Hoffmann Architects

Journal of architectural technology published by Hoffmann Architects, specialists in exterior rehabilitation

JOURNAL

Second Issue 1992 Volume 10 Number 2

Avoiding Added Wear and Tear to Roofing

Richard P. Kadlubowski

Although today's roofing systems are highly durable and well-designed for their primary weatherproofing function, they are not usually intended or manufactured to support weight-bearing loads of either equipment or foot traffic.

All too often, however, the roofing system is asked to do just that. These secondary uses can play a leading role in shortening a roof's lifespan and creating unnecessary maintenance and repair problems. But there are ways to avoid the pitfalls and still reap the added benefits a roof can offer beyond simple protection from the elements.

In many cases, the roof is the most convenient location for HVAC equipment, water towers, window washing rigs, and other accessories, such as satellite dishes and communication equipment. Roofs are also used for maintenance access or as terraced settings for tenant and public use.

Rooftop uses can go well beyond simply providing a water-tight building cover, as shown here in this open-air jogging track at Yale University's Paine Whitney Gymnasium.

As Project Manager for Hoffmann Architects, Mr. Kadlubowski investigates and designs the correction of deterioration and water infiltration problems within roofs, facades, plazas, and structural systems of existing facilities. He is also responsible for quality control of the firm's drafting department.

In these situations, roof damage occurs when:

- Roofing equipment is improperly installed directly on the roofing membrane, without adequate securement to the supportive substructure.
- Routine maintenance and emergency repairs require foot traffic across inadequately protected roof surfaces.
- Accessed and terraced roofs have insufficient drainage systems and walkway protection.

Here's a closer look at each of these potential problem areas and some recommended solutions for avoiding roof damage.

Rooftop Equipment

Whether new construction or retrofit, proper planning of equipment installation is the first step in minimizing the potential for long-term roof damage. Before installing or replacing any equipment, the following questions should be asked:

1. What are the current and anticipated future equipment needs of the building's tenants? If the building is a multi-tenant space, equipment needs may vary widely over time. For example, satellite dishes and other communication

In Pursuit of Positive Drainage

Any moisture that is allowed to collect on top of the roofing membrane is a leak waiting to happen. Even the smallest opening in the roofing system can lead to major water damage if a source of moisture is readily at hand.

The solution: Remove the water.
The strategy: Ensure positive slope to the roof drainage system.

The variety of roofing systems available today also means a variety of methods for achieving positive slope. The following examines some of these situations.

Exposed Membrane Roofs
These roofing systems offer the easiest path to successful drainage. A proper roof slope is created by using tapered fill, tapered insulation, or sloped decks and surface drains to remove the water at the roof's low points. Once proper pitch is achieved, water will not collect on the unobstructed inclined plane.

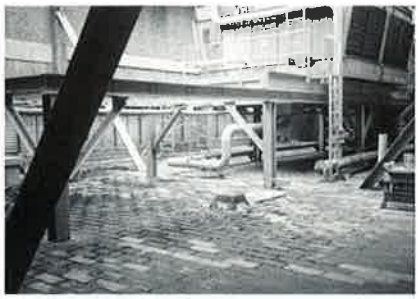
Ballasted Membrane Roofs
Water removal becomes a more difficult, but not impossible, task for ballasted and protected membrane systems. Roof slope is, again, the major contributor to positive drainage. While ballast won't prevent water runoff, it can slow it down. The best choice is a loose stone and masonry ballast with drainage channels that allow water to flow down the slope and either under or around the ballast to the drains.

In lieu of drainage channels for masonry ballast systems, a pedestal system can be used. The pedestals elevate the masonry units and allow water to flow beneath the ballast. Drains then remove the water at the membrane level.

Various promenade or bilevel drains can be used in this type of roof installation.

(continued)

Standing water – a sure sign of insufficient slope for proper drainage.



Proper flashing is critical, particularly where cooling towers introduce additional moisture to the rooftop; note vegetative growth at the tower base.

equipment are becoming increasingly popular for tenant use. Rather than installing a new dish for every tenant who comes and goes, consider if communal use of a single dish is feasible.

