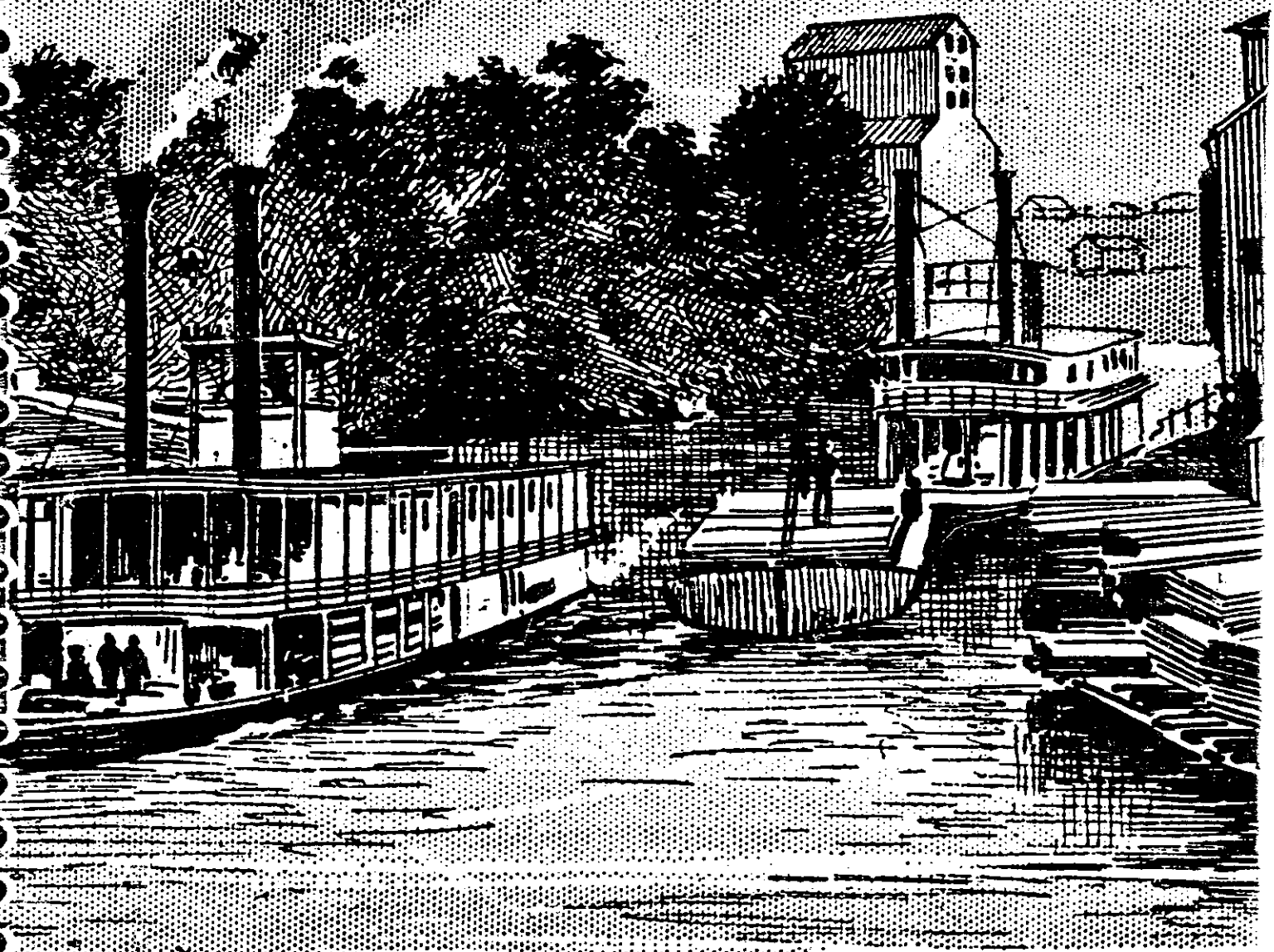
FLOOD PROOFING CODE

OF THE CITY OF

FARGO, NORTH DAKOTA



PREPARED BY:

MOORE ENGINEERING, INC.

Revised: December 9, 1975

FLOOD PROOFING
CODE

OF THE

CITY OF FARGO

December 10, 1974

Revised December 9, 1975

TO ORDER FIRM(S) 1.800.333.1363

MOORE ENGINEERING, INC.
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PART I

ADMINISTRATIVE

Chapter 1
Title & Scope

TITLE

Section 1.01 - These regulations shall be known as the "Floodproofing Code", may be cited as such, and will be referred to herein as "this code".

PURPOSE

Section 1.02 - The purpose of this code is to provide minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the construction, quality of materials, use and occuapncy, location and maintenance of all buildings and structures within the "Floodway and the Special Flood Hazard Area" and certain equipment specifically regulated herein.

SCOPE

Section 1.03 - The provisions of this code shall apply to the construction, alteration, moving, demolition, repair and use of any building within the "Floodway and the Special Flood Hazard Area".

Additions, alterations, repairs and changes of use or occupancy in all buildings and structures except as provided for in Section 1.04.

Where, in specific case, different sections of this code specify different materials, methods of construction or other requirements the more restrictive shall apply.

APPLICATION TO EXISTING STRUCTURES

Section 1.04 - (a) General. Buildings or structures to which additions, alterations or repairs are made shall comply with all the requirements for new buildings or structures except as specifically provided in this section.

(b) Additions, Alterations and Repairs; More than 50 percent. When additions, alterations or repairs exceed 50 percent of the value of an existing building or structure, such building or structure shall be made to conform to the requirements of this Code.

(c) Additions, Alterations and Repairs; Less than 50 Percent. Additions, alterations and repairs not exceeding 50 percent of the value of an existing building or structure and complying withthe requirements for new buildings or structures may be made to such building or structure without making the entire building or structure comply.

MOVING BUILDINGS

Section 1.05 - Buildings or structures moved into or within the city shall comply with the provisions of this Code for new buildings or structures.

ALTERNATE MATERIALS AND METHODS OF CONSTRUCTION

Section 1.06 - The provisions of this Code are not intended to prevent the use of any material or method of construction not specifically prescribed by this Code, provided any such alternate has been approved.

The Building Inspector may approve any such alternate provided he finds that the proposed design is satisfactory and complies with the provisions of this Code and that the material, method, or work offered is, for the purpose intended, at least the equivalent of that prescribed in this Code in quality, strength, effectiveness, fire resistance, durability and safety.

The Building Inspector shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use.

TESTS

Section 1.07 - Whenever there is insufficient evidence of compliance with the provisions of this Code or evidence that any material or any construction does not conform to the requirements of this Code, or in order to substantiate claims for alternate materials or methods of construction, the Building Inspector may require tests as proof of compliance to be made at the expense of the owner or his agent by an approved agency.

Test methods shall be as specified by this Code for the material in question. If there are no appropriate test methods specified in this Code, the Building Inspector shall determine the test procedure.

Copies of the results of all such tests shall be retained for a period of not less than two years after the acceptance of the structure.

DEMOLITION

Section 1.06 - Whenever a structure is demolished in the Special Floc Hazard Area all utilities shall be properly capped off. When this is complete and before any filling occures the Building Inspector shall make an inspection of the work. The Contractor shall contract the Building Inspector to perform this inspection.

Chapter 2
Administration and Enforcement

ZONING ADMINISTRATOR

Section 2.01 - The Building Inspector is charged with the duty of administration and enforcement of the provisions of this Code.

POWERS AND DUTIES

Section 2.02 - (a) General. The Building Inspector is hereby authorized and directed to enforce all the provisions of this Code. For such purpose he shall have the powers of a police officer.

(b) Deputies. In accordance with the procedure and with the approval of the chief appointing authority of the municipality, the Building Inspector may appoint such number of officers, inspectors and assistants, and other employees as shall be authorized from time to time. He may deputize such employees as may be necessary to carry out the functions of the Building Department.

(c) Reports and Records. The Building Inspector shall submit a report to the proper city official not less than once a year, covering the work of the department during the proceding period. He shall incorporate in said report a summary of his recommendations as to desirable amendments of this Code.

The Building Inspector shall keep a permanent, accurate account of all fees and other monies collected and received under this Code, the names of the persons upon whose account the same were paid, the date and amount thereof, together with the location of the building or premises to which they relate.

(d) Right of Entry. Whenever necessary to make an inspection to enforce any of the provisions of this Code, or whenever the Building Inspector or his authorized representatives has reasonable cause to believe that there exists in any building or upon any premises, any condition which makes such building or premises unsafe as defined in Section 2.03 of the Code, the Building Inspector or his authorized representative may enter such building or premises at all reasonable times to inspect the same or to perform any duty imposed upon the Building Inspector by this Code; provided that if such building or premises be occupied, he shall first present proper credentials and demand entry; and if such building or premises be unoccupied, he shall first make a reasonable effort to locate the owner or other persons having charge of control of the building or premises and demand entry. If such entry is refused, the Building Inspector or his authorized representative shall have recourse to every remedy provided by law to secure entry.

"Authorized Representative" shall include the officers named in Section 2.02 (a) and (b) of this Code.

No owner or occupant or any other person having charge, care of control of any building or premises shall fail or neglect, after proper demand is made as herein provided, to promptly permit entry therein by the Building Inspector or his authorized representative for the purpose of inspection and examiniation pursuant to this Code. Any person violating this subsection shall be guilty of a misdemeanor.

(e) Stop Orders. Whenever any building work is being done contrary to the provisions of this Code, the Building Inspector may order the work stopped by notice in writing served on any persons engaged in the doing or causing such work to be done, and any such persons shall forthwith stop such work until authorized by the Building Inspector to proceed with the work.

(f) Occupancy Violations. Whenever any structure is being used contrary to the provisions of this Code, the Building Inspector may order such use discontined and the structure, or portion thereof, vacated by notice served on any person causing such use to be continued. Such person shall discontinue the use within 10 days after receipt of such notice of this Code; provided, however, that in the event of an Unsafe Building Section 2.03 shall apply.

(g) Liability. The Building Inspector or any employee charged with the enforcement of this Code, acting in good faith and without malice for the city in the discharge of this duties, shall not thereby render himself liable personally and he is hereby relieved from all personal liability for any damage that may accrue to persons or property as a result of any act required or by reason of any act or omission in the discharge of his duties. Any suit brought against the Building Inspector or employee, because of such act or omissions performed by him in the enforcement of any provisions of this Code, shall be defended by the legal department of the city until final termination of the proceedings.

(h) Cooperation of Other Officials. The Building Inspector may request, and shall receive so far as may be necessary in the discharge of his duties, the assistance and cooperation of other officials of the city.

UNSAFE BUILDINGS

Section 2.03 - All buildings or structures which are structurally unsafe or not provided with adequate egress, or which constitute a flood hazard, or are otherwise dangerous to human life, or which in relation to existing use constitute a hazard to safety or health, or public welfare, by reason of inadequate maintenance, dilapidation, obsolescense, fire hazard, disaster damage, or abandonment, as specified in this Code or any other effective ordinance, are, for the purpose of this Section, unsafe buildings. All such unsafe buildings are hereby declared to be public nuisances and shall be abated by repair, rehabilitation, demolition, or removal in accordance with the procedure specified in Chapters 4 through

9 of the Uniform Code for the Abatement of Dangerous Buildings or by any other procedures provided by this Code and by law.

VIOLATIONS AND PENALTIES

Section 2.04 - It shall be unlawful for any person, firm or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert or demolish, equip, use, occupy, or maintain any building or structure in the city, or cause the same to be done, contrary to or in violation of any of the provisions of this Code.

Any person, firm, or corporation violating any of the provisions of this Code shall be deemed quilty of a misdemeanor, and each such person shall be deemed guilty of a separate offense for each and every day or portion thereof during which any violation of any of the provisions of this Code is committed, continued, or permitted and upon conviction of any such violation such person shall be punishable by a fine of not more than $300 or by imprisonment for not more than 90 days, or by both such fine and imprisonment.

ABROGATION AND GREATER RESTRICTIONS

Section 2.05 - It is not the intent of this Code to repeal, abrogate, or impair any existing building codes, or ordinances or laws, however, where this Code imposes greater restrictions the provisions of this Code shall apply.

Chapter 3
Permits and Inspections

Section 3.01 - Permit required in the "Floodway".

