



PRESERVATION

Tech Notes



U.S. Department of the Interior
National Park Service
Cultural Resources

Preservation Assistance Division

WINDOWS NUMBER 17

Repair and Retrofitting Industrial Steel Windows

Robert M. Powers
Mid-Atlantic Regional Office
National Park Service

LIPPINCOTT PRESS BUILDING Philadelphia, Pennsylvania

Located along Philadelphia's Schuylkill River, the Lippincott Press Building is a prominent early twentieth-century industrial structure contributing to the Schuylkill National Register Historic District. Designed by Mahlon H. Dickinson and constructed in 1915, it is a six story, 118,000 square foot structure of reinforced concrete with brick infill. The tripartite industrial steel windows, each with a central pivoting sash, were the dominant architectural feature of the building.

Constructed for the A.H. and F.H. Lippincott Company, the building served as a printing plant until the 1940's, at which time the U.S. Navy converted the building into offices. In

the 1960s the University of Pennsylvania leased portions of the structure for offices and laboratory space.

In 1985 the Lippincott Building was purchased by Historic Landmarks for Living, a Philadelphia-based development firm that specialized in the rehabilitation of historic properties. Their proposal was to convert the building into 105 apartments. The treatment of the windows needed to meet current residential and energy code requirements. In addition, the rehabilitation had to comply with the Secretary of the Interior's Standards for Rehabilitation in order to qualify for the historic preservation tax credits.

Historic steel windows should be repaired rather than replaced whenever possible.

Problem

Since the Lippincott Building was used for a long time as a storage facility, the windows had not been painted, oiled, reglazed, or caulked, nor had missing or damaged parts been replaced in well over twenty years (see figure 1). Naturally, many of the windows exhibited problems typically found on inadequately maintained steel windows, including corrosion, bent and bowed metal sections, non-operable ventilators, missing or non-functional hardware and broken glazing. Furthermore, some of the original windows had been removed and replaced with double-hung aluminum windows, and other window openings had been infilled with glass and concrete block, metal louvered air vents, ductwork and other mechanical equipment (see cover photo).

Solution

To ascertain the feasibility of repairing the existing steel windows, the project architects conducted a preliminary window condition survey. With this preliminary survey, each window opening was assigned a number and a physical inspection was undertaken window-by-window (see figure 2). The results of the inspection were recorded on a survey sheet that typically listed six window openings per page and included the following information:

1. The type of window present and the overall condition of the unit, evaluated on a scale of one to five, five being the poorest condition.
2. Whether the window in its current condition met the Pennsylvania State Energy Code requirements for heat loss, air infiltration, and other energy/comfort criteria.

3. Whether the window met the City of Philadelphia Code, Section 809.4, which requires that operable windows with sill heights no greater than 44" above finished floor level be provided for all habitable apartment spaces below the fourth floor level.

4. Comments on the type and location of deterioration or structural problem found on the window.

From this preliminary condition survey conducted in June, 1986, the following results were obtained. Of the building's 415 windows contained within 193 window openings:

- 6% of the historic windows on all elevations were missing. These windows had been removed and replaced over the years with incompatible windows, or had been enclosed with concrete block and/or mechanical equipment.
- 58% of the historic windows were in poor or nonrepairable condition. The windows designated as being in poor condition contained some heavily corroded sections, primarily in the jamb and sill areas. However, it was considered possible to bring these windows back to a weather-tight, structurally sound state. The nonrepairable windows were those with substantial warping or heavy corrosion on over fifty-percent of the steel members or were irreparably damaged by duct/mechanical equipment.
- 36% of the historic windows were in fair condition. These units had minor sill deterioration and slight warping and were clearly repairable.

