

Indefinite Quantity Contract No. 1443C4500040002  
Task Order No. T200005A048  
Historic Structure Report Services,  
Independence Hall Tower Rehabilitation  
Independence National Historical Park,  
Philadelphia County, Pennsylvania

## ***HISTORIC STRUCTURE REPORT/ PRESERVATION PLAN***

***Final Report Submittal • 22 May 2009***

*With minor revisions for printing 15 June 2009*

*Prepared for and presented to:*  
**NATIONAL PARK SERVICE**

Denver Service Center  
12795 West Alameda Parkway, P. O. Box 25287, Denver CO 80225-0287

Independence National Historical Park  
143 South Third Street, Philadelphia PA 19106

***by:***

**BARGMANN HENDRIE + ARCHETYPE, INC.**, Architecture, Planning, Interior Design  
300 A Street, Boston MA 02210 • 1.617.350.0450 • [www.bhplus.com](http://www.bhplus.com)  
Jack Glassman AIA, Principal

**KEAST & HOOD CO.**, Structural Engineers  
601 Walnut Street, Suite 450W, Philadelphia PA 19106  
1.215.625.0099 • [www.keasthood.com](http://www.keasthood.com)  
Constantine G. Doukakis PE, Principal;  
Suzanne M. Pentz; David G. Cornelius AIA PE; Jonathan S. Price PE; Robert W. Boris EIT

**1:1:6 TECHNOLOGIES INCORPORATED**, Consulting Architects and Conservators  
103 North Jackson Street, Media PA 19063 • 1.610.565.3340 •  
Barry A. Schnoll, Principal; Lorraine Schnabel AIC

**BRUCE E. BROOKS & ASSOCIATES**, Consulting Engineers  
2209 Chestnut Street, Philadelphia PA 19103 • 1.215.569.0400 • [www.brucebrooks.com](http://www.brucebrooks.com)  
Bruce E. Brooks PE, President; John Hodos Jr PE; Danette Ernst PE; Kevin Levy PE

**INTERNATIONAL CONSULTANTS, INC.**, Cost Estimators  
221 Chestnut Street, Suite 200, Philadelphia PA 19106 • 1.215.923.8888  
Michael C. Funk, Vice President • [www.iciconst.com](http://www.iciconst.com)

### 1.2.6 Preservation by the Nation (1951-date)

#### *First Attempts at Stabilization*

On 1 January 1951 the City of Philadelphia, while retaining title of ownership, transferred responsibility for the preservation and operation of the Independence Square buildings to Independence National Historical Park of the National Park Service.<sup>359</sup> Although the City's record of stewardship for its primary historic assets had been well above the minimum stereotypical level of municipal maintenance, the transfer meant that, for the first time in the buildings' histories, they were under the day-to-day care of experienced and trained professionals whose primary mandate was preservation.

Significant funding for physical preservation had been largely deferred for the park in the early 1950s while site acquisition and master planning arguments dominated attention ("The First Wars of Independence," Chapter 4 in Greiff 1987). Fortunately an account for "Maintenance and Rehabilitation of Physical Facilities" was created on 1 March 1951; although its funding was initially miniscule, a structure thereby existed wherein emergencies and highest priority work could be, to some extent, addressed.<sup>360</sup>

Reflecting the realities of the situation, priorities were established using a formula of one part emergency stabilization to two parts public relations, as frankly acknowledged in the report by John Lukens (NPS 1951, 3):

(a) There were certain situations, such as roof leaks, bare spots on outside woodwork, and washed-out mortar joints, neglect of which would lead to progressive decay of the buildings. The architects urged immediate attention to these conditions and repairs were undertaken with reasonable dispatch.

(b) This office, having been given responsibility for these historic structures by the Federal Government, was anxious to create an appearance of efficient housekeeping and of due concern for an important public trust. Consequently, such items as repair to plaster work, inside painting, and improvements of the lawns, were pushed ahead with almost the same emphasis as repairs which were vital for the preservation of the buildings.

---

359. Independence National Historical Park, named after an event rather than a building, was created by public law signed into effect on 28 June 1948, and opened for business on 1 October of that year with Charles E. Peterson and Edward M. Riley on board in the key positions of historical architect and park historian respectively (Greiff 1987. 68-70). The opening of the park was two and one-half years before the addition of Independence Hall and the other Independence Square buildings to its jurisdiction. During the interval the City and the Department of the Interior negotiated a Memorandum of Agreement, signed on 14 July 1950, which established the ground rules for the Park Service's stewardship of what remained City properties.

360. Also fortunate was that oversight for the allocation of maintenance funding was vested in those park staff members particularly qualified to make preservation judgments, including in addition to Superintendent Anderson, Peterson, Riley, and curator Warren A. McCullough, a survivor from the city administration (NPS 1951, 2). The retention of qualified City employees by the Park Service was encouraged in the 1950 Memorandum of Agreement.

(c) A considerable effort was made to have certain parts of the work finished in advance of "deadlines", the deadline in each case being an event which would involve focusing on the buildings the attention of small numbers of important personages or large numbers of the general public or both. Some of these deadlines were not met as planned, including, for the exterior paint job, the final deadline of July 1 which was the beginning date of the "Independence Homecoming Celebration", commemorating the 175<sup>th</sup> anniversary of the signing of the Declaration of Independence. The reasons for the work having lagged behind these deadlines will be outlined herein.

Roofing was given first priority. Because the M. G. Kulzer & Sons roofing company was already engaged in reroofing Congress Hall (presumably under an existing city contract), Lukens (the NPS architect in charge), Warren McCulloch (the park curator), and Harry Kulzer were able to rapidly define a scope, estimate, and purchase order for the necessary work on Independence Hall. The most difficult item in the roofing scope was identified as the replacement in kind of the tin apron roof, above Tower Level 4, that served as the primary flashing element at the base of the wooden portion of the steeple (see NPS 1951, Illustrations #2 and 5). Lukens's observations reflect his interpretation of a still-unresolved historical controversy, the history of the apron roof (NPS 1951, 6-8):

For the replacement of the tin roof around the tower, specifications were written by the writer of this report. No effort was spared to determine the construction and appearance of this roof as of the year 1828 when the present wooden steeple was added to the tower. The old tin was found to be laid over older wood shingles which had beveled butts (NPS 1951, Illustration #3) and an unusual arrangement at the hips. Some consideration was given to the possibility that this roof might have had a shingled surface after 1828 and that it should be restored as a shingled roof. However, further study convinced all concerned that the shingles were vestigial remains of the old pyramidal roof which covered the brick tower from 1781 to 1828, during which period there was no steeple on the tower. It is believed that the architect of the present steeple in 1828, William Strickland, simply had the central portion of this old pyramidal roof cut out and had his timber steeple built up through the hole, the remaining portion of the shingled roof being then covered over with tin. The policy adopted for the recent repairs was, therefore, to replace the existing tinwork with an exact reproduction in new material.

The existing tin roof was a standing seam roof with a flat-seamed portion around the lower (outer) edge (NPS 1951, Illustration #2) . . . The old wood shingles were measured by this office during the time when they were uncovered and observations are recorded on an Historic American Buildings Survey sheet under date of April 10, 1951 [present location unknown].