(a) A "City of Fargo, Conditional Use Building Permit", issued by the Zoning Administrator and approved by the Board of Adjustment shall be secured prior to erection, addition to, alteration of any building, structure or lands, prior to any filling or clearing, and prior to the change or extension of any nonconforming use.

(b) Application for a "City of Fargo Conditional Use Building Permit" shall be made to the Zoning Administrator on forms furnished for that purpose. Every application made shall:

1. Identify and describe the work to be covered by the permit for which application is made;

2. Describe the land on which the proposed work is to be done, by lot, block, tract, and house and street address, or similar description that will readily identify and definitely locate the proposed building or work;

3. Include a drawing or plat, drawn to scale and showing the lot, the proposed building or buildings thereon, dimensions of the lot and the buildings; the exact location, and proposed use of the proposed buildings on the lot, location, dimensions, present use and proposed use of any existing building on the same lot; such information on front yard depths and other yard sizes on other lots and such other information as the Zoning Administrator shall require for the proper enforcement of this article;

4. Indicate the use or occupancy for which the proposed work is intended

5. Be accompanied by plans and specifications as required in Section 3.01(d) of this Code.

6. State the estimated value of the proposed work;

7. Be signed by the permitee, or his authorized agent, who may be required to show proof to indicate such authority;

8. Give such other information as reasonably may be required by the Zoning Administrator;

(c) Application Form. The application form shall be of the type set forth

in Figure A-1 of the Appendix.

(d) Plans and Specifications. With each application two sets of plans and specifications shall be submitted. The Zoning Administrator shall require plans and specifications to be prepared by an engineer or architect licensed by the state to practice as such.

(e) Information on Plans and Specifications. Plans and specifications shall be drawn to scale upon substantial paper or cloth and shall be of sufficient clarity to indicate the nature and extent of the work proposed and show in detail that it will conform to the provisions of this Code, the Building Code, and all relevant laws, ordinances, rules and regulations. In lieu of detailed specifications, the Zoning Administrator may accept references on the plans and specific sections of the appropriate code.

Section 3.02 - Permit required in the Special Flood Hazard Area.

(a) A "City of Fargo Building Permit for Special Flood Hazard Area" issued by the Zoning Administrator shall be secured prior to erection, addition to, alteration of any building, structure or lands, prior to any filling or clearing and prior to the change or extension of a nonconforming use.

(b) Application for a "City of Fargo Building Permit for Special Flood Hazard Areas" shall be made to the Zoning Administrator on forms furnished for that purpose. Every application made shall:

1. Identify and describe the work to be covered by the permit for which application is made;

2. Describe the land on which the proposed work is to be done, by lot, block, tract, and house and street address, or similar description that will readily identify and definitely locate the proposed building or work;

3. Include a drawing or plat, drawn to scale and showing the lot, the proposed building or buildings thereof, dimensions of the lot and the buildings; the exact location, dimensions, present use and proposed use of any existing building on the same lot; such information on front yard depths and other yard sizes on other lots and such other information as the Zoning Administrator shall require for the proper enforcement of this article;

4. Indicate the use or occupancy for which the proposed work is intended;

5. Be accompanied by plans and specifications as required in section 3.02(d) of this Code.

6. State the estimated value of the proposed work;

7. Be signed by the permitee, or his authorized agent, who may be required to show proof to indicate such authority;

8. Give such other information as reasonably may be required by the Zoning Administrator;

(c) Application Form. The application form shall be of the type set forth in Figure A-1 of the Appendix.

(d) Plans and Specifications. With each application two sets of plans and specifications shall be submitted. The Zoning Administrator may require plans and specifications to be prepared by an engineer or architect licensed by the state to practice as such.

(e) Information on Plans and Specifications. Plans and specifications shall be drawn to scale upon substantial paper or cloth and shall be of sufficient clarity to indicate the nature and extent of the work proposed and show in detail that it will conform to the provisions of this Code, the Building Code, and all relevant laws, ordinances, rules and regulations. In lieu of detailed specifications, the Zoning Administrator may accept references on the plans to specific sections of the appropriate code.

Section 3.03 - Upon receipt of an application for a building permit the Zoning Administrator shall:

(a) Note the minimum allowable elevation of the first floor or lowest opening (whichever is lower), or the elevations to which a structure must be floodproofed. This elevation shall correspond to the "Flood Protection Elevation" for the particular reach of the stream as shown on the "Official Flood Insurance Rate Map".

(b) If the application is for a "City of Fargo Building Permit for Flood Hazard Areas" the Zoning Administrator shall check the application, plans and specifications for conformance to this Code, the Building Code, other applicable codes and ordinances. Such plans and specifications may be reviewed by other departments of the city to check compliance with the laws and ordinances under their jurisdication. The Zoning Administrator may:

1. If the Zoning Administrator is satisfied that the work described in the application for permit and the plans filed therewith conform to the Building Code, the Floodproofing Code, this Code, and other pertinent laws and ordinances and the fee specified in the Building Code has been paid, he shall issue a permit therefore to the applicant.

2. If the Zoning Administrator finds that the application does not comply with the provisions of this Code, the Building

Code, the Floodproofing Code or any other applicable laws or ordinances he shall so note on the application and return them to the applicant. The applicant may then correct the defective portion of the application, plans or specifications and resubmit the application, or he may appeal to the Board of Adjustment.

(c) If the application is for a "City of Fargo Conditional Use Building Permit" the Zoning Administrator shall call a meeting of the Board of Adjustment to review the application. The Board of Adjustment shall decide the issue as set forth in Section 21-0607 of Chapter 21 of the City of Fargo ordinances relating to flood plain management.

3.04 - Retention of Plans. One set of approved plans, specifications, and computations shall be retained by the Building Official for a period of not less than 90 days from date of completion of the work covered therein, and one set of approved plans and specifications shall be returned to the applicant, which set shall be kept on such building or work at all times during which the work authorized thereby is in progress.

Section 3.05 - Validity. The issuance of granting of a permit or approval of plans and specifications shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this Code. No permit presuming to give authority to violate or cancel the provisions of this Code shall be valid, except insofar as the work or use which it authorized is lawful.

Section 3.06 - Expiration. Every permit issued by the Building Official under the provisions of this Code shall expire by limitation and become null and void, if the building or work authorized by such permit is not commenced within 120 days from the date of such permit, if the building or work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of 120 days. Before such work can be recommenced a new permit shall be first obtained to do so, and the fee therefor shall be one-half the amount required for a new permit for such work, provided no changes have been made in the original plans and specifications for such work; and provided, further, that such suspension of abandonment has not exceeded one year.

Section 3.07 - Suspension or Revocation. The Building Official may, in writing, suspend or revoke a permit issued under provisions of this Code whenever the permit is issued in error or on the basis of incorrect information supplied, or in violation of any ordinance or regulation or any of the provisions of this Code.

Section 3.08 - Fees. Fees shall be as provided by resolution of the City Commission of Fargo, North Dakota.

INSPECTIONS

Section 3.09 - (a) General. All construction or work for which a permit is required shall be subject to inspection by the Building Official,

and certain types of construction shall have continuous inspection by special inspectors, as specified in Section 3.09(e).

A survey of the lot may be required by the Building Official to verify compliance of the structure with approved plans.

(b) Inspection Record Card. Work requiring a building permit shall not be commenced until the permit holder or his agent shall have posted an inspection record card in a conspicuous place on the front premises and in such position as to allow the Building Code conveniently to make the required entries thereon regarding inspection of the work. This card shall be maintained in such position by the permit holder until the Certificate of Occupancy has been issued.

(c) Approvals Required. No work shall be done on any part of the building or structure beyond the point indicated in each successive inspection without first obtaining the written approval of the Building Official. Such written approval shall be given only after an inspection shall have been made of each successive step in the construction as indicated by each of the inspections required in Subsection (d).

(d) Required Inspections. Reinforcing steel or structural framework of any part of any building or structure shall not be covered or concealed without first obtaining the approval of the Building Official.

The Building Official, upon notification from the permit holder or his agent, shall make the following inspections and shall either approve that portion of the construction as completed or shall notify the permit holder or his agent wherein the same fails to comply with this Code.

1. Foundation Inspection. To be made after trenches are excavated and forms erected and when all materials for the foundation are delivered on the job. Where concrete from a central mixing plant (commonly termed "transit mixed") is to be used, materials need not be on the job.

2. Frame Inspection. To be made after the roof, all framing, fire-blocking, and bracing are in place and all pipes, chimneys, and vents are complete.

3. Final Inspection. To be made after building is completed and ready for occupancy.

(e) Other Inspections. In addition to the called inspections specified above, the Building Official may make or require any other inspections of any construction work to ascertain compliance with the provisions of this Code and other laws which are enforced by the Building Department.

Section 3.1C - Certificate of Occupancy. After the final inspection when it is found that the building or structure complies with the pro-

visions of this Code, the Building Code and other applicable laws and ordinances the Building Inspector shall issue a Certificate of Occupancy which shall contain the following:

(a) The address of the building.

(b) The name and address of the owner.

(c) A description of that portion of the building for which the certificate is issued.

(d) A statement that the described portion of the building complies with the provisions of this Code and the Building Code.

(e) The signature of the Building Inspector.

No building or structure shall be in use or occupied prior to the issuance of such a certificate. The certificate shall be of the type shown in Figure A-4 of the Appendix.

P A R T I I

DEFINITIONS AND ABBREVIATIONS

Chapter 4
Definitions and Abbreviations

Section 4.01 - General. For the purpose of this Code, certain abgreviations, terms, phrases, words and their derivatives shall be construed as specified in this chaper.

Section 4.02 "A"

Alter or Alteration is any change, addition or modifications in construction or occupancy.

Approved as to materials and types of construction, refers to approval by the Building Official as the result of investigation and tests conducted by him, or by reason of accepted principals or tests by national authorities, technical or scientific organizations.

Section 4.03 "B"

Basement is that portion of a building between floor and ceiling which is partly below and partly above grade (as defined in this chapter) but so located that the vertical distance from grade to the floor below is less than the vertical distance from grade to ceiling.

Building is any structure used or intended for supporting or sheltering any use or occupancy.

Building Code - The Uniform Building Code, 1973 Edition as amended by the City of Fargo, North Dakota.

Building Existing is a building erected prior to the adoption of this Code, or one for which a legal building permit has been issued prior to adoption of this Code.

Building Official is the officer or other designated authority charged with the administration and enforcement of this Code, or his duly authorized representative, the Building Inspector.

Section 4.04 "C"

Cellar is that portion of building between floor and ceiling which is wholly or partly below grade (as defined in this chapter) and so located that the vertical distance from grade to the floor below is equal to or greater than the vertical distance from grade to ceiling.

Section 4.05 "F"

Fill the placing, storing or dumping of any materials, such as earth, clay, sand, concrete, rubble or waste of any kind upon the surface of the ground which results in increasing the natural ground surface elevations.

Floodproofing means any combination of structural and nonstructural additions, changes or adjustments to properties and structures which reduce or eliminate flood damage on lands, water and sanitary facilities, structures and contents of buildings.

Flood Protection Elevation (Regulatory Flood Datum) is the elevation to which uses regulated by this Code are required to be elevated or flood-proofed. It shall correspond to the elevation on the upstream side of each reach as shown on the Official Flood Insurance Rate Map.

Floodway means the channel of a river or other watercourse and the adjacent land areas required to carry and discharge a flood of a given magnitude.

Flood Plain means a land area adjoining a river, stream, watercourse, or lake, which is likely to be flooded.

Flood Plain Management means the operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works, and land use and control measures.

Section 4.06 "G"

Grade (adjacent ground elevation) is the lowest point of elevation of the finished surface of the ground, paving and sidewalk within the area between the building and a line ten (10) feet from the main building.

Section 4.07 "H"

Habitable Space is a space used for living, sleeping, eating or cooking or combination thereof, but not including bathrooms, toilet compartments, closets, halls, storage rooms, laundry and utility rooms, basement recreation rooms and similar spaces.

Section 4.08 "O"

Occupancy is the purpose for which a building or part thereof is used or intended to be used.

Occupancy Group is the occupancy for which a building is intended as defined in chapters 6 through 15 of the Building Code (as defined in this chapter).

Official Flood Insurance Rate Map means a map which shows the Flood Plain Area having Special Flood Hazard and Floodway which is approved by the Federal Insurance Administrator, and the City Commission of Fargo, North Dakota.

