings, the Secretary of the Interior's *Guidelines for Rehabilitation* do not recommend "changing the texture of exposed wooden architectural features (including structural members) and masonry surfaces through sandblasting or use of other abrasive techniques to remove paint, discolorations and plaster. . . ."

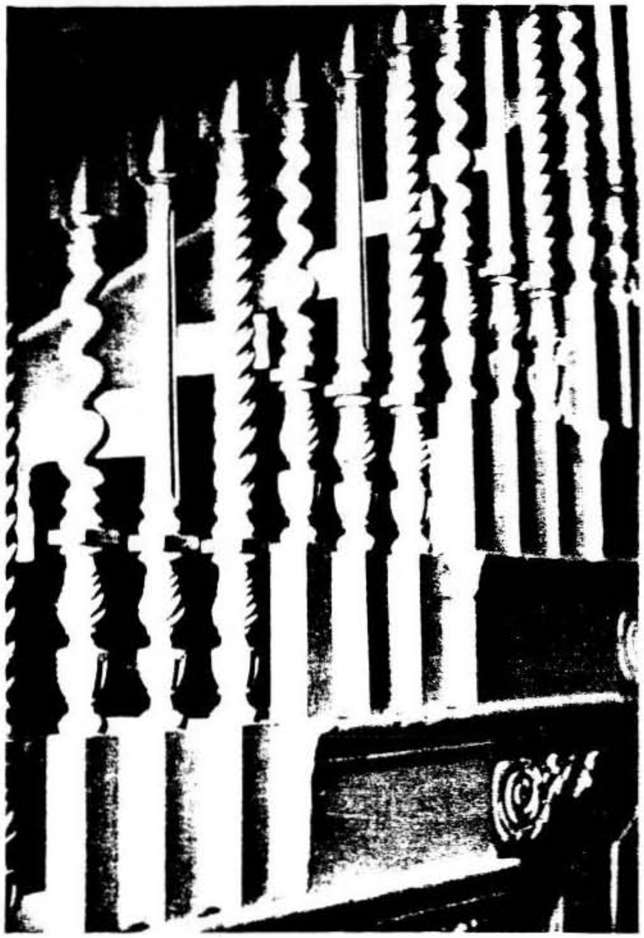
Thus, it is not acceptable to clean abrasively interiors of historic residential and commercial properties which have *finished* interior spaces featuring milled woodwork such as doors, window and door moldings, wainscoting, stair balustrades and mantelpieces. Even the most modest historic *house* interior, although it may not feature elaborate detailing, contains plaster and woodwork that is architecturally significant to the original design and function of the house. Abrasive cleaning of such an interior would be destructive to the historic integrity of the building.

Abrasive cleaning is also impractical. Rough surfaces of abrasively cleaned wooden elements are hard to keep clean. It is also difficult to seal, paint or maintain these surfaces which can be splintery and a problem to the building's occupants. The force of abrasive blasting may cause grit particles to lodge in cracks of wooden elements, which will be a nuisance as the grit is loosened by vibrations and gradually sifts out. Removal of plaster will reduce the thermal and insulating value of the walls. Interior brick is usually softer than exterior brick, and generally of a poorer quality. Removing surface plaster from such brick by abrasive means often exposes gaping mortar joints and mismatched or repaired brickwork which was never intended to show. The resulting bare brick wall may require repointing, often difficult to match. It also may be necessary to apply a transparent surface coating (or sealer) in order to prevent the mortar and brick from "dusting." However, a sealer may not only change the color of the brick, but may also compound any existing moisture problems by restricting the normal evaporation of water vapor from the masonry surface.

"Gentlest Means Possible"

There are alternative means of removing dirt, stains and paint from historic building surfaces that can be recommended as more efficient and less destructive than abrasive techniques. The "gentlest means possible" of removing dirt from a building surface can be achieved by using a low-pressure water wash, scrubbing areas of more persistent grime with a natural bristle (never metal) brush. Steam cleaning can also be used effectively to clean some historic building fabric. Low-pressure water or steam will soften the dirt and cause the deposits to rise to the surface, where they can be washed away.

A third cleaning technique which may be recommended to remove dirt, as well as stains, graffiti or paint, involves the use of commerically available chemical cleaners or paint removers, which, when applied to masonry, loosen or dissolve the dirt or stains. These cleaning agents may be used in combination with water or steam, followed by a clear water wash to remove the residue of dirt and the chemical cleaners from the masonry. A natural bristle brush may also facilitate this type of chemically assisted cleaning, particularly in areas of heavy dirt deposits or stains, and a wooden scraper can be



Do not Abrasively Clean these Interiors. *Most historic residential and some commercial interior spaces contain finished plaster and wooden elements such as this stair balustrade and paneling which contribute to the historic and architectural character of the structure. Such interiors should not be subjected to abrasive techniques for the purpose of removing paint, dirt, discoloration or plaster.*

useful in removing thick encrustations of soot. A limewash or absorbent talc, whiting or clay poultice with a solvent can be used effectively to draw out salts or stains from the surface of the selected areas of a building façade. It is almost impossible to remove paint from masonry surfaces without causing some damage to the masonry, and it is best to leave the surfaces as they are or repaint them if necessary.

Some physicists are experimenting with the use of pulsed laser beams and xenon flash lamps for cleaning historic masonry surfaces. At this time it is a slow, expensive cleaning method, but its initial success indicates that it may have an increasingly important role in the future.

There are many chemical paint removers which, when applied to painted wood, soften and dissolve the paint so that it can be scraped off by hand. Peeling paint can be removed from wood by hand scraping and sanding. Particularly thick layers of paint may be softened with a heat gun or heat plate, providing appropriate precautions are taken, and the paint film scraped off by hand. Too much heat applied to the same spot can burn the wood, and the fumes caused by burning paint are dangerous to inhale, and can be explosive. Furthermore, the hot air from heat guns can start fires in the building cavity. Thus, adequate ventilation is important when using a heat gun or heat plate, as well as when using a chemical stripper. A torch or open flame should never be used.

Preparations for Cleaning: It cannot be overemphasized that all of these cleaning methods must be approached with caution. When using any of these procedures which involve water or other liquid cleaning agents on masonry, it is imperative that *all* openings be tightly covered, and all cracks or joints be well pointed in order to avoid the danger of water penetrating the building's façade, a circumstance which might result in serious moisture related problems such as efflorescence and/or subflorescence. Any time water is used on masonry as a cleaning agent, either in its pure state or in combination with chemical cleaners, it is very important that the work be done in warm weather when there is no danger of frost for several months. Otherwise water which has penetrated the masonry may freeze, eventually causing the surface of the building to crack and spall, which may create another conservation problem more serious to the health of the building than dirt.

Each kind of masonry has a unique composition and reacts differently with various chemical cleaning substances. Water and/or chemicals may interact with minerals in stone and cause new types of stains to leach out to the surface immediately, or more gradually in a delayed reaction. What may be a safe and effective cleaner for certain stain on one type of stone, may leave unattractive discolorations on another stone, or totally dissolve a third type.

Testing: Cleaning historic building materials, particularly masonry, is a technically complex subject, and thus, should never be done without expert consultation and testing. No cleaning project should be undertaken without first applying the intended cleaning agent to a representative test patch area in an inconspicuous location on the building surface. The test patch or patches should be allowed to weather for a period of time, preferably through a complete seasonal cycle, in order to determine that the cleaned area will not be adversely affected by wet or freezing weather or any by-products of the cleaning process.

Mitigating the Effects of Abrasive Cleaning

There are certain restoration measures which can be adopted to help preserve a historic building exterior which has been damaged by abrasive methods. Wood that has been sandblasted will exhibit a frayed or "fuzzed" surface, or a harder wood will have an exaggerated raised grain. The only way to remove this rough surface or to smooth the grain is by laborious sanding. Sandblasted wood, unless it has been extensively sanded, serves as a dustcatcher, will weather faster, and will present a continuing and ever worsening maintenance problem. Such wood, after sanding, should be painted or given a clear surface coating to protect the wood, and allow for somewhat easier maintenance.

There are few successful preservative treatments that may be applied to grit-blasted exterior masonry. Harder, denser stone may have suffered only a loss of crisp edges or tool marks, or other indications of craft technique. If the stone has a compact and uniform composition, it should continue to weather with little additional deterioration. But some types of sandstone, marble and limestone will weather at an accelerated rate once their protective "quarry crust" or patina has been removed.

Softer types of masonry, particularly brick and architectural terra-cotta, are the most likely to require some remedial treatment if they have been abrasively cleaned. Old brick, being essentially a soft, baked clay product, is greatly susceptible to increased deterioration when its hard, outer skin is removed through abrasive techniques. This problem can be minimized by painting the brick. An alternative is to treat it with a clear sealer or surface coating but this will give the masonry a glossy or shiny look. It is usually preferable to paint the brick rather than to apply a transparent sealer since

Hazards of Sandblasting and Surface Coating. *In order to "protect" this heavily sandblasted brick, a clear surface coating or sealer was applied. Because the air temperature was too cold at the time of application, the sealer failed to dry properly, dripping in places, and giving the brick surface a cloudy appearance.*

sealers reduce the transpiration of moisture, allowing salts to crystallize as subflorescence that eventually spalls the brick. If a brick surface has been so extensively damaged by abrasive cleaning and weathering that spalling has already begun, it may be necessary to cover the walls with stucco, if it will adhere.

Of course, the application of paint, a clear surface coating (sealer), or stucco to deteriorating masonry means that the historical appearance will be sacrificed in an attempt to conserve the historic building materials. However, the original color and texture will have been changed already by the abrasive treatment. At this point it is more important to try to preserve the brick, and there is little choice but to protect it from "dusting" or spalling too rapidly. As a last resort, in the case of severely spalling brick, there may be no option but to replace the brick—a difficult, expensive (particularly if custom-made reproduction brick is used), and lengthy process. As described earlier, sandblasted interior brick work, while not subject to change of weather, may require the application of a transparent surface coating or painting as a maintenance procedure to contain loose mortar and brick dust. (See Preservation Briefs: No. 1 for a more thorough discussion of coatings.)

Metals, other than cast or wrought iron, that have been pitted and dented by harsh abrasive blasting usually cannot be smoothed out. Although fillers may be satisfactory for smoothing a painted surface, exposed metal that has been damaged usually will have to be replaced.

Summary

Sandblasting or other abrasive methods of cleaning or paint removal are by their nature destructive to historic building materials and should not be used on historic buildings except in a few well-monitored instances. There are exceptions when certain types of abrasive cleaning may be permissible, but only if conducted by a trained conservator, and if cleaning is necessary for the preservation of the historic structure.

There is no one formula that will be suitable for cleaning all historic building surfaces. Although there are many commerical cleaning products and methods available, it is impossible to state definitively which of these will be the most effective without causing harm to the building fabric. It is often difficult to identify ingredients or their proportions contained in cleaning products; consequently it is hard to predict how a product will react to the building materials to be cleaned. Similar uncertanities affect the outcome of other cleaning methods as they are applied to historic building materials. Further advances in understanding the complex nature of the many variables of the cleaning techniques may someday provide a better and simpler solution to the problems. But until that time, the process of cleaning historic buildings must be approached with caution through trial and error.

It is important to remember that historic building materials are neither indestructible, nor are they renewable. They must be treated in a responsible manner, which may mean little or no cleaning at all if they are to be preserved for future generations to enjoy. If it is in the best interest of the building to clean it, then it should be done "using the gentlest means possible."

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This Preservation Brief was written by Anne E. Grimmer, Architectural Historian, Technical Preservation Services Division. Valuable suggestions and comments were made by Hugh C. Miller, AIA, Washington, D.C., Martin E. Weaver, Ottawa, Ontario, Canada; Terry Bryant, Downers Grove, Illinois; Daniel C. Cammer, McLean, Virginia; and the professional staff of Technical Preservation Services Division. Deborah Cooney edited the final manuscript.

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U.S. Department
of the Interior
National Park Service
Technical Preservation
Services Division

Preservation Briefs: 9
The Repair of Historic Wooden Windows

John H. Myers

The windows on many historic buildings are an important aspect of the architectural character of those buildings. Their design, craftsmanship, or other qualities may make them worthy of preservation. This is self-evident for ornamental windows, but it can be equally true for warehouses or factories where the windows may be the most dominant visual element of an otherwise plain building (see figure 1). Evaluating the significance of these windows and planning for their repair or replacement can be a complex process involving both objective and subjective considerations. The *Secretary of the Interior's Standards for Rehabilitation*, and the accompanying guidelines, call for respecting the significance of original materials and features, repairing and retaining them wherever possible, and when necessary, replacing them in kind. This **Brief** is based on the issues of significance and repair which are implicit in the standards, but the primary emphasis is on the technical issues of planning for the repair of windows including evaluation of their physical condition, techniques of repair, and design considerations when replacement is necessary.

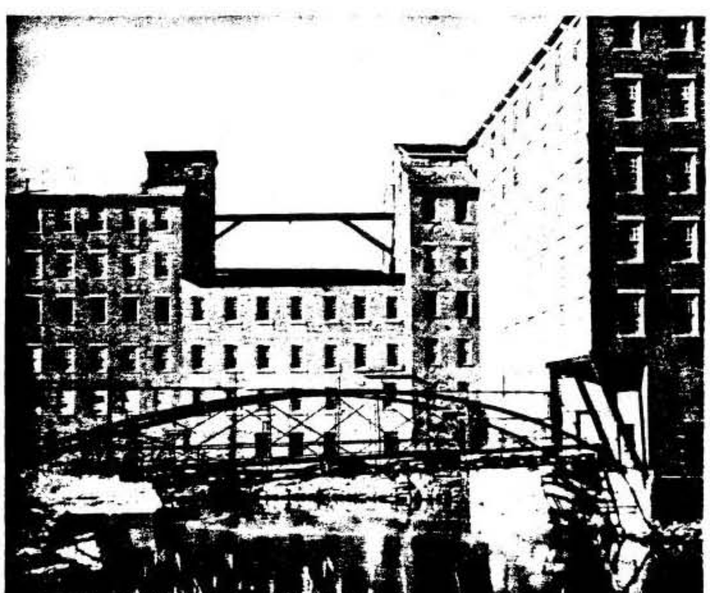

Figure 1. *Windows are frequently important visual focal points, especially on simple facades such as this mill building. Replacement of the multi-pane windows here with larger panes could dramatically change the appearance of the building. The areas of missing windows convey the impression of such a change. Photo: John T. Lowe*

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

Architectural or Historical Significance

Evaluating the architectural or historical significance of windows is the first step in planning for window treatments, and a general understanding of the function and history of windows is vital to making a proper evaluation. As a part of this evaluation, one must consider four basic window functions: admitting light to the interior spaces, providing fresh air and ventilation to the interior, providing a visual link to the outside world, and enhancing the appearance of a building. No single factor can be disregarded when planning window treatments; for example, attempting to conserve energy by closing up or reducing the size of window openings may result in the use of *more* energy by increasing electric lighting loads and decreasing passive solar heat gains.

Historically, the first windows in early American houses were casement windows; that is, they were hinged at the side and opened outward. In the beginning of the eighteenth century single- and double-hung windows were introduced. Subsequently many styles of these vertical sliding sash windows have come to be associated with specific building periods or architectural styles, and this is an important consideration in determining the significance of windows, especially on a local or regional basis. Site-specific, regionally oriented architectural comparisons should be made to determine the significance of windows in question. Although such comparisons may focus on specific window types and their details, the ultimate determination of significance should be made within the context of the whole building, wherein the windows are one architectural element (see figure 2).

After all of the factors have been evaluated, *windows should be considered significant to a building if they:* 1) are original, 2) reflect the original design intent for the building, 3) reflect period or regional styles or building practices, 4) reflect changes to the building resulting from major periods or events, or 5) are examples of exceptional craftsmanship or design. Once this evaluation of significance has been completed, it is possible to pro-

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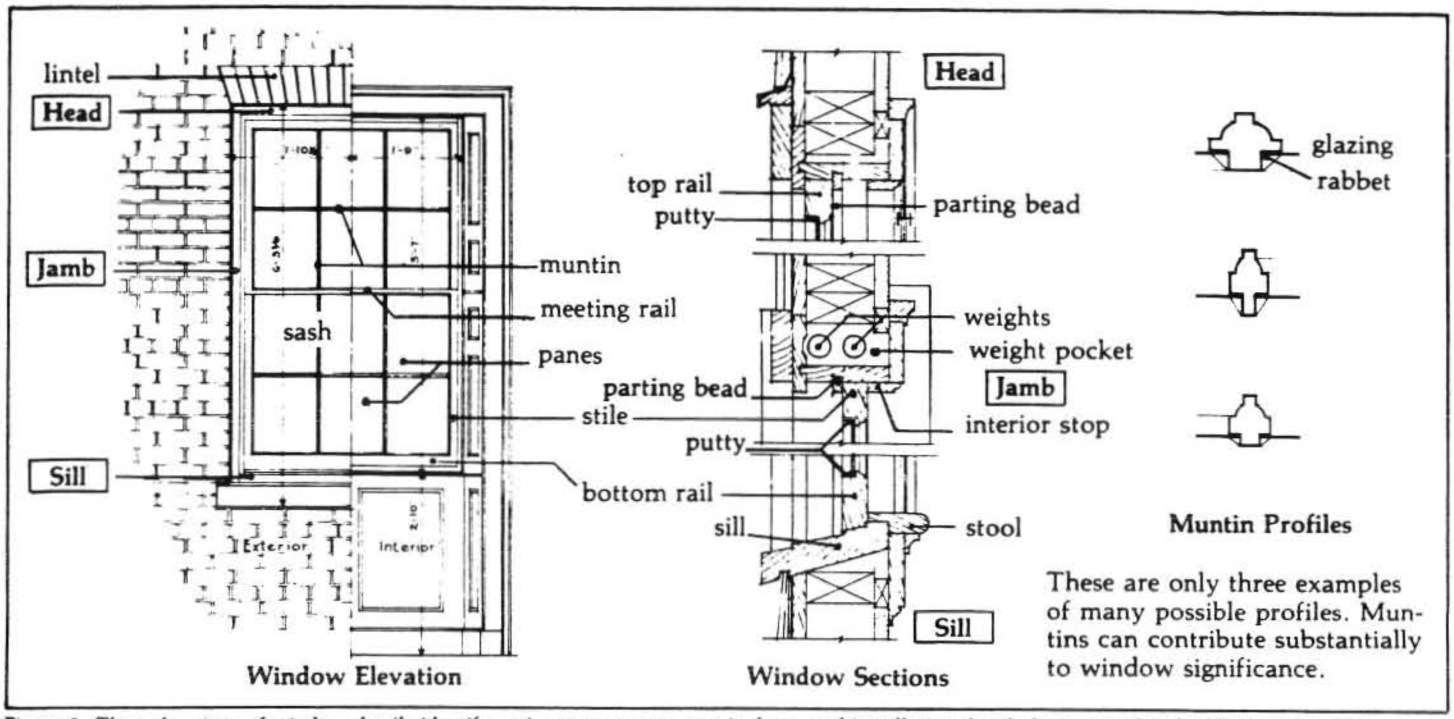

Figure 2. *These drawings of window details identify major components, terminology, and installation details for a wooden double-hung window.*

ceed with planning appropriate treatments, beginning with an investigation of the physical condition of the windows.

Physical Evaluation

The key to successful planning for window treatments is a careful evaluation of existing physical conditions on a unit-by-unit basis. A graphic or photographic system may be devised to record existing conditions and illustrate the scope of any necessary repairs. Another effective tool is a window schedule which lists all of the parts of each window unit. Spaces by each part allow notes on existing conditions and repair instructions. When such a schedule is completed, it indicates the precise tasks to be performed in the repair of each unit and becomes a part of the specifications. In any evaluation, one should note at a minimum, 1) window location, 2) condition of the paint, 3) condition of the frame and sill, 4) condition of the sash (rails, stiles and muntins), 5) glazing problems, 6) hardware, and 7) the overall condition of the window (excellent, fair, poor, and so forth).

Many factors such as poor design, moisture, vandalism, insect attack, and lack of maintenance can contribute to window deterioration, but moisture is the primary contributing factor in wooden window decay. All window units should be inspected to see if water is entering around the edges of the frame and, if so, the joints or seams should be caulked to eliminate this danger. The glazing putty should be checked for cracked, loose, or missing sections which allow water to saturate the wood, especially at the joints. The back putty on the interior side of the pane should also be inspected, because it creates a seal which prevents condensation from running down into the joinery. The sill should be examined to insure that it slopes downward away from the building and allows water to drain off. In addition, it may be advisable to cut a dripline along the underside of the sill. This almost invisible treatment will insure proper water 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 (see figure 3). 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.

An ice pick or an awl may be used to test wood for soundness. The technique is simply to jab the pick into a wetted wood surface at an angle and pry up a small sec-

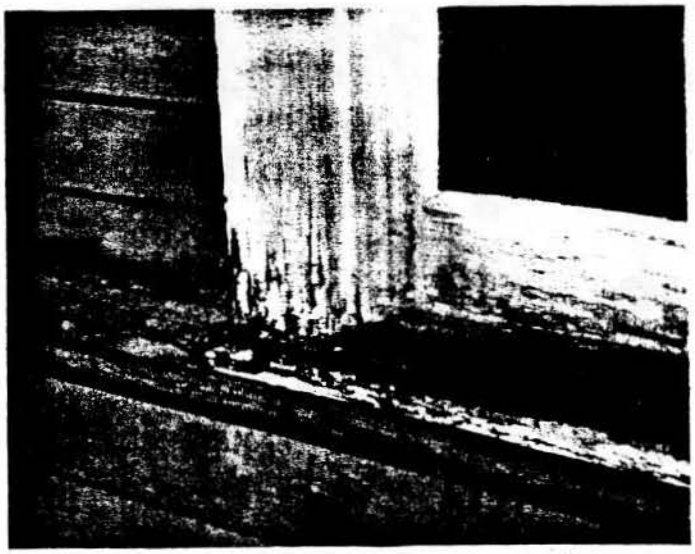

Figure 3. *Deterioration of poorly maintained windows usually begins on horizontal surfaces and at joints where water can collect and saturate the wood. The problem areas are clearly indicated by paint failure due to moisture. Photo: Baird M. Smith, AIA*

tion of the wood. Sound wood will separate in long fibrous splinters, but decayed wood will lift up in short irregular pieces due to the breakdown of fiber strength.

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

Following the inspection and analysis of the results, the scope of the necessary repairs will be evident and a plan for the rehabilitation can be formulated. Generally the actions necessary to return a window to "like new" condition will fall into three broad categories: 1) routine maintenance procedures, 2) structural stabilization, and 3) parts replacement. These categories will be discussed in the following sections and will be referred to respectively as Repair Class I, Repair Class II, and Repair Class III. Each successive repair class represents an increasing level of difficulty, expense, and work time. Note that most of the points mentioned in Repair Class I are routine maintenance items and should be provided in a regular maintenance program for any building. The neglect of these routine items can contribute to many common window problems.

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

Repair Class I: Routine Maintenance

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

The routine maintenance required to upgrade a window to "like new" condition normally includes the following steps: 1) some degree of interior and exterior paint removal, 2) removal and repair of sash (including reglazing where necessary), 3) repairs to the frame, 4) weatherstripping and reinstallation of the sash, and 5) repainting. These operations are illustrated for a typical double-hung wooden window (see figures 4a-f), but they may be adapted to other window types and styles as applicable.

Historic windows have usually acquired many layers of paint over time. Removal of excess layers or peeling and flaking paint will facilitate operation of the window and restore the clarity of the original detailing. Some degree of paint removal is also necessary as a first step in the proper surface preparation for subsequent refinishing (if paint color analysis is desired, it should be conducted prior to the onset of the paint removal). There are several safe and effective techniques for removing paint from wood, depending on the amount of paint to be removed. Several techniques such as scraping, chemical stripping, and the use of a hot air gun are discussed in "Preservation Briefs: 10 Paint Removal from Historic Woodwork" (see Additional Reading section at end).

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 (see figure 4b). With the stop removed, the lower or interior sash may be withdrawn. The sash cords should be detached from the sides of the sash and their ends may be pinned with a nail or tied in a knot to prevent them from falling into the weight pocket.

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

The sash can be stripped of paint using appropriate techniques, but if any heat treatment is used (see figure 4c), the glass should be removed or protected from the sudden temperature change which can cause breakage. An

Figure 4a. *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 4b. *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*

Figure 4c. *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 4d. *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*

Figure 4e. *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 4f. *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*

overlay of aluminum foil on gypsum board or asbestos can protect the glass from such rapid temperature change. It is important to protect the glass because it may be historic and often adds character to the window. Deteriorated putty should be removed manually, taking care not to damage the wood along the rabbet. If the glass is to be removed, the glazing points which hold the glass in place can be extracted and the panes numbered and removed for cleaning and reuse in the same openings. With the glass panes out, the remaining putty can be removed and the sash can be sanded, patched, and primed with a preservative primer. Hardened putty in the rabbets may be softened by heating with a soldering iron at the point of removal. Putty remaining on the glass may be softened by soaking the panes in linseed oil, and then removed with less risk of breaking the glass. Before reinstalling the glass, a bead of glazing compound or linseed oil putty should be laid around the rabbet to cushion and seal the glass. Glazing compound should only be used on wood which has been brushed with linseed oil and primed with an oil based primer or paint. The pane is then pressed into place and the glazing points are pushed into the wood around the perimeter of the pane (see figure 4d). 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 (see figure 4e). 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 (see figure 4f). The techniques can be applied by an unskilled person with minimal training and experience. To demonstrate the practicality of this approach, and photograph it, a Technical Preservation Services staff member repaired a wooden double-hung, two over two window which had been in service over ninety years. The wood was structurally sound but the window had one broken pane, many layers of paint, broken sash cords and inadequate, worn-out weatherstripping. The staff member found that the frame could be stripped of paint and the sash removed quite easily. Paint, putty and glass removal required about one hour for each sash, and the reglazing of both sash was accomplished in about one hour. Weatherstripping of the sash and frame, replacement of the sash cords and reinstallation of the sash, parting bead, and stop required an hour and a half. These times refer only to individual operations; the entire process took several days due to the drying and curing times for putty, primer, and paint, however, work on other window units could have been in progress during these lag times.

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 (see figure 5). Epoxy patching compounds can be used to build up

Figure 5. *This illustrates a two-part epoxy patching compound used to fill the surface of a weathered sill and rebuild the missing edge. When the epoxy cures, it can be sanded smooth and painted to achieve a durable and waterproof repair. Photo: John H. Myers*

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. Technical Preservation Services has published *Epoxies for Wood Repairs in Historic Buildings* (see Additional Reading section at end), which discusses the theory and techniques of epoxy repairs. The process has been widely used and proven in marine applications; and proprietary products are available at hardware and marine supply stores. Although epoxy materials may be comparatively expensive, they hold the promise of being among the most durable and long lasting materials available for wood repair.

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

Repair Class III: Splices and Parts Replacement

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

The repairs discussed in this section involve window frames which may be in very deteriorated condition, possibly requiring removal; therefore, caution is in order. The actual construction of wooden window frames and sash is not complicated. Pegged mortise and tenon units can be disassembled easily, *if* the units are out of the building. The installation or connection of some frames to the surrounding structure, especially masonry walls, can complicate the work immeasurably, and may even require dismantling of the wall. It may be useful, therefore, to take the following approach to frame repair: 1) conduct regular maintenance of sound frames to achieve the longest life possible, 2) make necessary repairs in place wherever possible, using stabilization and splicing techniques, and 3) if removal is necessary, thoroughly investigate the structural detailing and seek appropriate professional consultation.

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

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

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

Weatherization

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

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

Window Replacement

Although the retention of original or existing windows is always desirable and this **Brief** is intended to encourage that goal, there is a point when the condition of a window may clearly indicate replacement. The decision process for selecting replacement windows should *not* begin with a survey of contemporary window products which are available as replacements, but should begin with a look at the windows which are being replaced. Attempt to understand the contribution of the window(s) to the appearance of the facade including: 1) the pattern of the openings and their size; 2) proportions of the frame and sash; 3) configuration of window panes; 4) muntin profiles; 5) type of wood; 6) paint color; 7) characteristics of the glass; and 8) associated details such as arched tops, hoods, or other decorative elements. Develop an understanding of how the window reflects the period, style, or regional characteristics of the building, or represents technological development.

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

Consider energy efficiency as one of the factors for replacements, but do not let it dominate the issue. Energy conservation is no excuse for the wholesale destruction of historic windows which can be made thermally efficient by historically and aesthetically acceptable means. In fact, a historic wooden window with a high quality storm window added should thermally outperform a new double-glazed metal window which does not have thermal breaks (insulation between the inner and outer frames intended to break the path of heat flow). This occurs because the wood has far better insulating value than the metal, and in addition many historic windows have high ratios of wood to glass, thus reducing the area of highest heat transfer. One measure of heat transfer is the U-value, the number of Btu's per hour transferred through a square foot of material. When comparing thermal performance, the lower the U-value the better the performance. According to *ASHRAE 1977 Fundamentals*, the U-values for single glazed wooden windows range from 0.88 to 0.99. The addition of a storm window should reduce these figures to a range of 0.44 to 0.49. A non-thermal break, double-glazed metal window has a U-value of about 0.6.

Conclusion

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

Additional Reading

ASHRAE Handbook-1977 Fundamentals. New York: American Society of Heating, Refrigerating and Air-conditioning Engineers, 1978 (chapter 26).

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This publication has been prepared pursuant to Executive Order 11593, "Protection and Enhancement of the Cultural Environment," which directs the Secretary of the Interior to "develop and make available to Federal agencies and State and local governments information concerning professional methods and techniques for preserving, improving, restoring, and maintaining historic properties."

Preservation Briefs 9 has been developed under the technical editorship of Lee H. Nelson, AIA, Chief, Technical Preservation Services Division, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. Comments on the usefulness of this information are welcomed and can be sent to Mr. Nelson at this address.

