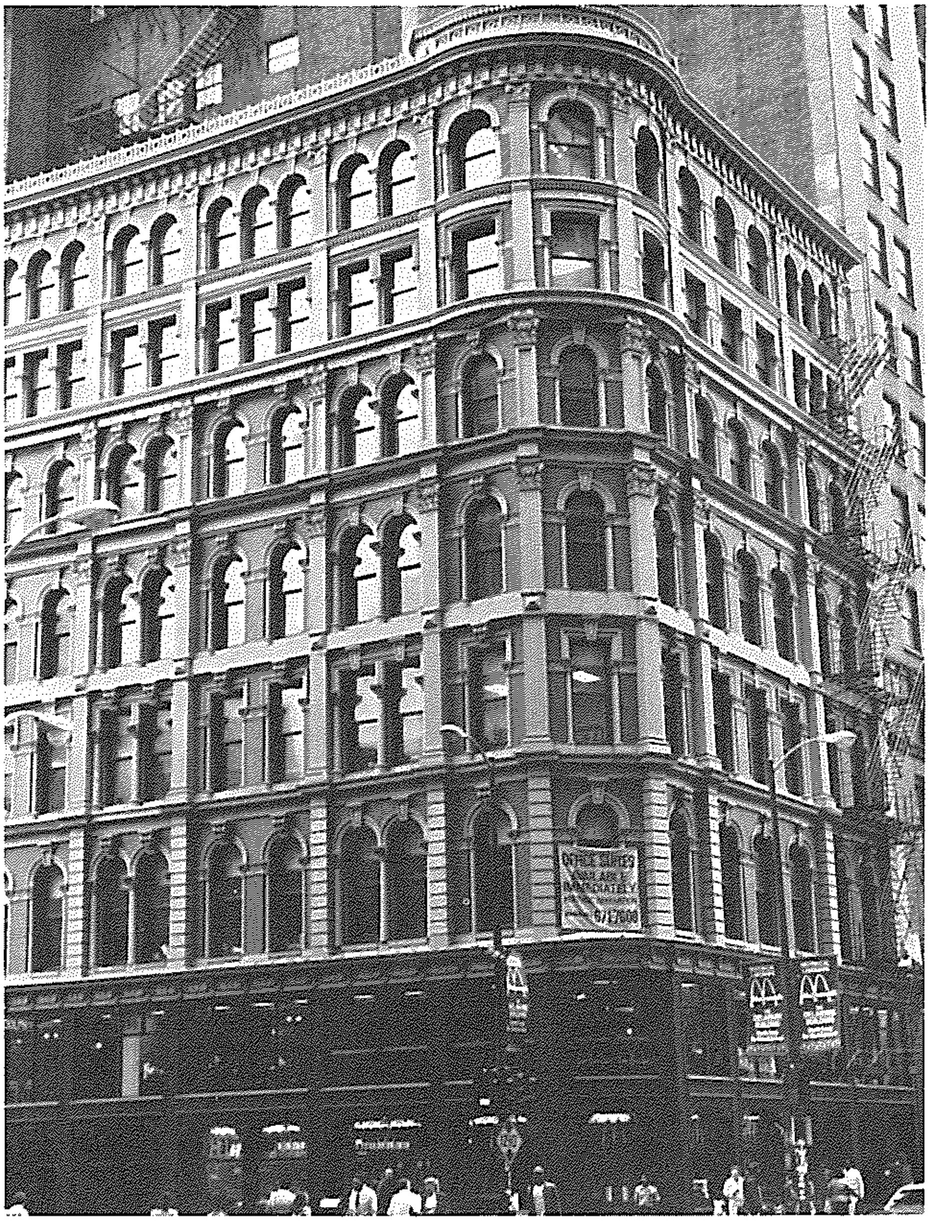

PRESERVATION

Tech Notes

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

WINDOWS
NUMBER 11

Installing Insulating Glass In Existing Wooden Sash Incorporating the Historic Glass

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DELAWARE BUILDING
Chicago, Illinois

The Delaware Building was constructed shortly after the Chicago Fire of 1871 using pre-cast concrete panels on the outside. Originally six stories in height, the Italianate-style office building received an additional two floors around 1890 that were faced with sheet metal to resemble the appearance of the facade below. The lower two floors were originally dressed with ornamental cast iron arches. Later removed, they have been recently restored. Individually listed on the National Register of Historic Places, the building has an impressive interior atrium that survives, providing light to offices on the upper floors.

