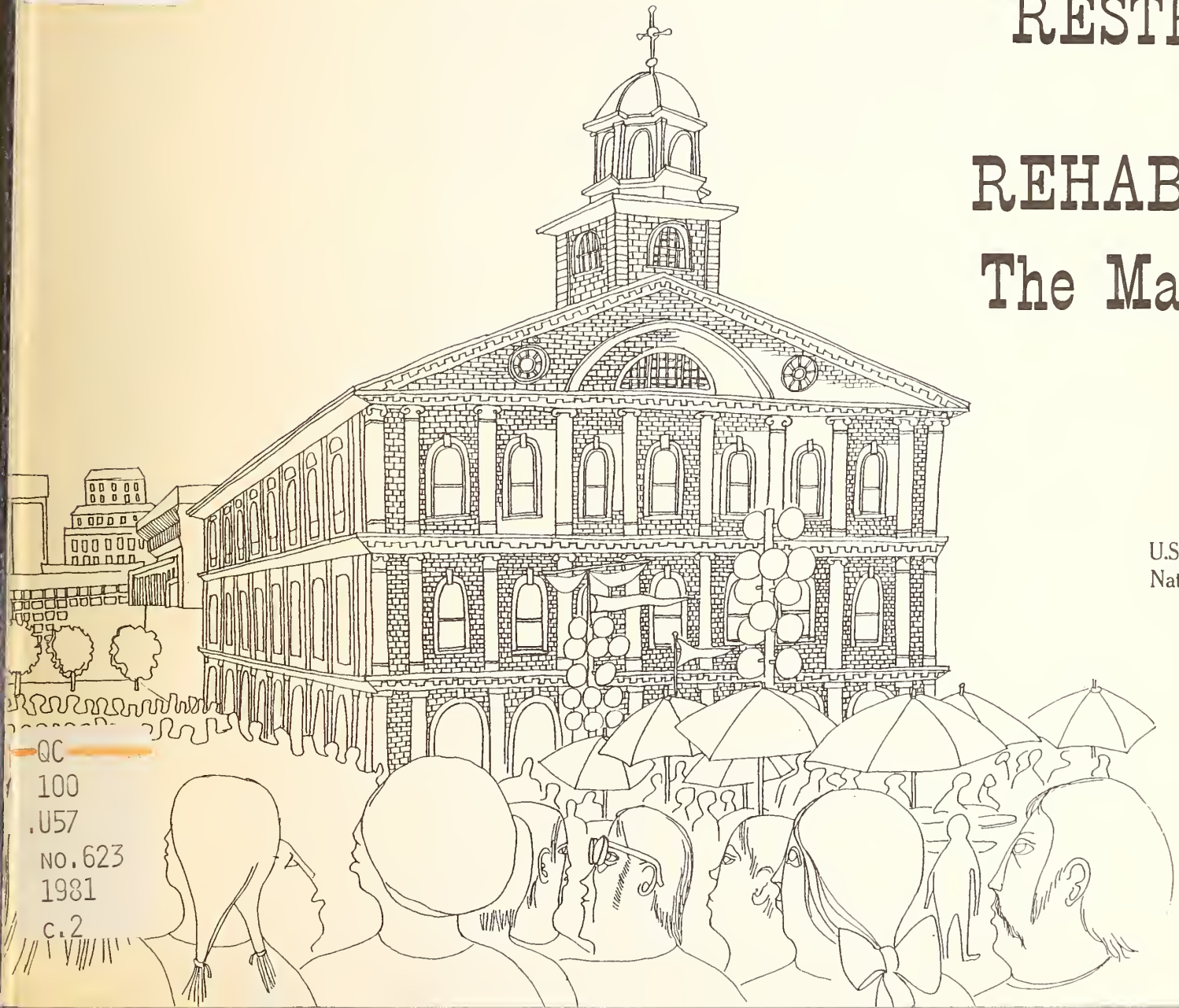
REMOVING REGULATORY RESTRAINTS TO BUILDING REHABILITATION:

The Massachusetts Experience



U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards SP623

REMOVING REGULATORY RESTRAINTS TO BUILDING REHABILITATION: The Massachusetts Experience

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NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

Issued October 1981

Library of Congress Catalog Card Number: 81-600141

National Bureau of Standards Special Publication 623
Nat. Bur. Stand. (U.S.), Spec. Publ. 623, 57 Pages (Oct. 1981)
CODEN: XNBSAV

U.S. GOVERNMENT PRINTING OFFICE
Washington, 1981

Preface

There is an increasing awareness of the need to more fully utilize existing buildings. The re-use of old buildings has grown far beyond the historic preservation movement which originally emphasized the need to preserve buildings as part of our national heritage. Current economic realities force us to view existing structures as assets that can be renewed creatively to provide shelter for people, commerce and industry. This is all to the good, for it avoids the dislocations of razing structures and building from the ground up, and additionally provides urban variety and continuity with our past.

Building regulations and the regulatory process have a powerful effect on building rehabilitation, often determining success or failure. The Commonwealth of Massachusetts, recognizing problems in the application of its building code to rehabilitation, has created a new regulatory approach which appears to work quite well and could have wider application.

This report documents the process that was begun in late 1977 and has continued to the present. Regulatory problems affecting building rehabilitation were identified, a regulatory response to these problems was developed, and the new approach was tested in the rehabilitation of a number of buildings - four of which are included herein as case studies.

The process outlined in the report can serve as a guide to other State and local jurisdictions that have similar problems with efficient re-use of existing buildings. Also included as an appendix is the text of Article 22, "Repair, Alterations, Additions, and Change of Use of Existing Buildings" of the Commonwealth of Massachusetts Building Code.

This publication is a joint product of the Design and Construction Technology Application Program (DACTAP) and the Building Economics and Regulatory Technology Division, both in the Center for Building Technology at the National Bureau of Standards. Your comments and suggestions are invited.

Porter Driscoll, AIA
DACTAP Coordinator
Center for Building Technology

Contents

Thrust of Report

An innovative regulatory approach has been implemented in the State of Massachusetts to encourage the reuse of the existing building stock. Technical support was provided by the National Bureau of Standards and other interested national organizations and individuals. This publication is intended to provide background information on the process that was followed in developing new code provisions, outline the scope of the provisions, and to illustrate their impact on actual buildings being rehabilitated.

This publication is organized in the following way:

- o Backgrond information on the level of building rehabilitation in the United States, impact of regulations and the regulatory process, and related activities at the national level
- o Formulation of a new regulatory concept to replace the "25-50 percent rule"
- o Events leading to publication of Article 22 of the Massachusetts State Building Code
- o Implementation and monitoring of Article 22
- o Case studies illustrating the impact of Article 22

BACKGROUND

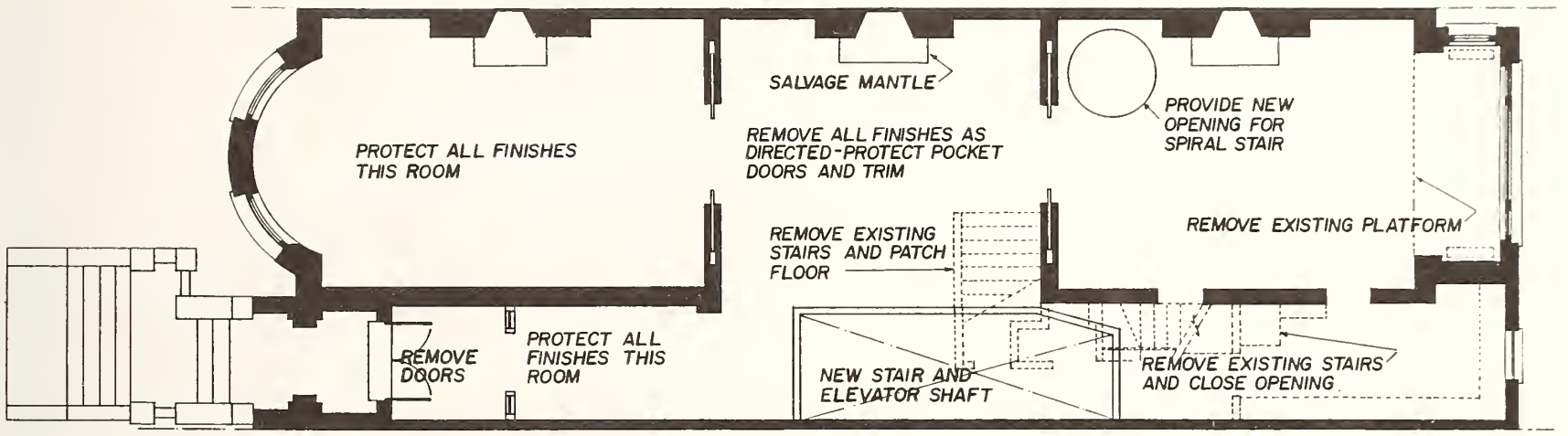
BUILDINGS THAT HAVE STOOD THE TEST OF TIME ARE NOW BEING RECOGNIZED AS PROVIDING UNIQUE AMENITIES ...

A national concern is emerging for the full utilization of the existing building stock. Buildings that have stood the test of time are now being recognized as providing unique amenities important to the stabilization of a neighborhood. It is becoming apparent that pleasing architectural characteristics can unify and preserve the fabric of the neighborhood which can be devastated by demolition and construction of new buildings. Established neighborhoods provide social and economic anchors against a tide of alienation caused by constant displacement of an increasingly mobile population. Reversing the trend of urban decay through building and neighborhood revitalization is a crucial and necessary undertaking if the quality of life in our inner cities is to be improved and a tax base created to make that quality possible.

There are many economic factors which are stimulating the growth of the building rehabilitation industry. Increasing costs of materials, labor, land acquisition, utilities, and financing have caused overall building costs to exceed the rapid general increase in the cost of living. The disproportionate increase in these costs aggravates the housing shortage which already exists. Even during periods of economic stability the industry has found it difficult to provide new building stock in sufficient quantity to meet the Nation's needs. An alarming fact emerged from the 1977 Annual Housing Survey [1][1]

FACADE OF 175 COMMONWEALTH AVE. (SEE CASE STUDY 3)

1 References are listed on page 31.



ALTERATIONS TO 175 COMMONWEALTH AVE.

which revealed that more than one-half of the 82 million homes in this country are 25 years old or older and each year about one percent of this inventory is lost to demolition, change in use, fire, and abandonment. Statistics from this study suggest that the number of people that are inadequately housed in this country remains large.

An increasing awareness of the need to conserve and reuse existing buildings is apparent at all levels of government, - Congress, Federal agencies, State government and city and local jurisdictions. The private sector is actively involved in alleviating the social problems of housing shortages and urban decay through rehabilitation.

This widespread concern is resulting in a major building effort on a national level. The Department of Commerce reports that $42.2 billion was spent in 1979 on what is classified as "maintenance, repair and construction improvements to residential properties," compared to $77.1 billion spent on construction of new housing units [2]. Architectural Record has reported that expenditures for nonresidential additions, alterations,and major replacements are expected to increase from an estimated $15 billion in 1978 to as much as $30 billion annually by the mid 1980's [3]. A recent F. W. Dodge report estimated that 77 percent of all construction activity in 1981 will involve preservation, adaptive use,and renovation.

CONSTRAINTS

The building code is the primary regulatory device used to assure that minimum requirements for public health, safety, and welfare are met in the design and construction of buildings. However, the building code and its enforcement have been identified as impeding the essential work of rehabilitation. This was addressed in Senate hearings held in 1978 [4].

> "In May 24, 1978, the Senate Committee on Banking, Housing, and Urban Affairs (96th Congress, 2nd Session) received testimony from architects, trade associations, building officials, and other interested parties to the effect that new construction oriented building codes impede rehabilitation projects in four ways:
>
> a. They add additional unnecessary project costs (estimated at 10 to 20 percent of total project costs);
>
> b. They add unnecessary project approval times (in some reported cases) as much as 16 months over comparable new construction projects;
>
> c. They discourage otherwise feasible rehabilitation projects; and
>
> d. They produce an environment which permits and encourages payoffs of building officials."

The lack of effective regulations for building rehabilitation forces the use of codes created for new construction. This frequently impedes those who attempt rehabilitation, and increases costs. The

language and format of these codes tend to delineate and model the construction process with appropriate regulatory controls; i.e., a synthesis process, as contrasted to the analytic process needed in building rehabilitation. These codes tend to be less effective, or even inappropriate, when applied to the process required to determine rehabilitation needs of existing structures. The physical status of an existing building must be assessed in order to determine the impact of building regulations, and quite often required techniques or technical data are not available.

The application of these codes for new construction to building rehabilitation is based on the amount of work planned. An example of this requirement is the "25-50 percent rule." The application of these administrative provisions is based on the following economic hierarchy, which is sometimes awkward and difficult to enforce in actual practice.

a. The alteration must be restored to at least its original condition for renovations which cost less than 25 percent of the value of the building.[2]

b. The extent to which the portion of the building altered or repaired conforms to new construction requirements is left to the discretion of the building official when the cost is between 25-50 percent of the building's value, or

---

[2] The definition of "value" is not agreed upon. It has been interpreted as assessed value, market value, or replacement value of the building.

c. the entire building must comply with the building code for new construction when alterations exceed 50 percent of the building's value.

It has been shown that these provisions exert a negative effect on both public safety and the quality and the size of the building stock. There is a considerable period of time when it is not economical to rehabilitate a building to the level required by codes for new buildings, yet the building has not deteriorated sufficiently to warrant condemnation and demolition. Extending the life of such badly deteriorated buildings contributes to social and economic problems in many urban neighborhoods, since such deterioration has an areawide effect and is not confined solely to individual structures.

ALTERATIONS TO 177 STATE STREET
(See Case Study 2)

WESTFIELD STATE NORMAL SCHOOL, Westfield Mass.
Erected circa 1848, demolition date unknown.

All model building codes and most code documents based on these models contain clauses stating that alternative materials and methods of construction will not be excluded from consideration. In actual practice many building officials hesitate to approve innovative systems because they lack a technical basis to make such decisions. Potential legal liability can result when such systems are approved without regulatory precedence.

CODE ENFORCEMENT FOR EXISTING BUILDINGS DIFFERS FROM THAT FOR NEW BUILDINGS

Some enforcement agencies have established ad hoc processes for regulation of additions and alterations to existing buildings with such projects forced into a model established for new building construction. Also, they may not be as familiar with condition assessment of existing building systems or have necessary data for making other technical decisions.

NEW CODE CONCEPTS TO REPLACE 25-50 PERCENT RULE

The National Bureau of Standards (NBS) began a study in late 1977 to determine the needs of model building code organizations and selected State and major city building regulatory agencies, regarding improved regulations for rehabilitation of existing buildings. The National Conference of States on Building Codes and Standards, Inc. (NCSBCS) assisted NBS in collecting data for this study.

This study reported on in NBS Technical Note 998 [5] resulted in the development of a matrix shown in Table 1 which identifies: (a) participants in the rehabilitation process (e.g., owner, designer, developer, code official, etc.); (b) regulatory problems impinging on each participant; and (c) technical input needed to alleviate the problem.

The study concluded that the following eight technical inputs are required for improved regulations:

1. Validation of technical constraints in current codes for various occupancies

2. Technical basis for elimination or modification of the "25-50 percent rule"

3. Performance requirements for materials, components, and systems in existing buildings

4. Catalog of systems found in existing buildings but no longer in current use

5. Destructive and nondestructive building condition assessment methods

6. Improved regulatory process for existing buildings

7. A definitive code statement which explicitly states the intent of the code regarding building performance

8. Legally defensible code requirements and enforcement processes

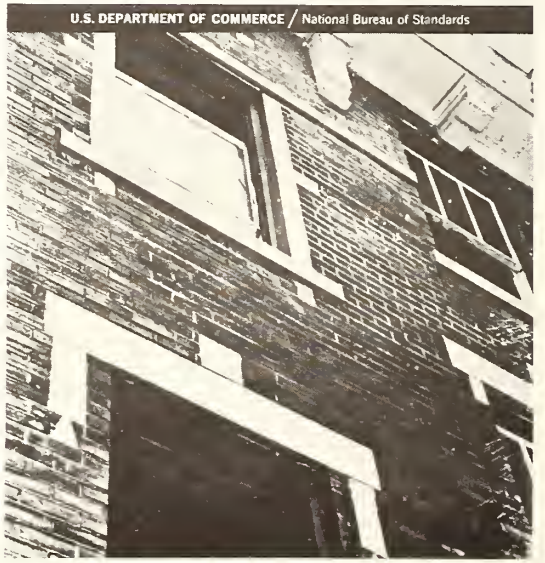


TABLE 1

REGULATORY REHABILITATION PROBLEMS, RELATIONSHIP TO PARTICIPANTS IN THE PROCESS AND THEIR TECHNICAL NEEDS

	REGULATORY PROBLEM	PARTICIPANT	TECHNICAL INPUT (See Key Below) 1	2	3	4	5	6	7	8
1	Limitation on options for occupancies	Owner/Developer	X							
2	Application of 25-50 percent rule	Owner/Developer, Code Official		X						
3	Difficult to establish requirements from prescriptive solutions	Owner/Developer Architect/Engineer, Code Official, Material Supplier			X					
4	Evaluation of existing condition of building (in relation to code)	Architect/Engineer, Code Official, Builder, Finance/Insurance				X	X			
5	Impediment to innovation	Architect/Engineer, Materials Supplier			X			X		
6	Lack of intent guideline in existing code	Architect/Engineer, Code Official, Materials Supplier			X	X	X		X	
7	More judgment required, therefore, more liability	Architect/Engineer, Code Official	X	X						
8	Inability to relate performance of archaic designs to modern reg's.	Architect/Engineer, Code Official			X	X	X			
9	Ad hoc regulatory process	Architect/Engineer, Code Official, Builder						X		

Key to Technical Inputs

1. Establish validity of technical constraints
2. Technical bases for elimination of 25-50 percent rule
3. Performance Requirements for materials, components, and systems
4. Catalog of building systems no longer in use
5. Nondestructive Evaluative Methods
6. Improved Regulatory Process
7. Definitive code intent statements
8. Legally defensible requirements

Conclusions concerning the development of a regulatory document for building rehabilitation relate to the following four issues:

1. A document is needed which will encompass all occupany building types, including mixed and multiple occupancies.

2. A systems approach should be utilized covering the building as a whole, including all subsystems (e.g., plumbing, electrical, mechanical).

