Appendix

Building Conservation Associates, Inc.

Exterior Building Survey

Introduction

Baker House at Massachusetts Institute of Technology in Cambridge, Massachusetts is a six-story, brick dormitory building, designed by Alvar Alto and built in 1948-49. Baker House is distinguished on the MIT campus by its curvilinear design, its "moon garden," and roof deck with panoramic views of the Boston skyline (figs. A1, A2).

The objective of this study is to document the existing conditions of the interior and exterior of the building and prepare treatment recommendations. Building Conservation Associates, Inc. (BCA) surveyed the exterior of the building on May 28-31. This survey was conducted with swing staging which facilitated our examination of the brick and mortar on all the elevations of the building and the stucco on the north elevation. Additional survey work was conducted by BCA on July 18 and 19. This work focused on the interior of the building.

Typical conditions were noted on architectural drawings provided by the architect and documented with color photographs. The drawings and photographs will be included with this report.

On the exterior of the building, mortar samples were removed from random locations on all of the elevations of the building. Both original and repointing mortars were removed from the brick and the limestone. Stucco samples were also removed from the roof penthouse, the north wall and the ceiling of the north entry. Soundings were taken of the stucco at random locations with a hammer to determine whether the stucco remains well-bonded to its substrate. Paint samples were removed from all the painted exterior surfaces to identify the original paint colors. On the north wall stucco and south wall limestone, RILEM Test No. II.4 should be performed in several locations to assess surface permeability.

On the interior of the building, representative paint samples were removed from the building fabric. Once a paint layering sequence was established, in-situ scraping was used to confirm the location of the same paint colors.

Laboratory analysis of the samples removed from Baker House was undertaken to identify original finishes and components of the original building materials, as well as to help assess their condition and causes of deterioration. The information derived from the laboratory analysis has been combined with the field observations to prepare the treatment recommendations.

Fig. A1 *Partial south elevation of Baker House*

Fig. A2 *Moon Garden on roof of dining hall*

Fig. A3 *Concrete at the building's foundation*

Fig. A4 *Triangular-shaped pier supporting north entry*

EXTERIOR

Division 3: Concrete

GENERAL DESCRIPTION

The exterior concrete is located at the building's foundation, in the triangular-shaped pier that supports the north entry and on the bracket that supports the east end of the north elevation stairs (figs. A3, A4). The concrete is cast-in-place, the horizontal lines of the formwork are still visible on many of the concrete surfaces. The concrete is light gray in color and has a relatively smooth finish. The surface of the concrete appears to have been smoothed with a concrete parging - not a continuous surface, but rather a parging to fill recesses caused by the placement of the formwork. This parging was applied at the time of construction because it runs under the foundation through-wall flashing.

Fig. A5 *Discoloration of concrete along joints of the formwork*

Fig. A6 *Brick mortar joints*

The concrete exhibits some of the same surface discoloration found on the mortar - in some areas gray surface has turned tan in color. The pattern of this discoloration tends to be in horizontal bands, along the joints of the formwork, where the concrete surface has been parged (fig. A5).

SAMPLING AND TESTING

No sampling or testing was done on the concrete.

EXISTING CONDITIONS

The concrete is in very good condition. All of its surfaces appear to be sound - there is no evidence of surface spalling or cracking that would be indicative of deterioration. As noted above, there is some surface discoloration. This surface discoloration may become less distinct when the building is cleaned, but it will not be removed by cleaning.

There are some random holes in the concrete where different equipment has been mounted on the building. These holes should be patched.

TREATMENT RECOMMENDATIONS

The concrete surfaces should be cleaned. The method of cleaning should be determined by cleaning tests performed on all of the exterior masonry surfaces.

The holes in the concrete surfaces should be patched with a concrete mix that matches the original concrete in color and surface texture.

Division 4: Masonry

1. Mortar

GENERAL DESCRIPTION

Brick Mortar

The entire south, east, and west elevations and part of the north elevation of Baker House are constructed of hard, water-struck brick originally laid and pointed with a dark gray Portland cement-based mortar. Historic photos indicate that the joints were originally tooled to look weathered and had a relatively rough surface. The width of the mortar joint is 3/4" to 1". The tops of most of the horizontal joints are set back approximately 1/2" to 1" from the surface of the bricks (fig. A6).

Although the exterior surface of the brick mortar ranges in color from tan to gray to dark gray, visual observation and laboratory analysis indicate that the only extensive areas of repointing are located on the south facade above the fifth floor windows. In addition, investigation revealed that the tan surface on some of the mortar was actually a surface discoloration of the original dark gray mortar that was found beneath the surface (fig. A7).

Limestone Mortar

The limestone cladding of the terrace and dining hall on the south side of Baker House has been extensively repointed, but original mortar remains behind the repointing mortar. Both are grayish white, but the repointing mortar is whiter than the limestone making it easy to distinguish from the original mortar. Due to repointing and water related deterioration of the joints, it is impossible to determine the original mortar profile. The repointing is finished flush, and the width of the mortar joint is approximately 5/16". Crushing revealed that the original mortar is moderately soft while the repointing mortar is very hard.

SAMPLING & TESTING

In the laboratory, the mortar samples from Baker House were analyzed according to procedures developed by the National Park Service for mortar analysis. Each sample was ground with a mortar and pestle and soaked in a 1-to-4 solution of hydrochloric acid (HCl) and water. The HCl dissolves the lime and cement in the mortar and enables the sands and fines to be separated. After separation, the different constituents of the mortar were weighed and their percentages in the mix calculated.

Four samples of original brick mortar, including those both with and without discolored surfaces, were examined in the laboratory (1-4). Analysis showed that all four mortars are composed of light gray or light-brownish gray sand and gray to dark gray fines, produced by the addition of a dark gray pigment to the cement. The binder:aggregate ratio, 1.5:3-4, is in accordance with ASTM standards for a standard Portland cement-based masonry mortar. Since ASTM standards were already in use when the building was constructed, it is probable that they were followed to create this typical mortar mix.

Fig. A7 above *Section of south elevation exhibiting both original gray mortar (upper left section) and discolored tan mortar (lower right section)*

Fig. A8 right *Brick mortar deterioration*

Brick Mortar

Two samples of repointing mortar were analyzed (5,6). Preliminary observations revealed a dark gray, porous mortar which resembles the original mortar in color. The surface of the repointing mortar also weathered to a tan consisting of a pure white, lime binder surrounding a variety of brown and black sand particles. Analysis indicated that both samples were composed of light brownish gray sand and dark gray fines which accurately matched the original mix. The repointing mortar is slightly softer than the original mortar (binder:aggregate ratio was approximately 2.5:10), a safe alternative in terms of protecting the original bricks. The softness of the repointing mortar also contributes to its greater degree of erosion than the original mortar.

Possibilities for the surface color change of the brick mortar include: discoloration or fading of the pigments used in the mortar mix due to exposure to daylight, acid rain, etc. and erosion of the binder exposing the tan colored aggregate at the surface. Because all of the mortar has not turned to tan, it is assumed that this color change was not originally intended. In certain locations, there is a distinct separation between discolored original mortar and original mortar that has retained its color. Because these conditions occur in locations with similar exposures, it is probable that in the original pointing campaign several different mortar mixes were used. Analysis confirmed that there are at least two different mixes for the original mortar, evidenced by noticeably different fines colors 1,4 vs. 2,3. It is possible that the two different mortars had different pigments/mixes and/or weather differently so that one does not lose the grayness.

Limestone Mortar

Laboratory analysis of the limestone mortar and repointing mortar revealed that although the original was much softer than the repointing, the ratio of their components is similar (1 : 1 : 3) and typical of a basic lime mortar. The relative softness of the original mortar may be due to the poor distribution of binder in the mix confirmed by microscopic investigation, which revealed large clumps of unmixed lime in the mortar. The softness of this mortar may also be due to the seepage of water through the bluestone patio above into the limestone wall.

EXISTING CONDITIONS

Brick Mortar

The exterior brick mortar at Baker House exhibits typical levels of deterioration of a hard Portland cement mortar, aged fifty years in an urban, marine environment. The tops of the horizontal joints are eroded and the aggregate exposed. The two unusual conditions observed are surface discoloration and severe erosion. At its most severe, the mortar is deteriorated as deep as one inch from the surface of the bricks. As mentioned above, large areas of deteriorated mortar have also changed color on the surface from gray to tan. This condition greatly changes the visual appearance of the building from what was originally intended (fig. A8).

Limestone Mortar

The repointing mortar on the limestone walls was very easily removed. It is very thin and brittle causing it to pop out of the joints, leaving the soft original bedding mortar exposed. The condition of the mortar joints also allows water to enter the walls and is causing damage to the limestone.

TREATMENT RECOMMENDATIONS

The depth of the joint erosion of some of the brick joints requires that they be repointed. The surface discoloration raises, however, questions about whether to repoint with a mortar that matches the original or the current surface color of the mortar. The tan surface discoloration creates a significantly different visual effect than the original gray mortar would have.

Conditions of the limestone mortar and repointing mortar suggest that both should be removed and repointed with a softer, water-tight mortar.

2. Brick

GENERAL DESCRIPTION

The brick used for Baker House is a hard water struck red brick. Richard Weston, in his recently published book entitled Alvar Aalto, says the following about the brick used at Baker House:

> Aalto seems to have regarded bricks as an example of the kind of 'cellular' standardization he advocated - which is hardly what the system builders had in mind - and when using them was eager to emphasize their individuality. For Baker House at MIT, he found a factory, which was on the brink of bankruptcy, and offered a product defying all the requirements of quality control. He insisted that the bricks be used without sorting, and the resulting walls are of exceptional vitality, with occasional banana-shaped ones almost falling out, colours ranging, as he noted with obvious pleasure, 'from black to canary yellow, though the predominant shade is bright red'. (This quote is from a paper in the Aalto Archives.)

As noted above, the bricks were set and pointed with a dark gray mortar. The choice of a dark gray mortar, rather than a standard gray Portland cement mortar, is further evidence of Aalto's interest in the color and texture of the exterior walls.

SAMPLING AND TESTING

None of the bricks from the Baker House walls have been removed for testing.

EXISTING CONDITIONS

In spite of the fact that the bricks for the exterior walls of Baker House were selected without quality controls, they are in very good condition. No surface spalling, a condition often associated with poor quality brick laid with a hard Portland cement mortar, was observed. Very little cracked brick was observed, and the cracks that do exist are located randomly. The black and yellow bricks also appear to preserve much of their original color, although it is presently obscured by the general soiling on the exterior walls.

TREATMENT RECOMMENDATIONS

The only treatment recommendation for the brick is that it should be cleaned in conjunction with the cleaning of the other exterior masonry surfaces. The cleaning materials and their dilution should be selected so that they do not damage the colored surfaces of the brick.

The repointing of the brick should take into account its irregular shape. The mortar joints should be cut with great care and hand chiseled around the brick surfaces. The joints themselves should be sufficiently recessed to reveal the irregular shape of the brick.

3. Stucco

GENERAL DESCRIPTION

Stucco is used as a cladding material from the second story to the roof on three of the north elevations of the building and on the four roof penthouses.

Fig. A9 right *North elevation stucco system*

Fig. A10 above *Roof penthouse stucco system*

North Elevation

The north elevation stucco is a three-coat system installed with metal lath. The scratch and brown coats are gray and white respectively, and the finish coat is reddish brown created by adding pigment to the stucco mix (fig. A9). The finish coat is scored. The texture of the stucco is coarser in the two base layers and finer with fewer voids in the finish coat. The samples removed for laboratory analysis are from the corner of the east end and the center stucco facade. In these locations, the finish coat is approximately 1/8" to 1/4" thick, while the scratch and brown coats vary from 1/8" to 1" thick.

Roof Penthouses

The stucco on the roof towers consists of one thick whitish gray layer supported on wire lath and coated with several layers of paint (fig. A10). There is no scoring or surface texture on this stucco, but microscopic investigation reveals that the first paint layer matches the original color on the other members of the roof penthouses, indicating that the stucco was most likely painted originally.

Entrance Foyer Ceiling

The stucco on the entrance foyer ceiling is a two layer system supported by wire lath. The finish coat is smooth. Both coats are white and there are several layers of white and off white paint covering the finish coat. Site observation confirmed by microscopic investigation reveals that this surface was not coated with paint originally. This is evidenced by a layer of soiling between the stucco surface and the first layer of paint. There is also evidence of a clear, yellowish coating under the paint layers. As expected, the middle coat contains coarser sands with a more heterogeneous mix of sand types, while the finish coat contains mostly quartz particles of a similar size.

SAMPLING & TESTING

The same laboratory procedure as described above (Section 2) was used to analyze the stucco finishes. In the case of the north facade stucco and the entrance foyer ceiling, the middle coat and finish coat were separated and analyzed separately.

North Elevation

Laboratory analyses indicate that the middle coat and finish coat on the north facades had 1:3 binder:aggregate ratio, and their reactions during analysis revealed that they behave similarly to a Portland cement based mortar. The aggregate in both coats contains large particles approaching 2 mm in diameter, but the majority of particles in both are in the 0.5 to 1 mm range. Quartz is the most prominent type of aggregate in the finish coat while a mix of quartz and a small amount of mica and yellow fluorite are present in the brown coat. The aggregate particles in the brown coat are angular to sub-angular, and those in the finish coat are sub-angular to sub-round. The fines of the finish coat clearly include particles of reddish brown pigment used to create the color of the stucco.