The windows are set in a deep reveal, paired in an alternating pattern of wide and narrow bays. The wooden sash are double hung and most have arched tops. The window openings are richly detailed with keystones, flanking columns and heavy surrounds, and are separated in pairs on most floors by various pilaster treatments. As part of the rehabilitation of the building in 1982, the existing wooden windows were repaired, weatherstripped and retrofitted with an additional sheet of glazing using a technique that permitted creation of sealed insulating units in each sash.

Rehabilitation Problem

The 102 wooden windows on floors 3 through 8 were over 100 years old yet still in good condition, partly because their deep setback from the face of the building provided some protection from the weather. There was considerable air leakage, how-

Physical damage and visual changes should be minimized when improving the energy performance of historic windows.

ever, due to lack of weatherstripping, cracked putty seals around the glass, and shrinkage and cracks in the caulk around the outside frame. Since tenants would be responsible for their heating and cooling bills upon completion of the rehabilitation work, some form of double glazing was considered desirable.

The windows had both square and arched tops and the size varied considerably, making the cost of a good quality aluminum replacement unit quite high. The 2 1/2″ thick windows varied in height from 6 1/2′ to 9′, depending on the floor level, and the windows on the two-story addition differed in width from those below; overall the windows ranged in width from 3 to 4 feet.

Solution

Since the sash were in the reasonably good condition and contained only single lights, the owner decided to retain them and install insulating glass. Due to the varying sizes and the arched tops, it was discovered to be more economical to create sealed insulating glass utilizing the historic glazing than to remove the existing glass and install all new insulating glass units.

The 2 1/4″ thick sash were in good condition and could handle the additional weight of insulating glass. Because of the height of the windows and the fact that the building could be climatically controlled by individual tenants year round without opening the windows, the top sash were to be fixed shut. The additional weight of the glass meant that the lower sash would need to be rebalanced or somehow modified for ease of operation.

The technique used for double glazing the windows, incorporating the existing glass, was developed in Europe and in use there since the mid 1970s. This technique uses only one additional sheet of glass, placed off the inside edges of the rails and stiles, to create a sealed insulating unit. Since the metal spacer placed between the glass sheets is set slightly off the edges of the rails and stiles, the retrofitted insulating unit reduces the historic glass exposure by about 1/2″ along all sides. This tends to limit the applicability of this technique for double glazing to upper floor windows with large lights since at such distances the reduction in exposed glass area is not readily visible (see figure 1). At the third floor level and above, the 1/2″ encroachment along the edges of the glass on the large sash at the Delaware Building was determined not readily visible from the street. The architect felt that the additional expense to avoid any sight encroachment was not justified for an alternate approach entailing the routing out the 2 1/4″ thick sash on the inside putty rabbet to a greater depth in order to accept an all new sealed insulating unit. Such an alternative, however, might have been appropriate had the interior moldings along the inside rail and stile been more decorative, since the added single pane would obscure such detailing. Fortunately in the case of the Delaware Building, the molding was quite plain.