Owners Contingency Plan means a plan of action for flood situations submitted at the time of application for permit by the applicant.

Section 4.09 "R"

Reach is a hydraulic engineering term to describe longitudinal segments of a stream or river.

100 Year Regional Flood means a flood which can be expected to occur in the magnitude of the 100 year recurrence interval.

Section 4.10 "S"

Special Flood Hazard Area means that maximum area of the Flood Plain that on the average is likely to be flooded once every 100 years.

P A R T I I I

BUILDING REQUIREMENTS

Chapter 5
Flood-Proof Construction Types

GENERAL

Section 5.01 - The floodproofing type of a space is determined by the degree of protection under these regulations to permit its intended use.

ASSIGNMENT OF FLOODPROOFING TYPE

Section 5.02 - Assignment is made by the owner at the time of application for a permit and is subject to the approval of the Building Official. Every space or portion of a building of an improvement in a Special Flood Hazard Area which impinges in whole or in part upon the flood protection elevation associated with a floodproofing type assigned to it, and all requirements associated with a floodproofing type shall be met by the space to which they apply in addition to all other requirements of these regulations and the Building Code.

DESCRIPTION OF FLOODPROOFING TYPES

Section 5.03 - The following descriptions of the floodproofing types are approximte and general. More precise specifications of the requirements associated with each type is given in Table I of the following section.

a) First floor above the Flood Protection Elevation, no basement (FP1): In this type of construction, no space within the structure is below the Flood Protection Elevation, however, the footings may be below the Flood Protection Elevation. Permitted contents and interior finish materials are unrestricted except as established in the Building Code.

b) First floor above the Flood Protection Elevation, with basement or cellar (FP2): This type of construction shall be permitted only when the finished grade at a distance of ten (10) feet from the building is at an elevation equal to or above the Flood Protection Elevation. In no case shall an opening be allowed below the Flood Protection Elevation unless enclosed by the window well as shown on Figure 2a and 2b of this Code.

(c) Other Construction (FP 3). All construction which does not meet the requirements of FP 1 or FP 2 shall be in one of the classes of FP 3 construction.

1) Completely Dry Spaces (W 1): These spaces shall remain completely dry during flooding to the R.F.D.; walls shall be impermeable to passage of water and water vapor. Permitted contents and interior finish materials are virtually unrestricted, except for high hazard type uses or human habitation. Structural components shall have capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

2) Essentially Dry Spaced (W 2): These spaces shall remain essentially dry during flood to the R.F.D.; walls shall be substantially impermeable to water, but may pass some water vapor or seep slightly. Contents and interior finish materials are restricted when hazardous or vulnerable under these conditions. Structural components shall have capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

3) Spaces Intentionally Flooded With Potable Water (W 3): These spaces will be flooded internally with potable water provided by the Owner in order to maintain the building's structural integrity by equalizing pressures on structural components during flooding to the R.F.D.; walls shall be sufficiently impermeable to prevent the passage, infiltration or seepage of contaminated flood waters. Contents and interior finish materials are restricted when hazardous or vulnerable under intentional flooding conditions.

4) Spaces Flooded with Flood Water (W 4): These spaces will be flooded with flood water (contaminated) by automatic means, or are otherwise partially exposed to the unmitigated effects of the flood. Although there are minimal structural requirements to be met for walls and other structural components, contents and interior finish materials are restricted to types which are neither hazardous nor vulnerable to loss under these flooding conditions.

5) Non-Floodproofed Spaces (W 5): A non-floodproofed space in an existing building or structure is defined as a space which fails to meet the requirements of any of the above described classification.

THE SPACE CLASSIFICATION CHART

Section 5.04 - Table I indicated the various degree of protection required to permit use of spaces for each floodproofed type and class. Although spaces must meet the requirements shown for each element of flood-proofing, the chart in itself shall not be construed as being exhaustive with respect to all requirements imposed by these Regulations. In disputes arising over the interpretation of this chart, the written provisions of these Regulations shall be considered as definitive.

TABLE I

SPACE CLASSIFICATION CHART

FLOOD-PROOFING CLASSIFICATION OF SPACES									
	MINIMUM REQUIREMENTS								
FLOOD-PROOFING TYPE AND CLASSES	WATER-PROOFING	STRUCTURAL LOADS	CLOSURE OF OPENINGS	INTERNAL FLOODING AND DRAINAGE	FLOORING	WALLS AND CEILINGS	CONTENTS	ELECTRICAL	MECHANICAL
FP1	*	*	*	*	*	*	*	*	*
FP2	TYPE D	CLASS 4	*	*	*	*	*	*	*
FP3									
W1 COMPLETELY DRY	TYPE A	CLASS 1	TYPE 1	— SEE CHAPTER 9 —	CLASS 1	CLASS 1	CLASS 1	*	SEE SECTION 5.06(b)3)
W2 ESSENTIALLY DRY	TYPE B	CLASS 1	TYPE 1		CLASS 2	CLASS 2	CLASS 2	— SEE CHAPTER 13 —	— SEE CHAPTER 14 —
W3 FLOODED WITH POTABLE WATER	TYPE B	CLASS 2	TYPE 3		CLASS 3	CLASS 3	CLASS 3		
W4 FLOODED WITH FLOOD WATER	TYPE C	CLASS 3	TYPE 4		CLASS 4	CLASS 4	CLASS 4		
W5 NON-FLOOD-PROOFING	*	*	TYPE 5		CLASS 5	CLASS 5	CLASS 5		

* NOT APPLICABLE

SEPARATION OF SPACES WITH DIFFERENT FLOOD-PROOFING CLASSIFICATION

Section 5.05 - Any two adjacent spaces below the R.F.D. having different flood-proofing type or class shall be separated by a barrier meeting the requirements for the space with the lower-numbered classification. In addition, any opening below the Flood Protection Elevation between two adjoining spaces shall be provided with a closure meeting the requirements for the space with the lower-numbered classification.

CONSTRUCTION REQUIREMENTS

Section 5.06 - All construction in Flood Hazard Areas shall conform to the provisions of this section.

(a) Type FP 1 Construction. No additional restrictions are provided on this type of construction, due to its location in Special Flood Hazard Areas.

(b) Type FP 2 Construction. In addition to the requirements that the yard grade at a point ten (10) feet from the building be at an elevation equal to or above the Flood Protection Elevation, the following must be met as a minimum.

1) Basements or cellars must be constructed, as a minimum as shown in Figures 1a, 1b, 2a and 2b.

2) The minimum weir level of any opening in the basement shall be 6" above the Flood Protection Elevation.

3) There shall be no wall penetrations (for pipes, wires, vents, ducts, etc.) or openings below the Flood Protection Elevation unless enclosed by the window well as shown on Figures 2a and 2b of this Code.

4) The sump pump shall meet or exceed the following specifications:

-Minimum size pump - 1/3 H.P.
a capacity of 2270 gph at a 10-foot head with a 1/3 H.P. motor

-The discharge pipe should be the same diameter as the pump outlet.

-The elevation of the outlet of the discharge pipe shall be above the Flood Protection Elevation. The discharge pipe shall extend 10' outside the foundation wall.

5) Backfill around the basement foundation wall and in the utility trenches should consist of clays to within 6" of the surface. It should be placed in layers thin enough for proper compaction. Sufficient top soil should be mounded over the backfill to provide the minimum slope of grade adjacent to the foundation wall and to avoid ponding over the location of the trenches.

Mechanical Systems

The unique indigenous conditions in Fargo and current basement construction practice combine to preclude the necessity for special provisions for the plumbing, electrical and HVAC systems except as noted above.

7) Underdrain System. Where underdrain system shown in Figure 1a or 2a of the Code is to be used, the methods of penetration of the footing between the inside and outside drain pipes shall be as follows:

Penetration of the footing shall be 4" nonperforated PVC or stronger pipe having adequate strength to resist crushing. There should be a total of four such connections between the inner and outer drain tile systems. These should be spaced at approximately equal intervals. In lieu of drain tile, Figure 2a of the Code provides for an alternate design using pea gravel (or larger) under the basement slab and outside the footings the filter shall extend upward above the top of the footing for approximately 12", see Figure 2a of the Code. One-and-one-half inch diameter pipes (or equivalent openings) should be placed 10 feet on center in the top of the footing so as to discharge beneath the slab. The surface of the undisturbed soil beneath the basement slab should be sloped toward the sump.

8) Structural

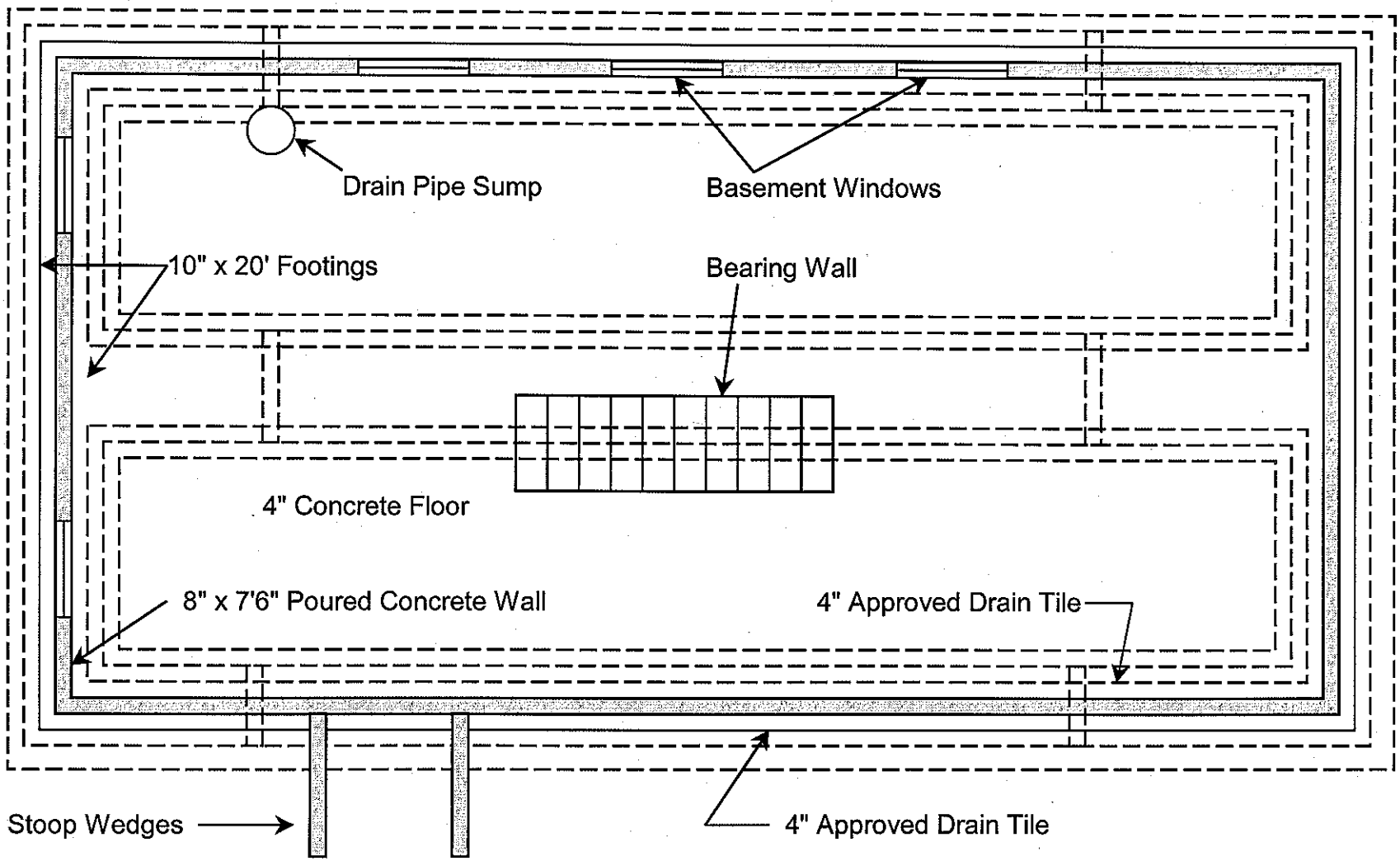
(a) Concrete - The basement walls shall be designed in accordance with the Building Code Requirements for Structural plain concrete of the American Concrete Institute (ACI 322-72). The minimum compressive strength of the concrete shall be 3000 psi at 28 days. The maximum permissible water/cement ratio for concrete shall be as specified in ACI 318-71, Table 4.2.4.