One feature of this roof which required special study was the method of fitting the new tinwork around the pedestals of twelve ornamental hollow copper urns which are built into the roof . . . In the final event, the following method was used by the contractor with the approval of the writer: The old tin was cut away right up to the pedestal; the new tin was laid to fit around the pedestals without moving them; a collar of new tin two inches high was run around each pedestal, soldered to the roof; and the upper edge of the collar was turned up slightly and filled with caulking compound to form a "muck pocket" between itself and the pedestal. The sides of these collars were then fastened tight against the pedestals with metal-screws.

The old lead flashing between the top edge of the tin and the sides of the wood steeple (Illus. 113, 114) was entirely replaced with new sheet lead by the contractor.<sup>361</sup>

Lukens summarizes the masonry restoration for the five Independence Square buildings in overall terms only and does not identify specific locations of work on the tower (NPS 1951, 9-14). He records that 19,245 square feet were repointed (NPS 1951, 11):

The mortar-mix finally selected was mixed to match the color of old lime-mortar uncovered behind some of the defective pointing which was cut out by the contractor. This color was obtained by mixing two kinds of sand half and half, a sharp brown river sand and a finer yellow sand from New Jersey, and using one part white non-staining cement, two parts sand, and  $\frac{1}{4}$  part hydrated lime by volume.

The style of mortar joint selected consisted of a flat surface of mortar sunk  $\frac{1}{16}$ " behind the face of the brick, with a square groove,  $\frac{1}{8}$ " wide and  $\frac{1}{8}$ " deep scored through the center of the mortar surface. Two of the contractor's men were taken by the writer to Carpenters' Hall where joints of this description were shown to them. The proper joint was produced by them on the job, after several attempts, by using a tool called a "slicker". The tongue in the center of the blade of the slicker, which makes the groove in the joint, was ground down somewhat, following the instructions of the writer, in order to make the groove less deep. (their illustrations #8 and #9).

238 bricks, which were obtained from a store in the basement, were replaced in the five buildings. "It will be noted," Lukens said, "that there remain in the masonry of the buildings, especially Independence Hall, a considerable number of bricks which show a slightly eroded salmon pink face. These were not replaced because in the opinion of the writer and of the contractor that are still solid and strong and will last for at least three or four more years without serious deterioration, and it was felt that replacement of all such bricks at this time would have been tantamount to practicing "meddlesome surgery" on the fabric of these old buildings, not to mention the large expense which would have been incurred" (NPS 1951, 12).

---

361. Lukens notes that the contract for the apron roof was awarded to Kulzer & Sons on 4 April 1951 and that the work was completed satisfactorily on 22 May (NPS 1951, 7).

While the Park Service was coming up to speed in preserving the building, another public entity was inadvertently working in the opposite direction. Several photographs in the Park Archives document water damage in the tower, both at what appears to be either Tower Level 4 or 5 and in the Tower Stairhall, which occurred during the Fire Department Thrill Show<sup>362</sup> on or before 7 October 1954 (INDE Neg. 2543). It would be interesting to know whether the source was activation of the tower sprinkler system by a less-than-totally controlled fire display, or a demonstration of fire-hose precision. Presumably the Fire Department was not invited back in 1955.

### *The Ewing Report*

In the Historical Background chapter we have discussed the excruciatingly exhaustive, and therefore highly useful, structural survey of the Independence Square buildings conducted by the George M. Ewing Co. at the behest of EODC in 1958-59 (Ewing 1959a, 1959b, 1959c). In the current chapter the survey's role will be reviewed as the single most controversial and divisive effort in the building's history since at least the T. Mellon Rogers restoration of 1896-98, if not the attempt to locate the new government buildings on Independence Square in the 1860s.

The engineers of the Ewing Co. were neither philistines nor charlatans. From their invaluable survey records, we recognize that they were highly perceptive, educated, competent, and conscientious professionals; they were also creatures of their time as much as we are of ours. The recommendations of the Ewing Co., which were endorsed by some although far from all of the Park professionals and management,<sup>363</sup> were the inevitable result of looking at eighteenth- and early nineteenth-century construction through a rigorous mid-twentieth-century worldview firmly founded in code compliance, technological innovation, managerial efficiency, and an optimistic historicist belief in progress that paid little regard to antiquarianism. In a culture saturated by images from advertising, propaganda, motion pictures, and television, "historic restoration" often accepted that outward appearance was the primary aspect of authenticity.<sup>364</sup> It

---

362. The Thrill Show was a Philadelphia Fire Department event featuring fire units performing circuslike stunts. It served to increase public awareness of fire safety[!] and to raise money for firefighters' orphans.

363. Among those in favor of the recommendations, even before the release of the completed Ewing report, were Charles Grossman, chief architect of Independence National Historical Park (for Grossman see Greiff 1987, 94, 130-31); Grossman's attitude to the Ewing Report is documented in succeeding pages of our report. Among those opposed were: Grossman's predecessor, Charles E. Peterson; Peterson's assistant at EODC, Thomas Wistar; Brumbaugh; and Penelope Hartshorne.

364. In fairness to Ewing, very few private design offices in the country could claim any substantive background in preservation in 1958. Unlike the situation of half a century earlier, where the study of ancient buildings was an integral element of the architect's education, the attitudes of the architectural academies at mid-century were characterized by hardened suspicion of and hostility to historical models. Those contemporary architects who did come out of the Beaux-Arts system to display a more sensitive approach to preservation work, such as R. Brognard Okie (1875-1945) and G. Edwin Brumbaugh (1890-1983) locally, cannot be faulted for the sincerity of their love of historic buildings, such as the Betsy Ross House (restored by both men at various times), but their approach is sometimes viewed as sentimental and personalized by the standards of the present. The real learning ground for the resurgence of historic preservation in the United States was to be in public and quasi-public entities, most notably the National Park Service beginning in the 1930s through the 1970s.

was also a view that could use historicity selectively to rationalize its more controversial conclusions (Ewing 1959a, 41-42):

In evaluating our survey and making our recommendations, we have kept in mind that neither the upper part of the tower nor the floors in the “Hall” are the original features, and that a strict adherence to the present framing systems could not be warranted.

Thus Strickland’s 1828 steeple could be dismissed in its entirety as an unoriginal feature; one could, of course have absurdly applied the same argument to Woolley’s steeple, had it survived to 1959, since it was not an original part of the 1732 building either. Similarly, the loss of original floor boards condemns the floor construction beneath, including its wealth of physical evidence, and its remarkable and almost unique “hand-in-hand” assemblies.

Our survey has shown that the finishing materials of the tower are in extremely poor condition. The wood structure as a whole is also in very poor condition, framing for platforms being the worst, followed by the tower framing; the latter seems to be especially insufficient at the points where the main columns are supported. The brick walls are in fair to poor condition, and require extensive strengthening. Ringing of the bell should not be permitted with the present state of the tower.