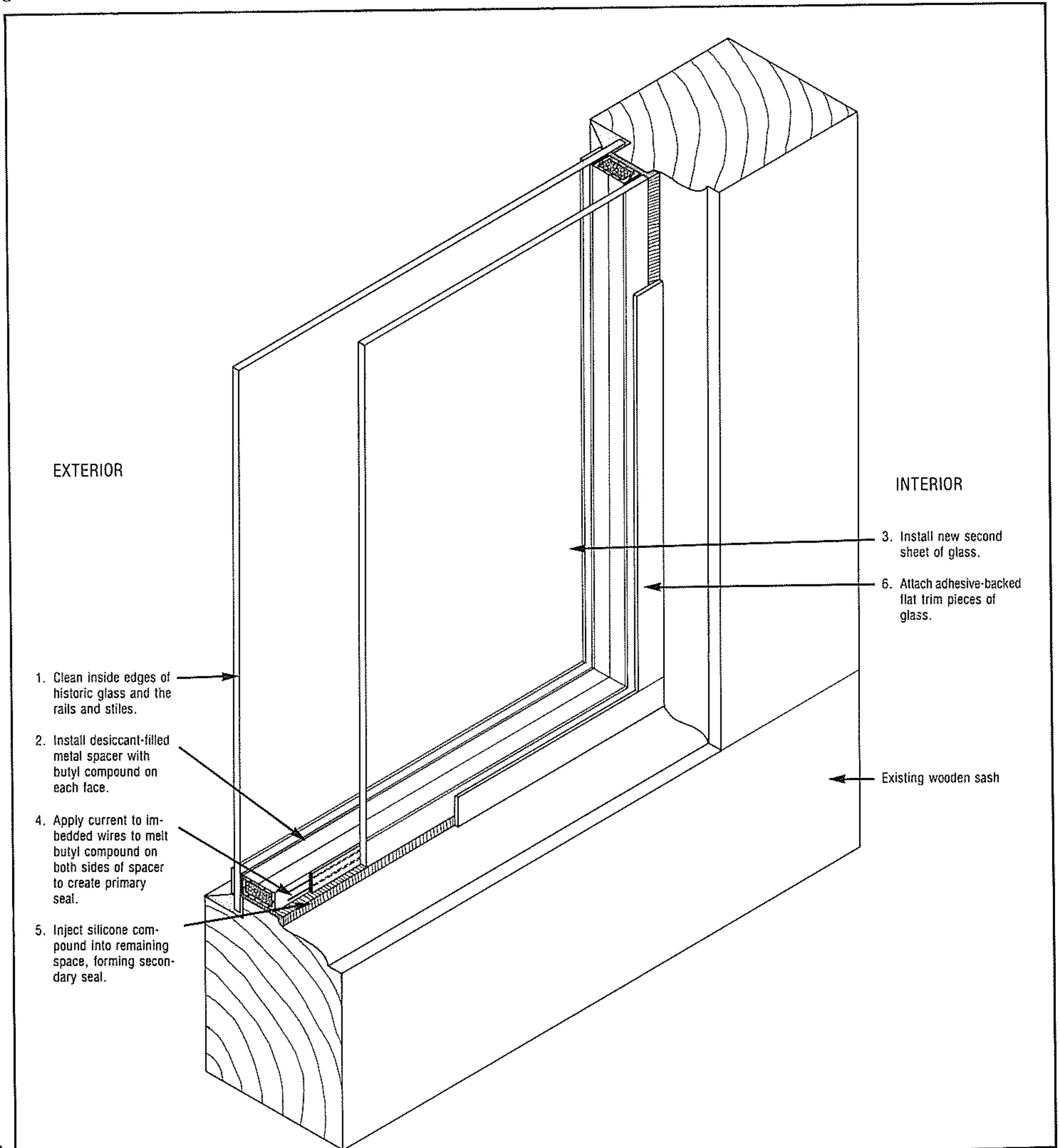
Sealed Insulating Units:

Modification of the window sash was accomplished off site. Each window was tagged, working one floor at a time, prior to shipment to a shop facility nearby. Once in the shop, necessary sash repairs were made, loose paint scraped off, and the glass on the inside surface carefully cleaned.

Figure 1. Since the metal spacer placed between the glass sheets is set slightly off the edges of the rails and stiles, the retrofitted insulating unit reduces the historic glass exposure by about 1/2″ along all sides. This change on large windows is hardly noticeable particularly once the flat trim piece is glued in place. Photo: Charles E. Fisher.

Then a standard hollow rectangular aluminum spacer was sized to fit the opening, filled with a desiccant to absorb any residual moisture that would be entrapped in between the glass sheets, and the corners of the spacer then were edged sealed. Both sides of the spacer that faced the glass were coated with a strip of polyisobutylene. The polyisobutylene strip on the room side also had two parallel copper wires running the entire length, terminating through one corner (see figure 2). With the sash lying flat, the spacer was set snugly up against the inner surface of the existing glass, then the sheet of new glass was placed upon it. Small setting blocks were placed under the bottom edge of the glass. A 3/16" tolerance was left between the bottom of the spacer and new glass and the edges of the rails and stiles. This space, which later is filed with a silicone seal, helps to compensate for any surface irregularities on the inside of the rails and stiles.

Figure 2. The isometric drawing of the window shows the manner in which the insulating glass units were created utilizing the existing glass without any damage to the wooden sash. Drawing: Christina Henry.