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The Repair of Historic Wooden Windows

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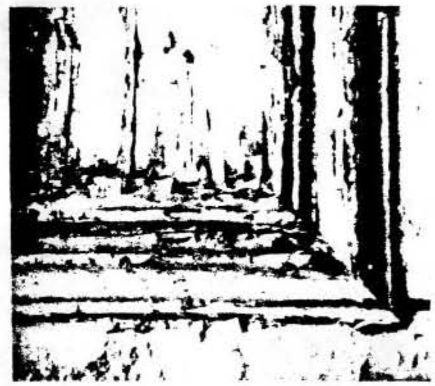

Exterior Paint Problems on Historic Woodwork

Kay D. Weeks and David W. Look, AIA

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National Park Service U.S. Department of the Interior

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

This Brief expands on that advice for the architect, building manager, contractor, or homeowner by identifying and describing common types of paint surface conditions and failures, then recommending appropriate treatments for preparing exterior wood surfaces for repainting[1] to assure the best adhesion and greatest durability of the new paint. Although the Brief focuses on responsible methods of "paint removal," several paint surface conditions will be described which do not require any paint removal, and still others which can be successfully handled by limited paint removal. In all cases, the information is intended to address the concerns related to *exterior wood.* It will also be generally assumed that, because houses built before 1950 involve one or more layers of lead-base paint,[2] the majority of conditions warranting paint removal will mean dealing with this toxic substance along with the dangers of the paint removal tools and chemical strippers themselves.

Purposes of Exterior Paint

Paint[3] applied to exterior wood must withstand yearly extremes of both temperature and humidity. While never expected to be more than a temporary physical shield—requiring re-application every 5-8 years—its importance should not be minimized. Because one of the main causes of wood deterioration is moisture penetration, a primary purpose for painting wood is to exclude such moisture, thereby slowing deterioration not only of a building's exterior siding and decorative features but, ultimately, its underlying structural members. Another important purpose for painting wood is, of course, to define and accent architectural features and to improve appearance.

Treating Paint Problems in Historic Buildings

Exterior paint is constantly deteriorating through the processes of weathering, but in a program of regular maintenance—assuming all other building systems are functioning properly—surfaces can be cleaned, lightly scraped, and hand sanded in preparation for a new finish coat. Unfortunately, these are ideal conditions. More often, complex maintenance problems are inherited by owners of historic buildings, including areas of paint that have failed[4] beyond the point of mere cleaning, scraping, and hand sanding (although much so-called "paint failure" is attributable to interior or exterior moisture problems or surface preparation and application mistakes with previous coats).

Although paint problems are by no means unique to historic buildings, treating multiple layers of hardened, brittle paint on complex, ornamental—and possibly fragile—exterior wood surfaces necessarily requires an extremely cautious approach (see figure 1). In the case of recent construction, this level of concern is not needed because the wood is generally less detailed and, in addition, retention of the sequence of paint layers as a partial record of the building's history is not an issue.

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

Justification for Paint Removal

At the outset of this Brief, it must be emphasized that removing paint from historic buildings—with the exception of cleaning, light scraping, and hand sanding as part of routine maintenance—should be avoided unless absolutely essential. *Once conditions warranting removal have*

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[1] General paint type recommendations will be made, but paint color recommendations are beyond the scope of this Brief.

[2] Douglas R. Shier and William Hall, *Analysis of Housing Data Collected in a Lead-Based Paint Survey in Pittsburgh, Pennsylvania, Part 1,* National Bureau of Standards, Inter-Report 77-1250, May 1977.

[3] Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer which is converted to an opaque solid film after application. *Paint and Coatings Dictionary.* 1978. Federation of Societies for Coatings and Technology.

[4] For purposes of the Brief, this includes any area of painted exterior woodwork displaying signs of peeling, cracking, or alligatoring to bare wood. See descriptions of these and other paint surface conditions as well as recommended treatments on pp. 5-10.

Fig. 1 *Excessive paint build-up on architectural details such as this ornamental bracket does not in itself justify total paint removal. If paint is cracked and peeling down to bare wood, however, it should be removed using the gentlest means possible. Photo: David W. Look, AIA.*

Fig. 2 *A traditionally painted bay window has been stripped to bare wood, then varnished. In addition to being historically inaccurate, the varnish will break down faster as a result of the sun's ultraviolet rays than would primer and finish coats of paint. Photo: David W. Look, AIA.*

been identified, the general approach should be to remove paint to the next sound layer using the gentlest means possible, then to repaint (see figure 2). Practically speaking as well, paint can adhere just as effectively to existing paint as to bare wood, providing the previous coats of paint are also adhering uniformly and tightly to the wood and the surface is properly prepared for repainting—cleaned of dirt and chalk and dulled by sanding. But, if painted exterior wood surfaces display continuous patterns of deep cracks or if they are extensively blistering and peeling so that bare wood is visible, then the old paint should be completely removed before repainting. The only other justification for removing all previous layers of paint is if doors, shutters, or windows have literally been "painted shut," or if new wood is being pieced-in adjacent to old painted wood and a smooth transition is desired (see figure 3).

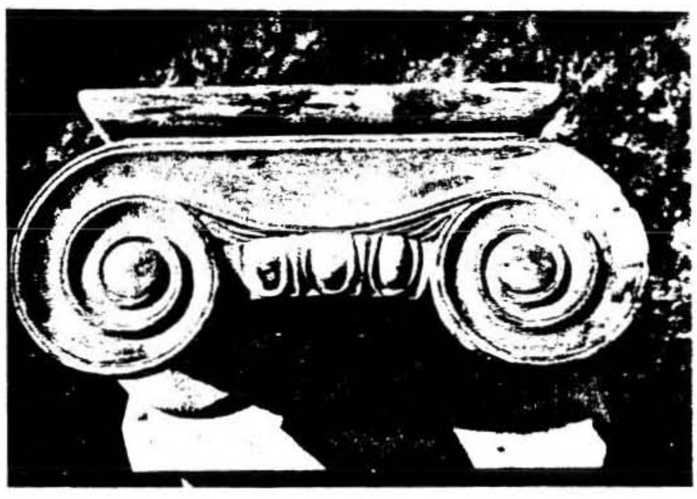

Fig. 3 *If damage to parts of a wooden element is severe, new sections of wood will need to be pieced-in. When such piecing is required, paint on the adjacent woodwork should be removed so that the old and new woods will make a smooth profile when joined. After repainting, the repair should be virtually impossible to detect. Photo: Morgan W. Phillips.*

Paint Removal Precautions

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

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

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

Repainting Historic Buildings for Cosmetic Reasons

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

The decision to repaint may not be based altogether on paint failure. Where there is a new owner, or even where ownership has remained constant through the years, taste in colors often changes. Therefore, if repainting is primarily to alter a building's primary and accent colors, a technical factor of paint accumulation should be taken into consideration. When paint builds up to a thickness of approximately 1/16" (approximately 16-30 layers), one or more extra coats of paint may be enough to trigger cracking and peeling in limited or even widespread areas of the building's surface. This results because excessively thick paint is less able to withstand the shrinkage or pull of an additional coat as it dries and is also less able to tolerate thermal stresses. Thick paint invariably fails at the weakest point of adhesion—the oldest layers next to the wood. Cracking and peeling follow. Therefore, if there are no signs of paint failure, it may be somewhat risky to add still another layer of unneeded paint simply for color's sake (extreme changes in color may also require more than one coat to provide proper hiding power and full color). When paint appears to be nearing the critical thickness, a change of accent colors (that is, just to limited portions of the trim) might be an acceptable compromise without chancing cracking and peeling of paint on wooden siding.

If the decision to repaint is nonetheless made, the "new" color or colors should, at a minimum, be appropriate to the style and setting of the building. On the other hand, where the intent is to restore or accurately reproduce the colors originally used or those from a significant period in the building's evolution, they should be based on the results of a paint analysis.[5]

Identification of Exterior Paint Surface Conditions/Recommended Treatments

It is assumed that a preliminary check will already have been made to determine, first, that the painted exterior surfaces are indeed wood—and not stucco, metal, or other wood substitutes—and second, that the wood has not decayed so that repainting would be superfluous. For example, if any area of bare wood such as window sills has been exposed for a long period of time to standing water, wood rot is a strong possibility (see figure 4). Repair or replacement of deteriorated wood should take place before repainting. After these two basic issues have been resolved, the surface condition identification process may commence.

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

Paint surface conditions can be grouped according to their relative severity: CLASS I conditions include minor blemishes or dirt collection and generally require *no* paint removal; CLASS II conditions include failure of the top layer or layers of paint and generally require *limited* paint removal; and CLASS III conditions include substantial or multiple-layer failure and generally require *total* paint removal. It is precisely because conditions will vary at different points on the building that a careful inspection is critical. Each item of painted exterior woodwork (i.e., siding, doors, windows, eaves, shutters, and decorative elements) should be examined early in the planning phase and surface conditions noted.

CLASS I Exterior Surface Conditions Generally Requiring No Paint Removal

- **Dirt, Soot, Pollution, Cobwebs, Insect Cocoons, etc.**

Cause of Condition

Environmental "grime" or organic matter that tends to cling to painted exterior surfaces and, in particular, protected surfaces such as eaves, do not constitute a paint problem unless painted over rather than removed prior to repainting. If not removed, the surface deposits can be a barrier to proper adhesion and cause peeling.

Recommended Treatment

Most surface matter can be loosened by a strong, direct stream of water from the nozzle of a garden hose. Stubborn dirt and soot will need to be scrubbed off using ½ cup of household detergent in a gallon of water with a medium soft bristle brush. The cleaned surface should then be rinsed thoroughly, and permitted to dry before further inspection to determine if repainting is necessary. Quite often, cleaning provides a satisfactory enough result to postpone repainting.

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[5] See the Reading List for paint research and documentation information. See also *The Secretary of the Interior's Standards for Historic Preservation Projects with Guidelines for Applying the Standards* for recommended approaches on paints and finishes within various types of project work treatments.

• **Mildew**

Cause of Condition

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

Recommended Treatment

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

• **Excessive Chalking**

Cause of Condition

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

Recommended Treatment

The chalk should be cleaned off with a solution of ½ cup household detergent to one gallon water, using a medium soft bristle brush. After scrubbing to remove the chalk, the surface should be rinsed with a direct stream of water from the nozzle of a garden hose, allowed to dry thoroughly, (but not long enough for the chalking process to recur) and repainted, using a non-chalking paint.

• **Staining**

Cause of Condition

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

Fig. 4 *Paint films wear unevenly depending on exposure and location. Exterior locations which are susceptible to accelerated deterioration are horizontal surfaces such as window sills. These and similar areas will require repainting more often than less vulnerable surfaces. In the case of this window sill where paint has peeled off and adjacent areas have cracked and alligatored, the paint should be totally removed. Prior to repainting, any weathered wood should be rejuvenated using a solution of 3 cups exterior varnish, 1 oz. paraffin wax, and mineral spirits/ paint thinner/or turpentine to make 1 gallon. Liberal brush application should be made. This formula was tested over a 20-year period by th. U.S. Department of Agriculture's Forest Products Laboratory and proved to be just as effective as water-repellent preservatives containing pentachlorophenol. After the surface has thoroughly dried (2-3 days of warm weather), the treated surface can be painted. A high quality oil-base primer followed by two top coats of a semi-gloss oil-enamel or latex-enamel paint is recommended. Photo: Baird M. Smith, AIA.*

Recommended Treatment

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

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

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

CLASS II Exterior Surface Conditions Generally Requiring Limited Paint Removal

• Crazing

Cause of Condition

Crazing—fine, jagged interconnected breaks in the top layer of paint—results when paint that is several layers thick becomes excessively hard and brittle with age and is consequently no longer able to expand and contract with the wood in response to changes in temperature and humidity (see figure 5). As the wood swells, the bond between paint layers is broken and hairline cracks appear. Although somewhat more difficult to detect as opposed to other more obvious paint problems, it is well worth the time to scrutinize all surfaces for crazing. If not corrected, exterior moisture will enter the crazed surface, resulting in further swelling of the wood and, eventually, deep cracking and alligatoring, a Class III condition which requires total paint removal.

Recommended Treatment

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

Fig. 5 *Crazing—or surface cracking—is an exterior surface condition which can be successfully treated by sanding and painting. Photo: Courtesy, National Decorating Products Association.*

• Intercoat Peeling

Cause of Condition

Intercoat peeling can be the result of improper surface preparation prior to the last repainting. This most often occurs in protected areas such as eaves and covered porches because these surfaces do not receive a regular rinsing from rainfall, and salts from air-borne pollutants thus accumulate on the surface. If not cleaned off, the new paint coat will not adhere properly and that layer will peel.

Another common cause of intercoat peeling is incompatibility between paint types (see figure 6). For example, if oil paint is applied over latex paint, peeling of the top coat can sometimes result since, upon aging, the oil paint becomes harder and less elastic than the latex paint. If latex paint is applied over old, chalking oil paint, peeling can also occur because the latex paint is unable to penetrate the chalky surface and adhere.

Recommended Treatment

First, where salts or impurities have caused the peeling, the affected area should be washed down thoroughly after scraping, then wiped dry. Finally, the surface should be hand or mechanically sanded, then repainted.

Where peeling was the result of using incompatible paints, the peeling top coat should be scraped and hand or mechanically sanded. Application of a high quality oil type exterior primer will provide a surface over which either an oil or a latex topcoat can be successfully used.

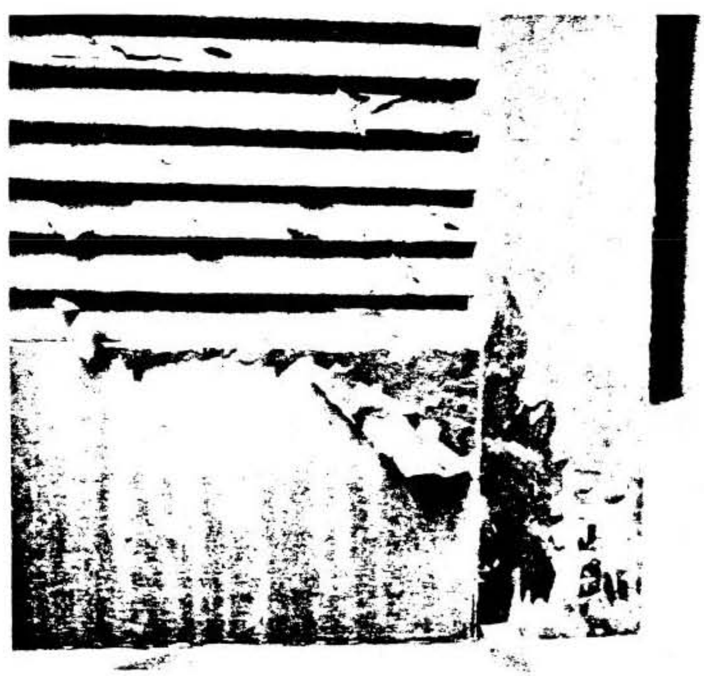

Fig. 6 *This is an example of intercoat peeling. A latex top coat was applied directly over old oil paint and, as a result, the latex paint was unable to adhere. If latex is being used over oil, an oil-base primer should be applied first. Although much of the peeling latex paint can be scraped off, in this case, the best solution may be to chemically dip strip the entire shutter to remove all of the paint down to bare wood, rinse thoroughly, then repaint. Photo: Mary L. Oehrlein, AIA.*

• Solvent Blistering

Cause of Condition

Solvent blistering, the result of a less common application error, is not caused by moisture, but by the action of ambient heat on paint solvent or thinners in the paint film. If solvent-rich paint is applied in direct sunlight, the top surface can dry too quickly and, as a result, solvents become trapped beneath the dried paint film. When the solvent vaporizes, it forces its way through the paint film, resulting in surface blisters. This problem occurs more often with dark colored paints because darker colors absorb more heat than lighter ones. To distinguish between solvent blistering and blistering caused by moisture, a blister should be cut open. If another layer of paint is visible, then solvent blistering is likely the problem whereas if bare wood is revealed, moisture is probably to blame. Solvent blisters are generally small.

Recommended Treatment

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

- **Wrinkling**

Cause of Condition

Another error in application that can easily be avoided is wrinkling (see figure 7). This occurs when the top layer of paint dries before the layer underneath. The top layer of paint actually moves as the paint underneath (a primer, for example) is drying. Specific causes of wrinkling include: (1) applying paint too thick; (2) applying a second coat before the first one dries; (3) inadequate brushing out; and (4) painting in temperatures higher than recommended by the manufacturer.

Recommended Treatment

The wrinkled layer can be removed by scraping followed by hand or mechanical sanding to provide as even a surface as possible, then repainted following manufacturer's application instructions.

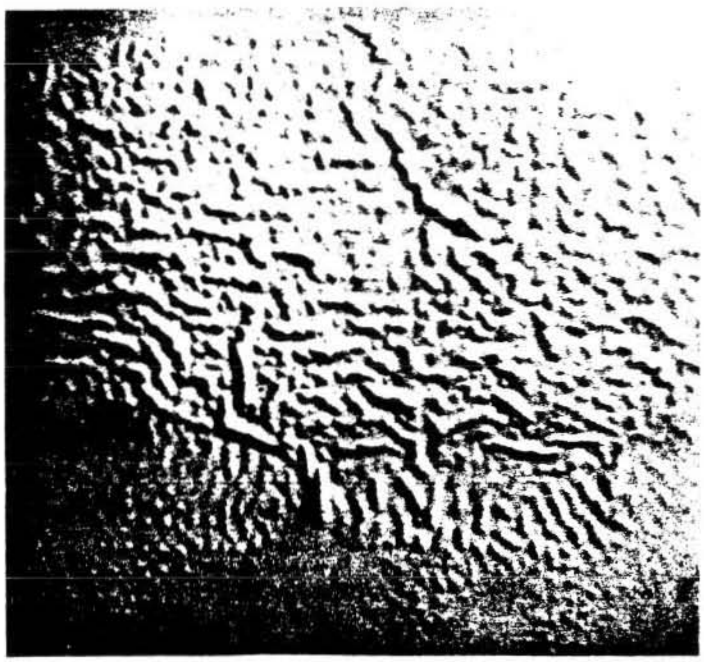

Fig. 7 *Wrinkled layers can generally be removed by scraping and sanding as opposed to total paint removal. Following manufacturers' application instructions is the best way to avoid this surface condition. Photo: Courtesy, National Decorating Products Association.*

CLASS III Exterior Surface Conditions Generally Requiring Total Paint Removal

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

- **Peeling**

Cause of Condition

Peeling to bare wood is most often caused by excess interior or exterior moisture that collects behind the paint film, thus impairing adhesion (see figure 8). Generally beginning as blisters, cracking and peeling occur as moisture causes the wood to swell, breaking the adhesion of the bottom layer.

Recommended Treatment

There is no sense in repainting before dealing with the moisture problems because new paint will simply fail. Therefore, the first step in treating peeling is to locate and remove the source or sources of the moisture, not only because moisture will jeopardize the protective coating of paint but because, if left unattended, it can ultimately cause permanent damage to the wood. Excess interior moisture should be removed from the building through installation of exhaust fans and vents. Exterior moisture should be eliminated by correcting the following conditions prior to repainting: faulty flashing; leaking gutters; defective roof shingles; cracks and holes in siding and trim; deteriorated caulking in joints and seams; and shrubbery growing too close to painted wood. After the moisture problems have been solved, the wood must be permitted to dry out thoroughly. The damaged paint can then be scraped off with a putty knife, hand or mechanically sanded, primed, and repainted.

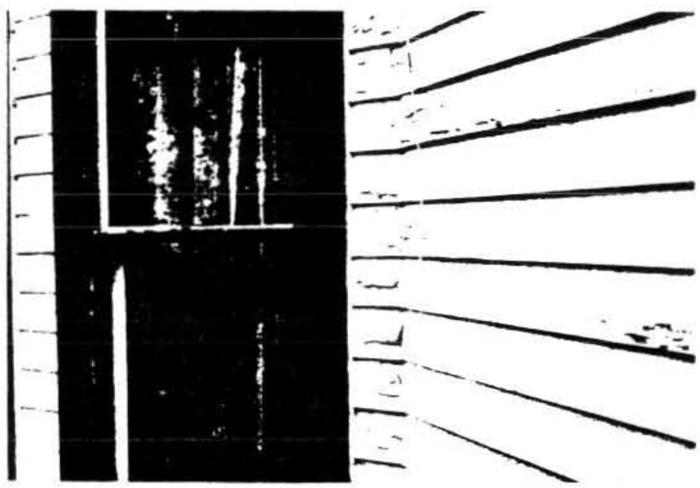

Fig. 8 *Peeling to bare wood—one of the most common types of paint failure—is usually caused by an interior or exterior moisture problem. Photo: Anne E. Grimmer.*

- **Cracking/Alligatoring**

Cause of Condition

Cracking and alligatoring are advanced stages of crazing (see figure 9). Once the bond between layers has been broken due to intercoat paint failure, exterior moisture is able to penetrate the surface cracks, causing the wood to swell and deeper cracking to take place. This process continues until cracking, which forms parallel to grain, extends to bare wood. Ultimately, the cracking becomes an overall pattern of horizontal and vertical breaks in the paint layers that looks like reptile skin; hence, "alligatoring." In advanced stages of cracking and alligatoring, the surfaces will also flake badly.

Recommended Treatment

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

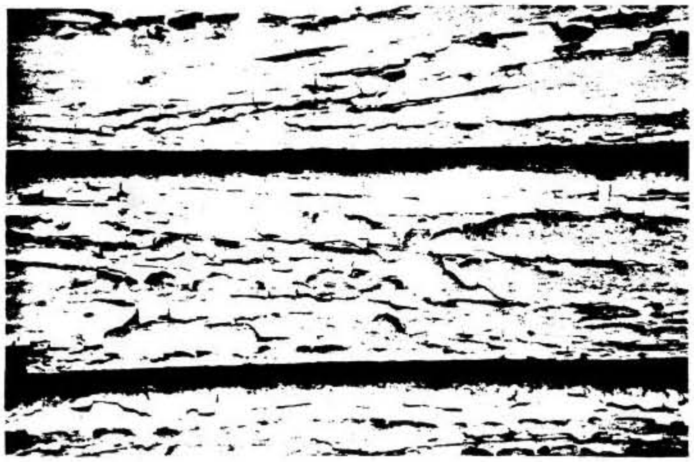

Fig. 9 *Cracking, alligatoring, and flaking are evidence of long-term neglect of painted surfaces. The remaining paint on the clapboard shown here can be removed with an electric heat plate and wide-bladed scraper. In addition, unsound wood should be replaced and moisture problems corrected before primer and top coats of paint are applied. Photo: David W. Look, AIA.*

Selecting the Appropriate/Safest Method to Remove Paint

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

The treatments recommended—based upon field testing as well as onsite monitoring of Department of Interior grant-in-aid and certification of rehabilitation projects—are therefore those which take three over-riding issues into consideration (1) the continued protection and preservation of the historic exterior woodwork; (2) the retention of the sequence of historic paint layers; and (3) the health and safety of those individuals performing the paint removal. By applying these criteria, it will be seen that no paint removal method is without its drawbacks and all recommendations are qualified in varying degrees.

Methods for Removing Paint

After a particular exterior paint surface condition has been identified, the next step in planning for repainting—if paint removal is required—is selecting an appropriate method for such removal.

The method or methods selected should be suitable for the specific paint problem as well as the particular wooden element of the building. Methods for paint removal can be divided into three categories (frequently, however, a combination of the three methods is used). Each method is defined below, then discussed further and specific recommendations made:

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

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

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

- **Abrasive Methods (Manual)**

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

Recommended Abrasive Methods (Manual)

Putty Knife/Paint Scraper: Scraping is usually accomplished with either a putty knife or a paint scraper, or both. Putty knives range in width from one to six inches and have a beveled edge. A putty knife is used in a pushing motion going under the paint and working from an area of loose paint toward the edge where the paint is still firmly adhered and, in effect, "beveling" the remaining layers so that as smooth a transition as possible is made between damaged and undamaged areas (see figure 10).

Paint scrapers are commonly available in $1\frac{5}{16}$, $2\frac{1}{2}$, and $3\frac{1}{2}$ inch widths and have replaceable blades. In addition, profiled scrapers can be made specifically for use on moldings. As opposed to the putty knife, the paint scraper is used in a pulling motion and works by raking the damaged areas of paint away.

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

Sandpaper/Sanding Block/Sanding sponge: After manually removing the damaged layer or layers by scraping, the uneven surface (due to the almost inevitable removal of varying numbers of paint layers in a given area) will need to be smoothed or "feathered out" prior to repainting. As stated before, hand sanding, as opposed to harsher mechanical sanding, is recommended if the area is relatively limited. A coarse grit, open-coat flint sandpaper—the least expensive kind—is useful for this purpose because, as the sandpaper clogs with paint it must be discarded and this process repeated until all layers adhere uniformly.

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

Summary of Abrasive Methods (Manual)

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

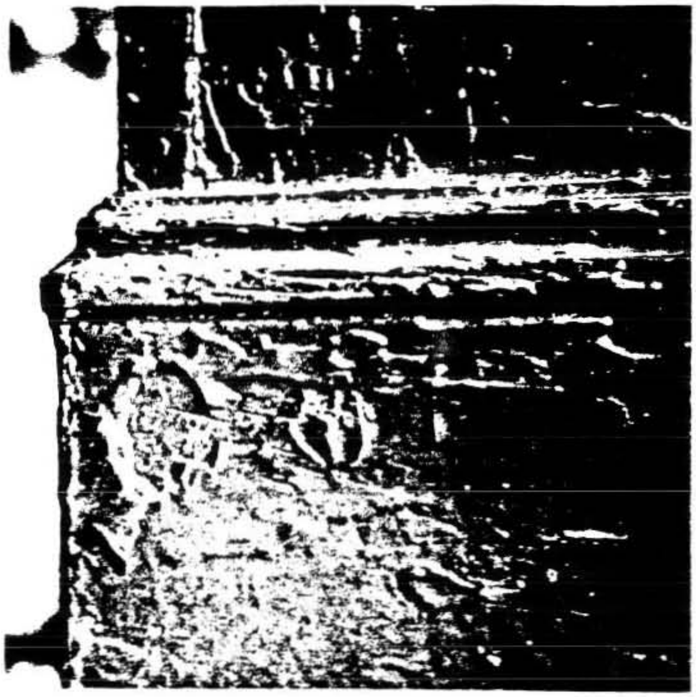

Fig. 10 *An excellent example of inadequate scraping before repainting, the problems here are far more than cosmetic. This improperly prepared surface will permit moisture to get behind the paint film which, in turn, will result in chipping and peeling. Photo: Baird M. Smith, AIA.*

- **Abrasive Methods (Mechanical)**

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

Recommended Abrasive Methods (Mechanical)

Orbital sander: Designed as a finishing or smoothing tool—not for the removal of multiple layers of paint—the oribital sander is thus recommended when limited paint removal is required prior to repainting. Because it sands in a small diameter circular motion (some models can also be switched to a back-and-forth vibrating action), this tool is particularly effective for "feathering" areas where paint has first been scraped (see figure 11). The abrasive surface varies from about 3×7 inches to 4×9 inches and sandpaper is attached either by clamps or sliding clips. A medium grit, open-coat aluminum oxide sandpaper should be used; fine sandpaper clogs up so quickly that it is ineffective for smoothing paint.

Belt sander: A second type of power tool—the belt sander—can also be used for removing limited layers of paint but, in this case, the abrasive surface is a continuous belt of sandpaper that travels at high speeds and consequently offers much less control than the orbital sander. Because of the potential for more damage to the paint or the wood, use of the belt sander (also with a medium grit sandpaper) should be limited to flat surfaces and only skilled operators should be permitted to operate it within a historic preservation project.

Fig. 11 *The orbital sander can be used for limited paint removal, i.e., for smoothing flat surfaces after the majority of deteriorated paint has already been scraped off. Photo: Charles E. Fisher, III.*

Not Recommended

Rotary Drill Attachments: Rotary drill attachments such as the rotary sanding disc and the rotary wire stripper should be avoided. The disc sander—usually a disc of sandpaper about 5 inches in diameter secured to a rubber based attachment which is in turn connected to an electric drill or other motorized housing—can easily leave visible circular depressions in the wood which are difficult to hide, even with repainting. The rotary wire stripper—clusters of metals wires similarly attached to an electric drill-type unit—can actually shred a wooden surface and is thus to be used exclusively for removing corrosion and paint from metals.

Waterblasting: Waterblasting above 600 p.s.i. to remove paint is not recommended because it can force water into the woodwork rather than cleaning loose paint and grime from the surface; at worst, high pressure waterblasting causes the water to penetrate exterior sheathing and damages interior finishes. A detergent solution, a medium soft bristle brush, and a garden hose for purposes of rinsing, is the gentlest method involving water and is recommended when cleaning exterior surfaces prior to repainting.

Sandblasting: Finally—and undoubtedly most vehemently "not recommended"—sandblasting painted exterior woodwork will indeed remove paint, but at the same time can scar wooden elements beyond recognition. As with rotary wire strippers, sandblasting erodes the soft porous fibers (spring wood) faster than the hard, dense fibers (summer wood), leaving a pitted surface with ridges and valleys. Sandblasting will also erode projecting areas of carvings and moldings before it removes paint from concave areas (see figure 12). Hence, this abrasive method is potentially the most damaging of all possibilities, even if a contractor promises that blast pressure can be controlled so that the paint is removed without harming the historic exterior woodwork. (For Additional Information, See Presevation Briefs 6, "Dangers of Abrasive Cleaning to Historic Buildings".)

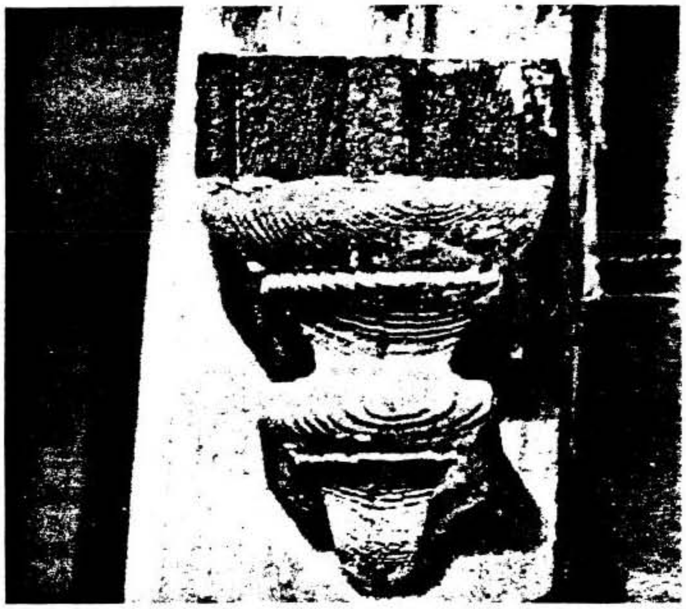

Fig. 12 *Sandblasting has permanently damaged this ornamental bracket. Even paint will not be able to hide the deep erosion of the wood. Photo: David W. Look, AIA.*

Summary of Abrasive Methods (Mechanical)

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

• Thermal Methods

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

Recommended Thermal Methods

Electric heat plate: The electric heat plate (see figure 13) operates between 500 and 800 degrees Fahrenheit (not hot enough to vaporize lead paint), using about 15 amps of power. The plate is held close to the painted exterior surface until the layers of paint begin to soften and blister, then moved to an adjacent location on the wood while the softened paint is scraped off with a putty knife (it should be noted that the heat plate is most successful when the paint is very thick!). With practice, the operator can successfully move the heat plate evenly across a flat surface such as wooden siding or a window sill or door in a continuous motion, thus lessening the risk of scorching the wood in an attempt to reheat the edge of the paint sufficiently for effective removal. Since the electric heat plate's coil is "red hot," extreme caution should be taken to avoid igniting clothing or burning the skin. If an extension cord is used, it should be a heavy-duty cord (with 3-prong grounded plugs). A heat plate could overload a circuit or, even worse, cause an electrical fire; therefore, it is recommended that this implement be used with a single circuit and that a fire extinguisher always be kept close at hand.