Roof Penthouses

On the roof penthouses, laboratory analysis indicates that the binder:aggregate ratio is 1:3.5. Aggregate is well graded with the majority of particles in the 0.5 to 1 mm range. Under microscopic investigation, angular to sub-angular particles of quartz (milky and smoky), mica, and yellow fluorite were observed.

Entrance Foyer Ceiling

For the stucco ceiling of the main entrance foyer, the binder:aggregate ratio is 1:2.7. Both coats have white fines and white-tan sands. The aggregate of the brown coat is more varied than that of the finish coat, and the particles are sub-angular in the brown coat as opposed to sub-round in the finish coat.

EXISTING CONDITIONS

North Elevation

Erosion

Comparison of the unexposed stucco on the underside of the stair with the wall stucco, reveals that the wall surface is abraded and faded. The aggregate is somewhat to completely exposed over most of the wall surface due to the erosion of the binder over time. There are two patterns of erosion evident on the wall surfaces. Dark areas appear beneath window corners in some locations, and upon close inspection it is noted that in these areas the surface aggregate has been eroded or washed away due to water dripping off the window sills (fig. A11). With the milky white surface aggregate gone, the darker pigmented binder is left at the

Fig. A11 *North elevation exhibiting dark areas of stucco under window corners where white surface aggregate is eroded*

Fig. A12 *Finish coat of stucco completely abraded exposing brown coat underneath*

Fig. A13 *Cracking and staining of the north elevation stucco*

surface causing these areas to be darker than the rest of the facade. In various other areas, most notably above the lintels of the sixth story windows, the stucco surface has been completely abraded away exposing the tan middle layer (fig. A12).

Cracking

Cracking is widespread on the stucco facades of Baker House (fig. A13). Cracks typically run vertically beginning at corners and vertical members of window frames. Water running off the corners of the sills is entering the surface of the stucco and during freeze/thaw cycles, causing it to crack. It is not known whether this condition existed prior to the installation of the new windows in the 1970s. When the windows are replaced, it is a condition that should be corrected.

There are a few cases of horizontal cracking running from window openings or branching off the vertical cracks. There is also a continuous vertical crack running down the corner of elevation O-P and P-Q. In most instances, the cracks do not appear to extend beyond the finish coat of the stucco system. Tapping with a hammer provided little evidence of detachment from the support, even in cracked areas. Thus the cracking appears to be indicative of surface deterioration and differential stresses between the layers of stucco rather than structural failure. (The pattern of the stucco cracking is shown on the attached field drawings).

Spalling

There are a limited number of areas where the top coat of the stucco has spalled off completely leaving the middle coat exposed. This condition creates visual discontinuity because the reddish brown surface coat is interrupted by a patch of the gray middle coat. In addition it creates points for water and debris to enter between the layers and cause further damage.

Staining

Dark patches of soiling attributed to normal environmental pollutants are present in various places on the facades (fig. A13). There is also staining due to water seepage behind the stucco layers.

Roof Penthouses

There are several large cracks on two of the roof towers (fig. A14). On penthouse #2 there is an eight foot long horizontal crack that runs across the top of the stucco facade about one foot from the cornice, in addition to surface cracking throughout the facades. On penthouse #3 there is another deep vertical crack running from the roof to about halfway down the wall.

On the south side of penthouse #2, there is a large patch of Portland cement mortar. This gray color is unsightly as it matches neither the color nor the texture of the existing painted stucco finish.

All of the paint on the roof penthouse stucco is severely flaking and peeling, exposing the stucco behind(fig. A14).

Entrance Foyer Ceiling

The entrance ceiling is in good condition and will require only minor patching.

TREATMENT RECOMMENDATIONS

North Elevations

For the cracks and erosion on the north elevations, it is recommended that they be filled or patched with pigmented cement to match existing surface color. Consideration should also be given to applying a coating to replicate the darker, uniform color of the original stucco. Because the finish coat of stucco is eroded to the scratch coat in numerous locations, a coating would provide protection to this more porous stucco layer.

Roof Penthouses

The cracks on the roof towers should be filled and any deteriorated stucco patched. The patching mortar should match the original stucco in color and texture. All of the stucco surfaces on the roof should be recoated with the original paint color.

Fig. A14 above *Deep cracking and peeling paint on roof penthouse stucco*

Fig. A15 right *Surface erosion on the limestone sheathing, west elevation of dining hall*

Entrance Foyer Ceiling

Strip paint to expose original surface of stucco. This stucco surface may require recoating, since stripping may not produce a uniformly colored surface. A test panel should be prepared to determine the best method of treatment to restore the ceiling's original appearance.

4. Limestone

GENERAL DESCRIPTION

Limestone is used to sheath the exterior walls of the dining room and lounge on the south elevation of the building. The limestone is installed over a concrete back-up wall. Baker House's limestone is a light gray, Indiana limestone. Its panels are 2'-5" wide. The height of the panels varies. On the north wall, the height of the panels is staggered to create a decorative pattern. The layout of the limestone panels is shown on the attached drawings.

The surface of the limestone was originally quite smooth - it appears to have matched the limestone panels located on the west wall of the main lounge (fig. A16). It was originally laid and pointed with a relatively soft light gray mortar. All of the exterior mortar joints have been repointed with a hard and brittle gray Portland cement mortar, however, fragments of the original mortar survive behind the repointing mortar.

Fig. A16 above *West wall main lounge clad with limestone*

Fig. A17 top right *Biological growth staining on limestone sheathing, south and west elevations of dining hall*

Fig. A18 bottom right *Slate panels facing cornice of north entry roof*

SAMPLING AND TESTING

Samples of the original and repointing mortars were removed for analysis. (Rilem tests should be performed.)

EXISTING CONDITIONS

The limestone is generally in good condition, although many of the stone surfaces exhibit measurable surface erosion (fig. A15). This surface erosion seems to have several causes. On the north wall, where the lower roof connects the Moon Garden to the main building, in heavy rainstorms, water cascades off the lower roof down the face of the limestone. The existing roof drains are not capable of carrying the volume of water that collects off this roof and its only means of escape is down the limestone walls. Another source of moisture that is causing the limestone to erode is water entering the terrace walls through open mortar joints in the bluestone cap. Water also appears to be entering these walls at the level of the terrace's bluestone paving. Mortar samples removed from the wall below the terrace were soaked, confirming the presence of large amounts of water in the wall. As the water migrates to the surface to evaporate, it causes the surface of the limestone to erode. A final source of erosion is the general exposure of the building on the Charles River. As discussed in the section of the report on mortar, wind driven moisture appears to cause measurable erosion on the exposed surfaces of the building.

In addition to general surface erosion, there are several areas of limestone that have been patched with a cementitious material colored to match the limestone. One of the larger patches has failed and there are several other small areas of loss that are in need of patching. On the south and west elevations of the dining room, where several large trees shade the wall surfaces, the limestone is stained with biological growth (fig. A17).

TREATMENT RECOMMENDATIONS

The primary goal of the treatment recommendations for the limestone is to remove the sources of moisture that are generating its surface erosion. This includes increasing the size of the roof drains on the connector roof and possibly redesigning the roof's pitch and cornice detail. On the terrace walls, the bluestone cap should be reset and its mortar joints filled with backer rod and sealant. The bluestone paving should be reset and its perimeter joints filled with backer rod and sealant.

The areas of limestone loss should be repaired with either a cementitious patching material or limestone dutchmen. With either method of repair, the new surface should match the existing limestone surface in color and texture.

The limestone should also be cleaned. The method of cleaning should be determined by tests performed on all the exterior masonry surfaces.

5. Slate

GENERAL DESCRIPTION

Rectangular panels of dark gray slate are used to face the cornice of the north entry roof. The panels are placed vertically, with their bedding planes fully exposed. The slate panels are anchored to the roof with bronze clips (fig. A18).

SAMPLING AND TESTING

No samples or testing has been done on the slate.

EXISTING CONDITIONS

The surfaces of many of the slate panels are spalled. This spalling has been caused by water entering the bedding planes, which are fully exposed at the top of the panels. When the water freezes, it expands, causing the layers of slate to separate.

The is also a broken slate at the northeast corner of the entry. This slate has broken into several pieces. It appears to have been hit, possibly by a delivery truck.

TREATMENT RECOMMENDATIONS

The broken slate should be removed immediately as its broken pieces are poorly anchored and may fall in an area of heavy traffic. It should be replaced with a slate panel that matches the original slate panels in color, size and thickness. The existing bronze clips should be re-used to hang the new slate.

Consideration should be given to creating a cap flashing for the top of the slate panels. Although this will change the appearance of Aalto's original design, if it is done with lead-coated copper, (used extensively elsewhere on the building) it will not be too noticeable. A cap flashing should extend the serviceable life of the slate considerably.

6. Bluestone

GENERAL DESCRIPTION

Bluestone is used for the pavers for the north and south terraces. The pavers are 1- 1/2" thick and 5'-0" long. Their width varies. The bluestone was originally set in a concrete mortar (fig. A19).

SAMPLING AND TESTING

No sampling or testing has been done on the bluestone.

EXISTING CONDITIONS

The bluestone pavers themselves are generally in good condition. They do exhibit some surface spalling which is indicative that the terraces are not draining properly. On the south terrace, their setting mortar and substructure is very deteriorated and will need replacement. The west wall of the terrace is cracked and displaced. The joints in the setting mortar have been repaired with a variety of materials and many are currently in need of repair.

The north terrace appears to be in good condition and in need of only general maintenance

TREATMENT RECOMMENDATIONS

The south terrace should be rebuilt. Before it is disassembled, it should be thoroughly documented - drawn and photographed. The bluestone pavers should be labeled and reinstalled as they were originally laid.

Fig. A19 above *South terrace bluestone pavers*

Fig. A20 top right *Sample paint stratigraphy for roof elements (substrate at bottom followed by subsequent layers of paint taken from door hinge)*

Fig. A21 right *Varnish exhibited on sample from dining hall window casing*

Division 9: Finishes

GENERAL DESCRIPTION

Exterior

The exterior surfaces of Baker House that are now finished include: the doors and door casings, the window casings, lintels, and sills on the brick elevations and dining hall, skylights in the Moon Garden, and all elements on the roof penthouses (cornice, downspout, window, sash, louvers, counterflashing, flashing, stucco, lights). The substrate of these surfaces varies. Most of the exterior dining hall surfaces and some of the doors on the roof towers are wood. Other substrates include: stucco, aluminum or lead-coated copper.

Examination of the surfaces revealed that originally some of the surfaces were not coated (stucco ceiling outside front door), wood surfaces were coated with a natural organic varnish, and other surfaces were finished with colors mimicking the material of which they were made (i.e. gray for metal). This scheme was consistent with Aalto's philosophy of maintaining the material's integrity by allowing its natural finish to be exposed.

SAMPLING AND TESTING

Paint samples were obtained with a scalpel by removing small portions of the surfaces down to the substrate. In certain areas, after obtaining several representative samples to be examined in the laboratory, scraping of the surface paint on repetitive members was done to confirm suspicions that all similar members had the same original finish or color. In total, thirty-eight exterior samples were taken and examined.

In the laboratory, the paint samples from Baker House were examined with a stereo binocular microscope with a fiber-optic light source balanced for daylight (3400_K). Representative samples were mounted on glass slides and the original paint colors and varnishes were matched to a Munsell Color System color and to a Benjamin Moore paint color.

Exterior

Microscopic investigation of the paint samples indicated that all elements on the roof were originally painted the same rose color with subsequent layers of tans, grays and browns (fig. A20). Most elements on the roof contained the same stratigraphy indicating simultaneous repainting of all elements throughout the history of the building.

All of the wooden elements on the exterior of the dining hall were originally coated with a natural resin varnish which provided a honey colored, glossy finish (fig. A21). These surfaces may have had more than one coat of varnish, but only the transoms have subsequent layers of colored paint between the varnish and the existing dark brown paint.

Metal surfaces in the bicycle yard were gray with subsequent layers of white, and the metal window lintels on the exterior were tan. The metal trim around the north entry was originally painted white. This white paint is applied over a dark red primer.

EXISTING CONDITIONS

With the exception of some of the wood elements, none of the surfaces is covered with its original colors. Most are covered with five to ten layers of paint. On the exterior, paint on the roof towers is significantly peeling and flaking as is the paint on the exterior of the dining hall and moon roof. Original paint on the metal window lintels and sills is significantly flaked off, faded, and soiled.

TREATMENT RECOMMENDATIONS

It is recommended that the original exterior paint colors for Baker House be restored. This will involve both changing paint colors and removing paint from surfaces that were originally unpainted.

Interior Building Survey

Introduction

The interior of Baker House was surveyed by Building Conservation Associates on June 30 and July 18 and 19, 1996. The interior survey was performed to document the interior building finishes - flooring, wall and ceiling finishes, and painted finishes. The Aalto furnishings and furniture were not included in this survey.

The survey inspected the public spaces in Baker House as well as representative student rooms. The student rooms inspected were rooms number 203, 206, 216, 311, 323, and 414. The rooms were chosen based upon their accessibility (all the 5th and 6th floor rooms were occupied at the time of the survey) and to be representative of the rooms of different size and furnishing.