3. The "25-50 percent rule" does not appear to be a workable solution in regard to the application of regulations for new construction to existing structures.

4. Technical data should be developed to provide a basis for rehabilitation decision making.

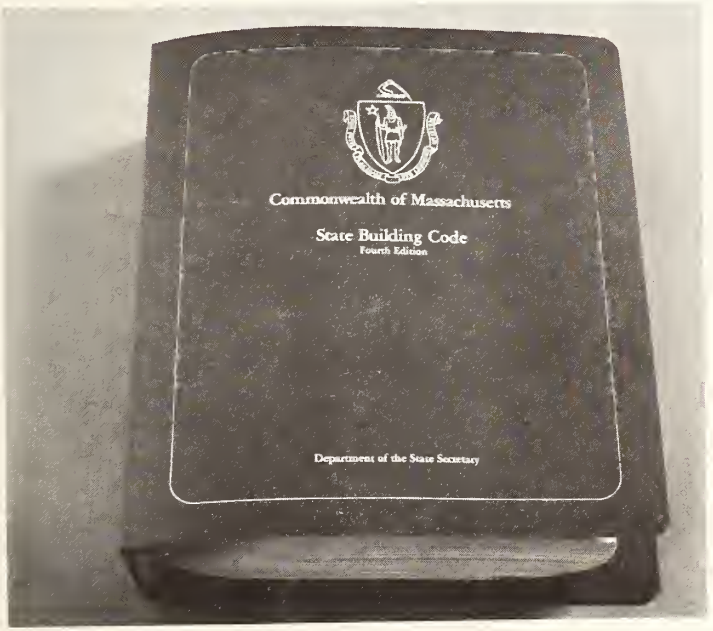
A regulatory approach was then formulated as a possible replacement for the "25-50 percent rule." It was based on the concept of allowing repairs, alterations and additions to existing buildings without necessarily meeting new construction requirements under the following general conditions.

a. all hazardous conditions must be corrected

b. the building must be occupiable under current requirements

c. the existing building becomes the minimum performance requirement

d. the performance level of the building after rehabilitation must not be below that existing before the change



e. additions must meet code requirements for new construction or equivalent

f. compliance with the building code for new construction or its equivalent may be required when the change is to a more hazardous occupancy or use group.

After reviewing the NBS study, former Massachusetts Governor, Michael S. Dukakis, and the State Building Code Commission, determined that the State could benefit from a review of its existing building code and from the adoption of interim building rehabilitation regulations. Massachusetts has a mandatory statewide building code applicable to all buildings and structures which the local municipalities cannot modify.

In March 1978, representatives of major organizations involved in rehabilitation were invited to a meeting in Boston to gain their assistance in developing such as interim code. Participants included representatives of the Building Officials and Code Administrators International, Inc. (BOCA), the International Conference of Building Officials, (ICBO), the Southern Building Code Congress International, Inc. (SBCCI), the Association of Major City Building Officials (AMCBO), the National Academy of Code Administration (NACA). the National Association of Housing and Redevelopment Officials (NAHRO), NCSBCS, and NBS. Governor Dukakis outlined for these representatives a plan for undertaking the Massachusetts rehabilitation project and pledged his personal support to that effort.

Following discussion of the plan the eight organizations pledged, together with the Commonwealth of Massachusetts, a total of approximately $206,000 in cash and in-kind services to the State building rehabilitation code project and agreed

to form a project team. The scope of the project called for NCSBCS, as the prime contractor, to produce with the other members of the project team, an interim code document containing code provisions for alterations and additions to existing buildings which the State Building Code Commission would consider for adoption. In addition to new code provisions, guidelines would be established for the designer, building owner, and enforcement officials to evaluate an existing building for possible rehabilitation.

In addition, the State Building Code Commission formed an Advisory Council comprised of affected parties in Massachusetts and interested representatives from throughout the country to review and provide constructive comments to the draft provisions and guidelines during the projects developmental stages.

The final draft of the interim code provisions was completed by the project team in August 1978, and was forwarded to the members of the State Building Code Commission for their review and comment. These comments were received by the project team and were incorporated into the rehabilitation document. A national conference was held on October 30, 1978 to discuss this code development activity [6].

In late September 1978, three one-day workshops were held in Massachusetts for local and State building officials to explain the interim code provisions and to receive their comments for possible changes in the document. The project was presented to the local officials by representatives of the State Building Code Commission and various members of the rehabilitation project team.

The major concerns raised by the building officials and reviewed by the Advisory Council were incorporated into a revised draft, which was approved by the State Building Code Commission late in the fall of 1978. The document was incorporated as Article 22 of the Massachusetts State Building Code and became effective in June 1979. The Article was revised in

KEY DATES IN THE HISTORY OF ARTICLE 22

March 1978	Initial Meeting of Massachusetts Project Team
August 1978	Final Draft of Article 22 Submitted to State Building Code Commission
September 1978	Workshops held for local and state building officials
November 1978	Revised Article 22 approved by State Building Code Commission
June 1979	Article 22 added to Third Edition of Massachusetts State Building Code
September 1980	Article 22 revised for Fourth Edition of Massachusetts State Building Code

1980 to include energy conservation provisions; recognition of types of construction, and the extension from two to five years for a building to quality under Article 22 [7]. The Article is reprinted in this document beginning on page 33. In addition to Article 22, Appendix T (see page 39) was added to the State Building Code containing:

Part One - Guidelines for Application
Part Two - Suggested Compliance Alternatives
Part Three - Detailed Classification of Occupancy by Hazard Index Number and Use Group
Part Four - Archaic Construction Systems

NBS technical support, in addition to the conceptualization of the regulatory approach discussed earlier, included the development of guidelines for the evaluation of existing buildings and application of performance based provisions based on regulatory appeal data from the State, and cataloging of data on outmoded structural systems.

ARTICLE 22 AND POTENTIAL IMPACT ON REHABILITATION

In order to test the validity of the concepts in Article 22 the State Building Code Commission set up a panel of nine building officials from the State to review plans and specifications of six existing buildings being considered for rehabilitation. The panel members were asked to individually analyze each building in regard to the impact of Article 22 as compared to the provisions of the existing code.

The preliminary conclusions that were drawn from this study are:

° Article 22 will allow individual building officials more leeway in lieu of requiring full code compliance and provides a basis for accepting compliance alternatives.

- Interpretation may not be consistent among the communities involved. They will reflect the building officials's interpretations (and presumably community values) regarding degree of code compliance and specific requirements.

- Building officials will exercise their prerogative under Article 22 and generally accept lesser requirements than under the "25-50 percent rule."

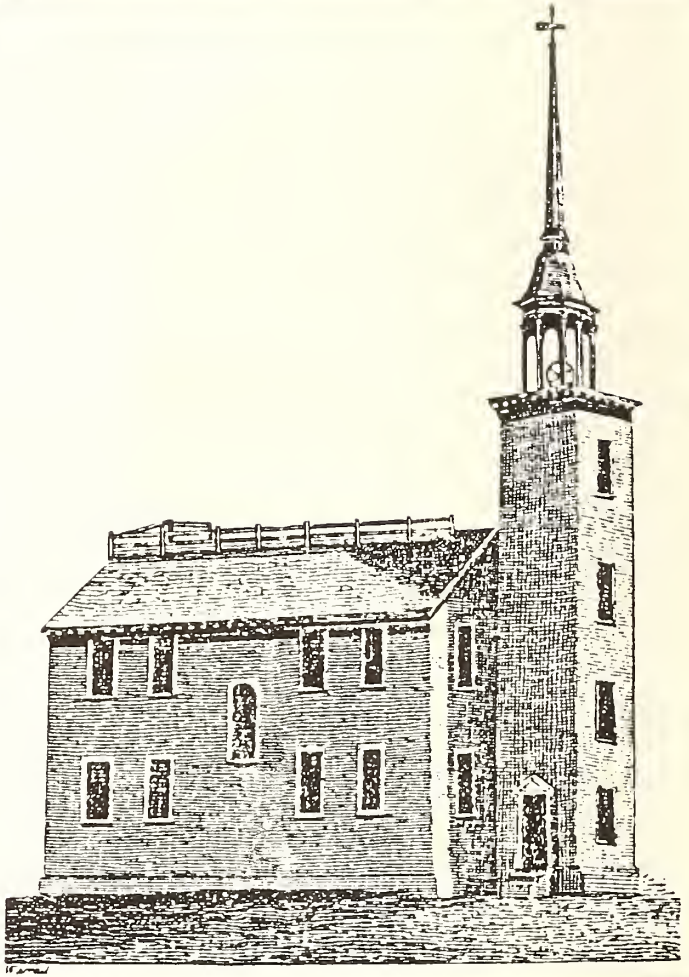
- Responsibility of the building officials will generally increase under Article 22, but will be no more than when the cost of rehabilitation fell within the 25 and 50 percent range under the old rule where building officials discretion is allowed.

IMPLEMENTATION AND MONITORING OF ARTICLE 22

The State of Massachusetts has set up an Advisory Committee on Code Provisions for Existing Buildings to assit the State Building Code Commission in monitorinng implementation of Article 22 and in considering changes. NBS is participating on this Advisory Committee. In addition to changes in Article 22, it is important that compliance alternatives in Appendix T are updated to reflect the latest technology. These possible changes are being identified by analysis of Board of Appeals decisions and by reviewing compliance alternatives being allowed by local building officials.

In regard to the impact of Article 22, an 80 percent reduction in appeals on existing buildings has been reported in Boston during the first six months that it was in effect [8]. Decisions are being made without resorting to the costly and time consuming appeal procedures.

Article 22 and the previous code (1978) governing rehabilitation in Massachusetts are compared in the following four case studies of buildings rehabilitated since 1979.



FEDERAL STREET CHURCH-BOSTON, MASS.
Erected 1744, demolished circa 1807

CASE STUDY 1

144 PLEASANT STREET, WEYMOUTH

A 2500 square foot two-family dwelling (use group R-3) originally built in the early 1800's of timber post and beam construction in Weymouth, Massachusetts was converted to an office building (group B). The rehabilitated building shown above contained two full stories and an utilized attic space. It was converted in 1979 under the provisions of Article 22 by Walter A. McKinnon Associates, Consulting Engineers.

IMPACT OF 1978 CODE ON REHABILITATION

The value of the building was estimated at $70,000, approximately the cost of the proposed improvements. Since the cost of the rehabilitation was 100 percent of the physical value of the building, the entire building would have been required to meet the code for new construction under the following provisions of the the Building Code of the Commonwealth of Massachusetts (1978 edition).

SECTION 106.0 ALTERATIONS AND REPAIRS

"Except as provided in this section, existing buildings or structures when altered or repaired as herein specified shall be made to conform to the full requirements of the Basic Code for new buildings:

106.1 ALTERATIONS EXCEEDING FIFTY PERCENT: If alterations or repairs are made within any period of twelve (12) months, costing in excess of fifty (50) percent of the physical value of the building;"

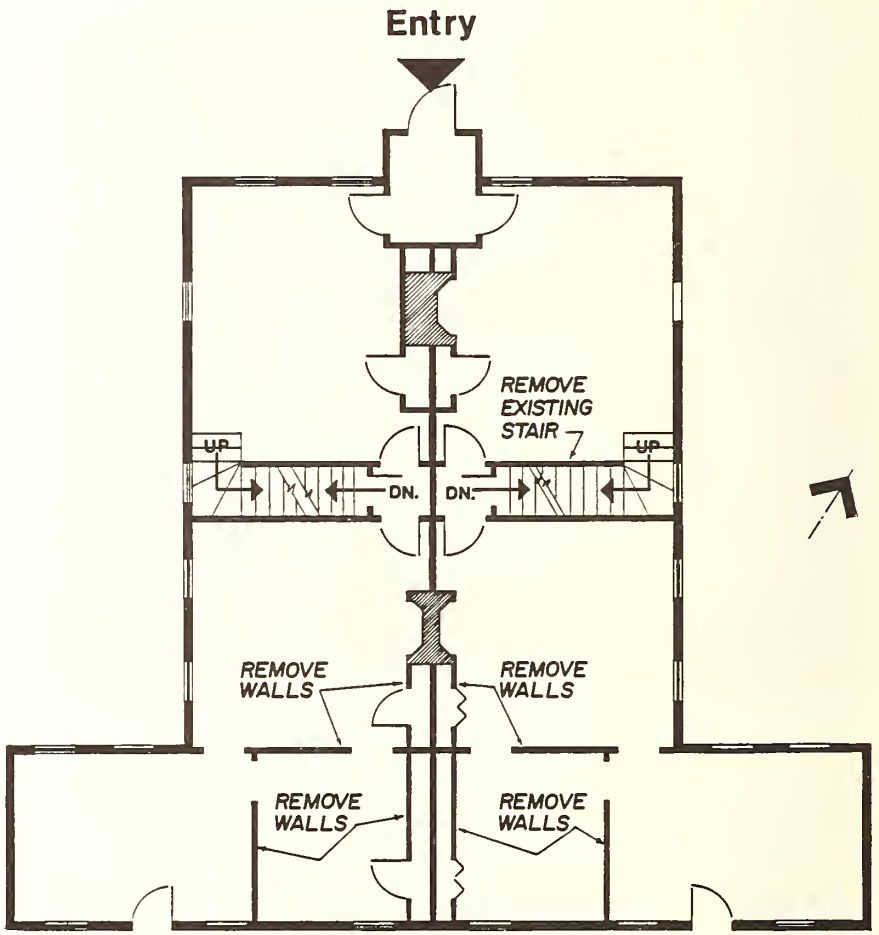
Additionally,since a change in use was involved, this type of post and beam construction would not have been allowed in Fire District I under provisions 302.5 and 303.0. In its place type 3B, ordinary protected or non-combustible construction would have been required.

> *"Section 302.5 Frame Construction: No building of frame construction (type 4) shall be erected within the fire districts ... and no building of otherwise lawful construction shall be extended in height or area within the fire districts by frame construction; except that one and two-family frame dwellings may be extended in area by not more than three hundred (300) square feet and to a height of not more than two and one half (2 1/2) stories nor more than thirty-five (35) feet.*

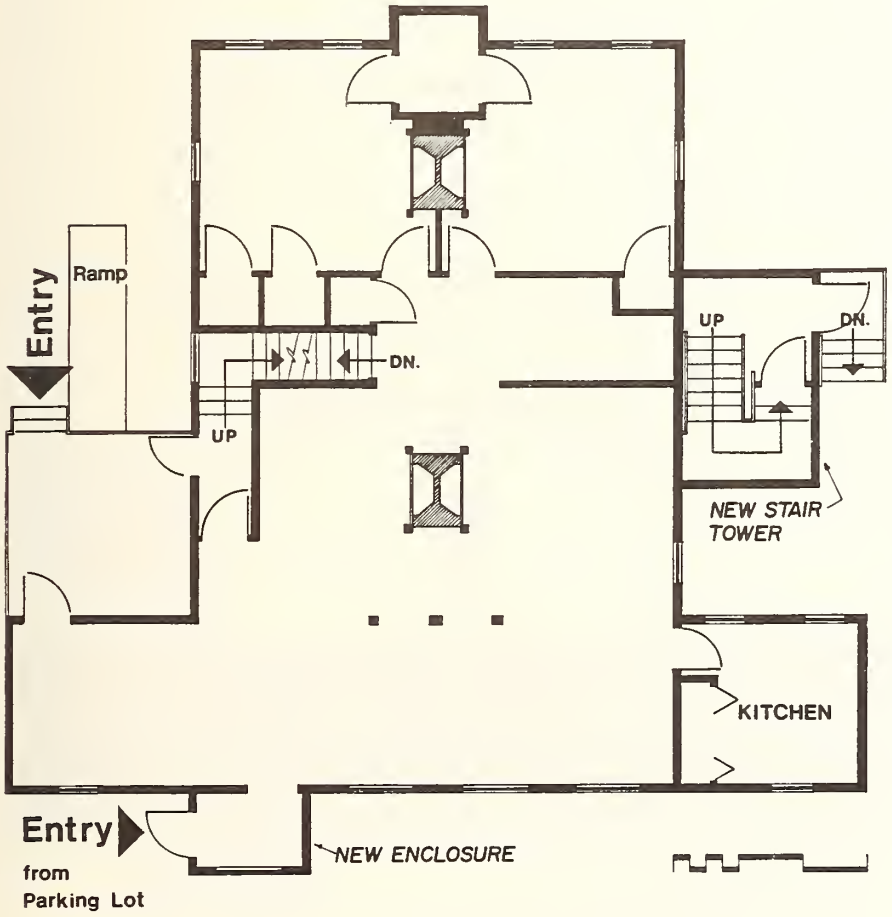
Section 303.3 RESTRICTIONS OF FIRE DISTRICT NO. 1: All buildings and structures, and all additions to existing buildings and structures, hereafter erected within the boundaries of Fire District No. 1 shall be of fireproof (type 1), protected non-combustible (types 2-A and 2-B), heavy timber (type 3-A) or ordinary protected (type 3-B) contruction as defined in article 2 and regulated in table 2-6, and shall be constructed within the height and area limitations of table 2-6; except as herein provided."

Since the building use was being changed from residential to office, the exception in Section 302.5 which allowed for an extension in area of frame dwellings would no longer have applied. The building would have been forced to conform to the more stringent construction requirements of Section 303.0, which would have required the upgrading of both fire resistance and load carrying capacity. Further, there is a 2-story limitation on unprotected frame office structures.

Even if possible, the provisions of increased fire separation and resistance in existing buildings are always very costly, and this project would most likely have been abandoned. A special variance could perhaps have permitted the project to proceed, but only after long and inevitable delays. Article 22 shortcuts the variance process by allowing the discussion of compliance alternatives early in the project.



EXISTING FIRST FLOOR PLAN



ALTERATIONS TO FIRST FLOOR PLAN

ACTIONS TAKEN UNDER ARTICLE 22

Although there was a change in use group from residential (R-3) to business (B), the hazard index shown in Table 2205 of Article 22 remained the same (2 for each use), and Article 22 makes only modest demands when there is no increased threat to public safety.