Fig. 13 *The electric heat plate (with paint scraper) is particularly useful for removing paint down to bare wood on flat surfaces such as doors, window frames, and siding. After scraping, some light sanding will probably be necessary to smooth the surface prior to application of primer and top coats. Photo: David W. Look, AIA.*

Electric heat gun: The electric heat gun (electric hot-air gun) looks like a hand-held hairdryer with a heavy-duty metal case (see figure 14). It has an electrical resistance coil that typically heats between 500 and 750 degrees Fahrenheit and, again, uses about 15 amps of power which requires a heavy-duty extension cord. There are some heat guns that operate at higher temperatures but they should not be purchased for removing old paint because of the danger of lead paint vapors. The temperature is controlled by a vent on the side of the heat gun. When the vent is closed, the heat increases. A fan forces a stream of hot air against the painted woodwork, causing a blister to form. At that point, the softened paint can be peeled back with a putty knife. It can be used to best advantage when a paneled door was originally varnished, then painted a number of times. In this case, the paint will come off quite easily, often leaving an almost pristine varnished surface behind. Like the heat plate, the heat gun works best on a heavy paint build-up. (It is, however, not very successful on only one or two layers of paint or on surfaces that have only been varnished. The varnish simply becomes sticky and the wood scorches.)

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

Fig. 14 *The nozzle on the electric heat gun permits hot air to be aimed into cavities on solid decorative elements such as this applied column. After the paint has been sufficiently softened, it can be removed with a profiled scraper. Photo: Charles E. Fisher, III.*

Not Recommended

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

Summary of Thermal Methods

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

• Chemical Methods

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

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

Recommended Chemical Methods
(Use With Extreme Caution)

Because all chemical paint removers can involve potential health and safety hazards, no wholehearted recommendations can be made from that standpoint. Commonly known as "paint removers" or "strippers," both solvent-base or caustic products are commercially available that, when poured, brushed, or sprayed on painted exterior woodwork are capable of softening several layers of paint at a time so that the resulting "sludge"—which should be remembered is nothing less than the sequence of historic paint layers—can be removed with a putty knife. Detachable wood elements such as exterior shutters can also be "dip-stripped."

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

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

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

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

Caustic Strippers: Until the advent of solvent-base strippers, caustic strippers were used exclusively when a chemical method was deemed appropriate for total paint removal prior to repainting or refinishing. Now, it is more difficult to find commercially prepared caustic solutions in hardware and paint stores for home-owner use with the exception of lye (caustic soda) because solvent-base strippers packaged in small quantities tend to dominate the market.

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

If exterior shutters or other detachable elements are being sent out[6] for stripping in a caustic solution, it is wise to see samples of the company's finished work. While some companies do a first-rate job, others can leave a residue of paint in carvings and grooves. Wooden elements may also be soaked too long so that the wood grain is raised and roughened, requiring extensive hand sanding later. In addition, assurances should be given by these companies that caustic paint removers will be neutralized with a mild acid solution or at least thoroughly rinsed with water after dipping (a caustic residue makes the wood feel slippery). If this is not done, the lye residue will cause new paint to fail.

Summary of Chemical Methods

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

General Paint Type Recommendations

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

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

[6] Marking the original location of the shutter by number (either by stamping numbers into the end grain with metal numeral dies or cutting numbers into the end with a pen knife) will minimize difficulties when rehanging them.

* If the top coat is latex paint (when viewed by the naked eye or, preferably, with a magnifying glass, it looks like a series of tiny craters) it may either be repainted with new latex paint or with oil paint. Normal surface preparation should precede any repainting.

If **CLASS III** conditions have necessitated total paint removal, there are two options, both of which assure protection of the exterior wood: (1) an oil primer may be applied followed by an oil-type top coat, preferably by the same manufacturer; or (2) an oil primer may be applied followed by a latex top coat, again using the same brand of paint. It should also be noted that primers were never intended to withstand the effects of weathering; therefore, the top coat should be applied as soon as possible after the primer has dried.

Conclusion

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

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This publication has been prepared pursuant to The Economic Recovery Tax Act of 1981, which directs the Secretary of the Interior to certify rehabilitations of historic buildings that are consistent with their historic character; the advice and guidance in this brief will assist property owners in complying with the requirements of this law.

Preservation Briefs 10 has been developed under the technical editorship of Lee H. Nelson, AIA, Chief, Preservation Assistance Division, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. Comments on the usefulness of this information are welcomed and can be sent to Mr. Nelson at the above address.

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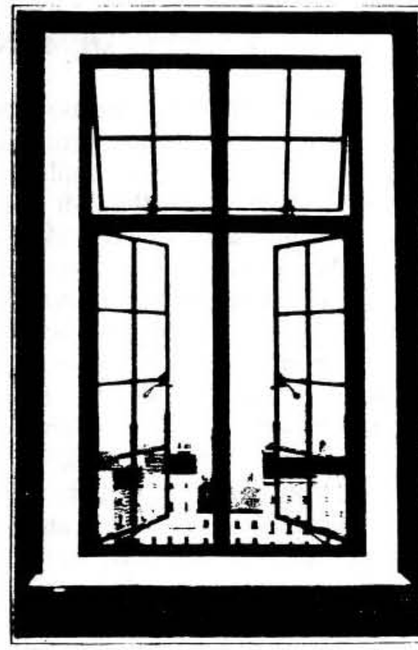


The Repair and Thermal Upgrading of Historic Steel Windows

Sharon C. Park, AIA

Technical Preservation Services Preservation Assistance Division
National Park Service U.S. Department of the Interior

The Secretary of the Interior's "Standards for Rehabilitation" require that where historic windows are individually significant features, or where they contribute to the character of significant facades, their distinguishing visual qualities must not be destroyed. Further, the rehabilitation guidelines recommend against changing the historic appearance of windows through the use of inappropriate designs, materials, finishes, or colors which radically change the sash, depth of reveal, and muntin configuration; the reflectivity and color of the glazing; or the appearance of the frame.

Windows are among the most vulnerable features of historic buildings undergoing rehabilitation. This is especially the case with rolled steel windows, which are often mistakenly not deemed worthy of preservation in the conversion of old buildings to new uses. The ease with which they can be replaced and the mistaken assumption that they cannot be made energy efficient except at great expense are factors that typically lead to the decision to remove them. In many cases, however, repair and retrofit of the historic windows are more economical than wholesale replacement, and all too often, replacement units are unlike the originals in design and appearance. If the windows are important in establishing the historic character of the building (see fig. 1), insensitively designed replacement windows may diminish—or destroy—the building's historic character.

This *Brief* identifies various types of historic steel windows that dominated the metal window market from 1890-1950. It then gives criteria for evaluating deterioration and for determining appropriate treatment, ranging from routine maintenance and weatherization to extensive repairs, so that replacement may be avoided where possible.[1] This information applies to do-it-yourself jobs and to large rehabilitations where the volume of work warrants the removal of all window units for complete overhaul by professional contractors.

This *Brief* is not intended to promote the repair of ferrous metal windows in every case, but rather to insure that preservation is always the first consideration in a rehabilitation project. Some windows are not important elements in defining a building's historic character; others are highly significant, but so deteriorated that repair is infeasible. In such cases, the *Brief* offers guidance in evaluating appropriate replacement windows.

Fig. 1 Often highly distinctive in design and craftsmanship, rolled steel windows play an important role in defining the architectural character of many later nineteenth and early twentieth century buildings. Art Deco, Art Moderne, the International Style, and Post World War II Modernism depended on the slim profiles and streamlined appearance of metal windows for much of their impact. Photo: William G. Johnson.

[1] The technical information given in this brief is intended for most ferrous (or magnetic) metals, particularly rolled steel. While stainless steel is a ferrous metal, the cleaning and repair techniques outlined here must not be used on it as the finish will be damaged. For information on cleaning stainless steel and non-ferrous metals, such as bronze, Monel, or aluminum, refer to *Metals in America's Historic Buildings* (see bibliography).

HISTORICAL DEVELOPMENT

Although metal windows were available as early as 1860 from catalogues published by architectural supply firms, they did not become popular until after 1890. Two factors combined to account for the shift from wooden to metal windows about that time. Technology borrowed from the rolling industry permitted the mass production of rolled steel windows. This technology made metal windows cost competitive with conventional wooden windows. In addition, a series of devastating urban fires in Boston, Baltimore, Philadelphia, and San Francisco led to the enactment of strict fire codes for industrial and multistory commercial and office buildings.

As in the process of making rails for railroads, rolled steel windows were made by passing hot bars of steel through progressively smaller, shaped rollers until the appropriate angled configuration was achieved (see fig. 2). The rolled steel sections, generally 1/8" thick and 1" - 1 1/2" wide, were used for all the components of the windows: sash, frame,and subframe (see fig. 3). With the addition of wire glass, a fire-resistant window resulted. These rolled steel windows are almost exclusively found in masonry or concrete buildings.

A byproduct of the fire-resistant window was the strong metal frame that permitted the installation of larger windows and windows in series. The ability to have expansive amounts of glass and increased ventilation dramatically changed the designs of late 19th and early 20th century industrial and commercial buildings.

The newly available, reasonably priced steel windows soon became popular for more than just their fire-resistant qualities. They were standardized, extremely durable, and easily transported. These qualities led to the use of steel windows in every type of construction, from simple industrial and institutional buildings to luxury commercial and apartment buildings. Casement, double-hung, pivot, projecting, austral, and continuous windows differed in operating and ventilating capacities. Figure 4 outlines the kinds and properties of metal windows available then and now. In addition, the thin profiles of metal windows contributed to the streamlined appearance of the Art Deco, Art Moderne, and International Styles, among others.

The extensive use of rolled steel metal windows continued until after World War II when cheaper, non-corroding aluminum windows became increasingly popular. While aluminum windows dominate the market today, steel windows are still fabricated. Should replacement of original windows become necessary, replacement windows may be available from the manufacturers of some of the earliest steel windows. Before an informed decision can be made whether to repair or replace metal windows, however, the significance of the windows must be determined and their physical condition assessed.

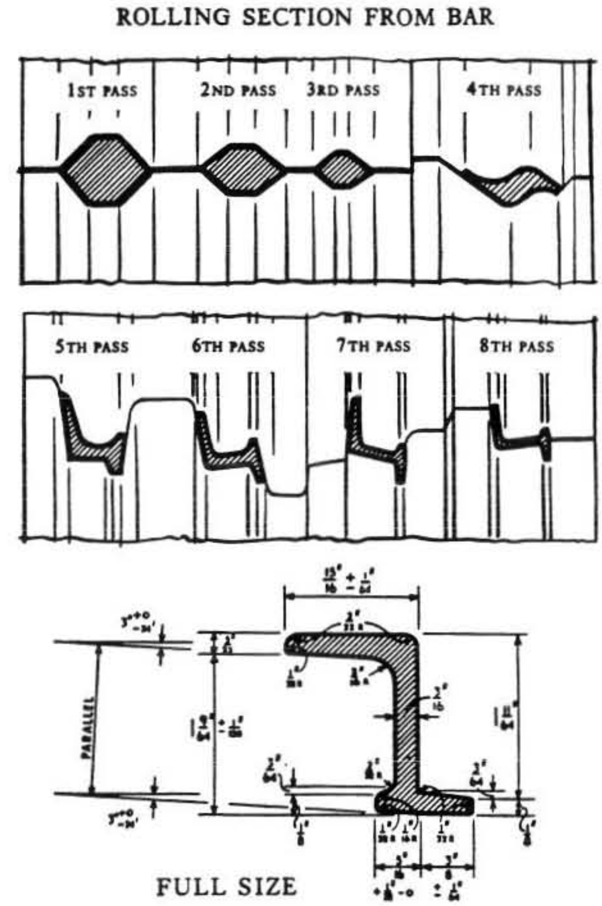


Fig. 2. The process of rolling a steel bar into an angled section is illustrated above. The shape and size of the rolled section will vary slightly depending on the overall strength needed for the window opening and the location of the section in the assembly: subframe, frame, or sash. The 1/8 " thickness of the metal section is generally standard. Drawing: A Metal Window Dictionary. Used with permission.

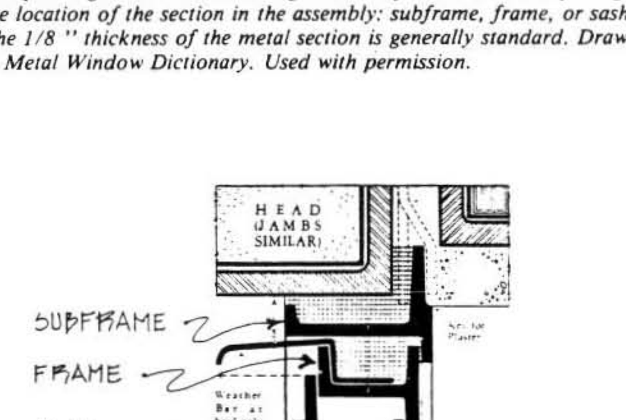


Fig. 3 A typical section through the top and bottom of a metal window shows the three component parts of the window assembly: subframe, frame, and sash. Drawings: Catalogue No. 15, January 1931; International Casement Co, Inc., presently Hope's Architectural Products, Inc., Jamestown, NY. Used with permission.

Cover illustration: from *Hope's Metal Windows and Casements: 1818-1926*, currently Hope's Architectural Products, Inc. Used with permission.

EVALUATION

Historic and Architectural Considerations

An assessment of the significance of the windows should begin with a consideration of their function in relation to the building's historic use and its historic character. Windows that help define the building's historic character should be preserved even if the building is being converted to a new use. For example, projecting steel windows used to introduce light and an effect of spaciousness to a warehouse or industrial plant can be retained in the conversion of such a building to offices or residences.

Other elements in assessing the relative importance of the historic windows include the design of the windows and their relationship to the scale, proportion, detailing and architectural style of the building. While it may be easy to determine the aesthetic value of highly ornamented windows, or to recognize the importance of streamlined windows as an element of a style, less elaborate windows can also provide strong visual interest by their small panes or projecting planes when open, particularly in simple, unadorned industrial buildings (see fig. 5).

One test of the importance of windows to a building is to ask if the overall appearance of the building would be changed noticeably if the windows were to be removed or radically altered. If so, the windows are important in defining the building's historic character, and should be repaired if their physical condition permits.

Physical Evaluation

Steel window repair should begin with a careful evaluation of the physical condition of each unit. Either drawings or photographs, liberally annotated, may be used to record the location of each window, the type of operability, the condition of all three parts—sash, frame and subframe—and the repairs essential to its continued use.

Specifically, the evaluation should include: presence and degree of corrosion; condition of paint; deterioration of the metal sections, including bowing, misalignment of the sash, or bent sections; condition of the glass and glazing compound; presence and condition of all hardware, screws, bolts, and hinges; and condition of the masonry or concrete surrounds, including need for caulking or resetting of improperly sloped sills.

Corrosion, principally rusting in the case of steel windows, is the controlling factor in window repair; therefore, the evaluator should first test for its presence. Corrosion can be light, medium, or heavy, depending on how much the rust has penetrated the metal sections. If the rusting is merely a surface accumulation or flaking, then the corrosion is light. If the rusting has penetrated the metal (indicated by a bubbling texture), but has not caused any structural damage, then the corrosion is medium. If the rust has penetrated deep into the metal, the corrosion is heavy. Heavy corrosion generally results in some form of structural damage,through delamination, to the metal section, which must then be patched or spliced. A sharp probe or tool, such as an ice pick, can be used to determine the extent of corrosion in the metal. If the probe can penetrate the surface of the metal and brittle strands can be dug out, then a high degree of corrosive deterioration is present.

In addition to corrosion, the condition of the paint, the presence of bowing or misalignment of metal sections, the amount of glass needing replacement, and the condition of the masonry or concrete surrounds must be assessed in the evaluation process. These are key factors in determining whether or not the windows can be repaired in place. The more complete the inventory of existing conditions, the easier it will be to determine whether repair is feasible or whether replacement is warranted.

Rehabilitation Work Plan

Following inspection and analysis, a plan for the rehabilitation can be formulated. The actions necessary to return windows to an efficient and effective working condition will fall into one or more of the following categories: routine maintenance, repair, and weatherization. The routine maintenance and weatherization measures described here are generally within the range of do-it-yourselfers. Other repairs, both moderate and major, require a professional contractor. Major repairs normally require the removal of the window units to a workshop, but even in the case of moderate repairs, the number of windows involved might warrant the removal of all the deteriorated units to a workshop in order to realize a more economical repair price. Replacement of windows should be considered only as a last resort.

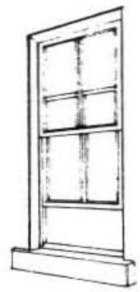
Since moisture is the primary cause of corrosion in steel windows, it is essential that excess moisture be eliminated and that the building be made as weathertight as possible before any other work is undertaken. Moisture can accumulate from cracks in the masonry, from spalling mortar, from leaking gutters, from air conditioning condensation runoff, and from poorly ventilated interior spaces.

Finally, before beginning any work, it is important to be aware of health and safety risks involved. Steel windows have historically been coated with lead paint. The removal of such paint by abrasive methods will produce toxic dust. Therefore, safety goggles, a toxic dust respirator, and protective clothing should be worn. Similar protective measures should be taken when acid compounds are used. Local codes may govern the methods of removing lead paints and proper disposal of toxic residue.

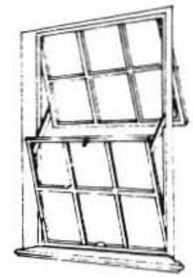
ROUTINE MAINTENANCE

A preliminary step in the routine maintenance of steel windows is to remove surface dirt and grease in order to ascertain the degree of deterioration, if any. Such minor cleaning can be accomplished using a brush or vacuum followed by wiping with a cloth dampened with mineral spirits or denatured alcohol.

Double-hung industrial windows duplicated the look of traditional wooden windows. Metal double-hung windows were early examples of a building product adapted to meet stringent new fire code requirements for manufacturing and high-rise buildings in urban areas. Soon supplanted in industrial buildings by less expensive pivot windows, double-hung metal windows regained popularity in the 1940s for use in speculative suburban housing.

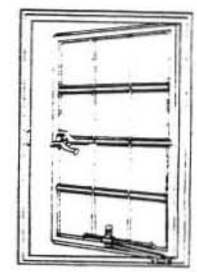


Austral windows were also a product of the 1920s. They combined the appearance of the double-hung window with the increased ventilation and ease of operation of the projected window. (When fully opened, they provided 70% ventilation as compared to 50% ventilation for double-hung windows.) Austral windows were often used in schools, libraries and other public buildings.



Pivot windows were an early type of industrial window that combined inexpensive first cost and low maintenance. Pivot windows became standard for warehouses and power plants where the lack of screens was not a problem. The window shown here is a horizontal pivot. Windows that turned about a vertical axis were also manufactured (often of iron). Such vertical pivots are rare today.

Casement windows adapted the English tradition of using wrought iron casements with leaded cames for residential use. Rolled steel casements (either single, as shown, or paired) were popular in the 1920s for cottage style residences and Gothic style campus architecture. More streamlined casements were popular in the 1930s for institutional and small industrial buildings.



Projecting windows, sometimes called awning or hopper windows, were perfected in the 1920s for industrial and institutional buildings. They were often used in "combination" windows, in which upper panels opened out and lower panels opened in. Since each movable panel projected to one side of the frame only, unlike pivot windows, for example, screens could be introduced.

Continuous windows were almost exclusively used for industrial buildings requiring high overhead lighting. Long runs of clerestory windows operated by mechanical tension rod gears were typical. Long banks of continuous windows were possible because the frames for such windows were often structural elements of the building.

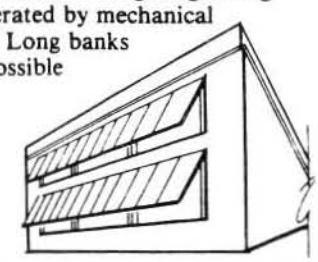


Fig. 4 Typical rolled steel windows available from 1890 to the present. The various operating and ventilating capacities in combination with the aesthetics of the window style were important considerations in the selection of one window type over another. Drawings: Sharon C. Park, AIA.

If it is determined that the windows are in basically sound condition, the following steps can be taken: 1) removal of light rust, flaking and excessive paint; 2) priming of exposed metal with a rust-inhibiting primer; 3) replacement of cracked or broken glass and glazing compound; 4) replacement of missing screws or fasteners; 5) cleaning and lubrication of hinges; 6) repainting of all steel sections with two coats of finish paint compatible with the primer; and 7) caulking the masonry surrounds with a high quality elastomeric caulk.

Recommended methods for removing light rust include manual and mechanical abrasion or the application of chemicals. Burning off rust with an oxy-acetylene or propane torch, or an inert gas welding gun, should never be attempted because the heat can distort the metal. In addition, such intense heat (often as high as 3800° F) vaporizes the lead in old paint, resulting in highly toxic fumes. Furthermore, such heat will likely result in broken glass. Rust can best be removed using a wire brush, an aluminum oxide sandpaper, or a variety of power tools

Fig. 5 Windows often provide a strong visual element to relatively simple or unadorned industrial or commercial buildings. This design element should be taken into consideration when evaluating the significance of the windows. Photo: Michael Auer.

adapted for abrasive cleaning such as an electric drill with a wire brush or a rotary whip attachment. Adjacent sills and window jambs may need protective shielding.

Rust can also be removed from ferrous metals by using a number of commercially prepared anti-corrosive acid compounds. Effective on light and medium corrosion, these compounds can be purchased either as liquids or gels. Several bases are available, including phosphoric acid, ammonium citrate, oxalic acid and hydrochloric acid. Hydrochloric acid is generally not recommended; it can leave chloride deposits, which cause future corrosion. Phosphoric acid-based compounds do not leave such deposits, and are therefore safer for steel windows. However, any chemical residue should be wiped off with damp cloths, then dried immediately. Industrial blow-dryers work well for thorough drying. The use of running water to remove chemical residue is never recommended because the water may spread the chemicals to adjacent surfaces, and drying of these surfaces may be more difficult. Acid cleaning compounds will stain masonry; therefore plastic sheets should be taped to the edge of the metal sections to protect the masonry surrounds. The same measure should be followed to protect the glazing from etching because of acid contact.

Measures that remove rust will ordinarily remove flaking paint as well. Remaining loose or flaking paint can be removed with a chemical paint remover or with a pneumatic needle scaler or gun, which comes with a series of chisel blades and has proven effective in removing flaking paint from metal windows. Well-bonded paint may serve to protect the metal further from corrosion, and need not be removed unless paint build-up prevents the window from closing tightly. The edges should be feathered by sanding to give a good surface for repainting.

Next, any *bare* metal should be wiped with a cleaning solvent such as denatured alcohol, and dried immediately in preparation for the application of an anti-corrosive primer. Since corrosion can recur very soon after metal has been exposed to the air, the metal should be primed immediately after cleaning. Spot priming may be required periodically as other repairs are undertaken. Anti-corrosive primers generally consist of oil-alkyd based paints rich in zinc or zinc chromate.[2] Red lead is no longer available because of its toxicity. All metal primers, however, are toxic to some degree and should be handled carefully. Two coats of primer are recommended. Manufacturer's recommendations should be followed concerning application of primers.

REPAIR

Repair in Place

The maintenance procedures described above will be insufficient when corrosion is extensive, or when metal window sections are misaligned. Medium to heavy corrosion that has not done any structural damage to the metal sections can be removed either by using the chemical cleaning process described under "Routine Maintenance" or by sandblasting. Since sandblasting can damage the masonry surrounds and crack or cloud the glass, metal or plywood shields should be used to protect these materials. The sandblasting pressure should be low, 80-100 pounds per square inch, and the grit size should be in the range of #10-#45. Glass peening beads (glass pellets) have also been successfully used in cleaning steel sections. While sandblasting equipment comes with various nozzle sizes, pencil-point blasters are most useful because they give the operator more effective control over the direction of the spray. The small aperture of the pencil-point blaster is also useful in removing dried putty from the metal sections that hold the glass. As with any cleaning technique, once the bare metal is exposed to air, it should be primed as soon as possible. This includes the inside rabbeted section of sash where glazing putty has been removed. To reduce the dust, some local codes allow only wet blasting. In this case, the metal must be dried immediately, generally with a blow-drier (a step that the owner should consider when calculating the time and expense involved). Either form of sandblasting metal covered with lead paints produces toxic dust. Proper precautionary measures should be taken against toxic dust and silica particles.

Bent or bowed metal sections may be the result of damage to the window through an impact or corrosive expansion. If the distortion is not too great, it is possible to realign the metal sections without removing the window to a metal fabricator's shop. The glazing is generally removed and pressure is applied to the bent or bowed section. In the case of a muntin, a protective 2 x 4 wooden bracing can be placed behind the bent portion and a wire cable with a winch can apply progressively more pressure over several days until the section is realigned. The 2 x 4 bracing is necessary to distribute the pressure evenly over the damaged section. Sometimes a section, such as the bottom of the frame, will bow out as a result of pressure exerted by corrosion and it is often necessary to cut the metal section to relieve this pressure prior to pressing the section back into shape and making a welded repair.

Once the metal sections have been cleaned of all corrosion and straightened, small holes and uneven areas resulting from rusting should be filled with a patching material and sanded smooth to eliminate pockets where water can accumulate. A patching material of steel fibers and an epoxy binder may be the easiest to apply. This steel-based epoxy is available for industrial steel repair; it can also be found in auto body patching compounds or in plumber's epoxy. As with any product, it is important to follow the manufacturer's instructions for proper use and best results. The traditional patching technique—melting steel welding rods to fill holes in the metal sections—may be difficult to apply in some situations; moreover, the window glass must be removed during the repair process, or it will crack from the expansion of the heated metal sections. After these repairs, glass replacement, hinge lubrication, painting, and other cosmetic repairs can be undertaken as necessary.

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[2] Refer to Table IV. Types of Paint Used for Painting Metal in *Metals in America's Historic Buildings*, p. 139. (See bibliography).

To complete the checklist for routine maintenance, cracked glass, deteriorated glazing compound, missing screws, and broken fasteners will have to be replaced; hinges cleaned and lubricated; the metal windows painted, and the masonry surrounds caulked. If the glazing must be replaced, all clips, glazing beads, and other fasteners that hold the glass to the sash should be retained, if possible, although replacements for these parts are still being fabricated. When bedding glass, use only glazing compound formulated for metal windows. To clean the hinges (generally brass or bronze), a cleaning solvent and fine bronze wool should be used. The hinges should then be lubricated with a non-greasy lubricant specially formulated for metals and with an anti-corrosive agent. These lubricants are available in a spray form and should be used periodically on frequently opened windows.

Final painting of the windows with a paint compatible with the anti-corrosive primer should proceed on a dry day. (Paint and primer from the same manufacturer should be used.) Two coats of finish paint are recommended if the sections have been cleaned to bare metal. The paint should overlap the glass slightly to insure weathertightness at that connection. Once the paint dries thoroughly, a flexible exterior caulk can be applied to eliminate air and moisture infiltration where the window and the surrounding masonry meet.

Caulking is generally undertaken after the windows have received at least one coat of finish paint. The perimeter of the masonry surround should be caulked with a flexible elastomeric compound that will adhere well to both metal and masonry. The caulking used should be a type intended for exterior application, have a high tolerance for material movement, be resistant to ultraviolet light, and have a minimum durability of 10 years. Three effective compounds (taking price and other factors into consideration) are polyurethane, vinyl acrylic, and butyl rubber. In selecting a caulking material for a window retrofit, it is important to remember that the caulking compound may be covering other materials in a substrate. In this case, some compounds, such as silicone, may not adhere well. Almost all modern caulking compounds can be painted after curing completely. Many come in a range of colors, which eliminates the need to paint. If colored caulking is used, the windows should have been given two coats of finish paint prior to caulking.

Repair in Workshop

Damage to windows may be so severe that the window sash and sometimes the frame must be removed for cleaning and extensive rust removal, straightening of bent sections, welding or splicing in of new sections, and reglazing. These major and expensive repairs are reserved for highly significant windows that cannot be replaced; the procedures involved should be carried out only by skilled workmen. (see fig. 6a—6f.)

As part of the orderly removal of windows, each window should be numbered and the parts labelled. The operable metal sash should be dismantled by removing the hinges; the fixed sash and, if necessary, the frame can then be unbolted or unscrewed. (The subframe is usually left in place. Built into the masonry surrounds, it can only be cut out with a torch.) Hardware and hinges should be labelled and stored together.

The two major choices for removing flaking paint and corrosion from severely deteriorated windows are dipping in a chemical bath or sandblasting. Both treatments require removal of the glass. If the windows are to be dipped, a phosphoric acid solution is preferred, as mentioned earlier. While the dip tank method is good for fairly evenly distributed rust, deep set rust may remain after dipping. For that reason, sandblasting is more effective for heavy and uneven corrosion. Both methods leave the metal sections clean of residual paint. As already noted, after cleaning has exposed the metal to the air, it should be primed immediately after drying with an anti-corrosive primer to prevent rust from recurring.

Sections that are seriously bent or bowed must be straightened with heat and applied pressure in a workshop. Structurally weakened sections must be cut out, generally with an oxy-acetylene torch, and replaced with sections welded in place and the welds ground smooth. Finding replacement metal sections, however, may be difficult. While most rolling mills are producing modern sections suitable for total replacement, it may be difficult to find an exact profile match for a splicing repair. The best source of rolled metal sections is from salvaged windows, preferably from the same building. If no salvaged windows are available, two options remain. Either an ornamental metal fabricator can weld flat plates into a built-up section, or a steel plant can mill bar steel into the desired profile.