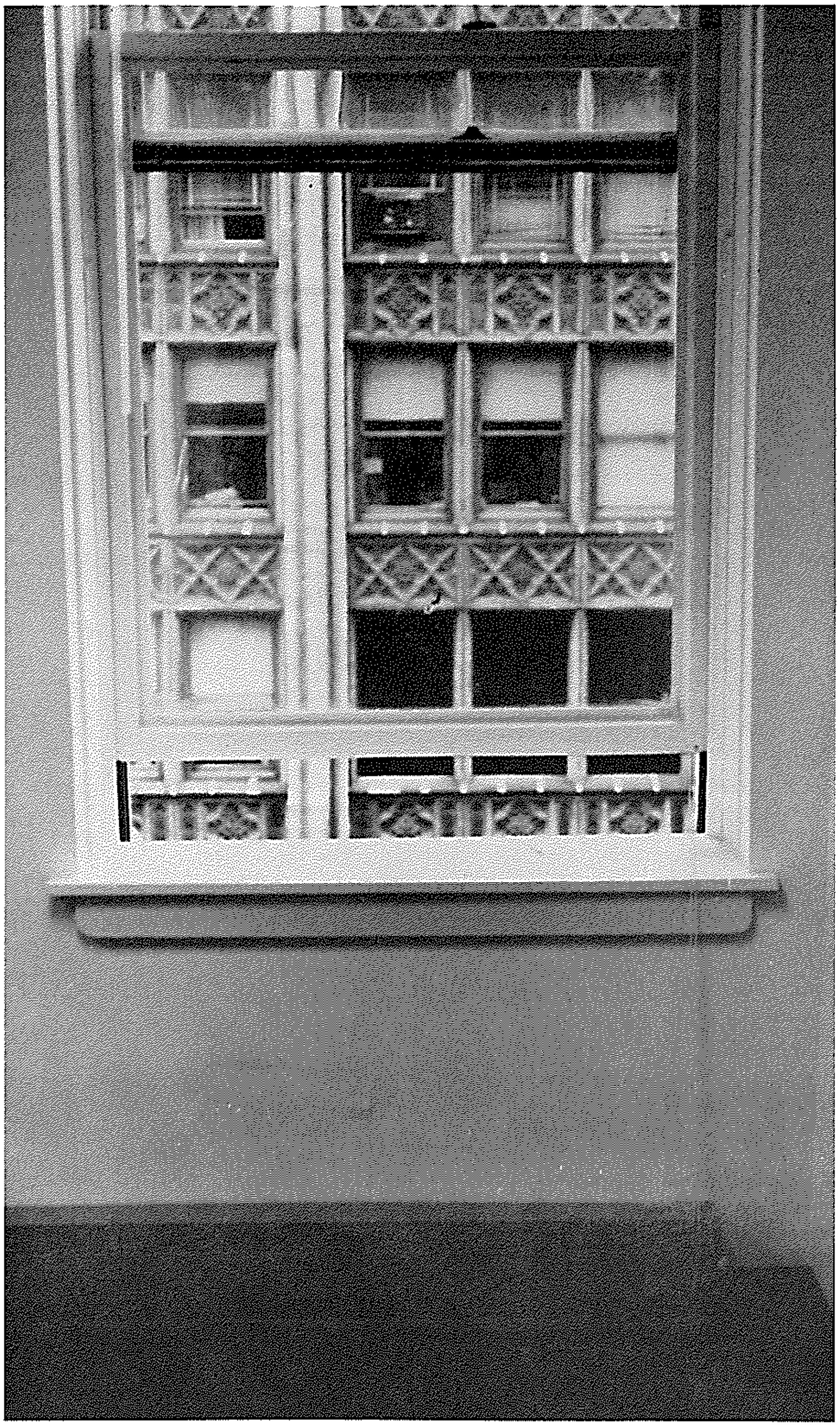


Figure 3. View of the window with the lower sash partially raised following completion of the work. Due to the large size of the sash, the small flat aluminum trim piece covering the spacer had little noticeable effect on the appearance of the windows as viewed from the typical office area. Photo: Charles E. Fisher.

The primary seal for the insulating unit was then created by applying an electrical charge for about 5 to 10 minutes through the two copper wires. The wire-resistant heating melted the butyl compound on both sides of the spacer since the aluminum spacer easily conducted the heat generated by the wires to the polyisobutylene strip on the opposite face. As a secondary seal to retard moisture collection between the glass and help secure the new glass in the sash, a silicone compound was applied in the space between the wood frame, the old glass and the edge of the new glass and the metal spacer (see figure 2).

To complete the glazing work, a flat piece of 5/8″ wide painted aluminum trim was adhered with silicone along the inside perimeter of the light as trim to cover the spacer (see figure 2). A similar trim piece, normally applied to the outside, was judged not to be necessary in this instance.

Balancing and Weatherstripping

Due to the street noise, it was assumed that with climate control available to each tenant mechanically the year round that the lower sash would rarely be opened. Rather than rebalance the lower sash weights, inexpensive "jiffy" springs were added. These springs permit the sash to be opened for outside access for maintenance work and occasional use by the tenants (see figure 3). While the bottom sash were weatherstripped, the upper sash were fixed closed through attachment of two small wooden blocks screwed into the jamb at the bottom corners of the sash. The upper sash were then caulked around the top and sides to minimize air infiltration.

