Windows

Rehabilitation Standard No. 6 - Part 1

Rehabilitation Standard No. 6: Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

Many historic buildings can achieve higher levels of energy efficiency simply by maintaining and repairing their exisiting historic windows. The addition of a storm window, weatherstripping, and proper maintenence is much more cost effective than replacement, and can yield better energy efficiency than a double-paned, thermal replacement window.

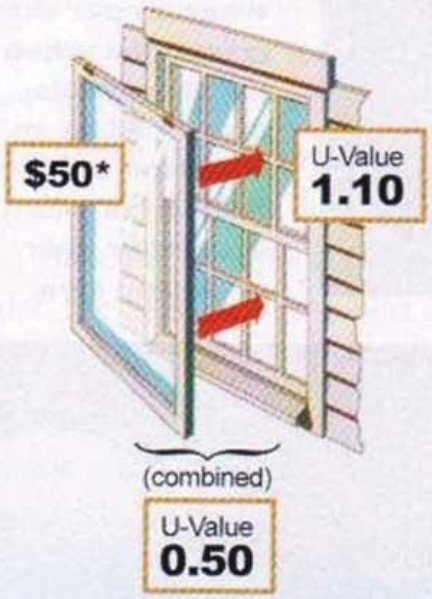
Vinyl replacement windows are not 'green'. They contain PVC (poly vinyl choride) which creates toxic by-products from their manufacture and can emit harmful gases into your home.

Always repair rather than replace. New windows often have a life of around 20 years, while historic windows in good repair can last centuries. Even new wood will not have the density and strength of the old wood, so it is always best to repair rather than replace whenever possible.

Closing or shrinking window openings is not an effective way to improve energy savings. Decreasing the amount of natural daylight creates an increased demand for artificial lighting, which give off more heat and can have the reverse result of increasing energy bills.

Windows are generally not the main culprit of energy loss. Only 10 - 25% of energy loss actually comes from windows. Most often simple weatherization projects, including adding insulation in the attic and maintaing fireplace dampers, can save building owners as much as several hundred dollars per year on energy bills.

Let the Numbers Convince You: Do the Math



TUNE-UP STRATEGIES

Storm window over single-pane original window

ANNUAL ENERGY SAVINGS

722,218 Btu

ANNUAL SAVINGS PER WINDOW**

$13.20

SIMPLE PAYBACK

$50/$13.20 = **4.5 Years**

Double-pane thermal replacement of single-pane window

625,922 Btu

$11.07

$450/$11.07 = **40.5 Years**

Low-e glass double-pane thermal replacement of single-pane window

902,772 Btu

$16.10

$550/$16.10 = **34 Years**

Low-e glass double-pane thermal replacement of single-pane window with storm window