While the sash and frame are removed for repair, the subframe and masonry surrounds should be inspected. This is also the time to reset sills or to remove corrosion from the subframe, taking care to protect the masonry surrounds from damage.

Missing or broken hardware and hinges should be replaced on all windows that will be operable. Salvaged windows, again, are the best source of replacement parts. If matching parts cannot be found, it may be possible to adapt ready-made items. Such a substitution may require filling existing holes with steel epoxy or with plug welds and tapping in new screw holes. However, if the hardware is a highly significant element of the historic window, it may be worth having reproductions made.

Following are illustrations of the repair and thermal upgrading of the rolled steel windows in a National Historic Landmark (fig. 6). Many of the techniques described above were used during this extensive rehabilitation. The complete range of repair techniques is then summarized in the chart titled *Steps for Cleaning and Repairing Historic Steel Windows* (see fig. 7).

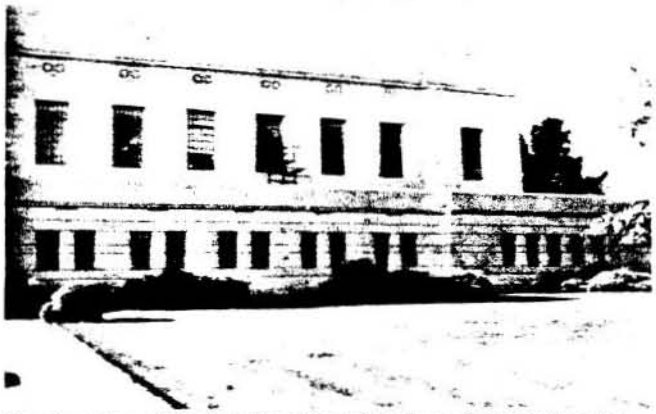


Fig. 6 a. View of the flanking wing of the State Capitol where the rolled steel casement windows are being removed for repair.

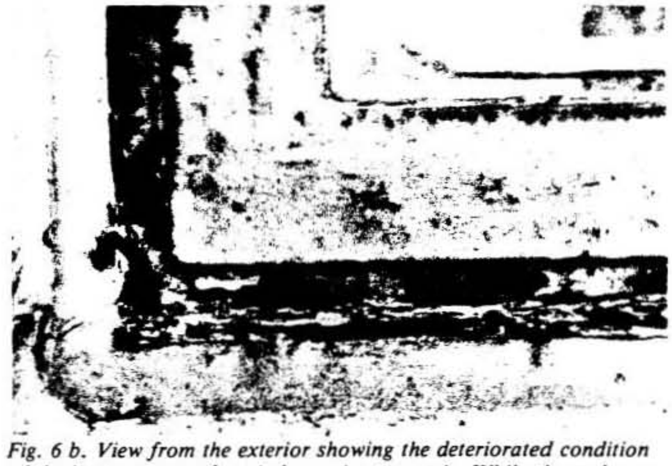


Fig. 6 b. View from the exterior showing the deteriorated condition of the lower corner of a window prior to repair. While the sash was in relatively good condition, the frame behind was rusted to the point of inhibiting operation.

Fig. 6 c. View of the rusted frame which was unscrewed from the subframe and removed from the window opening and taken to a workshop for sandblasting. In some cases, severely deteriorated sections of the frame were replaced with new sections of milled bar steel.

Fig. 6 d. View looking down towards the sill. The subframes appeared very rusted, but were in good condition once debris was vacuumed and surface rust was removed, in place, with chemical compounds. Where necessary, epoxy and steel filler was used to patch depressions in order to make the subframe serviceable again.

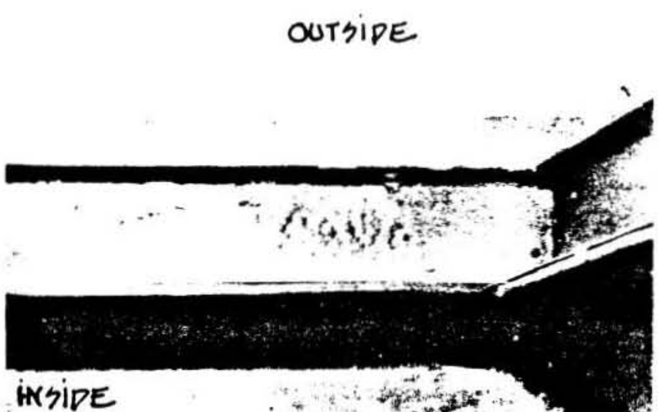


Fig. 6 e. View looking down towards the sill. The cleaned frame was reset in the window opening. The frame was screwed to the refurbished subframe at the jamb and the head only. The screw holes at the sill, which had been the cause of much of the earlier rusting, were infilled. Vinyl weatherstripping was added to the frame.

Fig. 6 f. View from the outside of the completely refurbished window. In addition to the steel repair and the installation of vinyl weatherstripping, the exterior was caulked with polyurethane and the single glass was replaced with individual lights of thermal glass. The repaired and upgraded windows have comparable energy efficiency ratings to new replacement units while retaining the historic steel sash, frames and subframes.

Fig. 6. The repair and thermal upgrading of the historic steel windows at the State Capitol, Lincoln, Nebraska. This early twentieth century building, designed by Bertram Goodhue, is a National Historic Landmark. Photos: All photos in this series were provided by the State Building Division.

STEPS FOR CLEANING AND REPAIRING HISTORIC STEEL WINDOWS

Work Item	Recommended Techniques	Tools, Products and Procedures	Notes
	*(Must be done in a workshop)		
1. Removing dirt and grease from metal	General maintenance and chemical cleaning	Vacuum and bristle brushes to remove dust and dirt; solvents (denatured alcohol, mineral spirits), and clean cloths to remove grease.	Solvents can cause eye and skin irritation. Operator should wear protective gear and work in ventilated area. Solvents should not contact masonry. Do not flush with water.
2. Removing Rust/ Corrosion			
Light	Manual and mechanical abrasion	Wire brushes, steel wool, rotary attachments to electric drill, sanding blocks and disks.	Handsanding will probably be necessary for corners. Safety goggles and masks should be worn.
	Chemical cleaning	Anti-corrosive jellies and liquids (phosphoric acid preferred); clean damp cloths.	Protect glass and metal with plastic sheets attached with tape. Do not flush with water. Work in ventilated area.
Medium	Sandblasting/abrasive cleaning	Low pressure (80-100 psi) and small grit (#10-#45); glass peening beads. Pencil blaster gives good control.	Removes both paint and rust. Codes should be checked for environmental compliance. Prime exposed metal promptly. Shield glass and masonry. Operator should wear safety gear.
Heavy	*Chemical dip tank	Metal sections dipped into chemical tank (phosphoric acid preferred) from several hours to 24 hours.	Glass and hardware should be removed. Protect operator. Deepset rust may remain, but paint will be removed.
	*Sandblasting/ abrasive cleaning	Low pressure (80-100 psi) and small grit (#10-#45).	Excellent for heavy rust. Remove or protect glass. Prime exposed metal promptly. Check codes for environmental compliance. Operator should wear safety gear.
3. Removing flaking paint.	Chemical method	Chemical paint strippers suitable for ferrous metals. Clean cloths.	Protect glass and masonry. Do not flush with water. Have good ventilation and protection for operator.
	Mechanical abrasion	Pneumatic needle gun chisels, sanding disks.	Protect operator; have good ventilation. Well-bonded paint need not be removed if window closes properly.
4. Aligning bent, bowed metal sections	Applied pressure	Wooden frame as a brace for cables and winch mechanism.	Remove glass in affected area. Realignment may take several days.
	*Heat and pressure	Remove to a workshop. Apply heat and pressure to bend back.	Care should be taken that heat does not deform slender sections.

Work Item	Recommended Techniques	Tools, Products and Procedures	Notes
	*(Must be done in a workshop)		
5. Patching depressions	Epoxy and steel filler	Epoxy fillers with high content of steel fibers; plumber's epoxy or autobody patching compound.	Epoxy patches generally are easy to apply, and can be sanded smooth. Patches should be primed.
	Welded patches	Weld in patches using steel rods and oxy-acetylene torch or arc welder.	Prime welded sections after grinding connections smooth.
6. Splicing in new metal sections	*Cut out decayed sections and weld in new or salvaged sections	Torch to cut out bad sections back to 45° joint. Weld in new pieces and grind smooth.	Prime welded sections after grinding connection smooth.
7. Priming metal sections	Brush or spray application	At least one coat of anti-corrosive primer on bare metal. Zinc-rich primers are generally recommended.	Metal should be primed as soon as it is exposed. If cleaned metal will be repaired another day, spot prime to protect exposed metal.
8. Replacing missing screws and bolts	Routine maintenance	Pliers to pull out or shear off rusted heads. Replace screws and bolts with similar ones, readily available.	If new holes have to be tapped into the metal sections, the rusted holes should be cleaned, filled and primed prior to redrilling.
9. Cleaning, lubricating or replacing hinges and other hardware	Routine maintenance, solvent cleaning	Most hinges and closure hardware are bronze. Use solvents (mineral spirits), bronze wool and clean cloths. Spray with non-greasy lubricant containing anti-corrosive agent.	Replacement hinges and fasteners may not match the original exactly. If new holes are necessary, old ones should be filled.
10. Replacing glass and glazing compound	Standard method for application	Pliers and chisels to remove old glass, scrape putty out of glazing rabbet, save all clips and beads for reuse. Use only glazing compound formulated for metal windows.	Heavy gloves and other protective gear needed for the operator. All parts saved should be cleaned prior to reinstallation.
11. Caulking masonry surrounds	Standard method for application	Good quality (10 year or better) elastomeric caulking compound suitable for metal.	The gap between the metal frame and the masonry opening should be caulked; keep weepholes in metal for condensation run-off clear of caulk.
12. Repainting metal windows	Spray or brush	At least 2 coats of paint compatible with the anti-corrosive primer. Paint should lap the glass about 1/8" to form a seal over the glazing compound.	The final coats of paint and the primer should be from the same manufacturer to ensure compatibility. If spraying is used, the glass and masonry should be protected.

Fig. 7. STEPS FOR CLEANING AND REPAIRING HISTORIC STEEL WINDOWS. Compiled by Sharon C. Park, AIA.

WEATHERIZATION

Historic metal windows are generally not energy efficient; this has often led to their wholesale replacement. Metal windows can, however, be made more energy efficient in several ways, varying in complexity and cost. Caulking around the masonry openings and adding weatherstripping, for example, can be do-it-yourself projects and are important first steps in reducing air infiltration around the windows. They usually have a rapid payback period. Other treatments include applying fixed layers of glazing over the historic windows, adding operable storm windows, or installing thermal glass in place of the existing glass. In combination with caulking and weatherstripping, these treatments can produce energy ratings rivaling those achieved by new units.[3]

Weatherstripping

The first step in any weatherization program, caulking, has been discussed above under "Routine Maintenance." The second step is the installation of weatherstripping where the operable portion of the sash, often called the ventilator, and the fixed frame come together to reduce perimeter air infiltration (see fig. 8). Four types of weatherstripping appropriate for metal windows are spring-metal, vinyl strips, compressible foam tapes, and sealant beads. The spring-metal, with an integral friction fit mounting clip, is recommended for steel windows in good condition. The clip eliminates the need for an applied glue; the thinness of the material insures a tight closure. The weatherstripping is clipped to the inside channel of the rolled metal section of the fixed frame. To insure against galvanic corrosion between the weatherstripping (often bronze or brass), and the steel window, the window must be painted prior to the installation of the weatherstripping. This weatherstripping is usually applied to the entire perimeter of the window opening, but in some cases, such as casement windows, it may be best to avoid weatherstripping the hinge side. The natural wedging action of the weatherstripping on the three sides of the window often creates an adequate seal.

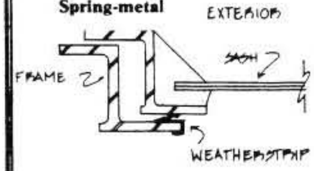
Vinyl weatherstripping can also be applied to metal windows. Folded into a "V" configuration, the material forms a barrier against the wind. Vinyl weatherstripping is usually glued to the frame, although some brands have an adhesive backing. As the vinyl material and the applied glue are relatively thick, this form of weatherstripping may not be appropriate for all situations.

Compressible foam tape weatherstripping is often best for large windows where there is a slight bending or distortion of the sash. In some very tall windows having closure hardware at the sash mid-point, the thin sections of the metal window will bow away from the frame near the top. If the gap is not more than 1/4", foam weatherstripping can normally fill the space. If the gap exceeds this, the window may need to be realigned to close more tightly. The foam weatherstripping comes either with an adhesive or plain back; the latter variety requires application with glue. Compressible foam requires more frequent replacement than either spring-metal or vinyl weatherstripping.

A fourth type of successful weatherstripping involves the use of a caulking or sealant bead and a polyethylene bond breaker tape. After the window frame has been thoroughly cleaned with solvent, permitted to dry, and primed, a neat bead of low modulus (firm setting) caulk, such as silicone, is applied. A bond breaker tape is then applied to the operable sash covering the metal section where contact will occur. The window is then closed until the sealant has set (2-7 days, depending on temperature and humidity). When the window is opened, the bead will have taken the shape of the air infiltration gap and the bond breaker tape can be removed. This weatherstripping method appears to be successful for all types of metal windows with varying degrees of air infiltration.

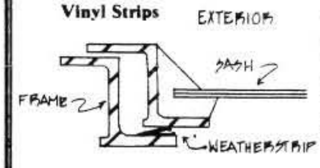
Since the several types of weatherstripping are appropriate for different circumstances, it may be necessary to use more than one type on any given building. Successful weatherstripping depends upon using the thinnest material adequate to fill the space through which air enters. Weatherstripping that is too thick can spring the hinges, thereby resulting in more gaps.

Spring-metal



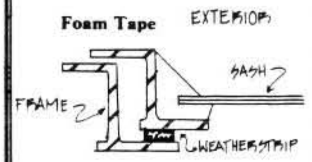
Spring-metal comes in bronze, brass or stainless steel with an integral friction-fit clip. The weatherstripping is applied after the repaired windows are painted to avoid galvanic corrosion. This type of thin weatherstripping is intended for windows in good condition.

Vinyl Strips



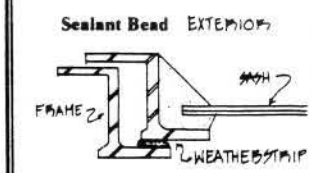
Vinyl strips are scored and fold into a "V" configuration. Applied adhesive is necessary which will increase the thickness of the weatherstripping, making it inappropriate for some situations. The weatherstripping is generally applied to the window after painting.

Foam Tape



Closed cell foam tape comes either with or without an adhesive backing. It is effective for windows with a gap of approximately ¼" and is easy to install. However, this type of weatherstripping will need frequent replacement on windows in regular use. The metal section should be cleaned of all dirt and grease prior to its application.

Sealant Bead



This very effective type of weatherstripping involves the application of a clean bead of firm setting caulk on the primed frame with a polyethelene bond breaker tape on the operable sash. The window is then closed until the bead has set and takes the form of the gap. The sash is then opened and the tape is removed leaving the set caulk as the weatherstripping.

Fig. 8 APPROPRIATE TYPES OF WEATHERSTRIPPING FOR METAL WINDOWS. Weatherstripping is an important part of upgrading the thermal efficiency of historic steel windows. The chart above shows the jamb section of the window with the weatherstripping in place. Drawings: Sharon C. Park, AIA.

[3]One measure of energy efficiency is the U-value (the number of BTUs per hour transferred through a square foot of material). The lower the U-value, the better the performance. According to *ASHRAE HANDBOOK-1977 Fundamentals*, the U-value of historic rolled steel sash with single glazing is 1.3. Adding storm windows to the existing units or reglazing with 5/8" insulating glass produces a U-value of .69. These methods of weatherizing historic steel windows compare favorably with rolled steel replacement alternatives: with factory installed 1" insulating glass (.67 U-value); with added thermal-break construction and factory finish coatings (.62 U-value).

Thermal Glazing

The third weatherization treatment is to install an additional layer of glazing to improve the thermal efficiency of the existing window. The decision to pursue this treatment should proceed from careful analysis. Each of the most common techniques for adding a layer of glazing will effect approximately the same energy savings (approximately double the original insulating value of the windows); therefore, cost and aesthetic considerations usually determine the choice of method. Methods of adding a layer of glazing to improve thermal efficiency include adding a new layer of transparent material to the window; adding a separate storm window; and replacing the single layer of glass in the window with thermal glass.

The least expensive of these options is to install a clear material (usually rigid sheets of acrylic or glass) over the original window. The choice between acrylic and glass is generally based on cost, ability of the window to support the material, and long-term maintenance outlook. If the material is placed over the entire window and secured to the frame, the sash will be inoperable. If the continued use of the window is important (for ventilation or for fire exits), separate panels should be affixed to the sash without obstructing operability (see fig. 9). Glass or acrylic panels set in frames can be attached using magnetized gaskets, interlocking material strips, screws or adhesives. Acrylic panels can be screwed directly to the metal windows, but the holes in the acrylic panels should allow for the expansion and contraction of this material. A compressible gasket between the prime sash and the storm panel can be very effective in establishing a thermal cavity between glazing layers. To avoid condensation, 1/8" cuts in a top corner and diagonally opposite bottom corner of the gasket will provide a vapor bleed, through which moisture can evaporate. (Such cuts, however, reduce thermal performance slightly.) If condensation does occur, however, the panels should be easily removable in order to wipe away moisture before it causes corrosion.

The second method of adding a layer of glazing is to have independent storm windows fabricated. (Pivot and austral windows, however, which project on either side of the window frame when open, cannot easily be fitted with storm windows and remain operational.) The storm window should be compatible with the original sash configuration. For example, in paired casement windows, either specially fabricated storm casement windows or sliding units in which the vertical meeting rail of the slider reflects the configuration of the original window should be installed. The decision to place storm windows on the inside or outside of the window depends on whether the historic window opens in or out, and on the visual impact the addition of storm windows will have on the building. Exterior storm windows, however, can serve another purpose besides saving energy: they add a layer of protection against air pollutants and vandals, although they will partially obscure the prime window. For highly ornamental windows this protection can determine the choice of exterior rather then interior storm windows.

The third method of installing an added layer of glazing is to replace the original single glazing with thermal glass. Except in rare instances in which the original glass is of special interest (as with stained or figured glass), the glass can be replaced if the hinges can tolerate the weight of the additional glass. The rolled metal sections for steel windows are generally from 1" - 1 1/2" thick. Sash of this thickness can normally tolerate thermal glass, which ranges from 3/8" - 5/8". (Metal glazing beads, readily available, are used to reinforce the muntins, which hold the glass.) This treatment leaves the window fully operational while preserving the historic appearance. It is, however, the most expensive of the treatments discussed here. (See fig. 6f).

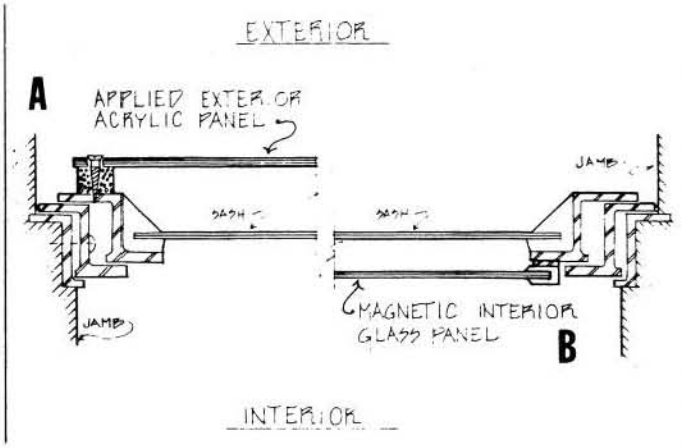


Fig. 9 Two examples of adding a second layer of glazing in order to improve the thermal performance of historic steel windows. Scheme A (showing jamb detail) is of a ¼" acrylic panel with a closed cell foam gasket attached with self-tapping stainless steel screws directly to the exterior of the outwardly opening sash. Scheme B (showing jamb detail) is of a glass panel in a magnetized frame affixed directly to the interior of the historic steel sash. The choice of using glass or acrylic mounted on the inside or outside will depend on the ability of the window to tolerate additional weight, the location and size of the window, the cost, and the long-term maintenance outlook. Drawing: Sharon C. Park, AIA.

WINDOW REPLACEMENT

Repair of historic windows is always preferred within a rehabilitation project. Replacement should be considered only as a last resort. However, when the extent of deterioration or the unavailability of replacement sections renders repair impossible, replacement of the entire window may be justified. In the case of significant windows, replacement in kind is essential in order to maintain the historic character of the building. However, for less significant windows, replacement with compatible new windows may be acceptable. In selecting compatible replacement windows, the material, configuration, color, operability, number and size of panes, profile and proportion of metal sections, and reflective quality of the original glass should be duplicated as closely as possible.

A number of metal window manufacturing companies produce rolled steel windows. While stock modern window designs do not share the multi-pane configuration of historic windows, most of these manufacturers can reproduce the historic configuration if requested, and the cost is not excessive for large orders (see figs. 10a and 10b). Some manufacturers still carry the standard pre-World War II multi-light windows using the traditional 12" x 18" or 14" x 20" glass sizes in industrial, commercial, security, and residential configurations. In addition, many of the modern steel windows have integral weatherstripping, thermal break construction, durable vinyl coatings, insulating glass, and other desirable features.

Fig. 10 a. A six-story concrete manufacturing building prior to the replacement of the steel pivot windows. Photo: Charles Parrott.

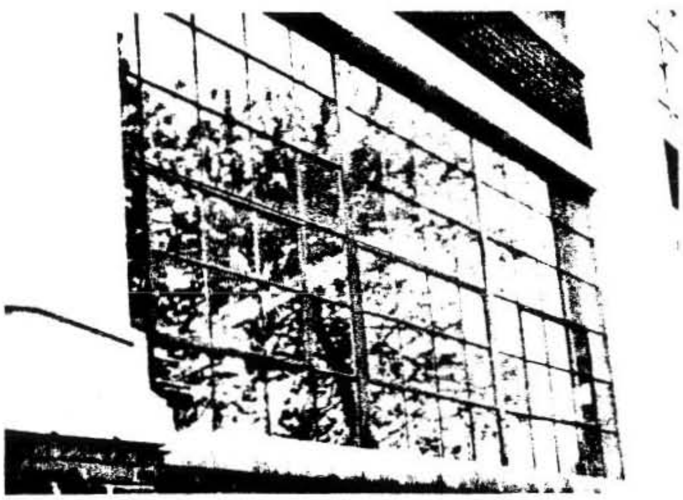


Fig. 10 b. Close-up view of the new replacement steel windows which matched the multi-lighted originals exactly. Photo: Charles Parrott.

Windows manufactured from other materials generally cannot match the thin profiles of the rolled steel sections. Aluminum, for example, is three times weaker than steel and must be extruded into a box-like configuration that does not reflect the thin historic profiles of most steel windows. Wooden and vinyl replacement windows generally are not fabricated in the industrial style, nor can they reproduce the thin profiles of the rolled steel sections, and consequently are generally not acceptable replacements.

For product information on replacement windows, the owner, architect, or contractor should consult manufacturers' catalogues, building trade journals, or the Steel Window Institute, 1230 Keith Building, Cleveland, Ohio 44115.

SUMMARY

The National Park Service recommends the retention of significant historic metal windows whenever possible. Such windows, which can be a character-defining feature of a historic building, are too often replaced with inappropriate units that impair rather than complement the overall historic appearance. The repair and thermal upgrading of historic steel windows is more practicable than most people realize. Repaired and properly maintained metal windows have greatly extended service lives. They can be made energy efficient while maintaining their contribution to the historic character of the building.

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This publication has been prepared pursuant to the Economic Recovery Tax Act of 1981, which directs the Secretary of the Interior to certify rehabilitations of historic buildings that are consistent with their historic character; the guidance provided in this brief will assist property owners in complying with the requirements of this law.

Preservation Briefs: 13 has been developed under the technical editorship of Lee H. Nelson, AIA, Chief, Preservation Assistance Division, National Park Service, U.S. Department of the Interior, Washington, D.C. 20240. Comments on the usefulness of this information are welcomed and can be sent to Mr. Nelson at the above address.

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14 PRESERVATION BRIEFS

New Exterior Additions to Historic Buildings: Preservation Concerns

Kay D. Weeks

U.S. Department of the Interior National Park Service
Preservation Assistance Division Technical Preservation Services

Because a new exterior addition to a historic building can damage or destroy significant materials and can change the building's character, an addition should be considered only after it has been determined that the new use cannot be met by altering nonsignificant, or secondary, interior spaces. If the new use cannot be met in this way, then an attached addition may be an acceptable alternative if carefully planned. A new addition should be constructed in a manner that preserves significant materials and features and preserves the historic character. Finally, an addition should be differentiated from the historic building so that the new work is not confused with what is genuinely part of the past.

Change is as inevitable in buildings and neighborhoods as it is in individuals and families. Never static, buildings and neighborhoods grow, diminish, and continue to evolve as each era's technological advances bring conveniences such as heating, street paving, electricity, and air conditioning; as the effects of violent weather, uncontrolled fire, or slow unchecked deterioration destroy vulnerable material; as businesses expand, change hands, become obsolete; as building codes are established to enhance life safety and health; or as additional family living space is alternately needed and abandonded.

Preservationists generally agree that the history of a building, together with its site and setting, includes not only the period of original construction but frequently later alterations and additions. While each change to a building or neighborhood is undeniably part of its history—much like events in human life—not every change is equally important. For example, when a later, clearly nonsignificant addition is removed to reveal the original form, materials, and craftsmanship, there is little complaint about a loss to history.

When the subject of *new* exterior additions is introduced, however, areas of agreement usually tend to diminish. This is understandable because the subject raises some serious questions. Can a historic building be enlarged for a new use without destroying what is historically significant? And just what *is* significant about each particular historic building that should be preserved? Finally, what new construction is appropriate to the old building?

The vast amount of literature on the subject of change to America's built environment reflects widespread interest as well as divergence of opinion. New additions have been discussed by historians within a social and political, framework; by architectural historians in terms of construction technology and style; and by urban planners as successful or unsuccessful contextual design. Within the historic preservation programs of the National Park Service, however, the focus has been and will continue to be the protection of those resources identified as worthy of listing in the National Register of Historic Places.

National Register Listing—Acknowledging Change While Protecting Historical Significance

Entire districts or neighborhoods may be listed in the National Register of Historic Places for their significance to a certain period of American history (e.g., activities in a commercial district between 1870 and 1910). This "framing" of historic districts has led to a concern that listing in the National Register may discourage any physical change beyond a certain historical period—particularly in the form of attached exterior additions. This is not the case. National Register listing does *not* mean that an entire building or district is frozen in time and that no change can be made without compromising the historical significance. It also does not mean that each portion of a historic building is equally significant and must be retained intact and without change. Admittedly, whether an attached new addition is small or large, there will always be *some* loss of material and *some* change in the form of the historic building. There will also generally be some change in the relationship between the buildings and its site, neighborhood or district. Some change is thus anticipated within each rehabilitation of a building for a contemporary use.

Scope of National Park Service Interest in New Exterior Additions

The National Park Service interest in new additions is simply this—a new addition to a historic building has the potential to damage and destroy significant historic material and features and to change its historic character. A new addition also has the potential to change how one perceives what is genuinely historic and thus to diminish those qualities that make the building eligible for listing in the National Register of Historic Places. Once these basic preservation issues have been addressed, all other aspects of designing and constructing a new addition to extend the useful life of the historic building rest with the creative skills of the architect.

The intent of this Brief, then, is to provide guidance to owners and developers planning additions to their historic buildings. A project involving a new addition to a historic building is considered acceptable within the framework of the National Park Service's standards if it:

1. **Preserves significant historic materials and features; and**
2. **Preserves the historic character; and**
3. **Protects the historical significance by making a visual distinction between old and new.**

Paralleling these key points, the Brief is organized into three sections. Case study examples are provided to point out acceptable and unacceptable preservation approaches where new use requirements were met through construction of an exterior addition. These examples are included to suggest ways that change to historic buildings can be sensitively accomplished, not to provide indepth project analyses, endorse or critique particular architectural design, or offer cost and construction data.

1. Preserving Significant Historic Materials and Features

Connecting a new exterior addition always involves some degree of material loss to an external wall of a historic building and, although this is to be expected, it can be minimized. On the other hand, damage or destruction of *significant* materials and craftsmanship such as pressed brick, decorative marble, cast stone, terra-cotta, or architectural metal should be avoided, when possible.

Generally speaking, preservation of historic buildings is enhanced by avoiding all but minor changes to primary or "public" elevations. Historically, features that distinguish one building or a row of buildings and can be seen from the streets or sidewalks are most likely to be the significant ones. This can include window patterns, window hoods, or shutters; porticoes, entrances, and doorways; roof shapes, cornices, and decorative moldings; or commercial storefronts with their special detailing, signs, and glazing. Beyond a single building, entire blocks of urban or residential structures are often closely related architecturally by their materials, detailing, form, and alignment. Because significant materials and features should be *preserved*, not damaged or hidden, the first place to consider constructing a new addition is where such material loss will be minimized. This will frequently be on a secondary side or rear elevation. For both economic and social reasons, secondary elevations were often constructed of "common" material and were less architecturally ornate or detailed.

In constructing the new addition, one way to minimize overall material loss is simply to reduce the size of the new addition in relationship to the historic building. If a new addition will abut the historic building along one elevation or wrap around a side and rear elevation, the integration of historic and new interiors may result in a high degree of loss—exterior walls as well as significant interior spaces and features. Another way to minimize loss is to limit the size and number of openings between old and new. A particularly successful method to reduce damage is to link the new addition to the historic block by means of a hyphen or connector. In this way, only the connecting passageway penetrates a historic side wall; the new addition can be visually and functionally related while historic materials remain essentially intact and historic exteriors remain uncovered.