The Ewing engineers were trained in construction in steel, reinforced concrete, and portland cement mortar. In their assessments, timber elements were noted as checked, twisted, water stained, etc. (Illus. 33-34). No criteria were established to delineate whether checking or twisting significantly reduced structural performance, or if water staining was recent or historic or denoted actual decay. Aside from obvious but largely inconsequential cracking, which they attributed to differential settlement more than contraction, the condition of the tower masonry did not warrant their concern. Their comments on the inefficacy of numerous framing connections, such as the questionable bearing of the Strickland columns, had greater merit, and would often be reflected in the remedial work that was ultimately performed:

We therefore propose the following alterations to the structure of the tower:

Complete removal of tower and spire to the level of platform #5 [Tower Level 4]<sup>365</sup> (Shaft Housing Floor);

Remove and replace platforms #3 and #4 [Tower Levels 2 and 3] and replace with reinforced concrete;

---

365. In their nomenclature the Ewing team counted levels beginning with the first and second building levels, making the floor level above the Stairhall ceiling Platform #3. Beginning with the Keast and NPS documents shortly thereafter, and continued in this report, the floor of the stairhall is labeled Tower Level 1, and the landings are ignored as not constituting complete floor levels, with the level above the Stairhall ceiling thus becoming Tower Level 2. Each Ewing Platform Level designation therefore corresponded to the present Tower Level plus 1.

Strengthening of brick walls from platform #5 to the foundation level, by replacing of damaged bricks, pressure grouting and repointing and underpinning of walls as necessary to support new structure above;<sup>366</sup>

Build up tower to the base of the dome with precast reinforced concrete wall sections, perforated where necessary for clocks, windows, access doors, etc. Covering to be weather-resisting siding resembling original materials in appearance on light-weight framing;

[42] Replace dome by thin precast reinforced concrete shell covered with clay tile;

Replace lantern and spire by precast reinforced concrete shell covered with siding resembling original materials in appearance;

Reuse original ball and vane after necessary repairs have been made.

Although structural condition appears to be the ruling criterion in the recommendations for the tower, the recommendations for the main Hall and the other buildings reveal that replacement of combustible materials with fireproof substitutes was also a major objective.<sup>367</sup> Another, less acknowledged, objective was to achieve assembly loading for public events.<sup>368</sup>

---

366. Here we have an echo of Strickland's initial proposal for a masonry steeple, with the critical difference that Strickland and Struthers considered the existing tower sufficiently strong to support the new work. Ewing's engineers saw the need to reinforce the masonry in addition to underpinning the foundations, doubtless due in part to the heavier dead loads they were proposing, but also to a lack of confidence in (or perhaps understanding of) the eighteenth-century masonry. This is a classic example of a preservation solution creating a domino effect of new problems. More than one historic structure has ultimately been demolished for economic reasons, not because of the cost of in-kind repairs, but because of the expense of radical interventions and their collateral consequences.

367. From Ewing 1959a, "Tower Log" for 24 February 1959, page 55: "Mr. Oliver a struct. engineer with the Park Service whom I had not met before expressed great interest in the maximum fireproofing of all Ind. Hall group bldgs." The proposed fireproof construction would have been achieved through, among other means, extensive asbestos spray-on fireproofing of the new steel framing. In replacing wooden roofs in the 1920s, the City had indeed put down asbestos-containing fiberboard between the structural sheathing and shingles of several of the Independence Square buildings.

These asbestos installations gradually disappeared during later roofing replacements, most before the development of hazardous material abatement rules. The last surviving application, on Congress Hall roof, was removed during the Utility Improvement Project of the 1990s when the Park Service enforced a no-tolerance policy for all known existing asbestos installations. Had the Ewing recommendations been implemented, they would have thus mandated unforeseen but significant down-the-road costs for abatement.

368. From Ewing 1959a, "Tower Log" for 4 February 1959, page 35: "Mr Grossman described a luncheon he attended at noon with officials of Ind. Hall Nat'l Park & the Eastern Area Office . . . Grossman also warned that since it was their hope to utilize these buildings for public assemblies, we would not hesitate in recommending sound reconstruction throughout."

*First Stabilization by Keast & Hood Co., 1961-63*<sup>369</sup>

From “A Brief History of Past Structural Rehabilitations” (Keast & Hood 1993b, 5.1-5.2):

Coincidentally, during the same week that the Ewing report was submitted, an unusual spring snowstorm hit the city, and the south (rear) portion of the roof of Congress Hall collapsed and fell in onto the attic floor/second floor ceiling which had already been shored.

Structural engineer Sheldon A. Keast and his associate, Nicholas Gianopulos, were called in to assess the damage. Keast’s inclination was to try to work with the remaining structure, rebuilding only the collapsed portion of the roof, resupporting the failed timber truss on a new steel truss, and reinforcing the weak or defective portions of the remaining timber trusses with new structural steel supplements. Sheldon Keast’s proposals for Congress Hall were adopted by the Park Service in the fall of 1959.

[5.2] While the partial collapse of the roof of Congress Hall might have given ammunition to those who wanted to “gut” and reconstruct the Independence Square buildings, Keast’s proposals for reinforcing and resupporting the roof framing of Congress Hall ultimately showed that another approach was possible. The internal debate which was generated over the Ewing report was finally resolved in June 1959, with the Park Service rejecting the drastic proposals for reconstructing the buildings and adopting a preservation philosophy which favored retention of historic structural features where possible, minimizing damage to, or removal of, original historic fabric. At this point the National Park Service also elected to perform in-house the structural assessment of the rest of the Independence Square buildings: Independence Hall, the East and West wings, and Old City Hall.

The second event, that got Keast & Hood Co. into the hall proper, was the failure of ceiling plaster above the Long Room on 13 July 1961 (Nelson 1976, 290-295).<sup>370</sup> On the basis of their recently completed work at Congress Hall, Sheldon Keast was immediately retained by NPS to develop a design concept for the stabilization of the superstructure of the main portion of the Hall (Keast & Hood 1993b, 5.2):

Sheldon Keast’s preliminary report on structural conditions in Independence Hall (exclusive of the tower) was submitted in August 1961. Once again Keast’s approach was to retain the historic structural features where possible, and to supplement the original system with new steel structures where necessary. In most cases the original timber structure could remain as historic evidence while the primary load-carrying function

---

369. General narrative sources for the first campaign of structural interventions by Keast & Hood Co. include the following: Keast & Hood Co., “A Brief History of Past Structural Rehabilitations” (Keast & Hood 1993a); Lee H. Nelson, “Independence Hall: Its Fabric Reinforced” (Nelson 1976); and Sheldon Keast, “A Philadelphia Engineer Reminisces” (Keast 1971).

370. “The ceiling unraveled like a snakeskin from one end to the other.” Nicholas L. Gianopulos, conversation with D. G. Cornelius, 18 August 2006.

could be taken over by the new structural steel work. This approach was not without its critics, chiefly Grant Simon, who remained in essential sympathy with the Ewing recommendations. After a second submission of the report on 22 September, Sydney Martin of the Independence Architectural Advisory Commission was recorded by Lee H. Nelson (Illus. 115) as proposing on 2 October:

. . . a steel cage system with columns chased in the walls. General feeling of the committee (including Keast and I) is that chasing walls would create unforeseen problems of brick cracking due to differences in expansion.