Costs

The cost of creating sealed insulating units installed was $17,403 for the 102 windows, averaging $170.62 per window in 1982. Additional expense to scrape, paint, caulk, weatherstrip and enhance the operability of the lower sash averaged $47.63 per window, bringing total cost for the windows to $22,262, (average $218.25 per window) less than half the cost of good quality aluminum replacement windows. While the creation of sealed insulating units in place was laborintensive, the cost of doing so was lower than the cost of installing all new sealed units into the existing frame.The frames did not have to be rabbeted further to receive the additional thickness of the unit glass, as in the case of all new sealed units; furthermore, only a single sheet of glass per window had to be cut with a curved top.

Evaluation

The incorporation of the existing glass into a sealed insulating unit was accomplished in the Delaware Building without any damage to the historic sash and without any loss of historic material (see figure 4). The retrofit work, which is easily reversible, has performed well since its completion in 1982.

There are a number of companies in the United States which market similar systems. The particular system used in the Delaware Building was tested in the late 1970s by the Danish Institute of Technology, an independent government testing institution, and has been marketed in the U.S. since the early 1980s. The work carries a 5 year manufacturer's guarantee, typical of the insulating glass industry.

Two construction details should be carefully examined when evaluating available systems. Particular care needs to be taken with the corner keys (which hold the metal spacers together), since they need to be coated individually with a sealant in order to maintain the continuous primary insulating seal around the retrofitted unit. Also the butyl compounds used in primary seals can vary in their resistance to the effect of ultraviolet solar radiation.
It is recommended, therefore, that flat exterior trim be applied around the edges of the rails and stiles—even where not needed visually—in order to reduce the possibility of the degradation of the seal as a result of sunlight.

Attractive cost savings over all new sealed units can be realized with this retrofit system, particularly when dealing with arched top sash or windows that vary in size. There are though certain obvious limitations. Where the interior moldings around the inside edges of the rails and stiles are decorative, the manner in which the additional sheet of glass is installed would obscure such detailing. With multipane sash with typical muntin sizes, the encroachment onto the historic glass area would normally be excessive even where the window structurally might accept the additional glass weight. Yet certainly this form of retrofitting insulating glass into large single-light windows on upper floors of structures the size of the Delaware Building easily can be achieved in many cases, permitting the preservation of both the material and appearance of the historic windows while improving their energy performance.