Division 8: Doors and Windows

1. Doors

GENERAL DESCRIPTION

There are two primary types of interior doors in Baker House - the metal fire doors in the hallways and the wooden doors of the dormitory rooms. The metal doors are double doors with a single glazed panel and brass hardware. The student room doors are solid wood doors with a birch veneer (fig. A22). The wooden doors are also fitted with brass hardware. Both the metal and wooden doors have 2-1/2" wide metal casings. The metal casings and doors were originally painted light gray.

SAMPLING AND TESTING

Paint samples were removed from the doors and their casings for analysis.

EXISTING CONDITIONS

The metal doors are generally in good condition. Located in the public spaces of the building, they have been subject to heavy wear. Many of their surfaces are dented and they have been repainted numerous times. On many of the doors the painted surface is chipped and peeling. The brass hardware is very tarnished. Many of the veneers on the wooden doors are cracked, warped and in some cases have peeled off completely. This delaminated condition exists primarily at the bottom of doors (fig. A23).

TREATMENT RECOMMENDATIONS

The metal doors should be stripped of their failing paint. Documentary samples of the original paint should be preserved. The doors should then be repainted with their original light gray paint color and their brass hardware cleaned and treated with a protective coating. Options for treatment of the veneers on the wooden doors should be explored in order to make appropriate repairs.

Fig. A22 above *Wooden dormitory room door*

Fig. A23 top right *Delamination, warping, and cracking of wooden door veneer*

Fig. A24 right *First floor hallway with asphalt and bluestone flooring*

2. Windows

GENERAL DESCRIPTION

The windows in Baker House have wooden casings that were originally painted gray. The window sash was also wood originally; it was replaced with metal sash in the 1970s. The exception is the wooden dining room window sashes that have not been replaced. Their original interior finish was varnish.

SAMPLING AND TESTING

Paint samples were removed from the original windows and their casings for laboratory analysis.

EXISTING CONDITION

The existing condition of the wooden window casings is fair. Their sills exhibit some checking and peeling paint, but they are in repairable condition.

Fig. A25 above *Vertical wood paneling in hallway*

Fig. A26 top right *Red clay wall tile*

Fig. A27 right *Fireplace in main lounge*

TREATMENT RECOMMENDATIONS

The existing metal sash should be replaced and the wooden sash and casings repaired and repainted. As much of the original wooden components of the windows as possible should be preserved, since they are original Aalto building fabric. Therefore, epoxies and wood splices should be used to make these repairs.

Division 9: Finishes

GENERAL DESCRIPTION

The interior finishes of Baker House are simple and repetitive. Aalto seems to have clearly chosen interior finishes that were durable and easy to maintain. For the floors, he chose a 9" square black and gray asphalt tile. This tile was used for the corridors, dining room, and student room floors. It was also used for the treads in the north stairs. In the main lounge, the floor is covered with bluestone and bluestone is used for the dining room stair treads and the treads of the first floor stairs that lead to the north elevation stairs (fig. A24).

The walls of Baker House are covered with a red clay structural facing tile. The tiles measure 3 -3/4" x 11-3/4" . The surface of the tile is 3/4" thick and originally had a matte finish. The tiles are laid in a dark gray mortar and have a 3/8" wide joint that is flush tooled. Many of the wall tiles are currently covered with a glossy anti-graffiti coating (fig. A26).

The tile sections of the walls are set into the concrete clad framing members of the building. The concrete surfaces are painted. In the corridors there are also some walls that are constructed of vertical birch paneling. These walls enclose the Janitor's and utility closets. This same paneling is also used for the phone booths (fig. A25).

The ceilings in Baker House are covered with metal lath and plaster. The plaster has a textured surface and is painted white.

There are several decorative interior trim details in the public spaces that are noteworthy. A section of the west wall of the main lounge is clad with limestone, like the exterior walls of the dining room. The fireplace in the main lounge is also a unique component of the Aalto design. It is a raised, open fireplace, with a bluestone hearth and firebox (fig. A27). Also of interest were the wooden trellises that originally surrounded the metal columns in Lounge No. 1. (the mezzanine lounge above the dining room.)

1. Lath and Plaster

GENERAL DESCRIPTION

Limited sections of the walls and the ceilings in Baker House are plastered. The plaster is installed over metal lath. It is a relatively hard plaster, with a textured surface. The plaster ceilings have always been painted white.

SAMPLING AND TESTING

Paint samples were removed from the plaster ceilings. No plaster samples were removed for analysis.

EXISTING CONDITIONS

The condition of the plaster ceilings is good. No areas of cracking or detachment were observed that would be indicative serious plaster deterioration. There are some holes in the plaster, from where light fixtures and other items have been mounted, that will require minor patching.

TREATMENT RECOMMENDATIONS

The ceiling plaster should be patched as necessary to fill areas of loss. The patches should match the original plaster in color and surface texture. Once repaired, the ceilings should be painted.

2. Structural Clay Tile

GENERAL DESCRIPTION

Structural clay tile is used for the construction of most of the interior walls in Baker House. It is a dark red, unglazed tile, measuring 3-3/4" x 11- 3/4". It is a hollow tile, with a surface thickness of 3/4". The tile is set in a light gray mortar. The mortar joints are approximately 3/8" wide and tooled flush.

Historic photographs of the dormitory rooms show that the tile surface has always attracted "graffiti". Mathematical equations that appear to be written in chalk are evident in several interior photos. During this inspection, none of the markings on the tile appeared to be permanent, although some of the surface discoloration evident on the tile may be indicative of harsh or abrasive cleaners that have been used to remove graffiti.

Selected areas of the tile have been treated with an "anti-graffiti" coating. This coating has created a glossy surface on the tile that is markedly different from its original matte appearance.

Replacement tiles that have been used in the remodeling of the lounges are a poor match to the original tiles. The rough surface texture of the replacement tiles blends poorly with the original tile and is a regrettable addition to the Aalto building fabric.

SAMPLING AND TESTING

No sampling and testing has been done on the ceramic wall tiles.

EXISTING CONDITION

The structural clay tile is generally in very good condition. There are random broken tiles, and holes have been drilled in the tile for hanging furnishings. Fortunately, many of the holes have been drilled into the mortar joints rather than into the tile.

TREATMENT RECOMMENDATIONS

The broken tiles should be replaced with a custom-made tile that matches the original tiles. If the modern tile partition walls are to remain, their tiles should also be replaced with this reproduction tile. When the tiles are replaced, the mortar used for their setting should match the original mortar in color and joint tooling. A sample of this mortar should be analyzed to facilitate the mixing of this mortar.

The holes in the tile should be patched with a mortar that matches the original color of the tile. Again, this will require careful color matching and finishing of the patched surfaces.

It is recommended that cleaning tests be performed to determine the appropriate means for removing the glossy "anti-graffiti" coating. All of the tile surfaces should be cleaned. Tests should also be performed to determine whether another protective coating, which will not change the surface appearance of the tile, should be applied.

3. Flooring

GENERAL DESCRIPTION

Asphalt Tile

Most of the original flooring in Baker House is made up of gray asphalt tiles, 9" square with a flecked black pattern. The exact composition of the tile has not been determined, however, it must be assumed at this time that the tile contains asbestos. The tiles are adhered directly to the concrete floor. The asphalt tiles were originally used in the entire building except in the entry, main lounge and for some of the stair treads. In the dining room, the original tiles have been replaced with a yellow tile. In the dining room lounge and in the north stairs, they have been replaced with 12" square gray tiles with a light colored speckled pattern.

Bluestone

The bluestone paving in the entry hall and main lounge is large slabs of stone set in mortar. The stone surface is smooth and is presently covered with multiple layers of wax. It is assumed that the bluestone is laid directly on the cement slab, like the floor tile, although this has not been verified by opening up a section of the floor.

SAMPLING AND TESTING

No sampling and testing has been done for either the asphalt tile or the bluestone.

EXISTING CONDITIONS

Asphalt Tile

The asphalt tile is in poor condition. After nearly fifty years, it has reached its life's expectancy. In many areas, it has worn through to the concrete floor (fig. A28). In the dormitory rooms, small sections of the tile have been replaced frequently around the sinks. As noted above major areas of tile replacement include the dining room, the dining room lounge, and the north stairs. In the hallways carpeting has been installed. It is assumed that the carpeting was installed over the tile, but this has not been verified by lifting large areas of carpet.

Bluestone

The bluestone flooring is in very good condition. It is discolored by an accumulation of wax and dirt on its surface. This wax and dirt extends up the walls roughly 4".

TREATMENT RECOMMENDATIONS

Asphalt Tile

The asphalt tile should be restored wherever possible in the student and recreation rooms. Areas that need replacement should be ideally patched with unworn tiles from other locations. Prior to undertaking this work, a sample of the tile should be analyzed to determine its original material composition. The replacement tiles should match the original tiles in size, color and pattern and they would be installed directly onto the concrete slab.

Fig. A28 *Asphalt tile deterioration*

Fig. A29 *Paint stratigraphy from door casing in first floor hall (substrate at bottom of photo)*

If the florring is to be replaced, a sample area of the original tile should be preserved, although we recognize that the presence of asbestos in the tile that makes its handling very difficult and costly. Ideally, an entire dormitory room might be preserved by replacing worn tile with unworn tile from other rooms. The original tiles should be cleaned and stripped of their heavy build-up of wax.

Bluestone

The bluestone floor paving and the walls should be cleaned and stripped of their heavy build-up of floor wax.

4. Paint

GENERAL DESCRIPTION

The painted interior finishes include: doors and door casings, columns, walls, ceilings, railings, windows and window casings, and radiators. As on the exterior, substrates vary. They include: wood, concrete, plaster, and metal.

Examination of the surfaces revealed that originally some were probably not coated at all. Wood surfaces were coated with a natural organic varnish, and other surfaces were finished with colors mocking the material of which they were made (i.e. gray for metal). This scheme was consistent with Aalto's philosophy of maintaining the material's integrity by allowing its natural finish to be exposed.

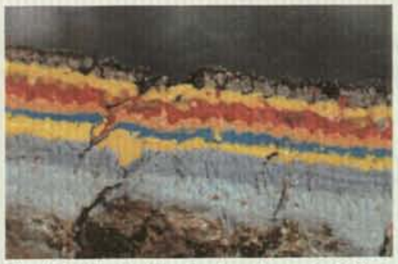


Fig. A30 *Paint stratigraphy from door casing in Room 320 (substrate at bottom of photo)*

Fig. A31 *Paint stratigraphy from door casing in Room 206 (substrate at bottom of photo)*

The general color scheme of the interior was grays and white with the natural exposed surfaces of brick, concrete, and wood.

SAMPLING AND TESTING

Paint samples were obtained with a scalpel by removing small portions of the surfaces down to the substrate. In certain areas, after obtaining several representative samples to be examined in the laboratory, scraping of the surface paint on repetitive members was done to confirm suspicions that all similar members had the same original finish or color. For example, because each bedroom has similar members - radiators, concrete walls, door casings, and plaster ceilings - representative samples of each were taken from two or three rooms on each floor, and then confirmed by scraping random members in other rooms. In total, 100 interior samples were removed for laboratory analysis.

In the laboratory, the paint samples from Baker House were examined with a stereobinocular microscope with a fiber-optic light source balanced for daylight (3400_K). Representative samples were mounted on glass slides and the original paint colors and varnishes were matched to a Munsell Color System color and to Benjamin Moore paint colors.

All metal door casings and doors on the interior hallways and in the students' rooms were finished with a gray paint followed by several layers similar to the original color, then layers which include bright rainbow colors (figs. A29, A30). After analyzing samples from several interior doors and door casings, it was apparent that at some time the hallways were multi-colored, each door painted in a different bright color (green, yellow, fuchsia, turquoise, lavender, etc.). Metal columns in the dining hall appear to have been painted white with a four inch gray band around the bottom. Metal radiator covers in the students' rooms were originally gray as well.

A natural cleavage was found between the paint layers and the concrete surface on both walls and columns on the interior. In addition, when the paint was scraped off, it was observed that the concrete surface was soiled. It was originally thought that these concrete surfaces were originally unpainted. However, examination of early photographs of the these surfaces showed them painted white. The oily, soiled surface on the concrete probably resulted from the release agent used on the concrete forms.

Wood surfaces (doors, window surrounds, stair railing) in the dining hall were coated originally with a natural resin varnish. In the students' rooms (windows and sills) were originally painted gray or white, followed again by layers of whites and bright colors (fig. A31).

Ceilings were always painted white or off -white.

EXISTING CONDITIONS

With the exception of some of the wood elements, none of the surfaces is coated with the original colors. Most have from five to ten layers of paint. Paint on most of the interior surfaces is sound with the exception of the remaining wooden window casings and sills where the paint is cracked and flaking.

TREATMENT RECOMMENDATIONS

Restore the original interior and exterior color schemes. This will involve both changing paint colors and removing paint from surfaces that were originally unpainted.

LeMessurier Consultants, Inc.

Structural Review

Baker House dormitory at MIT comprises a 6-story reinforced concrete framed building of irregular serpentine plan configuration with approximate plan dimensions of 406′ by widths varying from 30′ to 50′. A 2-story 42′ x 42′ lounge and terrace building framed in structural steel abuts the dormitory along its length. Existing drawings indicate floor construction consists of a 5 1/2″ thick one-way reinforced slab spanning across the width of the building to concrete beams at the corridor and exterior. Column spacing varies, but generally is at 18′-10″ on center. Exterior stairs are supported on 7″ thick slabs cantilevering from floor slabs. At column locations, foundations consist of caissons founding +/- 14′-0″ below ground floor. Ground floor is a 9″ framed slab spanning in two directions between caissons. No indication is noted on the drawings as to what live load capacity the floors were designed for.