On 4 October Nelson "Rec'd (by mail a copy of Keast's report to S. Martin, re disadvantages of chasing out walls in Independence Hall." The next day,

Arch. Advisory Committee met, discussed Keast's supplementary report, and decided to accept the Keast Proposal and recommended that we start work as soon as possible. Sidney Martin reversed himself and decided that chasing the walls wasn't a good idea after all. This left only Grant Simon stubbornly clinging to the idea. Otherwise it was unanimous.<sup>371</sup>

Similar approaches were ultimately proposed by Sheldon Keast, and adopted by the National Park Service, for Independence Hall tower (1963) and Old City Hall (1964). The work designed by Keast & Hood Co. for the main portion of the Hall was implemented by A. Raymond Raff Company in 1962-63

The stabilization of the tower (Illus. 116, 117) followed the work in the main portion of the Hall for obvious reasons, including its lesser structural urgency and less critical impact on restoration and visitation. Whereas Nicholas L. Gianopulos had assumed primary responsibility for the work in the main portion, Keast assumed the lead in designing the reinforcement of the tower, assisted by Mr Gianopulos.

The rationale of the reinforcing was described by Keast in a letter to the Superintendent, with drawings, which was incorporated by Lee Nelson in the 1962 "Structural Reinforcement of Steeple" supplement to the HSR (Sheldon A. Keast to Superintendent, Independence National Historical Park, September 1, 1961, revised November 16, 1962, in NPS 1962b). In the pages immediately following, Nelson recommended that the Ewing recommendations, which had already been rejected for Congress Hall and the main block of Independence Hall, be abandoned for the tower as well, and that Keast's recommendations be implemented ("Recommendations for Structural Repairs" in NPS 1962b, 20-21).

The reinforcing of the tower reflected the distinct identities of the Woolley and Strickland superstructures, with independent approaches to each system of historic fabric. Strickland made no provisions for uplift or overturning, which one would tend to compare unfavorably to the installation of tie-downs in both the predecessor steeple by Woolley and in Robert Smith's

---

371. INDE Archives, Lee H. Nelson, "Daily Log, July 1961-Jan. 1963," entries for the various dates cited.

contemporary steeple at Christ Church. That Strickland actually overlooked such a significant design criterion is unlikely in view both of the considered provisions for moment fixity in the detailing of his steeple frame at Independence Hall and in the history of his career generally. That he considered the steeple dead load sufficient to resist overturning is more likely, especially when the results of the twentieth-century analyses, described above, are taken into account.

The replacement of the 4600-pound bell of 1828 with the 13,000-pound Centennial bell however gave pause in both 1876 and 1961-62. Although the diagonal braces added in 1876, in anticipation of the heavier bell, resemble wind bracing, our analysis demonstrates that they also serve also to redistribute gravity loads. The lateral impact of the bell ringing did however enter into Keast's larger consideration of lateral stability during the early 1960s (Keast 1971, 75):

We found on operating the bell that the tower swayed slightly. The National Park Service wanted a bell that could be tolled, if possible, and also be used as part of the clock mechanism. It would be very difficult to reinforce the bell cupola because of the small vertical posts supporting it.<sup>372</sup> Diagonal bracing was out of the question. By placing steel channels rigidly connected at the ends and by tying the tower down with rods we were able to reduce the sway of the steeple. We checked this sway by placing a transit on the ground and ringing the bell. We decided the resulting movement was so slight as to permit the use of the bell in the cupola.<sup>373</sup>

In the final analysis, however, wind remained the most critical load. Sheldon Keast's calculations (1 September, 1961, revised 16 November 1962; NPS 1962, ff.19) actually indicated that overturning would be possible under a 100-mile-per-hour (m.p.h.) wind loading, which was more rigorous and more conservative than that required by the Philadelphia building code then in effect.<sup>374</sup>

---

372. The belfry posts were, however, eventually reinforced during the Utility Improvement Project (1993-98). At that time the design intent was not to dampen the movement of the bell, which had been subsequently rendered stationary, but to improve the vertical continuity of the upper steeple under wind loading, particularly in response to decay recently discovered in the belfry posts.

373. N. L. Gianopulos expanded on Keast's recollections. The muting was calibrated by Mr Gianopulos and others in the belfry gradually reducing the strike, with Keast standing at the John Barry statue, following the movement of the steeple centerline with a theodolite. The muting level was identified when the steeple would no longer sway, although it did continue to vibrate.

Gianopulos also recalled that the pre-muted bell was not only louder, but much sharper: "A good bell, like a European cathedral bell." Discussion with D. G. Cornelius, 30 April 2009.

374. The Philadelphia building code, the most recent significant revision of which had been ten years earlier (Philadelphia 1952), mandated an archaic pounds-per-square-foot (p.s.f.) loading, which began with 15 p.s.f. at ground level and increased upward. Keast was using an early version of ANSI 58.1, which eventually became the basis of wind load provisions in the model codes including the current ASCE 7-05 and 2006 International Building Code. When Keast & Hood Co. reanalyzed the steeple in the 1990s as part of the Utilities Improvement Project, the BOCA-based revised Philadelphia Code showed a basic wind speed of 80 miles per hour. Furthermore, Keast's calculations, preserved at Keast & Hood Co., show that he did not consider the stabilizing effect of the loads from the Centennial Bell and the clock mechanism, either or both of which could potentially have been removed at some future date.

The primary design objective for Strickland's steeple was therefore compensatory stabilization against the possibility of overturning under wind loading.<sup>375</sup> This was achieved by installing new angled grillage beams in the corners below the bearing points of Strickland's four sloping columns, which were anchored via straps to threaded rods through the cast-iron bearing plates into the new grillage. In Keast's own accounting (Keast 1971: 74), the actual process was more interesting than the previous dry summary suggests:

The steeple was supported on four 12 x 12's diagonally up from about the 3<sup>rd</sup> floor level to the bell floor. These 14-1/2 x 14-1/2 at the bottom and 12 x 12 at the top and 48 long canting inwardly formed a truncated pyramid, and were supported on C.I. shelves or brackets resting on 3 inches of masonry at each corner. This presented a precarious support for the main posts of the steeple with a tendency to tip to the inside. Several of these had tipped slightly and I recommended that diagonal steel I beam be placed under the inside ledge of this C.I. shelf with the beam supported at each end in pockets in the wall. We did this successfully on three of the corners. On the S.E. corner post, because of the nature of the mortar and brickwork, on cutting out the pockets for the beam we found that the pressure under the casting was becoming excessive and started to crush. I was called to the site one day when it was feared that the tower was in a possible state of collapse. No expense had been spared to protect this structure and every possible precaution had been taken to protect all parts of the structure from damage in any form.

I considered every possible method of shoring the steeple but in all cases, because of the conditions involved, they presented difficult problems. I carefully calculated the stresses in the casting and masonry and figured by carefully cutting the pockets as far away from the casting as possible and by wedging dry packing under the casting that we would be able to place the beam in the pockets and gradually ease the beam into position under the casting. This was done and the beams encased in the wall.

A secondary objective was to renew the stiffness of the pyramidal frame, as had previously been addressed in part by the Centennial cross-bracing. Keast observed that "[t]he weak part of the structure was at the point under the bell floor where the steeple changes to eight (8) columns instead of four (4). It was difficult to develop a rigid connection at this point and the lack of bracing produced internal movement within the steeple" (Keast 1971, 75). The further enhancement of stiffness at this location was one of the deferred items later addressed during the Utility Improvement Project.