Anticipating that full replacement of the historic windows was necessary,

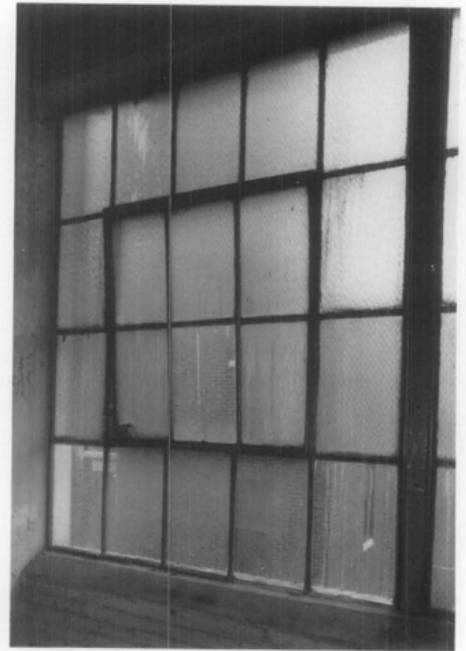


Figure 1. Typical multi-light steel window with ventilator as seen from the interior. This window exhibits typical pre-rehab conditions including sill corrosion, missing hardware and a poorly operating ventilator. Photo: Clio Group.

the project architects prepared detailed drawings of the fifteen existing window types as well as the proposed replacement window options (see figure 3). The new replacement window options considered were:

1. An industrial steel sash with double-glazing manufactured by A and S Steel Company—exterior bars would have a cavetto rather than a bullnose shape.
2. A "Landmark Series" steel window, also with double-glazing, manufactured by Hope's Architectural Products, Inc.—exterior bars would be flat.

WINDOW DESIGNATION	WINDOW TYPE	WINDOW CONDITION					ENERGY COMPLIANCE			CODE COMPLIANCE			REMARKS	RECOMMENDATIONS	WINDOW DESIGNATION	
		1.	2.	3.	4.	5.	PASS	FAIL	NOT APPL.	PASS	FAIL	NOT APPL.				
116a														MISSING 9 PANE		116a
116														1200.		116
216														LOUVER IN 6 PANE		216
316														LOUVER IN 6 PANE		316
416																416
516														OP. RACKED. CLAMP DEM.		516
616														MINOR RACKING RUST DET. AT SILL: op.		616

Figure 2. Window survey form. Prepared by H2L2 Architects.