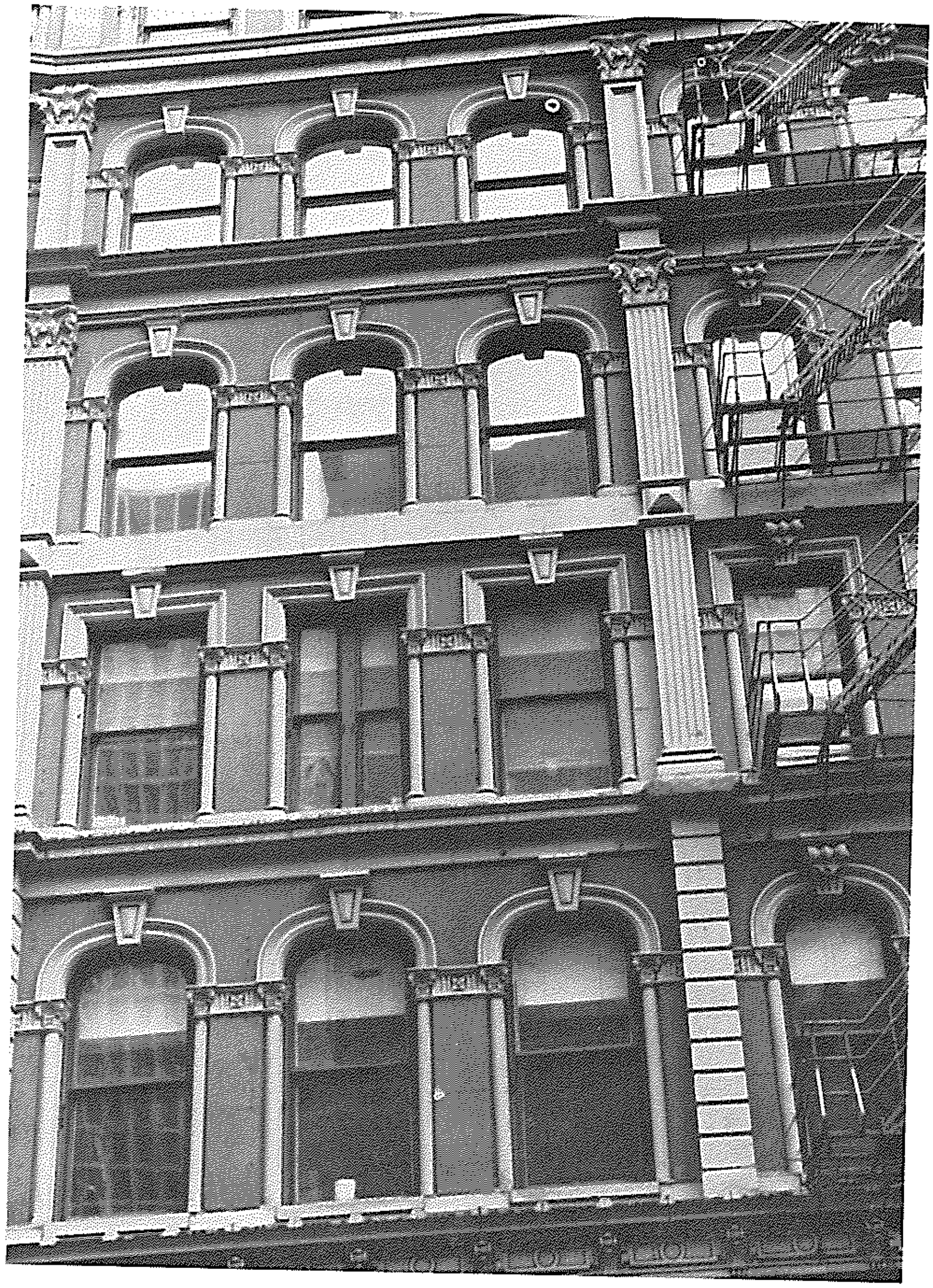


Figure 4. View of the windows on floors 3 thru 6 shows that the technique used for creating sealed insulating glass units in the existing wooden sash had no noticeable impact on the historic appearance of the windows as seen from the street below. Photo: Charles E. Fisher.

PROJECT DATA:

Building:
Delaware Building
36 West Randolph
Chicago, Illinois

Owner:
Delaware Building Partnership
Chicago, Illinois

Project Date: 1982

Project Architect:
Fred Matthias, AIA
Bernheim, Kahn, and Lozano
Chicago, Illinois

Restoration Consultant:
Wilbert R. Hasbrouck, FAIA
Historic Resources
Chicago, Illinois

Window Contractor:
Gail Wallace
Signa Systems Inc.
307 N. Michigan Avenue
Chicago, Illinois

Project Cost:
The total window cost for floors 3 through 8 (102 windows) was $22,262, with the per window cost being $170.62 for the insulating glass work and $42.63 for painting, caulking and weatherstripping.

This PRESERVATION TECH NOTE was prepared by the National Park Service. Charles E. Fisher, Preservation Assistance Division, serves as Technical Coordinator for the PRESERVATION TECH NOTES. Information on the window repair work was generously supplied by Gail Wallace, Historic Preservation Specialist with Signa Systems Inc. Thanks go to the following Preservation Assistance Division staff who contributed to the production: Michael J. Auer, Brenda Johnson, Theresa Robinson, and Christina Henry. Cover photo: Charles Fisher.

This and many of the PRESERVATION TECH NOTES on windows are included in "The Window Handbook: Successful Strategies for Rehabilitating Windows in Historic Buildings", a joint effort of the Preservation Assistance Division, National Park Service, and the Center for Architectural Conservation, Georgia Institute of Technology. For information write to the Center for Architectural Conservation, P.O. Box 93402, Atlanta, Georgia 30377.

PRESERVATION TECH NOTES are designed to provide practical information on innovative techniques and practices for successfully maintaining and preserving cultural resources. All techniques and practices described herein conform to established National Park Service policies, procedures, and standards. This Tech Note was prepared pursuant to the National Historic Preservation Act Amendments of 1980 which direct the Secretary of the Interior to develop and make available to government agencies and individuals information concerning professional methods and techniques for the preservation of historic properties.

Comments on the usefulness of this information are welcomed and should be addressed to Tech Notes, Preservation Assistance Division, National Park Service, P. O. Box 37127, Washington, D.C. 20013-7127.

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