132,407 Btu

$2.29

$550/$2.29 = **240 Years**

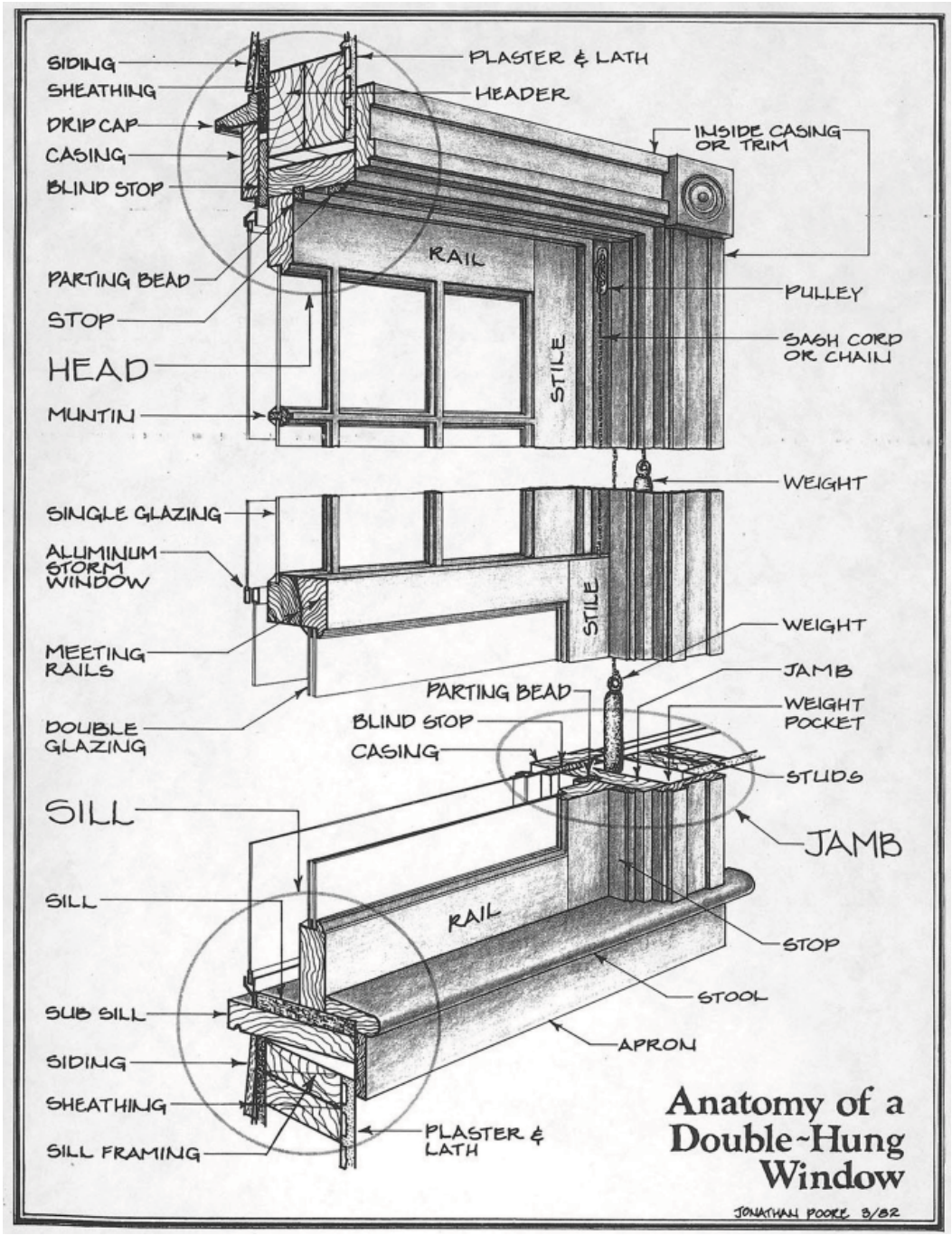
*Cost of 3' x 5' window, installed

**Assuming gas heat at $1.09/therm

Source: Keith Haberern P.E., R.A. Collingswood Historic District Commission

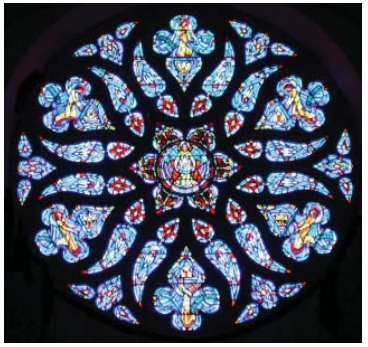
JOHN VAN PELT

Window Parts and Terminology



Architectural Window Styles

Fanlight



Rose or Wheel

Oriel

Eyebrow or Eyelid

Porthole or Round

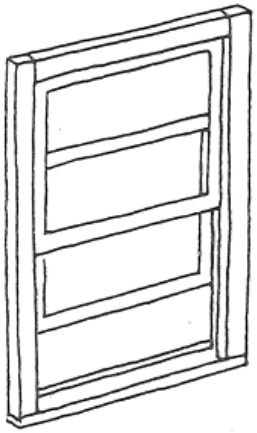
Ribbon or Continuous

Palladian

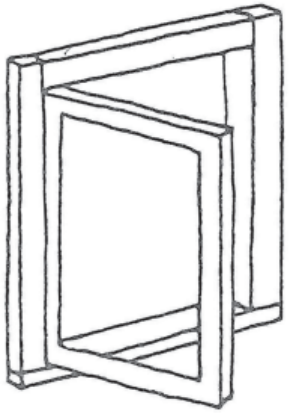
Chicago

Sash Operating Types

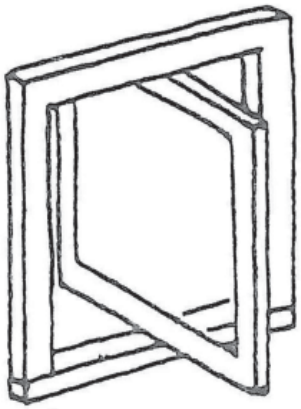
Typical Wood Sash Operation



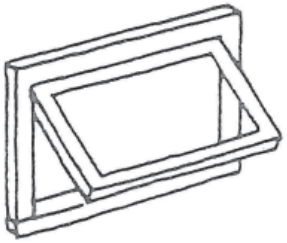
Single- or
Double-Hung



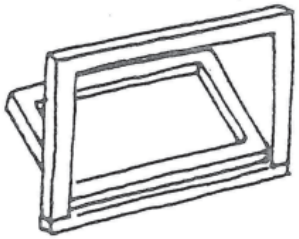
Casement



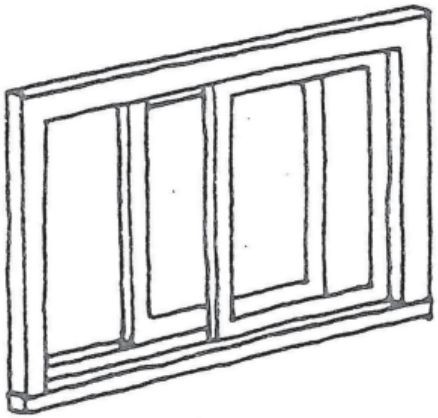
Pivot



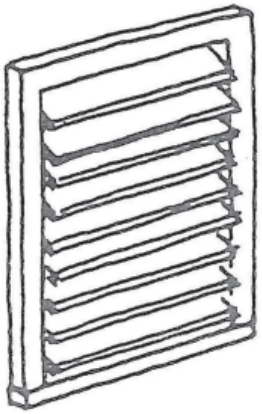
Awning



Hopper

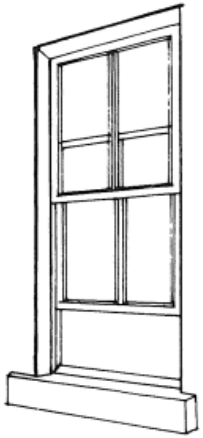


Sliding

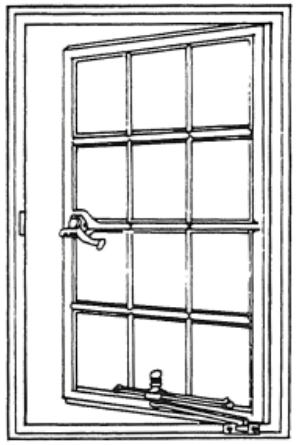


Louver / Jalousie

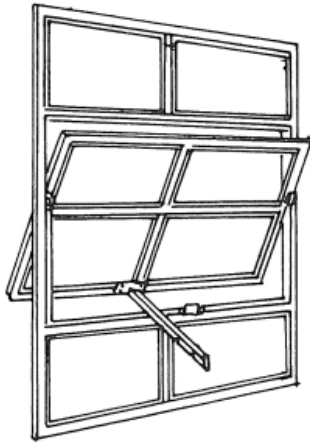
Typical Metal Sash Operation



Single- or
Double-Hung

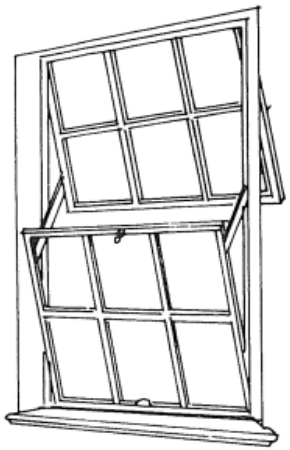


Casement

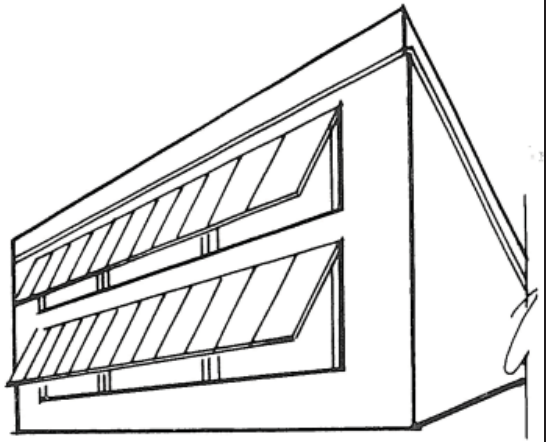


Pivot

Projecting
(Awning or Hopper)



Austral



Continuous / Clerestory / Awning

Steps for Planning Your Window Project

1.) Research the history of the building and its windows through pictoral and written documents found in libraries, archives, historical society collections, and the National Register of Historic Places. Document the windows with interior and exterior photographs BEFORE any work is done.

2.) Using the earlier research, evaluate the historical significance of the windows. Consider any original windows and their materials, features and finishes. Also identify any changes that have occured over time, which may or may not be an integral part of the historic character.

3.) If energy efficiency is a goal, it is best to identify and evaluate any historic, energy saving physical features such as entry vestibules, windows sized for daylighting, and shutters or awnings. It is vital for owners to understand these inherent energy saving qualities.

4.) Assess the water tightness of the building. Repair or replacement of windows may be useless if the roof or building envelope is not water tight.

5.) Assess the existing physical condition of the windows through a window survey (see next column).

6.) Following inspection and analysis of results, create a plan of the necessary repairs or replacement. Consider three categories: routine maintenance procedures, structural stabilization, and parts replacement. (See table?)