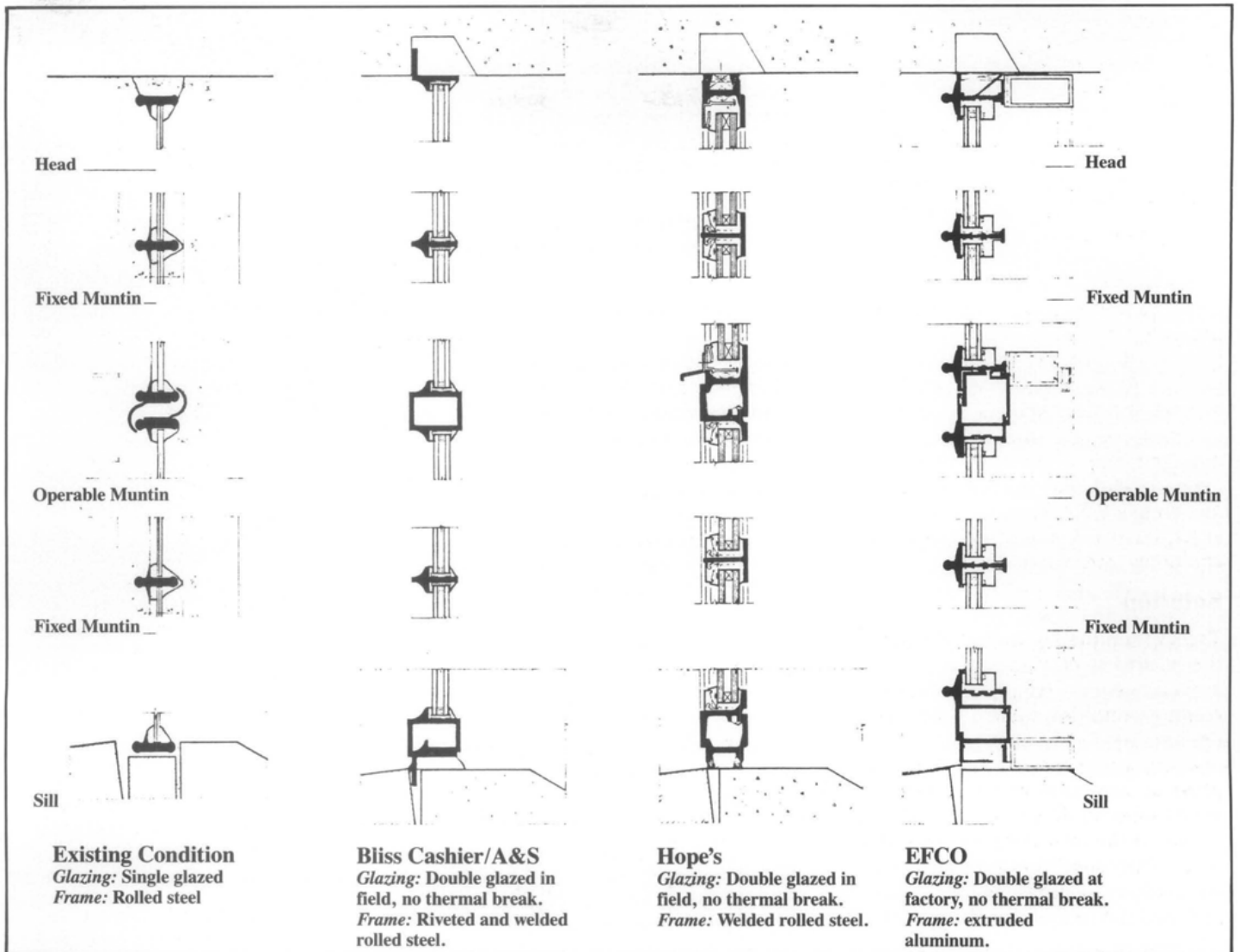


Figure 3. Comparative window sections showing the existing steel window on the left and the three thermally glazed replacement proposals on the right. Drawing: H2L2 Architects.

3. An EFCO, non-thermally broken aluminum sash with double-glazing—exterior pieces would be extruded with a bullnose shape.

In addition to the comparative drawings, mock-ups of the windows manufactured by Hope's and EFCO were installed on the third floor of the south elevation to evaluate how closely the replacements matched the historic windows.

As seen in the comparative drawings and as evident from the mock-ups, the new double-glazed windows did not match the proportions, dimensions, thin profiles and sight lines of the historic steel windows due to the increased dimensions of the new window members. Thus, although the new proposed windows promised increased energy performance, the installation of these non-matching windows would

not have been in keeping with the building's historic character.

Recognizing the visual problems with the proposed replacement windows, the project team decided to examine further the feasibility of repairing and retrofitting the existing windows. Since the preliminary window survey indicated that 58% of the historic windows were in either poor or nonrepairable condition, a second and more detailed analysis of these windows was undertaken by the architectural firm and historical consultants. Particular emphasis was placed on distinguishing between windows categorized as poor-but-repairable and those considered nonrepairable.

From this more detailed analysis it was concluded that in 85–90% of the windows originally categorized as poor or unrepairable condition, heavy

corrosion was confined to the jamb and sill areas and that these units were in fact repairable. Of all the windows within the building, only 10–15% of the existing historic windows were in a non-repairable condition according to the second, more indepth survey, and 6% were missing, leaving 80–85% of all the windows in arguably repairable condition.

The project team decided to rehabilitate the majority of the existing windows after taking into account the following factors: the majority of the existing windows were repairable; the proposed replacement windows installed as mock-ups did not adequately match the existing windows; and the entire rehabilitation project was on a fast-track work schedule that could not allow for delays in the manufacturing and delivery of a new design for custom-made windows.

The rehabilitation included replacing the deteriorated steel sections, particularly in the sill areas, and replacing the missing and nonrepairable windows with new single-glazed steel windows similar in profile and configuration to the existing windows. As part of the repair process, the existing ventilator windows would be modified from center pivoting sash to projecting sash (to meet Philadelphia code for emergency egress), and both the repaired and new steel windows would receive interior storm windows to bring the windows into compliance with the Pennsylvania State Energy Code requirements for heat loss, air infiltration, and other energy/comfort criteria.

To accommodate the first floor lobby and parking garage, the decision was made to repair and reglaze with frosted glass the existing steel windows in the garage area, and to install new windows in the newly created lobby area where no windows previously existed. The garage windows retained their operable pivoting sash, since compliance with energy requirements was not applicable. To provide for adequate garage ventilation, glazing was omitted from a number of the ventilators (see figure 4).

Work Description

The new steel windows were ordered immediately so that their installation would be concurrent with the repair of the historic windows. All the other windows were to be repaired.