The reinforcing of Woolley's two-story double queen-post trusses of 1750-53, which support the Tower Level 2 ceiling-floor assembly and the floors at Tower Levels 3 and 4, was essentially an afterthought (Illus. 118-120). Some deficiencies, including fire damage to one of the trusses at Level 3, had already been known. However, when removal of the stair hall ceiling was selectively performed to permit observation of conditions not visible during the Ewing survey, severe deterioration of the bottom chords of the lower queen-post trusses was revealed (EODC 157.568, 570).

---

375. Seismic stability was not considered to be a relevant structural criterion in Philadelphia in the early 1960s.

The work was executed between June 1962 and the end of 1963, with A. Raymond Raff again as general contractor. To sustain the deteriorated Tower Level 2 queen posts prior to and during the transfer of their loads to the new steel channel assemblies, a massive wooden shoring tower assembly was constructed from the Stairhall floor to the underside of the queen-post lower chords. The shoring was designed by George Schmidt, president of the Raff Company and a highly capable structural engineer in his own right, using select Southern Yellow Pine members.<sup>376</sup>

Owing to advanced age and ill health, Sheldon Keast was unable to ascend the steeple to observe the numerous field conditions encountered during the course of the work. Instead, a card table was set up for him, with the project drawings, in the Stairhall. As situations arose, Richard Hannigan, Keast & Hood's drafter for the project drawings,<sup>377</sup> would be sent up to document them with an early Polaroid camera, permitting almost instant review and response by Keast.<sup>378</sup> The range of field conditions encountered is reflected in the large-scale revisions of the structural drawings during the work (Drawing NPS:IND 33:07, Sheets 1, 2, 2A, 2B, 3, 3B, 3C, 4, 5, and 5A of 5[!], 1963). The issues addressed by the revision sheets included the discovery of the deteriorated bottom chords of the Level 3 queenpost trusses and the substitution of field bolting for field welding in view of the risk of fire.

#### *Additional Structural Work During Mission 66*

The condition of the second floor landing, which retains a remarkable amount of its original fabric, was revealed by selectively lifting the floorboards (EODC photo 157.1361, 27 August 1964). The need for the investigation, and the subsequent remedial reinforcing, was summarized by Keast (Keast 1971, 75):

The National Park Service believed that the second floor would be used by the public which meant that the stairway and platforms in the tower had to be reinforced by steel as also the railing. The latter was reinforced by substituting, at various places, fifty<sup>379</sup>

---

376. N. L. Gianopulos, discussion with D. G. Cornelius, 25 August 2006. By the early 1960s prefabricated metal shoring had already rendered timber shoring obsolete; Schmidt's use of the material was dictated by its greater design flexibility in addressing the relatively small, although still critical, loads involved with minimum damage to precious structure and interior finishes. The latter were particularly worrisome because the stair tower had most of its original finish work intact. The timber assembly would have resembled something out of Michelangelo's Sistine Chapel via Irving Stone. Similar timber towers, except half again as tall, were provided by Schmidt, Raff, and Keast & Hood Co. in the early 1980s to "temporarily" (they remained in place for two decades) stabilize failed roof trusses in the Baptist Temple, Philadelphia; D. G. Cornelius, conversation with T. J. Leidigh PE, Keast & Hood Co., 28 August 2006. Although Keast & Hood had originally envisioned steel towers, Schmidt proposed timber to use up some material "in the yard," possibly there since 1963.

377. Hannigan subsequently worked for the Philadelphia office of Geddes Brecher Qualls Cunningham, became registered as both an architect and an engineer, and established his own preservation-oriented practice, still functioning, in San Francisco.

378. Gianopulos to Cornelius, 25 August 2006. The shoring had caused the Stair Hall to be closed to the public, although limited views of the Liberty Bell were permitted. Presumably Keast was located sufficiently out of the line of sight to avoid becoming a tourist attraction in his own right.

379. This number seems a little high.

steel rods 1-1/8 inches or more in diameter set into steel blocks at the bottom and rigidly connecting them at the bottom. The rods were covered with either wood or aluminum to correspond to the appearance of the stair baluster.

The locations of the reinforced balusters in the second run are inarguably apparent in a contemporary photograph (Illus. 121). The extent of the structural reinforcing is indicated in two drawings prepared by Keast & Hood Co. (NPS 1965 illus. 3, sheets 1-2).

### *Envelope and Interior Maintenance and Restoration during Mission 66*

In 1961 the upper portion of the wooden steeple received maintenance repairs, as documented by Michael Everett in NPS 1962c.

One of the more interesting aspects of this work was that the scaffolding was supported from the steeple (Illus. 122), avoiding the recurring park *bête noire* of full-height scaffolding during periods of heavy visitation. Two separate assemblies comprised the 1961 staging. The lower was a platform cantilevered from outriggers supported from the belfry floor (Tower Level 7) and threaded through the belfry arches to a perimeter frame. Access scaffolding was built up from the platform to the below the belfry entablature. The platform was also braced down to, but apparently not supported from, Tower Level 6. The second platform was constructed at the base of the lantern (Tower Level 9) and supported by a series of radial plywood fins centered on each segmental face of the cupola dome. Three tiers of access scaffolding were erected off of the platform, the highest near the spire cap.

During this time the infamous replacement of the shingles on the spire occurred, resulting in 16 courses instead of the previous 15 (NPS 1962c, 19).<sup>380</sup> This error had been promised with rectification at the next opportunity, which would turn out to be the Utility Improvement Project three decades later (Vitetta 1995a, Appendix, "Summary of Repairs at Independence Hall Tower, March – December 1963").

Another work item of the project with ongoing repercussions was the first of three removals and rehabilitations of the weathervane assembly, which was repeated, to address different issues, in 1982 and 1993. The 1962 work was primarily concerned with repainting and other surface condition issues (Illus. 123). Those in 1982 (Illus. 124) and 1993 incorporated metallurgical

---

380. Had there always been 15 courses prior to 1961? The 1918 A.I.A. drawings (Drawing No. 10, INDE 4563; Detail 41, Drawing No. 23, INDE 4576) indicate 14 regular courses, and a double-length exposure on the top course; the spire cap was too shallow to conceal a sixteenth course; the accuracy of these drawings appears to be confirmed by a contemporary photograph (INDE 5354). Among the clearer nineteenth-century photographs, Newell & Son, 1873 (INDE 6631/39,020), also appears to show 15, although things get fuzzy toward the spire cap. Finally, NPS concluded that the shingles removed in 1961, as well as the mitered sheathing below, were original to Strickland's 1828 work, based in part on a graffito date of "July 12, 1828" (EODC 157.1784).

testing; the latter project also entailed major rehabilitation and replacement of various components and attempted to address deterioration of the assembly by water intrusion.<sup>381</sup>

Of particular interest to our present study is Nelson's and Petrak's review of the exterior siding of the steeple between the top of the Level 4 apron roof and Level 6, best known for the clock faces. The term "curtain wall" is used for the first time to our knowledge to describe this remarkable and problematic assembly; very detailed drawings of existing conditions with some treatment recommendations were included in the report (NPS 1965). Drawing 3423, Sheet 2/2, (our Illus. 97) shows both the existing double bevelled lap joints, and their proposed enlargement to permit installation of a contemporary backer rod and sealant, on the exterior face, in lieu of the caulking haphazardly applied, usually on the interior, to the relatively narrow joints in the past. This detail was not implemented.<sup>382</sup>