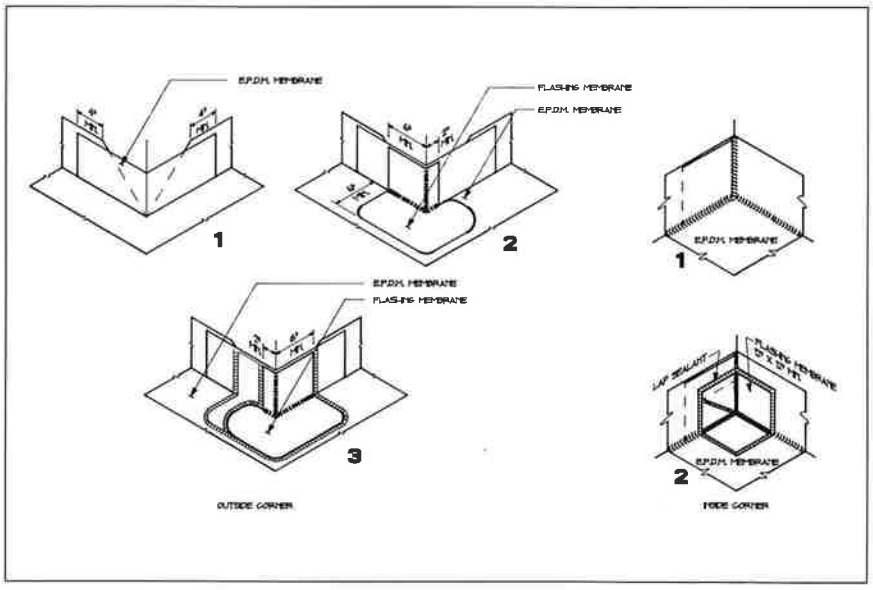
2. Where will the equipment be placed? Is this placement optimal over the long term for both maintenance and future replacement? Will equipment needs change as tenancy changes? How will replacement affect the existing roofing system? When it's time to replace the equipment, will the existing support be sufficient?

3. Is the roof adequately protected with walkways to equipment for regular and emergency maintenance and repair?

The Damage Potential

Rooftop equipment can affect roof integrity in several ways. The equipment exerts pressure on the membrane and can compress the insulation. Typical insulation materials have compressive strengths of 25 psi or less, which will not withstand much loading without appreciable damage. This compression creates a shear plane that works as a knife edge trying to cut through the membrane, creating a new source for water entry.

As an additional concern, compression



A basic, step-by-step guide to proper flashing techniques. Vulnerable corners must be wrapped to ensure water-tight barriers.

Poured concrete support pads are improperly placed directly on stone ballast.

of the insulation will also lessen its insulating value, leading to increased heating and cooling costs.

Mechanical vibrations caused by rooftop equipment can act as a further destructive force to the membrane. When the equipment is placed on top of stone ballast, for example, each stone becomes a point load working away at the membrane. Couple this with typical equipment vibration, and the stones act as miniature jackhammers forcing their way through the membrane.

Cooling and water towers introduce a resident source of moisture and water treatment chemicals, both of which can further hasten membrane deterioration. Exhaust fans and other ventilation equipment can also introduce potentially damaging contaminants. In addition, improperly leveled equipment that fails to account for the required drainage slope can cause condensation to drain into the ducts, rather than onto the rooftop.

Window washing rigs offer their own set of problems. These include excessive loading, added maintenance traffic, and the potential for hydraulic fluid leaks onto the roof membrane. (Please see the related story on page 5 for an overview of rig types and installation methods.)

The location of rooftop accessories is just as critical as proper equipment selection and installation procedures. By planning and anticipating now for the future, unnecessary intrusions into the roofing membrane can be avoided and the risk of a patchwork roof minimized.

Proper Installation Methods

Another vital step in preserving roof integrity is, of course, installing and securing equipment to provide sufficient support without compromising the roof's weather-protective qualities.

Ideally, all equipment supports should be directly supported by the building structure — not by the roof mem-

In Pursuit of Positive Drainage *(cont.)*

These collect the bulk of the water at the membrane level and surface runoff at the ballast level, while providing a clean profile at the same height of the masonry ballast.

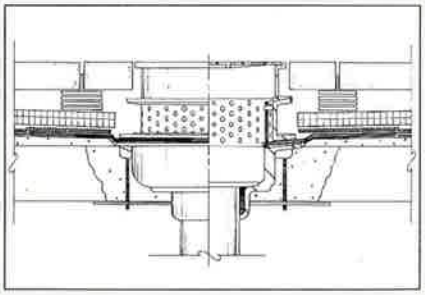
Terraced Roofs

Terraced roofs present the greatest challenges to water drainage. Here, many of the walking surfaces are mortar-setting beds finished with quarry tile, with the bed typically laid directly over the membrane. When probed, these setting beds have often been found to be saturated. Neither the tile nor the mortar are waterproof, thus allowing water to collect within the matrix of the bed.