Working directly with the project's general contractor, a number of specialized subcontractors were chosen for the window work:

1. Two contractors for the repair and replacement work of the steel components;
2. A contractor who worked directly with a steel window company and supplied all the replacement window parts, including entire windows for those locations that required new windows and stock lengths of steel window sections for replacement pieces for deteriorated members;
3. A glazing contractor who removed all the old glazing and putty, cleaned the steel sections and glazed the windows; and
4. A painting contractor who caulked and painted the windows.

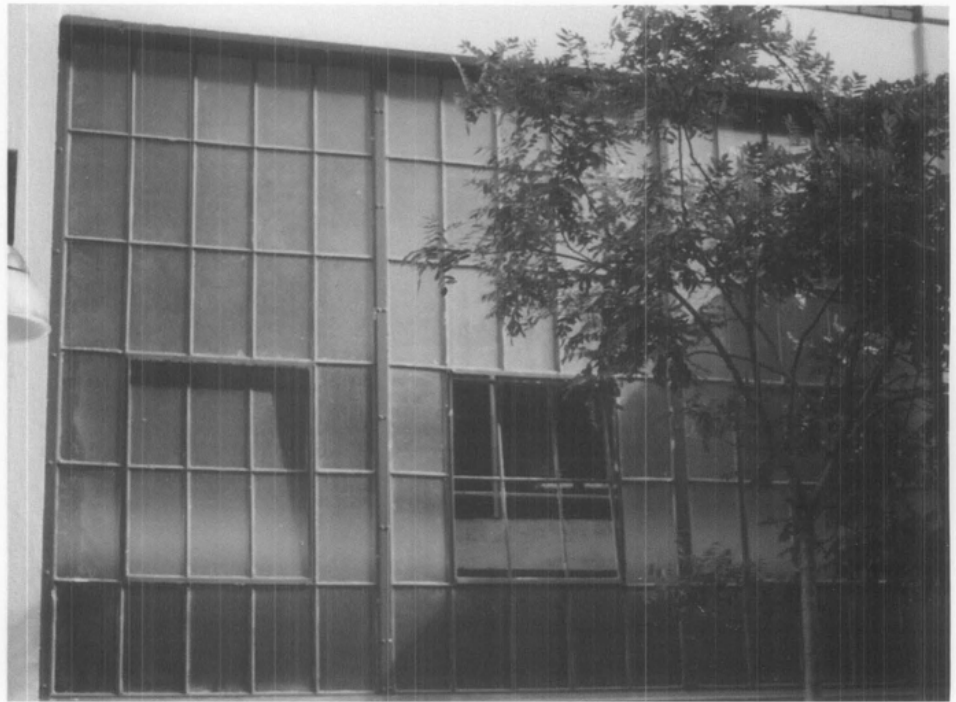


Figure 4. First floor, garage level showing the frosted glass and the center ventilator without glazing. Photo: Robert Powers.

The repair work on the historic steel windows began in November 1986, under the direction of the general contractor.

Glazing Removal

The first step in the repair process was the removal of all the wire glass and other types of more recent glazing. The glazing contractor with a team of eight to twelve men, usually in two-man crews, began breaking out the glass, commencing on the top floor and completing all of the elevations on one entire floor at a time. As much

of the glass as possible was removed at this time, but there was no attempt made to remove all of the putty.

Steel Repair and Ventilator Retrofitting

Immediately after the glazing contractor had removed the glazing from an entire floor, the contractors for the metal work began. Since this rehabilitation was on such a tight completion schedule, and given the labor-intensive nature of the repair work, two metal working contractors were utilized. Each contractor was responsible for



Figure 5. Sill corrosion typically found on 95% of the windows. Photo: Clío Group.

the repair/replacement of windows on three floors of the building. Although most of the seriously deteriorated windows were identified as part of the window surveys, the general rule for the contractors was that if, after close examination, more than 50% of the window unit exhibited severe deterioration, then the entire unit could be replaced. The remaining reusable members would be salvaged for use as replacement pieces on other windows.