### *Ongoing Maintenance 1976-1993*

The completion of the Mission 66 program at the time of the Bicentennial established a sound datum for the ongoing maintenance of the park properties including Independence Hall. The day-to-day record of this maintenance, directed by Batcheler, the Chief Historical Architect in the 1970s and '80s, is chronicled in the Office of the Architect (INDE-OA) records now in the Park Archives.<sup>383</sup>

With the cyclical weathering of exterior finishes, such as paint coatings, sealants, and shingles installed for the most part in the early to middle 1960s, a scaffolded rehabilitation of the tower and steeple was undertaken in 1982. This work is best remembered for the "Maintenance is Preservation" banner applied to the scaffold on Batcheler's recommendation (INHP 157.4482-11).<sup>384</sup>

The relative quiet within the park also permitted the creation of three significant documents, Batcheler's HSR components for "The Central Hall and Stairhall" (NPS 1989) and "The Physical History of the Second Floor" (NPS 1992), and the photogrammetric recordation of the building, as part of a nationwide NPS initiative, by Denet, Muessig, Ryan & Associates Ltd. of Iowa City (HABS 1990; our Illus. 125). Also as part of a larger NPS initiative, this time covering

---

381. For the 1982 metallurgical analysis, refer to MTC 1982; the corresponding document for 1993 is Viewsonics 1993. Extensive additional documentation of the 1993 project includes Keast & Hood 1993d and 1995a, and Vitetta 1995a. An unresolved concern in 1993, noted in the Keast & Hood documents, was the inability to investigate concealed portions of the wrought-iron spindle within the rehabilitation scope at that time.

382. According to Penelope Hartshorne Batcheler, in an undated 2006 conversation with D. G. Cornelius, Nelson and Petrak on second thought realized that the new joint configuration would create a trap, with no relief, for water migrating from above or within. This was a textbook example of the inappropriateness of contemporary "superior" technology as a replacement for a more "primitive" component in a preservation context.

383. The relevant records of Batcheler, and those she inherited from Nelson, her predecessor, are summarized in Appendix Section 3.1.8.

384. See also P. H. Batcheler, "Log of Restoration, Exterior, Independence Hall: 1956-1957-1960, 1966, 1982," INDE-AO 44:02.

southeastern Pennsylvania and vicinity, dendrochronologist Edward Cook cored samples from several locations, including the steeple, on 25 November 1989 (Illus. 126).<sup>385</sup>

### *The Utility Improvement Project (1993-99): Overview*

Pedantically speaking, the Utility Improvement Project was to some degree a misnomer, as it was concerned as much with services within the buildings as with utilities outside of them. Perhaps the terminology was chosen to be less alarming than its actual intent, which was the improved protection of human life safety, building fabric, and historic artifacts within the buildings, all of which had been perceived as being at increasing risk with the approaching obsolescence of building systems dating to the Mission 66 era or even to era of the city's oversight.<sup>386</sup>

### *UIP: Life Safety and Building Services*

For the details of the buildings' services as installed in the 1990s and extant at the time of the report, the reader is referred to the description and assessment sections of the mechanical and building services.

The protection against fire of life as the primary objective, and of historic fabric as a very important second one, was better ensured through a relatively straightforward design. Updated technology was introduced in the form of pre-action fire suppression equipment with advanced detection and response functions; this equipment, which kept sprinkler piping dry until filled and activated by a two-step determination of combustion, permitted the extension of the sprinkler system over large portions of the buildings not previously covered when the only choice was between wet and dry piping.

The most important historical issue for the Utility Improvement Project pertaining to the Independence Square buildings derived from the proposed introduction of curatorial climate controls within the buildings. The air conditioning introduced in the 1960s and '70s largely predated the development of design criteria for museum collections and was basically designed to enhance visitor comfort, and to permit windows to remain closed for security and cleanliness. This existing system was considered to be adequately sized for temperature control, although the equipment had reached its effective lifetime (Vitetta 1993, 6.1-6.2).

The UIP schematic design evoked significant controversy by attempting to maintain generic museum conservation standards,<sup>387</sup> defined as 70 +/- 2 degrees Fahrenheit dry bulb temperature and 50 +/- 2% relative humidity year-round (Vitetta 1993, 6.3-6.4), year-round, without significant spatial variation (stratification) in unusual spaces such as the tower Stair Hall. The controversy, which involved heated differences of opinion within the Park Service and the

---

385. Memo to J. Randall Cotton, Philadelphia Historic Preservation Corporation, from Batcheler, 11 December 1989, regarding "Dendrochronology Data Base (Report 2)," INDE-OA 45:9; Goldstein 1992.

386. For the process wherein public opinion was harnessed to implement the UIP, see Mires 2002, xvi.

387. By which is meant average conditions for collections with a broad range of artifacts, rather than specific conditions suitable to artifacts of a common material.

design team, and between the Park and the City, centered on three potentially adverse effects of achieving the mechanical design conditions.

The first was the need for additional air handling units, larger ductwork, and more and larger air terminal units. For example, a local air handling unit was proposed within the tower in order to address stratification of heat and humidity in the upper expanse of the Stair Hall. When the architect's suggested installation of a terminal in the middle of the ceiling plaster roundel had been rejected by NPS, Vitetta instead proposed flexible ductwork, connecting to a louver in the door into the tower at Level 2, which would have to be disconnected and moved aside every time the door was opened.<sup>388</sup>

The liabilities associated with moving larger quantities of air included the need to increase concealed ducts and duct penetrations with significant loss of additional building fabric. The installation of additional air handling units was specifically opposed by Ms Batcheler of INDE and by Keast & Hood Co. because past experience demonstrated that the presence of oversized units in attics and basements inhibited regular inspection and maintenance, permitting envelope and structural problems to go unobserved.

Such units would also necessitate reinforcing of existing framing to sustain both their operating weight and that of vibration isolation equipment. Above all, humidification in winter was felt to create a potential for increased deterioration of fabric because of the potential for condensation and freeze-thaw damage within building masonry and cavities. This last issue had recently become critically apparent to preservationists and was the subject of both an ICOMOS protocol and an NPS *Preservation Brief* (NPS 1991).

The controversy was resolved by the owner of the Independence Square buildings, the City of Philadelphia, as represented by the Philadelphia Historical Commission ("PHC"). The PHC requested that the existing HVAC system be essentially replaced in kind, with limited provisions for expansion where such measures could be taken without significant loss of fabric. On the conservation principle that rapid changes in temperature or humidity had greater destructive relevance than the given temperature or relative humidity at any given time, air controls would be stepped to permit gradual reductions in humidity during the winter season.

To help ensure the protection of artifacts within the buildings, the City requested an environmental monitoring system with data logging and feedback to remote monitoring stations. An initial proposal for the monitoring system was proposed by Vitetta and, on the basis of extensive criticism of the Vitetta system by Rose and Brown, independent building environment consultants, a revised monitoring system was designed and installed per the recommendations of the latter (Rose and Brown 1995, 1999).