In order for the system to drain and dry out, the moisture must leach through the depth of the setting bed to reach the roof-level drains — a long, slow process. One way to speed up the process and minimize water saturation problems is the installation of specially designed drainage materials between the roof membrane and the beds. These drainage materials combine a filtering fabric adhered to a porous filler. The fabric allows water to drain from the setting bed to the rooftop, while the filler maintains adequate space for water to flow through to the drainage system.

Bilevel drains handle water flow from both the tile level and membrane level, reducing water saturation. Make sure there is sufficient capacity drainage at the membrane level and institute a regular cleaning program to avoid clogged drains. Otherwise, the problems of standing water, including those related to freeze-thaw cycles, will remain.

(Editor's note: for additional information on design and maintenance issues for terraced roofs, please refer to Journal, First Issue 1991, Volume 9, Number 1.) ■



Detail of bilevel drain shows how water is removed from the roof/terrace and how system components are integrated.

Large support bases for satellite dishes evenly distribute imposed loads.

brane. In this way, equipment is supported by a stable substrate and any negative impact on the roofing membrane and system is reduced or eliminated.

Supports should be of sufficient size and strength to handle the intended loads and should have a specific method for tying into the roofing system. There are a number of pre-manufactured and custom-built equipment support systems available for this purpose. The initial expense of these systems will pay for itself over time in extended roof life.

Flashing and terminations are the next line of defense in creating watertight transitions between the roof and equipment and other accessories. While proper flashing techniques are worthy of a separate article, two basic principles are worth noting here:

Layering uses various flashing materials that are bonded together to prevent water entry. This technique creates multiple barriers that block potential water entry.

Placement of terminations should be above the level of possible standing water and secured to a sound substrate. Termination bars and cap flashings use compression and covering to prevent water entry.

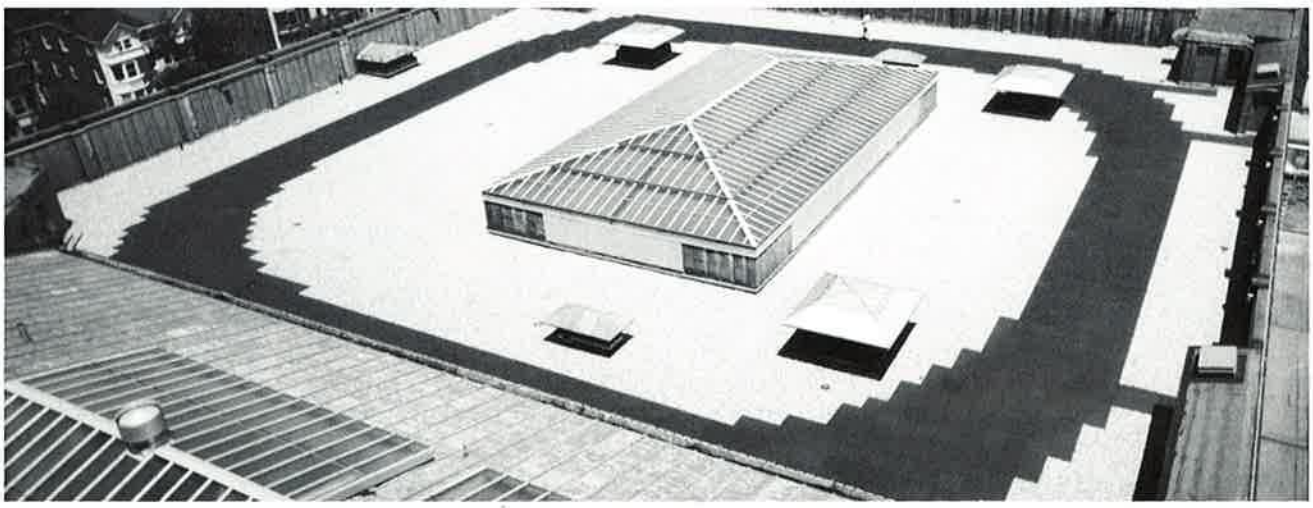
Of course, facility managers are rightfully concerned about any penetration through the roofing membrane. But, if the equipment support is properly chosen and flashed in, the risks of damage are far less than would occur with equipment indiscriminately placed and improperly secured.