Generally employing three crews of three to four men, each contractor began by cutting out all the severely corroded and/or heavily bent metal sections from each window. Severe corrosion occurred primarily in the sill areas where the original steel sill section was embedded in concrete—a condition existing in approximately 95% of the window sills to be repaired (see figure 5). The spalled concrete and the corroded metal sill sections were chopped out with a portable band saw. In addition to the corrosion in the sill areas, extensive deterioration typically extended up the window muntins approximately three to six inches. These members were cut at a 45 degree angle with a five-inch grinding wheel using a five-inch disk, usually at a point four to seven inches from the sill or where the steel was no longer corroded.

Concurrent with the cutting out of the window's corroded steel members, each of the existing pivot window ventilators on floors two through six were cut from their jambs, labeled and brought to an on-site work station. At the work station, the pivoting ventilators were modified to operate as projecting windows (see figure 6). This was accomplished by cutting off the bullnose outside face of the side and bottom rails on the sash and riveting a new water-shed steel angle at the same locations. To allow the ventilators to swing out, two 16", heavy duty, 6 bar, zinc chromate plated steel, TRUTH hinges were screwed to each ventilator (see figure 7). New right-hand, cast iron, bronze lacquered, locking handles were installed on the bottom rail by face-mounting and screwing to each ventilator.

In addition to the retrofitting of the ventilators, many of the window muntins and structural mullions needed to be straightened, patched and repaired (see figure 8). Members that were seriously bowed and could not be adequately straightened were cut off using grinding wheels and salvaged;

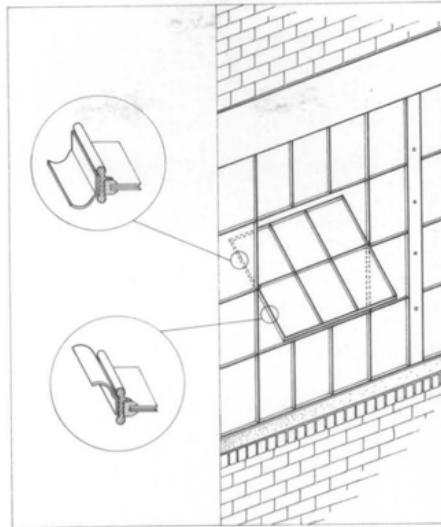


Figure 6. Pivot ventilators prior to retrofitting on the upper floors. Bullnose trim pieces to be modified as part of the retrofitting from pivot to projecting ventilators. Drawing: Martha Raymond.

replacement members were welded into place. Two relatively simple techniques were used to straighten the less seriously bent and bowed steel members. With mullions, a wooden brace (usually a two-by-four) was attached to the mullion; a wire cable was wrapped around the wooden brace and the mullion; and slowly the cable was pulled with a "come-along" winch hooked to the ceiling of the building. Since the mullions had typically bowed toward the exterior, the member was pulled in the direction opposite its bowing, towards the inside of the building. To straighten out bent and bowed muntins, the contractor applied constant pressure through the use of 14" bar-type clamps on the muntin. All indentations and gouges left in the steel members were filled with an auto-body patching compound containing steel fibers and an epoxy binder, sanded smooth and primed with a rust-inhibiting primer.

Once the muntins and mullions were set plumb, the final steps in the steel repair process began. In most of the sill areas, lengths of new steel sections were installed to replace the original corroded members. The new cavetto-shaped steel sections did not match exactly the bullnose profile of the historic windows (see figures 9 and 10). However, the original profile was no longer available and the new profile was close enough so that the overall proportions, profile, and shadow lines were compatible with the historic window appearance. The new steel sections at the sill and the lengths



Figure 7. Retrofitting projecting ventilator with the TRUTH hinges. Photo: Robert Powers.



Figure 8. Bowed and corroded window during construction. Photo: Clío Group.

extending up into the muntins were welded together, installed in the appropriate location and then clamped and welded to the remaining original window. All welds were ground smooth and primed immediately with a rust-inhibiting primer. The concrete sills were then patched. Concurrent with the splicing-in of the new members, the ventilator jambs were also retrofitted to accept the new projecting ventilator. Similar to the work on the ventilators, the bullnose trim piece on the upper portion of the exterior side rails was cut off and a new steel angle was installed on the interior of the side and bottom rails and the hinges were attached.