---

388. D. G. Cornelius, personal recollection. Cornelius was employed by Vitetta during the Utility Improvement Project, and was in part responsible for engineering coordination in the Independence Square buildings.

**UIP: Structural Scope**

Keast & Hood Co.'s participation as the structural engineer in the Vitetta project team for several UIP projects, including the Independence Square Buildings, recognized their ongoing experience with the buildings and people of Independence National Historical Park since the early 1960s (Illus. 127). Mr Gianopulos served as principal-in-charge, and Ms Pentz as project manager. Their work for the UIP included: (1) theoretical studies; (2) conditional assessments; (3) remedial systemic structural interventions; and (4) coordination with the building services program.

*Seismic loading.* The theoretical studies included a "Seismic Resistance Assessment for the Principal Buildings of Independence Square" (Keast & Hood 1994, 2.1).

Pursuant to the submission of December 23, 1993 [Keast & Hood 1993b] and the project's Round Table Review of December 14, 1993, Keast & Hood Co. has conducted an overview assessment of Independence Hall, Congress Hall, [Old] City Hall and the Wing Buildings relative to their resistance to seismic forces prescribed for the BOCA Building Code for this region of the country. Since the BOCA 93 code<sup>389</sup> does not include requirements for the seismic analysis of existing buildings, the review assessment was conducted per the NEHRP Handbook, FEMA-178/June 1992 (National Earthquake Hazard Reduction Program) for Building Type 15-Unreinforced Masonry Bearing Wall Buildings, which is specifically aimed at the analysis of existing buildings . . . The assessments consequent of the analysis are in a summary form to simplify and to facilitate conformance or nonconformance to NEHRP.

The various buildings in the Independence Square were discussed relative to the NEHRP analytical criteria, which are included in the complete version of the "Seismic Resistance Assessment" document included in the Appendices. Independence Hall excluding the tower was assessed separately from the tower and steeple. The assessment of the tower (page 2.3) included the following salient observations:

The timber-framed portion of the tower above the heavy masonry base is, in a relative sense, lightweight construction . . . From a design and stability point of view, the critical load condition for the tower is wind rather than seismic.

. . . The tower's resisting moment to overturning . . . provides an ample factor of safety providing the supporting soils are competent for maximum soil pressures of 9.0 ksf (431kPa). We have designed new building structure foundations in the historic portion of the city for normal bearing values of 5 ksf (240kPa) and 6 ksf (287kPa) and are of the opinion that the short term increased loading can be accommodated. Of greater concern though, is the presence of ground water approximately 10 ft. (3m) to 15 ft. (4.5m) below the basement levels and that the fine grained silty sands supporting the tower and the other buildings of the square could be affected by liquefaction of the soils in the unlikely circumstance of a major seismic event. If such an event did occur, the consequences

---

389. The Building Code of the City of Philadelphia then in force was based on the 1993 edition of the BOCA (Building Officials' Congress of America) model code. The National Park Service, as a Federal entity, was exempt from regulation by the Philadelphia Department of Licenses and Inspections, the jurisdiction having authority in the city, but had a general "Good Neighbor" policy of meeting or exceeding local requirements.

would be devastating to not only the Independence Square group, but also to much of the city that is built between the two major rivers.

*Soil liquefaction.* Soil liquefaction was of course a major factor in the massive destruction and loss of life in Tokyo in 1923 and Mexico City in 1985, two cities located in regions with much more seismically active recent histories than Philadelphia. In view of the likelihood of a similar geological response to a seismic event of any significant magnitude in the Philadelphia region, the remainder of the tower assessment has a slightly anticlimactic character:

The masonry foundation walls which are at least 36 inches (914mm) thick have adequate shear capacity for the prescribed loading required by the code.

In summary, the tower as reviewed, has sufficient resistance to overturning from lateral seismic loading; however, there will occur some local degradation of the walls at the old through-wall shrinkage cracks above the major window openings of the tower's masonry base. The interventive repairs contemplated for the decay diminished upper portion of the timber steeple per appropriate applicable wind forces, will enhance that portion of the tower's resistance to seismic activity.

*Seismic resistance.* The "Summary and Recommendations for Seismic Resistance" for the five buildings (pages 2.6-7) were outspokenly consistent with other studies of similar historic structures in the northeast United States:

In view of the fact that these 18th century structures were of unreinforced masonry and that their associated floor and roof structures were timber-framed, the calculated outcome with respect to seismic code conformance was predictable from the outset. The 20th century interventions of structural steel reinforcements of one form or another, provided few if any predictable improvements to seismic resistance . . .

[2.8] In view of the comments ventured so far . . . this office is reluctant to recommend an interventive seismic retrofit of the five buildings on the square because, other than the fact that the code requirements for new structures and additions became more stringent in the 1987 edition of the BOCA code, the historic perspective of the buildings having survived the numerous small events of the region since the late 18th century should not be ignored. To pursue the implementation of seismic retrofit for the buildings on the basis of a code modification that may well have been generated by probabilistic theory better suited to the southwestern regions of the country, ignores the historic record.<sup>390</sup>

---

390. These conclusions also appeared in somewhat different form as "Code Analysis and Risk Management vs. Preservation of Integrity of Historic Fabric" in the Task Order No. 9 Schematic Submittal (Keast & Hood 1993b, 5.75-76), wherein is concluded "[t]he rigorous imposition of the present code will most likely result in the diminishment and/or loss of historic fabric as a consequence of retrofit requirements" (5.76). The same passage recommends "that consideration be given as well, to the effects of traffic-generated vibrations on the five buildings." This recommendation was followed up in a proposed monitoring program, designed by subconsultant Anthony Coppa, which was ultimately not implemented for cost reasons.

*Wood pathology.* The conditional assessments involved both visual observations and wood pathology. The observations pertaining to the tower included the examination of the second landing of the monumental staircase, in the northwest corner of the stairhall (Keast & Hood 1993b, "Assessment of Existing Conditions," 5.9-10):

Movements in the wood finishes at the northwest tower stair landing have been observed, apparently having occurred at some time subsequent to the 1965 structural rehabilitation, when the finishes were restored and reported to be tight-fitting.

[There was an accompanying photograph of the paneled soffit of the landing.]

The structure of the landing consists of one timber beam spanning diagonally across the corner between the north and west masonry walls, with another timber beam at right angles to the first, pocketed into the intersection of the walls, and cantilevering outward to support the newel post. The two timber beams are in the same plane and are half-lapped at their intersection. Both of these beams were reinforced with steel in 1965.

The recollection of those involved in the 1965 work is that the landing boards were removed and the structural reinforcement was accomplished from above, without removal of the wood trim and soffit below. If there has been a structural failure in the landing framing, it is likely to have occurred in the area obscured by the wood trim and soffit which was not exposed for inspection in 1965. At the inception of this project we requested that NPS-INDE provide scaffolding and removal of finishes so that the area can be inspected.

Upon the requested removal of finishes Keast & Hood Co. found that the headers at the top and bottom of the stair stringers were inadequately connected to the newel. The deficiencies in the headers and their attachments to the newel were corrected by a new campaign of steel reinforcements implemented during the UIP project.