(b) Reinforcing Steel - All reinforcing steel shall be grade 40 or higher as detailed in ASTM A651-68.

(c) Type FP 3 Construction. This type of construction must be designed and certified by a Registered Engineer or Architect licensed by the State of North Dakota to practice as such. Construction shall conform to all the requirements of this Code.

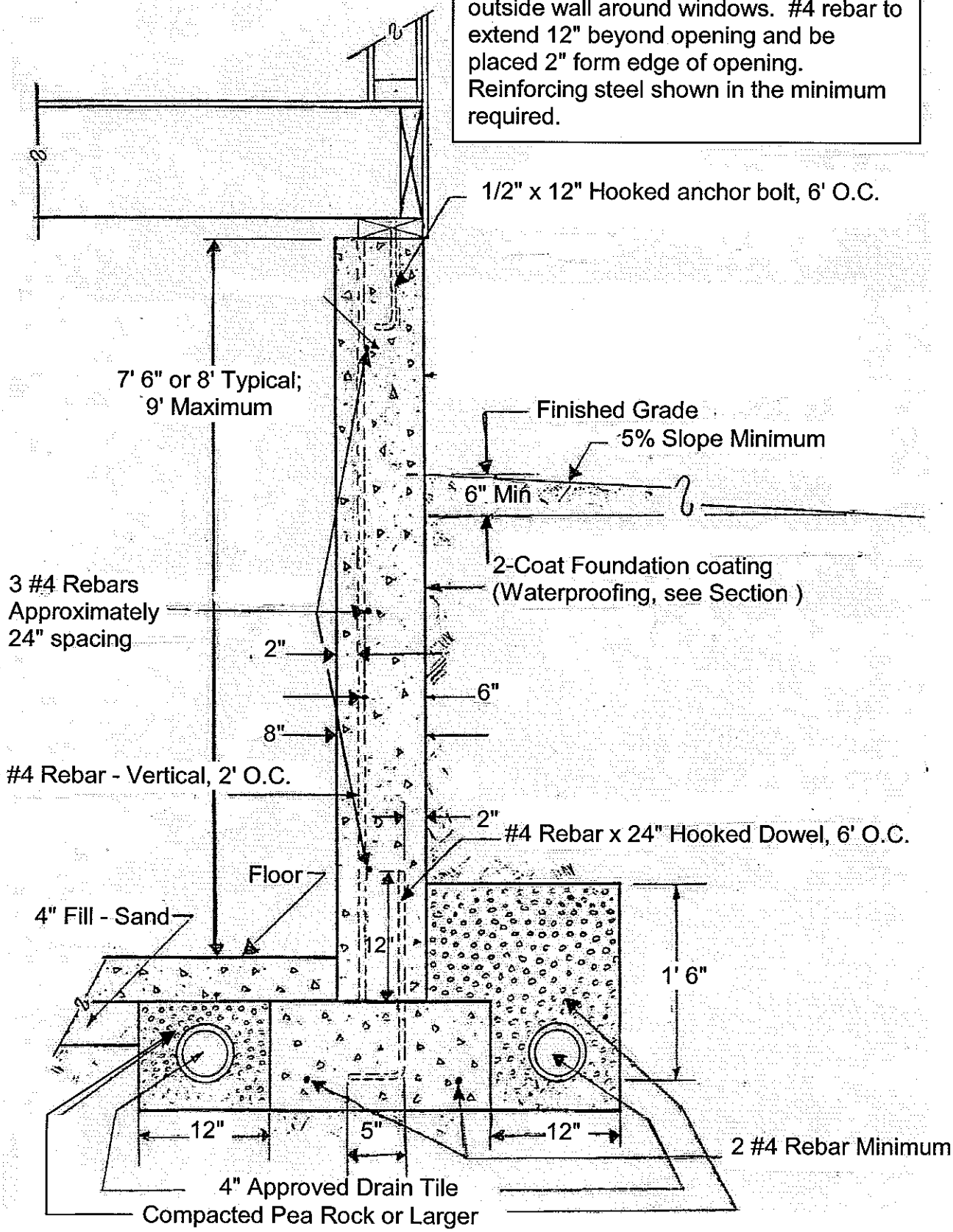
FOOTING AND FOUNDATION WALL PLAN

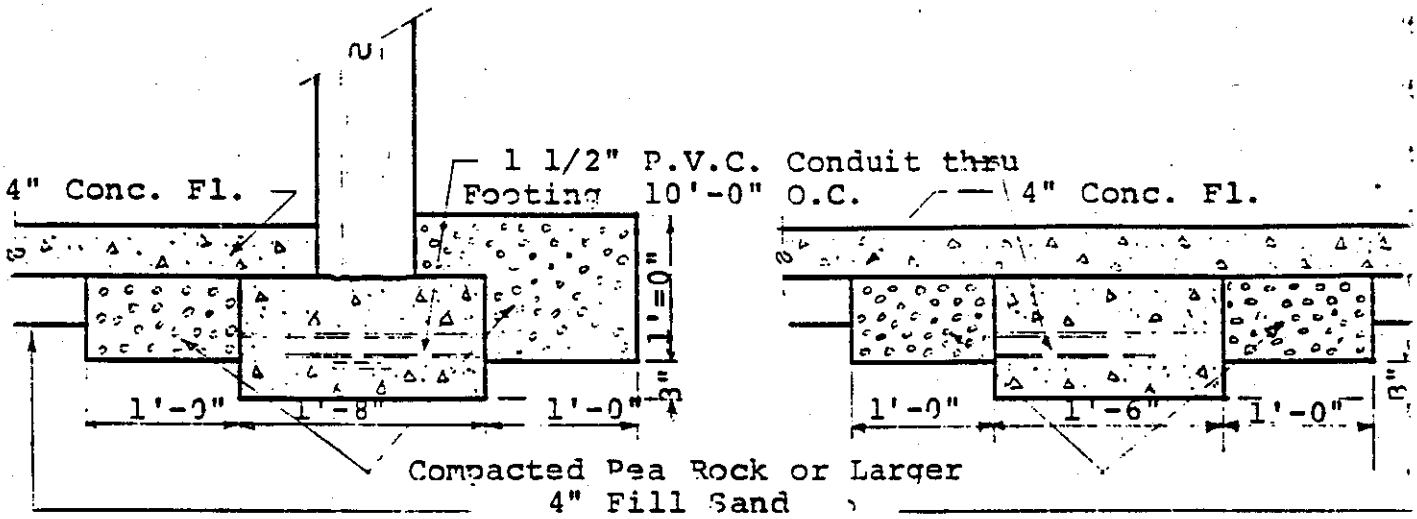
Note: Contractor may use continuous footings or sufficient pad footings as required.



TYPICAL WALL SECTION

Note: Install #4 rebar 2" from inside and outside wall around windows. #4 rebar to extend 12" beyond opening and be placed 2" form edge of opening. Reinforcing steel shown in the minimum required.

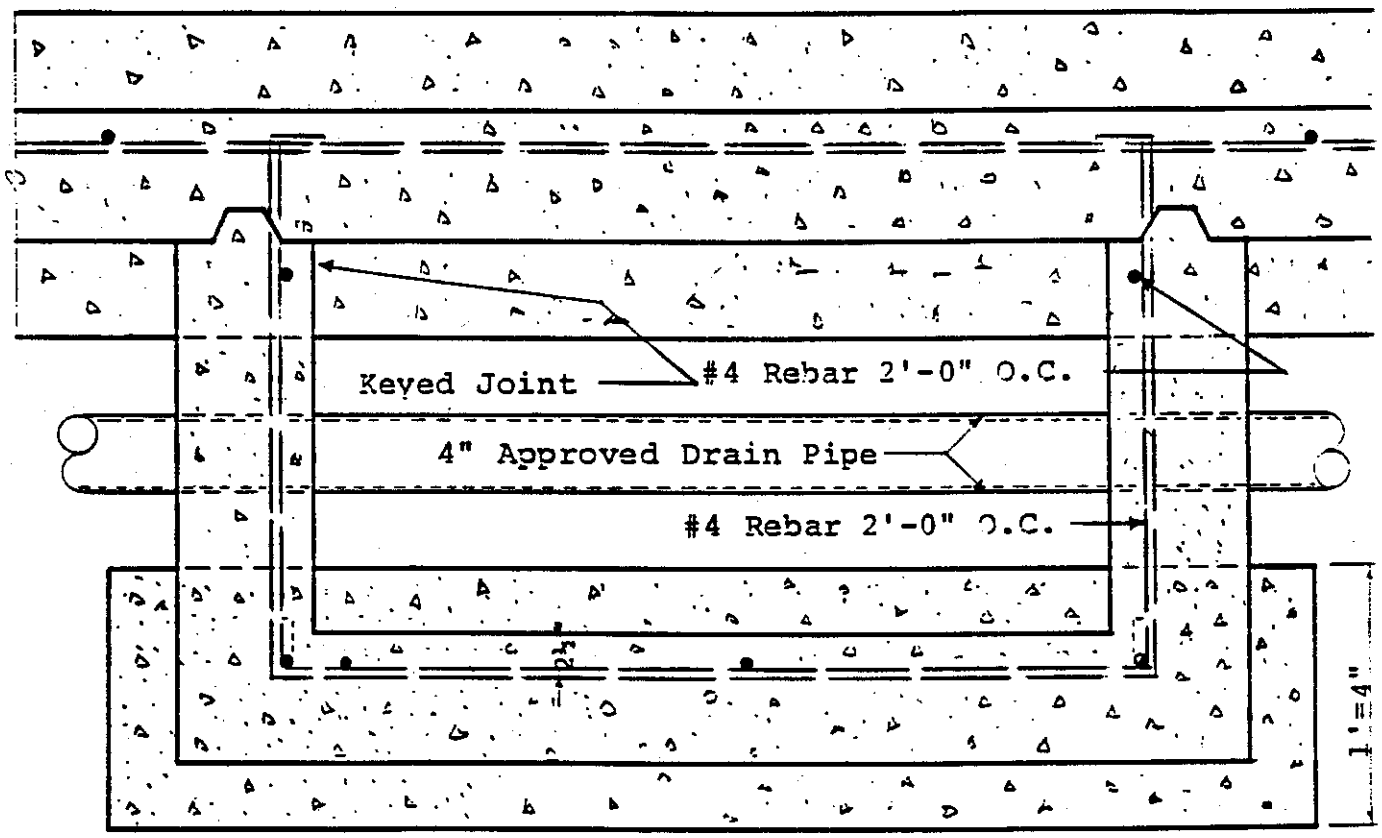




3/4"=1'-0"

ALTERNATE UNDERDRAIN SYSTEMS

NOTE: Reinforcing steel shown is minimum requirement.
Window wells less than 7'-0" wide require 6" wall.
Over 7'-0" wide require 8" wall.