Cleaning of the Steel, Glazing and Painting

After the metalworkers had cut out the deteriorated pieces, spliced in new steel sections, retrofitted the ventilators and ventilator jambs, and straightened out all the bent and bowed muntins and mullions, the glazing contractor began preparing the steel windows for the installation of new glass. A formidable task in reglazing the windows was the removal of the old glazing putty still left in the glazing rabbet. Two basic techniques were employed. Hammer-guns with chisel-ends were used extensively, although care had to be taken to prevent damage to the steel sections. Slower and less effective, acetylene torches were also used to remove the putty. The torches softened the putty to the point where it could be removed with a scraper.

After the putty was removed, remaining flaking and loose paint and light surface corrosion were removed by rotary wire brushes attached to electric drills or by hand-scraping and sanding. No attempt was made to remove sound paint from the steel windows since the paint did not interfere with the effective operation of the windows.

The windows were then backglazed and new double-strength glass was installed in the bed of compound. Fortunately most of the original clips that helped secure the glass in place remained in good condition and were reinstalled wherever possible. New glazing clips were used as needed. The same compound was used for the finish glazing.

The final step in the repair of the historic steel windows was painting. Operating from swing-staging, which

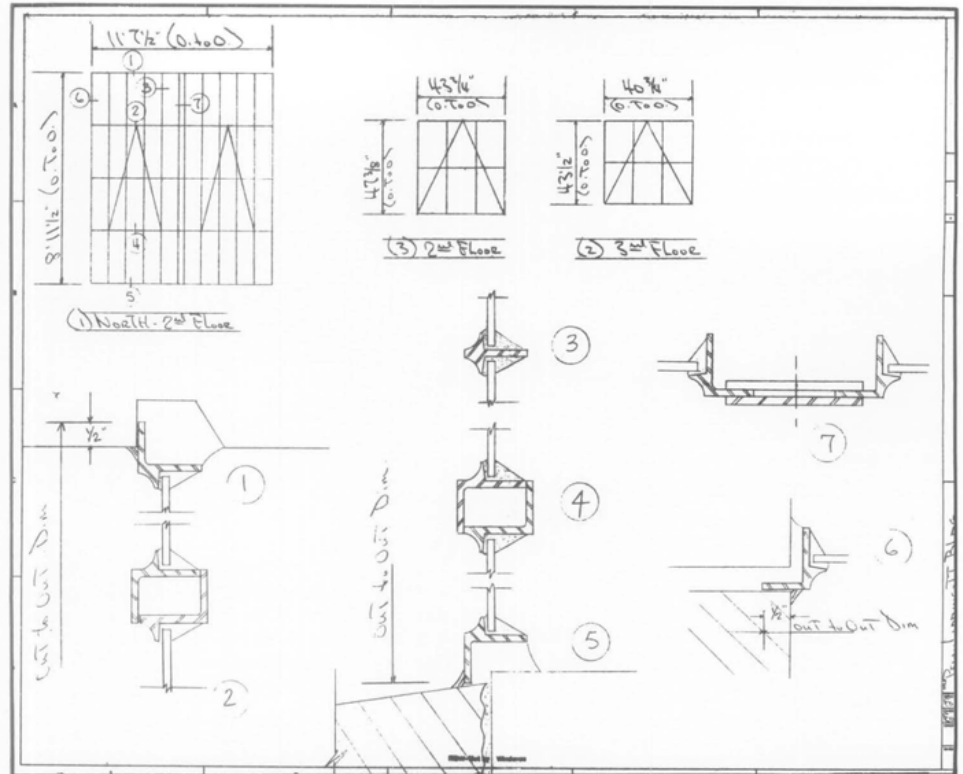


Figure 9. Sectional drawings of replacement window manufactured by A & S Window. Drawing: Winderco, Inc.

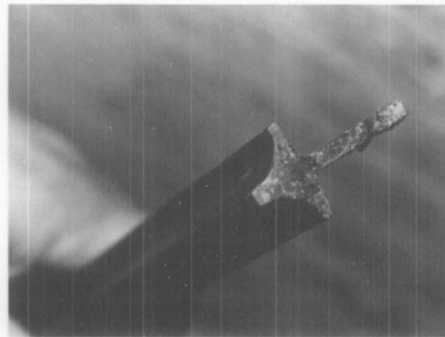


Figure 10. Replacement steel window section used primarily in the sill areas. Photo: Clio Group.

extended the width of an entire three-window opening, the painting contractor lightly sanded and primed with a rust-inhibiting primer all the surfaces that had not been previously primed. All of the windows were then given two coats of a dark green, alkyd-based paint. Prior to the final paint coat, all of the window perimeters were caulked with a vinyl acrylic caulking compound that was also given a coat of finish paint.