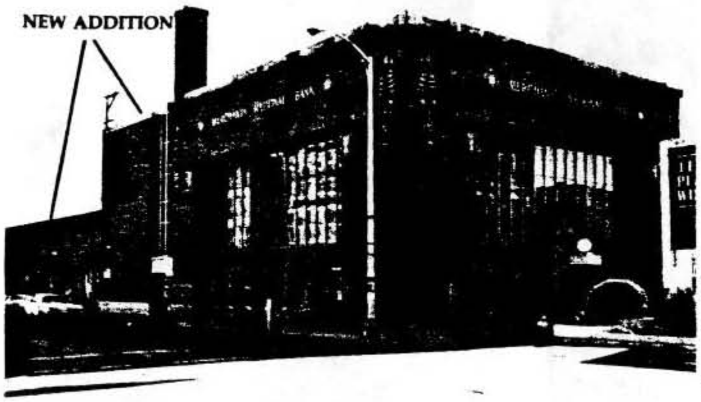
Although a general recommendation is to construct a new addition on a secondary elevation, there are several exceptions. First, there may simply be no secondary elevation—some important freestanding buildings have significant materials and features on all sides, making any aboveground addition too destructive to be considered. Second, a structure or group of structures together with their setting (for example, in a National Historic Park) may be of such significance in American history that any new addition would not only damage materials and alter the buildings' relationship to each other and the setting, but seriously diminish the public's ability to appreciate a historic event or place. Finally, there are other cases where an existing side or rear elevation was historically intended to be highly visible, is of special cultural importance to the neighborhood, or possesses associative historical value. Then, too, a secondary elevation should be treated as if it were a primary elevation and a new addition should be avoided.

Photo: Maxwell Mackenzie

Photo: Gary L. Hume

Historic residential structure with new office addition. This approach preserves significant historic materials and features.

Built in 1903 as the private residence of a wealthy mine owner, the 3½ story building utilizes a variety of materials, including granite, limestone, marble, and cast iron. Of special interest is the projecting conservatory on a prominent side elevation. The Walsh-McLean House in Washington, D.C., has been used as the Indonesian Embassy since 1954. When additional administrative space was required for the embassy in 1981, loss of significant exterior materials was minimized by utilizing a narrow hyphen connector that cuts through a side wall behind the distinctive conservatory. Finally, the modestly scaled addition is well set back on the adjoining site, thus preserving the historic character of this individually-listed property.



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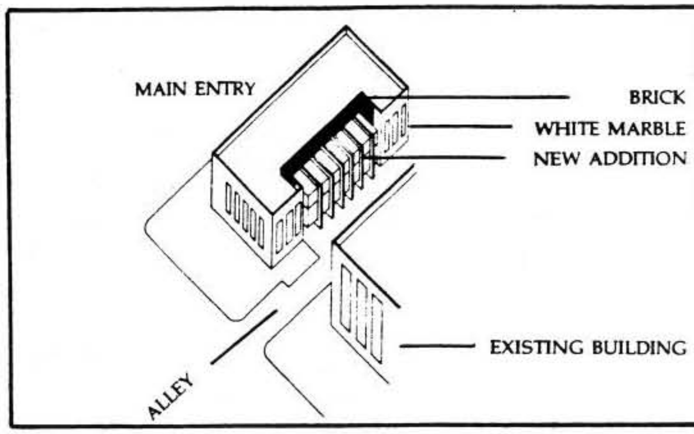


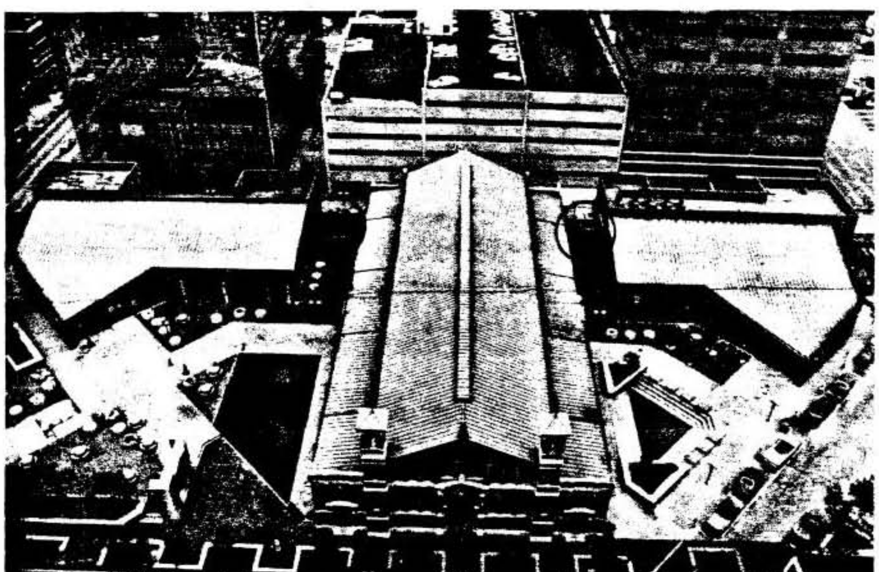
Drawing: Christina Henry

Historic bank structure with new drive-in bank addition. This approach preserves significant materials and features.

The bank building in Winona, Minnesota, (Purcell, Feick, and Elmslie, 1911-1912) is a noteworthy example of Prairie School architecture. Of particular significance is the ornamental work in terra-cotta and stained glass. In 1969-70 a brick addition was joined to the historic structure on the unoramented north and east party walls. This responsible approach successfully met additional square footage requirements for bank operations while retaining the historic banking room with its stained glass panels and skylighted space.

Historic library with new reading room addition. This approach preserves significant historic materials and features.

When Washington, D.C.'s Folger Shakespeare Library (Paul P. Cret, 1929) required additional space for a new reading room in 1983, significant exterior materials and interior spaces were respected. This expansion was successfully accomplished by filling-in a nonsignificant, common brick, U-shaped service area on the building's rear elevation, thus permitting almost total savings of the historic decorative marble on significant front and side facades. The new reading room addition was sensitively joined to the historic library by a limited number of doorways, further enhancing overall preservation of historic materials.



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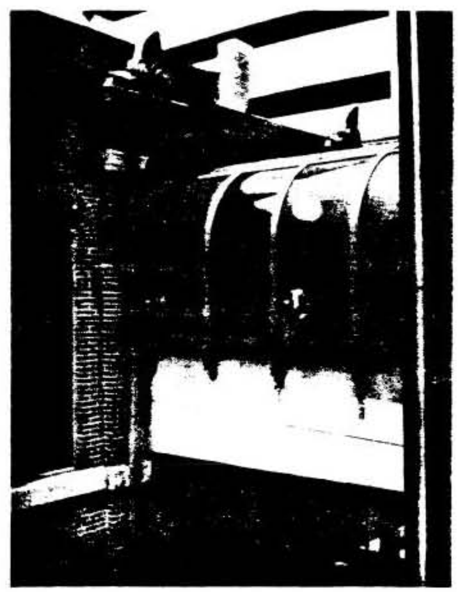


Photo: Jim Vaseff

Historic city market with flanking new retail additions. This approach preserves significant historic materials and features.

An aerial view shows the two-level connectors (circled) between Indianapolis' 1886 City Market and the new retail business wings. Historic openings on both levels at the rear of the building have been utilized for entrance and egress to the new additions, requiring minimal intrusion in the historic fabric of the side walls. A detail photograph shows how the glass and metal connectors parallel the form of the historic round-headed window openings. Finally, because the new additions are essentially detached from the original market building, the external form and the interior plan, with its significant cast-iron roofing system, have been retained and preserved.

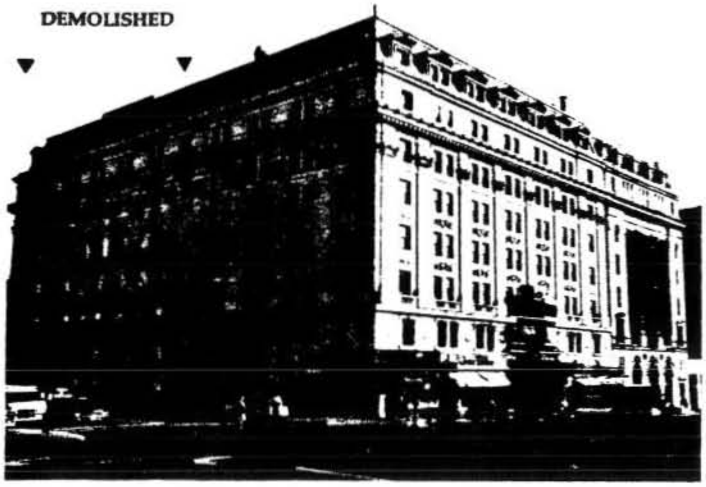


Photo: A. Pierce Bounds

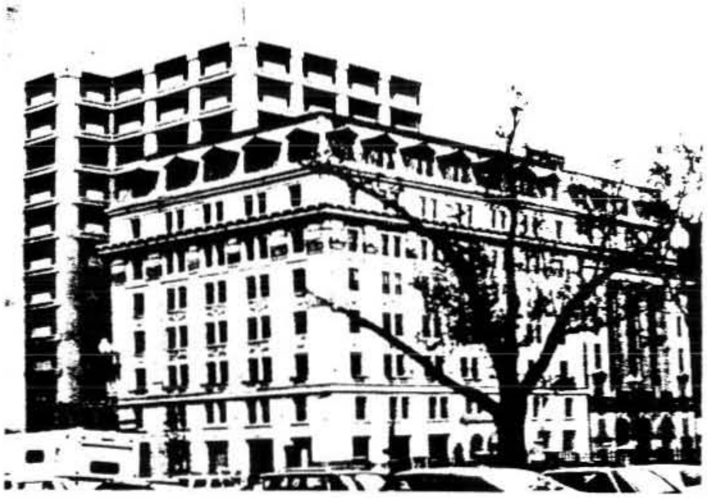


Photo: Michael J. Auer

Historic theater and office building with new office addition. This approach results in the destruction of significant materials and features.

Materials and features comprise the life history of a building from its initial construction to its present configuration; their destruction thus represents an equivalent and unfortunate loss to history. Chase's Theater and Riggs Building were constructed in Washington, D.C. in 1911-1912 as one architectural unit. Originally 11 bays wide, it featured elaborate granite, terra-cotta and marble ornamentation (see "before" above). As part of a plan to increase office space in a prime downtown location, 6 side bays and the significant theater space of the historic structure were demolished to make way for a major new addition (see "after" below).

Photo: Lee H. Nelson, FAIA

Historic cast-iron storefront re-installed as facade on modern department store. This approach results in the destruction of significant materials and features.

Where there is need for a substantially larger building, the most destructive approach is to demolish everything but the facade of the historic building. In the example above, the 3-story-cast-iron front was originally the facade of a large, 19th century department store. In the 1970s, when the rest of the building was demolished, the metal facade was dismantled, then re-assembled on a new site where it has become the ornamental entrance to a modern department store.

2. Preserving the Historic Character

The second, equally important, consideration is whether or not the new addition will preserve the resource's historic character. The historic character of each building may differ, but a methodology of establishing it remains the same. Knowing the uses and functions a building has served over time will assist in making what is essentially a physical evaluation. But while written and pictorial documentation can provide a framework for establishing the building's history, *the historic character, to a large extent, is embodied in the physical aspects of the historic building itself—its shape, its materials, its features, its craftsmanship, its window arrangements, its colors, its setting, and its interiors.* It is only after the historic character has been correctly identified that reasonable decisions about the extent—or limitations—of change can be made.

To meet National Park Service preservation standards, a new addition must be "compatible with the size, scale, color, material, and character" of the building to which it is attached or its particular neighborhood or district. A new addition will always change the size or actual bulk of the historic building. But an addition that bears no relationship to the proportions and massing of the historic building—in other words, one that overpowers the historic form and changes the scale will usually compromise the historic character as well. The appropriate size for a new addition varies from building to building; it could never be stated in a tidy square or cubic footage ratio, but the historic building's existing proportions, site, and setting can help set some general parameters for enlargement. To some extent, there is a predictable relationship between the size of the historic resource and the degree of change a new addition will impose.

For example, in the case of relatively low buildings (small-scale residential or commercial structures) it is difficult, if not impossible, to minimize the impact of adding an entire new floor even if the new addition is set back from the plane of the facade. Alteration of the historic proportions and profile will likely change the building's character. On the other hand, a rooftop addition to an eight story building in a historic district of other tall buildings might not affect the historic character simply because the new work would not be visible from major streets. A number of methods have been used to help predict the effect of a proposed rooftop addition on the historic building and district, including pedestrian sight lines, three-dimensional schematics and computer-assisted design (CAD). Sometimes a rough full-size mock up of a section or bay of the proposed addition can be constructed using temporary material; the mock-up can then be photographed and evaluated from critical vantage points.

In the case of freestanding residential structures, the preservation considerations are generally twofold. First, a large addition built out on a highly visible elevation can radically alter the historic form or obscure features such as a decorative cornice or window ornamentation. Second, an addition that fills in a planned void on a highly visible elevation (such as a "U" shaped plan or feature such as a porch) may also alter the historic form and, as a result, change the historic character.

Some historic structures such as government buildings, metropolitan museums, or libraries may be so massive in size that a large-scale addition may not compromise the historic character. Yet similar expansion of smaller buildings would be dramatically out of scale. In summary, where any new addition is proposed, correctly assessing the *relationship* between actual size and relative scale will be a key to preserving the character of the historic building.

Constructing the new addition on a secondary side or rear elevation—in addition to material preservation—will also address preservation of the historic character. Primarily, such placement will help to preserve the building's historic form and relationship to its site and setting. Historic landscape features, including distinctive grade variations, need to be respected; and any new landscape features such as plants and trees kept at a scale and density that would not interfere with appreciation of the historic resource itself.

In highly developed urban areas, locating a new addition on a less visible side or rear elevation may be impossible simply because there is no available space. In this instance, there may be alternative ways to help preserve the historic character. If a new addition is being connected to the adjacent historic building on a primary elevation, the addition may be set back from the front wall plane so the outer edges defining the historic form are still apparent. In still other cases, some variation in material, detailing, and color may provide the degree of differentiation necessary to avoid changing the essential proportions and character of the historic building.

Photo: Michael J. Auer

Historic townhouse with compatible new stairtower addition. This approach preserves the historic character.

Creating two separate means of egress from the upper floors may be a fire code requirement in certain types of rehabilitation projects. This may involve a second stair within the historic building or an exterior fire stair. To meet preservation concerns, an exterior fire stair should always be subordinate to the historic structure in size and scale, and preferably, placed on a secondary side or rear elevation. Finally, as in any other type of addition, the material and color should be compatible with the historic character of the building. Because this modest brick stairtower has been placed on a rear elevation as a subsidiary unit, the form, features and detailing of the historic building have been preserved.

Photo: Martha L. Werenfels

Historic university building with incompatible new stairtower addition. This approach changes the historic character.

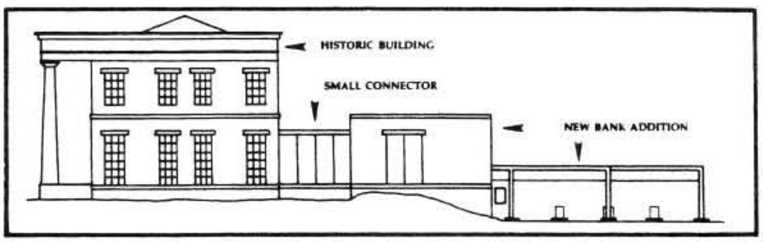
In contrast, this stairtower has been constructed on a highly visible side elevation and, together with its width and height, has obscured the historic form and roofline. The materials and color of the addition further enhance its prominence.

Photo: Rodney Gary

Photo: Rodney Gary

Historic residential structure with new drive-in bank addition. This approach preserves the historic character.

Built in 1847 and individually listed in the National Register in 1973, the Stephen Upson House in Athens, Georgia, is a two-story, five-bay structure featuring a distinctive columned portico. Of particular importance in its successful conversion from residential to commercial use in 1984 was the sensitive utilization of a sloping, tree-shaded historic site consisting of over 6 acres. A low-scale office and drive-in bank addition have been attached by a small glass connector at the rear of the historic building. A drawing, below, shows how the three-unit addition has been stepped down the hill, each unit set further back from the historic structure as it extends horizontally. As a result, the new addition is only partially visible from the historic "approach;" it can, however, be seen at full size from a new service road on the rear elevation (see photos, above).



Drawing: Christina Henry

Photo: Joseph Borysthen Tcacz.

Historic bank with compatible new bank addition. This approach preserves the historic character.

The overall size of an 1893 bank in Salem, Massachusetts, was nearly doubled in 1974 when a new addition was constructed on an adjacent lot, yet the addition is compatible with the historic character. A deep set-back and similarity in scale permit the historic form to be appreciated; the addition is also compatible in materials and color. Finally, the pattern of arched and rectangular openings of the historic building is suggested in the new work.

Photo: Harry Weese & Associates

Historic library with new addition for "uncommon" and rare books. This approach preserves the historic character.

Designed by architect Henry Ives Cobbs and completed in 1892, the Newberry Library in downtown Chicago extends the length of a city block and features a series of elongated, arch-headed windows. In 1981, when additional space was required with light and humidity control for storage of the rare book collection, a 10-story, windowless brick addition was linked to the historic block on side and rear elevations. Although constituting major expansion, the new wing still reads as a subsidiary unit to the substantially larger historic library complex. Its simple rectangular shape and lack of ornamentation stand in contrast with the highly articulated historic library complex; the rhythm of the historic windows is suggested in the windowless addition through a series of recessed square and arched bands. This is one example of a solution that is considered compatible with the historic character.

Photo: Baird M. Smith, AIA

Historic residential buildings with incompatible three-story rooftop addition. This approach changes the historic character.

The historic character of one building or an entire row of buildings may be radically altered by even one highly visible, inappropriately scaled rooftop addition. This is partly because the proportions or dimensions of a historic building play such a major role in determining its identity. Major expansion at the roofline alters the proportions and profile of the building—a change that is particularly noticeable when seen in outline against the sky. A modest clerestory addition (extending across townhouses to the right) is almost overlooked because the focal point of the row is a three-story, pyramidally-shaped glass and metal addition whose mass, size, and scale overpowers the block's residential character.

Photo: David Kroll

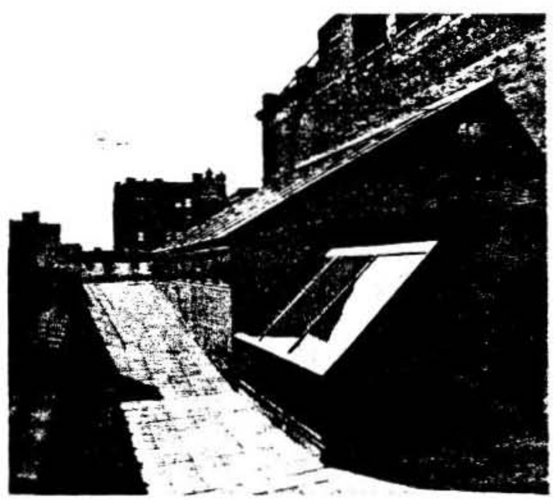


Photo: David Kroll

Historic commercial building with compatible new, one-story rooftop addition. This approach preserves the historic character.

This rooftop addition—sharing a similarity to the example above in its use of glass and metal and an angular shape—has been set back from both the front and side roof edges against a party wall, thus preserving the character of the historic building as well as the district. Although the addition appears to be very small from a street perspective, in actuality it is spacious enough to be used as a business conference room and employee lounge.

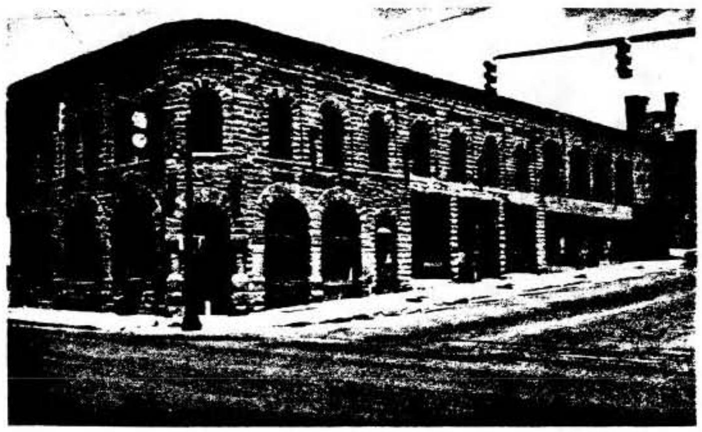
3. Protecting the Historical Significance—Making a Visual Distinction Between Old and New

The following statement of approach could be applied equally to the preservation of districts, sites, buildings, structures, and objects of National Register significance: "A conservator works within a conservation ethic so that the integrity of the object as an historic entity is maintained. The concern is not just with the original state of the object, but the way in which it has been changed and used over the centuries. Where a new intervention must be made to save the object, either to stabilize it or to consolidate it, it is generally accepted that those interventions must be *clear, obvious, and reversible*. It is this same attitude to change that is relevant to conservation policies and attitudes to historic towns . . . "[1]

Rather than establishing a clear and obvious difference between old and new, it might seem more in keeping with the historic character simply to repeat the historic form, material, features, and detailing in a new addition. But when the new work is indistinguishable from the old in appearance, then the "real" National Register property may no longer be perceived and appreciated by the public. Thus, the third consideration in planning a new addition is to be sure that it will protect those visual qualities that made the building eligible for listing in the National Register of Historic Places.

A question often asked is what if the historic character is *not* compromised by an addition that appears to have been built in the same period? A small porch or a wing that copied the historic materials and detailing placed on a *rear* elevation might not alter the public perception of the historic form and massing. Therefore, it is conceivable that a modest addition could be replicative without changing the resource's historic character; generally, however, this approach is not recommended because using the same wall plane, roof line, cornice height, materials, siding lap, and window type in an addition can easily make the new work appear to be part of the historic building. If this happens on a visible elevation, it becomes unclear as to which features are historic and which are new, thus confusing the authenticity of the historic resource itself.

The National Park Service policy on new additions, adopted in 1967, is an outgrowth and continuation of a general philosophical approach to change first expressed by John Ruskin in England in the 1850s, formalized by William Morris in the founding of the Society for the Protection of Ancient Buildings in 1877, expanded by the Society in 1924 and, finally, reiterated in the 1964 Venice Charter—a document that continues to be followed by 64 national committees of the International Council on Monuments and Sites (ICOMOS). The 1967 *Administrative Policies for Historical Areas of the National Park System* thus states, " . . . a modern addition should be readily distinguishable from the older work; however, the new work should be harmonious with the old in scale, proportion, materials, and color. Such additions should be as inconspicuous as possible from the public view." Similarly, the Secretary of the Interior's 1977 "Standards for Rehabilitation" call for the new work to be "compatible with the size, scale, color, material, and character of the property, neighborhood, or environment."



Photos: Noré V. Winter

Historic bank with new bank addition. This approach protects the historical significance of the resource by making a visual distinction between what is old and what is new.

Constructed in the early 1890s in Durango, Colorado, the split-faced ashlar bank structure is characterized by its flat roof, rounded form at the main entrance, a series of large arched window and door openings, and heavily textured surfaces. When additional office space was needed in 1978 to serve a commercially revitalized historic district, the new work was respectful of the historic structure through its proportional similarities, and alignment of openings and cornice. While echoing the historic bank's arched and rectangular shapes, the addition features a contrasting, smooth-faced brick that—together with the variation in window size, recessed detailing, and exaggerated verticality of the pilasters—places the new work in a clearly contemporary idiom and also permits the historic building to predominate.

[1] Roy Worskett, RIBA, MRTIP, "Improvemment of Urban Design in Europe and the United States: New Buildings in Old Settings." Background Report (prepared July, 1984) for Seminar at Strasbourg, France, October, 1984.

Protecting the Historical Significance—Making a Visual Distinction Between Old and New

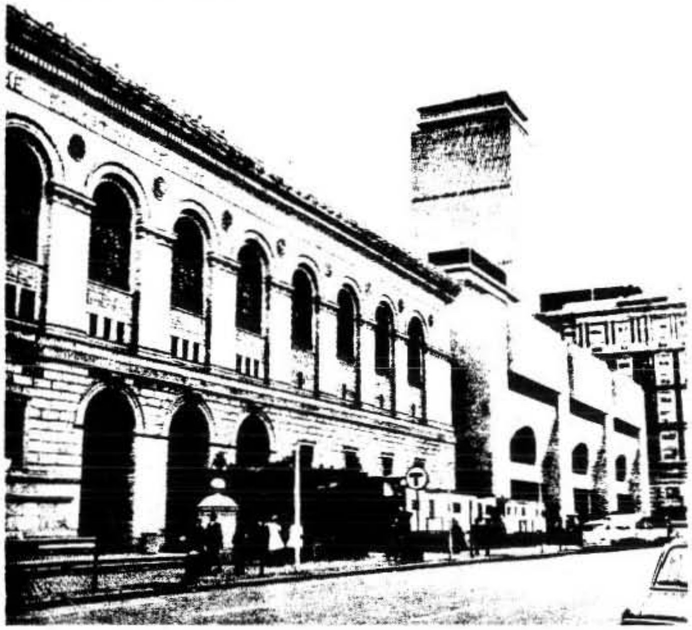


Photo: Carleton Knight, III

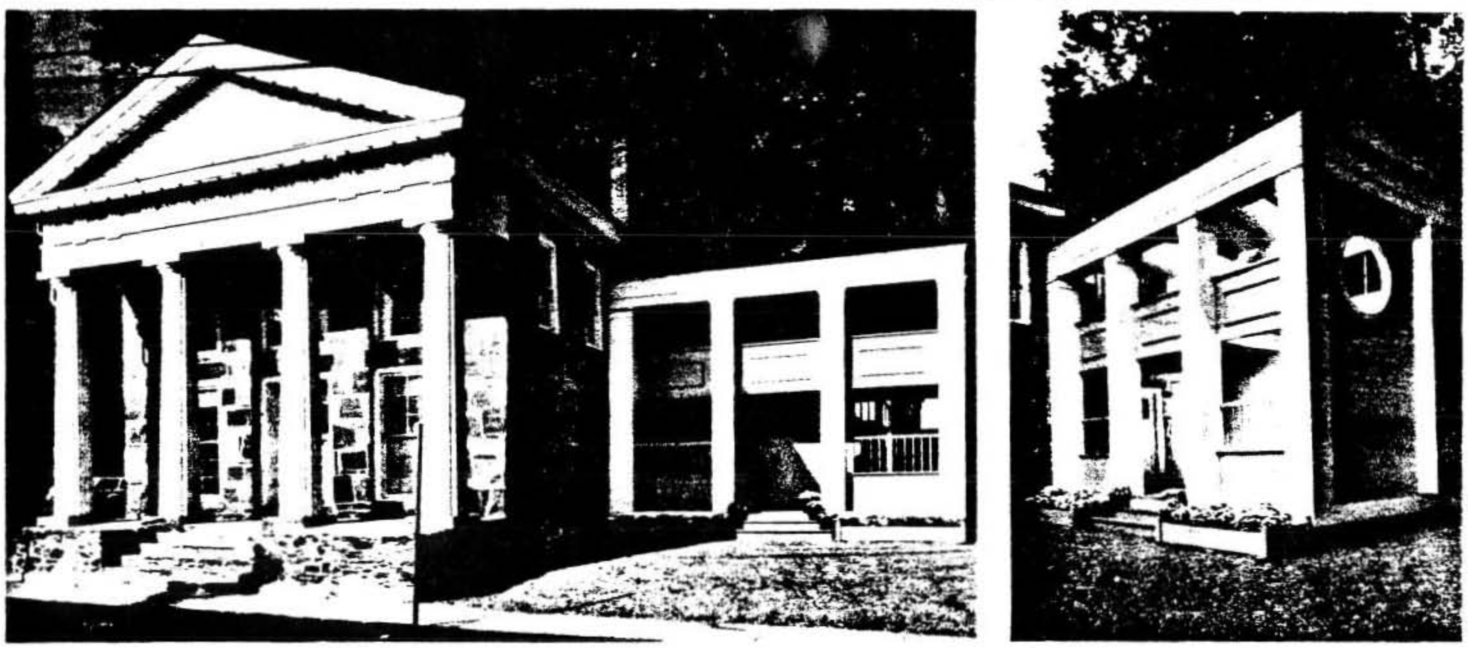
Historic library with new library wing. This approach protects the historical significance of the resource by making a visual distinction between what is old and what is new.

Charles Follen McKim's Boston Public Library, a 3 story, granite-faced, rectangular structure built between 1888-1895, was significantly expanded in 1973 by Phillip Johnson's new library addition on highly visible side and rear elevations. While the new addition is closely related to the historic block in its basic proportions, Johnson's bold use of material and detailing—juxtaposed to McKim's delicately patterned facade—provide clear differentiation between old and new and result in an addition that is unequivocally a product of its own time.

Photo: Kay D. Weeks

Private residence with new addition. This approach does not protect the historical significance of the resource because it fails to make a visual distinction between what is old and what is new.

The most distinctive portion of this c. 1900 wood-frame residence—the decorative gable and three-part window—was repeated in a new addition to the left. As a result of copying the form, features and detailing of the new addition on the front elevation, the historic building and the new addition are virtually indistinguishable.



Photos: Jerry Liebman

Historic post office with new commercial entrance addition. This approach protects the historical significance of the resource by making a visual distinction between what is old and what is new.

An 1810 granite and wood structure in Chester, Connecticut has been used over its long history as a post office, a school, and most recently, for two businesses—one downstairs and one upstairs. In 1985, as part of the conversion of the second floor into a graphic arts studio, an extensively deteriorated straight-run wooden stair was replaced by this small new entrance and stairtower addition. Because of the addition's deep set-back and restrained size, the form, features, and detailing of the historic structure continue to dominate both site and streetscape; moreover, the new work has a separate identity and could not be mistaken as part of the historic building.

Drawing: National Register files

Historic city hall with new rooftop office addition. This approach does not protect the historical significance of the resource because it fails to make a visual distinction between what is old and what is new.

The drawing shows a proposed penthouse addition to a former municipal building. Originally a flat-roofed structure with a modestly detailed cornice, the proposed new addition has changed the proportions and profile, creating a verticality and degree of ornamentation that never existed historically. These changes have effectively *re-defined* the historic character. With its highly replicative ornamentation, the addition has become an integral component of the historic design. The result is that a passerby would probably not be able to tell that the rooftop addition is new and not part of the original construction.

NEW EXTERIOR ADDITIONS TO HISTORIC BUILDINGS

Preserve Significant Historic Materials and Features

Avoid constructing an addition on a primary or other character-defining elevation to ensure preservation of significant materials and features.

Minimize loss of historic material comprising external walls and internal partitions and floor plans.

Preserve the Historic Character

Make the size, scale, massing, and proportions of the new addition compatible with the historic building to ensure that the historic form is not expanded or changed to an unacceptable degree.

Place the new addition on an inconspicuous side or rear elevation so that the new work does not result in a radical change to the form and character of the historic building.