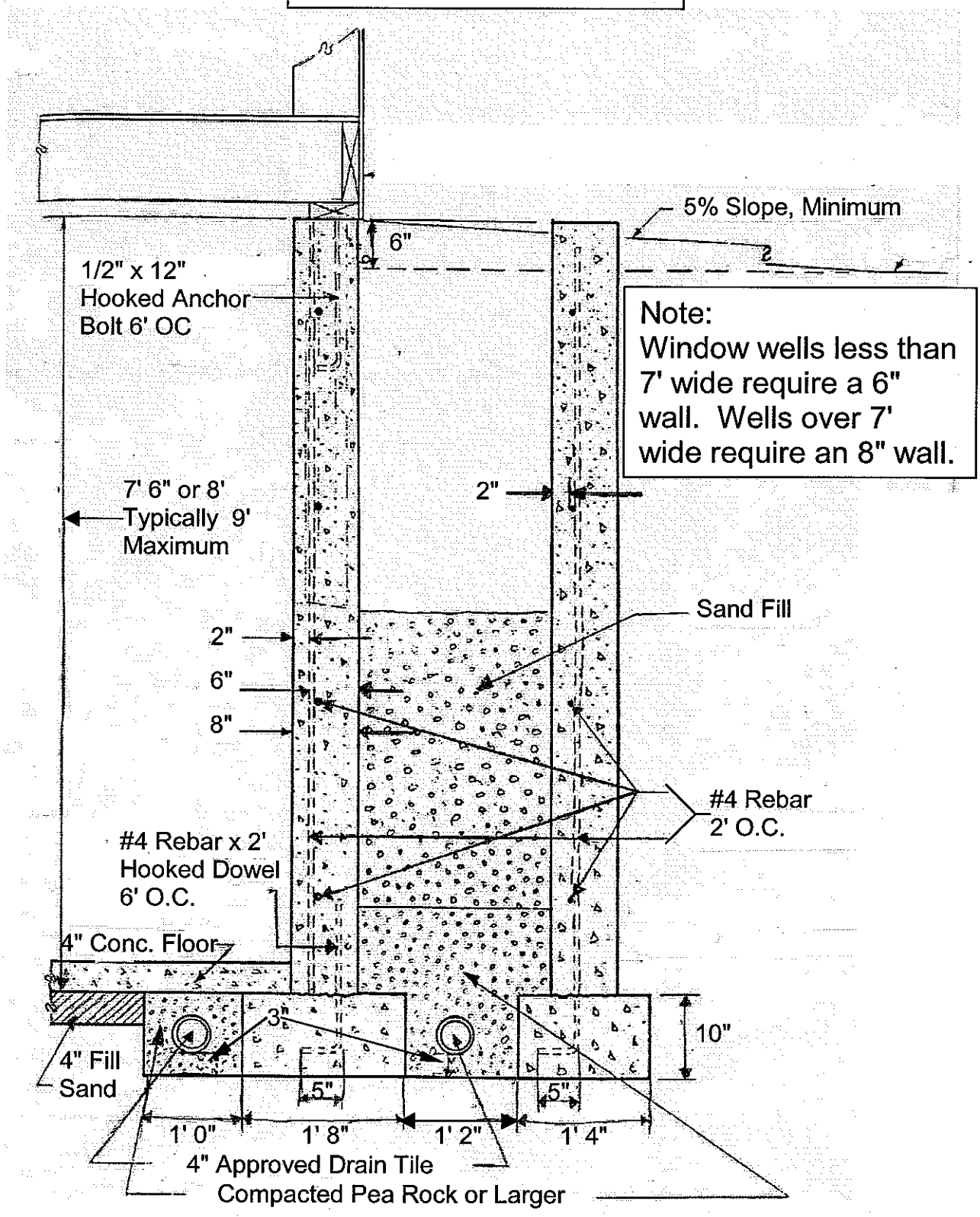
1"=1'-0"

SECTION A-A

WINDOW WELL SECTION

Figure 2a

DEEP WINDOW WELL



B. Foundations

Set back dimensions are referenced to the 100 year flood plain line at the side(s) of the flooding source such as adjacent to a river or drainage ditch.

1. Standard concrete foundations "Required" for all construction within 50' of 100 year flood plain line.

2. Construction to all flood proof codes "Recommended" within 150' of the 100 year flood plain line.

3. Construction to all flood proof codes "Required" within 25' of the 100 year flood plain line.

C. Floodway Setback

All structures to be set back 100' from floodway line.

D. Certifications

Elevation Certificate required for all structures (Provided by City)
Floodproof Certification required for flood proof foundations

E. LOMR Areas

LOMR application must include primary flood protection line to protect the entire LOMR area to elevation BFE plus 2.5'.

III. Structures in LOMR Areas More Than 150' from the 100 Year Flood Plain Line (See Exhibits C & C-1)

A. Primary Flood Protective Line

Must be protected by a primary flood protection line elevated 2.5' above the BFE. This protection line would be placed on lots or streets adjacent to the 100 year flood plain line.

B. Elevations

Lowest opening including area walls	2.5' above BFE
Fill around building	2.0' above BFE

C. Foundations

No special requirements

D. Certifications

Elevation Certificate required (Provided by the City)

IV. Flood Proof Foundations

A. Additional concrete reinforcing requirements.

1. Place three additional horizontal rebar at the corners of the foundation wall (#4 "L" rebar 36" x 36").

2. Place diagonal rebar (#4 x 36") at bottom corners of basement window penetrations.

Chapter 6
Waterproofing

PURPOSE

Section 6.01 - This chapter shall govern the design, use, and methods of construction and materials with respect to obtaining, for a given space, the degree of protection against water, water vapor, and water-borne contamination determined by the vulnerability or hazard potential of the contents and interior finish materials to meet its flood-proofing classification.

PERFORMANCE STANDARDS

Section 6.02 - Four types of waterproofing are defined herein as to the degree to which they satisfy a standard of dryness. If any material or method of construction meets the functional performance standard defining a type of waterproofing construction it shall be considered as satisfying the requirements of this chapter. For the purpose of these Regulations, the detailed specification of Type A waterproofing construction, as contained in this chapter, shall be interpreted as a guide to measures which are reasonable prerequisites for attaining this standard of dryness.

Section 6.03 - Type A Constructions

(a) Permeability. Type A waterproofing constructions are completely impermeable to the passage of external water and water vapor under hydrostatic pressure of flooding to the RFD. Type A waterproofing construction shall consist of either a continuous membrane satisfying 6.03(b), integrally waterproofed concrete satisfying 6.03(c) or a continuous interior lining satisfying 6.03(d).

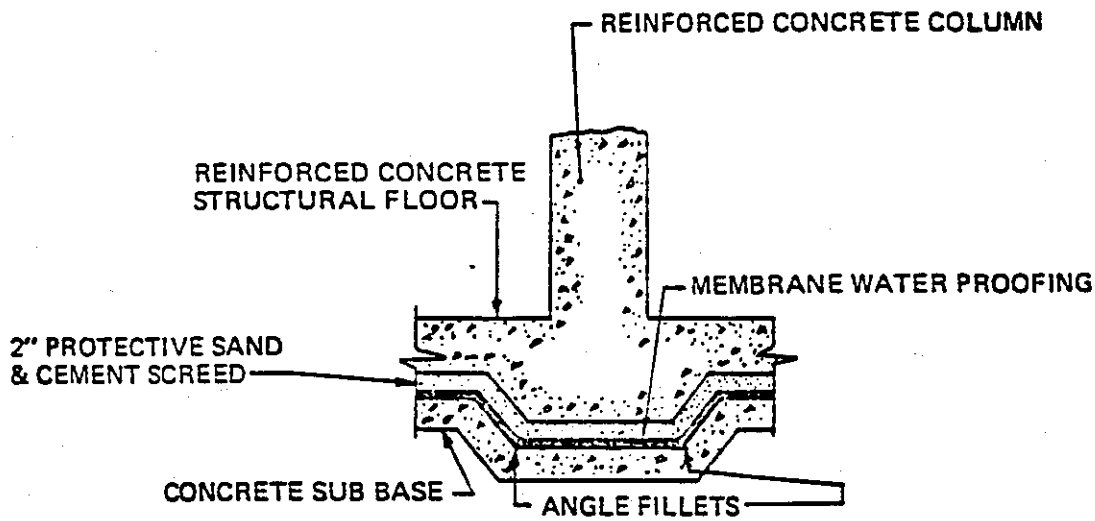
(b) Type A Membrane Construction. Type A membrane water-proofing forms a continuous external impervious lining to protect a structure with a concrete floor slab and concrete or reinforced concrete masonry unit walls. It shall comply with the following requirements for structural prerequisites, materials and installation.

1) Structural Prerequisites

a) Continuity of Structure: Structural slabs below grade shall be continuous under perimeter walls to prevent differential settlement and shall be designed to act monolithically with the walls; reinforced concrete masonry unit walls shall be connected rigidly to slabs with reinforcing steel. Where conventional footings are necessary to achieve bearing below the frost line, the structrual slab shall be formed monolithically with the walls or anchored into the walls by means of a keyway and reinforcing steel so as to act monolithically with the wall.

b) Projection of Slab: Where a slab is continuous under perimeter walls, it shall project not less than six (6) inches beyond the outside of the wall in order to provide space for joining horizontal and vertical membranes.

c) Columns: Where columns occur, there shall be no vertical discontinuity or abrupt change in slab cross-sections. Where slab thicknesses change, they shall do so gradually, and the effects of pressure distribution on the thinner portions of the slab cross-section shall be considered.



TYPE "A" MEMBRANE WATER PROOFING IN FLOOR SLABS

Figure 3

d) Protection: All membranes shall be installed on exterior surfaces of perimeter walls. For floor slabs, the membrane shall be installed between the structural slab and wearing surface or otherwise placed on a non-structural concrete sub-base at least two (2) inches in thickness to protect the membrane and insure its flatness; in the latter case (Fig. 3) a two (2) inch thick sand-cement screed shall be placed over the membrane before laying reinforcing steel for the structural slab. If a floor membrane is sandwiched between two structural slabs, the membrane shall be positioned at a location that will not subject it to excessive overstress conditions.

e) Pile Foundations: When spaces are supported on pile foundations, there shall be complete separation between pile caps and floor slab; the membrane shall be continuous and loads

shall be transferred to the piles through basement walls acting as deep beams or through isolated foundations. The pile caps shall be interconnected with stabilizing beams and a reinforced concrete slab not less than four (4) inches thick shall be provided over the entire area between the beams (and monolithic with them) in order to receive the membrane.

2) Materials. For the purpose of these Regulations, a membrane shall be any layered sheet construction of tar/asphalt bitumen and felts, at least 3-ply in thickness neoprene coated nylon fabric; other approved sheet material; or multiple applied hydrolithic coatings of asphlatic bitumens. All applicable ASTM standards shall apply to Type A membranes and their component parts.

a) Permeability: Type A membrane shall permit passage of no more than three (3) pounds of water per 1,000 square feet in 24 hours at 40 psi.

b) Plastic Waterproofing Materials: Various plastic materials, including among others, polyethylene, PVC, polyurethane, and polyisobutylene, shall be permitted in sufficient thicknesses in sheets or coatings. In certain cases the Building Official may require less protection beneath the plastic than the concrete sub-base required in 6.03-(b)-1)-(d).

3) Installation.

a) Application: All Type A membrane waterproofing shall be applied by a certified roofing or waterproofing contractor.

b) Turns: Turns at corners, both vertical and horizontal, shall be made with chamfers or fillets of not less than two (2) inches dimension on any side.

c) Seams: Membrane seams or overlaps, if any, shall be thoroughly interleaved and protected in accordance with accepted practice, but in no case shall seams or overlaps be less than two (2) inches in any direction.

d) Pipes: Points where pipes or ducts penetrate waterproofed construction shall be designed to be watertight in accordance with accepted engineering practice.

e) Joints: Membranes shall be continuous across expansion, control, and construction joints, which shall have waterstops of rubber, copper, plastic, or other suitable materials.

f) Protection: Membranes on walls shall extend at least three (3) inches above the RFD of the protected space and shall be attached with a reglet or covered with protective masonry at its upper termination. To protect all wall membranes

during backfill operations, protection of not less than ½-inch thickness of cement parging, plastic sheets, or other rigid non-cellulose material, installed in a workmanlike manner, shall be provided; however, in large projects or where the protection required above may not be adequate, the Building Official may require protection by some other means.

g) Excavation: Excavation preceding construction shall extend a minimum distance of 24 inches beyond the exterior wall lines to facilitate construction operations. In build-up areas where this requirement cannot be met, excavation limits will be as designated by the Building Official.

(c) Type A Integrally Waterproofed Concrete Construction. Type A integrally waterproofed concrete construction shall comply with the following requirements for structural prerequisites, materials, and installation.

1) Structural Prerequisites.

a) Continuity of Structure. Structural slabs shall be continuous under perimeter walls. Slabs shall be designed to act monolithically with perimeter walls, or otherwise shall carry them non-rigidly in a recess with mastic V fillings and waterstops. (Fig. 4) Where conventional footings are necessary to achieve bearing below the frost line, the structural slab shall be formed monolithically with the walls or anchored into the walls by means of a keyway and reinforcing steel.