Weatherization

An essential component of the rehabilitation project was the upgrading of the steel windows to meet current residential and energy code requirements. The repair and retrofitting of

the existing steel windows in and of itself was not sufficient in bringing the windows up to code. The development of an interior storm window system provided the additional thermal performance for code compliance. The solution involved an aluminum, triple-track, interior storm unit with flanking, fixed "sidelites" (see figure 11). A major consideration in the development of this storm system was the desire to minimize the outside visibility of the storm unit by aligning as closely as possible the meeting rails and other aluminum members with the steel window members (see figure 12). The exterior face of the storm windows was painted the same color as the steel windows so as to be as inobtrusive as possible (see figure 13). Although, the aluminum members do not match exactly the width of the opposite steel members, the storm windows were not readily visible from the exterior.

Project Evaluation

Whether to repair or replace historic windows is a complex issue often facing building owners, contractors, architects and others involved in the rehabilitation field. In this case, the various options available to the development team—from full replacement with a new insulated window system to repairing the existing windows—

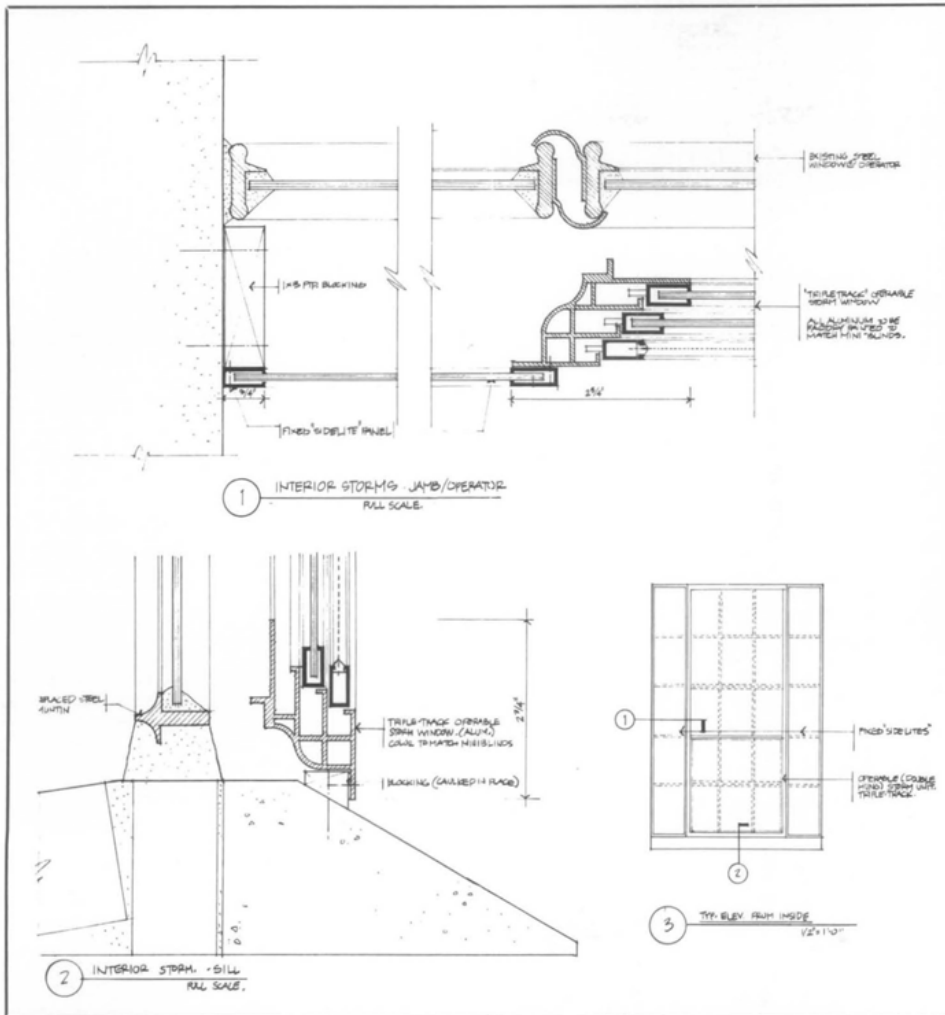


Figure 11. Interior storm window drawings, showing the alignment of the storm and steel window members. Drawings: H2L2 Architects.