The building official required the following features in the rehabilitated building:

1. One of the two unprotected interior stairways to be replaced by a rated stair tower providing a safe egress from the second floor. This was considered necessary since the building exceeded two stories, and constituted a significant upgrading in terms of public safety.

2. Solid core doors with closers to be installed at the new stairs, leading into each office.

3. Two toilets to be installed on the second floor.

4. The basement furnace room to be enclosed with a 3/4 hour rated enclosure and a fresh air supply to be added.

5. Chimneys to be repaired and fireplaces blocked off. They were previously connected to the furnace flue and the code prohibits connecting any appliance to flues serving operating fireplaces.

6. Smoke detectors to be installed.

7. The existing interior stairway to be modified. The winder was changed to a platform leading to an egress.

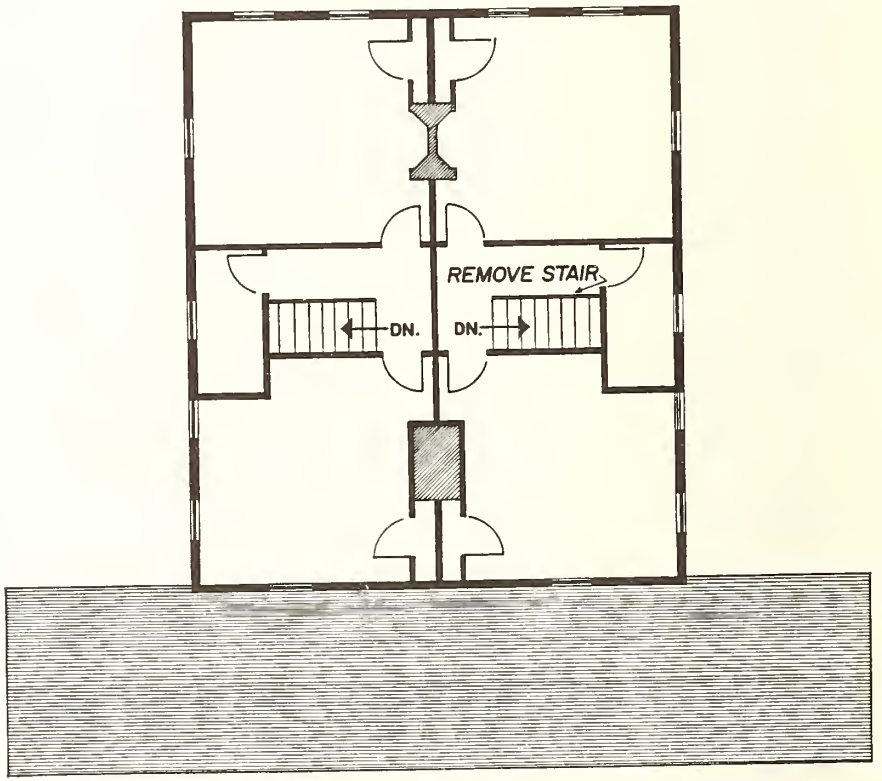
8. Compliance with Article 20 relating to energy provisions was required.

9. A ramp to be installed for the physically handicapped and additional emergency lights and exit signs added.

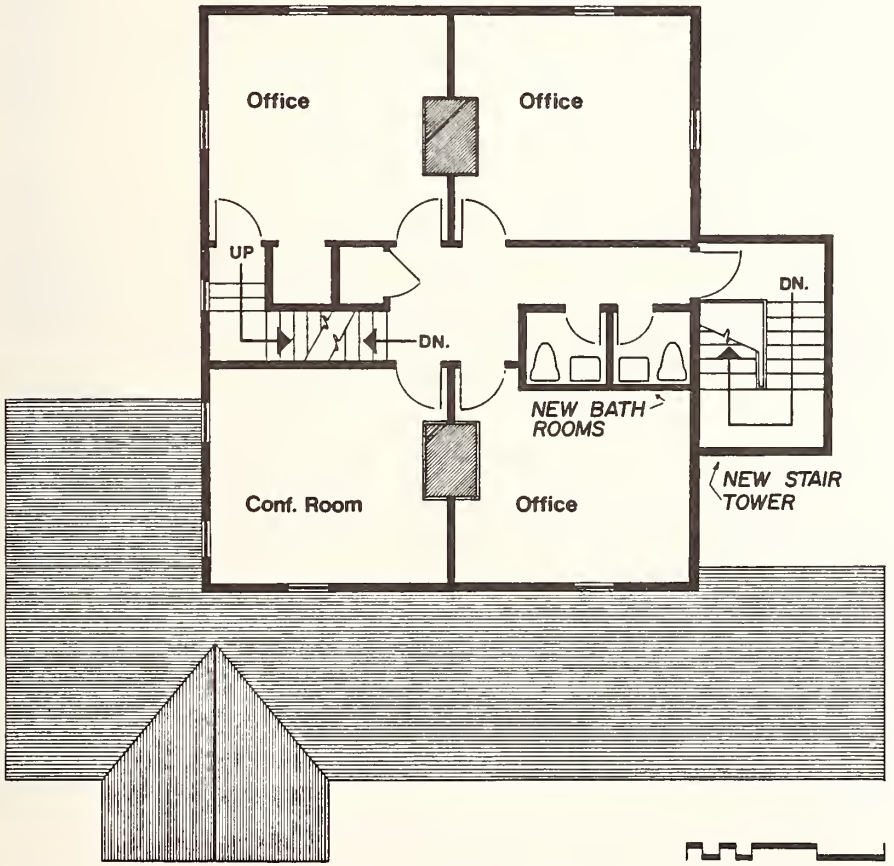
In addition to required alterations, the electrical system in the building was almost entirely changed, with additional power brought into the building to supply the anticipated needs of office functions. New wiring met code requirements for new construction.

The addition of two bathrooms constituted the major plumbing alteration. These were located on the second floor in the space formerly occupied by the stairway. The kitchen on the first floor was retained and reused without modification.

A modern oil-fired hot air system with central air-conditioning was substituted for the old two boiler system. After inspection by the local fire prevention official, the existing fireplace flues were deemed safe as airshafts for the new HVAC system.



EXISTING SECOND FLOOR PLAN



ALTERATIONS TO SECOND FLOOR PLAN

Structural changes were made on the first floor at the rear of the building where a former exterior wall of pegged construction, with cross-bracing, was removed. Two 4" x 4" wall posts were left in place and a new post added between them, with new foundations poured under all three. The original wood beam above these posts was exposed, inspected and determined to be structurally sound. It was left in place intact.

A new enclosed porch was added at the rear of the building to serve as the main entry from the parking lot with the front door no longer used. A covered side porch was added to serve the door at the foot of the interior stairs and another door at the rear of the building. As previously discussed, the other structural changes were the removal of one interior stair and the addition of an exterior stair tower.

Existing interior finishes, including lath and plaster walls, plaster ceilings and some more recent suspended ceilings were removed. Walls were inspected for deterioration, insulated, and gypsum wallboard was installed over existing studs. New suspended ceilings were installed throughout the building. The existing wood floors were maintained throughout, except where the stair was removed.

CASE STUDY 2

The existing building at 177 State Street in Boston contained offices and a restaurant (use groups B and A-3). The seven story, 85-foot high building reached its present height around 1910 when the two-story mansard was added. While originally built of type 3A, heavy timber construction, the building was sold to a printing company in the 1930's, and this new owner stripped the entire interior and replaced the existing wood floors with reinforced concrete construction. The exterior envelope consists of a granite facing over brick walls.

The proposed new use was similar to the use prior to renovation: the restaurant was moved to a different location, and the remainder of the building converted to condominimum office occupancy. Office renovation was undertaken by the Boston architectural firm of Dyer/Brown and the restaurant designed by Jerrel Angell.

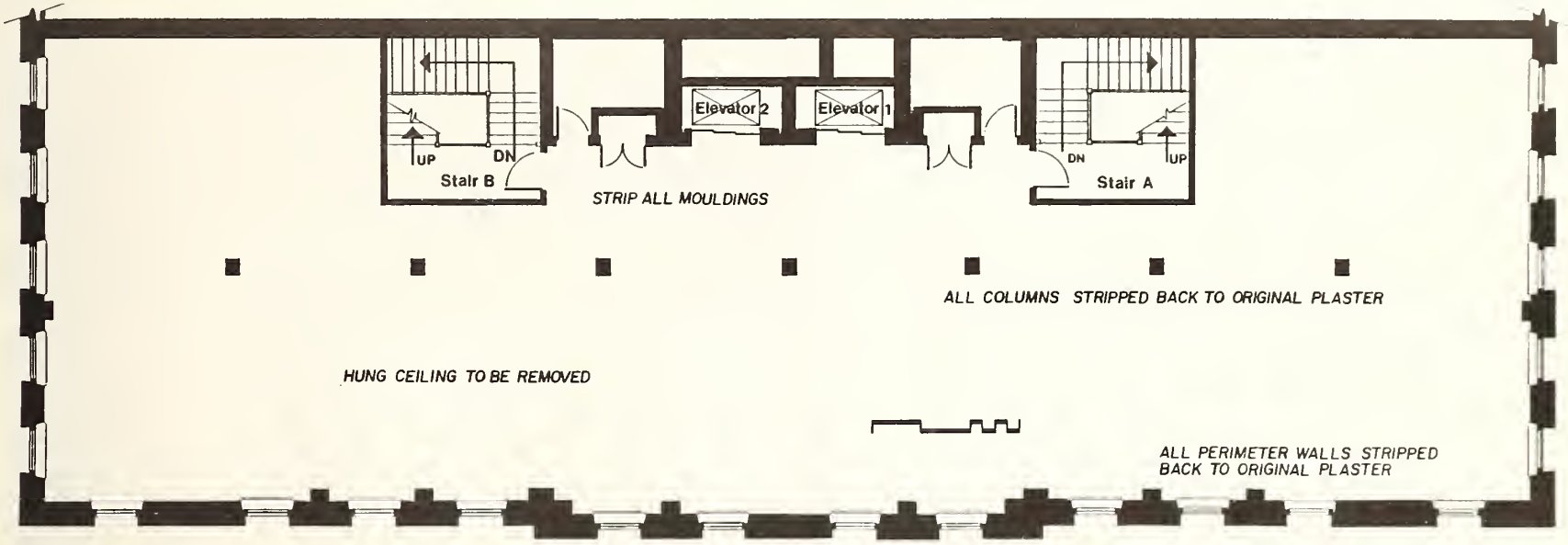
IMPACT OF 1978 CODE ON REHABILITATION

The replacement cost of the building, which the City of Boston uses rather than the assessed cost, was estimated at $1,411,760. The rehabilitation cost was estimated at approximately $1,000,000, well over 50 percent of the replacement cost; therefore, the owner would have had to comply with the requirements of the code for new construction for the entire building.

The code provisions which would have been mandatory included new earthquake design standards (Section 718) and mortar requirements (Section 816). Not only would it have been very difficult to upgrade the seismic resistance of the building, but, since the building was constructed during the 19th century, it could not possibly conform to modern code requirements for mortar, which specify such materials as Portland Cement and hydrated lime or lime putty. The existing stairway width was thirty-six inches which was less than the forty-four inches required by the code. Additionally, Article 12 and section 431.0 of the Code, relating to high rise buildings (over 70 feet), would have required compliance with provisions for smoke proof towers, smoke evacuation systems, emergence fire alarm systems, emergency generators, and additional elevators.

SEVEN STORY OFFICE BUILDING WITH RESTAURANT - RESTAURANT REMODELED AND RELOCATED; OFFICE SPACE REMODELED AND CONVERTED TO CONDOMINUM SPACE

Case Study 2



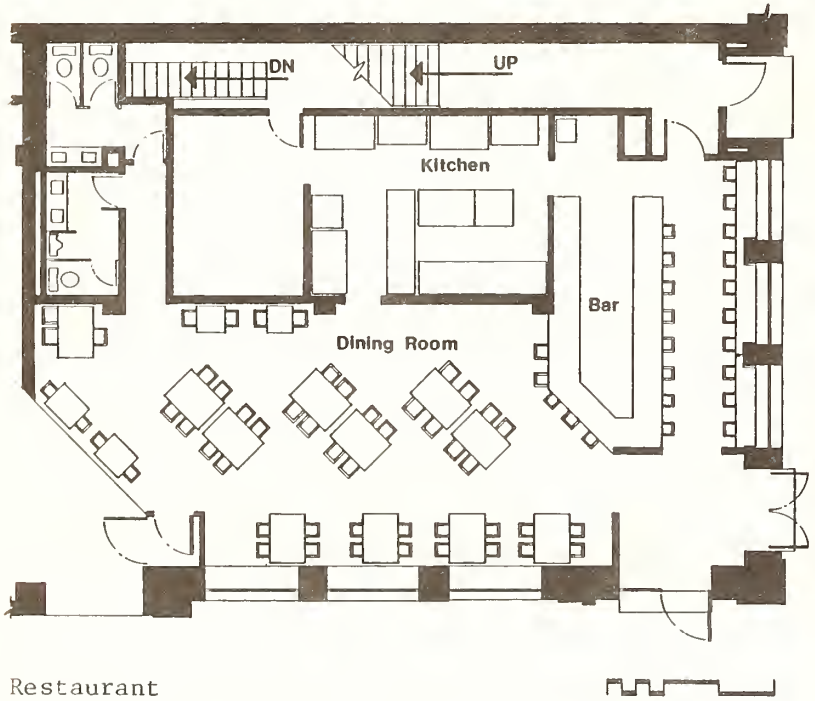
ALTERATIONS TO TYPICAL FLOOR

ACTIONS TAKEN UNDER ARTICLE 22

Waiver of the earthquake, mortar and stairway width requirements was allowed without filing an appeal with the State Appeals Board, thus saving months of valuable time. The restaurant was required to meet the code provisions for new construction with respect to emergency lights and exit signs, and Class 2 flame spread rating for interior finish was approved. (Class 1 would have been required if the owner had not been required under another state law to install a sprinkler system.)

The reason for waivers under Article 22 can be derived from the rationale for the establishment of the article itself. The building, as it existed, had served well in the past, and with reasonable modifications and improvements, fire and safety hazards could be minimized without requiring total conformity to the code for new construction. Since the building was examined by an architect and an engineer who determined that it was structurally sound and adequate for anticipated loading, compliance with the exact requirements of the earthquake and mortar sections of the code for new construction was considered unnecessary. As the basement level was not occupied, but only used to house the mechanical services and general storage space, the fact that the existing stair was too narrow to meet the code for new construction was deemed irrelevant. This may seem obvious but is a fine example of how the broad wording of Article 22 permits common sense to prevail.

Case Study 2



Restaurant

In addition to mandated requirements, the project included:

1. total stripping of the interior, leaving only floors, bare walls, stair shaft and elevator shaft;

2. installation of new electrical and HVAC systems, meeting codes for new construction;

3. the refurbishing of two toilets per floor;

Office Space During Rehabilitation

Completed Office Space

4. checking and repairing of all existing standpipes;

5. reglazing of the entire structure with insulating glass;

6. levelling floors;

7. installation of new interior partitions, and

8. the installation of a sprinkler system which, while not required under Article 22, is required by State Statues (MGLA - C 26A, Massachusetts General Laws Annotated).

The existing plumbing was reused throughout the building, with only the replacement of sinks. New plumbing was only required in the restaurant kitchen and rest rooms.

Most of the surface coverings over the concrete floors were removed and replaced, but wood floors in the restaurant area were saved, and some existing terrazzo was also cleaned and reused. The vaulted plaster-on-brick ceilings on the first floor were exposed, cleaned and patched. A variety of finishes were used since each office floor was planned by the individual tenants.

CASE STUDY 3

A single-family residence which had been converted to a church (use group A-4) in 1952 was reconverted to a five unit dwelling (use group R-2). A partial fifth floor addition was made to the building during the conversion. The architect for the renovation was Stephen Tise.

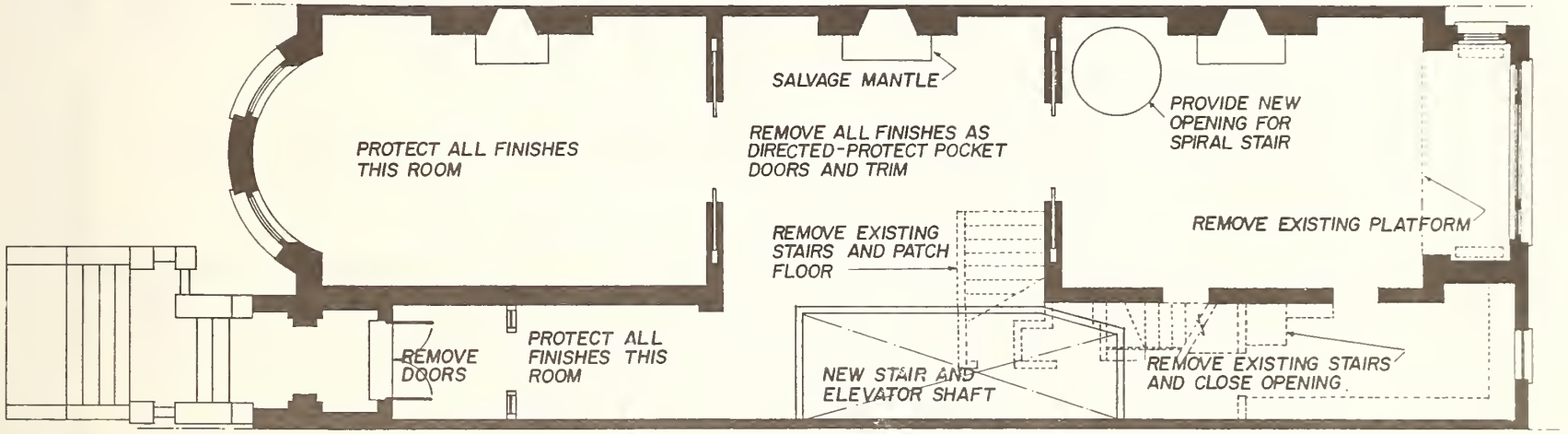
The building was erected in the late 1800's and is located in a designated historic district. The four-story structure is 47 feet high, 29 feet wide and 78 feet deep, and has approximately 11,000 square feet including the basement. The building had a front stairs and connecting balconies to an adjacent building which were used as a second means of egress.