Lateral loads appear to be resisted by frame action between beams and columns as no shear walls are shown in existing drawings. For this age of building, it is unlikely that lateral loads due to earthquake were addressed. If the Owner requires the building to be seismically upgraded, then a comprehensive structural seismic analysis would be required. This would involve calculating all the required building properties, such as its mass and fundamental period, to enable a total lateral seismic force that the building would have to resist by Code in the direction of each of its main axes, to be calculated. This would then be compared to the Code total wind lateral force. Our experience leads us to believe that the lateral seismic force for this building would be significantly higher than the lateral wind force due to the mass of the building. Therefore, a method would have to be proposed as to how to resist these seismic loads in each direction of the building. One method would be to use concrete shear walls throughout the height of the building in each direction at discrete locations. Additional load and/or uplift at column locations from seismic loads would also impact foundations and would have to be investigated. Since only minor renovations are envisaged at this time, the building is not required by the current Massachusetts State Building Code to be seismically upgraded.

A walk-through inspection of the building showed the inside to have no visible sign of structural distress and appeared in good structural condition. The outside of the building showed signs of severe scouring of some of the brick mortar joints, and mortar crumbles to the touch. A more thorough examination of the brick mortar jointing throughout its height is recommended, with possible raking and repointing of the mortar joints being required.

Miscellaneous spalling of the ground floor piers at junctions of piers with brickwork at the west end of the building (closer to Mass Ave.) is occurring. These piers should be repaired.

There is minor spalling of the limestone panel at the dining room as vertical pier meets horizontal roof panel. The joint between vertical and horizontal panel is probably not large enough. A larger joint should be cut at this location.

At the dining room plaza, a topping slab has been added at some point in time, and where it sits over an existing support wall is misaligned; the wall appears to have a ragged joint at this location. Freeze/thaw action is spalling some of this concrete. Loose concrete should be removed, and the wall should be repaired.

A vertical crack in the isolated brick wall at the bicycle enclosure is probably due to thermal movements and should be raked and repointed.

R. G. Vanderweil Engineers

Mechanical/Electrical Feasibility Study
Draft Report

Introduction & Summary

Vanderweil Engineers has conducted a thorough field investigation and has had conversations with several MIT Physical Plant Staff. Based on this, it is concluded that the majority of the mechanical/electrical infrastructure must be replaced in order to extend the life of Baker House another 50 years.

This report describes options for replacing the infrastructure, and summarizes the findings of our investigations. The report is organized as follows:

Analysis - The basic available systems options are reviewed, including mechanical/electrical approaches for the student rooms and advanced energy applications. Air conditioning options are described.

Phasing - A phasing approach that will work mechanically/electrically is presented.

Physical Assessment - A condition assessment of existing HVAC, Plumbing, Fire Protection, and Electrical systems is provided, and improvement options are described.

To perform the work, the engineering team had several meetings at MIT and had phone conversations regarding various systems with Messrs. Moore, Harrison, Wohlfarth, Narcotta, Crayton and Cunkelman.

2. Analysis

2.1 <u>BACKGROUND</u>

The mechanical/electrical systems in Alvar Aalto's 1949 Baker House are simple, solid, functional, and without frills; and they have served effectively for almost fifty years.

Aalto seems to have been at ease both concealing mechanical/electrical systems and exposing them. Where they are exposed, they don't make a bold statement; they are simply there, like the structure.

This is the case for the steam and condensate risers which run exposed up through the student rooms. Lateral branches are taken off the risers at the window wall, at the students ceilings, in order to serve the convectors in the floor above. When MIT retrofitted sprinklers, they used a similar approach. The lateral sprinkler piping runs at the ceiling in the students rooms, at the corridor wall.

The conduits for the minimal electrical and telephone systems prevalent in 1950 were run concealed in floors and student party walls, and the hot and cold water risers for students' lavs rose in the corner of the rooms enclosed in boxed out wooden chases.

In 1949, with #6 heating oil at a few pennies a gallon, the Baker House windows were single glass, common practice at the time, and the uninsulated roof and wall construction had fairly typical U-values: U=.2 for the roof, .4 for the walls. At the time, sprinklers weren't in use in dormitories, smoke detectors weren't in use, and personal computers were unknown. Air conditioning was first being introduced in office buildings, but was not yet contemplated for residential applications.

The goal of our engineering analysis is to recommend systems renovations and improvements that will extend the life of Baker House another 50 years. In so doing, we ask ourselves how Alvar Aalto might have approached the mechanical/electrical infrastructure, given all the requirements and constraints of a 1996 project. There are many performance standards--enhanced glazing, heating, air conditioning if in the program, copious telephone and data wiring, smoke detectors, plenty of power outlets that have to be incorporated into any building of this nature today. It is also clear that he would have considered concealing the infrastructure, but would not have been disturbed by an approach that incorporates a partially exposed infrastructure. Our analysis is consistent with this thinking, and a variety of options are provided.

2.2 <u>STUDENTS' ROOMS</u>

The systems in the dorm rooms have outlived their useful lives. The basic option is to renew and expand them as follows:

<u>*Plumbing*</u>
The lav, the system of boxed-in riser piping, and the lav connections will all be replaced with modern materials, in the same locations as they are currently.

<u>*Heating*</u>
Refer to figure A32. A basic option on student room heating is to replace the existing system in kind, but to covert to hot water. With this approach, new hot water heating risers will be installed, replacing the steam and condensate risers. The new risers will run exposed in the same locations as the existing. There are several options for hot water room terminals. The architecturally-preferred option is to employ Runtal plate-type radiators in place of the existing convectors. Another option is to use two-tiered fin tube radiation, mounted within the existing convector covers. The existing covers are unacceptable, and covers would have to be provided. Another option is to use fintube without covers. In all cases, individual valves and heating control would be provided.

Fig. A32 *Existing Heating Student Rooms*

The views show the existing steam and condensate piping. It is recommended that this be removed, due to its poor condition, and new hot supply and return risers be run in its place.

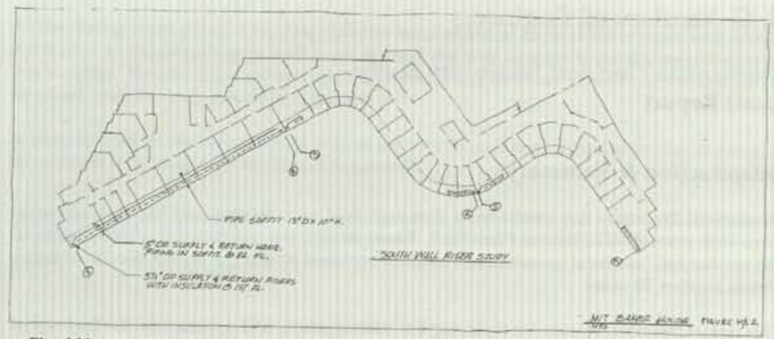


Fig. A33

An alternate approach to the foregoing is to provide a soffit at the ceiling along the window wall, and to run lateral heating hot water mains in this soffit. Branches to perimeter radiation would rise out of the soffit into the heating unit of the room above. This system would require one supply riser and alternating return riser at each of three locations along the south wall. The riser scheme is shown in Fig. A33. These could run exposed or be furred in each of the affected rooms. A similar pattern would be employed at the North Wall. Any of the room terminal options can be used with this system.

Figs. A34, A35, and A36 show three options for the room terminals. Fig. A34 is a cut of the Runtal Unit, Fig. A35 of a hot water convector, and Fig. A36 of fintube radiation.

Windows & Insulation

In order to conserve energy and enhance comfort, windows will be replaced with energy conserving modern varieties, and an insulating panel with a higher R-value than the existing should be installed behind the radiation. The roof must also be insulated. Heating system design will be based on the new energy efficient U-values. Except for the insulated panel behind the existing convectors, there is no wall insulation, and none is proposed. The existing wall construction is 8" of brick, 1/2" mortar parging, 1/4" mastic, 1/2" insulation 1 1/4" blocking with a convector at the windows. The runtal plate radiator option could be placed over a newly insulated and finished pocket, which would improve the R value considerably. The same condition exists on the remaining wall except 2" facing tile is installed in lieu of the convector.

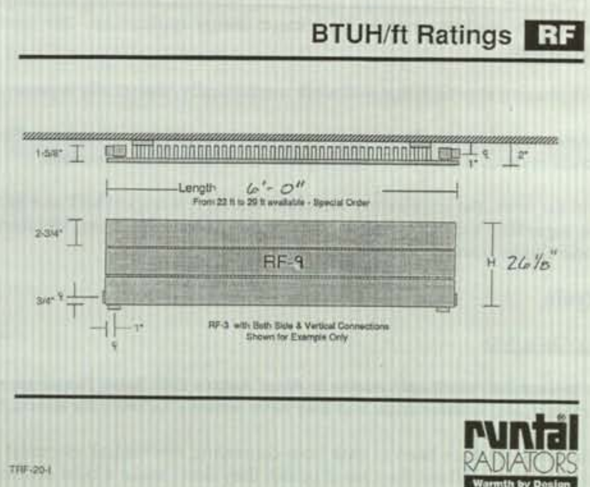
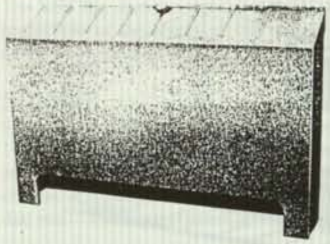


Fig. A34



SF-A/SFG-A

Type SF-A: The Type SFA Free-Standing Cabinet Enclosure is designed to be used exposed and fitted flush against the wall. Readily installed without alteration of wall interior, the SFA enclosure is frequently used for system modernization where it is desirable to avoid the expense of recessing the unit in the wall. Arched inlet shown is standard. Unit may be provided with integral inlet grille, (SFG-A). See page 18.

SF-A = ARCHED INLET
SFG-A = LOUVERED INLET
(Grille)

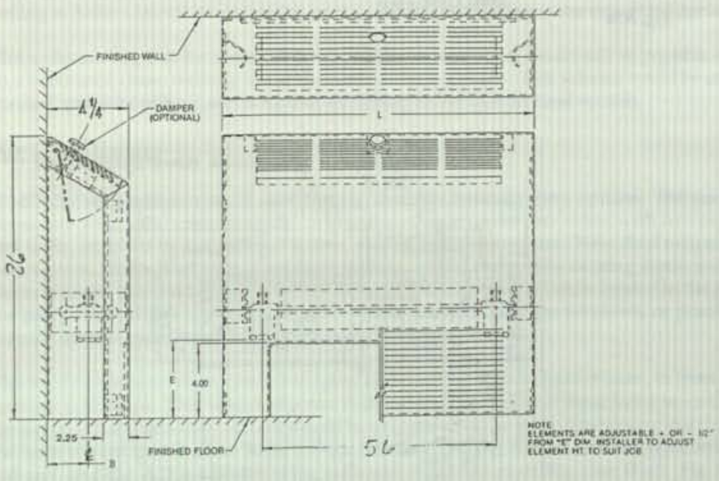


Fig. A35

Electrical

Design of new student room electrical systems is a challenge since it will require running conduit outside the walls, since concealment would be prohibitively costly. In its own previous upgrades, MIT has run exposed surface raceway around and down the walls and across the ceilings. The desire going forward is to clean this up.

The existing conduit system has capacity for wiring to support the additional power required in student rooms. The side walls and rear walls of the rooms tend to be blocked by furniture against the wall, and most power is used in a four foot band along the outer wall. Currently energy is conserved by students since they conscientiously attempt to reduce demand in order to avoid overloading circuits and thereby popping circuit breakers. Once copious power is provided, this incentive will no longer exist and MIT will experience increased energy use. Most of this appears to be for lighting - as the students seem to like using dimmable 300 or 500 w floor mounted indirect halogen lighting.

To provide additional power it is proposed to recircuit the existing outlets at the inside of the room, and to provide some kind of raceway with multiple outlets at desk height running across the window wall. This would be fed from one of the existing outlets at the side wall near the windows.

In single rooms, the existing original telephone outlet has been rewired to provide one telephone and one data outlet. It is proposed to run a cable-TV riser conduit up in one of the perimeter corners to provide a TV outlet at the window wall for each room. Figure A37 shows the elec-tel-data-TV wiring as proposed herein. In the double rooms, the existing telephone outlet would be used for one tel and one data outlet. In the opposite corner, a riser will be installed to provide an additional tel and data outlet, plus a cable-TV outlet.

The original semi-globe ceiling light fixtures have been replaced with energy conserving fluorescent. An option here is remove the replacement light fixtures and to install smoke detectors in their places, wiring through their conduits. Otherwise, smoke detectors will have to be located elsewhere on the ceiling to meet MIT standards, and this will require using unsightly surface raceway for wiring of the detectors.

With detectors located in place of the ceiling fixtures, the wall switch at the door could be used to activate the lavatory light when students enter the room. They can then turn on their floor lamps and shut off the lavatory light.