Consider setting an infill addition or connector back from the historic building's wall plane so that the form of the historic building—or buildings—can be distinguished from the new work.

Set an additional story well back from the roof edge to ensure that the historic building's proportions and profile are not radically changed.

Protect the Historical Significance—Make a Visual Distinction Between Old and New

Plan the new addition in a manner that provides some differentiation in material, color, and detailing so that the new work does not appear to be part of the historic building. The character of the historic resource should be identifiable after the addition is constructed.

Conclusion

A major goal of our technical assistance program is a heightened awareness of significant materials and the historic character *prior* to construction of a new exterior addition so that essential change may be effected within a responsible preservation context. In summary, then, these are the three important preservation questions to ask when planning a new exterior addition to a historic resource:

1. **Does the proposed addition preserve significant historic materials and features?**
2. **Does the proposed addition preserve the historic character?**
3. **Does the proposed addition protect the historical significance by making a visual distinction between old and new?**

If the answer is YES to all three questions, then the new addition will protect significant historic materials and the historic character and, in doing so, will have satisfactorily addressed those concerns generally held to be fundamental to historic preservation.

Additional Reading

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Good Neighbors: Building Next to History. State Historical Society of Colorado, 1980.

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National Trust for Historic Preservation. *Old and New Architecture: Design Relationship*. Washington, D.C.: Preservation Press, 1980.

Rehab Right: How to Rehabilitate Your Oakland House Without Sacrificing Architectural Assets. City of Oakland Planning Department, Oakland, California, 1978.

Ruskin, John. *The Seven Lamps of Architecture*. London: George Allen and Unwin, Ltd., 1925.

Schmertz, Mildred F., and Architectural Record Editors. *New Life for Old Buildings*. New York, Architectural Record Books, McGraw-Hill, 1980.

The Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings. Washington, D.C.: Preservation Assistance Division, National Park Service U.S. Department of the Interior, rev. 1983.

The following historic buildings with new additions are listed in the order in which they appeared in sections 1., 2., and 3. Those approaches to constructing new additions that met all three preservation concerns addressed in Preservation Briefs 14 are in boldface; the date of the new addition is given together with the name of the project architect(s):

1. Preserves Significant Historic Materials and Features

Walsh-McLean House (Indonesian Embassy), Washington, D.C. New addition, 1981, The Architects Collaborative (TAC).

Merchant's National Bank, Winona, Minnesota. New addition, 1969-1970, Dykins and Handford.

City Market, Indianapolis, Indiana. New addition, 1977, James Associates.

Folger Shakespeare Library, Washington, D.C. New addition, 1983, Hartman-Cox.

Chase's Theater and Riggs Building, Washington, D.C.

Historic cast-iron facade on new department store (ZCMI Building), Salt Lake City, Utah.

2. Preserves the Historic Character

Montgomery Street residence, Federal Hill, Baltimore, Maryland. New addition, 1983, James R. Grieves Associates, Inc.

Brown University stairtower addition, Providence, Rhode Island.

Stephen Upson House, Athens, Georgia. New addition, 1978-1979, The Group Five Architects and Designers.

Salem 5¢ Savings Bank, Salem, Massachusetts. New addition, 1974, Padjen Architects.

Historic residential buildings with rooftop addition, Boston, Massachusetts.

Nutz & Grosskopf Building, Indianapolis, Indiana. New addition, 1984, Robert V. Donelson, AIA.

Newberry Library, Chicago, Illinois. New addition, 1981, Harry Weese & Associates.

Historic commercial building with new rooftop addition, Denver, Colorado.

Historic commercial building, with rooftop addition, Washington, D.C.

Private residence with medical office addition, Providence, Rhode Island.

Historic commercial building with new greenhouse addition, Newport, Rhode Island.

3. Protects the Historical Significance by Making a Visual Distinction Between Old and New

Burns National Bank, Durango, Colorado. New addition, 1978, John Pomeroy, Architect.

Boston Public Library, Boston, Massachusetts. New addition, 1973, Johnson/Burgee Architects.

Historic post office with new entrance/stairtower addition, Chester, Connecticut. New addition, 1985, Thomas A. Norton, AIA.

Private residence, Chevy Chase, Maryland.

Historic city hall with proposed new rooftop addition, New Orleans, Louisiana.

First, special thanks go to Ernest A. Connally, Gary L. Hume, and W. Brown Morton, III for their efforts in establishing and refining our preservation and rehabilitation standards over the past 20 years. (The "Secretary of the Interior's Standards for Historic Preservation Projects" constitute the policy framework of this, and every technical publication developed in the Preservation Assistance Division.) H. Ward Jandl, Chief, Technical Preservation Services Branch, is credited with overall supervision of the project. Next, appreciation is extended to the Branch professional staff, the NPS cultural programs regional offices, the Park Historic Architecture Division, and the National Conference of State Historic Preservation Officers for their thoughtful comments. Finally, the following specialists in the field are thanked for their time in reviewing and commenting on the manuscript: Bruce Judd, AIA, Noré V. Winter, John Cullinane, AIA, Ellen Beasley, Vicki Jo Sandstead, Judith Kitchen, Andrea Nadel, Martha L. Werenfels, Diane Pierce, Colden Florance, FAIA, and H. Grant Dehart, AIA. The photograph of Chicago's Newberry Library with the Harry Weese & Associates' 1981 addition was graciously lent to us by David F. Dibner, FAIA, and Amy Dibner-Dunlap, co-authors of *Buildings Additions Design*, McGraw-Hill, 1985. The front page "logo" by Noré Winter is a detail of historic Burns National Bank, Durango, Colorado, with John Pomeroy's 1978 addition.

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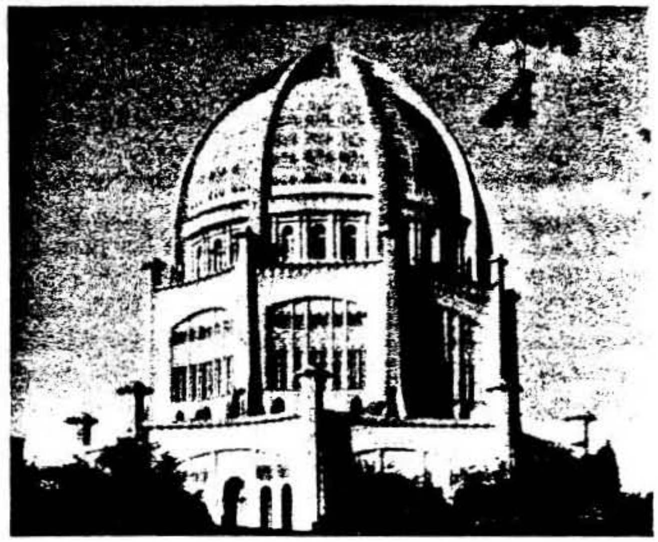
15 PRESERVATION BRIEFS



Preservation of Historic Concrete: Problems and General Approaches

William B. Coney, A.I.A.
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U.S. Department of the Interior, National Park Service
Rocky Mountain Regional Office, Division of Cultural Resources

The Secretary of the Interior's "Standards for Rehabilitation" require that deteriorated architectural features shall be repaired rather than replaced. When the severity of deterioration requires removal of historic material, its replacement should match the material being replaced in composition, design, color, texture, and other visual qualities.

"Concrete" is a name applied to any of a number of compositions consisting of sand, gravel, crushed stone, or other coarse material, bound together with various kinds of cementitious materials, such as lime or cements. When water is added, the mix undergoes a chemical reaction and hardens. An extraordinarily versatile building material, concrete is used for the utilitarian, the ornamental, and the monumental. While early proponents of modern concrete considered it to be permanent, it is, like all materials, subject to deterioration. This Brief surveys the principal problems posed by concrete deterioration, their likely causes, and approaches to their remedies. In almost every instance, remedial work should only be undertaken by qualified professionals. Faulty concrete repair can worsen structural problems and lead to further damage or safety hazards. Concrete repairs are not the province of do-it-yourselfers. Consequently, the corrective measures discussed here are included for general information purposes only; they do not provide "how to" advice.

HISTORICAL OVERVIEW

The Romans found that the mixture of lime putty with pozzolana, a fine volcanic ash, would harden under water. The result was possibly the first hydraulic cement. It became a major feature of Roman building practice, and was used in many buildings and engineering projects such as bridges and aqueducts. Concrete technology was kept alive during the Middle Ages in Spain and Africa, with the Spanish introducing a form of concrete to the New World in the first decades of the 16th century. It was used by both the Spanish and English in coastal areas stretching from Florida to South Carolina. Called "tapia," or "tabby," the substance was a creamy white, monolithic masonry material composed of lime, sand, and an aggregate of shells, gravel, or stone mixed with water. This mass of material was placed between wooden forms, tamped, and allowed to dry, the building arising in layers, about one foot at a time.

Despite its early use, concrete was slow in achieving widespread acceptance as a building material in the United States. In 1853, the second edition of Orson S. Fowler's *A Home for All* publicized the advantages of "gravel wall" construction to a wide audience, and poured gravel wall buildings appeared across the United States (see fig. 1). Seguin, Texas, 35 miles east

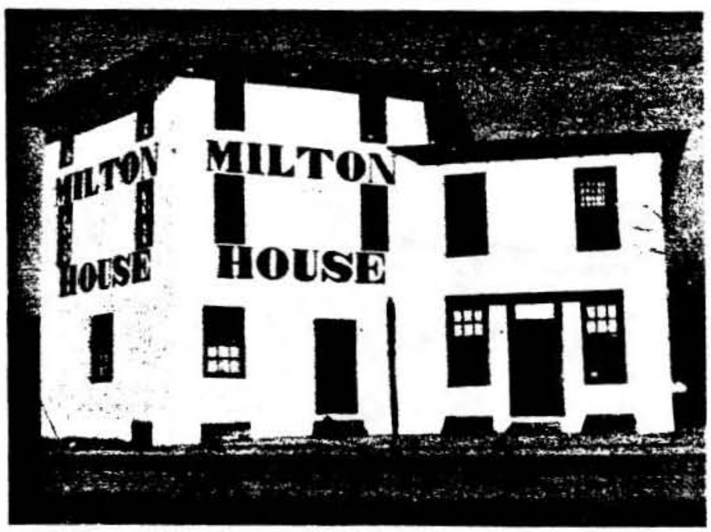

Fig. 1. Milton House, Milton, Wisconsin (1844). An early example of gravel wall construction with 12- to 15-inch thick monolithic concrete walls coated on the exterior with stucco. Photo: William B. Coney.

of San Antonio, came to be called "The Mother of Concrete Cities" for some 90 concrete buildings made from local "lime water" and gravel (see fig. 2). Impressed by the economic advantages of poured gravel wall or "lime-grout" construction, the Quartermaster General's Office of the War Department embarked on a campaign to improve the quality of building for frontier military posts. As a result, lime-grout structures were built at several western posts, such as the buildings that were constructed with 12- or 18-inch-thick walls at Fort Laramie, Wyoming between 1872 and 1885. By the 1880s sufficient experience had been gained with unreinforced concrete to permit construction of much larger buildings. The Ponce de Leon Hotel in St. Augustine, Florida, is a notable example from this period (see fig. 3).

Reinforced concrete in the United States dates from 1860, when S.T. Fowler obtained a patent for a reinforced concrete wall. In the early 1870s William E. Ward built his own house in Port Chester, New York, using concrete reinforced with iron rods for all structural elements. Despite these developments, such construction remained a novelty until after 1880, when innovations introduced by Ernest L. Ransome made reinforced concrete more practicable. The invention of the horizontal rotary kiln allowed production of a cheaper, more uniform and reliable cement, and led to the greatly increased acceptance of concrete after 1900.

During the early 20th century Ransome in Beverly, Massachusetts, Albert Kahn in Detroit, and Richard E. Schmidt in Chicago promoted concrete for utilitarian buildings with their "factory style," featuring an exposed concrete skeleton filled with expanses of glass. Thomas Edison's cast-in-place reinforced concrete homes in Union Township, New Jersey, proclaimed a similarly functional emphasis in residential construction (see fig. 4). From the 1920s onward, concrete began to be used with spectacular design results: in James J. Earley and Louis Bourgeois' exuberant, graceful Baha'i Temple in Wilmette, Illinois (see cover); and in Frank Lloyd Wright's masterpiece "Fallingwater" near Mill Run, Pennsylvania (see fig. 5). Eero Saarinen's soaring Terminal Building at Dulles International Airport outside Washington, D.C., exemplifies the masterful use of concrete achieved in the Modern era.

Fig. 2. Sebastopol House, Seguin, Texas (1856). This Greek Revival dwelling is one of the few remaining poured-in-place concrete structures in this Texas town noted for its construction of over 90 concrete buildings in the mid-nineteenth century. The high parapets surrounding the flat roof were lined and served as a water reservoir to cool the house. Photo: Texas Historical Commission.

Fig. 4. Thomas A. Edison's Cast-in-Place Houses, Union Township, New Jersey (1909). This construction photo shows the formwork for the cast-in-place reinforced concrete houses built as low-cost housing using a standard 25- by 30-foot module. Photo: Edison National Historical Site.

Fig. 3. Ponce de Leon Hotel, St. Augustine, Florida (1885-87). An example of unreinforced concrete used on a grand scale, this Spanish Colonial Revival hotel was designed by Carrere and Hastings and commissioned by railroad magnate Henry Flagler. The building now serves as the main campus hall for Flagler College. Photo: Flagler College.

Fig. 5. "Fallingwater," near Mill Run, Pennsylvania (1936-37). This dramatic reinforced concrete residence by Frank Lloyd Wright is anchored into bedrock on the hillside and cantilevered over the stream. The great tensile strength of reinforced concrete made this type of construction possible. Photo: Paul Mayen.

Types of Concrete

Unreinforced concrete is a composite material containing aggregates (sand, gravel, crushed shell, or rock) held together by a cement combined with water to form a paste, and gets its name from the fact that it does not have any iron or steel reinforcing bars. It was the earliest form of concrete. The ingredients become a plastic mass that hardens as the concrete hydrates, or "cures." Unreinforced concrete, however, is relatively weak, and since the turn of the century has largely been replaced by reinforced concrete. *Reinforced concrete* is conrete strengthened by the inclusion of metal bars, which increase the tensile strength of concrete. Both unreinforced and reinforced concrete can be either cast in place or precast. *Cast-in-place* concrete is poured on-site into a previously erected formwork that is removed after the concrete has set. *Precast concrete* is molded off-site into building components. More recent developments in concrete technology include *post-tensioned concrete* and *pre-stressed concrete*, which feature greater strength and reduced cracking in reinforced structural elements.

CAUSES OF CONCRETE DETERIORATION

Deterioration in concrete can be caused by environmental factors, inferior materials, poor workmanship, inherent structural design defects, and inadequate maintenance (see figs. 6, 7, and 8).

Environmental factors are a principal source of concrete deterioration. Concrete absorbs moisture readily, and this is particularly troublesome in regions of recurrent freeze-thaw cycles. Freezing water produces expansive pressure in the cement paste or in nondurable aggregates. Carbon dioxide, another atmospheric component, can cause the concrete to deteriorate by reacting with the cement paste at the surface.

Materials and workmanship in the construction of early concrete buildings are potential sources of problems. For example, aggregates used in early concrete, such as cinders from burned coal and certain crushed brick, absorb water and produce a weak and porous concrete. Alkali-aggregate reactions within the concrete can result in cracking and white surface staining. Aggregates were not always properly graded by size to ensure an even distribution of elements from small to large. The use of aggregates with similarly sized particles normally produced a poorly consolidated and therefore weaker concrete.

Fig. 6. Battery Fortifications, Ft. Washington, Maryland (1891-97). This unreinforced concrete fortification exhibits several kinds of deterioration: the diagonal structural crack due to uneven settlement, the long horizontal crack at the cold joint, the spalling of the concrete surface coating, and vegetative growth. Photo: Sharon C. Park, AIA.

Fig. 7. Battery Commander's Station, Ft. Washington, Maryland (1904). This reinforced concrete tower with a cantilevered balcony is showing serious deterioration. Water has penetrated the slab, causing freeze-thaw spalling around the posts and corrosion of the reinforcing bars. This internal corrosion is causing expansion inside the slab and creating major horizontal cracks in the concrete. Under the balcony can be seen the network of hardened white calcified deposits, which have exuded through cracks in the concrete as a result of alkali-aggregate reaction. Photo: Lee H. Nelson, FAIA.

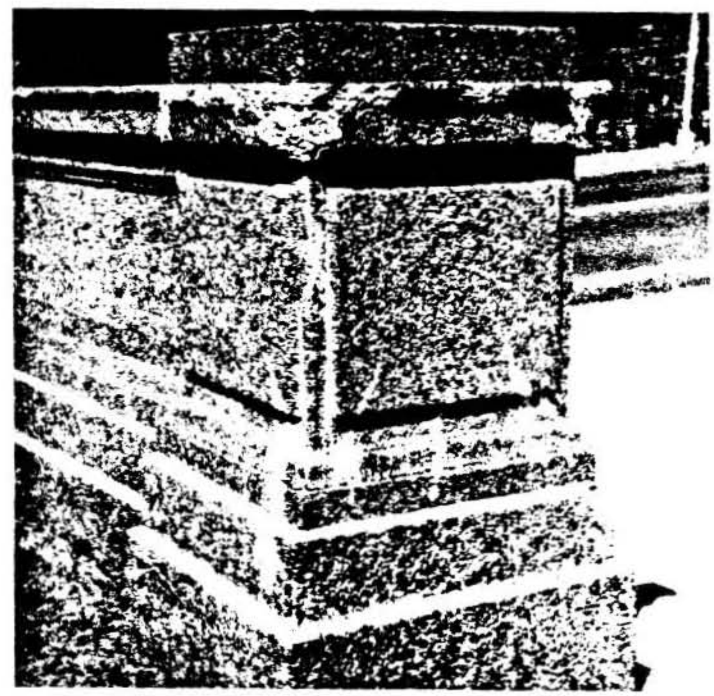

Fig. 8. Meridian Hill, Washington, D.C. (1934). This reinforced concrete pier has lost much of its projecting molding partly from accidental impact and partly from spalling induced by freeze-thaw action. Evidence of moisture leaching out from the interior through cracks is seen as white deposits on the surface of this exposed aggregate concrete. Photo: Lee H. Nelson, FAIA.

Early builders sometimes inadvertently compromised concrete by using seawater or beach sand in the mix or by using calcium chloride or a similar salt as an additive to make the concrete more "fireproof." A common practice, until recently, was to add salt to strengthen concrete or to lower the freezing point during cold-weather construction. These practices cause problems over the long term.

In addition, early concrete was not vibrated when poured into forms as it is today. More often it was tamped or rodded to consolidate it, and on floor slabs it was often rolled with increasingly heavier rollers filled with water. These practices tended to leave voids (areas of no concrete) at congested areas, such as at reinforcing bars at column heads and other critical structural locations. Areas of connecting voids seen when concrete forms are removed are known as "honeycombs" and can reduce the protective cover over the reinforcing bars.

Other problems caused by poor workmanship are not unknown today. If the first layer of concrete is allowed to harden before the next one is poured next to or on top of it, joints can form at the interface of the layers. In some cases, these "cold joints" visibly detract from the architecture, but are otherwise harmless. In other cases, "cold joints" can permit water to infiltrate, and subsequent free-thaw action can cause the joints to move. Dirt packed in the joints allows weeds to grow, further opening paths for water to enter. Inadequate curing can also lead to problems. If moisture leaves newly poured concrete too rapidly because of low humidity, excessive exposure to sun or wind, or use of too porous a substrate, the concrete will develop shrinkage cracks and will not reach its full potential strength.

Structural Design Defects in historic concrete structures can be an important cause of deterioration. For example, the amount of protective concrete cover around reinforcing bars was often insufficient. Another design problem in early concrete buildings is related to the absence of standards for expansion-contraction joints to prevent stresses caused by thermal movements, which may result in cracking.

Improper Maintenance of historic buildings can cause long-term deterioration of concrete. Water is a principal source of damage to historic concrete (as to almost every other material) and prolonged exposure to it can cause serious problems. Unrepaired roof and plumbing leaks, leaks through exterior cladding, and unchecked absorption of water from damp earth are potential sources of building problems. Deferred repair of cracks allowing water penetration and freeze-thaw attacks can even cause a structure to collapse. In some cases the application of waterproof surface coatings can aggravate moisture-related problems by trapping water vapor within the underlying material.

MAJOR SIGNS OF CONCRETE DETERIORATION

Cracking occurs over time in virtually all concrete. Cracks vary in depth, width, direction, pattern, location, and cause. Cracks can be either active or dormant (inactive). Active cracks widen, deepen, or migrate through the concrete. Dormant cracks remain unchanged. Some dormant cracks, such as those caused by shrinkage during the curing process, pose no danger, but if left unrepaired, they can provide convenient channels for moisture penetration, which normally causes further damage.

Structural cracks can result from temporary or continued overloads, uneven foundation settling, or original design inadequacies. Structural cracks are active if the overload is continued or if settlement is ongoing; they are dormant if the temporary overloads have been removed, or if differential settlement has stabilized. Thermally-induced cracks result from stresses produced by temperature changes. They frequently occur at the ends or corners of older concrete structures built without expansion joints capable of relieving such stresses. Random surface cracks (also called "map" cracks due to their resemblance to the lines on a road map) that deepen over time and exude a white gel that hardens on the surface are caused by an adverse reaction between the alkalis in a cement and some aggregates.

Since superficial repairs that do not eliminate underlying causes will only tend to aggravate problems, professional consultation is recommended in almost every instance where noticable cracking occurs.

Spalling is the loss of surface material in patches of varying size. It occurs when reinforcing bars corrode, thus creating high stresses within the concrete. As a result, chunks of concrete pop off from the surface. Similar damage can occur when water absorbed by porous aggregates freezes. Vapor-proof paints or sealants, which trap moisture beneath the surface of the impermeable barrier, also can cause spalling. Spalling may also result from the improper consolidation of concrete during construction. In this case, water-rich cement paste rises to the surface (a condition known as laitance). The surface weakness encourages scaling, which is spalling in thin layers.

Deflection is the bending or sagging of concrete beams, columns, joists, or slabs, and can seriously affect both the strength and structural soundness of concrete. It can be produced by overloading, by corrosion, by inadequate construction techniques (use of low-strength concrete or undersized reinforcing bars, for example), or by concrete creep (long-term shrinkage). Corrosion may cause deflection by weakening and ultimately destroying the bond between the rebar and the concrete, and finally by destroying the reinforcing bars themselves. Deflection of this type is preceded by significant cracking at the bottom of the beams or at column supports. Deflection in a structure without widespread cracking, spalling, or corrosion is frequently due to concrete creep.

Stains can be produced by alkali-aggregate reaction, which forms a white gel exuding through cracks and hardening as a white stain on the surface. Efflorescence is a white, powdery stain produced by the leaching of lime from Portland cement, or by the pre-World War II practice of adding lime to whiten the concrete. Discoloration can also result from metals inserted into the concrete, or from corrosion products dripping onto the surface.

Erosion is the weathering of the concrete surface by wind, rain, snow, and salt air or spray. Erosion can also be caused by the mechanical action of water channeled over concrete, by the lack of drip grooves in beltcourses and sills, and by inadequate drainage.

Corrosion, the rusting of reinforcing bars in concrete, can be a most serious problem. Normally, embedded reinforcing bars are protected against corrosion by being buried within the mass of the concrete and by the high alkalinity of the concrete itself. This protection, however, can be destroyed in two ways. First, by carbonation, which occurs when carbon dioxide in the air reacts chemically with cement paste at the surface and reduces the alkalinity of the concrete. Second, chloride ions from salts combine with moisture to produce an electrolyte that effectively corrodes the reinforcing bars. Chlorides may come from seawater additives in the original mix, or from prolonged contact with salt spray or de-icing salts. Regardless of the cause, corrosion of reinforcing bars produces rust, which occupies significantly more space than the original metal, and causes expansive forces within the concrete. Cracking and spalling are frequent results. In addition, the load-carrying capacity of the structure can be diminished by the loss of concrete, by the loss of bond between reinforcing bars and concrete, and by the decrease in thickness of the reinforcing bars themselves. Rust stains on the surface of the concrete are an indication that internal corrosion is taking place.

PLANNING FOR CONCRETE PRESERVATION

Whatever the causes of deterioration, careful analysis, supplemented by testing, is vital to the success of any historic concrete repair project. Undertaken by experienced engineers or architects, the basic steps in a program of testing and analysis are document review, field survey, testing, and analysis.

Document Review. While plans and specifications for older concrete buildings are rarely extant, they can be an invaluable aid, and every attempt should be made to find them. They may provide information on the intended composition of the concrete mix, or on the type and location of reinforcing bars. Old photographs, records of previous repairs, documents for buildings of the same basic construction or age, and news reports may also document original construction or changes over time.

Field Survey. A thorough visual examination can assist in locating and recording the type, extent, and severity of stress, deterioration, and damage.

Testing. Two types of testing, on-site and laboratory, can supplement the field condition survey as necessary. On-site, nondestructive testing may include use of a calibrated metal detector or sonic tests to locate the position, depth, and direction of reinforcing bars (see fig. 9). Voids can frequently be detected by "sounding" with a metal hammer. Chains about 30 inches long attached to a 2-foot-long crossbar, dragged over the slabs while listening for hollow reverberations, can locate areas of slabs that have delaminated. In order to find areas of walls that allow moisture to penetrate to the building interior, areas may be tested from the outside by spraying water at the walls and then inspecting the interior for water. If leaks are not readily apparent, sophisticated equipment is available to measure the water permeability of concrete walls.

If more detailed examinations are required, nondestructive instruments are available that can assist in determining the presence of voids or internal cracks, the location and size of rebars, and the strength of the concrete. Laboratory testing can be invaluable in determining the composition and characteristics of historic concrete and in formulating a compatible design mix

Fig. 9. Nondestructive sonic tests are one way of determining the location and soundness of internal reinforcing bars and the hardness of the concrete. There are a variety of other nondestructive tests provided by professional consultants that will help in the evaluation of the structural integrity of concrete prior to major repair work. Photo: Feld, Kaminetzky and Cohen and American Concrete Institute.

for repair materials (see fig. 10). These tests, however, are expensive. A well-equipped concrete laboratory can analyze concrete samples for strength, alkalinity, carbonation, porosity, alkali-aggregate reaction, presence of chlorides, and past compostion.

Fig. 10. Testing of actual samples of concrete in the lab may be necessary to determine the strength and condition of the concrete. In this sample, the surface, which is lighter than the sound concrete core, shows that carbonation has taken place. Carbonation reduces the alkalinity in concrete and may hasten corrosion of reinforcing bars close to the surface. Photo: Stella L. Marusin.

Analysis. Analysis is probably the most important step in the process of evaluation. As survey and test results are revised in conjunction with available documentation, the analysis should focus on determining the nature and causes of the concrete problems, on assessing both the short-term and long-term effects of the deterioration, and on formulating proper remedial measures.

CONCRETE REPAIR

Repairs should be undertaken only after the planning measures outlined above have been followed. Repair of historic concrete may consist of either patching the historic material or filling in with new material worked to match the historic material. If replacement is necessary, duplication of historic materials and detailing should be as exact as possible to assure a repair that is functionally and aesthetically acceptable (see fig. 11). The correction and elimination of concrete problems can be difficult, time-consuming, and costly. Yet the temptation to resort to temporary solutions should be avoided, since their failure can expose a building to further and more serious deterioration, and in some cases can mask underlying structural problems that could lead to serious safety hazards (see fig. 12).

Principal concrete repair treatments are discussed below. While they are presented separately here, in practice, preservation projects typically incorporate multiple treatments (see figs. 13a-i).

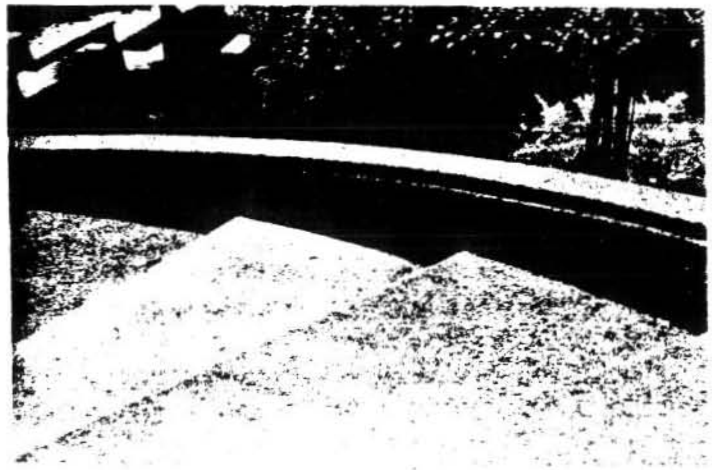

Fig. 11. Meridian Hill, Washington, D.C. (1934). It is important to match the visual qualities, such as color and texture, when repairs or replacement sections are undertaken. In this case, the new replacement step, located second from the left, matches the original pebble-finish surface of the adjacent historic steps. Photo: Sharon C. Park, AIA.

Fig. 12. Without proper preparation and correction of a pre-existing problem, repairs will fail. Insufficient concrete at the surface caused this patch around a reinforcing bar to fail within a year. In this case, a structural engineer should have assessed the need for this rod so close to the surface. Redundant rods are often cut out prior to patching. Photo: Alonzo White.

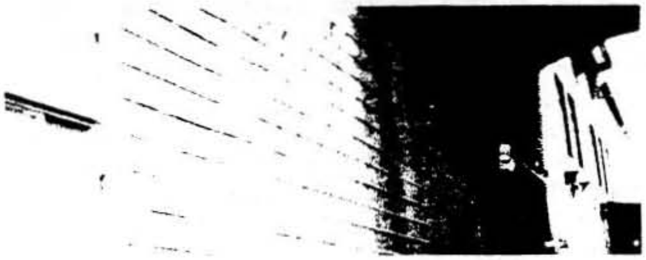

Fig. 13a. Buckling concrete under a painted surface indicates underlying deterioration. It is often difficult to assess the amount of deterioration until the area has been cleaned and examined closely.

Fig. 13c. Narrow cracks often need to be widened to receive concrete patches. Here a pneumatic chisel is being used.

Fig. 13e. A spalled area of concrete has been cleaned back to a sound surface, and is being coated with a bonding agent to increase adherence of the new concrete patch.

Fig. 13g. A soft brush is used to smooth the patch and to blend it with the adjacent historic concrete.