If replacement is the only viable option the new windows must match the historic windows in design, color, texture and material.*

*Whenever existing windows that are considered significant are to be replaced, SHPO and NPS require a detailed condition survey to justify the assessment. Contact SHPO for details.

Steps for Evaluating Existing Window Condition

1.) Check for water penetration or air infiltration around the window frame interior and exterior. Caulk any joints or seams.

2.) Inspect all moving parts. Check that the sash lock is operable and keeps the window shut tightly. Ensure that the sash(es) move freely up and down and the sash cord or chain moves smoothly through its pulley. Jamb pegs?

3.) Check glazing putty for cracked, loosened or missing sections. Also check the glazing bed on interior side of glass pane.

4.) Examine the sill to ensure it slopes down, away from the window for water to drain off. You may also cut a dripline on the underside of the sill for proper water run off.

5.) On wood windows, look for areas with paint failure (peeling, cracking, blistering, etc.) to help identify points of water penetration. DO NOT assume that paint failure equals bad wood condition and requires replacement.

6.) Inspect the condition of the wood (or metal?). Common areas for water collection and deterioration are the sill, joints between the sill and jamb, corners of the bottom rails, and muntin joints. If severe deterioration exists it is usually visible. To check less visible deteriorated areas use a small ice pick or awl and jab into wood surface at an angle. Try to pry up a small section of the wood. Sound wood comes up in long, fibrous splinters, but decayed wood will lift up in short, irregular pieces due to the breakdown of fiber strength.

7.) Document window condition through a window condition survey or schedule, and interior and exterior photographs. (For examples see following pages.)

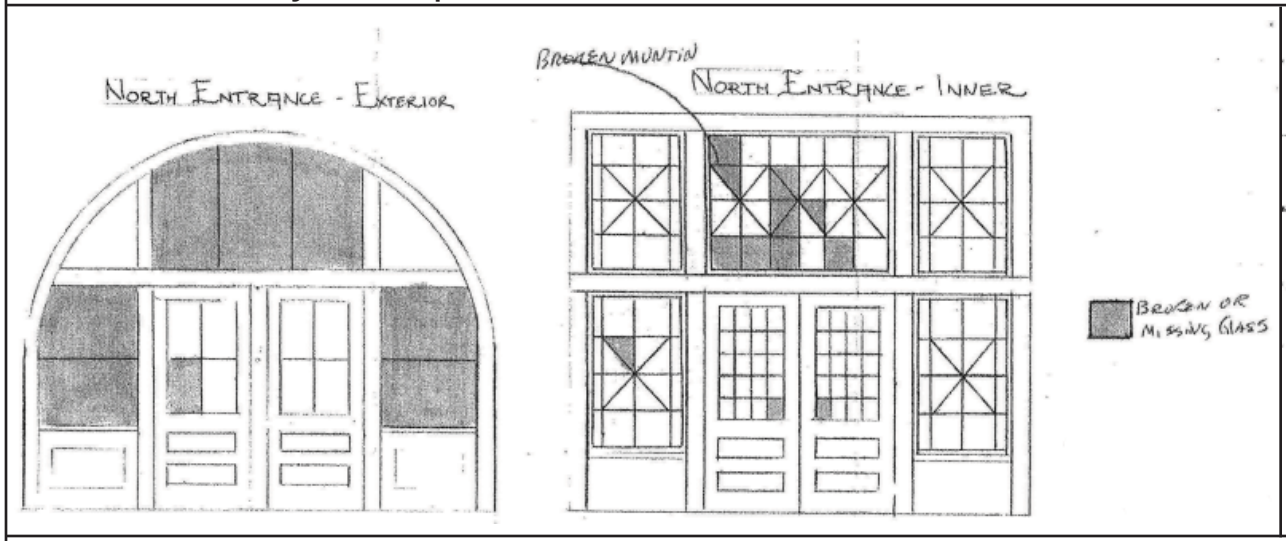
Window Condition Survey Examples

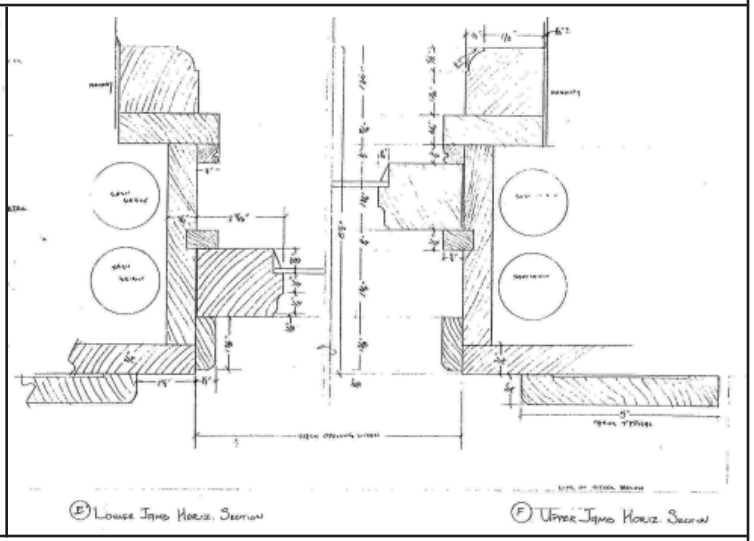
Whenever historic windows that are considered significant are to be replaced, SHPO and NPS require a window condition survey.