One option to provide additional lighting, would be to install wooden mounting strips on the long walls of the rooms and halogen sconce fixtures mounted thereon. These could have integral switches, and wiring could be run along the mounting strips.

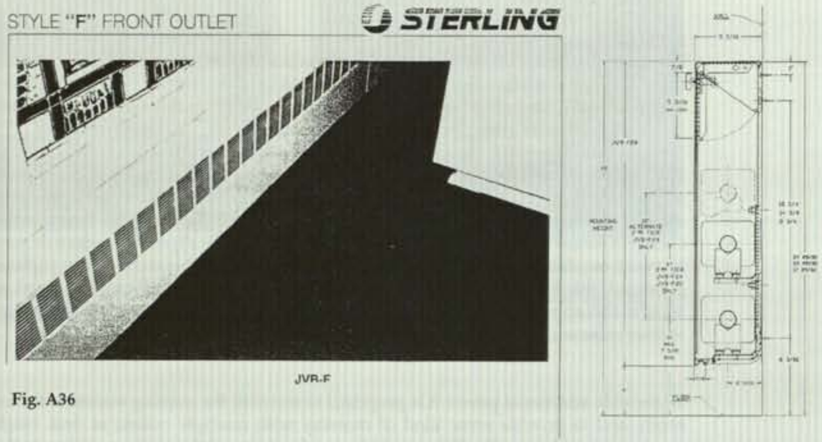
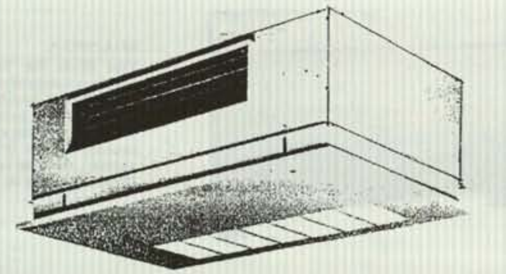


Fig. A36



42CK
Cabinet model with telescoping flip-down panel and stamped louver bottom return or duct collar rear return. (200-1200 cfm)

Fig. A38

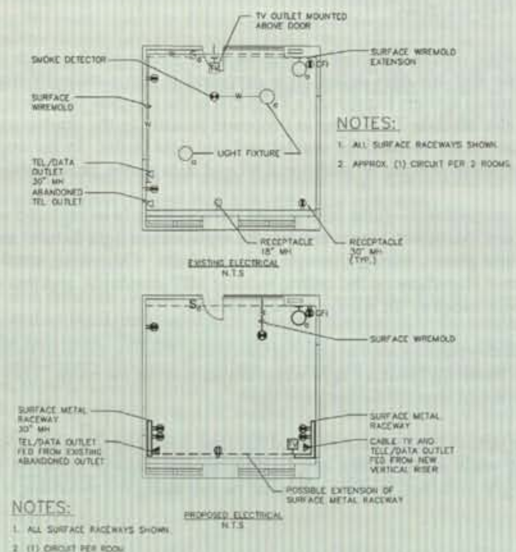


Fig. A37

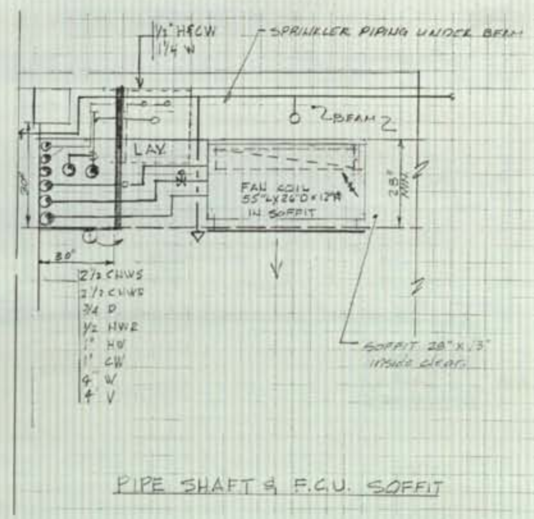


Fig. A39

The MIT fire alarm system standards require smoke detectors to be located on the ceiling, so regardless of the source of the wiring, there will be some exposed surface raceway that extends across the ceiling.

Sprinkler

Sprinkler modification is probably best left undone. MIT retrofitted complete sprinklers in 1987. At the time it was decided to keep all piping out of public spaces. Consequently, there are numerous vertical risers in the student rooms, many concealed in the wooden plumbing chases, and there is extensive exposed horizontal piping in the student rooms along the corridor wall. The horizontal runs serve adjacent student rooms as well as the corridor.

The only conceptual option to this is to run the horizontal distribution in the corridors and public spaces. As favorable as this would be for the student rooms, it would have major negative impact on the public spaces. For this reason, it is felt that the sprinkler should remain as is. It does provide a sort of symmetry in the student rooms - at the window wall ceiling is Aalto's lateral steam piping, at the corridor wall ceiling is the retrofitted sprinkler.

Not withstanding that the sprinkler concept will remain as-is, it would still be possible to furr in a horizontal chase running along the corridor ceiling room. This scheme could be used to conceal sprinkler piping, and is further addressed in the architectural section.

Air Conditioning

If MIT desires student room air conditioning, there are basically three options. The one most consistent with Aalto's design would be to replace the perimeter convectors with two-pipe fan coil units, supplied by hot water in winter, chilled water in summer. New dual temperature water risers, plus a third riser, a condensate drain, would replace the existing steam and condensate risers. A second option is the use of vertical stacked fan coil units located in the jogs in the party walls, where such exist, or in the outside corners near the windows, or possibly in interior corners coordinated with the wooden plumbing chases.

The third option is to create a furred-in space at the ceiling of each student room, in front of the corridor wall beam. This would be some 10 inches deep and extend three feet ± inward from the beam. A horizontal fan coil unit would be suspended in the soffit, discharging out through the front toward the window. Refer to Figs. A38 and A39, Fig. A38 is a cut of a horizontal fan coil unit, and Fig. A39 is a sketch of the soffit and expanded plumbing riser shaft. Fig. A40 is a photo of the existing conditions.

Fig. A40 *Electrical & Teledata Rewiring Student Rooms*

The view above shows the party wall with the corridor wall at right The wooden plumbing chase designed by Aalto is in the right hand corner, and one of the lavs it was designed to serve is also visible. The energy conserving disc shape light fixture was substituted by MIT for Aalto's incandescent bowl fixture, in a different location than the original. MIT-installed surface metal raceway running from the lighting fixture to a smoke detector is also visible, as is a lateral section of sprinkler piping, also retrofitted by MIT, which penetrates the party wall.

The corridor beam butts into the plumbing chase at the upper right. With the soffit option, a furred in space the depth of the beam would extend about three feet into the room, running across the width of the room from party wall to party wall. It would contain an A.C. unit, sprinkler piping, possibly also some lateral electrical or telecommunications. The smoke detector would be wired through this, but mounted a way out on the ceiling, connected by surface raceway, to meet MIT standards.

This scheme is addressed further in the architectural section.

This option has the benefit of being able to clean up the room by taking advantage of the furred-in space to conceal the sprinkler piping. Other items may also be integrated with it. The smoke detector could be mounted on the soffit and supplemental lighting also. The latter could be accomplished with a strip fluorescent concealed and mounted on the front of the soffit in such a manner to project indirect lighting across the ceiling.

One issue that needs to be considered if air conditioning is installed is the possibility of condensation and mildew if residents open the windows with the A.C. on. To avoid this, an interlock could be provided to shut down the air conditioner if windows are open. This is a cost item, and is rarely done in practice; most owners choose to live with any resulting moisture problems. MIT has indicated that they would not consider such an interlock.

The proposed air conditioning can maintain reasonable room conditions in the summer in spite of the heat gain at the south wall. It is not intended to be operated in winter when the south wall solar gain is maximum; however, that is the situation that has prevailed in the building since it opened in 1949.

2.3 PUBLIC SPACES

Lobbies and corridors will remain with the same basic approaches now used for sprinkler, heating and ventilating, and lighting. Hot water heat will replace steam and new heating piping will be installed, plus new heating and ventilating controls. New air handling units would replace the existing ones. Existing ductwork will be reused as possible.

In the stairwells on the North side, the ducted heated system can be retained (with new ductwork), with supplementary hot water heat added, or else the ducted system can be removed in its entirety and replaced with hot water fin tube.

It would be desirable to replace the lighting with more historically compatible fixtures as proposed for student rooms, and a new fire alarm system and exit lights must be installed. The emergency generator and wiring will remain as-is. Note that the elevator is not on an emergency circuit. It is recommended that an accessible ceiling be used in the basement, due to the presence of all the infrastructure located in the ceiling space. Aalto had designed a plaster ceiling, but access is difficult.

Because of age and condition, as well as marginal existing electrical service capacity, most of the mechanical/electrical infrastructure requires replacement. The exception to this is the emergency generator and the sprinkler, both relatively new retrofits.

A new, increased electrical service will be provided. New steam valves and convertors, new controls, new horizontal distribution, new pumps, new domestic water heaters and piping, and new electrical panels will all be required. New drain, waste, and vent piping is required, except that rain water leaders and below grade sanitary lines are proposed to be re-used.

2.4 ADVANCED ENERGY APPLICATIONS

It is recommended that MIT set aside a modest budget for advanced energy applications. With Aalto's excellent integration of mechanical/electrical systems in his 1949 design, it is not inconceivable that the year 2000 redesign should incorporate photovoltaic and hot water solar panels on available roof area. A budget of $100,000 could provide an exciting environment for the students.

P.V. cells could be used to generate several kw of power during sunlit hours, with an ampmeter located in the lobby, and panels for domestic hot water heating could be similarly monitored.

2.5 AIR CONDITIONING OF ENTRANCE LOBBY AREA AND DINING

It may be desirable to air condition the lobby area and the dining room area, since both are heavily used and occupied spaces. The existing ventilating system could be replaced with air conditioning ductwork and fan, and supplementary fan coil units installed as required.

Two locations have been identified for the outside equipment: there appears to be space available in the outside storage area at the northeast of the building, and also adjacent to the receiving area at the southeast of the building. It is desirable to install blinds or other shading on south and west facing glass to reduce load. Air conditioning should also be considered for the Master's Suite at the East end of the building and for the tutor's apartments on the west side.

3. Phasing

A phasing scheme that would work with the mechanical/electrical systems and allows normal dorm occupancy during the school year involves the following sequential summer-long steps:

1. Asbestos abatement in basement (and penthouses if necessary)
2. Replacement of mechanical/electrical central equipment in basement, and new air handling units in penthouses. Combine phases (1) and (2) if possible.
3. Renovation of basement, new kitchen.
4. Renovation of one third of the building in a vertical slice.
5. Renovation of the second third.
6. Renovation of the remainder. If possible, do (4), (5), and (6) in two instead of three phases.

Phasing issues are also addressed in the Proposed Project Scope and Schedule section.

4. Physical Assessment

4.1 PLUMBING

Existing Conditions

1. Storm Water System

a. The rooftop penthouses drain via scuppers and downspouts to the main roof. Several roof drains and leaders drain the main roof down through the building. The leaders connect below the ground floor and exit the building at three locations to Amherst Alley. In general the storm system appears in good condition.

2. Sanitary System

a. Sanitary stacks run vertically up thru the building and serve the room lavatories and the central toilet and shower facilities. Wherever possible the sanitary waste is collected at the ground floor level and exits along with the storm water at three locations. Sanitary waste in areas on the ground floor, not able to be drained by gravity, is directed to two sewage ejectors and two sump pumps, which pump the effluent to the gravity mains.

b. Grease traps have been provided where required at the kitchen waste and plumbing.

c. The sewage ejectors were replaced approximately five years ago with new pumps, controls and floats. These pumps should provide reliable service for the next several years. The remainder of the sanitary system appears to be in poor condition. Some problems have occurred over the years with the lavatory drains being plugged by students dumping food and other material down the drains.

3. Natural Gas System

a. Natural gas enters the building on the west side to an interior meter. Gas is distributed to the kitchen for gas appliances and to the laundry for dryers. Gas supplied appliances under the kitchen exhaust hood have safety shut off valves. The gas piping appears to be in good condition.

4. Domestic Hot and Cold Water Systems

a. The water service enters the building along side the fire protection, from Memorial Drive on the west end of the building. The water is distributed at the ground floor ceiling to several risers located through the building, which rise to feed the room lavatories and central toilet and shower facilities. The existing water piping and valves have been replaced in several locations, but in general are in very poor condition. The piping insulation is suspected to be asbestos and must be abated.

b. The original hot water tanks were removed and replaced with shell and tube instantaneous heaters. These heaters do not have over-temperature protection.

c. The existing lavatories, showers, drinking fountains, and fixtures are all in poor condition and do not comply with current water savings requirements.

5. Typical Student Room

a. Each student room contains a single wall mounted lavatory with dual hot and cold water faucets. In some cases, the students have provided their own piping to make it a single spout. Typically, piping to the sinks is fed from a riser in the corner of the room.

Proposed Plumbing Upgrades and Options

1. Replace in their existing location, the existing bell and spigot sanitary waste piping above ground with new no-hub piping. This includes the vertical risers throughout the building as well as the horizontal piping at the lower level.

2. Replace in their existing location all existing horizontal hot water, cold water and hot water return horizontal mains and vertical riser piping and valves. Shut-off and drain valves will be provided at the base of each riser. Valves to be 2-piece ball valves.