Fig. 13a-i. Virginia Heating Plant, Arlington, Virginia (1941). This reinforced concrete building exhibits several serious problems, including cracking, spalling, and corrosion of reinforcing bars. As a result of careful planning and close supervision, successful repairs have been carried out. Photos: Alonzo White and Sharon C. Park, AIA.

Fig. 13b. Upon removal of the deteriorated surface, a pocket of poorly mixed concrete (mostly sand and gravel) was easily chiseled out. The reinforcing rods were in good condition.

Fig. 13d. Deteriorated or redundant reinforcing bars are removed after evaluation by a structural engineer. An acetylene torch is being used to cut out the bars.

Fig. 13f. Workmen are applying patching concrete and using a trowel to form ridges to match the appearance of the historic concrete ridges that were originally created by the form boards.

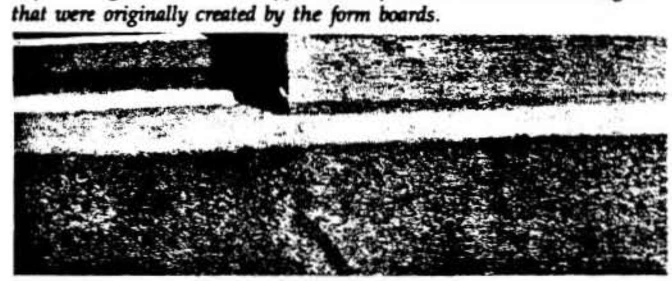

Fig. 13h. This active crack at a window sill and in the foundation wall has been filled with a flexible sealant. This area was subsequently painted with a masonry paint compatible with the sealant.

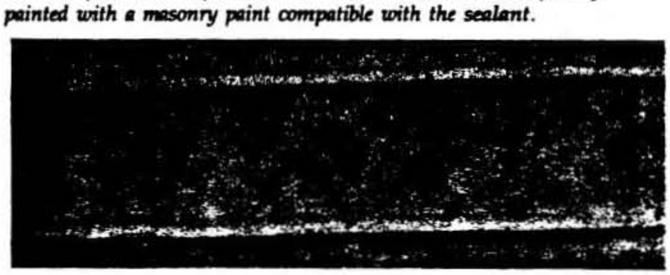

Fig. 13i. Upon completion of all repairs, the building was painted. The finished repair of the deterioration seen in 13a and b is shown in this photograph. The patch matches the texture and detailing of the historic concrete.

Repair of Cracking. Hairline, nonstructural cracks that show no sign of worsening normally need not be repaired. Cracks larger than hairline cracks, but less than approximately one-sixteenth of an inch, can be repaired with a mix of cement and water. If the crack is wider than one-sixteenth of an inch, fine sand should be added to the mix to allow for greater compactibility, and to reduce shrinkage during drying. Field trials will determine whether the crack should be routed (widened and deepened) minimally before patching to allow sufficient penetration of the patching material. To ensure a long-term repair, the patching materials should be carefully selected to be compatible with the existing concrete as well as with subsequent surface treatments such as paint or stucco.

When it is desirable to reestablish the structural integrity of a concrete structure involving dormant cracks, epoxy injection repair should be considered. An epoxy injection repair is made by sealing the crack on both sides of a wall or a structural member with an epoxy mortar, leaving small holes, or "ports" to receive the epoxy resin. After the surface mortar has hardened, epoxy is pumped into the ports. Once the epoxy in the crack has hardened, the surface mortar can be ground off, but the repair may be visually noticeable. (It is possible to inject epoxy without leaving noticeable patches, but the procedure is much more complex.)

Other cracks are active, changing their width and length. Active structural cracks will move as loads are added or removed. Thermal cracks will move as temperatures fluctuate. Thus, expansion-contraction joints may have to be introduced before repair is undertaken. Active cracks should be filled with sealants that will adhere to the sides of the cracks and will compress or expand during crack movement. The design, detailing, and execution of sealant-filled cracks require considerable attention, or else they will detract from the appearance of the historic building.

Random (map) cracks throughout a structure are difficult to correct, and may be unrepairable. Repair, if undertaken, requires removing the cracked concrete. A compatible concrete patch to replace the removed concrete is then installed. For some buildings without significant historic finishes, an effective and economical repair material is probably a sprayed concrete coating, troweled or brushed smooth. Because the original concrete will ultimately contaminate new concrete, buildings with map cracks will present continuing maintenance problems.

Repair of Spalling. Repair of spalling entails removing the loose, deteriorated concrete and installing a compatible patch that dovetails into the existing sound concrete. In order to prevent future crack development after the spall has been patched and to ensure that the patch matches the historic concrete, great attention must be paid to the treatment of rebars, the preparation of the existing concrete substrate, the selection of compatible patch material, the development of good contact between patch and substrate, and the curing of the patch.

Once the deteriorated concrete in a spalled area has been removed, rust on the exposed rebars must be removed by wire brush or sandblasting. An epoxy coating applied immediately over the cleaned rebars will diminish the possiblity of further corrosion. As a general rule, if the rebars are so corroded that a structural engineer determines they should be replaced, new supplemental reinforcing bars will normally be required, assuming that the rebar is important to the strength of the concrete. If not, it is possible to cut away the rebar.

Proper preparation of the substrate will ensure a good bond between the patch and the existing concrete. If a large, clean break or other smooth surface is to be patched, the contact area should be roughened with a hammer and chisel. In all cases, the substrate should be kept moist with wet rags, sponges, or running water for at least an hour before placement of the patch. Bonding between the patch and substrate can be encouraged by scrubbing the substrate with cement paste, or by applying a liquid bonding agent to the surface of the substrate. Admixtures such as epoxy resins, latexes, and acrylics in the patch may also be used to increase bonding, but this may cause problems with color matching if the surfaces are to be left unpainted.

Compatible matching of patch material to the existing concrete is critical for both appearance and durability. In general, repair material should match the composition of the original material (as revealed by laboratory analysis) as closely as possible so that the properties of the two materials, such as coefficient of thermal expansion and strength, are compatible. Matching the color and texture of the existing concrete requires special care. Several test batches of patching material should be mixed by adding carefully selected mineral pigments that vary slightly in color. After the samples have cured, they can be compared to the historic concrete and the closest match selected.

Contact between the patch and the existing concrete can be enhanced through the use of anchors, preferably stainless-steel hooked pins, placed in holes drilled into the structure and secured in place with epoxy. Good compaction of the patch material will encourage the contact. Compaction is difficult when the patch is "laid-up" with a trowel without the use of forms; however, by building up thin layers of concrete, each layer can be worked with a trowel to achieve compaction. Board forms will be necessary for large patches. In cases where the existing concrete has a significant finish, care must be taken to pin the form to the existing concrete without marring the surface. The patch in the form can be consolidated by rodding or vibration.

Because formed concrete surfaces normally develop a sheen that does not match the surface texture of most historic concrete, the forms must be removed before the patch has fully set. The surface of the patch must then be finished to match the historic concrete. A brush or wet sponge is particularly useful in achieving matching textures. It may be difficult to match historic concrete surfaces that were textured, as a result of exposed aggregate for example, but it is important that these visual qualities be matched. Once the forms are removed, holes from the bolts must also be patched and finished to match adjacent surfaces.

Regardless of size, a patch containing cement binder (especially Portland cement) will tend to shrink during drying. Adequate curing of the patch may be achieved by keeping it wet for several days with damp burlap bags. It should be noted that although greater amounts of sand will reduce overall shrinkage, patches with a high sand content normally will not bond well to the substrate.

Repair of Deflection. Deflection can indicate significant structural problems and often requires the strengthening or replacement of structural members. Because deflection can lead to structural failure and serious safety hazards, its repair should be left to engineering professionals.

Repair of Erosion. Repair of eroded concrete will normally require replacing lost surface material with a compatible patching material (as outlined above) and then applying an appropriate finish to match the historic appearance. The elimination of water coursing over concrete surfaces should be accomplished to prevent further erosion. If necessary, drip grooves at the underside of overhanging edges of sills, beltcourses, cornices, and projecting slabs should be installed.

SUMMARY

Many early concrete buildings in the United States are threatened by deterioration. Effective protection and maintenance are the keys to the durability of concrete. Even when historic concrete structures are deteriorated, however, many can be saved through preservation projects involving sensitive repair (see figs. 14a-c), or replacement of deteriorated concrete with carefully selected matching material (see figs. 15a-c). Successful restoration of many historic concrete structures in America demonstrates that techniques and materials now available can extend the life of such structures for an indefinite period, thus preserving significant cultural resources.

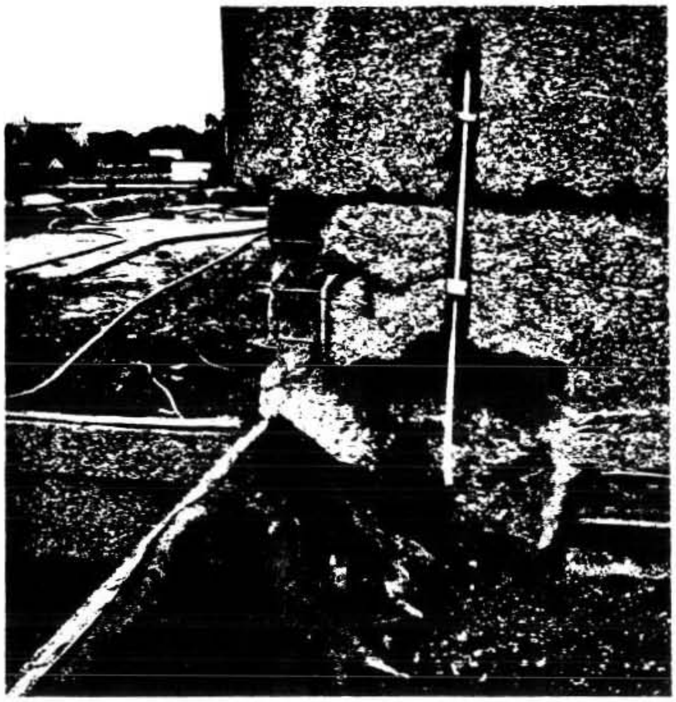

Fig. 14a. Spalled concrete was most noticeable at locations of concentrated rebars. Deteriorated concrete, the 1960s stucco finish, and corrosion were removed by grit-blasting. Photo: Robert Bell.

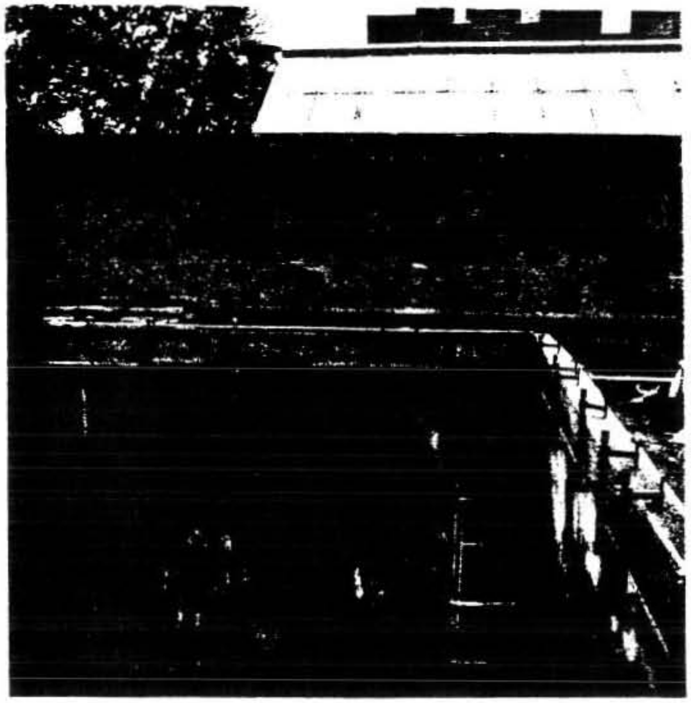

Fig. 14b. Board screeds were attached to the building to recreate the sharp edges of the original detail. Photo: Robert Bell.

Fig. 14c. Once the repair work was complete, the entire building was sprayed with a concrete mixture consisting of pea-gravel, cement, and sand, which was then hand-troweled. Finally, the building was lightly grit-blasted to remove the cement paste and reproduce the exposed agregate finish. Photo: Harry J. Hunderman.

Fig. 14a-c. Unity Temple, Oak Park, Illinois (1906). Architect Frank Lloyd Wright used cast-in-place concrete with an exposed aggregate finish. However, reinforcing bars placed too close to the surface resulted in corrosion, cracking, and spalling. A superficial repair in the 1960s coated the surface with a concrete mix and Portland cement paint which produced a stucco-like finish and accelerated deterioration. Repair work was undertaken in 1971.

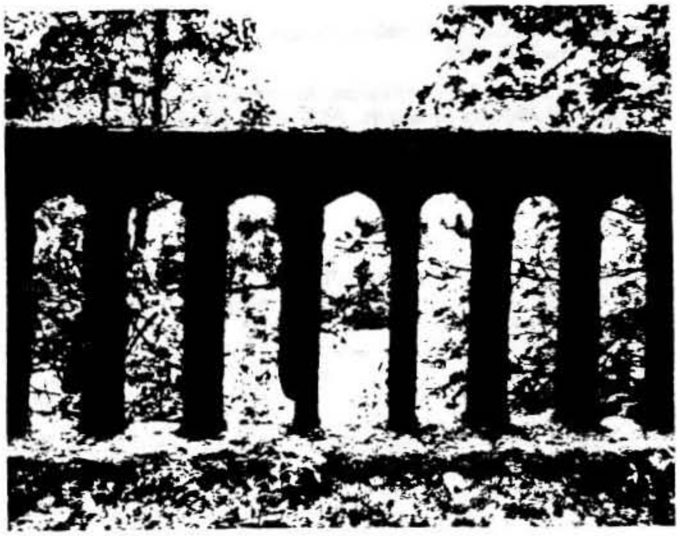

Fig. 15a. The spindle-type railings were deteriorated beyond repair. The concrete was cracked or broken and the center reinforcing rods were exposed and badly rusted.

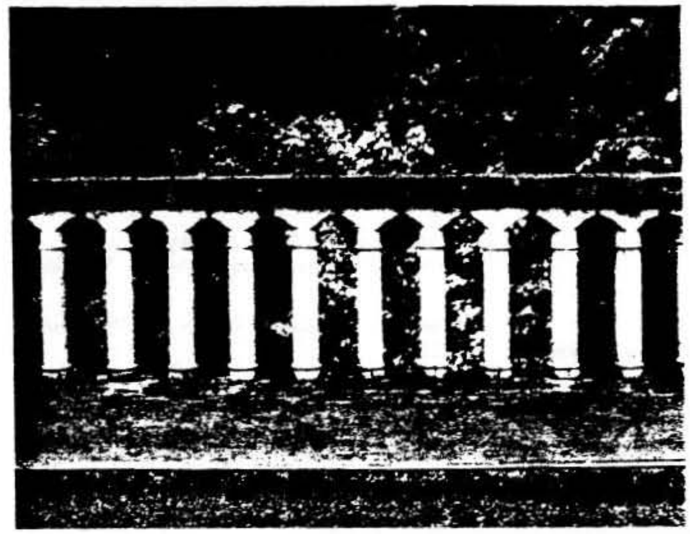

Fig. 15b. Deteriorated spindles were removed. The original 1914 molds were still available and used in casting new concrete spindles, but had they not been available, new molds could have been made to match the originals.

Fig.15c. The new concrete spindles have been installed. This sensitive renovation reused the historic concrete cap railing and stone piers, as they were still in sound condition.

Fig. 15a-c. Columbia River Highway, Oregon. This historic highway overlooking the Columbia River Gorge was constructed from 1913 to 1922 and contains a number of significant concrete bridges. These photos illustrate the sensitive replacement of the concrete spindle-type balusters on the Young Creek (Shepperd's Dell) Bridge of 1914. Photos: James Norman, Oregon Department of Transportation.

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Cover: Baha'i Temple, Wilmette, Illinois (1933). Photo: William B. Coney.

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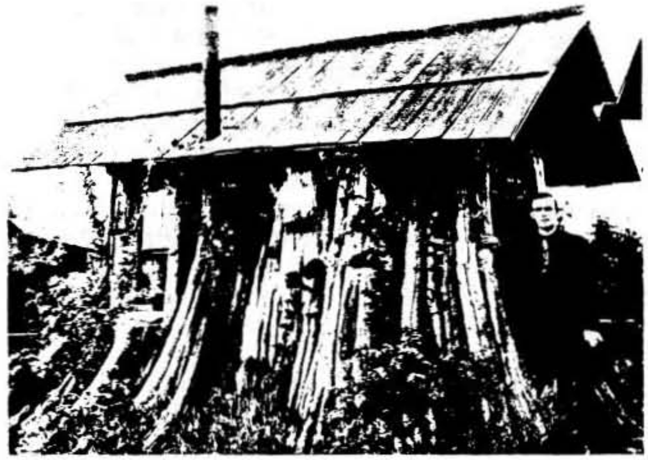

The Repair and Replacement of Historic Wooden Shingle Roofs

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Preservation Assistance Division, Technical Preservation Services

The Secretary of the Interior's "Standards for Rehabilitation" call for the repair or replacement of missing architectural features "based on accurate duplication of features, substantiated by historic, physical, or pictorial evidence rather than on conjectural designs." On a wooden shingle roof, it is important not only to match the size, shape, texture, and configuration of historic shingles, but also to match the craftsmanship and details that characterize the historic roof. Proper installation and maintenance will extend the life of the new roof.

Introduction

Wooden shingle roofs are important elements of many historic buildings. The special visual qualities imparted by both the *historic shingles* and the *installation patterns* should be preserved when a wooden shingle roof is replaced. This requires an understanding of the size, shape, and detailing of the historic shingle and the method of fabrication and installation. These combined to create roofs expressive of particular architectural styles, which were often influenced by regional craft practices. The use of wooden shingles from the early settlement days to the present illustrates an extraordinary range of styles (see illus. 1, 2, 3, 4).

Wooden shingle roofs need periodic replacement. They can last from 15 to over 60 years, but the shingles should be replaced before there is deterioration of other wooden components of the building. Appropriate replacement shingles are available, but careful research, design, specifications, and the selection of a skilled roofer are necessary to assure a job that will both preserve the appearance of the historic building and extend the useful life of the replacement roof.

Unfortunately, the wrong shingles are often selected or are installed in a manner incompatible with the appearance of the historic roof. There are a number of reasons why the wrong shingles are selected for replacement roofs. They include the failure to identify the appearance of the original shingles; unfamiliarity with available products; an inadequate budget; or a *confusion in terminology.* In any discussion about historic roofing materials and practices, it is important to understand the historic definitions of terms like "shingles," as well as the modern definitions or use of those terms by craftsmen and the industry. Historically, from the first buildings in America, these wooden roofing products were called *shingles,* regardless of whether they were the earliest handsplit or the later machine-sawn type. The term *shake* is a relatively recent one, and today is used by the industry to distinguish the sawn products from the split products, but through most of our building history there has been no such distinction.

Considering the confusion among architects and others regarding these terms as they relate to the appearance of early roofs, it should be stated that there is a considerable body of documentary information about historic roofing practices and materials in this country, and that many actual specimens of historic shingles from various periods and places have been collected and preserved so that their historic appearances are well established. Essentially, the rustic looking shake that we see used so much today has little in common with the shingles that were used on most of our early buildings in America.

Throughout this **Brief,** the term *shingle* will be used to refer to historic wooden roofs in general, whether split or sawn, and the term *shake* will be used only when it refers to a commercially available product. The variety and complexity of terminology used for currently available products will be seen in the accompanying chart entitled "Shingles and Shakes."

This **Brief** discusses what to look for in historic wooden shingle roofs and when to replace them. It discusses ways to select or modify modern products to duplicate the appearance of a historic roof, offers guidance on proper installation, and provides information on coatings and maintenance procedures to help preserve the new roof.*

(***Preservation Brief 4: Roofing for Historic Buildings** discusses research methods, analysis of deterioration, and the general significance of historic roofs.)

Wooden Shingle Roofs in America

Because trees were plentiful from the earliest settlement days, the use of wood for all aspects of construction is not surprising. Wooden shingles were lightweight, made with simple tools, and easily installed. Wooden shingle roofs were prevalent in the Colonies, while in Europe at the same time, thatch, slate and tile were the prevalent roofing materials. Distinctive roofing patterns exist in various regions of the country that were settled by the English, Dutch, Germans, and Scandinavians. These patterns and features include the size, shape and exposure length of shingles, special treatments such as swept valleys, combed ridges, and decorative butt end or long side-lapped beveled handsplit shingles. Such features impart a special character to each building, and prior to any restoration or rehabilitation project the physical and photographic evidence should be carefully researched in order to document the historic building as much as possible. Care should be taken not to assume that aged or deteriorated shingles in photographs represent the historic appearance.

Shingle Fabrication. Historically wooden shingles were usually thin (3/8"-3/4"), relatively narrow (3"-8"), of varying length (14"-36"), and almost always smooth. The traditional method for making wooden shingles in the 17th and 18th centuries was to handsplit them from log sections known as bolts (see illus. 5A). These bolts were quartered or split into wedges. A mallet and froe (or ax) were used to split or rive out thin planks of wood along the grain. If a tapered shingle was desired, the bolt was flipped after each successive strike with the froe and mallet. The wood species varied according to available local woods, but only the heartwood, or inner section, of the log was usually used. The softer sapwood generally was not used because it deteriorated quickly. Because handsplit shingles were somewhat irregular along the split surface, it was necessary

1. The Rolfe-Warren House, a tidewater Virginia property, was restored to its 18th-century appearance in 1933. The handsplit and dressed wooden shingles are typical of the tidewater area with special features such as curved butts, projecting ridge comb and closed swept valleys at the dormer roof connections. Circa 1970 Photo: Association for the Preservation of Virginia Antiquities.

2. Handsplit and dressed shingles were also used on less elaborate buildings as seen in the restoration of the circa 1840 kitchen at the Winedale Inn, Texas. The uneven surfaces of the handsplit shingles were generally dressed or smoothed with a draw-knife to keep the rainwater from collecting in the wood grain and to ensure that the shingles lay flat on the sub-roof. Photo: Thomas Taylor.

3. Readily available and inexpensive sawn shingles were used not only for roofs, but also for gables and wall surfaces. The circa 1891 Chambers House, Eugene, Oregon used straight sawn butts for the majority of the roof and hexagonal butts for the lower portion of the corner tower. Decorative shingles in the gable ends and an attractive wooden roof cresting feature were also used. Photo: Lane County Historical Society.

4. With the popularity of the revival of historic styles in the late 19th and early 20th centuries, a new technique was developed to imitate English thatch roofs. For the Tudor Revival thatch cottages, steaming and curving of sawn shingles provided an undulating pattern to this picturesque roof shape. Photo: Courtesy of C.H. Roofing.

to dress or plane the shingles on a shavinghorse with a draw-knife or draw-shave (see illus. 5B) to make them fit evenly on the roof. This reworking was necessary to provide a tight-fitting roof over typically open shingle lath or sheathing boards. Dressing, or smoothing of shingles, was almost universal, no matter what wood was used or in what part of the country the building was located, except in those cases where a temporary or very utilitarian roof was needed.

Shingle fabrication was revolutionized in the early 19th century by steam-powered saw mills (see illus. 6). Shingle mills made possible the production of uniform shingles in mass quantities. The sawn shingle of uniform taper and smooth surface eliminated the need to hand dress. The supply of wooden shingles was therefore no longer limited by local factors. These changes coincided with (and in turn increased) the popularity of architectural styles such as Carpenter Gothic and Queen Anne that used shingles to great effect.

Handsplit shingles continued to be used in many places well after the introduction of machine sawn shingles. There were, of course, other popular roofing materials, and some regions rich in slate had fewer examples of wooden shingle roofs. Some western

5. Custom Handsplit shingles are still made the traditional way with a mallet and froe or ax. For these cypress shingles, a "bolt" section of log (photo A) the length of the shingle has been sawn and is ready to be split into wedge-shaped segments. Handsplit shingles are fabricated with the ax or froe cutting the wood along the grain and separating, or riving, the shingle away from the remaining wedge. The rough surfaces are dressed on a shavinghorse using a draw-knife as shown above (photo B). Note the long wooden shingles covering the work shed in photo A. Photos: Al Honeycutt, North Carolina Division of Archives and History.

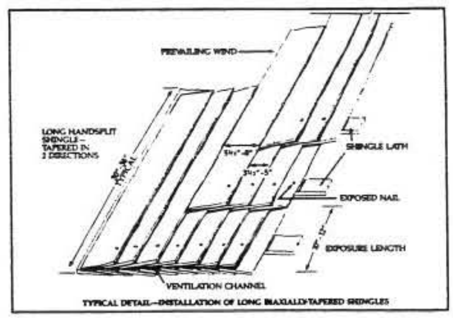
6. Modern machine-made shingles are sawn. Shown are: (photo A) Eastern White Pine quarter split shingle block on equalizer saw being trimmed to parallel the ends; and (photo B) the restored 19th-century shingle mill saw cutting tapered flitches or shingles. The thickness and taper can be precisely controlled. Photo: Steve Ruscio, The Shingle Mill.

"boom" towns used sheet metal because it was light and easily shipped. Slate, terneplate, and clay tile were used on ornate buildings and in cities that limited the use of flammable wooden shingles. Wooden shingles, however, were never abandoned. Even in the 20th century, architectural styles such as the Colonial Revival and Tudor Revival, used wooden shingles.

Modern wooden shingles, both sawn and split, continue to be made, but it is important to understand how these new products differ from the historic ones and to know how they can be modified for use on historic buildings. Modern commercially available shakes are generally thicker than the historic handsplit counterpart and are usually left "undressed" with a rough, corrugated surface. The rough surface shake, furthermore, is often promoted as suitable for historic preservation projects because of its rustic appearance. It is an erroneous assumption that the more irregular the shingle, the more authentic or "historic" it will appear.

Historic Detailing and Installation Techniques. While the size, shape and finish of the shingle determine the roof's texture and scale, the installation patterns and details give the roof its unique character. Many details reflect the craft practices of the builders and the architectural style prevalent at the time of construction. Other details had specific purposes for reducing moisture penetration to the structure. In addition to the most visible aspects of a shingle roof, the details at the rake boards, eaves, ridges, hips, dormers, cupolas, gables, and chimneys should not be overlooked.

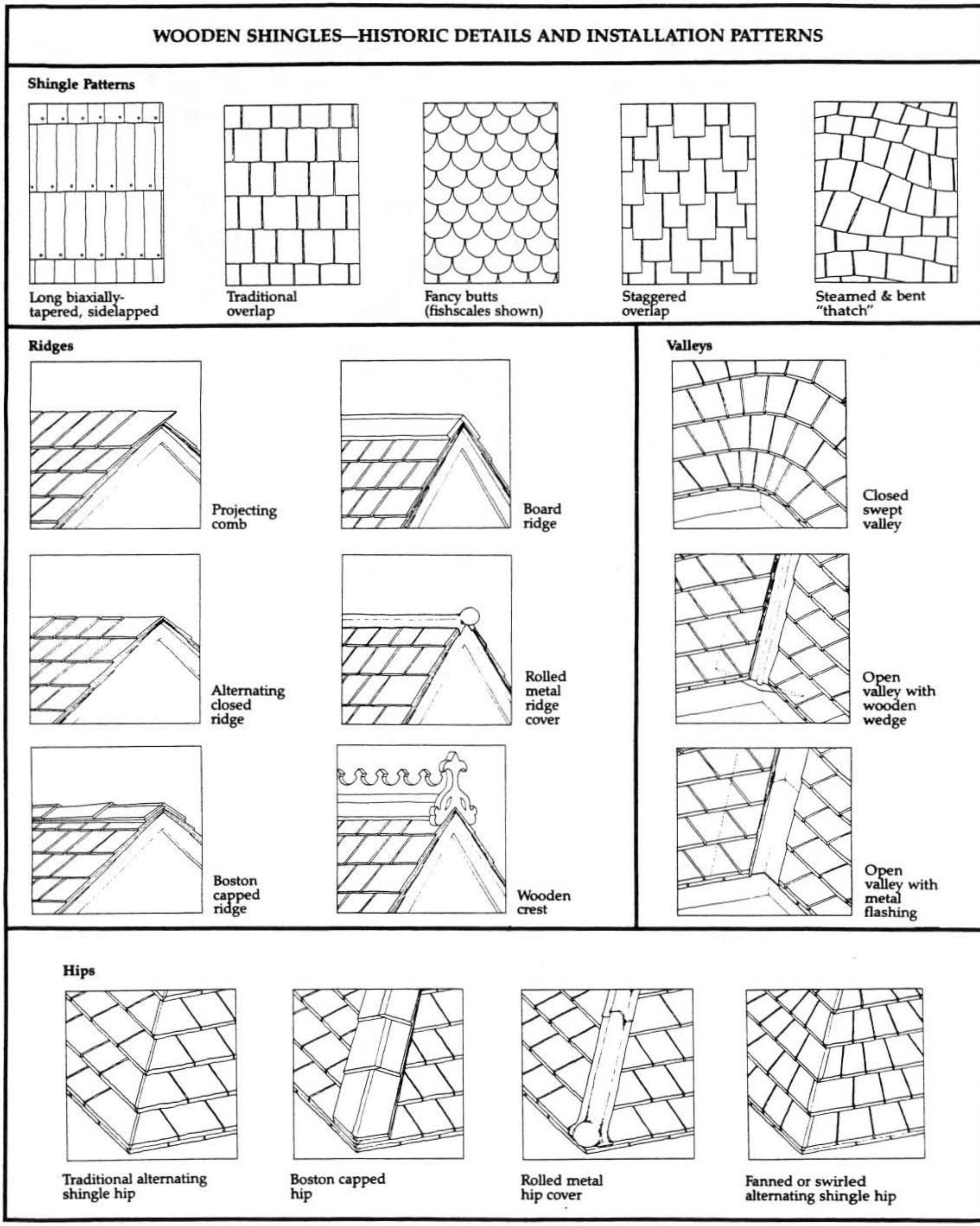
The way the shingles were laid was often based on functional and practical needs. Because a roof is the most vulnerable element of a building, many of the roofing details that have become distinctive features were first developed simply to keep water out. Roof combs on the windward side of a roof protect the ridge line. Wedges, or cant strips, at dormer cheeks roll the water away from the vertical wall. Swept valleys and fanned hips keep the grain of the wood in the shingle parallel to the angle of the building joint to aid water



8. The long biaxially tapered handsplit shingles on the Ephrata Cloisters in Pennsylvania were overlapped both vertically and horizontally. The insert sketch shows channels under the shingles that provided ventilation and drainage of any trapped moisture. The aged appearance of these handsplit and dressed shingles belies their original smoothness. Replacement shingles should match the original, not the aged appearance. Photo: National Park Service; Sketch: Reed Engle.