A specific format is not required. However, the information provided must be sufficient enough for SHPO to understand the existing condition of all original?? windows. Window condition surveys should include clear photographs of existing windows, elevation and section drawings of the historic windows, and elevation and section drawings of the proposed replacement windows.

Replacement windows must accurately replicate the appearance of the existing historic windows. Window sections provided must show the profiles of muntins, meeting rails, sash, frames, moldings and other features. They must also show the window's relationship to the existing wall plane for the historic window as well as the replacement window.

Window Survey Example 1





Window Survey

1st Floor

1	Replace Component
2	Cut out rotted or deteriorated area, install wood dutchman using epoxy and fastners
3	Correct weathering or deterioration using epoxy resin and or epoxy gel.
3 medium	Correct weathering using both epoxy resin (liquid as primer) and epoxy gel
3 heavy	Major epoxy repair using two or more lifts of epoxy gel after epoxy primer
4	Scrape paint

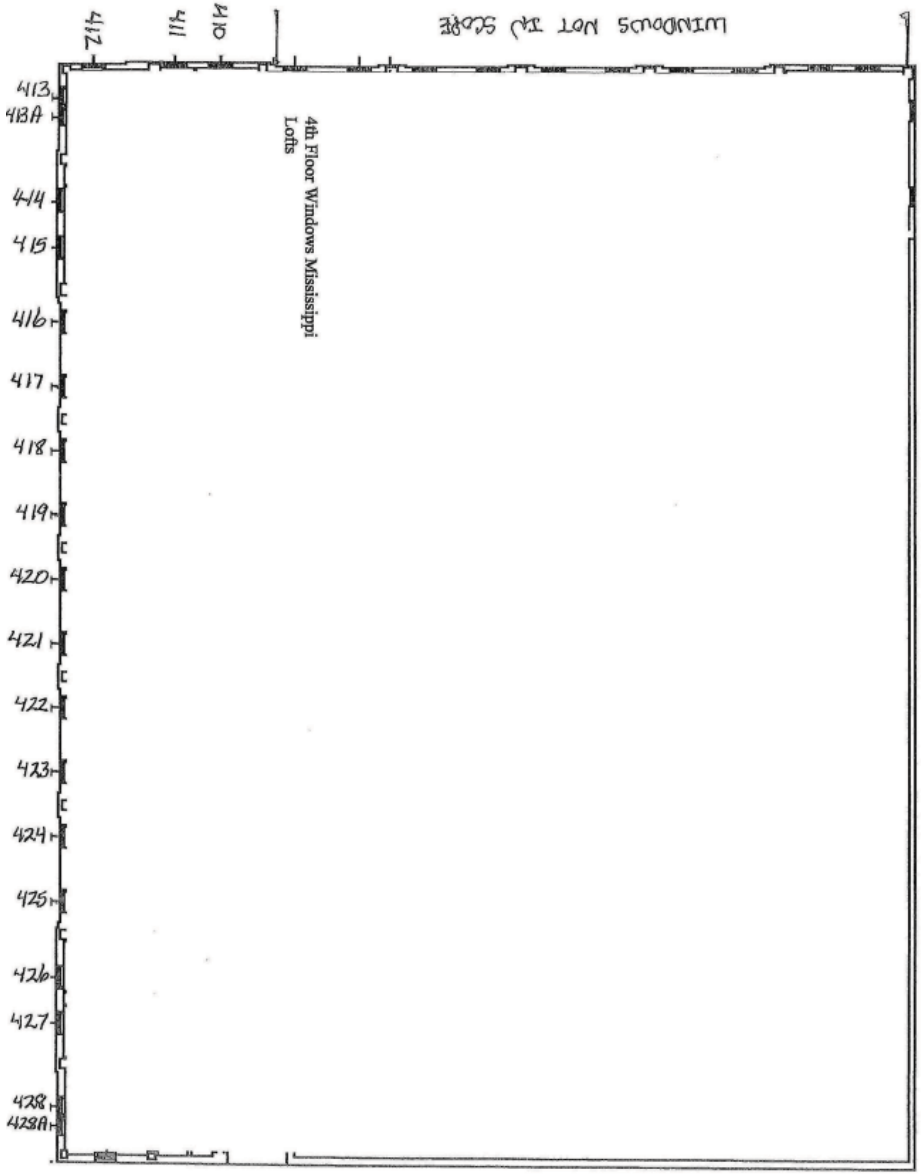
Window Number	Elevation	Sill Condition	Lower Jamb Condition	Parting Stop Condition	Sash Stop Condition	Blind Stop Condition	Brickmold Condition	Upper Sash Condition	Lower Sash Condition	Lock	Lifts	Upper Jamb Condition	Upper Glass
101	East	4	4	1 Replace	4	3, 4	4	3, 4	1 Replace	1/2	2	4	Broken
101 Transom	East	3, 4	4	NA	4	3, 4	4	4	NA			4	
102	East	3, 4	4	1 Replace	4	3, 4	4	3, 4	1 Replace	1	2	4	2/4 broken
102 transom	East	3, 4	4	NA	4	4	4	4	NA			4	OK
103	East	3	2 right, 3, 4	1 Replace	3	3 left, 4	4	3, 4	3, 4	1	2	4	4 lite ok
103 transom	East	4	4	NA	4	4	4	4	NA			4	Gone