3. Install new instantaneous steam-fired water heaters with over-temperature control and hot water return pumps, (2) heaters for general use (1) heater for the kitchen. All heaters to be interconnected for redundancy. As an option, a summer gas-fired water heater could be installed to eliminate the need for steam in the summer.

4. Install new low flow plumbing fixtures in the revised toilet layouts.

5. Provide new lavatories in the bedrooms with single lever faucets. Bottle traps or interceptors should be provided to control food waste.

6. The existing kitchen will be modified as proposed by the food service consultant. Piping of all systems will be modified to serve the kitchen equipment.

Phasing of Plumbing Installation

1. The existing horizontal water distribution and sanitary piping at the ground floor, including take-offs with valves to the risers, could be done in the first phase. Risers could then be replaced during subsequent phases.

2. All new equipment would be installed in the first phase.

3. All modifications to the laundry and kitchen would be done in the second phase.

4. Toilets and showers would be modified in conjunction with each phase.

4.2 FIRE PROTECTION

Existing Conditions

1. In 1960 partial sprinkler systems fed from the domestic water system were installed on the ground floor in both the east and west ends. The systems were limited and covered mainly the storage rooms in those areas.

2. In 1987 the building was completely sprinklered and fed from a new 6" service, which enters the ground floor on the west end. This service is fed from the existing water main in Memorial Drive. The service has an exterior post indicator valve and upon entering the building it has a alarm check valve, shut off valve, Siamese Fire Department connection and a flow indicator. There is no backflow protection on this service. The static pressure was observed to be 75 psi at the alarm check valve. The sprinkler piping feeder main was distributed at the ground floor level to several risers which then feed up the building to the sprinklers. This was done to minimize horizontal sprinkler piping on the floors due to the low and exposed ceiling height. Sprinkler piping on the floors is exposed and runs along the corridor walls to feed the corridor and several rooms. The entire system has one flow alarm which is located at the main alarm valve. In the kitchen the hood over the ranges is protected by an ansul dry chemical system. The building presently does not have a fire pump, roof manifold, or standpipes.

3. The majority of the sprinkler piping is exposed with either sidewall, pendant or upright heads. None of the heads has sprinkler guards.

4. In general the sprinkler system is in good condition.

5. Each student room is provided with sidewall sprinkler heads installed on exposed sprinkler piping at the corridor side of the room.

Proposed Fire Protection Upgrades and Options

1. The existing sprinkler system can remain with one flow alarm for the whole building. This can be supplemented with an additional piping system to feed standpipes: two located in the east and west stairways and two located along the corridor. Standpipes are required by code for this type of building.

2. The ground floor sprinkler piping can be modified to isolate the sprinkler system to indicate east and west sections with flow alarms. Standpipes will be fed as above. An additional option would be to provide a flow alarm at the base of each sprinkler riser.

3. In accordance with current code, a double check valve assembly should be installed on the main sprinkler service. Should the code change prior to construction, this could be eliminated.

4. Initial pressure calculations indicate a fire pump is needed to provide a 15 psi cushion at the top most sprinklers. At the time of design, hydraulic calculations should be performed to confirm the need for a fire pump.

5. Another option is to replace the system in its entirety. The standpipes in the east and west stair would feed the sprinkler system. Piping on the floors would run horizontally at the ceiling to feed the rooms. This option has more distribution piping on the floor, but it could be concealed in a soffit over the door within other horizonally distributed systems.

Phasing of the Fire Protection Installation

1. A separate standpipe system can be installed in the first phase if the sprinkler system remains as is. Sprinkler modifications can be made per phase as required by partition modifications.

2. The modification of the sprinkler system to east and west zones can be done in the first phase.

3. The replacement of the entire system would be more difficult to phase. This will require temporary connection between phases to maintain coverage.

4.3 HVAC

Existing Conditions

1. Steam Piping

a. The building is served by an underground 200 psig high pressure steam main which enters the building at the northeast ground floor mechanical room. The steam main appears to run in a concrete trench outside the building. The high pressure steam in the building is reduced to 70 psig by two pressure reducing valves. The kitchen is supplied with 30 psig MP steam by a dedicated pressure reducing valve. Two additional pressure reducing valves provide 8-10 psig low pressure steam to the building heating and ventilating systems.

b. Steam condensate is returned to the underground mains by a steam condensate pump receiver located respectively in the northeast mechanical room and fan room 1. The condensate pump sets seem to be relatively new and appear to be in good condition.

c. A dedicated supply line provides 30 psig MP steam to the kitchen equipment and 70 psig MP line supplies steam to the domestic water heaters and kitchen booster water heater. The low pressure steam heating piping is split into two mains when leaving the mechanical room. A 6-inch main serves the area east of the Lobby and an 8-inch main serves the areas west of the Lobby. The heating steam mains are further split into approximately 10 branch mains serving the various building exposures and the heating and ventilating units.

d. Perimeter spaces are heated by convectors and radiation. Convectors on the ground floor are down-fed from the steam piping running below the ceiling. Some of the convector covers were found to be falling off due to missing screws.

e. It appears the steam and condensate piping throughout the building has passed its useful life. Some sections of the steam piping are currently leaking and being replaced. The piping has started to develop pinhole leaks and joints are failing. Sections of the piping have been removed for inspection, which confirms this condition.

f. The steam piping throughout the building appears to be covered with asbestos insulation. Protective PVC covers have been added over the pipe insulation to improve appearance and to provide further protection to the pipe insulation.

2. Building ventilation:

a. The ground and first floor interior spaces are ventilated by five 100% outside air heating and ventilating units and one kitchen exhaust fan in the ground floor mechanical room. The upper corridors and main stair wells are served by 3 air handling units and 10 exhaust fans located in the roof fan rooms as follows:

SYSTEM	SUPPLY	RETURN	EXHAUST	REMARKS
Lounge 2	1600	-	-	1
Ground fl corridors	6000	-	-	1
Dinning rm	10000	-	-	1
Kitchen	0	-	10000	1
Work shop	450	-	-	2
Lobby	3100		-	MR
Stairs & corr.	2700	1350+/-	-	3
Toilet exh.	-	-	3340	3
General exh.	-	-	2650	3
Lounge 2	-	-	1600	3
Corridors & lounges	4600	2800+/-	-	4
General Exh.	-	-	2500	4
Toilet Exhaust	-	-	500	4
Stairs	1560	1560+/-	-	5
Workshop	-	-	450	5
Toilet Exh.	-	-	2920	5
Toilet exh. Fan #1	-	-	4320	7
Toilet exh. Fan #3	-	-	1640	7
Toilet exh. Fan #4	-	-	1080	7
Totals	30000	5710 +/-	31000	

1 indicates units located in the ground floor fan room #1
2 indicates units located in the ground floor fan room #2
3 indicates units located in the roof fan room #3.
4 indicates units located in the roof fan room #4.
5 indicates units located in the roof fan room #5.
6 indicates units located in the ground floor mech. room
7 indicates units located on roof.

b. The lobby is currently being provided with approximately 5-8 air changes, the dining room with approximately 13 air changes, and lounge 2 is provided with approximately 10 air changes.

c. It was noted that the outside air intake to the Lounge, Dining room and corridor is blanked off. The fans are sucking against a closed plenum, no return air openings could be seen connecting to the outdoor air plenum.

d. The air handling units located in roof fan room #3 supplies heating and ventilation to the central stairs on the northwest side of the building. The air handling unit in fan room #4 supplies heating and ventilation to the upper corridors and lounge areas. The air handling unit in roof fan room #5 provides heating and ventilation to the northeast stair well. The air handling units located in the roof fan rooms all have recirculating duct work. The duct work serving the stairs along the north side of the building runs exposed up tight along the stair ceiling. This duct work shows signs of damage and is unsightly.

e. The air handling units are operating and show signs of good maintenance. Casing panels were in place, little sign of corrosion on the outside of the equipment casings, piping insulation was intact and the machine rooms for the most part were clean with little or no debris. The air handling equipment is original to the building and although still running has exceeded its service life.

f. The ventilation units have steam heating coils and are individually controlled. Server units have duct mounted coils for zone heating. The exposed duct work appears to be in good condition. The majority of duct work is concealed in chases and above plaster ceiling. The outdoor louvers on the roof fan rooms were damaged.

g. The Fans located in the roof fan rooms are in fair condition and are operating but have also exceeded their service lives. Three additional roof mounted exhaust fans serve toilets on the west end of the building. These fans and housing are old and antiquated.

h. The gas meter and sewage pump room does not have ventilation. The air quality in this area is poor and stagnant. Several large storage areas in the basement do not have any ventilation.

3. Student rooms

a. Student rooms are heated by steam-fed, wall-mounted, 4-inch-deep convectors. The convectors sit flush with the walls and are located under the windows. The pipe risers feeding the convectors run exposed throughout the building. Exposed piping to the convectors rises along the outside walls. The branches to the convectors run horizontally above the windows and under the ceiling of the floor below. Branch piping from the floor below rises up under the convectors. As the risers pass vertically through the building, the supply and return risers in most cases feed two convectors. Convectors were found to be plugged with dust, but for the most part seemed to be in fair condition. The covers have been repeatedly painted and their appearance is unsightly.

4. Kitchen

a. The kitchen is equipped with a full hood exhaust system for the cooking area and the dish-wash area. The kitchen is exhausted by a 10,000 CFM fan located in the ground floor and ducted up to the roof. Air make up to the hood exhaust system is from the surrounding spaces. Transfer screens along the kitchen wall and door openings transfer air to the kitchen. No direct make up air to the kitchen or hoods is provided.

5. Laundry

a. The Laundry dryers are exhausted up through the building in what appears to be an abandoned incinerator chute. The exhaust louver at the roof shows signs of lint buildup. No indication of lint filters was observed. The system did not have a barometric damper or a relief.

6. Controls

a. Automatic controls consist of pneumatic thermostats and actuators to control the air handling unit steam coil. Spence self contained pressure regulating valves regulate the building steam pressure. There appear to be approximately seven Zone control valves operated by an old weather master control system with outdoor thermostats. Self contained radiation control valves have been added to the convectors throughout the building to allow individual space temperature control. Many of the thermostat components are damaged.

7. Dining Room

a. The dining room is an open well to the second floor. The doors leading from the upper part of the dining hall to the second floor public area have been removed, opening the upper level of the dining hall to the center stair.

b. The dining room is supplied with 10,000 cfm of outdoor air. The dining room supply is used as make up to the kitchen hood exhaust.

Proposed HVAC Upgrades and Options

1. Retain existing steam heating system:

The following work would be required to maintain the existing steam systems:

- Replacement of all the central equipment with new.
- Replace all the piping distribution.
- Retrofit convector control valves. Replace valves with concealed valves and patch existing enclosures.
- Retain steam convectors in rooms and connect to new piping.
- New control valves would be installed at floor level within the cover on the supply entering the unit.
- The exposed supply heating duct work serving the northwest and northeast stairs is damaged in some areas. For historical purposes, this duct could be removed and replaced with new. The new duct work could be a heavier gauge to withstand damage. An alternate solution is to permanently remove the duct work in the stairs and replace it with radiation.
- Replace all existing steam traps with MIT approved traps

2. Hot water heating system:

A hot water approach is preferred to re-use of steam, for improved longevity and O&M, as well as controllability.

The following work would be required to upgrade the heating system:

- Use existing HPS steam to generate 190° heating hot water. Provide new pumps and piping.
- Replace exposed damaged heating duct work.
- Provide new hot water piping to feed up through building in the same location as the existing piping or run new hot water piping in the corner of rooms and conceal the piping architecturally. Piping running along the floor to the convectors could be concealed in an architectural toe space. In some cases, piping could run tight to ceilings before turning up to convector on the floor above.
- Replace steam heating element with exposed runtal type radiation element in convector cover. This is our preferred option.
- Replace convector covers with similar type.
- Add new radiation in stair well and remove exposed heating ducts where possible.
- Insulate wall behind radiators, add roof insulation and replace window with energy conserving type to allow the use of fin radiation.

3. Air-conditioning

If air-conditioning is desirable, the following options should be considered:

a. The nearest chilled water line is in building W20 across the street. The existing 8 inch main would not likely have the capacity to handle an additional building. An increase in both plant supply and the size of the chilled water main may be required.

b. A more practical approach is to provide a chiller in the 250 ton range at the building. The chiller could be located in the basement of the building, possibly in the existing water heater room or trunk storage room. Pumps serving the chiller and specialties could also be located in the same space. A cooling tower would be located on the west end of the roof to serve the new chiller.

c. If only the dining hall and lobby are to be cooled, a DX unit air handler unit could be located in Fan Room No. 2, with a condensing unit located behind the loading dock or in the outdoor service area adjacent to the superintendent's office.

d. If the perimeter heating system is to remain, whether it be steam or hot water, a dual piping system could be provided. Separate piping for the chilled water will allow the use of the following.

- Vertical stack Whalen type units along the corridor wall.
- Horizontal fan coil units located along the corridor wall in a ceiling soffit.

e. If the perimeter heating system is removed and replaced with Fan coil units, a dual temperature pipe system can be utilized. Hot water is supplied in the winter and chilled water is supplied in the summer, as in a hotel system.

f. Air-conditioning in lounge areas can be by similar system. Lobby, Dining areas and common areas would be served by central dedicated air handling systems.

g. If it is desired to make provisions for future air conditioning, space in the wooden plumbing shafts could be designated for the risers. These shafts will be rebuilt as part of this project, and holes could be cored and capped through the floor plates at this time, within the limits of the rebuilt shafts. In the future, risers could be installed and room fan coil units added at the ceilings along the corridor.