7. The reshingling of the circa 1856 Stovewood House in Decorah, Iowa, revealed the original open sheathing boards and pole rafters. Sawn cedar shingles were used as a replacement for the historic cedar shingles seen still in place at the ridge. A new starter course is being laid at the eaves. Photo: Norwegian-American Museum, Decorah, Iowa.

9. This 1927 view of the reshingling of the French Castle at Old Fort Niagara, N.Y., shows the wooden sleepers being laid (see arrow) over solid sheathing in order to raise the shingles up slightly to allow under-shingle ventilation. Note that the horizontal strips are not continuous to allow airflow and trapped moisture to drain away. This cedar roof has lasted for over 60 years in a harsh moist environment. Photo: Old Fort Niagara, Assoc. Inc.



10. The Historic Details and Installation Patterns Chart illustrates a number of special features found on wooden roofs. Documented examples of these features, different for every building and often reflecting regional variations, should be accurately reproduced when a replacement roof is installed. Chart: Sharon C. Park; delineation by Kaye Ellen Simonson.

run-off. The slight projection of the shingles at the eaves directs the water run-off either into a gutter or off the roof away from the exterior wall. These details varied from region to region and from style to style. They can be duplicated even with the added protection of modern flashing.

In order to have a weathertight roof, it was important to have adequate coverage, proper spacing of shingles, and straight grain shingles. Many roofs were laid on open shingle lath or open sheathing boards (see illus. 7). Roofers typically laid three layers of shingles with approximately 1/3 of each shingle exposed to the weather. Spaces between shingles (1/8"–1/2" depending on wood type) allowed the shingles to expand when wet. It was important to stagger each overlapping shingle by a minimum of 1-1/2" to avoid a direct path for moisture to penetrate a joint. Doubling or tripling the starter course at the eave gave added protection to this exposed surface. In order for the roof to lay as flat as possible, the thickness, taper and surface of the shingles was relatively uniform; any unevenness on handsplit shingles had already been smoothed away with a drawknife. To keep shingles from curling or cupping, the shingle width was generally limited to less than 10".

Not all shingles were laid in evenly spaced, overlapping, horizontal rows. In various regions of the country, there were distinct installation patterns; for example, the biaxially-tapered long shingles occasionally found in areas settled by the Germans (see illus. 8). These long shingles were overlapped on the side as well as on top. This formed a ventilation channel under the shingles that aided drying. Because ventilation of the shingles can prolong their life, roofers paid attention to these details (see illus. 9).

Early roofers believed that applied coatings would protect the wood and prolong the life of the roof. In many cases they did; but in many cases, the shingles were left to weather naturally and they, too, had a long life. Eighteenth-century coatings included a pine pitch coating not unlike turpentine, and boiled linseed oil or fish oil mixed with oxides, red lead, brick dust, or other minerals to produce colors such as yellow, Venetian red, Spanish brown, and slate grey. In the 19th century, in addition to the earlier colors, shingles were stained or painted to complement the building colors: Indian red, chocolate brown, or brown-green. During the Greek Revival and later in the 20th century with other revival styles, green was also used. Untreated shingles age to a silver-grey or soft brown depending on the wood species.

The craft traditions of the builders often played an important role in the final appearance of the building. The Historic Details and Installation Patterns Chart (see illus. 10) identifies many of the features found on historic wooden roofs. These elements, different on each building, should be preserved in a re-roofing project.

Replacing Deteriorated Roofs: Matching the Historic Appearance

Historic wooden roofs using straight edgegrain heartwood shingles have been known to last over sixty years. Fifteen to thirty years, however, is a more realistic lifespan for most premium modern wooden shingle roofs. Contributing factors to deterioration include the

11. The replacement sawn red cedar shingles matched the deteriorated shingles exactly for this barn re-roofing. The old shingles, seen to the far left, were removed as the new shingles were installed. Even the horizontal coursing matched because the exposure length for both old and new shingles was the same. Photo: Williamsport Preservation Training Center.

thinness of the shingle, the durability of the wood species used, the exposure to the sun, the slope of the roof, the presence of lichens or moss growing on the shingle, poor ventilation levels under the shingle or in the roof, the presence of overhanging tree limbs, pollutants in the air, the original installation method, and the history of the roof maintenance. Erosion of the softer wood within the growth rings is caused by rainwater, wind, grit, fungus and the breakdown of cells by ultraviolet rays in sunlight. If the shingles cannot adequately dry between rains, if moss and lichens are allowed to grow, or if debris is not removed from the roof, moisture will be held in the wood and accelerate deterioration. Moisture trapped under the shingle, condensation, or poorly ventilated attics will also accelerate deterioration.

In addition to the eventual deterioration of wooden shingles, impact from falling branches and workmen walking on the roof can cause localized damage. If, however, over 20% of the shingles on any one surface appear eroded, cracked, cupped or split, or if there is evidence of pervasive moisture damage in the attic, replacement should be considered. If only a few shingles are missing or damaged, selective replacement may be possible. For limited replacement, the old shingle is removed and a new shingle can be inserted and held in place with a thin metal tab, or "babbie." This reduces disturbance to the sound shingles above. In instances where a few shingles have been cracked or the joint of overlapping shingles is aligned and thus forms a passage for water penetration, a metal flashing piece slipped under the shingle can stop moisture temporarily. If moisture is getting into the attic, repairs must be made quickly to prevent deterioration of the roof structural framing members.

When damage is extensive, replacement of the shingles will be necessary, but the historic sheathing or shingle lath under the shingles may be in satisfactory condition. Often, the historic sheathing or shingle laths, by their size, placement, location of early nail holes, and water stain marks, can give important infor-

12. Inappropriately selected and installed wooden shingles can drastically alter the historic character of a building. This tavern historically was roofed with handsplit and dressed shingles of a relatively smooth appearance. In this case, a commercially available shake was used to effect a "rustic" appearance. Photo: National Park Service.

mation regarding the early shingles used. Before specifying a replacement roof, it is important to *establish the original shingle material, configuration, detailing and installation* (see illus. 11). If the historic shingles are still in place, it is best to remove several to determine the size, shape, exposure length, and special features from the unweathered portions. If there are already replacement shingles on the roof, it may be necessary to verify through photographic or other research whether the shingles currently on the roof were an accurate replacement of the historic shingles.

The following information is needed in order to develop accurate specifications for a replacement shingle:

Original wood type (White Oak, Cypress, Eastern White Pine, Western, Red Cedar, etc.)
Size of shingle (length, width, butt thickness, taper)
Exposure length and nailing pattern (amount of exposure, placement and type of nails)
Type of fabrication (sawn, handsplit, dressed, beveled, etc.)
Distinctive details (hips, ridges, valleys, dormers, etc.)
Decorative elements (trimmed butts, variety of pattern, applied color coatings, exposed nails)
Type of substrate (open shingle lath or sheathing, closed sheathing, insulated attics, sleepers, etc.)

Replacement roofs must comply with local codes which may require, for example, the use of shingles treated with chemicals or pressure-impregnated salts to retard fire. These requirements can usually be met without long-term visual effects on the appearance of the replacement roof.

The accurate duplication of a wooden shingle roof will help ensure the preservation of the building's architectural integrity. Unfortunately, the choice of an inappropriate shingle or poor installation can severely detract from the building's historic appearance (see illus. 12). There are a number of commercially available wooden roofing products as well as custom roofers who can supply specially-made shingles for historic preservation projects (see Shingle and Shake Chart, illus. 13). Unless restoration or reconstruction is being undertaken, shingles that match the visual appearance of the historic roof without replicating every aspect of the original shingles will normally suffice. For example, if the historic wood species is no longer readily available, Western Red Cedar or Eastern White Pine may be acceptable. Or, if the shingles are located high on a roof, sawn shingles or commercially available shakes with the rustic faces factory-sawn off may adequately reproduce the appearance of an historic handsplit and dressed shingle.

There will always be certain features, however, that are so critical to the building's character that they should be accurately reproduced. Following is guidance on matching the most important visual elements.

Highest Priority in Replacement Shingles:
- best quality wood with a similar surface texture
- matching size and shape: thickness, width, length
- matching installation pattern: exposure length, overlap, hips, ridges, valleys, etc.
- matching decorative features: fancy butts, color, exposed nails

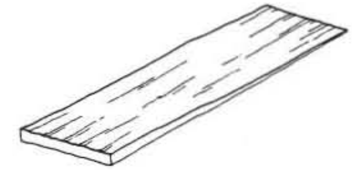
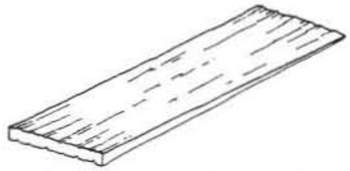
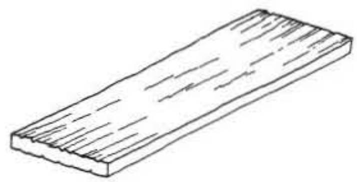
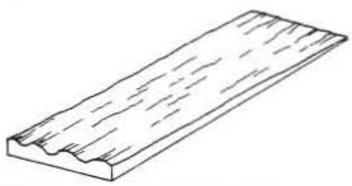
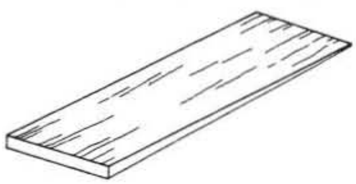
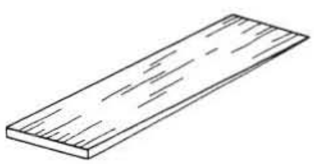
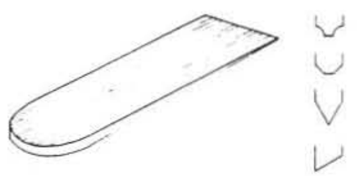
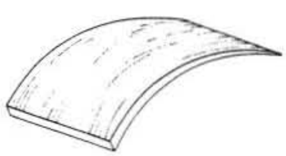
Areas of Acceptable Differences:
- species of wood
- method of fabrication of shingle, if visual appearance matches
- use of fire-retardants, or preservative treatments, if visual impact is minimal
- use of modern flashing, if sensitively installed
- use of small sleepers for ventilation, if the visual impact is minimal and rake boards are sensitively treated
- method of nailing, if the visual pattern matches

Treatments and Materials to Avoid:
- highly textured wood surfaces and irregular butt ends, unless documented
- standardized details (prefab hips, ridges, panels, etc.) unless documented
- too wide shingles or those with flat grain (which may curl), unless documented

What is Currently Available

Types of Wood: Western Red Cedar, Eastern White Pine, and White Oak are most readily available today. For custom orders, cypress, red oak, and a number of other historically used woods may still be available. Some experiments using non-traditional woods (such as yellow pine and hemlock) treated with preservative chemicals are being tested for the new construction market, but are generally too thick, curl too easily, or have too pronounced a grain for use on historic buildings.

Method of manufacture: Commercially available modern shingles and shakes are for the most part machine-made. While commercially available shakes are promoted by the industry as handsplit, most are split by machine (this reduces the high cost of hand labor). True handsplit shingles, made the traditional way with a froe and mallet, are substantially more expensive, but are more authentic in appearance than the rough, highly textured machine-split shakes. An experienced shingler can control the thickness of the handsplit shingle and keep the shingle surface grain relatively

AVAILABLE WOODEN SHINGLES AND SHAKES FOR RE-ROOFING			
TYPE	SIZE	DESCRIPTION	NOTES
Custom split & dressed 	Made to match historic shingles	Handsplit the traditional way with froe & mallet. Tapered. Surfaces dressed for smoothness	Appropriate if: • Worked to match uniformly dressed original shingles
Tapersplit* 	Typically: L = 15", 18", 24" W = 4"–14" Butts vary 1/2"–3/4"	Commercially available. Handsplit the traditional way with froe & mallet. Tapered. Bundles contain varying widths & butt thicknesses. Surfaces may be irregular along grain.	Appropriate if: • irregular surfaces are dressed • butt thicknesses ordered uniform • wide shingles are split
Straightsplit 	Typically: L = 15", 18", 24" W = 4"–14" Butts vary mediums = 3/8–3/4" heavies = 3/4–1¼"	Commercially available. Hand or machine split without taper. Bundles contain varying butt thicknesses; often very wide shingles. Surface may be irregular along the grain. Thick shingles not historic.	*Not* appropriate for most preservation projects • Limited use of thin, even straightsplits on some cabins, barns, etc.
Handsplit* resawn 	Typically: L = 15", 18", 24" W = 4"–14" Butts vary mediums = 3/8–3/4" heavies = 3/4–1¼"	Commercially available. Machine split and sawn on the backs to taper. Split faces often irregular, even corrugated in appearance. Butt thickness vary and may be too wide.	*Not* appropriate for preservation projects
Tapersawn* 	Typically: L = 15", 18", 24" W = 4"–14" Butts vary 1/2"–3/4"	Commercially available. Made from split products with sawn surfaces. Tapered. Butt thicknesses vary and shingles may be too wide. Saw marks may be pronounced.	Appropriate if: • butt thicknesses ordered uniform • wide shingles are split • pronounced saw marks sanded
Sawn-straight butt 	Typically: L = 16"–.40 (<3/8") 18"–.45 24"–.50 (1/2") W = Varies by order	Custom or commercially available. Tapered. Sawn by circular saw.	Appropriate to reproduce historic sawn shingles
Sawn-fancy butt 	Typically: L = 16"–.40 (<3/8") 18"–.45 24"–.50 (1/2") W = Varies by order	Custom or commercially available. Tapered. Sawn by circular saw. A variety of fancy butts available	Appropriate to reproduce historic fancy butts
Steam-bent 	Varies by order to match, "Thatch" roofs	Custom or commercially available. Tapered. Thin sawn shingles are steamed and bent into rounded forms.	Appropriate to reproduce "thatch" shingles

*13. This chart identifies a variety of shingles and shakes used for reroofing buildings. The * identifies product names used by the Red Cedar Shingle and Handsplit Shake Bureau, although shingles and shakes of the types described are available in other woods. Manufacturers define "Shakes" as split products while "shingles" refer to sawn products.* Shingle, *however, is the historic term used to describe wooden roofing products, regardless of how they were made. Whether shingles or shakes are specified for re-roofing, they should match the size and appearance of the historic shingles. Chart: Sharon C. Park; delineation by Kaye Ellen Simonson.*

even. To have an even roof installation, it is important to have handsplit shingles of uniform taper and to have less than 1/8th variation across the surface of the shingle. For that reason, it is important to dress the shingles or to specify uniform butt thickness, taper, and surfaces. Commercially available shakes are shipped with a range of butt sizes within a bundle (e.g., 1/2", 5/8", 3/4" as a mix) unless otherwise specified. Commercially available shakes with the irregular surfaces sawn off are also available. In many cases, except for the residual circular saw marks, these products appear not unlike a dressed handsplit shingle.

Sawn shingles are still made much the same way as they were historically—using a circular saw. The circular saw marks are usually evident on the surface of most sawn shingles. There are a number of grooved, striated, or steamed shingles of the type used in the 20th century to effect a rustic or thatched appearance. Custom sawn shingles with fancy butts or of a specified thickness are still available through mill shops. In fact, shingles can be fabricated to the weathered thickness in order to be integrated into an existing historic roof. If sawn shingles are being used as a substitute for dressed handsplit shingles, it may be desirable to belt sand the surface of the sawn shingles to reduce the prominence of the circular saw marks.

As seen from the Shingle and Shake chart, few of the commercially available shakes can be used without some modification or careful specification. Some, such as heavy shakes with a corrugated face, should be avoided altogether. While length, width, and butt configuration can be specified, it is more difficult to ensure that the thickness and the texture will be correct. For that reason, whatever shingle or shake is desired, it is important to view samples, preferably an entire bundle, before specifying or ordering. If shingles are to be trimmed at the site for special conditions, such as fanned hips or swept valleys, additional shingles should be ordered.

Coatings and Treatments: Shingles are treated to obtain a fire-retardant rating; to add a fungicide preservative (generally toxic); to revitalize the wood with a penetrating stain (oil as well as water-based); and to give color.

While shingles can be left untreated, local codes may require that only fire-retardant shingles be used. In those circumstances, there are several methods of obtaining rated shingles (generally class "B" or "C"). The most effective and longest-lasting treatment is to have treated salts pressure-impregnated into the wood cells after the shingles have been cut. Another method (which must be periodically renewed) is to apply chemicals to the surface of the shingles. If treated shingles need trimming at the site, it is important to check with the manufacturer to ensure that the fire-retardant qualities will not be lost. Pressure-impregnated shingles, however, may usually be trimmed without loss of fire-retardant properties.

The life of a shingle roof can be drastically shortened if moss, lichens, fungi or bacterial spores grow on the wood. Fungicides (such as chromated copper arsenate, CCA) have been found to be effective in inhibiting such fungal growth, but most are toxic. Red cedar has a natural fungicide in the wood cells and unless the shingles are used in unusually warm, moist environments, or where certain strains of spores are found, an applied fungicide is usually not needed. For most woods, the Forest Products Laboratory of the U.S. Department of Agriculture has found that fungicides do extend the life of the shingles by inhibiting growth on or in the wood. There are a variety available. Care should be taken in applying these chemicals and meeting local code requirements for proper handling.

Penetrating stains and water repellent sealers are sometimes recommended to revitalize wood shingles subject to damage by ultraviolet rays. Some treatments are oil-borne, some are water-borne, and some are combined with a fungicide or a water repellent. If any of these treatments is to be used, they should be identified as part of the specifications. Manufacturers should be consulted regarding the toxicity or other potential complications arising from the use of a product or of several in combination. It is also important not to coat the shingles with vapor-impermeable solutions that will trap moisture within the shingle and cause rotting from beneath.

Specifications for the Replacement Roof

Specifications and roofing details should be developed for each project. Standard specifications may be used as a basic format, but they should be modified to reflect the conditions of each job. Custom shingles can still be ordered that accurately replicate a historic roof, and if the roof is simple, an experienced shingler could install it without complicated instructions. Most rehabilitation projects will involve competitive bidding, and each contractor should be given very specific information as to what type of shingles are required and what the installation details should be. For that reason, both written specifications and detailed drawings should be part of the construction documents.

For particularly complex jobs, it may be appropriate to indicate that only roofing contractors with experience in historic preservation projects be considered (see illus. 14). By pre-qualifying the bidders, there is greater assurance that a proper job will be done. For smaller jobs, it is always recommended that the owner or architect find a roofing contractor who has recently completed a similar project and that the roofers are similarly experienced.

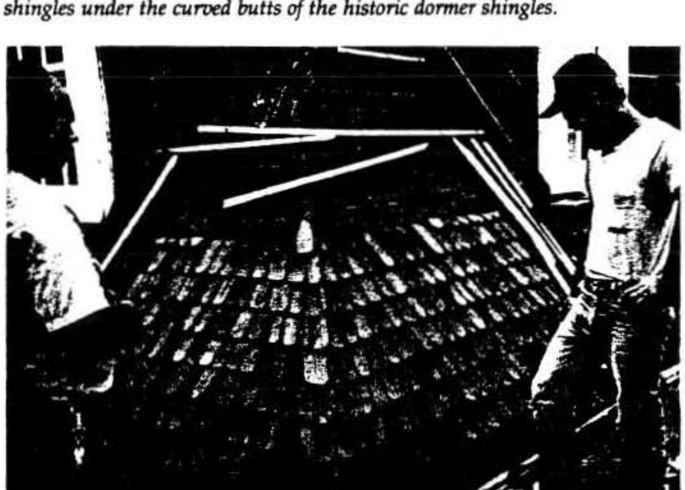
Specifications identify exactly what is to be received from the supplier, including the wooden shingles, nails, flashing, and applied coatings. The specifications also include instructions on removing the old roofing (sometimes two or more earlier roofs), and on preparing the surface for the new shingles, such as repairing damage to the lath or sheathing boards. If there are to be modifications to a standard product, such as cutting beveled butts, planing off residual surface circular saw marks, or controlling the mixture of acceptable widths (3"–8"), these too should be specified. Every instruction for modifying the shingles themselves should be written into the specifications or they may be overlooked.

The specifications and drawn details should describe special features important to the roof. Swept valleys, combed ridges, or wedged dormer cheek run-offs should each be detailed not only with the patterning of the shingles, but also with the placement of flashing or other unseen reinforcements. There are some modern products that appear to be useful. For example, paper-

Replacement Roofing for Appomattox Manor: City Point Unit of Petersburg National Battlefield, Hopewell, Virginia

A. The later non-historic shingles were removed from Appomattox Manor (circa 1840 with later additions) and roofing paper was installed for temporary protection during the re-shingling.

B. These weathered historic 19th-century handsplit and dressed shingles were found in place under a later altered roof. Note the straight butt eave shingles under the curved butts of the historic dormer shingles.



D. The fanned hips (seen here), swept valleys, and projecting ridge combs were installed as part of the re-roofing project. Special features, when documented, should be reproduced when re-shingling historic roofs.

Excerpts from Specifications:

Type of wood to be used: Western Red Cedar.
Grade of wood and manufacturing process: Number One, Tapersplit Shakes, 100% clear, 100% edgegrain, 100% heartwood, no excessive grain sweeps, curvatures not to exceed 1/2" from level plain in length of shake; off grade (7% tolerance) material must *not* be used.
Size of the shingle: 18" long, 5/8" butt tapered to 1/4" head, 3"–4" wide, sawn curved butts, 5-1/2" exposure
Surface finish and any applied coatings: relatively smooth natural grain, no more than 1/8" variation in surface texture, butt thickness to be uniform throughout bundles. Site dipped with fire-rated chemicals tinted with red iron oxide for opaque color.
Type of nails and flashing: double hot dipped galvanized nails sized to penetrate sheathing totally; metal flashing to be 20 oz. lead-coated copper, or terne-coated stainless steel; additional flashing reinforcement to be aluminum foil type with fiber backing to use at hips, ridges, eaves, and valleys.
Type of sheathing: uninsulated attic, any deteriorated 3/4" sheathing boards, spaced 1/2"-3/4", to be replaced in kind.

C. The replacement shingles (see specifications above), matched the historic shingles and were of such high quality that little hand dressing was needed at the site. The building paper, a temporary protection, was removed as the shingles were installed on the sheathing boards.

E. In order to achieve a "Class B" fire-rating, the shingles were dipped in fire-retardant chemicals and allowed to dry prior to installation. Iron oxide was added to this chemical dip to stain the shingles to match the historic red color. These coatings will need periodic reapplication.

14. Original 19th-century handsplit and dressed wooden shingles 18" long, 3"–4" wide, and 5/8" thick were found in place on the Appomattox Manor at Hopewell, Virginia. The butts were curved and evidence of a red stain remained. The specifications and details were researched so that the appearance of the historic shingles and installation patterns could be matched in the re-shingling project. Photos: John Ingle.

coated and reinforced metal-laminated flashing is easy to use and, in combination with other flashing, gives added protection over eaves and other vulnerable areas; adhesives give a stronger attachment at projecting roofing combs that could blow away in heavy wind storms. Clear or light-colored sealants may be less obvious than dark mastic often used in conjunction with flashing or repairs. These modern treatments should not be overlooked if they can prolong the life of the roof without changing its appearance.

Roofing Practices to Avoid

Certain common roofing practices for modern installations should be avoided in re-roofing a historic building unless specifically approved in advance by the architect. These practices interfere with the proper drying of the shingles or result in a sloppy installation that will accelerate deterioration (see illus. 15). They include improper coverage and spacing of shingles, use of staples to hold shingles, inadequate ventilation, particularly for heavily insulated attics, use of heavy building felts as an underlayment, improper application of surface coatings causing stress in the wood surfaces, and use of inferior flashing that will fail while the shingles are still in good condition.

Avoid skimpy shingle coverage and heavy building papers. It has become a common modern practice to lay impregnated roofing felts under new wooden shingle roofs. The practice is especially prevalent in roofs that do not achieve a full triple layering of shingles. Historically, approximately one third of each single was exposed, thus making a three-ply or three-layered roof. This assured adequate coverage. Due to the expense of wooden shingles today, some roofers expose more of the shingle if the pitch of the roof allows, and compensate for less than three layers of shingles by using building felts interwoven at the top of each row of shingles. This absorptive material can hold moisture on the underside of the shingles and accelerate deterioration. If a shingle roof has proper coverage and proper flashing, such felts are unnecessary as a general rule.

15. These commercially available roofing products with rustic split faces are not appropriate for historic preservation projects. In addition to the inaccurate appearance, the irregular surfaces and often wide spaces between shingles will allow wind-driven moisture to penetrate up and under them. The excessively wide boards will tend to cup, curl and crack. Moss, lichens and debris will have a tendency to collect on these irregular surfaces, further deteriorating the roofing. Photo: Sharon C. Park.

However, the selective use of such felts or other reinforcements at ridges, hips and valleys does appear to be beneficial.

Beware of heavily insulated attic rafters. Historically, the longest lasting shingle roofs were generally the ones with the best roof ventilation. Roofs with shingling set directly on solid sheathing and where there is insulation packed tightly between the wooden rafters without adequate ventilation run the risk of condensation-related moisture damage to wooden roofing components. This is particularly true for air-conditioned structures. For that reason, if insulation must be used, it is best to provide ventilation channels between the rafters and the roof decking, to avoid heavy felt building papers, to consider the use of vapor barriers, and perhaps to raise the shingles slightly by using "sleepers" over the roof deck. This practice was popular in the 1920s in what the industry called a "Hollywood" installation, and examples of roofs lasting 60 years are partly due to this under-shingle ventilation (refer to illus. 9).

Avoid staples and inferior flashing. The common practice of using pneumatic staple guns to affix shingles can result in shooting staples through the shingles, in crushing the wood fibers, or in cracking the shingle. Instead, corrosion-resistant nails, generally with barked or deformed shanks long enough to extend about 3/4" into the roof decking, should be specified. Many good roofers have found that the pneumatic nail guns, fitted with the proper nails and set at the correct pressure with the nails just at the shingle surface, have worked well and reduced the stress on shingles from missed hammer blows. If red cedar is used, copper nails should not be specified because a chemical reaction between the wood and the copper will reduce the life of the roof. Hot-dipped, zinc-coated, aluminum, or stainless steel nails should be used. In addition, copper flashing and gutters generally should not be used with red cedar shingles as staining will occur, although there are some historic examples where very heavy gauge copper was used which outlasted the roof shingles. Heavier weight flashing (20 oz.) holds up better than lighter flashing, which may deteriorate faster than the shingles. Some metals may react with salts or chemicals used to treat the shingles. This should be kept in mind when writing specifications. Terne-coated stainless steel and lead-coated copper are generally the top of the line if copper is not appropriate.

Avoid patching deteriorated roof lath or sheathing with plywood or composite materials. Full size lumber may have to be custom-ordered to match the size and configuration of the original sheathing in order to provide an even surface for the new shingles. It is best to avoid plywood or other modern composition boards that may deteriorate or delaminate in the future if there is undetected moisture or leakage. If large quantities of shingle lath or sheathing must be removed and replaced, the work should be done in sections to avoid possible shifting or collapse of the roof structure.

Avoid spray painting raw shingles on a roof after installation. Rapidly drying solvent in the paint will tend to warp the exposed surface of the shingles. Instead, it is best to dip new shingles prior to installation to keep all of the wood fibers in the same tension. Once the entire shingle has been treated, however, later coats can be limited to the exposed surface.

Maintenance

The purpose of regular or routine maintenance is to extend the life of the roof. The roof must be kept clean and inspected for damage both to the shingles and to the flashing, sheathing, and gutters. If the roof is to be walked on, rubber soled shoes should be worn. If there is a simple ridge, a ladder can be hooked over the roof ridge to support and distribute the weight of the inspector.

Keeping the roof free of debris is important. This may involve only sweeping off pine needles, leaves and branches as needed. It may involve trimming overhanging branches. Other aspects of maintenance, such as removal of moss and lichen build-up, are more difficult. While they may impart a certain charm to roofs, these moisture-trapping organisms will rot the shingles and shorten the life of the roof. Buildups may need scraping and the residue removed with diluted bleaching solutions (chlorine), although caution should be used for surrounding materials and plants. Some roofers recommend power washing the roofs periodically to remove the dead wood cells and accumulated debris. While this makes the roof look relatively new, it can put a lot of water under shingles, and the high pressure may crack or otherwise damage them. The added water may also leach out applied coatings.

If the roof has been treated with a fungicide, stain, or revitalizing oil, it will need to be re-coated every few years (usually every 4–5). The manufacturer should be consulted as to the effective life of the coating. With the expense associated with installation of wood shingles, it is best to extend the life of the roof as long as possible. One practical method is to order enough shingles in the beginning to use for periodic repairs.

Periodic maintenance inspections of the roof may reveal loose or damaged shingles that can be selectively replaced before serious moisture damage occurs (see illus. 16). Keeping the wooden shingles in good condition and repairing the roof, flashing and guttering, as needed, can add years of life to the roof.

16. Routine maintenance is necessary to extend the life of the roof. On this roof, the shingles have not seriously eroded, but the presence of lichens and moss is becoming evident and there are a few cracked and missing shingles. The moss spores should be removed, missing shingles replaced, and small pieces of metal flashing slipped under cracked shingles to keep moisture from penetrating. Photo: Williamsport Preservation Training Center.

Cover Photo: 1907 view of a young couple's first home in a cedar stump with a shingled roof. Photo: Historical Society of Seattle and King County, Washington.

Conclusion

A combination of careful research to determine the historic appearance of the roof, good specifications, and installation details designed to match the historic roof, and long-term maintenance, will make it possible to have not only a historically authentic roof, but a cost-effective one. It is important that professionals be part of the team from the beginning. A preservation architect should specify materials and construction techniques that will best preserve the roof's historic appearance. The shingle supplier must ensure that the best product is delivered and must stand behind the guarantee if the shipment is not correct. The roofer must be knowledgeable about traditional craft practices. Once the new shingle roof is in place, it must be properly maintained to give years of service.

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APPENDIX B
Skagit Maintenance Guidelines

To assist Skagit crews in the long-term maintenance of historic properties, the HRMMP calls for the development and implementation of Skagit Maintenance Guidelines. The purpose and scope of the guidelines are outlined in full in Section 3.5 of this document. Once completed, the Skagit Maintenance Guidelines should be incorporated both physically and functionally in the HRMMP as Appendix B.