Accessed and Terraced Roofs

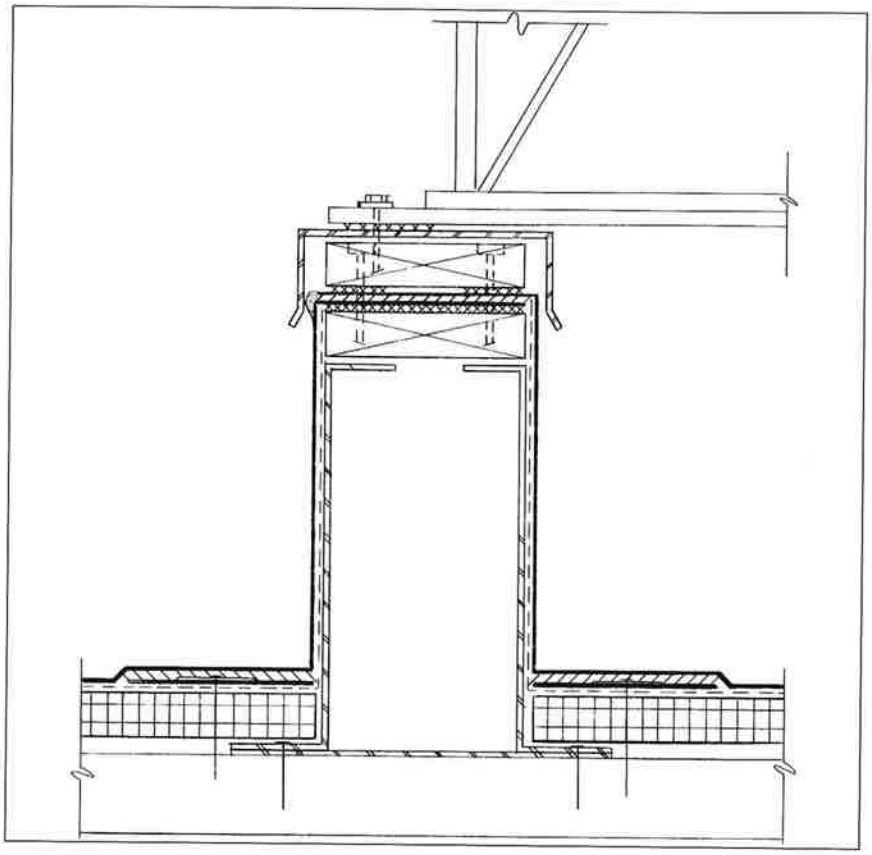
If the roof is usable space, it can technically be considered part of a waterproofing system, rather than simply a component of the building envelope, as a non-accessed roof would be. This is a key consideration when it comes to manufacturers' warranties. Most manufacturers will not warranty their roofing product if it is used as a waterproofing system. This situation occurs most often when the roof is used as a terrace or when window washing runways are installed. The facility manager should be aware of warranty restrictions when determining rooftop uses.

Roof terraces typically call for the placement of walkways, furniture, and planters directly on top of the roofing membrane, creating added sources for roof damage. It is imperative that the membrane on an accessed roof be protected as much as possible both during construction and throughout its life.

One recommendation is the installation



Proper drainage for the jogging track is achieved by protection mats installed under the track and surrounding stone ballast, along with a correctly pitched slope on the concrete deck below.



For proper water protection, flashing terminations occur well above the finished roof level, with integral cap flashing to cover the assembly.

of protection boards. These 1/8"-thick sheets are usually a bonded composite of fibrous material and asphalt. During construction, the boards are installed over the finished membrane and the remainder of the roofing system installed on top of this protective board barrier. The boards protect the roof by helping to:

- provide an alternative load-bearing surface,
- absorb the abuse that would otherwise be inflicted on the membrane,
- distribute loads, and
- promote positive drainage.

Conclusion

The rooftop can be an ideal site for such secondary uses as equipment location and tenant access, and these uses should not be avoided out of fear of roof damage. The key is to plan ahead before beginning any work. Take into consideration future needs and potential tenant demands. The work should successfully integrate the equipment and accessories with the roofing system, adhere to manufacturers' warranty restrictions, and preserve the integrity of the roofing system. The combination of proper planning, correct installation, and routine maintenance will go a long way toward ensuring that a roof meets its maximum life expectancy. ■

Window Washing Rigs: Selection and Installation

Window washing rigs can help ease one of a facility manager's most tedious maintenance chores. But they can also open up a whole new world of maintenance and roof preservation problems.