The building is type 3-C ordinary unprotected construction with 12 inches thick exterior masonry walls supported by a granite foundation on piles. Brick party walls are load bearing while front and rear walls are not. The structure contained a complex system of cast iron columns and beams within walls and ceilings, and was in deteriorated condition before renovation.

IMPACT OF 1978 CODE ON REHABILITATION

Replacement cost estimates for the building were between $330,000 and $500,000 with renovation costs figured at $350,000. These figures would have required compliance with the code for new construction under the "25-50 percent rule." Additionally, the following code requirements would have been applied.

1. The building would have exceeded the height and area limitation for type 3-C construction which is three stories or forty feet. (Table 305 of the code).



ALTERATIONS 175 Comm. Ave.

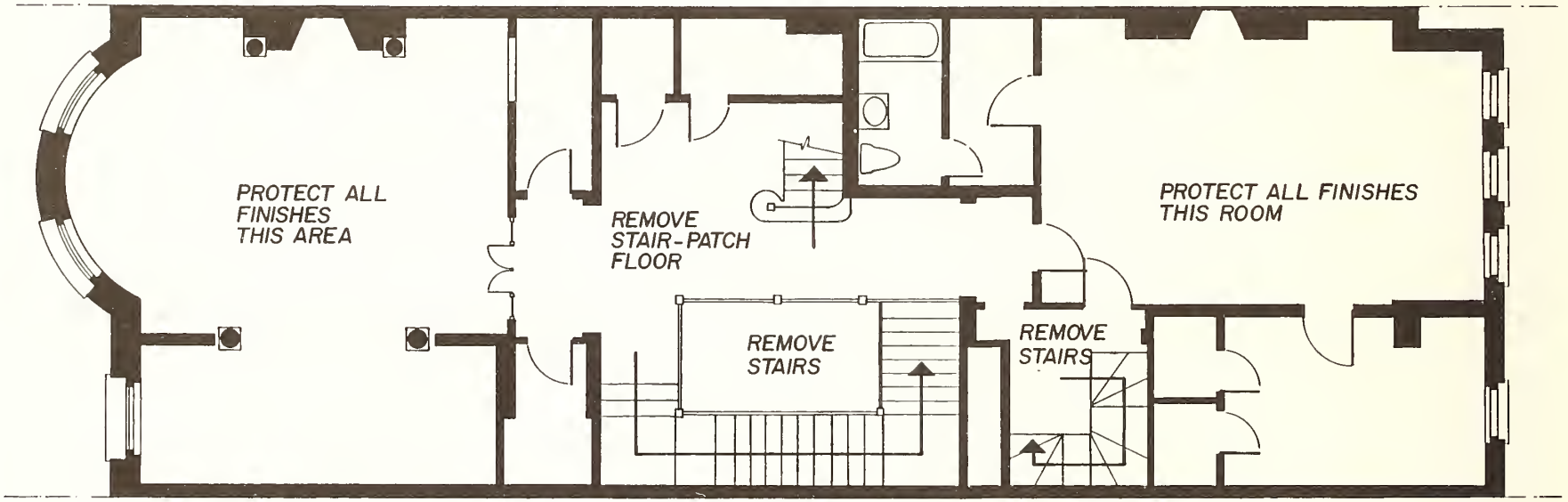
2. Type 3-C construction would not be permitted in the fire district for buildings exceeding the three story, forty foot or 9,600 square foot limitations of Table 305. Further limitations are placed on this type of construction by Table 302 entitled, "Exterior Fire Resistance Rating Requirements."

3. The existing connnecting balconies could not have been retained, since the former code disallowed them as a means of egress. The alternative - a fire escape - is expressly disallowed by the special commission which has jurisdiction over all exterior modifications in this historic district, and the only other solution - an interior stair tower - would have further reduced the already very cramped interior area in this typically narrow row house, making rehabilitation unlikely and very uneconomical.

4. All earthquake provisions of the Code would have been enforced, and the cost of rebuilding the structure prohibitive. It would also have been excessively expensive, and inappropriate, for a historic structure to be modified to conform to modern mortar requirements in the code.

Case Study 3

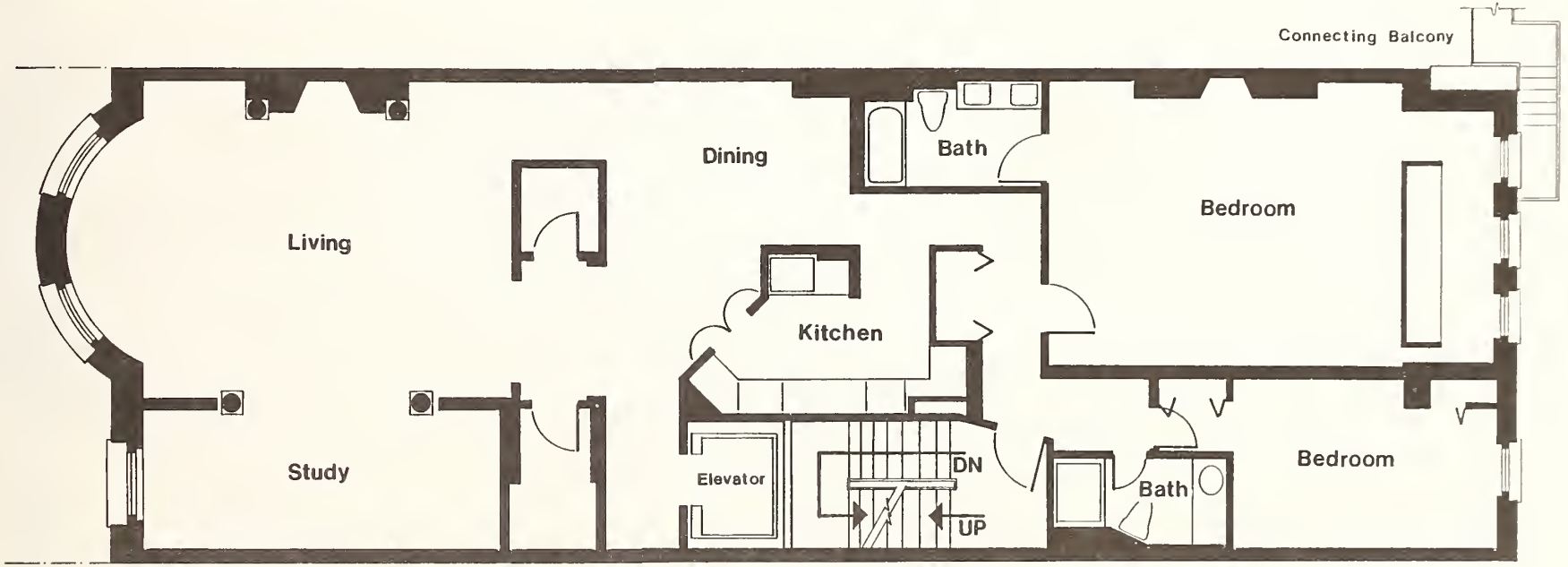
175 COMMONWEALTH AVENUE, BOSTON



EXISTING SECOND FLOOR PLAN

ACTIONS TAKEN UNDER ARTICLE 22

This conversion from a church with a hazard index of 4 (Table 2205) to a multi-family residence with a hazard index of 2 represents a net decrease in hazard, as covered under Section 2203.0 of Article 22. In such cases, Article 22 is particularly lenient, and even the connecting balconies were accepted as a second means of egress, as suggested in Section T202.1.1 of Appendix T. A variance from the city of Boston was required to allow the partial 5th floor addition, after the commission governing the architectural district determined that it would be acceptable since it would not be visible from a public way. A new interior stairway was added. Had this not been done, the building official would have required enclosure of the existing stair to provide a smoke barrier (Article 22-Section 2203.12) or some unspecified compliance alternative (Appendix T-202.3.1). Also, the building official required that the floor plan be changed to allow direct access to the stairway from the front of the building rather than only from the rear, as had previously been the case.



SECOND FLOOR AFTER ALTERATIONS

Under Article 22, compliance with the code for new construction was only required with respect to exit signs and emergency lights (2203.9), fire alarms (2203.11), and the new interior partitions (2203.3). Compliance was not required, on the other hand, with respect to fire district requirements (302.1) or with respect to area and height limitations (305.2 and 305.3), all of which would have required lengthy variance hearings under the old code.

Further, no compliance was required with seismic or mortar requirements, but code compliance was required for the electrical, plumbing, and HVAC systems. A new gas-fired boiler was installed with individual hot water fan coil units in each living space. The air conditioning system utilized 14 inch diameter vertical ducts concealed behind wallboard and horizontal ducts over dropped ceilings, as required for each living space. Extreme care was taken to disrupt as little historic fabric of the building as possible during these modifications.

Had Article 22 not been in force, the architects estimate that code compliance would have cost an additional $50-$100,000 as well as months of extra time, and the resulting building spaces might have been less satisfactory.

CASE STUDY 4

PRIME PARK, BOSTON

An unoccupied brewery (use group F) was converted to offices for the headquarters of a computer company (use group B). Beckstoffer and Associates were the architects for the conversion.

The largest building in the complex, completed in 1955, was the former Carling Brewery bottling plant which was a one-story space, 240 by 613 feet with a clear 24 feet height. The structure was steel frame with exterior non-bearing masonry and glass walls. The floor area was approximately 150,000 square feet, and the roofing system consisted of four inch precast concrete channel roof planks covering approximately one-third of the roof area with the balance consisting of two inch thick precast reinforced solid gypsum plank decking with a two inch covering of gypsum fill.

The proposed new use for the building was as the World Corporate Headquarters of Prime Computer, Inc., planned to consolidate the corporations executive offices scattered over the Boston area. The use group was changed to B, and fire resistance rating upgraded to 1B.

UNOCCUPIED BREWERY CONVERTED TO OFFICE BUILDING

CASE STUDY 4

A new floor was designed to fit within the 24 foot high structure, thus doubling usable floor area. Seventy-five percent of the existing building walls were retained. Pre-cast insulated panels were added on the exterior, and insulated metal stud walls with dry-wall were used on the interior. A large skylight was cut into the roof to create a central sunlit multi-level interior court.

IMPACT OF 1978 CODE ON REHABILITATION

Before Article 22 the building would have been required to meet all provisions of the code for new construction through application of the "25-50 percent rule," including full complaince with earthquake provisions. The roof would have required additional fire proofing to meet a 1B rating, as Section 928.1 of the code requires that the *"repair of existing roofs shall comply with the provisions of section 106 but in no case shall more than twenty-five (25) percent of the roof covering of any building be replaced in a period of twelve (12) months unless the entire roof covering is made to conform to the requirements for new roofing."*

ACTIONS TAKEN UNDER ARTICLE 22

The hazard index, as indicated by table 2205, was decreased by one number, so that the requirements of Section 2203.0 for change in use to equal or lesser hazard and other pertinent sections of Article 22 were applicable. The building official could then approve the existing roof as having an adequate fire resistance rating, and the Appendix T listing of archaic construction systems provided favorable equivalency guidelines.

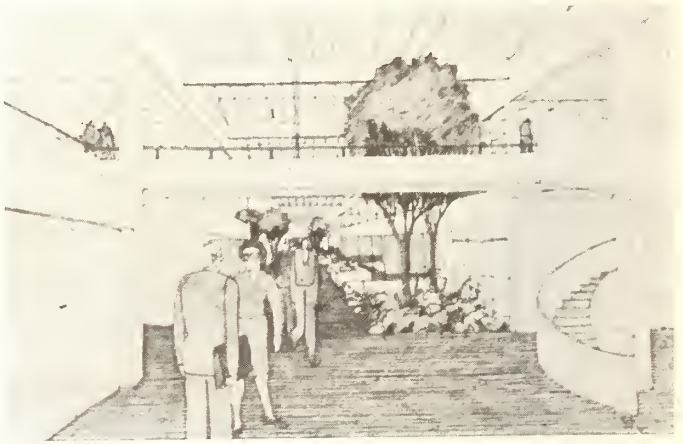
CASE STUDY 4

As Section 2203.3 only requires new systems to conform to the Code for new construction, "to the fullest extent practical," some compliance alternatives were accepted under Section 2206.1. Egress requirements in the large space were met by dividing the floor area into four quadrants with a minimum of two approved means of egress from each quadrant with no exitway being greater than 150 feet away from any point in the building.

After the required structural investigation, the existing steel frame structure was deemed adequate to support the new floor, which was allowed under section 2200.3 and 2203.5 covering additions and increase in floor loads.

The building was strengthened against possible earthquake damage, but it was not specifically brought up to the full earthquake load requirements of the code.

The owner's optional additions included sprinklers throughout the building because of the large open area. Additional precautions were taken by spraying the roof system with mineral fiber fireproofing. Additional thermal insulation was also added to maximize energy performance of the building envelope.



SKYLIGHTED GALLERY

AERIAL VIEW OF PRIME PARK

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3. Philip E. Kidd, Value of Nonresidential Rehabilitation Will Double By Mid-1980's, Architectural Record (pg. 61), October 1979.

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7. State of Massachusetts, Article 22 - Repair, Alteration, Addition and Changes in Use of Existing Buildings, Massachusetts State Building Code Commission, October 1980.

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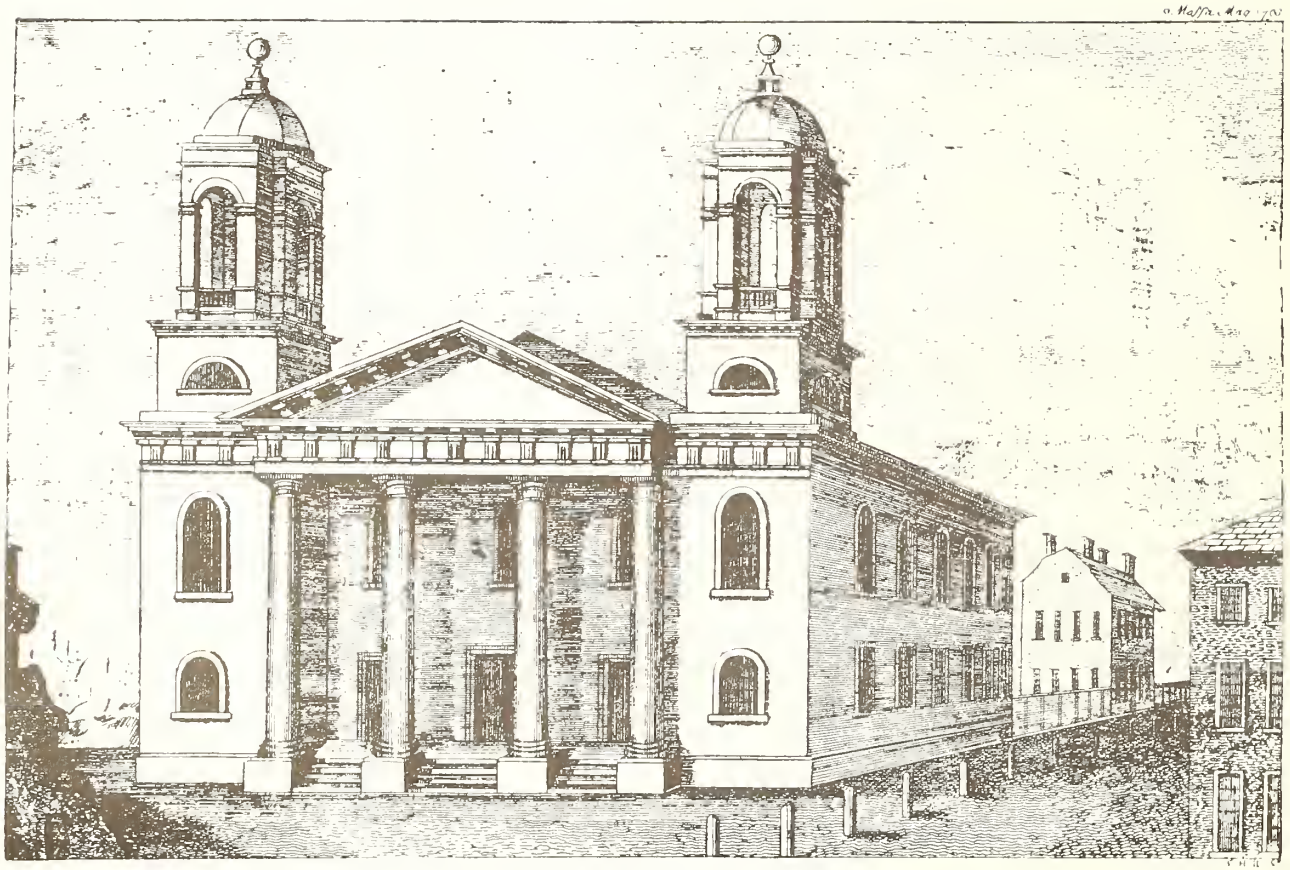

Hollis St. Church (built 1788: Charles Bulfinch, architect; demolished 1810), Boston, Mass., c. 1793.

Article 22

ARTICLE 22

REPAIR, ALTERATION, ADDITION, AND
CHANGE OF USE OF EXISTING BUILDINGS

SECTION 2200.0 SCOPE

2200.1 General: The provisions of this article are intended to maintain or increase public safety, health, and general welfare in existing buildings by permitting repair, alteration, addition, and/or change of use without requiring full compliance with the code for new construction except where otherwise specified in this article.

2200.2 Compliance: Repairs, alterations, additions, and changes of use shall conform to the requirements of this article. Where compliance with the provisions of this code for new construction, required by this article, is impractical because of structural or construction difficulties or regulatory conflicts, compliance alternatives as described in Section 2206.0 may be accepted by the building official.

Note: Specialized codes, rules, regulations, and laws pertaining to repair, alteration, addition, or change of use of existing buildings promulgated by various authorized agencies may impact upon the provisions of this article. Specialized state codes, rules, regulations, and laws include, but are not limited to those listed in Appendix P.