4. Kitchen:

a. Locate exhaust fan on roof and place the exhaust duct under negative pressure. All duct shall be welded.

b. Provide 80% makeup air into kitchen and 20% to surrounding spaces. This will reduce food odors from exiting the kitchen.

c. A kitchen exhaust hood with auxiliary makeup air is recommended. This will reduce the amount of heating and cooling required to heat and cool the hood makeup air.

The auxiliary makeup air will require tempering in the winter and no conditioning in the summer.

5. Ventilation:

a. Bath rooms, showers and toilets will be exhausted per current code. Make up air to these spaces will come from the public areas through louvered doors and door undercuts.

b. Ventilation and heating to the Lobby, Dining room, Lounge areas and Corridor will be treated in a similar way by using dedicated air handling units similar to the existing system. The units will provide reduced outdoor air and will have a recommended 6 air changes per hour for building pressurization. Units will have return air and will have an economizer cycle. If cooling is provided, the air handling units will have the cooling capacity for its designated space.

c. The existing duct work will be retained and reused as much as possible. Changes will be required per the space planning.

6. Controls

a. Improvements to existing:

- Replace self contained temperature control valves at each convector with electric or pneumatic.
- Locate control valve at ceiling of floor below.
- Control convectors from thermostats located on the interior walls. This will reduce damage to the controls and improve space temperature.
- Control heating pressure reducing valve by outdoor thermostat to close when outdoor temperature is above 65 deg.

b. Replacement of existing:

- Delete the existing outdoor master heating controls.
- Provide new DDC control system by Andover Controls and tie-in to MIT's central control system to monitor and alarm equipment.
- Control individual rooms from a local thermostat. This will also allow individual room control by the occupant.
- Provide DDC controls on new air and water systems.

4.4 ELECTRICAL

Existing Electrical Installation

1. Electric Service and Distribution

a. Baker House is served from the MIT campus 2400V loop. Electric service consists of two oil-filled loop switches and a circuit breaker which feeds three single-phase 100 kVA dry type transformers. Service voltage is 120/208V 3 phase 4 wire 60 Hz. Switchboard is 1600 amp individual mounted circuit breaker style. All equipment is original except the two oil-filled loop switches.

b. 120/208 volt distribution equipment is circuit breaker panelboard wired with PVC insulated wire. Equipment grounding is by conduit. Generally equipment is original, wiring is new.

2. Emergency Service and Distribution

a. A 35 kVA diesel fired emergency generator, automatic transfer switch and distribution were installed to present codes in 1984. System appears to be in good condition. Emergency system provides life safety lighting and exit signs. The generator also serves sump pumps and heating circulating pumps. These loads are considered optional loads by the NEC.

3. Branch Circuits and Lighting Fixtures

a. The electrical system was rewired with PVC insulated copper cable and grounding type receptacles installed generally in existing conduits. Existing conduits are installed in basement corridors, electric closets and in concrete slabs. A majority of lighting was replaced with energy savings PL fluorescent fixtures. We note that several opal globes with incandescent lamps are still installed. These may be the original general use light fixtures.

b. Lighting for the dining area is mercury vapor fixtures installed above skylights.

c. Emergency exit lights are non-code-compliant due to small lettering size and black lettering. Many of the existing signs are original and of unique design. They will have to be replaced, but should be retained by the Institute for their value as artifacts.

4. Student Rooms

a. Wiring for receptacles is PVC insulated copper. It is rewired into existing conduits except for surface metal raceway extension from vanity light to new surface ground fault receptacle at sink.

b. Wiring for telephone and data wiring is surface raceway from corridor to outlet above desk. The original telephone conduit has been abandoned.

c. Wiring for Fire alarm single station smoke detector is surface raceway extension from existing ceiling mounted light fixture.

d. Wiring for light fixtures is PVC insulated copper. It is rewired into existing conduits.

e. Receptacles are new grounding type. Grounding is existing metal conduit system as allowed by NEC. Minimal (2 or 3 double duplex) receptacles are provided in each room.

f. Light fixtures are energy saving fluorescent which provide only minimal light to space.

g. Video cable outlet is installed above entry door to student room.

h. Receptacles are circuited for one 20 amp circuit to serve four or five rooms.

5. Fire Alarm System

a. The fire alarm system is not code compliant. The system is deficient in smoke alarms, ADA compliance and elevator recall.

6. Other Systems

a. Data and telephone are routed through building, along corridors and to individual outlets utilizing surface raceways. Original telephone outlets have been abandoned.

b. Security is provided by individual card access at main entry doors and by battery detex alarms on secondary egress doors.

c. Video wiring for campus television is wired in surface metal raceway on corridor walls to an outlet above each room's entry door.

Proposed Electrical Upgrades and Options

The following lists items that require work to renovate the electrical system and possible methods for renovation.

1. Electrical Distribution

The existing electric service was reviewed with MIT Physical Plant. Bill Wohlfarth indicated that the manufacturer of the oil switches indicated that they were unsafe to operate under load. We reviewed the 2400 volt service for upgrading to 13.8 kV. MIT prefers to retain the 2400 volt service and provide new equipment.

Renovation work includes new service, transformers, switchgear and panelboards. The existing equipment will not provide a further 25 years service as much is original and has already provided extended useful life.

a. Service 2400 volt switchgear.

b. Provide 750 kVA 240/120/208V 3 phase 4 wire 60 hz dry type transformer to meet projected load demands.

c. Provide new 120/208V switchgear

Items a, b and c would be provided in a unit substation. The transformer capacity will allow for load growth. However, a 1000 kVA transformer would be required should central air conditioning be considered.

d. Throughout the building provide larger capacity branch circuit panelboards with more circuits, reusing existing conduit systems.

e. Existing conduit systems for both feeders and branch circuits are large enough to accept larger feeders or more branch circuits. Some new feeder conduits may be required in basement and in electric closets.

2. Emergency Service and Distribution.

The existing system is moderately loaded and has significant useful service life remaining. If no further demands are made for emergency power, this system is adequate. Should smoke exhaust be required for the dining room, these fans could be added, however, a larger load, such as the elevator, could not be added.

Consider reusing existing non-code-compliant exit signs, retrofitted with PL lights to light Exit Signage to provide code compliant exit signs on egress routes.

3. Branch Circuit andLlighting Fixtures.

Generally existing branch circuits have 8-12 duplex receptacles on each circuit. Generally buildings have 4-6 receptacles on each circuit today. MIT has indicated that they would prefer that branch circuits have larger capacity than existing. Rewiring would provide greater capacity availability and stop nuisance tripping from overloaded circuits.

Generally the lighting fixtures installed do not light the building adequately. New fixtures with appropriate energy saving lamps should be installed to enhance the historic character of the building and provide adequate lighting.

4. Student Rooms

Consider replacing existing inadequate lighting with energy saving fixtures of historic design.

Consider reusing existing abandoned telephone conduits for telephone or data raceway.

Consider using baseboard raceway, mounted 4" above floor to facilitate floor cleaning, for power, telephone and data or wiring outlets. Home runs could be routed from floor below.

Consider using surface metal raceway with multiple outlets as extension from existing conduit outlet box above desk.

Consider vertical window wall distribution of power/tele/data wiring if piping risers are replaced by mechanical trades.

Consider rewiring electrical system and replacing all devices if higher branch circuit loads are expected. Existing receptacles do have remaining life but will need replacing if extensive renovation is undertaken.

The code-required, single-station smoke detector does not comply with MIT standards. A single-station smoke detector alarming the room occupants and a central station shall be installed. This should be mounted close to the corridor wall to reduce unsightly wireway.

5. Fire Alarm System

The existing fire alarm system was reviewed with MIT Physical Plant. Howard Harrison indicated that the Baker House system did not conform to MIT standards, had minimal useful life and did not comply with current building codes.

Building fire alarm should be an analogue addressable ADA compliant system and incorporating the following alarms and devices:

Manual pull stations
Smoke and duct detectors
Heat detectors
Sprinkler switches
Audible/visual alarms
Elevator recall
Reporting to central station

The main fire alarm control panel would be located in the electric room with an annunciator at the front desk. The fire alarm system will require added conduits in corridors to incorporate ADA alarms incorporated into each room and wiring to student room single station smoke detectors.

Separate student room fire alarm system should be an addressable fire alarm system installed to monitor student room individual station smoke detectors only.

<u>Phasing of Electrical Installation</u>

1. Electric Service: New electric unit substation will allow a one-to-three-day shutdown for service replacement. Distribution equipment will be limited to existing vertical electric closet risers. Shutdowns for distribution equipment will be localized on a panel-by-panel basis.
2. General: Generally electrical work can follow phasing of architectural and mechanical trades.
3. Fire Alarm: During the installation of a new fire alarm system, the existing system must be maintained. This may require temporary/extra conduits to be installed and out-of-phase work to be performed.

Rolf Jensen & Associates, Inc.

Introduction

This report serves as the Building Code and Fire Protection Systems Analysis Report for the Baker House at MIT, Cambridge, Massachusetts. The Baker House Project entails renovations to the majority of the building, as well as many building systems. The specific scope of this report is to identify building code and fire protection systems issues for the building and provide recommendations.

Applicable Codes

The following codes were reviewed for requirements applicable to MIT - Baker House:

1. 780 CMR: Massachusetts State Building Code, Fifth Edition (MSBC).
2. 521 CMR: Massachusetts Architectural Access Board, dated Feb. 23, 1996 (MAAB).
3. 248 CMR: Massachusetts State Plumbing and Gas Codes, dated March 11, 1994 (MSPGC).
4. 524 CMR: Safety Code for Elevators and Escalators
5. NFPA 13, Standard for the Installation of Sprinkler Systems, 1989 Edition, as referenced by MSBC.
6. NFPA 72A, Local Protective Signaling Systems, 1985 Edition, as referenced by MSBC.

MAAB was effective February 23, 1996 and provided the option to either comply with the previous MAAB dated September 1, 1993 and The Americans with Disabilities Act Accessibility Guidelines, or to comply with the new MAAB dated February 23, 1996. The option to comply with either code was available up to September 1, 1996. This report is based upon MAAB dated February 23, 1996.

MIT - Baker House Renovation Project Scope

The MIT - Baker House Renovation project scope is currently being developed. The scope of the project and the phasing of the project may be significantly influenced by the requirements of MAAB. The following criteria (MAAB Chapter 3) defines the extent to which an existing building needs to be renovated to meet the MAAB requirements:

1. If the work being performed amounts to less than 30% of the full and fair cash value of the building <u>and</u> if the work costs less than $100,000, then only the work being performed is required to comply with 521 CMR. (MAAB 3.3.1)
2. If the work being performed amounts to less than 30% of the full and fair cash value of the building <u>and</u> if the work costs $100,000 or more, then the work being performed is required to comply with 521 CMR. In addition, an accessible public entrance and an accessible toilet room, telephone, drinking fountain (if toilets, telephones and drinking fountains are provided) shall also be provided in compliance with 521 CMR. (MAAB 3.3.1)
3. If the work performed amounts to 30% or more of the full and fair cash value or the building the entire building is required to comply with 521 CMR. (MAAB 3.3.2)

Exceptions for Nos. 1, 2, and 3: Whether performed alone or in combination with each other, the following types of alterations are not subject to 521 CMR 3.3.1 and 3.3.2. (When performing exempted work, a memo stating the exempted work and its costs must be filed with the permit application or a separate building permit must be obtained.)

a. Curb Cuts: The construction of curb cuts must comply with 521 CMR 21.

b. Repairs: Ordinary repairs as defined in 780 CMR, the State Building Code.

c. Alteration work which is limited solely to electrical, mechanical, or plumbing systems; to abatement of hazardous materials; to retrofit of automatic sprinklers and does not involve the alteration of any elements or spaces required to be accessible under 521 CMR. Where electrical outlets and controls are altered, they must comply with 521 CMR.

d. Roof repair or replacement, window repair or replacement, repointing masonry repair work.

In addition to the MAAB cost criteria influencing the project scope, the building may be considered an historic building. An historic building or facility that is listed or is eligible for listing in the National or State Register of Historic Places or is designated as historic under appropriate state or local laws may be granted a variance by the Board to allow alternate accessibility. If a variance is requested on the basis of historical significance, then consultation with the Massachusetts Historical Commission is required in order to determine whether a building or facility is eligible for listing or listed in the National or State Register of Historic Places. The Massachusetts Historical Commission may request a copy of the proposed variance request and supporting documentation to substantiate the variance request and its effect on historic resources. A written statement from the Massachusetts Historical Commission is required with the application for variance.

The project may be able to be phased in such a way as to lessen the extent to which the MAAB requirements apply. However, this report assumes that the cost of the renovation will exceed 30% of the full and fair cash value of the building and that the entire building will need to comply with MAAB.

General Building Description

The MIT - Baker House was originally constructed in 1949. The building consists of seven stories with approximately 19,000 square feet of area per level. The building's primary use is a residential dormitory (R-2). Accessory uses include: a cafeteria; a lounge; a dining room; and administrative offices. A kitchen is located on the Ground Floor.