Fritz Miller Consulting

Window Survey Example 2

Window 410: Bottom sash, bottom rail has significant rot at the attachment point of the left hand stile. The joint is not loose however; this may stay as a class II for condition. However there will be a significant amount of labor to do so. See photographs for 410 below.

FOURTH FLOOR		
WINDOW 410:	**CONDITION**	**PAINT**
Top Sash Top Rail	Class II	Class III
Top Sash LH Stile	Class II	Class III
Top Sash RH Stile	Class II	Class III
Top Sash Check Rail	Class II	Class III
Bottom Sash Bottom Rail	Class III	Class III
Bottom Sash LH Stile	Class II	Class III
Bottom Sash RH Stile	Class II	Class III
Bottom Sash Check rail	Class I	Class I
Sill	Class II	Class III
LH Jamb	Class I	Class II
LH Brickmold	Class II	Class III
RH Jamb	Class I	Class II
RH Brickmold	Class II	Class III
Head Jamb	Class I	Class I
Head Brickmold	Class II	Class III
Glass	ONE BROKEN	
Muntins	Class I	Class II
Glazing	Class I	



A window condition survey form can be found at http://www.iowahistory.org/historic-preservation/index.html

Repair

Window repair can be classified into three categories (classes):

Repair Class I - Rountine Maintenance
Typical maintenance to keep a window in good condition usually includes 1) some degree of paint removal, 2) repair of sash, including reglazing where necessary, 3) repairs to the frame, 4) weather-stripping and 5) repainting.

Repair Class II - Stabilization
Many windows will show some degree of physical deterioration, especially on the sill, but even badly damaged wood can be repaired easily.

Partially decayed wood can be waterproofed, patched, built-up, or consolidated and repainted to achieve sound condition, good appearance and long life. Techniques listed in this guideline can be done using products found in most hardware stores.

Repair Class III - Splices and Parts Replacement
In some cases, wood deterioration is so advanced that stabilization is impractical, and the only way to retain some of the original fabric is to replace damaged parts.

This involves splicing new matching wood into existing members or replacing parts of the frame. It is necessary to remove the affected parts and have a carpenter or woodworking mill reproduce the missing parts.

Retrofit

Most historic windows can be retrofitted to achieve greater energy efficiency. These measures are often applied in conjunction with comprehensive repairs.

One of the best ways to increase energy efficiency is the addition of storm windows. They can be added on the interior or exterior of the historic window, but care should be taken to decide which is best for each building case.

Other retrofit measures include adding weatherseals, additional glazing layers, or devices such as shutters, shades, blinds and awnings.

Replace

When the condition of an historic window clearly indicates replacement, the decision process for selecting replacement windows should begin with looking closely at the historic window.

Take note of:
1) pattern of openings and their size
2) proportions of the frame and sash
3) configuration of window panes
4) muntin profiles
5) material (type of wood, metal)
6) paint color
7) the glass (color, type, etc.)
8) details (arched tops, hoods, etc.)

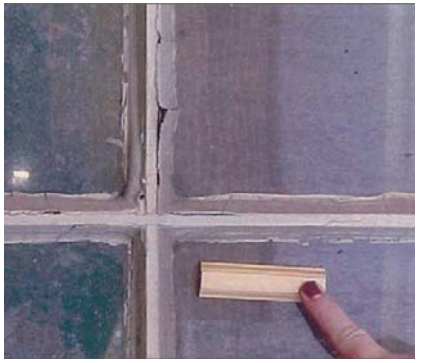
Replacement windows must match the original in size, appearance, finish, and whenever possible, materials.