2200.3 Applicability: The provisions of this article apply to repair, alteration and/or addition to existing buildings which qualify to use this article (see Section 2200.3.1), based on the proposed continuation of or change in use group, as follows:

1. Continuation of the same use group, or a change in use group to a use group of an equal or lesser hazard index number (as listed in Table 2204) shall comply with Section 2203.0.
2. Change in use group to a use group of one (1) or greater hazard index number (as listed in Table 2204) shall comply with Section 2204.0.
3. Change in use group to a use group of two (2) or greater hazard index numbers (as listed in Table 2204) shall comply with the requirements of Section 2205.0 and the code for new construction.
4. Part change in use: If a portion of the building is changed to a new use group, and that portion is separated from the remainder of the building with vertical and horizontal fire separation assemblies complying with the fire grading required in Table 902, or with approved compliance alternatives, then the portion changed shall be made to conform to the provisions of this article.

   If a portion of the building is changed to a new use group, and that portion is not separated from the remainder of the building with vertical and horizontal fire separation assemblies complying with the fire grading required in Table 902, or with approved compliance alternatives, then the provisions of this article applying to each use shall apply to the entire building. If there are conflicting provisions, then those requirements which secure the greater public safety shall apply.
5. Additions: Additions to existing buildings shall comply with all code requirements for new construction. The combined height and area of the existing building and new addition shall not exceed that allowed by Table 305 and Sections 305.0 and 306.0. Where a fire wall complying with Section 907.0 is provided, the addition may be considered as a separate building.

   Exception: One story vertical additions to a dwelling unit shall be permitted providing that the floor area of the addition does not exceed that of the floor area immediately below. Such additions shall be of the same or better type of construction as the existing building.

   No addition shall impose loads which would cause the existing building to be subject to stresses exceeding those permitted by the code for new construction.
6. Ordinary repairs: Ordinary repairs conforming to Section 102.0 may be performed without a building permit.
7. Institutional use groups: When there is no change in occupancy within the institutional use group (I), the provisions of Section 2203.0 shall apply.

   Any change to an institutional use group (I) or any change in occupancy within an institutional use group shall comply with the requirements of the code for new construction.
8. Places of assembly: Nothing contained herein shall prohibit the alteration of a building heretofore occupied as a place of assembly for such continued use, provided that the seats, aisles, passageways, balconies, stages, appurtenant rooms, and all special permanent equipment comply with the provisions of Sections 417.0 and 418.0.

   All buildings changed to an assembly use group (A) or changed within the assembly use groups shall comply with the requirements of Section 417.0 and 418.0 and the applicable provisions of this article.
9. Historic buildings: Buildings which qualify as historic under Section 436.0 need only meet the provisions set forth in that section. The provisions of this article shall apply to historic buildings only when specifically cited in Section 436.0.

2200.3.1 Buildings which qualify: The provisions of this article shall apply to existing buildings which have been legally occupied and or used for a period of at least five (5) years. No building for which there exists an outstanding notice of violation or other order of the building official shall qualify to use this article unless such proposed work includes correction of all outstanding violations and compliance with all outstanding orders of the building official. Structures which fail to qualify for use of the provisions of this article shall comply fully with the code for new construction.

Article 22

2200.4 Hazardous exitways: The following exitway conditions shall be deemed to be hazardous when so cited by the building official. The owner of any building where such conditions are cited shall be required to correct such condition immediately:

1. Less than two (2) acceptable exitways serving every story.

   Exceptions: One- or two-family dwellings and buildings subject to Sections 417.0, 418.0, or 609.3.

2. Any required door, aisle, passageway, stairway, or other required means of egress which is not of sufficient width to comply with Section 608.0 or is not so arranged as to provide safe and adequate means of egress.

SECTION 2201.0 DEFINITIONS

2201.1 General: Definitions shall be construed as being the same as defined in Article 2, except as follows:

Building system: Any mechanical, structural, egress, electrical, plumbing, building enclosure and/or fire protection system, or fire resistive construction system, or portion thereof.

Existing building or structure: Any completed building or structure.

Hazard index: The rating of a use group for relative hazard as listed in Table 2204.

SECTION 2202.0 IMPLEMENTATION

2202.1 Investigation and evaluation: For any proposed work covered by this article, the building owner shall cause the existing building to be investigated and evaluated in accordance with the provisions of this Article (see Appendix T).

2202.2 Submittal: The results of the investigation and evaluation, along with any proposed compliance alternatives, shall be submitted to the building official.

2202.3 Determination of compliance: The building official shall determine whether the existing building, with the proposed work incorporated, complies with the provisions of this article.

2202.4 Permit application: In addition to the requirements specified in Article 1, the application for a building permit shall include items of non or partial compliance with the requirements of this article, and compliance alternatives, if any are proposed, for approval by the building official. The building official shall respond to the acceptability of any proposed compliance alternatives within thirty (30) days of the filing of the building permit application.

2202.5 Documentation of compliance alternatives: Whenever action is taken on any building permit application to repair, make alterations or additions or change the use or occupancy of an existing building, and when said application proposes the use of compliance alternatives, the building official shall ensure that one (1) copy of the proposed compliance alternatives, including applicable plans, test data, or other data for evaluation, be submitted to the Commission, along with a copy of the building permit application and the building official's decision regarding the proposed compliance alternatives.

SECTION 2203.0 REQUIREMENTS FOR CONTINUATION OF THE SAME USE GROUP OR CHANGE TO A USE GROUP OF EQUAL OR LESSER HAZARD INDEX

2203.1 General: The requirements of this section shall apply to all repairs and alterations to existing buildings having a continuation of the same use group or to existing buildings changed in use group to an equal or lesser hazard index number (Table 2204).

2203.2 Requirements exceeding those required for new construction: Existing buildings which, in part or as a whole, exceed the requirements of this code may, in the course of compliance with this article, reduce or remove, in part or completely, features not required by this code for new construction.

2203.3 New systems: Any new building system or portion thereof shall conform to this code for new construction to the fullest extent practical. However, individual components of an existing building system may be repaired or replaced without requiring that system to comply fully with the code for new construction.

2203.4 Alterations and repairs: Alterations or repairs to existing buildings which maintain or improve the performance of the building may be made with the same or like materials. Full compliance to the provisions of Section 2203.0 is not required unless there is a change in use.

2203.5 Floor loads: All floors shall be specifically investigated to determine the adequacy of the existing floor system to support the proposed specific floor loads, which shall not be less than those provided in Article 7 for the proposed use group. However, the loads specified in Article 7 may be reduced by a registered professional engineer based on the specific occupancy loads to be encountered, provided such reduction is approved by the building official.

2203.6 Structural loads: Any portion of the existing building which will not safely support the loads of the proposed use group as specified in Article 7 or Section 2203.5 shall be replaced or strengthened to provide such support.

2203.7 Number of exits: Any existing building shall provide at least two (2) means of egress serving every story which are acceptable to the building official.

Exception: One- and two-family dwellings and buildings as modified in Sections 417.0, 418.0 (places of assembly), or 609.3 (two-story business buildings).

2203.8 Capacity of exits: All required means of egress shall comply with Section 608.0. Existing means of egress may be used to contribute to the total egress capacity requirement based on the unit egress widths of Section 608.0.

2203.9 Exit signs and lights: Exit signs and lighting shall be provided in accordance with Section 623.0.

2203.10 Means of egress lighting: Means of egress oighting shall be provided in accordance with Section 624.0.

2203.11 Fire alarm systems: Fire alarm systems shall be provided in accordance with Sections 1216.0 and 1217.0.

2203.12 Enclosure of stairways: Open stairways are prohibited except in one- and two-family dwellings or unless otherwise permitted by Article 6. There shall be no minimum fireresistance rating required for an existing enclosure of a stairway. Partitions or other new construction which is added in order to fully and solidly enclose a stairway shall provide a minimim fireresistance rating of one (1) hour. All doors in the enclosure shall be self-closing and tight-fitting with approved hardware. All doors in those portions of the stairway which are fireresistance rated shall comply to the applicable portions of Article 9.

2203.13 Places of assembly: Nothing herein contained shall prohibit the alteration of a building heretofore occupied as a place of public assembly for such continued use provided the seats, aisles, passageways, balconies, stages, appurtenant rooms, and all special permanent equipment comply with the requirements of Sections 417.0 and 418.0.

All buildings changed to an assembly use group (A) or changed within the assembly use groups shall comply with the requirements of Sections 417.0 and 418.0 and the applicable provisions of this article.

2203.14 Fire hazard to adjacent buildings: Any proposed change to the occupancy of an existing building shall not increase the fire hazard to adjacent buildings. If the fire hazard to adjacent buildings is substantially increased, then the requirements of Table 214 for exterior walls shall apply.

2203.15 Increase in the number of dwelling units: In buildings classified in residential use groups (R), the number of dwelling units may be increased up to fifteen (15) per cent without full compliance to the provisions of Section 2203.9 through 2203.11 inclusive. If an increase of greater than fifteen (15) per cent in the number of dwelling units is involved, the building shall comply with the requirements of Section 2203.0. For the purposes of this section only, the base number of dwelling units, which shall be used to calculate percentages of all increases in numbers of dwelling units, shall be that number of dwelling units legally occupied on June 1, 1979.

Exception: Buildings classified in residential use groups (R) containing less than seven (7) dwelling units may be altered to add one (1) dwelling unit without requiring full compliance with the provisions of Section 2203.0.

2203.16 Institutional uses: When there is no change in use or occupancy within the institutional use group (I), the provisions of Section 2203.0 shall apply.

Any change to an institutional use group (I) or any change within an institutional use group shall comply with the requirements of the code for new construction.

SECTION 2204.0 REQUIREMENTS FOR CHANGE IN USE GROUP TO ONE HAZARD INDEX GREATER

2204.1 General: When the existing use group is changed to a new use group of one (1) hazard index higher (as provided in Table 2204), the existing building shall conform to the requirements of the code for new construction, except as further provided in this section.

2204.2 Mixed use: Compliance is required with Section 213.0 and Table 902 except that floors and walls providing horizontal and vertical separation in buildings of Types 3 and 4 construction shall have a fire-resistance rating of not less than one (1) hour and shall be equipped with a fire suppression system.

2204.3 Restrictions within fire limits: No further compliance is required with Section 302.0. However, if the fire hazard to adjacent buildings is substantially increased due to an increased fire loading, then the requirements of Section 302.0 shall apply.

2204.4 Area and height limitations: No further compliance is required with Sections 305.2 and 305.3 (e.g., a change in use is allowed in an existing building even if it exceeds the area and height limits of Table 305).

2004.5 Accessibility for physically handicapped: No further compliance is required with Section 315.1.

2204.6 Exitway stairs: Compliance is required with Section 616.0, except that existing exitway stairways may be used as part of the required egress for the new use, provided that the width is of sufficient capacity for the occupancy load, they are structurally sound, and that the enclosures in buildings of Types 3 and 4 construction shall have a fireresis-

tance rating of not less than one (1) hour. Stairway enclosures in buildings of Type 1 and 2 construction shall have a fire resistance rating of not less than two (2) hours. Where stair exitway doors are doors to an apartment or office they need not swing onto the landing. Such doors shall be self-closing and tight-fitting with approved hardware.

2204.7 Earthquake resistance and liquefaction: No further compliance to Sections 716.0 and 720.0 is required. Structural alterations may be made to existing buildings, but the resistance to lateral forces shall not be less than before such alterations were made, unless the building as altered meets the requirements of this code for earthquake loads.

2204.8 Mortar: No further compliance is required with Section 815.0.

2204.9 Fire and party walls: No further compliance is required with Section 907.0. The height above the roof of existing fire, party and exterior walls need not comply with this section.

Table 2205[1]
HAZARD INDEX

Scale: 1-8 (1 is lowest, 8 is highest hazard)

Use Group*	Description	Index No.**
A-1-A	Theatre with stage	6
A-1-B	Theatre without stage	5
A-2	Night club	7
A-3	Restaurant	5
	Lecture halls, recreation centers, museums, libraries, similar assembly buildings	4
A-4	Churches and schools	4
B	Business	2
F	Factory and industrial	3
H	High hazard	8
I-1	Institutional restrained	5
I-2	Institutional incapacitated	4
M	Mercantile	3
R-1	Hotels, motels	2
R-2	Multi-family	2
R-3	One and two family	2
S-1	Storage, moderate hazard	3
S-2	Storage, low hazard	1

[1] Table 1 of Appendix T shows a much more detailed listing of use group and related hazard index.

Notes to Table 2205:

*See Section 203.0 thru 212.0 and Appendix T.

**Hazard Index Modifier for selected construction types.

When a building is classified in Construction Type 1A, 1B, 2A, or 2B, subtract one (1) from the Hazard Index number shown in Table 2204 for the applicable proposed new use group only.

When a building is classified in construction Type 3C or 4B, add one (1) to the Index number shown in Table 2204 for the applicable proposed new use group only.

SECTION 2205.0 REQUIREMENT FOR CHANGE IN USE GROUP TO TWO OR MORE HAZARD INDICES GREATER

2205.1 General: When the existing use group is changed to a new use group of two (2) or more hazard indices higher (as provided in Table 2204), the existing building shall conform to the requirements of the code for new construction.

SECTION 2206.0 COMPLIANCE ALTERNATIVES

2206.1 General: Where compliance with the provisions of the code for new construction, required by this article, is impractical because of structural or construction difficulties or regulatory conflicts, compliance alternatives may be accepted by the building official.

Some compliance alternatives which have been used are provided in Appendix T. The building official may accept these compliance alternatives or others proposed.

2206.2 Documentation: In accordance with Section 2202.5, the building official shall ensure that the Commission is provided with information regarding compliance alternatives accepted or rejected by him.

SECTION 2207.0 ENERGY PROVISIONS FOR EXISTING BUILDINGS

2207.1 General: This section establishes the energy provisions for existing buildings governed by Section 2203.0. Existing buildings governed by Sections 2204.0, 2205.0, or by the code for new construction shall comply with the requirements of Article 20 for new construction.

2207.2 Compliance alternatives: Alterations to any of the building elements of an existing building must comply with Table 2207 on either a component basis; or an equivalent energy usage analysis basis; or a system analysis basis.

2207.2.1 Component basis: Alterations to any of the building elements (walls, windows, doors, roofs or mechanical systems) shall comply with Table 2207 and the applicable subsections of Article 20 for the altered elements only.

2207.2.2 Equivalent energy usage analysis: Alterations to any of the building envelope elements (walls, windows, doors, or roof) may be adjusted so that the energy losses of any element may be increased or decreased as long as the total does not exceed that which would have been calculated for the individual components.

2207.2.3 Systems analysis: Refer to Section 2013.0 of this code for design criteria for systems analysis.

2207.3 Exempt buildings: Refer to Section 2001.4 for thermally exempt buildings and Section 2015.0 for lighting exemptions.

2207.4 Compliance exceptions

2207.4.1 Fenestration: When alterations to a wall assembly include only altering the fenestration component, the areas of fenestration may be decreased or replaced with an opaque wall element made to comply with the thermal transmittance value of the existing wall.

2207.4.2 Ordinary repairs: Ordinary repairs need not comply with the energy provisions.

2207.4.3 Roofs: Compliance of the roof/ceiling assembly is not required unless the existing roofing material is stripped off the roof deck. However, if a structural analysis by a registered professional engineer shows that the roof will not support the additional live loads imposed by compliance of the roof/ceiling assembly, or, if such analysis shows that addition of the required amount of insulation will cause ponding of water, then compliance of the roof/ceiling assembly is not required.

TABLE 2207
COMPONENT VALUES FOR ALTERED ELEMENTS

Walls	All wall construction containing heated or mechanically cooled space	0.08	6, 8
Foundation Walls Including Band	Containing heated or mechanically cooled space	0.08	4
	Containing unheated space	0.17	
Roof/Ceiling Assembly	Wood plank and beam construction containing heated or mechanically cooled space	0.08	1
Roof/Ceiling Assembly	Construction other than wood plank and beam containing heated or mechanically cooled space	0.05	
Doors, Skylights and Windows	All construction enclosing heated or mechanically cooled space	0.65 0.65	2, 7 5 6
Floors	Floor sections over areas exposed to outside air or unheated areas	0.08	3
	Unheated slab on grade	5.50 (R)	
	Heated slab on grade	7.75 (R)	
Mechanical Equipment	Heating, cooling, sizing and efficiency	Sect. 2010.1 thru 2010.7	9
Equipment Controls	Humidstats, thermostats and zoning	Sect. 2010.8	9
Duct and Pipe Insulation and Construction	Located in unconditioned areas	Sect. 2010.9 2010.10, 2010.13	

APPENDIX T

REFERENCE DATA FOR REPAIR, ALTERATION, ADDITION AND CHANGE OF USE OF EXISTING BUILDINGS

PART ONE-GUIDELINES FOR APPLICATION

T-101.0 Purpose

T-101.1 Intent of Article 22: The purpose of this guideline is to provide guidance to users of the Massachusetts State Building Code as to techniques of acceptable practice which can be used to assess the acceptability of various methods of meeting the intent of the code provisions of Article 22 on a case-by-case basis. The purpose of the code provisions in Article 22 and this guideline is to allow repair, alteration, addition and change of use of existing buildings without requiring the entire building to be brought up to new construction requirements, while still providing for the public health, safety and general welfare. The provisions of Article 22 and this guideline recognize that the provisions of the Massachusetts State Building Code for new construction reflect the latest improvements in materials, construction techniques, standards of living and safety and, therefore, may preclude the repair, alteration, addition, or change of use of existing buildings that have demonstrated their usefulness and safety.

T-102.0 Scope

T-102.1 Techniques: This guideline is intended to demonstrate techniques of analysis and compliance with Article 22 of the Massachusetts State Building Code in the repair, alteration, addition, and change of use of existing buildings.

T-103.0 Statement of concept

T-103.1 General conditions: Conceptually, it is the intent of Article 22 and these guidelines to allow repair, alteration, addition, or change of use of existing buildings without meeting all new construction requirements under the following general conditions:

1. all hazardous conditions must be corrected;
2. the existing building becomes the minimum performance standard, and
3. the degree of compliance of the building after changes must not be below that existing before the changes, except that nothing in this section will require compliance with requirements more stringent than that required for new construction.

T-104.0 Implementation

T-104.1 Framework: Implementation of the above concept requires that a framework be established for evaluating the condition of the building; determining the potential for modification; and establishing the acceptability of proposed changes.