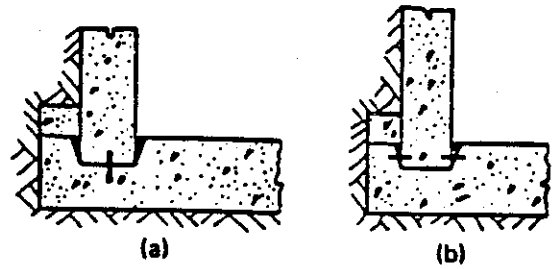
b) Deflections: To prevent increases of permeability in tension zones, the maximum deflection of any structural slab or perimeter wall shall not exceed 1/500 of its shorter span.

c) Columns: Where columns occur there shall be no vertical discontinuity or abrupt change in slab cross-section. Where slab cross-sections change, they shall be so gradually, and the effects or pressure distribution on the thinner portions of the slab cross-section shall be considered.

2) Materials.

a) Strength: All Type A integrally waterproofed concrete shall have a seven-day compressive strength of at least 3,000 psi and a 28 days compressive strength of 4,000 psi.

b) Waterproofing Admixtures: If an approved waterproofing admixture is used, the cement content required to achieve the strength specifications may not be reduced by more than 10%. Approved admixtures shall not reduce the compressive strength of the concrete and shall act as a densifier and/or to increase workability.



NON-RIGID PERIMETER WALL AND FLOOR SLAB CONNECTIONS

Figure 4

c) Joints: Expansion joints shall be keyed and provided with waterstops. Construction joints shall be provided with waterstops and shall be thoroughly roughened and cleaned before continuation of concrete placement.

d) Protection of Fresh Concrete: When potentially aggressive ground water conditions exist, the Building Official may require the protection of fresh concrete from contact with ground water for a minimum of 14 calendar days. Protection shall be accomplished either by the removal of ground water or by the application of a temporary membrane or surface coating (e.g. bitumen or tar emulsion) which, however, need not meet standards for permanent protection.

(d) Type A Interior Linings. A Type A interior lining forms a continuous internal impervious barrier to protect a structure with a concrete floor slab and concrete or reinforced concrete masonry unit walls. All Type A interior linings shall conform to the following requirements for structural prerequisites, materials, and installation.

1) Structural Prerequisites.

a) Continuity of Structure: Structural slabs below grade shall be continuous under perimeter walls to prevent differential settlement and shall be designed to act monolithically with the walls; reinforced concrete masonry unit walls shall be connected rigidly to slabs with reinforcing steel. Where conventional footings are necessary to achieve bearing below the frost line, the structural slab shall be formed monolithically with the walls or anchored into the walls by means of a keyway and rein-

forcing steel so as to act monolithically with the wall.

b) Columns: Where columns occur, there shall be no vertical discontinuity or abrupt change in slab cross-sections. Where slab thicknesses change, they shall do so gradually, and the effects of pressure distribution on the thinner portions of the slab cross-section shall be considered.

c) Deflections: To prevent cracking of the interior lining, the maximum deflection of any structural slab or perimeter wall to which the lining is applied shall not exceed 1/500 of its shorter span.

2) Materials. For the purpose of these Regulations, an interior lining shall be any continuous coating, parging, or rendering of a cementitious or other approved waterproofing material or compound with adequate structural strength and impermeability to serve its intended purpose. All relevant ASTM standard shall apply to Type A interior lining materials.

a) Permeability: Type A interior linings shall permit the passage of no more than three (3) pounds of water per 1,000 square feet in 24 hours at 40 psi.

3) Installation.

a) Application: All Type A interior lining waterproofing shall be applied by a certified roofing or waterproofing contractor.

b) Turns: Turns at corners, both vertical and horizontal, shall be made with fillets of not less than two (2) inches dimension on any side.

c) Pipes: Points where pipes or ducts penetrate water-proofed construction shall be designed to be watertight in accordance with accepted engineering practice.

d) Joints: Interior linings shall be continuous across expansion, control and construction joints, which shall have waterstops of rubber, copper, plastic, or other suitable material.

e) Vertical Extent: Interior linings on walls shall extend at least three (3) inches above the RFD of the protected space.

Section 6.04 - Type B Constructions

(a) Permeability. Type B waterproofing constructions shall be substantially impermeable but may pass water vapor and seep slightly during flooding to the RFD. Large cracks, openings, or other channels that could permit unobstructed passage of water shall not be permitted. In

no case shall there be permitted the accumulation of more than four (4) inches of water depth in such a space during a 24 hour period if there were no devices provided for its removal. However, sump pumps shall be required to control this seepage.

(b) Upgrading Existing Spaces. Spaces with Type B waterproofing construction may be upgraded to Type A through the installation of a continuous exterior or interior lining or a combination of both which the Building Official may approve as meeting the requirements for permeability of Type A waterproofing.

1) Inspections. The Building Official shall make inspections prior to and upon completion of this work before approving the completed work as meeting Type A waterproofing requirements. The Building Official may require that tests be made to demonstrate the adequacy of the work before granting this approval.

Section 6.05 - Type C Constructions.

(a) Non-Waterproofed. Type C waterproofing constructions are any which do not satisfy the requirements for Type A or B in 6.03 and 6.04, respectively.

(b) Upgrading of Spaces. Non-waterproofed spaces may be upgraded to Type A or B waterproofing when the Building Official shall approve such work as meeting the standards for Type A or B, respectively.

1) Inspections. The Building Official shall make inspections prior to, during, and upon completion of this work before approving the improvement of Type A or B waterproofing, and may require tests be made to demonstrate the adequacy of the work before granting this approval.

Section 6.06 - Type D Constructions.

(a) Permeability. Type D waterproofing construction shall be substantially impermeable to the passage of free ground water. This type of waterproofing relies on the low permeability of the soils to retard the seepage of flood waters to the Flood Protection Elevation. At least two (2) coatings of the waterproofing material shall be applied and it shall be of the type manufactured by Southwest Grease, Kansas City, Missouri, under the name of fortress foundation coating or equal.

(b) Existing Spaces. Existing spaces which meet the requirements of this section shall be so classified.

(c) Construction Standards. Figure 2 is an example of the type of construction required by this type of construction. This shall not be construed as a design but only as an example. The Owner may engage the services of a licensed Engineer or Architect for the purpose of design. These standards are minimum standards.

Chapter 7
Structural Requirements

GENERAL

Section 7.01 - All Buildings and structures, covered by these Regulations and all parts thereof, shall be capable of resisting all loads required by "The Building Code" and, in addition, all loads prescribed in this chapter, without exceeding the prescribed allowable stresses.

CLASSES OF LOADS

Section 7.02

(a) Class 1 Loads. Reflect the probable effects of flooding on structures which are waterproof (W 1 or W 2). These loads shall be calculated in complete accordance with this Chapter and shall include all water, impact, and soil loads specified herein.

(b) Class 2 Loads. Reflect the probable effects of flooding on structures which include internal flooding as a means of structural protection and which shall be so flooded in accordance with Chapter 9. These loads shall be calculated in accordance with this Chapter except that only hydrodynamic and impact loads must be considered with the interior and exterior water levels are equal.

(c) Class 3 Loads. Apply to buildings or structures which are to be flooded with flood water either internally by automatic means or externally in partially exposed areas. For such internal flooding, Class 3 loads shall coincide with those of Class 2. For partially exposed spaces, however, any dependent or supporting structural components shall be designed for Class 1 or 2 loads if they are also structural components of any adjacent enclosed space, whichever is required; isolated or free-standing columns or walls shall meet all criteria of 7.12-(b)-3).

(d) Class 4 Loads. Those loads required by the Building Code.

WATER LOADS

Section 7.03

(a) Types. Water loads, as defined herein, are loads or pressures on surfaces of the buildings and structures caused and induced by the presence of flood waters. These loads are of two basic types: hydrostatic and hydrodynamic.

(b) Hydrostatic Loads. Hydrostatic loads are those caused by water either above or below the ground surface, free or confined, which is either stagnant or moves at very low velocities, or up to five (5) feet per second. These loads are equal to the product of the water pressure times

the surface area on which the pressure acts. The pressure at any point is equal to the product of the unit weight of water (62.5 pound per cubic foot) multiplied by the height of water above the point or by the height to which confined water would rise if free to do so. Hydrostatic pressures at any point are equal in all directions and always act perpendicular to the surface on which they are applied. For the purpose of these Regulations, hydrostatic loads are subdivided into the following types:

1) Vertical Loads. These are loads acting vertically downward on horizontal or inclined surfaces of buildings or structures, such as roofs, decks or floors, and walls, caused by the weight of flood waters above them.

2) Lateral Loads. Lateral hydrostatic loads are those which act in a horizontal direction, against vertical or inclined surfaces, both above and below the ground surface and tend to cause lateral displacement and overturning of the building, structure, or parts thereof.

3) Uplift. Uplift loads are those which act in a vertically upward direction on the underside of horizontal or sloping surfaces of buildings or structure, such as basement slabs, footings, floors, decks, roofs and overhangs. Hydrostatic loads acting on inclined, rounded or irregular surfaces may be resolved into vertical or uplift loads and lateral loads based on the geometry of the surfaces and the distribution of hydrostatic pressures.

(c) Hydrodynamic Loads. Hydrodynamic loads, for the purpose of these Regulations, are those induced on buildings or structures by the flow of flood water moving at moderate or high velocity around the buildings or structures or parts thereof, above ground level. Such loads may occur below the ground level when openings or conduits exist which allow free flow of flood waters. Hydrodynamic loads are basically of the lateral type and relate to direct impact loads by the moving mass of water, and to drag forces as the water flows around the obstruction. Where application of hydrodynamic loads is required, the loads shall be computed or estimated by recognized and authoritative methods. Methods of evaluating water velocities and related dynamic effects are beyond the scope of these Regulations, but shall be subject to review and approval by the Building Official.

1) Conversion to Equivalent Hydrostatic Loads. For the purpose of these Regulations, and for cases when water velocities do not exceed 10 feet per second, dynamic effects to the moving water may be converted into equivalent hydrostatic loads by increasing the depth of water to the RFD by an amount dh, on the headwater side and above the ground level only, equal to:

$$dh = \frac{a\ v^2}{2g}, \quad \text{where}$$

V is the average velocity of the water in feet per second;
g is the acceleration of gravity; 32.2 feet per second per second;
a is the coefficient of drag of shape factor. (The value of a, unless otherwise evaluated, shall not be less than 1.25)

The equivalent surcharge depth dh shall be added to the depth measured between the design level and the RFD and the resultant pressures applied to, and uniformly distributed across, the vertical projected area of the building or structure which is perpendicular to the flow. Surfaces parallel to the flow or surfaces wetted by the tailwater shall be considered subject to hydrostatic pressures for depths to the RFD only.

(d) Intensity of Loads.

1) Vertical Loads. Full intensity of hydrostatic pressure caused by a depth of water between the design level and the RFD applied on all surfaces involved.

2) Lateral Loads. Full intensity of hydrostatic pressures caused by a depth of water between the design elevation(s) and the RFD applied over all surfaces involved, both above and below ground level, except that for surfaces exposed to free water, the design depth shall be increased by one foot.

3) Uplift. Full intensity of hydrostatic pressures caused by a depth of water between the design level and the RFD acting on all surfaces involved, unless provisions are made to reduce uplift intensities as permitted in Section 7.11

4) Hydrodynamic Loads. Hydrodynamic loads, regardless of method of evaluation, shall be applied at full intensity over all above ground surfaces between the ground level and the RFD.

(e) Applicability. For the purpose of these Regulations, hydrostatic loads shall be used in the design of buildings and structures exposed to water loads from stagnant flood waters, for conditions when water velocities do not exceed five (5) feet per second, and for buildings and structures or parts thereof not exposed or subject to flowing water. For buildings and structures, or parts thereof, which are exposed and subject to flowing water having velocities greater than five (5) feet per second, hydrostatic and hydrodynamic loads shall apply.

IMPACT LOADS

Section 7.04

(a) Types. For the purpose of these Regulations, impact loads are those which result from floating debris, ice, and any floatable object or mass carried by flood waters striking against buildings and structures or parts thereof. These loads are three basic types: normal, special and extreme.

1) Normal Impact Loads. Normal impact loads are those which relate to isolated occurrences of logs, ice blocks or floatable objects of normally encountered sizes striking buildings or parts thereof.

2) Special Impact Loads. Special impact loads are those which relate to large conglomerates of floatable objects, such as broken up ice floats and accumulation of floating debris, either striking or resting against a building, structure, or parts thereof.

3) Extreme Impact Loads. Extreme impact loads are those which relate to large floatable objects and masses such as runaway barges or collapsed buildings and structures, striking the building, structure or component under consideration.