The most significant impact of this equipment is its weight. Self-propelled rigs weigh approximately 15,000 pounds, far in excess of typical roof loading calculations. New construction must take this additional weight into consideration when designing the structural system. In existing buildings, however, rig installation may not always be feasible. The cost of beefing up the building's load-bearing capacity to accommodate the added weight could be prohibitive. Therefore, all relevant design and structural issues must be investigated before installing this equipment.

Window washing rigs also produce significant vibration during operation, causing added stress to the building and roofing system. That vibration, in turn, can damage both the roof and the building's structural integrity.

As well, having a window washing rig usually means a lot more people up on the roof, with both maintenance and

(continued)

Poured-in-place concrete runway acts as a wearing surface and distributes the weight of the window washing rig carriage.

Window Washing Rigs: Selection and Installation *(cont.)*

operating staff traipsing back and forth. The rigs should be installed for easy maintenance access via a well-protected roof membrane.

There are several basic types of mobile washing rigs and installation methods. One type uses a roof carriage that travels on a runway, usually poured concrete, resting on top of the roof membrane.

Another is the rail-mounted rig, which offers three installation choices:

1. The rail system is mounted above the roofing membrane on support stanchions which are tied into the supportive structure.

2. The system is mounted to the parapet walls and secured to the structure, keeping it independent of the roofing system.

3. A freely laid system, where the rails are supported on top of the roofing membrane.

Each rig type and installation method has its drawbacks and advantages. The freely laid rail systems transmit unnecessary loads and vibrations to the roofing membrane, leading to undue stress on the roofing system. Repairs can be more difficult and costly, as they usually require disassembly of the rail system.

On the other hand, the mass and size of rooftop runways for carriage rigs are beneficial in evenly distributing the weight across a broader expanse of the roof. Vibration problems are similarly reduced. But runways tend to encourage moisture retention, as water is trapped beneath the concrete and kept in direct contact with the membrane. If leaks occur, repairs could require the removal of the runway — an intensive and costly proposition.

The most widely recommended solution is a rail-mounted system that is attached to the roof deck or to the parapet. These systems typically present fewer maintenance problems and reduce the risk of damage to the roof. Both installation methods usually conform to manufacturers' warranty limitations for roofing systems. ■

The Facility Manager's Bookshelf: **Roof Accessories**

A. Basic References

1. Ballast:
   ANSI/RMA/SPRI RP-4-1988 ***Wind Design Guide for Ballasted Single-Ply Roofing Systems***. $15.00

   To order: American National Standards Institute, Sales Dept., 11 West 42nd Street, New York, NY 10036. (212) 302-1286.

2. Roof Loads:
   ASCE 7-88 (formerly ANSI A58.1-1982) ***Minimum Design Loads for Buildings and Other Structures***. 108 pp., 1990, 742-X. $24.00

   To order: American Society of Civil Engineers, Marketing Services, 345 East 47th Street, New York, NY 10017-2398. (212) 705-7538.

3. Drains:
   Cast Iron Soil Pipe and Fittings Handbook, 7th edition, 1990. $10.50

   To order: Cast Iron Soil Pipe Institute, 5959 Shallowford Road, Suite 419, Chattanooga, TN 37421. (615) 892-0137.

4. Sheet Metal:
   Architectural Sheet Metal Manual, 4th edition, 1987. $113.00

   To order: Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 4201 Lafayette Center Drive, Chantilly, VA 2201-1209. (703) 803-2980.

B. General Reading

1. Roofing Details:
   McCampbell, B. Harrison. ***Problems in Roofing Design***. 1992. 224 pp., IBSN 0-7506-9162X. $39.95

   To order: Butterworth Architecture, 1-800-366-2665.

C. Construction Specifications Institute
Specifier Reprints
601 Madison Street
Alexandria, VA 22314-1791
(703) 684-0300

Cost: $4.00 each, $10.00 minimum order. VA residents add 4.5% tax.

1. Heineman, Paul. "Coping with Membrane Roof Penetrations." ***The Construction Specifier***, November 1987, p. 36.

2. Reidel, George C. "Ghost Leaks and Roof-Mounted Equipment." ***The Construction Specifier***, November 1984, p. 122.

Compiled by Alan P. Eddy, Records and Information Manager ■

REPRESENTATIVE PROJECTS

Roof Rehabilitation

Hoffmann Architects specializes in the rehabilitation of the exteriors of existing facilities. A major portion of the firm's practice involves roof rehabilitation, including repair and replacement of membranes, insulation, decks, flashing, and parapets.