Energy conservation is no excuse for wholesale removal of historic windows which can be made thermally efficient by historically and aesthetically acceptable means.

Always repair rather than replace.





Common Window Problems and Repair Solutions

CAUTION - Solutions listed here are considered appropriate for the corresponding problem, but may NOT be the best solution in every instance. Research should be done to determine the most effective solution that 'does no harm' to any historic material. Manufacturer's instructions should be followed at all times.

Problem	Likely Cause	Solution
Flaking / missing paint	Deterioration from weather, or may indicate excess moisture levels in wood.	Check moisture levels in wood and correct any moisture problems. Remove loose paint to sound paint layer or wood, prime and repaint.
Damp plaster around interior side of window	Lack of ventilation, or water leaking in around window frame.	Check for water penetration around exterior window frame and caulk where necessary. Serious water leakage will require more investigation. Remove defective plaster and ensure all adjacent areas are dry before replacing plaster.
Broken / cracked glass	Accidental damage or vandalism. Small diagonal cracks in corners indicate distortion in sash frame.	Small corner cracks in original, valuable glass are often acceptable. For large breaks, remove broken glass without damaging wood framing and re-glaze. (See Missing / cracked glazing putty)
Broken sash cords	Wear and tear in old cords or cord snagging on pulley wheel.	Take out sashes and weigh them to ensure correct weight. Replace or add weight as necessary. Replace sash cord (cotton rope is best, nylon rope will break down from UV light). Keep cord free of paint. Check that sash pulleys move freely and won't snag cord.
Missing / cracked glazing putty	Deterioration from ageing or where new putty has not been re-painted correctly.	Cut out defective putty. Putty may first need to be softened by an alkali paint stripper, or, with extreme care to not crack glass, a heat gun on low setting. Coat exposed muntins with boiled linseed oil before applying new putty. UGL GLAZOL® putty is acceptable, DAP® putty is not recommended. Wait 28 days before priming and painting putty.
Wood decay in sill	Water pooling from improper slope of sill away from window.	Remove all decayed wood to repair with an epoxy like Abatron®, or replace with new matching wood. Ensure sill slopes down away from window for proper drainage. You may also cut a drip line on the underside of the sill. Prime and repaint.
Wood decay in sash joinery (commonly at lower rails and mortice joints of upper and lower sashes)	External weathering or excessive internal condensation on horizontal frame members.	Remove all decayed wood to repair with an epoxy like Abatron®, or replace severely deteriorated pieces with splices of new matching wood. If muntins need repair it is best to replace the whole piece, unless it is minimal deterioration / damage. Prime and repaint.
Sash joints opening up	Mortices snapped or dowels cracked.	Glue, wedge and clamp the joint. Or strengthen sash by adding non-ferrous metal angle plates across corners. You may also piece in new wood pieces at rails and stiles with new mortices and/or tenons. Any old, loose dowels should be carefully driven out and new dowels glued into place. Prime and repaint as necessary.

Retrofitting Measures

Research indicates that existing historic windows can be upgraded to meet or exceed the performance standards of replacement windows, and at less cost than purchasing replacement windows.

	Weatherstripping is one of the least expsensive components of a window, and can be responsible for over 50% of energy performance. It reduces air, water and noise infiltration around the window. There are many types including thin spring metal strips, spring plastic strips, plastic foam or felt strips, rolled vinyl or rubber gaskets, extruded rubber or plastic profiles, film clad foam, pile weatherstripping, and sealant beads. Plastic foam or felt strips absorb moisture and can cause wood to rot or metal to rust, so they should only be used in limited instances.
	Storm windows can be installed on the interior or exterior of historic windows and can be made out of materials like wood and aluminum, among others. **Exterior storms** protect the more valuable prime window, but can also obscure the historic window if not done properly. **Interior storms** leave the historic, prime window unprotected and may allow it to deteriorate faster, however they do not obscure the historic window. Leaded glass windows require extra attention when adding interior or exterior storms. Exterior storm windows will create a greenhouse effect that can melt the lead and cause the window to buckle. Interior storm windows will cause condensation to gather on the prime window that can exacerbate rot or rust on the prime window. In either case, it is important to vent the outermost window (prime or storm) to prevent this.
	Specialty glazing like insulated glass is another option, but it requires a very thick window sash to accomodate the thick glass and added weight. A better option is the addition of laminated, safety glass (automobile glass). It is twice as soundproof as laminated glass, shatter resistant, readily available and relatively inexpensive. It is also very thin, so it is easily added to most historic windows and can be used in conjunction with a low-e coating for increased energy effieciency.
	Shutters, shades, awnings and blinds have all been used historically to counter the poor thermal performance of glass. Insulated shutters and curtains are effective in winter to keep cold air out. Louvered shutters, awnings and blinds are effective for reducing solar gain in the summer. For best performance, awnings and shutters should be operable. In the summer they can shade windows to pre-vent solar gain, but they can be pushed back or opened in the winter for passive heating during the day. Roll-up window shades with reflective solar-control film laminates or sunscreens can also prevent solar gain in summer, and can be retracted in winter for passive heating during the day.