(b) Applicability. Impact loads shall be considered in the design of buildings, structures and parts thereof as stipulated below:

1) Normal Impact Loads. A concentrated load acting horizontally at the RFD or at any point below it, equal to the impact force, produced by a 1,000 pound mass traveling at the velocity of the flood water and acting on a one (1) square foot surface of the structure.

2) Special Impact Loads. Where special impact loads are likely to occur, such loads shall be considered in the design of buildings, structures, or parts thereof. Unless a rational and detailed analysis is made and submitted for approval by the Building Official, the intensity of load shall be taken as 100 pounds per foot acting horizontally over a one-foot wide horizontal strip of RFD or at any level below it. Where natural or artificial barriers exist which would effectively prevent these special impact loads from occuring, the loads may be ignored in the design.

3) Extreme Impact Loads. It is considered impractical to design buildings having adequate strength for resisting extreme impact loads. Accordingly, except for special cases when exposure to these loads is highly probable and the resulting damages are extremely severe, no allowances for these loads need be made in the design.

SOIL LOADS

Section 7.05

(a) Applicability. Full consideration shall be given in the design of buildings, structures and parts thereof, to the loads of pressures resulting from the presence of soils against or over the structure. Loads or pressures shall be computed in accordance with accepted engineering practice, giving full consideration to the effects that the presence of flood water, above or within the soil, has on loads and pressures. When expansive soils are present, the Building Official may require that spec-

ial provisions be made in foundation and wall design and construction to safeguard against damage due to this expansiveness. He may require a special investigation and report to provide these design and construction criteria.

LOADING CONDITIONS

Section 7.06

(a) Applicability. Buildings and structures, covered by these Regulations, and all parts thereof, shall be designed for all loads and loading conditions required by "The Building Code" for the prevalent state of loading when the structure is not subject to flood loads. In a separate analysis, the effects of flood related loads and loading conditions shall be calculated. Maximum values of loads and member stresses shall then be computed under the combined effects of the normal loads required by "The Building Code" and those of flood related loads. The buildings, structures, and all structural members or components thereof shall be capable of resisting these maximum loads and stresses without exceeding the prescribed allowable stresses.

COMBINED LOADS

Section 7.07

(a) Applicability. All loads stipulated in "The Building Code" and all flood related loads shall be applied on the structure and on structural components, alone and in combination, in such a manner that the combined effect will result in maximum loads and stresses on the structure and members. Loads required by "The Building Code" shall be used in combination with flood related loads defined in this chapter to the extent and subject to the exceptions stated below.

1) Dead Load. Use at full intensity.

2) Live Load. Use at reduced intensity as provided in "The Building Code" for design of columns, piers, walls, foundations, trusses, means, and flat slabs. Live loads on floors at or below RFD and particularly on basement slabs, shall not be used if their omission results in greater loading or stresses on such floors. Similarly, for storage tanks, pools, bins, silos and other similar structures designed to contain and store materials, which may be full or empty when a flood occurs, both conditions shall be investigated in combination with flood related loads of the containing structure being full or empty.

3) Snow Load. Use at full intensity.

4) Wind Load. Use at full intensity as required in "The Building Code" on areas of the building and structure above the RFD.

5) Earthquake Load. Combined earthquake and flood related loads need not be considered.

ALLOWABLE STRESSES

Section 7.09

(a) Applicability. Allowable stresses for all materials shall be as stipulated in "The Building Code". Except as otherwise permitted by "The Building Code", only basic allowable stresses shall be used under flood related loads or combined loads, and those allowable stresses shall in no way be increased or permitted to be used in an "overstress" condition.

ALLOWABLE SOIL PRESSURES

Section 7.08

(a) Applicability. Under flood conditions, the bearing capacity of submerged soils is affected and reduced by the buoyancy effect of the water on the soil. For foundations of buildings and structures covered by these Regulations, the bearing capacity of soils shall be evaluated by a recognized acceptable method. Expansive soils should be investigated with special care. Soils which lose all bearing capacity when saturated, or become "liquified", shall not be used for supporting foundations. If a detailed soils analysis and investigation is not made, and if bearing capacities of the soils are not evaluated as required above, allowable soil pressures permitted in "The Building Code" may be used, provided those values are reduced 10%.

STABILITY

Section 7.10

(a) Overturning. All buildings and structures covered by these Regulations and all parts of elements thereof shall be proportioned to provide a minimum factor of safety of 1.50 against failure by sliding or overturning when subjected to flood related loads or combined loads defined under 7.07. The required stability shall be provided by the normal resistance between the foundations and the soil, passive earth pressure, batter and vertical piles and permanent anchors which may be provided. For the purpose of providing stability, only the dead load shall be considered effective. No use shall be made of any resistance, either as weight or frictional or passive, from soils which could be removed or displaced by excavation, scour or other causes. Similarly, no use shall be made of frictional resistance between the foundation and the underlying soil in the case of structures supported on piles.

(b) Flotation. The building or structure, and all appurtenances or

components thereof not rigidly anchored to the structure, shall have enough weight (deadload) to resist the full or reduced hydrostatic pressures and uplift from flood water at the RFD with a factor of safety of 1.33. For provisions governing reduced uplift intensites, see 7.11. In cases when it is not practical to provide the required factor of safety against flotation by weight alone, the difference shall be made up by providing dependable and permanent anchors that meet the approval of the Building Official. Elements which depend on anchorage to other portions of the structure shall be anchored to a portion or portions of the structure which has the required factor of safety against flotation from all contributing elements subject to uplift and resisting forces shall be made by a recognized method of structural analysis in accordance with accepted engineering practice.

(c) Anchorage. Any building and structure as a whole, which lacks adequate weight and mass to provide the required factors of safety against overturning, sliding, and flotation, shall be dependably and permanently anchored to the ground and preferably to underlying sound rock formations. In addition, all elements of a building or structure, such as walls, floor slabs, girders, beams, columns and other members, shall be dependably connected or anchored to form an adequate structural system to support the individual members and all the applied loads. Provisions of adequate anchorage is also essential and required for all tanks and vessels, sealed conduits and pipes, lined pits and sumps and all similar structures which have negligible weight of their own.

REDUCTION OF UPLIFT PRESSURES

Section 7.11

(a) General. Uplift forces, in conjunction with lateral hydrostatic forces, constitute the most adverse flood related loading on buildings and structures and elements thereof. Their combined effect determines to a major extent the requirements for weight and anchorage of a structure as a whole to assure its stability against flotation, sliding and overturning. When uplift forces are applied to structural elements of a building or structure, such as footings, walls, and particularly basement slabs, they generally constitute the critical loading on such elements. In the interest of providing economical solutions to the bacis problem of structurally flood-proofing buildings and structures, it is permissible under these Regulations to make provisions for effectively reducing uplift forces acting under the structure. The plan and design data submitted to the Building Official for approval shall show complete and detailed procedures, assumptions, analyses and design information, and specific provisions to be incorporated in the work for accomplishing the proposed reduction in uplift. Data and design procedures shall be based on recognized and acceptable methods of foundation drainage and waterproofing. Such provisions shall include, but are not limited to, the following items, used alone or in combination, as conditions will dictate.

(b) Impervious Cutoffs. Impervisous cutoffs are barriers installed

below the ground line and externally to the perimeter of the building or structure for the purpose of decreasing seepage quantities and/or reducing exit gradients. Such cutoffs must, in all cases where flood waters will rise above the ground level, be connected by suitable impervious blankets or membranes to the walls of the building or structure. Cutoffs may consist of interlocking steel sheeting, compacted barrier or impervious soil, grouted or injected cutoffs, imprevious wall of interconnected concrete piles or panels, and similar seepage barriers, used alone or in combination.

(c) Foundation Drainage. Where impervious cutoffs are provided or where suitable foundation conditions exist, drainage and relief of uplift pressures under buildings and structures can be achieved. These foundation materials must be free-draining and have the desired degrees of permeability. For the purpose of these Regulations, foundation drainage is intended to consist of the provision of drainage blankets, trenches, and, in all cases, drain tiles or perforated drain tiles or perforated drain pipes adjacent to footings and under floor slabs. Other methods of foundation drainage, such as by means of sumps, well points, or deep wells can be used for special applications. Drain pipes shall discharge into a sump or suitable collection structure, where the water is collected and ejected by sump pumps.

(d) Sumps and Pumps. Spacing, sizing and determination of depth of sumps shall be consistent with and correlated to the intended drainage system, the estimated amount of seepage and drainge yield.

REQUIREMENTS FOR OTHER FLOODPROOFING METHODS

Section 7.12

(a) Methods. A building shall be considered as being completely flood-proofed if the lowest elevation of all space(s) within the building perimeter is above the RFD as achieved by:

1) building on natural terrain beyond the RFD limit line on natural undisturbed ground,
2) building on fill,
3) building on stilts,
4) protection by dikes, levees and/or flood walls.

These methods may be used or in combination to achieve the required edge of flood-proofing. Data and design procedures shall, in all cases, be based on recognized and acceptable methods of the applicable disciplines involved, and the following additional requirements.

(b) Floodproofing By Elevating the Building

1) Natural Terrain. In addition to the requirements of "The Building Code", the building shall be located not less than 15 feet back from

the line of incidence of the RFD on the ground, foundation design shall take into consideration the effects of soil saturation on the performance of the foundation, the effects of flood waters on slope stability shall be investigated, normal access to the building shall be by direct connections with areas above the RFD and all utility service lines shall be designed and constructed as required to protect the building and/or its components from damage or failure during a flooding event to the RFD.

2) Building On Fill. The building and all parts thereof may be constructed above the RFD on an earth fill. Prior to placement of any fill or embankment materials, the area upon which fill is to be placed, including a five-foot strip measured horizontally beyond and contiguous to the toe line of the fill, shall be cleared of standing trees and snags, stumps, brush, down timber, logs and other growth, and all objects including structures on and above the ground surface or partially buried. The area shall be stripped of topsoil and all other material which is considered unsuitable by the Building Official as foundation material. All combusible and noncombustible materials and debris from the clearing, grubbing and stripping operations shall be removed from the proposed fill area and disposed of at locations above the RFD and/or in the manner approved by the Building Official. Fill material shall be of a selected type, preferably granular and free-graining, placed in compacted layers. Fill selection and placement shall recognize the effects of saturation from flood waters on slope stability, uniform and differential settlement, and scour potential. The minimum elevation of the top of slope for the fill section shall be at the RFD. Minimum distance from any point of the building perimeter to the top of the fill slope shall be either 15 feet or twice the depth of fill at that point, whichever is the greater distance. This requirement does not apply to roadways, driveways, playgrounds, and other related features which are not integral and functional parts of the building proper. Fill slopes for granular materials shall be no steeper than one vertical on one and one-half horizontal, unless substantiating data justifying steeper slopes are submitted to the Building Official and approved. For slopes exposed to flood velocities of less than five (5) feet per second, grass or vine cover, weeds, bushes and similar vegetation undergrowth will be considered to provide adequate scour protection. For higher velocities, stone or rock slope protection shall be provided.

3) Building on "Stilts". The building may be constructed above the RFD by supporting it on "stilts" or other columnar type members, such as columns, piers, and in certain cases, walls. Clear spacing of support members, measured perpendicular to the general direction of flood flow shall not be less than eight (8) feet apart at the closet point. The "stilts" shall, as far as practicable, be compact and free from unnecessary appendages which would tend to trap or restrict free passage of debris during a flood. Solid walls, or walled in columns are permissible if oriented with the longest

dimension of the member parallel to the flow. "Stilts" shall be capable of resiting all applied loads as required by "The Building Code" and all applicable flood related loads as required herein. Bracing, where used to provide lateral stability, shall be of a type that causes the least obstruction to the flow and the least potential for trapping floating debris. Foundation supports for the "stilts" may be of any approved type capable of resisting all applied loads, such as spread footings, mats, piles and similar types. In all cases, the effect of submergence of the soil and additional flood water related loads shall be recognized. The potential of surface scour around the stilts shall be recognized and protective measures provided, as required.