Figure 12. Installed interior triple-track storm window with fixed sidelights. Photo: Clio Group.

were explored with the ultimate decision made to repair the significant historic steel windows. This decision was based on the assumption that repair of the windows was both a practical and cost-effective undertaking. The end product was a practical, cost-effective and ultimately successful solution to a difficult rehabilitation problem. The prominence of the thinly profiled, multi-light, industrial steel windows has been retained while current residential and energy code requirements as well as the Secretary of the Interior's Standards for Rehabilitation have been met.

There were, however, some aspects of this project that could be modified in future rehabilitations involving the repair of steel windows. First and foremost would be hiring skilled metal workers experienced to undertake the intricate steel work. Since most of the metal workers on the job had little or no experience in this type of work, considerable time was spent training



Figure 13. Lippincott Press Building (now Locust Point) after repair of the multi-light steel windows. Photo: Robert Powers.

and supervising the workers. For optimum paint performance and long-term maintenance, the repaired steel windows should have been sandblasted to fully remove the remaining paint and rust and to ensure a long-lasting bond between the steel and the new coats of paint. The additional cost would undoubtedly be justified by the more effective paint finish. Finally, although the storm window installed met the energy and overall visibility criteria established for the project, alternative schemes could have been developed that more closely reflected the operational and structural design of the historic steel window.

PROJECT DATA

Building:

Lippincott Press Building (Locust Point)
25th and Locust Streets
Philadelphia, Pennsylvania

Owner:

Lippincott Penn Historic Associates
c/o Historic Landmarks for Living
30 South Front Street
Philadelphia, Pennsylvania

Project Dates:

November, 1986—April, 1987
(Window work)

Architects:

H2L2 Architects/Planners
714 Market Street
Philadelphia, Pennsylvania

Historic Consultants:

Clio Group
Lancaster Avenue
Philadelphia, Pennsylvania

Contractors:

J.J. DeLuca, Inc. (General)
Chester, Pennsylvania

Metal:

Colory Metal, Inc.
Bensalem, Pennsylvania
Ornamental Security and Maintenance
Company
Moorestown, New Jersey

Windows:

Winderco, Inc.
Mt. Laurel, New Jersey
A and S Windows
Glendale, New York

Glazing:

H. Perilstein Glass Division
Philadelphia, Pennsylvania

Painting:

Murphy Painting
Trevose, Pennsylvania

Project Costs:

\$12,100,000 (Total project rehabilitation costs)
\$708,800 (Total window rehabilitation costs)
\$41,800 (Window repair work, material)
\$351,000 (Window repair work, labor)
\$116,000 (Window demolition, glass and glazing)
\$130,000 (Storm windows)
\$70,000 (Painting)
Total of units rehabilitated:
191 window openings
408 windows
8,964 total lights

This PRESERVATION TECH NOTE was prepared by the National Park Service. Charles E. Fisher, Preservation Assistance Division, National Park Service, serves as the Technical Coordinator for the PRESERVATION TECH NOTES. Information on the steel window repair work described here was supplied by Tim Noble of the Clio Group, Jeffrey L. Matthews AIA, of H2L2 Architects, Greg Mason of Colory Metal, Inc., Edward J. McCourt of Winderco, Inc., Neil Goldberg of H. Perilstein Glass Division and Sam Marabella and Terry Adams of J.J. DeLuca, Inc., the General Contractor for the project. Special thanks go to the following National Park Service staff who contributed to the production of this Tech Note: William Bolger, John Hnedak, Cynthia MacLeod and Martha Raymond of the Mid-Atlantic Regional Office. Cover photo: Clio Group, Inc.

This and many of the PRESERVATION TECH NOTES on windows are included in "The Window Handbook: Successful Strategies for Rehabilitating Windows in Historic Buildings."

For information write to the Historic Preservation Education Foundation, P.O. Box 27080, Central Station, Washington, D.C. 20038.

PRESERVATION TECH NOTES are designed to provide practical information on practices and innovative techniques 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 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 PRESERVATION TECH NOTES, Preservation Assistance Division-424, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127.