T-104.2 Evaluation of existing building: Evaluation of existing conditions in a structure is required to determine the existence of any hazardous conditions, which must be corrected; and to provide a basis for evaluating the impact of the proposed changes on the performance of the building.

The following list of evaluation tools described in Sections T-104.2.1 through T-104.2.7 of this appendix can be used for determining the condition of the structure. However, this list is not necessarily complete and the use of other methods should not be precluded.

T-104.2.1 Available documentation of existing building: Prime sources of design information for existing buildings are the architectural and engineering drawings and specifications used in the construction of the building. Although the passing of time often obscures the identifies of depositaries of such documents, the following are likely prospects in attempting to locate such information:

1. If the building is currently in use, an individual or office responsible for its management may have retained drawings and specifications to facilitate maintenance. A building manager, resident engineer, superintendant, custodian, stationary engineer or plant engineer may be the most direct contact at the building site.
2. Other potential sources (especially if the building is not in use) include the original designer-architect or engineer.
3. The building department which issued the permit for construction may have documentation.
4. Documentation may have been retained by the general contractor or numerous subcontractors. This presents the mason, carpenter, plumber, electrician, HVAC installer, steel erector, etc., as well as manufacturers of component parts, as potential sources of documentation.
5. In the case of large corporations or government agencies, a separate contracting officer may have developed a technical file on the erection of a building.
6. In some cases, individual consultants are contracted to serve as "clerk-of-the-works" and pursue the inspection of a building project from start to finish with the keeping of a file likely.
7. Insurance companies sometimes maintain drawings or records of their insured buildings.
8. Historical or archaeological societies may have considered a building to be important enough to develop a file of documentation.

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T-104.2.2 Field surveys: Having drawn upon available documentation to help evaluate a building's condition, such documentation may be augmented by on-site data acquired through field survey. The most obvious approach is to make use of detailed visual examination to confirm and/or alter any previously available information pertaining to the building.

T104.2.3 Testing: Testing is a tool that may be used in evaluating the condition of a building or structure or parts thereof when other methods of evaluation will not suffice. Testing may be initiated voluntarily on the part of the permit applicant or may be required by the building official in the absence of approved rules as indicated in Section 800.6 of the code. This section points out that ". . .the building official shall make or cause to be made the necessary tests and investigations, or he shall accept duly authenticated reports from recognized authoritative sources." The costs of all such tests are to be borne by the permit applicant and should, therefore, be required by the building official only when other methods of evaluation prove inadequate or insufficient. Such testing should be conducted by an approved testing agency under the supervision of a registered architect or engineer. The report of the tests shall be submitted to the building official and shall include the details of test procedures, references to any accepted test standards used, the results of the tests and any conclusions drawn from the test results.

T-104.2.4 Field tests: Both nondestructive and destructive test procedures can be applied to evaluate the condition of a building.

T-104.2.5 Nondestructive testing: This includes techniques where the structural integrity of the building is not affected, such as the following:

1. analyzing various portions of the building to determine dimensions, types and condition of materials, etc.;
2. portable apparatus for impact testing;
3. load application short of failure to determine capacity of materials and components;
4. magnetic methods for detecting flaws in ferrous metals;
5. proximity magnetometers (locating rebars in concrete, concealed ferrous fasteners, etc.);
6. electronic means for measuring the sonic modulus of elasticity of concrete and masonry in assessing its soundness;
7. ultrasonic transmission or reflective methods in detecting flaws in various materials; and
8. x-ray or infrared-ray photographic techniques used to evalute portions of elements whose integrity is questionable.

T-104.2.6 Destructive testing: In destructive testing a sample of the building could be removed and tested (e.g., concrete core), or components of the building could be reconstructed and tested in the laboratory.

T-104.2.7 Laboratory analysis: In some cases tests can be performed in the laboratory. Such tests might include the following:

1. chemical or metallurgical tests;
2. optical or electronic microscopic examination which can help identify and evaluate the soundness of materials where decay or other molecular degradation is involved;
3. conventional laboratory tests for determining physical properties (strength, ductility, absorption, solubility, permeability, stiffness, etc.; and/or
4. testing of a scale model of the building (computer model, wind tunnel model, etc.).

T-104.3 Evaluation of change in performance level: It is necessary to determine if the level of performance of the building after alteration is below that which existed before the change. The hazard level could be increased for certain attributes (such as fire safety) while decreased for other attributes (such as floor loads) for a given alteration. The evaluation of the change in hazard levels of each attribute can be accomplished using various tools singly or in combination as described below in Sections 104.3.1 through 104.3.5.

T-104.3.1 Data on archaic systems: Performance data on architectural and structural systems being encountered in existing buildings in the Commonwealth are tabulated in part four of this appendix. This data can be compared to the proposed altered systems to determine if the performance is being adversely affected.

T-104.3.2 Compliance alternatives: Alternate solutions tabulated in part two of this appendix were developed from appeal data and from accepted practice. The list is not all-inclusive and should not preclude consideration of other alternatives.

T-104.3.3 Analysis methods: Analytical methods based on good engineering practice may be used to determine changes in performance levels.

T-104.3.4 Test methods: Test procedures as discussed in Sections T-104.2.3 through T-104.2.6 of this appendix can be used to evaluate the performance of existing construction.

T-104.3.5 Professional judgment: Professional judgement based on previous experience with similar buildings should be used to the fullest extent possible.

PART TWO-SUGGESTED COMPLIANCE ALTERNATIVES

T-201.0 Purpose and scope

T-201.1 Purpose: The purpose of this reference is to assist the building official and those regulated by this code in judging the accepta-

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bility of compliance alternatives to specific code provisions required by the code.

T-201.2 Application: This reference contains generally acceptable compliance alternatives and examples. The examples are solely for the purpose of illustrating principles which can be applied to the solution of code compliance problems and are not necessarily acceptable under all circumstances. It is recognized that all building systems interact with each other. Therefore, any consideration of compliance alternatives must take into account all existing and proposed conditions to determine their acceptability. The principles applied can be used for the solution of similar compliance problems in other buildings and occupancy groups. Commentaries are provided where the philosophy in establishing the alternatives is not obvious. The examples were developed from appeal data and accepted practice. They are not all-inclusive and should not preclude consideration of other alternatives.

Note: It is anticipated that additional compliance alternatives will be added to this reference through the mechanism of appeal decisions and from results of research being conducted by various organizations in the field of relative performance of life safety systems.

T-202.0 Compliance alternatives for egress requirements

T-202.1 Number of exits

T-202.1.1 General compliance alternatives:

1. Provide connecting fire balconies.
2. Provide alternate egress facilities (windows, etc.).
3. Provide a fire escape.
4. Provide fire-rated areas of refuge.

T-202.1.2 Examples: Example 1 involves a five-story "row house" of occupancy group B without a fire suppression system and with only one (1) means of egress.

Solution A. Add one (1) or more fire escapes as may be necessary to provide all tenants with reasonable access to two (2) means of egress in separate directions. Access to a street, public way or area of refuge shall be provided at the termination of the fire escape.

Section B. Add connecting fire balconies across fire walls if the above solution is impractical due to construction difficulties.

Example 2 involves a building of group R-2 occupancy with an apartment in the basement. There is only one (1) means of egress from the basement.

Solution A. Provide egress windows in each apartment that comply with Section 609.4.

T-202.2 Travel distance

T-202.2.1 General compliance alternatives.

1. Add detection system.
2. Add a partial fire suppression system.
3. Add smoke doors.
4. Increase fireresistance rating of corridor walls and doors.

T-202.2.2 Example: This example involves a four (4) story building of occupancy group R-2 without a fire suppression system. The length of exitway access travel is one hundred fifty (150) feet.

Solution A. Add a partial fire suppression system off the domestic water supply (if adequate) in the exit access corridor.

Solution B. Subdivide corridor into segments of less than one hundred 100 feet with smoke doors.

Solution C. If not required by other sections of the code, install smoke and fire detectors with audible alarms in the corridor.

Solution D. Increase the fireresistance rating of the exit access corridor from one (1) hour to two (2) hours and provide one-half hour (1/2) hour "B" label self-closing or automatic closing fire doors in all openings into the corridor.

T-202.3 Enclosure of exitways

T-202.3.1 General Compliance alternatives

1. Improve enclosure of exitway.
2. Add a partial fire suppression system.
3. Add a detection system.

T-202.3.2 Examples: This example involves a four (4) story row building of occupancy group R-2 with connecting fire balconies and an interior stair. The stair is enclosed with wood lath and plaster on wood stud partitions and paneled doors.

Solution A. Cover partitions on the apartment side with 5/8" Type X gypsum wallboard or its equivalent. Replace or build up panel doors until minimum solid portion is one and three-eights (1 3/8") and install self-closers.

Solution B. Provide a heat and smoke detection system in the stairwell with an alarm audible to all tenants. Provide self-closers on all stairwell doors.

Solution C. Provide a partial fire suppression system in the stairwell off the domestic water supply (if adequate). Provide self-closers on all stairwell doors.

T-202.3.3 Commentary: The above example, while pertaining to a four (4) story group R-2 building, can also be applied to other buildings of various heights and occupancies. The principle that the degree of compliance may not be reduced should be remembered. If the existing enclo-

sure is of fireresistive construction, it must be maintained. The primary principle to remember, in the required enclosure of exitway, is that an enclosure must be provided, whether fireresistive or not, so as to provide a smoke barrier. The purpose of providing a smoke barrier is to prevent the passage of smoke from a fire on one (1) floor to the exitways and exit access corridors of other floors and thus render them unusable for for egress. This principle is illustrated by solutions A, B, and C in the above example.

T-203.0 Compliance alternatives for fire hazards

T-203.1 Fire separations and partitions

T-203.1.1 General compliance alternatives:

1. Improve fire separation.
2. Add a fire suppression system.
3. Add a detection system.

T-203.1.2 Examples: Example 1 involves a three (3) story Type 3A building, of occupancy group M, on the first floor and occupancy group B on the second and third floors. The required separation is three (3) hours.

Solution A. Add a fire suppression system to the first and second floors.

Solution B. Add five-eighths (5/8) inch Type X gypsum wallboard or its equivalent to the underside of the second floor and install a system of smoke and heat detectors with audible alarms on the first and second floors.

Example 2 involves the separation between two (2) tenants of wood lath and plaster on a wood studs partition. The required spearation is one (1) hour.

Solution A. Add five-eights (5/8) inch Type X gypsum wallboard or its equivalent to either side of the existing partition.

Example 3 involves a building of occupancy B with unrated exit access corridors.

Solution A. Install a partial fire suppression system in the exit access corridors.

Solution B. Add five-eighths (5/8) inch Type X gypsum wallboard or its equivalent to either side of the corridor partition and install self-closers on all corridor doors.

Solution C. Install a smoke and heat detection system in the corridor with an alarm audible to all tenants on the floor and install self-closers on all corridor doors.

T-203.2 Openings and exterior wall protection

T-203.2.1 General compliance alternatives:

1. Add fire suppression system.
2. Improve fireresistance.
3. Remove or improve openings.

T-203.2.2 Examples: Example 1 involves a two (2) story Type 4B building, of occupancy M, on the first floor with the basement and upper floors used for storage. The distance between the building and the side lot line is five (5) feet and between it and the adjacent building is ten (10) feet. The adjacent building is of Type 4B construction and of occupancy group R-2. The former occupant was a grocery store; the new occupant is a hardware store.

Solution A. Install a deluge sprinkler system along the interior side of the wall affected.

Solution B. Add five-eighths (5/8) inch Type X gypsum wallboard to interior side of the wall affected.

Example 2 is the same as example 1 but with double-hung wood windows in affected wall.

Solution A. Remove windows and close opening with one (1) hour fireresistive construction.

Solution B. Remove windows and install fire windows.

Solution C. Install a deluge sprinkler system as in solution A to example 1.

PART THREE-DETAILED CLASSIFICATION OF OCCUPANCY BY HAZARD INDEX NUMBER AND USE GROUP

This part provides a more detailed guide for users of the code to determine hazard index numbers and use groups for various types of occupancies. It supplements Article 2 and Table 2203 contained in Article 22.

Table T-1 (Not reproduced here)

PART FOUR-ARCHAIC CONSTRUCTION SYSTEMS

T-401.0 Purpose and Scope

T-401.1 Purpose: The purpose of this part of Appendix T is to assist the building official and those regulated by this code in evaluating the properties of archaic construction systems.

T-401.2 Scope: This part of Appendix T contains data on construction systems no longer in general use but which may be encountered in older existing buildings. It is meant to be used for assessing existing conditions when evaluating how proposed changes will impact upon the performance of the building.

T-401.3 Application: In any given problem, all available data should be collected and professional judgment exercised in arriving at decisions

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Evaluative judgment should be used when test data does not exist or when applying the data contained in this standard

T-402.0 Archaic fireresistive systems

T-402.1 General: This part of Appendix T contains a list of fireresistive materials and construction which are not necessarily currently in common use. Some of the hourly ratings contained in the listing predate ASTM E-119 that is in current use. The hourly ratings may be higher or lower if tested according to ASTM E-119. In addition to the data contained herein, see Report BMS92, Building Materials and Structures, dated October 7, 1942, National Bureau of Standards. The data listed below is extracted from the Boston Building Code, circa 1943.

T-402.2 Fireresistive materials and construction

T-402.2.1 Minimum qualities: Materials, to be given the fireresistive ratings specified in this part, shall have the following minimum qualities set forth in Sections T-402.2.2 through T-402.2.19.

T-402.2.2 Class 1 concrete: Concrete of Class 1 shall be so proportioned as to have a strength of at least fifteen hundred (1500) pounds per square inch (psi) and the coarse aggregate shall consist of limestone, trap rock, blast furnace slag, cinders containing not more than twenty (20) per cent of combustible material, burned clay or shale.

T-402.2.3 Class 2 concrete: Concrete of Class 2 shall be so proportioned as to have a strength of at least fifteen hundred (1500) pounds psi, the coarse aggregate consisting of sandstone, granite, quartzite, siliceous gravel or other similar material not over one (1) inch in size

T-402.2.4 Masonry: Masonry shall be laid in lime-cement or cement mortar, or approved masonry cement mortar, except that masonry of gypsum tile shall, and masonry of structural clay tile may, be laid in gypsum mortar Masonry shall be thoroughly bonded by breaking joints in successive courses or by the use of metal ties.

T-402.2.5 Brick: Brick shall be burned clay or shale, concrete or sand-lime brick of Grade C or better.

T-402.2.6 Stone: Stone shall be limestone, marble, slate or equally fireresistive natural stone. Sandstone, granite or other stone which, because of its crystalline structure or for other reason, is less fireresistive, shall not be considered fire protection for structural metal, but may be used in a masonry wall not less than twelve (12) inches thick required to have fireresistance. Stone masonry shall have the same fireresistive rating as brick masonry.

T-402.2.7 Cast stone: Cast stone masonry shall have the same fireresistive rating as brick masonry.

T-402.2.8 Concrete blocks: Concrete blocks, whether solid or hollow, shall have as coarse aggregate limestone, trap rock, blast furnace slag, cinders containing not more than twenty (20) per cent of combustible material, burned clay or shale.

T-402.2.9 Structural clay tile: Structural clay tile shall conform to the specifications for load-bearing tile, floor tile or partition tile. Where partition tile is specified, load-bearing tile may be used.

T-402.2.10 Gypsum: Gypsum tile or pre-cast gypsum concrete, whether solid or hollow, shall conform to Standard Specifications for Gypsum Partition Tile or Block of the American Society for Testing Materials and shall not contain more than three (3) per cent by weight of wood or other combustible binder or filler.

T-402.2.11 Gypsum concrete: Gypsum concrete shall not contain more than twelve and one-half (12 1/2) percent by weight of wood or other combustible binder or filler and shall have a compressive strength of at least five hundred (500) psi. It shall not be used where exposed to the elements.

T-402.2.12 Lath: Expanded metal or wire lath as a base or reinforcement for plastering shall weigh not less than two and two-tenths (2.2) pounds per square yard and shall have not less than two and one-half (2½) meshes per inch.

T-402.2.13 Metal mesh for masonry: Metal mesh reinforcement specified for masonry fire protection of structural metal shall consist of wire lath strips the full thickness of the masonry, laid in the beds thereof, or its approved equivalent.

T-402.2.14 Metal mesh for concrete: Metal mesh reinforcement specified for concrete fire protection of structural metal shall consist of wire mesh weighing not less than one and one-half (1½) pounds per square yard with wire spaced not over four (4) inches, or not less than No. 11 gauge steel wire spaced not over four (4) inches apart, or its approved equivalent.

T-402.2.15 Cement plaster: Cement plaster shall be proportioned of one (1) part Portland cement, and not more than two (2) parts of sand measured by volume dry and loose to which may be added lime putty or hydrated lime not exceeding fifteen (15) per cent of the cement.

T-402.2.16 Gypsum plaster: Gypsum plaster: Gypsum plaster, except where otherwise specified, may contain sand, not in excess of three (3) times the weight of the gypsum.

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T-402.2.17 Lime plaster: Lime plaster shall consist of a mixtu e of one (1) part lime, not over three (3) parts sand, and water.

T-402.2.18 Pneumatically projected mortar: Pneumatically projected mortar made of Portland cement, sand and water shall be rated for fire protection the same as Class 1 concrete.

T-402.2.19 Concrete fill: Concrete fill, where specified in this appendix in connection with hollow masonry units shall consist of Class 1 or Class 2 concrete poured in the hollow spaces of the units as they are laid.

T-402.2.20 Reinforced concrete: Portland cement concrete or gypsum concrete poured in place as fire protection for beams, trusses and other horizontal or inclined members of structural steel and pneumatically projected mortar applied to structural steel as fire protection shall be reinforced with metal mesh reinforcement. Concrete protection for vertical columns of structural metal shall have reinforcing consisting of No. 5 wire spaced not over eight (8) inches apart or its equivalent. Reinforcement shall be wrapped around the structural member and so arranged as to be completely embedded in the fire protection material and to ensure its integrity.

T-402.2.21 Reinforced plaster: Plaster used as fire protection or to resist the spread of fire shall be reinforced with metal lath, except plaster less than one (1) inch thick or masonry or concrete.