Its professional architects and engineers conduct surveys to investigate problem areas, determine causes of deterioration, analyze structural integrity, and evaluate roof life expectancy.

The firm prepares detailed plans and specifications for competitive bidding of re-roofing projects. Contract administrators and on-site project representatives track the progress and quality of construction.

Hoffmann Architects has provided roof rehabilitation services for such prominent buildings as:

Time-Warner Building
New York, New York
(Rockefeller Center Management Corporation)

GE Building
New York, New York
(Rockefeller Center Management Corporation)

American Brands, Inc. Headquarters
Old Greenwich, Connecticut
(American Brands, Inc.)

New Haven Community Correctional Center
New Haven, Connecticut
(State of Connecticut, Department of Public Works)

Old Saybrook Central Office
Old Saybrook, Connecticut
(Southern New England Telephone Company)

Yale Press Building
New Haven, Connecticut
(Cesar Pelli & Associates)

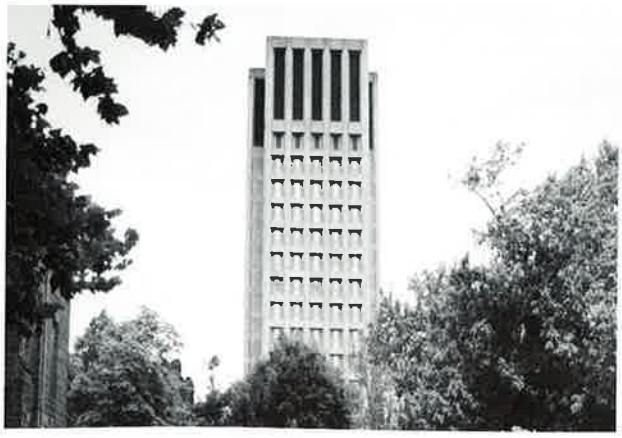
Yale University -
various academic buildings
New Haven, Connecticut
(Yale University)

New Haven Garage Facility
New Haven, Connecticut
(Southern New England Telephone Company)

Office Centre at Short Hills
Short Hills, New Jersey
(Prudential Realty Group)

Simon & Schuster Building
New York, New York
(Rockefeller Center Management Corporation)

Pall Corporation Technical Center
Port Washington, New York
(Centerbrook Architects) ■



Kline Biology Tower at Yale University, New Haven, Connecticut.

The Hartford Insurance Company Headquarters complex in downtown Hartford, Connecticut.

Staff News

Professional Accomplishments:

John J. Hoffmann, FAIA was elected to the Board of Directors of The Avenue of the Americas Association, a non-profit civic association based in New York.

Jane B. Beaudry has been elected a vice president of the Housatonic Chapter of the Construction Specifications Institute.

Roy C. Olsen, AIA has been designated a Certified Construction Specifier by the Construction Specifications Institute.

Alan P. Eddy has been elected president of the New Haven/Bridgeport Chapter of the Association of Records Managers and Administrators. His article, "Reducing Energy Costs by Controlling Air Infiltration", appeared in the May/June 1992 issue of AIPE Facilities, a publication of the American Institute of Plant Engineers.

Harwood W. Loomis, AIA has rejoined the firm as Senior Architect and Project Manager. He is currently serving a one-year term as vice president of the Connecticut chapter of BOCA (Building Officials and Code Administrators International) and is a member of the AIA ad hoc task force reviewing HUD procurement policies and Standard Owner-Architect documents. ■

JOURNAL is a publication of Hoffmann Architects, specialists in investigative and rehabilitative architecture/engineering, including the analysis and solution of problems within roofs, exterior walls, glazing, and structural systems of existing buildings, plazas, and parking garages.

Please send news, technical information, address changes, or requests for free subscriptions to Brian Schafer, Editor, Hoffmann Architects/*JOURNAL* at 432 Washington Avenue, North Haven, Connecticut 06473 or 1270 Avenue of the Americas, New York, New York 10020.

For answers to specific questions or for information on the services we offer, please call Brian Schafer at (203) 239-6660 or (212) 332-1320.

Hoffmann Architects
432 Washington Avenue
North Haven, Connecticut 06473
(203) 239-6660

Editor: Brian Schafer *Graphic Services:* MossWarner Communications, Inc.
Editorial Services: Jonelle Lawhorn Hobbs Communications