The wood pathology of Independence tower steeple was conducted in three stages (April, 11-16 August, and 18-27 October 1993, by Keast & Hood Co. and its subconsultant, Joe W. Clark.<sup>391</sup> Cumulative reports of findings followed each investigation (Keast & Hood 1993a, 1993b, and 1994 respectively). The examination of the steeple was one component of a study that also included the roofs of both wings of Independence Hall, and the roof and cupola of Congress Hall.

*Tunnel decay.* The rationale for the investigations was explained in the final report (Keast & Hood 1994, 2.9):

The investigation into the presence of hidden fungal decay in the timber structures of Independence Square has been a primary focus of our efforts during this period. While research into the mechanism, manifestation, and effects of decay has long been

---

391. Dr. Joe W. Clark was a wood pathologist located in Madison, WI who retired from the U.S. Forest Service, Forest Products Laboratory. He was the coauthor of *Wood Bridges—Decay Inspection and Control*, Agriculture Handbook # 557 (Madison, WI: U. S. Forest Products Laboratory, 1979).

established in the fields of forestry and agriculture, this information has only recently begun to be recognized by the professional preservation community. The structural assessments and repairs that were carried out in the Independence Square Buildings in 1958-65 had been based on the presumption that the timber framing was sound unless visible evidence of decay was present on the external surfaces of the timbers. However, it is now known that hidden internal decay is in fact widespread and indeed typical of historic timber framing that has been subject to prolonged roof leaks.

These comments derive directly from Keast & Hood Co.'s discovery of the phenomenon of "tunnel decay" in two specific occurrences in 1989-1992 at the Arch Street Meeting House and at the Academy of Music, both in Philadelphia. Tunnel decay occurs in larger timbers, such as the top and bottom chords of roof trusses and wood columns, when prolonged water intrusion infiltrates the less decay-resistant heartwood and instigates fungal decay. The heartwood can be afflicted for several feet beyond the point of entry while retaining an outer shell of apparently sound wood. For this reason, as the narrative continues:

[t]he only established method of detecting internal decay in heavy members is by extracting core samples for evaluation by an experienced Wood Pathologist.

The preliminary report [in Keast & Hood 1993a] of Wood Pathologist Dr. Joe W. Clark's overview investigation of Independence Hall tower had identified the presence of some degree of decay damage in the tower and suggested the need for further sampling. Subsequent testing performed during Dr. Clark's second visit was focused on the area of Tower Levels 6 and 7 (just below the bell). The data from that effort was included in the schematic submission of October 29, 1993 (Keast & Hood 1993b), and indicated a significant amount of decay damage having occurred at these upper tower levels.

During the period of October 18-27, 1993, Wood Products Pathologist Dr. Joe W. Clark continued his field investigation of the timber framing members of the Independence Square buildings. The primary areas of sampling were the lower levels (Levels 3-5) of Independence Hall steeple, the unreinforced sections of roof trusses in Congress Hall, and the cupola framing members of Congress Hall . . .

The findings were summarized on the same page of the final wood pathology report:

While a significant amount of decay had been found in the upper Tower Levels (Levels 6 and 7), the lower tower levels (levels 3 to 5) were found to have been relatively unaffected by decay. The principal exceptions of note are the four main columns comprising William Strickland's 1828 frame.<sup>392</sup> These columns, which are approximately 356 mm x 356 mm [14 inches square] in cross section, were found to have interior decay infections ranging from 23 mm to 198+ mm [1 inch to 8 inches] in diameter and

---

392. Within the scope of this present study, these column bases were subjected to additional investigations in the summer of 2006, employing more current technology, in the hope of better mapping the extent of compromised material. The newer findings are discussed in Chapter 1.4, "Condition Assessments".

extending upwards approximately 0.6 meters [two feet] from the historic corner cast iron brackets just above Tower Level 3.

Generally the lower tower levels were found to be in much better condition than the upper levels (below the bell) where water entry apparently provided a favorable environment for the development of decay infections. As Dr. Clark has emphasized in his previous reports, it will be important to maintain dry conditions throughout the tower in order to prevent the development of new infections or the re-activation and spread of old infections.

The final report was extensively illustrated with structural drawings showing the locations of the sampling cores and photographs of the extracted cores. The latter were accompanied by core data tables interpreting the areas of decay and other visual indicators in the individual cores.

### ***UIP: Envelope Restoration and Repairs***

In contrast to the priority given to life safety improvements and structural stabilization, other work affecting the tower and steeple during the Utility Improvement Project was limited in nature. This could be justified further by the differentiation between the major capital improvements comprising the UIP scope and the capabilities of park maintenance, and also by the relatively recent work on the envelope performed during the 1980s.

The most important work item, however, was in some respects a reprise of the 1980s. The spire continued to be a problem area for water intrusion and consequent deterioration. The weathervane assembly was found to have dropped approximately 2 inches vertically in approximately 30 years. When opened for visual inspection, the timber grillage beams supporting the spindle and spire were found to be destroyed by advanced decay.

The improvements included structural steel, designed by Keast & Hood Co., to reinforce the cupola and spire. During the spire rehabilitation, excessive vibrations were reduced by limiting the bell hammer stroke to 50% of its previous impact force.

The weathervane was disassembled, a new stainless steel grillage was installed, and the remaining timber grillage beams were repaired by epoxy fills. After strengthening the framework, the weathervane was reinstalled. The spindle, which had been examined in 1982 and again in 1993 was “deemed sound”<sup>393</sup> although of slightly diminished cross-section where galvanic action had occurred. A barrier was placed between the dissimilar metals to mitigate further section loss.

As noted previously, documents (NPS 1996) were developed by Bill Brookover, the Park Historic Architect, for the protective metal cladding of the upper steeple, but not implemented.<sup>394</sup> Per the

---

393. Vitetta 1995, 4.4

394. W. Brookover, conversation with D. Cornelius, 5 February 2007. Apparently one aspect of the funding issue was that the cladding work, although to have been concurrent with the UIP, was to have been funded separately from a source which was not ultimately made available.

Summary of Work (01010-1), the following scope was anticipated, no aspect of which was actually executed:

1. shoring and scaffolding as necessary to provide access to work areas;
2. weatherproofing circular windows at Level 6;
3. removing existing shingle roof, just below Level 7, and providing new lead coated copper roof;
4. refurbishing metal urns just below Level 7;
5. providing lead coated copper cladding at piers, arches, and entablatures of belfry at Level 7 and lantern at Level 9;
6. improving mounting of guard rods at Level 7;
7. making certain existing incidental openings weathertight at Level 7;
8. painting of all new work, circular windows, and metal guard rods.

The proposed treatment definitely attempted an aggressively proactive approach to addressing problems which had bedeviled the two steeples in this location since the 1750s.

The replacement of the shingles below Level 6, despite the eventual determination of their authenticity within the Strickland fabric, acknowledged the inadequacy of the historic roofing system for this low-slope application. We have noted that similar shallow shingle roofs at Level 4 and the predecessors to Levels 6 and 7 probably doomed Woolley's steeple; furthermore, as discussed more extensively in the following sections, the belfry post bases at Level 7 comprise one of the most significant sources of current water intrusion in the steeple.