T-402.2.22 Replacement material: In the protection of structural metal including reinforcement, one-half (½) inch of cement or gypsum plaster may replace an equal thickness of poured concrete or pneumatically projected mortar as protective material; and one (1) inch of cement or gypsum plaster reinforced with metal lath may replace an equal thickness of poured concrete, pneumatically projected mortar or masonry protection.

T-402.2.23 Plaster: Where plaster is required without other specification, it shall consist of one-half (½) inch of cement or gypsum plaster, except that only gypsum plaster shall be used on gypsum masonry.

T-402.2.24 Thickness: In this appendix, except where otherwise specifically stated, the thickness given in a list of materials applies to the next following item only, and not to the total thickness where additional materials are specified.

T-402.2.25 Embedding limitations: Pipes, wires, conduits and ducts shall not be embedded in or placed behind the fire-protective materials required for the protection of structural steel or iron except as otherwise provided in this paragraph. Above fire-protective hung ceilings and within the enclosed space in buildings of Type 1 and Type 2 construction, within which, other than the enclosure, fire protection of steel is not required, pipes, wires, conduits and ducts may be placed, provided they are so arranged and so secured that they will not, either by expanding in the event of fire, or otherwise impair, the effectiveness of the enclosing protective materials. Electric conduits and wires and gas pipes may be embedded in concrete or masonry fire protection of structural steel where the protective material is reinforced with wire mesh, provided they shall have protective covering except over the tops of beams and girders, at least as thick as required for the steel.

T-402.2.26 Damage protection: In factories, garages, warehouses and other buildings in which the fire-protective covering required for steel or iron columns may be damaged by the movement of vehicles, materials or equipment, such covering shall be protected by metal or other material in a manner satisfactory to the building official.

T-402.2.27 Firestopping: Firestopping shall mean the stopping off or enclosure at the ends and wherever else specified of the spaces between studs of partitions, joists of floors and roofs and other similar spaces to prevent drafts of air and the communication of fire from one (1) such space to another. Fire-stopping shall consist of wood not less than one and one-half (1½) inches thick, of sheet metal not less than No. 24 gauge or of masonry, or a combination of such materials. Firestopping shall be tightly fitted in the space to be filled, about pipes, wires and ducts and, if cut or disturbed in the placement of pipes, wires and ducts, shall be repaired.

T-402.3 Fire protection of steel columns

T-402.3.1 Protective thickness: Structural steel columns required to have fire protection of a given rating shall be covered on all sides with protective material having not less than the thickness necessary for the required rating. Except where "no fill" is specified, re-entrant and other accessible spaces behind the specified outer protection shall be filled with concrete or brick masonry or the material of the outer protection.

T-402.3.2 Fireresistance rating: Materials shall be assumed to afford to steel columns fire protection of the rating indicated in the following Sections T-402.3.3 through T-402.3.6:

T-402.3.3 Four (4) hour rating:

1. Two (2) inches Class 1 concrete.
2. Three (3) inches Class 2 concrete, metal mesh reinforcement.
3. Three and one-half (3½) inches brick masonry.
4. Two (2) layers two (2) inch structural clay partition tile masonry, metal mesh in beds.
5. Two (2) inches structural clay partition tile masonry, concrete fill, metal mesh in beds, three-fourths (3/4) inch gypsum plaster.

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6. Four (4) inches structural clay partition tile masonry, concrete fill, metal mesh in beds, five-eighths (5/8) inch lime plaster.
7. Four (4) inches structural clay partition tile or concrete block masonry, concrete fill, plaster.
8. Three (3) inches hollow gypsum tile masonry and plaster
9. Two (2) inches gypsum concrete, metal mesh reinforcement.
10. Two (2) inches solid gypsum tile masonry and plaster.
11. Three (3) inches solid cinder concrete block masonry and plaster.
12. Four (4) inches hollow cinder concrete block masonry and plaster

T-402.3.4 Three (3) hour rating:

1. One and three-fourths (1 3/4) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete, metal mesh reinforcement.
3. Two (2) inches gypsum concrete.
4. Two (2) inches solid cinder concrete block masonry and plaster.
5. Two (2) inches structural clay partition tile masonry, concrete fill.
6. Four (4) inches structural clay partition tile masonry, concrete fill, metal mesh in beds, five-eighths (5/8) inch lime plaster.

T-402.3.5 Two (2) hour rating:

1. One and one-half (1½) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete, metal mesh reinforcement.
3. One (1) inch Class 1 or Class 2 concrete encased in standard weight steel or wrought iron pipe.
4. Two (2) inches structural clay partition tile masonry and plaster.
5. Two (2) layers plaster, each on metal lath, with three-fourths (3/4) inch air space between, two (2) inches total thickness.
6. Two (2) inches gypsum concrete.
7. Two (2) inches solid or three (3) inches hollow gypsum tile masonry.

T-402.3.6 One (1) hour rating:

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete with metal mesh reinforcement.
3. Two and one-fourth (2¼) inches brick masonry.
4. Two (2) inches structural clay partition tile or concrete block masonry.
5. One (1) inch cement or gypsum plaster on metal lath.

T-402.3.7 Thickness: The thickness of protection on the outer edges of lugs or brackets need not exceed one (1) inch.

T-402.4 Fire protection of cast iron columns

T-402.4.1 Protective thickness: Cast iron columns required to have fire protection of a given rating shall be covered on all sides with protective materials having not less than the thickness necessary for the required rating. Re-entrant spaces, if any, on the exterior of cast iron columns, and other accessible spaces behind the specified protection, shall be filled with Class 1 concrete or brick masonry or the material of the outer protection.

T-402.4.2 Fireresistance rating: Materials shall be assumed to afford to cast iron columns fire protection of the rating indicating in the following Sections T-402.4.3 through T-402.4.5:

T-402.4.3 Four (4) hour rating: Cast iron columns shall not be used where the protection of a four 4) hour rating is required.

T-402 4.4 Three (3) hour rating

1. Two (2) inches Class 2 concrete.
2. Three (3) inches Class 2 concrete, metal mesh reinforcement.
3. Two (2) inches structural clay partition tile or concrete block masonry conrete fill.
4. One and one-half (1½) inches cement or gypsum plaster on metal lath and metal furring to form one-half (½) inch air space.
5. One and one-half (1½) inches Class 1 concrete.
6. Two (2) inches Class 2 concrete with metal mesh reinforcement.

T-402.4.5 One (1) hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete with metal mesh reinforcement.
3. One (1) inch cement or gypsum plaster on metal lath.

T-402.5 Fire protection of steel in reinforced concrete columns

T-402.5.1 Protection thickness: The main steel reinforcement, including spiral reinforcement and ties larger than one-half (½) inch, in reinforced concrete columns required to have fire protection of a given rating shall be covered with concrete having not less than the thickness listed in this section for the rating indicating in the following Sections T-402 .5.2 through T-402.5.6:

T-402.5.2 Four (4) hour rating

1. One and one-half (1½) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete.

T-402.5.3 Three (3) hour rating: One and one-half (1½) inches Class 1 or Class 2 concrete.

T-402.5.4 Two (2) hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete.

T-402.5.5 One (1) hour rating: One (1) inch Class 1 or Class 2 concrete.

T-402.5.6 Ties less than one-half (½) inch: The thickness of protection on column ties not larger than one-half (½) inch may be one-half (½) inch thinner than that listed above.

T-402.6 Fire protection of steel beams, girders, and trusses

T-402.6.1 Protective thickness: Steel beams, girders and trusses or the members of trusses, required to have fire protection of a given rating, shall be covered on all sides with material having not less than the thickness necessary for the required rating.

T-402.6.2 Fireresistance rating: Materials shall be assumed to afford steel beams, girders and trusses, or the members thereof, fire protection of the rating indicated in the following Sections T-402.6.3 through T-402.6.6:

T-402.6.3 Four (4) hour rating

1. Two (2) inches Class 1 concrete.
2. Three (3) inches Class 2 concrete.
3. Three (3) inches structural clay partition tile or concrete block masonry and plaster.
4. Three (3) inches hollow gypsum tile masonry and plaster.
5. Two (2) inches gypsum concrete.
6. Two (2) inches solid gypsum tile masonry and plaster.

T-402.6.4 Three (3) hour rating

1. One and three-quarters (1 3/4) inches Class 1 concrete.
2. Two and one-half (2½) inches Class 2 concrete.
3. Two (2) inches gypsum concrete.
4. Two (2) inches structural clay partition tile, or concrete block masonry and plaster.
5. Two (2) inches solid, or three (3) inches hollow gypsum tile masonry.

T-402.6.5 Two (2) hour rating

1. One and one-half (1½) inches Class 2 concrete
2. Two (2) inches gypsum concrete.

T-402.6.6 One (1) hour rating

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete.
3. Seven-eighths (7/8) inch or cement or gypsum plaster on metal lath.

T-402.7 Fire protection of steel in reinforced concrete beams

T-402.7.1 Protective thickness: The main steel reinforcement including stirrups larger than one-half (½) inch, in reinforced concrete beams, girders and trusses, including the ribs of reinforced concrete ribbed floors or roofs where one (1) or both sides of the ribs, in addition to the soffit, are exposed to fire, required to have fire protection of a given rating, shall be covered on all sides with concrete having not less than the thickness listed in this section for the required rating. Where a reinforced concrete floor or roof has a flush ceiling formed with approved permanent masonry fillers between ribs, the reinforcement shall have the protection required for reinforcing steel of floors and roofs in Section T-402.8.

T-402.7.2 Four (4) hour rating:

1. One and one-half (1½) inches Class 1 concrete.
2. Two (2) inches Class 2 concrete.

T-402.7.3 Three (3) hour rating: One and one-half (1½) inches Class 1 or Class 2 concrete.

T-402.7.4 Two (2) hour rating:

1. One (1) inch Class 1 concrete.
2. One and one-half (1½) inches Class 2 concrete.

T-402.7.5 One (1) hour rating: One (1) inch Class 1 or Class 2 concrete.

T-402.7.6 Stirrups less than one-half (½) inch: The thickness of protection on stirrups not larger than one-half (½) inch may be less than that listed by not more than one-half (½) inch.

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T-402.8 Fire protection of steel reinforcing in floors and roofs.

T-402.8.1 Protection thickness: The steel reinforcement in reinforced concrete floors and roofs with flush or plane ceilings, such that the exposure to fire is on the soffit only, required to have fire protection of a given rating, shall be covered with concrete having not less than the thickness listed in this section for the required rating. In floors or roofs having reinforced concrete ribs where the concrete surrounding the steel reinforcement is exposed to fire on one (1) or both sides in addition to the soffit, such reinforcement shall have the protection specified in Section T-402.7 for steel in reinforced concrete beams.

T-402.8.2 Four (4) hour rating:

1. One (1) inch Class 1 concrete.
2. One and one-fourth (1¼) inches Class 2 concrete.

T-402.8.3 Three (3) hour rating: One (1) inch Class 1 or Class 2 concrete.

T-402.8.4 Two (2) hour rating:

1. Three-fourths (3/4) inch Class 1 concrete.
2. One (1) inch Class 2 concrete.

T-402.8.5 One (1) hour rating: Three-fourths (3/4) inch Class 1 or Class 2 concrete.

T-402.9 Fireresistive floor and roof construction

T-402.9.1 Protective thickness: Floors and roofs required to have resistance of a given rating to the spread of fire shall have such thickness of the materials of which it is constructed, as shall be necessary for the required rating, and structural metal forming a part of such floors or roofs shall have protection against fire of such required rating. Floors and roofs required to have two (2) hour or longer resistance to fire shall be constructed of noncombustible materials. Granolithic, burned clay tile, ceramic tile or other similar incombustible floor finish of a given thickness may be substituted for an equal thickness, and sand, cinder or other incombustible filling material, with or without embedded wooden screeds, may be substituted for two-thirds (2/3) its thickness, of the floor or roof construction material specified in this section, provided that such floors and roofs shall have adequate thickness for structural purposes.

T-402.9.2 Fireresistance rating: Floor or roof construction shall be assumed to afford resistance to the spread of fire of the rating indicated in the following Sections T-402.9.3 through T-402.9.6:

T-402.9.3 Four (4) hour rating

1. Four (4) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Four (4) inches solid masonry arches or slabs.
3. Four (4) inches structural clay floor tile masonry arches or slabs with top covering of not less than two (2) inches of solid masonry or reinforced concrete.
4. Five (5) inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one and one-half (1½) inches of concrete topping, but if structural clay partition tiles are used for fillers, they shall be plastered on the soffit.

T-402.9.4 Three (3) hour rating

1. Three (3) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Three (3) inches solid masonry arches or slabs.
3. Four (4) inches structural clay floor tile masonry, arches or slabs with top covering of not less than one and one-half (1½) inches of solid masonry or reinforced concrete.
4. Four (4) inches combination reinforced Portland cement concrete slab consisting of permanent fillers of concrete block, gypsum or structural clay tile and one (1) inch concrete topping; but if structural clay partition tiles are used for fillers, they shall be plastered on the soffit.

T-402.9.5 Two (2) hour rating

1. Two and one-half (2½) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Two and one-half (2½) inches solid masonry arches or slabs.
3. Three (3) inches structural clay floor tile masonry, arches or slabs with top covering of not less than one (1) inch of solid masonry or reinforced concrete.

T-402.9.6 One (1) hour rating

1. Three (3) inches structural clay floor tile masonry, arches or slabs with all joints thoroughly filled with cement or gypsum mortar.
2. Wood floor or roof construction with joists not less than one and five-eighths (1 5/8) inches in least dimension, firestopped, double board floor, approved asbestos felt between layers of boards, and with a ceiling of at least three-quarters (3/4) inch cement or gypsum plaster on metal lath.
3. Steel beams or steel joists not more than thirty-six (36) inches apart on centers with noncombustible floor and a ceiling of at least three-quarters (3/4) inch cement or gypsum plaster on metal lath metal furring.

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T-402.10 Fireresistive ceiling construction

T-402.10.1 Protective thickness: Ceilings required to afford fire protection of a given rating to the floor or roof framing under which it is supported shall be of fireresistive materials of at least the thickness necessary for the given rating. A fireresistive ceiling and all hangers and fastenings necessary for its support to the protected framing shall be of noncombustible materials. It shall be capable of sustaining its own weight without exceeding allowable stresses. Metal reinforcement in such a ceiling shall be protected from fire as specified in Section T-402.8 for reinforcing in a floor.

T-402.10.2 Fireresistance rating: Ceiling construction shall be assumed to afford to floor or roof framing fire protection of the rating indicated in the following Sections T-402.10.3 through T-402.10.6.

T-402.10.3 Four (4) hour rating

1. Two and one-half (2½) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Two (2) inches precast reinforced gypsum concrete, plastered.

T-402.10.4 Three (3) hour rating

1. Two (2) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.
2. Two (2) inches precast reinforced gypsum concrete, lapped or rabbeted joints.

T-402.10.5 Two (2) hour rating: One and one-half (1½) inches solid slab of reinforced Portland cement concrete or reinforced precast gypsum concrete.

T-402.10.6 One (1) hour rating: Three quarter (3/4) inch cement or gypsum plaster on metal lath.

T-402.11 Fireresistive bearing walls and partitions

T-402.11.1 Protective thickness: Bearing walls and partitions required to have resistance to fire or the spread of fire of a given rating shall be constructed of fireresistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two (2) hour or longer rating shall be of noncombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in Section T-402.9 for floors.

T-402.11.2 Fireresistance rating: Bearing walls and partitions shall be assumed to have resistance to fire and the spread of fire of the rating indicated in the following Sections T-402.11.3 through T-402.11.6:

T-402.11.3 Four (4) hour rating:

1. Eight (8) inches solid brick masonry.
2. Twelve (12) inches hollow wall of brick masonry, minimum eight (8) inch masonry thickness.
3. Twelve (12) inches structural clay load-bearing tile masonry with two (2) units and not less than three (3) cells in the thickness of the wall.
4. Eight (8) inches structural clay load-bearing tile masonry with one (1) unit and not less than two (2) cells in the thickness of the wall, plastered both sides.
5. Twelve (12) inches concrete block masonry with one (1) unit and not less than two (2) cells in the thickness of the wall.
6. Eight (8) inches one (1) piece concrete block masonry with shells and webs at least one and one-half (1½) inches thick, plastered both sides.
7. Twelve (12) inches total thickness of brick masonry facing bonded to structural clay load-bearing tile masonry backing.
8. Eight (8) inches solid concrete.
9. Six (6) inches solid reinforced concrete.
10. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of four (4) hour rating, with panel filling as specified in Section T-402.12 for a nonbearing wall of four (4) hour rating.

T-402.11.4 Three (3) hour rating.

1. Eight (8) inches structural clay load-bearing tile masonry with two (2) units and not less than four (4) cells in the thickness of the wall.
2. Twelve (12) inches structural clay load-bearing tile masonry with one (1) unit and not less than three (3) cells in the thickness of the wall.
3. Eight (8) inches one (1) piece concrete block masonry with shells and webs not less than one and one-half (1½) inches thick, plastered both sides.
4. Eight (8) inches one (1) piece concrete block masonry with shells and webs not less than two (2) inches thick.
5. Five (5) inches solid reinforced concrete.
6. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of three (3) hour rating, with panel filling as specified in Section T-402.12 for a nonbearing wall of three (3 hour rating.

T-402.11.5 Two (2) hour rating:

1. Eight (8) inches structural clay load-bearing tile masonry with not less than three (3) cells in the thickness of the wall.
2. Eight (8) inches concrete block masonry with shells and webs not less than one and one-half (1½) inches thick.

3. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of two (2) hour rating, with panel filling as specified in Section T-402.12 for a nonbearing wall of two (2) hour rating.

T-402.11.6 One (1) hour rating:

1. A steel or wooden stud bearing wall covered on both sides with one (1) inch cement or gypsum plaster on metal lath, firestopped if of wood
2. A steel or reinforced concrete frame bearing wall in which the steel has fire protection of one (1) hour rating, with panel filling as specified in Section T-402.12 for a nonbearing wall of one (1) hour rating.