Energy Conservation in Historic Buildings

Energy conservation should never be a strategy base solely on windows. It should be a comprehensive project looking at the building as a whole, as well any inherent energy saving features that are found in many historic buildings. Historic buildings were designed to help mediate the outside environment from the inside environment as efficently as possible (i.e. often without electricity).

Consider these historic energy conserving features when beginning an energy conservation project:

Roof Overhangs Properly sized overhangs can keep high summer sun off walls and windows while allowing in the lower, winter sun.

Porches Porches provide the same benefits as roof overhangs, as well as sheltered outdoor living space. They can also be partially or fully enclosed to provide a 'buffer' zone for entry doors similar to a vestibule.

Color Exterior color on walls and roofs have an important efffect on heat gain. Dark colors will absorb and transfer heat into a building, while light colors, specifically white, will reflect it away.

Window Size Windows were historically sized to be no larger than neccessary for adequate light and ventilation.

Vestibules Vestibules minimize the air exchange between interior and exterior environments when exterior doors are opened and closed. This creates a 'buffer' area that minimizes heat transfer.

Shading Devices Interior or exterior shading devices like shutters, awnings, curtains and blinds can be used to shade out hot summer sun, or insulate against cold, winter air.

Landscape Landscape features, like trees, can have a big impact on energy usage. Deciduous trees can block out solar heat gain in the summer, and allow sunlight through for passive heating during winter.

High Ceilings Historic buildings often have high ceilings, which allows hot air to rise above inhabitants in the summer. It can pose a problem during the heating season, but this can be solved by the use of a ceiling fan.

Light Wells / Clerestories Light wells and clerestory windows provide light and ventilation from above. In summer, opening these windows can create a stack effect, that draws hot air up and out of the building. However, these can be a continual expense in winter due to heat loss.

Not Recommended:

- Closing or shrinking window openings. This will decrease the amount of natural daylight and ventilation, and increase the demand for artificial lighting and ventilation which can increase energy bills.

- Replacing significant, historic windows that can be repaired. Windows are an important character defining feature of any building, and they help identify the buildings architectural style and design.

- Non-operable aluminum and vinyl shutters. If the building historically had shutters, operable wooden shutters will perform much better.

- Putting a dropped-in ceiling. This will not increase energy efficiency, and has the adverse affect of trapping warm air in the void between the dropped ceiling and the historic ceiling.

Cost Effective Energy Efficiency:

- Add insulation to your attic. Adding just 3.5” of insulation in your attic can save more energy than replacing all your windows.

- Use heavy interior drapes. You can buy thermal window panels as most home stores.

- Make use of any operable shutters or awnings over your windows that can keep out hot, summer sun.

- Make sure your window sash lock works correctly. This will keep the window tightly shut and reduce air infiltration.

- **Use storm windows.** Make sure they are in good condition and properly weatherstripped.

- **Caulk around the window opening** on the exterior, and around the window trim on the inside to reduce air infiltration.

- **Keep window paint in good condition** to prevent wood decay or metal rust.

With a little practice, it can be easy and inexpensive to repair and maintain your windows. If you’re not a DIY-er there are often local tradesmen near you that can do it for you.

And remember.....

Old is the new Green.

Sources

Preservation Brief 3 - Conserving Energy in Historic Buildings

Preservation Brief 9 - The Repair of Historic Wooden Windows

Preservation Brief 13 - The Repair and Thermal Upgrading of Historic Steel Windows

The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings

"Let the Numbers Convince You: Do the Math." Old House Journal 35 no. 5 (September/October 2007).

"Sash & Case Windows: A Short Guide for Homeowners". Historic Scotland. Techinical Preservation Group, Edinburgh 2008.

"Repairing Old and Historic Windows: A Manual for Architects and Homeowners". New York Landmarks Conservancy. John Wiley & Sons, Inc., New York 1992.

Burns, John A. "Energy Conserving Features Inherent in Older Homes". U.S. Department of the Interior. U.S. Government Printing Office, Washington, D.C. 1981.

For More Information

Preservation Brief 33 - The Preservation and Repair of Historic Stained and Leaded Glass

*Preservation Brief 37 - Appropriate Methods for Reducing Lead-Paint Hazards in Historic Housing**

The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines for Rehabilitating Historic Buildings <www.nps.gov/history/hps/tps/tax/rhb/index.htm>

The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings <www.nps.gov/history/hps/tps/standguide/index.htm>

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