EVALUATION

The existing building information contained in this report is based on a visual walk-through survey conducted on Thursday, June 6, 1996 by Robert M. Carasitti, P.E. and Rockwood J. Edwards, P.E. of Rolf Jensen & Associates, Inc. Functional testing, destructive testing and destructive visual inspection were outside the scope of the survey and were not conducted. Information was also obtained through project documents and through discussions with Perry, Dean, Rogers, & Partners (PDRP) project team members and MIT - Baker House staff.

BUILDING HEIGHT, AREA & CONSTRUCTION TYPE

Based upon the various occupancies, the building was reviewed against MSBC requirements for height, area and construction type. The following table identifies the floor, occupancy and use classification(s) based upon MSBC criteria.

FLOOR	USE	USE CLASSIFICATION
Ground	Dining Area	Group A-3
	Cafeteria	Group B
	Offices	Group B
First	Lounge	Group A-3
	Residential	Group R-2
Second-Seventh	Residential	Group R-2

Given the identified uses, the overall building Use Classification is Residential, Use Group R-2.

The building construction consists of: concrete floors, columns, and beams. Interior partitions are constructed of various noncombustible materials such as terra cotta, brick, and concrete block. However, some of the interior partitions have wood paneling or sheathing. Additionally, over the years it appears some partitions were erected using combustible materials. Based upon the height, area and use of the building (seven stories - 64', 19,000 square feet per floor, and R-2 Use Group), current MSBC criteria requires that the building be constructed of Type 2A, protected noncombustible construction.

If the combustible construction materials are removed, then the building will be classified as being constructed of Type 2 construction. Further if the structural and fire resistive requirements of specific building elements can be determined to meet the provisions of table 401 of the MSBC for Type 2A construction, then the building height, area, and construction type requirements will be satisfied.

The interior partitions that have wood paneling or sheathing are not required to have the paneling or sheathing replaced. MSBC Section 3203 does not require that the existing interior finish meet the new construction flammability criteria. Any new interior finish applied to the architectural features of the building must comply with Section 922, Interior Finish and Trim.

ROOF DECK

Currently, the building has a wood deck feature located on the roof. The deck is accessed via the center stair. Exit access, which does not comply with code, is provided to the remaining two stair towers. The deck is approximately 1,000 square feet in area. A railing is provided around the deck perimeter. The deck is used by the occupants of Baker House as a recreational area.

The base code approach for roof structures requires that such structures be constructed of materials consistent with the building's type of construction. Exceptions are then discussed in Section 927 which identify when specific types of construction, noncombustible construction or fire-retardant treated wood must be utilized.

Given the type of construction required for the building, the area of the deck, and the height of the deck above grade, fire-retardant treated wood should be an acceptable construction material for the deck. This approach must be reviewed with the building and fire departments of the City of Cambridge.

In addition to the construction issue, the deck must be provided with code-compliant exit facilities and accessibility features. An exit path of appropriate width must be provided to a second exit. The surface of the exit path also has to comply with code provisions for exits.

Since the deck is accessible by the general building population, access must be provided for persons with disabilities in accordance with ADA and MAAB. This required accessible route may include elevator access to the deck. Additional accessibility impacts could include, but not be limited to, accessible exits, deck surfacing, ramps between levels of the deck, etcetera.

Fire Detection and Alarm Systems

The building is currently protected by an Autocall fire alarm system. The fire alarm system consists of: manual pull stations; smoke detectors at the top of the stairwells and in the ground floor corridors; a heat detector in the generator room; water flow switches for the sprinkler system; alarm horns; an annunciator panel; and a fire alarm control panel. Battery operated smoke detectors are provided in student rooms, but these detectors are not connected to the fire alarm system.

MSBC Section 1017.3.6 requires buildings of Use Group R-2 of four or more stories in height to have a protective signaling system installed in accordance with NFPA 72A, 1985. Additionally, the fire alarm system must comply with ADA and MAAB requirements for accessibility.

The fire alarm system appears to be approximately 20 years old. It would be difficult to upgrade the system to meet the new requirements of ADA. Additionally, it is probably already difficult to obtain replacement parts to service the system. We recommend that the existing fire alarm system be removed and replaced with a new code compliant fire alarm system.

Fire Suppression Systems

The building is protected with automatic sprinklers throughout. All areas of the building that were surveyed appear to be provided with proper coverage. The system consists of approximately 12 separate risers that supply small sprinkler zones on each floor.

The building sprinkler system is controlled by a 6 inch valve, which is located in the locker room on the west end of the building on the ground floor. The valve does not have a valve supervisory switch connected to the fire alarm system, however, the valve is chained and locked in the open position. The water supply for the building, as reported on the ground floor sprinkler drawing dated April 20, 1987, is 60 psi static pressure and 53 psi residual pressure, while flowing 1,003 gpm.

The MSBC does not currently require the building to be sprinklered. The Sixth edition of the MSBC, due to be released soon, is based upon BOCA 1993 Edition which does require Use Group R-2 buildings to be fully sprinklered. MSPGC Section 2.14(6)(k) requires that the potable water system be provided with backflow prevention.

The system should have a backflow preventer installed as required by the MSPGC. System hydraulic calculations should be performed to verify that the existing water supply is capable of properly supplying the sprinkler systems. Additional control features should be provided in conformance with NFPA 13 (i.e. floor control valves, tamper devices, etc.).

Standpipes are not provided in the building. MSBC Section 1012 requires all areas of each floor to be within 130 feet of a standpipe riser outlet. NFPA 14 permits a distance of 200 feet in sprinklered buildings. It may be possible to provide standpipe outlets in the stairs located at the north and south ends of the central corridor. This issue should be discussed with the Cambridge Fire Department.

Plumbing Fixtures

The typical floors currently have three separate, shared, unisex, restroom facilities. The typical floors have 7 water closets, 7 urinals, 5 lavatories, and 8 showers. It should be noted that each bedroom on each floor contains its own lavatory. None of the restroom facilities are currently accessible. Typical floors have 46 bedrooms and have approximately 100 occupants.

MSPGC Table 1, Minimum Facilities for Building Occupancy, requires R-2 occupancies to provide the following minimum facilities:

Water Closets		Urinals	Lavatories	Showers	Drinking
Male	Female				
1 per 8	1 per 6	33%	1 per 8	1 per 8	1 per 75

Therefore, each floor must be provided with 6 male water closets, 8 female water closets, 12 lavatories, 12 showers, and 1 drinking fountain. Two male water closets may be substituted for by urinals. The following notes from Table 1 apply for R-2 occupancies:

1. Water closets of the elongated type and solid plastic non-porous seats must be of the open front type.
2. In a room with more than one water closet, each water closet must be separated by walls of partitions which will afford privacy.
3. Water closets, showers and hand wash facilities must be accessible from within the building and must be placed so that passing through any part of another dwelling or rooming unit is not required.
4. One laundry tray must be installed for each 50 persons.
5. Toilet and bathing facilities for males and females must be separate and so designated.
6. Fixtures must be installed in conformance with 521 CMR 3.30.0 *Public Toilets* (for fixtures dimension requirements only).

7. When public rest rooms are installed, handicap fixtures must be installed to comply with the requirements of 248 CMR 2.10(19)(m).

8. Unisex handicap facilities are allowed when approved by the Board through a variance process as indicated in 248 CMR 2.01(1).

   a. A variance is not required if the fixtures in a unisex toilet room fulfill the minimum fixture requirements in 248 CMR 2.10(19) Table 1. No more than one water closet and one lavatory may be counted towards the minimum requirement.

   b. These facilities must be kept clear of obstructions at all times in accordance with 105 CMR (the sanitary code).

9. Wherever drinking fountains are provided, at least one drinking fountain must be accessible to and usable by person in a wheel chair.

10. Toilet rooms accessible to the public, which have two or more water closets or urinals, or two or more thereof in combination, must have a floor drain and a valved hose bibb connection equipped with an approved backflow preventer for the purpose of flushing and/or sanitary hosing.

11. Floor drains must be of an approved design and must be installed in the vicinity of the urinal(s) and at a grade to permit floor drainage to it from all directions.

12. Water closets for public use must be of the elongated type and seats must be solid plastic, non-porous of the open front type. Refer to 2.10(6)(a) through (f).

13. When a urinal(s) is provided, floor areas to one foot in from of the urinal lip and one foot on each side of the urinal and the wall areas to four feet above the floor, must be furnished so as to be non-absorbent. Wood and fiber boards are prohibited in above noted areas. Refer to 2.10(7)(c).

14. In a room with more than one water closet, or with a water closet and a urinal, each water closet must be enclosed. Each urinal must be side shielded for privacy.

15. When two or more urinals are required a shield must be provided between urinals.

16. When urinals are used at least one must be set for handicapped use.

The restroom facilities for the building will need to be redesigned to provide the required number of water closets and showers per floor. In addition, the appropriate number of accessible water closets and showers will need to be provided. Requirements for accessible plumbing fixtures can be found in the Accessibility section of this report. In addition, the men's and women's restroom facilities will need to be provided separately and designated as such.

Means of Egress

Three stairs serve all levels of the building. One stair is located at each end of the main corridor of each floor. Each of these stairs provide approximately 42 inches of clear width. The third stair discharges at the main entrance to the building. Access to this central stair varies floor to floor. Generally, two access points are provided to the stair on each floor. As the stair progresses from the sixth floor down to the first floor, access points and stair runs converge to a single point on the first floor.

An exit access corridor is provided on each floor. The minimum clear width of the corridor is approximately 51 inches wide at the south end (60 inches wide at the north end). Based on the anticipated occupant load of the floor being greater than 50 people, the MSBC requires a minimum of 44 inches of clear width in the corridor. The corridor width is therefore adequate.

Doors from student rooms to the corridor are approximately 30 inches wide (28.5 inches clear). MSBC section 812.3 requires doors to provide a minimum of 32 inches in clear width. Doors must also comply with accessibility requirements.

The exit signage is not compliant with current code requirements. A complete new exit sign system should be provided in accordance with the requirements of MSBC Section 823.0.

Accessibility

MIT - Baker House was constructed in 1949. At the time the building was designed, accessibility for the disabled was not included in the design. Currently, the building does not have accessible entrances, routes, or facilities.

MAAB Section 8.1 categorizes dormitories as Transient Lodging. Transient Lodging buildings are required to provide accessible entrances, accessible routes, accessible sleeping rooms, and accessible facilities, including any public facility provided for the general public.

The building entrances must be accessible to the handicapped. The elevator will need to have its controls and accessories upgraded to provide required features, however, the elevator size appears adequate. A ramp from the lobby to the First Level will need to be provided to make the elevator accessible to the handicapped.

The handrails and guardrails for the center, north, and south stairs, and surrounding the moon garden on the first floor do not comply with MAAB requirements. The handrails and guardrails must be replaced with handrails and guardrails that comply with MAAB 27.4.

The existing elevator cab size meets the dimensional requirements of MAAB for accessibility. 524 CMR, Safety Code for Elevators and Escalators requires that new buildings of two or more floors must have an elevator cab with minimum dimensions of 80 inches by 54 inches in order to accommodate a gurney. The existing elevator cab does not meet this requirement. However, 524 CMR does not have any requirements that necessitate the cab be replaced to meet this requirement. This was confirmed with Mr. Charles Murphy of the Department of Public Safety in a telephone conversation on September 5, 1996. Mr. Murphy stated that the cab size requirements in 524 CMR were not intended to apply to existing buildings.

The restroom facilities must meet the plumbing code and accessibility requirements. Additional men's and women's restroom facilities will be required as noted in the plumbing fixture section. In addition, the men's and women's restrooms will each need to be provided with accessible water closets, lavatories, and showers. The men's room will also require accessible urinals.

The doors to every sleeping room will be required to be made accessible to the handicapped. The intent of this requirement is to permit non-disabled occupants to be visited by guests who are disabled.

If the roof deck is to remain as a public facility for the occupants of Baker House, the roof deck will be required to be made accessible to the handicapped. This will require an elevator with access to the roof.

Summary

The building is deficient with regard to complying with various code requirements for fire protection systems and features, as well as for accessibility. Specific deficiencies include the following:

1. The building needs to be upgraded to comply with the requirements of MAAB.

   a. All sleeping room doors will be required to be replaced. The doors are all required to be accessible and currently do not meet the minimum door width requirement.

   b. New accessible plumbing facilities will be required to be installed to provide equal facilities for the handicapped.

   c. The building entrances will be required to be redesigned to allow handicapped access to the building.

   d. If the roof deck is to remain, it will be required to be made accessible to the handicapped, which will require elevator access to the roof.

   e. Stair handrails and guardrails will be required to be replaced.

2. The fire alarm system is approximately 20 years old and incapable of expansion necessary to accommodate devices required as part of the renovation. The fire alarm system will need to be replaced with a new code complying fire alarm system.

3. The sprinkler system will require a backflow preventer to protect the potable water system. Additionally, floor control valves, tamper devices, and other equipment to be in compliance with NFPA 13 will be necessary.

4. A standpipe system should be provided in the stairs located at the north and south ends of the central corridor.

In lieu of one or more of the identified required features, the Authority-Having-Jurisdiction may accept alternative approaches which provide reasonably equivalent levels of protection.

Property of Baker House

Client Team Chair
Tracy Sadowski