T-402.12 Fireresistive nonbearing walls and partitions

T-402.12.1 Protective thickness: Nonbearing walls and partitions required to have resistance to fire and the spread of fire of a given rating shall be constructed of fireresistive materials and shall have at least the thickness necessary for the required rating. Walls required to have two (2) hour or longer rating shall be of incombustible materials. Steel reinforcement in reinforced concrete walls shall have the same protection for the given rating as is required in Section T-402.8.

T-402.12.2 Fireresistance rating: Nonbearing walls and partitions shall be assumed to have resistance to fire and the spread of fire of the rating indicated in the following Sections T-402.12.3 through T-402.12.6:

T-402.12.3 Four (4) hour rating:

1. Eight (8) inches solid brick masonry.
2. Three and one-half (3½) inches solid brick masonry, plastered both sides.
3. Six (6) inches structural clay load-bearing tile, plastered both sides.
4. Six (6) inches solid concrete.
5. Four (4) inches solid reinforced concrete.
6. Any wall which, as a bearing wall, has a three (3) hour or four (4) hour rating in Section T-402.11, except the steel or reinforced concrete frame bearing wall.

T-402.12.4 Three (3) hour rating:

1. Three and one-half (3½) inches solid brick masonry.
2. Four (4) inches structural clay load-bearing tile, plastered both sides.
3. Four (4) inches solid concrete.
4. Three (3) inches reinforced concrete.
5. Any wall which, as a bearing wall, has a two (2) hour rating in Section T-402.11 except the steel or reinforced concrete frame bearing wall.

T-402.12.5 Two (2) hour rating:

1. Three (3) inches gypsum tile masonry plastered both sides except in exterior walls
2. Eight (8) inches structural clay partition tile masonry, plastered both sides.
3. Eight (8) inches structural clay load-bearing tile, with three (3) cells in the thickness of the wall.
4. Four (4) inches concrete block plastered both sides.
5. Two (2) inches solid neat, fibered, gypsum plaster on metal lath and noncombustible studding.

T-402.12.6 One (1) hour rating:

1. Three (3) inches gypsum tile masonry.
2. Two (2) inches solid gypsum tile masonry plastered both sides
3. Three (3) inches structural clay partition tile plastered both sides.
4. Two and one-half (2½) inches solid cement or sanded gypsum plaster on metal lath and noncombustible studding.
5. Three (3) inches total thickness of hollow wall, three-quarter (3/4) inch cement or gypsum plaster on metal lath and noncombustible studding.
6. Three (3) inches total thickness of hollow wall, three-quarter (3/4) inch cement or gypsum plaster on metal lath and wooden studding, firestopped.

T-402.13 Fireresistive doors

T-402.13.1 General: Doors which are required to be fire doors, fireresistive doors, or of fireresistive construction shall conform to the requirements of this section and Section T-402.14.

T-402.13.2 Classification: Fire doors shall be classified for the purposes of this code as Class A, Class B, and Class C.

T-402.13.3 Class A fire doors: Class A fire doors shall be doors of the following construction and as specified in Section T-402.14:

1. Tin-clad, three (3) ply wood core, sliding.
2. Tin-clad, three (3) ply wood core, swinging single leaf, doorway not over six (6) feet wide.
3. Tin-clad, three (3) ply wood core, swinging in pairs, doorway not over (4) feet wide.

4. Hollow metal, swinging single leaf, doorway not over four (4) feet wide.
5. Hollow metal, swinging in pairs, doorway not over eight (8) feet wide.
6. Sheet metal, sliding, single, doorway not over ten (10) feet wide.
7. Sheet metal, sliding in pairs, doorway not over twelve (12) feet wide.
8. Sheet metal, swinging single leaf, doorway not over six (6) feet wide.
9. Sheet metal, swinging in pairs, doorway not over ten (10) feet wide.
10. Steel rolling doorway not over twelve (12) feet wide.
11. Steel plate, doorway not over four (4) feet wide.
12. Any other construction equal or superior to a tin-clad three (3) ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

T-402.13.4 Class B fire doors: Class B fire doors shall be doors of the following construction and as specified in Section T-402.14:

1. Tin-clad, three (3) ply wood core.
2. Tin-clad, two (2) ply wood core, sliding, doorway not over ten (10) feet wide.
3. Tin-clad, two (2) ply wood core, swinging single leaf, doorway not over six (6) feet wide.
4. Tin-clad, two (2) ply wood core, swinging in pairs, doorway not over ten (10) feet wide.
5. Hollow metal, sliding, doorway not over eight (8) feet wide.
6. Metal-clad, paneled, swinging single leaf, doorway not over three (3) feet wide.
7. Metal-clad, paneled, swinging in pairs, doorway not over six (6) feet wide.
8. Any other construction equal or superior to a tin-clad two (2) ply wood core door in a standard fire test, for resistance to fire, the spread of fire and smoke, and transmission of heat.

T-402.13.5 Class C fire doors: Class C Fire doors shall be doors of the following construction and as specified in Section T-402.14:

1. Metal-clad, paneled, swinging single leaf, doorway not over four (4) feet wide.
2. Metal-clad, paneled, swinging in pairs, doorway not over eight (8) feet wide.

T-402.13.6 Substitution: A Class A door may be used where Class B or Class C is specified; a Class B door may be used where Class C is specified. Two (2) Class B or Class C doors on opposite sides of the wall may be used where a single Class A or Class B door is specified.

T-402.13.7 Overlap: Fireresistive doors, when closed, shall completely cover the doorways in the walls and partitions or the openings in the floors or roofs to which they are fitted. A swinging fire door shall either overlap both jambs and the head of the opening not less than four (4) inches or be fitted to a fireresistive frame with a rabbet the full thickness of the door and with not less than one half (½) inch overlap on the door. A sliding fire door, except in enclosures about passenger elevators, shall overlap both jambs and the head of the opening not less than four (4) inches. A sliding fire door in an enclosure about a passenger elevator shall overlap jambs, head and adjoining panels not less than one half (½) inch. Fire doors shall fit closely at the floor with clearance of not over one quarter (¼) inch.

T-402.13.8 Thresholds: In buildings with combustible floors, doorways required to have fire doors shall have noncombustible thresholds the full thickness of the wall, extending at least four (4) inches from the face of the wall where a door is hung and extending laterally at least six (6) inches behind each jamb of the doorway. Thresholds may be flush with the floor.

T-402.13.9 Rabbeted frame: The rabbeted frame of a swinging fire door shall be constructed of structural steel built into the concrete, masonry or other fireresistive material of the wall about the opening and secured thereto, except that the rabbeted frame of a Class B or C door may be of wood, covered with sheet metal not less than No. 26 gauge in thickness, secured to the wall in the opening.

T-402.13.10 Fit: Fire doors when closed shall fit tightly against the wall or frame so as to provide an effective stop for fire and smoke. Except for the metal-covered wooden frame specified in this section, combustible material shall not intervene between the door and the fireresistive material of the wall, floor or roof to which it is fitted.

T-402.13.11 Hardware: Hinge hardware for fire doors shall be of malleable iron or rolled structural steel not less than one quarter (¼) inch thick except that tubular steel track for sliding doors may be not less than one eighth (1/8) inch thick. Equivalent thickness of solid bronze or brass may be used. Fire doors shall not depend upon cords, cables or chains to support them in closed position except in elevator shafts.

T-402.13.12 Tracks: Tracks for sliding fire doors shall be so supported that a track hanger comes at each door hanger when the door is closed. Track hangers shall be secured to wood stud walls by screws or bolts, to steel stud walls by bolts or rivets, to masonry walls by through bolts and to concrete walls by through bolts or approved built-in inserts. Expansion shields shall not be used to support fire doors.

T-402.13.13 Hinges: Hinges for swinging fire doors, except in wooden stud walls, shall be riveted or through-bolted to the structural steel frame of the opening, through-bolted to the wall if of masonry or con-

crete or secured by approved inserts in the concrete or built into masonry in an approved manner.

T-402.13.14 Strap hinges: Strap hinges and sliding door hangers shall be secured to fire doors by through-bolting, riveting or welding. Swinging fire doors in rabbeted frames, except tin-clad, wood core doors, may be hung on butts. Other swinging fire doors shall have strap hinges.

T-402.13.15 Straps, locks and latches: Sliding fire doors shall have adequate stops for the closed position. Swinging Class A fire doors shall have surface latches or unit locks. Class B and C doors shall have surface latches, unit or mortise locks. The latch bolts of unit or mortise locks on fire doors shall have a throw of three quarters (3/4) inch. When mounted in pairs, fire doors shall be rabbeted by means of an astragal or otherwise where they come together. One of a pair of swinging fire doors shall have push bolts at top and bottom with a throw of three quarters (3/4) inch and the other shall be held by latch to the first.

T-402.13.16 Opening hardware: Except in detention buildings, fire doors hung in required exits shall be so fitted with hardware that they can be opened from inside without use of a key when the building is occupied.

T-402.14 Fire door construction

T-402.14.1 Fastening: In the construction of fire doors, solder shall not be used except for filling joints. Sheet metal shall be fastened to wood by nailing and to metal frame by bolting, riveting or welding.

T-402.14.2 Glass: Class A doors shall not have glass panels. Class B doors may have glass panels not larger than one hundred (100) square inches in exposed area nor more than twelve (12) inches in width or height. Class C doors may have glass panels not larger than two thousand and sixteen (2,016) square inches in total exposed area, and any single light shall not have an exposed area exceeding twelve hundred and ninety-six (1,296) square inches. Glass in fire doors shall be wire glass not less than one quarter (¼) inch thick and shall be set five eighths (5/8) inch in grooves three quarters (3/4) of an inch deep.

T-402.14.4 Tin-clay, two (2) ply: In-clad, two (2) ply wood core doors shall be constructed in accordance with the specifications of the National Board of Fire Underwriters for such doors in Class B openings and shall bear the label of the Underwriters' Laboratories to this effect.

T-402.14.5 Hollow metals: Hollow metal doors shall have substantial stiles and rails of heavy pressed steel, reinforced for hinges and other hardware. Panels shall be of sheet filled with asbestos board or other approved insulating materials. The door shall be assembled by welding or riveting.

T-402.14.6 Sheet metals: Sheet metal doors shall be constructed with a rolled steel rigid frame covered both sides with one sixteenth (1/16) inch asbestos board and No. 26 gauge corrugated sheet metal, with corrugations vertical on one (1) side and horizontal on the other, bound on the edges with rolled steel or pressed steel shapes.

T-402.14.7 Steel rolling: A steel rolling fire door shall be constructed of sheet steel interlocking slats, sliding in grooves, counterweighted by springs, with the roller and mechanism enclosed in heavy sheet metal.

T-402.14.8 Steel plate: A steel plate fire door shall be constructed of not less than No. 12 gauge steel plate mounted on a rolled steel frame, assembled by welding or riveting.

T-402.14.9 Metal clad: A metal clad, paneled fire door shall have a wood core with stiles and rails not less than one and three quarters (1 3/4) inches thick covered with No. 26 gauge sheet steel; panels three quarters (3/4) inch thick covered with No. 26 gauge sheet steel, set three quarters (3/4) inch in grooves; joints of metal lapped and well nailed.

T-402.14.10 Class A label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class A opening shall be acceptable as a Class A door.

T-402.14.11 Class B label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class B opening shall be acceptable as a Class B door, except that metal clad doors wider than three (3) feet shall not be accepted as Class B doors.

T-402.14.12 Class C label: A door properly bearing the Underwriters' label certifying that it is suitable for the protection of a Class C opening shall be acceptable as a Class C door.

T-402.15 Fireresistive shutters: Shutters required to be fire shutters or fireresistive shutters shall be constructed and hung as specified for Class B fireresistive doors in Sections T-402.13 and T-402.14.

T-402.16 Fireresistive windows

T-402.16.1 General: Windows which are required to be fire windows, fireresistive windows, or of fireresistive construction shall conform to the requirements of this section.

T-402.16.2 Moveable: Fireresistive windows may be fixed or arranged to open and close. Fixed fireresistive windows shall be so secured in the walls in which they are placed that they may expand in case of fire without buckling. Moveable fireresistive windows shall be opened or closed in one (1) of the following manners:

1. One (1) or more sashes may slide horizontally in a fireresistive frame.
2. One (1) or more sashes may slide vertically with counterweights or with two (2) sashes counterbalanced and hung on chains. If a sash is closed in raised position, it shall have a fastening.
3. A sash may be hinged at top, bottom, or either side.
4. A sash may be pivoted at top and bottom or at the sides.
5. A sash may be arranged to open and close in any other approved manner, with approved hardware.

T-402.16.3 Sash: Moveable sashes in fireresistive windows shall be fitted to fireresistive frames of the same or similar construction. Both sashes and frames, and metal mullions between window units, shall be so fitted in the walls in which they are placed as to be continuous with the fireresistive material of the wall and so secured that they may expand in case of fire without buckling.

T-402.16.4 Glass: Glass in fireresistive windows shall be wired glass not less than one quarter (¼) inch thick and the area of a single light shall not exceed seven hundred and twenty (720) square inches. Glass shall be set three eighths (3/8) inch in grooves at least one half (½) inch deep. Glass shall be secured by glazing angles or moldings screwed to the sash and forming continuous grooves for the glass.

T-402.16.5 Construction: Fireresistive windows shall be of the following construction:

1. Hollow sheet metal sashes and frames fabricated by pressing, welding, riveting or crimping without the use of solder or other fusible alloy, except for filling joints, and bearing the label of Underwriters' Laboratories.
2. Rolled steel or pressed steel sashes fabricated by pressing, welding, riveting or crimping, of a make and style approved by the commissioner.
3. Any other approved constructions as fireresistive as that specified in item 1 above.

T-402.16.6 Hollow sheet metal: Fired fireresistive windows of hollow sheet metal construction shall not exceed seven (7) feet in width nor ten (10) feet in height. Fireresistive windows of hollow sheet metal construction with moveable sashes shall not exceed six (6) feet in width nor ten (10) feet in height.

T-402.16.7 Rolled steel: Fireresistive windows of rolled steel construction shall not exceed eighty-four (84) square feet in area nor twelve (12) feet in either height or width.

T-402.16.8 Wind pressure: Fireresistive windows and their fastenings shall be capable of resisting the wind pressure on the wall of the building applied either on the inside or the outside of the window without exceeding allowable stresses.

T-402.16.9 Substitution: Where fireresistive windows are required, wooden windows and plain glass may be substituted provided the openings are protected by fireresistive doors or shutters, or, in buildings of approved occupancy and construction, by an approved system of open sprinklers.

T-402.17 Fireresistive roof covering

T-402.17.1 Classification: Roof covering allowed under this code shall be classified as fire-retardant or ordinary, according to resistance to fire outside, as provided in this section. Fire-retardant roof covering is the more fireresistive and may be used on any building. Ordinary roof covering shall not be used where fire-retardant roofing is specified. Roof covering less fireresistive than ordinary roof covering shall not be used on any building.

T-402.17.2 Fire-retardant roofing: Fire-retardant roofing shall be any roof covering that meets the requirements of Class A or Class B roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for fire-retardant roofing:

1. Built-up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asphalt in which, while molten, is embedded a continuous layer of roofing gravel or slag.
2. Built-up roofing consisting of successive layers of roofing felt impregnated with coal tar; a final layer of tar in which, while molten, is embedded a continuous layer of roofing gravel or slag.
3. Built-up roofing consisting of successive layers of roofing felt impregnated with asphalt; a final layer of asbestos roofing felt impregnated with asphalt weighing not less than fourteen (14) pounds per hundred (100) square feet, or a final layer of asphalt-saturated prepared roofing coated with granulated slate or other similar material.
4. Built-up roofing consisting of successive layers of roofing felt impregnated with tar or asphalt and a finish of burned clay floor tile, stone flagging, cement concrete or other similar material.
5. Sheet metal with locked and soldered joints not less than No. 26 gauge in thickness.
6. Shingles of natural slate.
7. Shingles of burned clay tile.
8. Shingles of sheet metal not less than No. 26 gauge in thickness.
9. Shingles of asbestos board not less than one-eighth (1/8) inch thick.
10. Shingles of asphalt saturated felt surfaced with granulated slate or other similar material and carrying the Underwriters Class "C" label.

11. Corrugated sheet metal with lapped joints not less than No. 26 gauge in thickness.

12. Corrugated asbestos board not less than three-sixteenths (3/16) inch thick.

T-402.17.3 Ordinary roofing: Ordinary roofing shall be of any roof covering which meets the requirements of Class C roofing under the specifications of the Underwriters' Laboratories, Inc. The following roof covering shall be assumed to meet the requirements for ordinary roofing:

1. Built-up roofing consisting of successive layers of roofing felt impregnated with asphalt, coal tar or other approved material, not equal in fireresistance to a fire-retardant roofing.
2. Prepared roofing consisting of felt or fabric impregnated or coated, or both, with asphalt, tar or other approved material or shingles of such prepared roofing, not equal in fireresistance to fire-retardant roofing.
3. Canvas stretched tightly and coated with paint.

T-402.17.4 Means of securing: Built-up roofing shall be secured to the roof deck in the following manner:

1. Over masonry slab, the first layer shall be laid in molten asphalt or tar mopped on the roof deck, after the deck is properly primed, or by nailing a layer of building paper to nailing inserts other than wood placed in the deck.
2. Over wood decks, the built-up roofing shall be secured by nailing a layer of building paper to the roof deck over which the prepared roofing is to be laid with the first layer laid in molten asphalt or tar.
3. Roofings other than built-up roofings, such as shingles, slates, and tile roll roofing shall be well secured to the deck by nailing, bolting, wiring, or other approved methods.

SI UNITS AND THEIR EQUIVALENT
VALUES IN CUSTOMARY UNITS

International SI (unit)	Customary Unit	Approximate Conversion
meter (m)	foot (ft)	1 m = 3.2804 ft
millimeter (mm)	inch (in)	1 mm = 0.0394 in
square meter (m^2)	square foot (ft^2)	1 m^2 = 10.764 ft^2
kilopascal (kPa)	pounds per square inch (lb/in^2)	1 kPa = 0.1450 lb/in^2
square millimeter (mm^2)	square inch (in^2)	1 mm^2 = 1.5500 x 10^{-3} in^2

✪U.S. GOVERNMENT PRINTING OFFICE: 1981-340-997/1842

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington DC 20234

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