(c) Protection By Dikes, Levees, and Floodwalls. The building shall be considered a flood-proofed type when it is protected from flood waters to the RFD by means of dikes, levees, or floodwalls, either used alone or in combination, as necessary. This protection may extend all around the building where all surrounding ground is low, or on one or more sides where high ground (above the RFD) exists on the remaining sides. Regardless of type and method of construction, dikes, levees, and floodwalls shall be designed and constructed in accordance with recognized and accepted engineering practice and methods. They shall have adequate strength and stability to resist all applied loads and shall provide an effective watertight barrier up to the RFD.

1) Dikes and Levees. Dikes and levees shall be constructed of suitable selected materials, place and compacted in layers to a section that has the required stability and impermeability. Prior to start of placement operations, the area on which the dike or levee is to be constructed shall be prepared as required by 7.12-b)-2). In cases where underlying materials are highly pervious, it may be necessary to provide impervious cutoffs. A filter blanket, drainage ditch and/or trench shall be provided along the interior toe of the construction to collect seepage through the dike or levee. All seepage and storm drainage shall be collected at a sump or sumps where it may be pumped through the dike or levee. All seepage and storm drainage shall be collected at a sump or sumps where it may be pumped out over the dike. Normal surface runoff within and into the dikes area during nonflooded periods may be discharged through appropriate drainage pipes or culverts through the dike. Such culverts shall have a dependable flap, slide gate, or backflow preventing device which would close either automatically or manually to prevent backflow during a flood. Scour protection measures for dikes and levees shall comply with the requirements of 7.12-b)-2). Clearance from the toe to the dike or levee to the building shall be a minimum of 20 feet or twice the height of the dike or levee above the interior finished grade, whichever is greater.

2) Floodwalls. Floodwalls may be constructed of concrete, steel sheet piling, or other suitable structural materials. Regardless of type, the wall shall have adequate strength and stability to

resist the applied loads. The provision of 7.12-c)-1) shall be followed, as applicable, regarding removal of unsuitable materials, provision of impervious cutoffs, provision of seepage and storm drains, drainage ditches, sumps and sump pumps, and the minimum clearances from the floodwall to the building. It shall be recognized in the drainage provisions that substantial amounts of leakage may occur through the interlock of a steel sheet piling wall. Adequate expansion and contract joints shall be provided in the walls. Expansion joints will be provided for all changes in wall direction. Contraction and expansion joints in concrete walls shall be provided with waterstops and joint sealing material both in the stem and in the base. Steel sheet piling walls may be encased in concrete for corrosion protection or shall be coated with a coat tar epoxy coating system and periodically inspected and maintained. Steel sheet piling walls may be used as the impervious core of a dike.

PROVISIONS OF SAFE REFUGE

Section 7.03

(a) New Buildings and Structures. Every building or structure hereafter erected, that is located in the Special Flood Hazard Area where the ground surface is 1 foot or more below the R.F.D., or where flood water velocities may exceed 5 feet per second, shall be provided with an enclosed refuge space above the R.F.D. of sufficient area to provide for the occupancy load a minimum of 12 square feet per person. It shall be provided with one or more exists through the exterior walls above the R.F.D. to an exterior platform and stairway not less than 3 feet wide. Said stairway to terminate on grade at an elevation above the R.F.D.

(b) Buildings or Structures Hereafter Altered. Existing buildings and structures in the Special Flood Hazard Area that are subject to flood conditions described in (a) and which are hereafter enlarged, extended or altered or where change of use or occupancy shall be made, shall conform to all provisions of new buildings and structures required by (a).

Chapter 8
Closure Of Openings

GENERAL

Section 8.01 - Openings in exterior and interior walls of buildings or structures in a Flood Hazard Area which are wholly or in part below the RFD shall be provided in waterproof closures meeting the requirements of this chapter.

TYPES OF CLOSURES

Section 8.02

(a) Classification. Closures shall be classified into five types according to their compatability with the waterproofing standards of the various floodproofing classes.

1) Type 1 Closures. Shall form a complete sealed barrier over the opening that is impermeable to the passage of water at the full hydrostatic pressure of a flood to the RFD.

2) Type 2 Closures. Shall form essentially dry barriers or seals, allowing only slight seepage during the hydrostatic pressure conditions of flooding to the RFD.

3) Type 3 Closures. Shall form barriers or seals that are impermeable to the passage of water-borne contamination under equalized pressure conditions.

4) Type 4 Closures. Shall form barriers to the passage of flood carried debris and the loss of floating items from the interior, but not required to form impermeable seals.

5) Type 5 Closures. Are those of existing spaces which do not meet the requirements of any of the above described types, but are in use as required by "The Building Code".

REQUIREMENTS

Section 8.03

(a) Design Standard For Closure Assemblies. The structural capacity of all closures shall be adequate to support all flood loads acting upon its surface. Closure assemblies may be fabricated of cast iron, steel, aluminum, or other adequate and durable structural material, provided with a continuous support around its perimeter, and shall be attached to the building or structure at its immediate location of use i.e.; hinged, on slides, or in a vertical recess. The closure device shall be capable of being set in place with minimal manual effort. Seals, where required,

shall be gasketed pressure types permanently anchored or attached to the structure or to the closure assembly. Closures designed to lift into vertical recesses for storage when not in use, and/or located so that the open position of the assembly will not impead fire exit or the functioning of fire closure assembly, shall be supported in the open position by auxiliary supports or safety latches that can be released at times of flooding. In the closed position the closure assembly shall engage fixed wedging blocks that will force the closure into a tight sealing position. The entire closure assembly should be inspected by the owner anually and suitably maintained to preserve its waterproof and structural quality, or be replaced as required.

(b) Frames For Openings. Each opening below the RFD shall have a metal frame suitable for providing an adequate sealing surface and for supporting and floodproofing closures assembly. The frame shall be connected to the adjacent walls and floors and provide adequate bearing surface and anchorage to transfer the panel loading into the wall. It shall be supported upon adjacent floor or wall intersections or sufficient reinforcement shall be provided around the opening in the concrete or masonry wall to transfer the panel load to such intersections as required.

(c) Openings In Shafts. All buildings or structures which have inclosing walls, decks, or shafts with horizontal or inclined openings at the top that are at or below the RFD and which would inundate W 1 or W 2 spaces shall be provided with Type 1 closure assemblies that can be readily positioned and secured to prevent entrance of flood waters. Construction of such openings shall provide for permanently affixed doors, wall extensions, gates, panels, etc., that are either hinged or on slide tracks to facilitate prompt and positive sealing of opening with only minimal manual effort. Windows, grilles, vents, door openings, etc., in the side walls of a shaft and below the RFD shall be provided with flood-proofing closures meeting the requirements of 8.02.

SPECIAL APPLICATIONS FOR CLOSURE ASSEMBLIES

Section 8.04

(a) Applicability. Residences, firms, businesses or institutions with fewer than 10 permanent employees' or spaces which are or would be unoccupied and unattended in their foreseeable normal operation for periods of greater than 72 hours shall not have any window, doorway, or other such opening any part of which is below the RFD unless at least one of the following conditions is met:

1) Type 1 and 2 closures are utilized and are fully automatic types.

2) Manually installed closure devices meeting requirements of the appropriate floodproofing class are provided and are installed in their protective position by the Owner at any time in the season of high flood danger during which the space will be unoccupied and

unattended for periods of longer than eight (8) hours. This requirement shall be considered in the Owner's Contingency Plan and noted by the Building Official on the permit and Certificate of Occupancy.

3) Watertight exterior walls, dikes, levees or floodwalls of adequate design (as specified in Chapter 7) are constructed to prevent flood waters up to the RFD from entering the structure or space.

Chapter 9
Internal Flooding and Drainage

GENERAL

Section 9.01 - The provisions of this chapter shall apply to the intentional flooding of buildings, structures, and spaces with water from potable or flood water sources for the purpose of balancing internal and external pressure to protect a structure and/or its components from damage or failure during floods up to the RFD.

INTENTIONAL FLOODING WITH POTABLE WATER

Section 9.02

(a) Applicability. Spaces to be intentionally flooded (W 3 spaces) to maintain a balanced internal and external pressure condition shall be filled automatically with potable water from a source provided by the Owner as required by 902-(b) and approved by the Building Official. This level of filling shall be equal to that of the external flood surface unless a reduction in the internal flooding level is requested in writing by the Owner, and such approval is granted by the Building Official. The Owner shall, together with the written request, submit sufficient evidence that full internal flooding is unnecessary to protect the structure. The potable water flooding system shall activate and operate automatically and completely without human intervention and shall act independently of the emergency flooding system utilizing flood waters as required for these spaces by 9.02-(c). An automatic drainage system shall also be provided that will assure positive drainage of the space(s) at a rate comparable to the reduction of exterior flood height when flood waters are receding.

(b) Potable Water Sources. At any location where disruption of water supply service from a public utility may occur, or such service may be deemed inadequate, the Building Official shall require the Owner to provide an independent source of potable water that will be stored at the location of the improvement. In areas with a history of multiple cresting, the Building Official may require that the supply of stored water be increased by a specified amount to cover this condition.

(c) Safeguard Against Failure of Potable Water Flooding System: Where intentional flooding with a potable water flooding system is used for maintaining the structural integrity of buildings, structures or spaces during flood events to the RFD, an emergency (back up) flooding system utilizing flood waters shall be provided and maintained in a state of readiness for automatic implementation in event of failure of the primary potable water flooding system. The emergency flooding system shall comply with all requirements of 9.03.

AUTOMATIC FLOODING WITH FLOOD WATER

Section 9.03

(a) Applicability. Spaces to be intentionally flooded with flood water (W 4) shall be provided with the necessary equipment, devices, piping, controls, etc. necessary for automatic flooding during the flood event and drainage of the space(s) when flood waters recede. The automatic flooding and drainage system(s) shall utilize approved piping materials and have sufficient capacity for raising or lowering the internal water level at a rate comparable to the anticipated rate of rise and fall of a flood that would reach the RFD. These pipe systems shall be directly connected to the external flood waters to maintain a balanced internal and external water pressure condition. Provisions shall be made for filling the lower portions of the structure first and for interconnections through or around all floors and partitions to prevent unbalanced filling of chambers or parts within the structures. All spaces below the RFD, shall be provided with air vents extending to at least two (2) feet above the elevation of the RFD to prevent the trapping of air by the rising water surface. All openings to the filling and drainage systems shall be protected by screens or grills to prevent the entry or nesting of rodents or birds in the system.

EMERGENCY FLOODING OF WATERPROOFED SPACES

Section 9.04

(a) Applicability. Spaces which have been waterproofed (W 1 or W 2) to the RFD shall be provided with an automatic internal flooding system meeting all requirements of 9.03 to maintain structural intergrity during floods which exceed the RFD elevation. Inverts shall be located at the RFD elevation unless an increase in invert elevation(s) above the RFD is requested in writing by the Owner, and approval is granted by the Building Official. Approvals shall not be granted by the Building Official until sufficient evidence has been furnished by the Owner that automatic internal flooding at the RFD elevation is not necessary to maintain structural integrity. Outlets for the drainage of water from water-proofed spaces shall be located properly to drain the water from all part of the spaces. To prevent the inflow of water at flood levels below the RFD each exterior drainage outlet shall be provided with a device for preventing backflow of water (flood) through the drainage system. Auxiliary outlets shall be provided as required to evacuate all water from upper floor levels before draining the lower spaces. All watertight walls shall be designed for an internal hydrostatic pressure equal to at least two (2) feet of differential head to provide for unknown factors that may cause malfunction of the required drains.

Chapter 10
Flooring

GENERAL

Section 10.01 - This chapter shall govern the design and use of floor systems and their constituent materials for buildings and structures located in a Flood Hazard Area.

BASIS FOR RESTRICTION

Section 10.02 - Floor systems and flooring materials are restricted according to their vulnerability to flood water. For the purpose of these Regulations, vulnerability of a given floor material may result from one or more of the following:

(a) Normal suspended floor adhesives specified for above grade use water soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.

(b) Flooring material contains wood or paper products.

(c) Flooring material is not resistant to alkali or acid in water.

(d) Sheet type floor coverings (linoleum, rubber, vinyl) restrict evaporation for non-W1 slabs.

(e) Flooring material is impervious but dimensionally unstable.

FLOORING CLASSIFICATIONS

Section 10.03

(a) Classes Of Flooring. Floor systems and flooring materials are divided into five classes according to their degree of vulnerability. Class 1 floorings require conditions of dryness provided by W 1 spaces. Class 2 floors require essentially dry spaces which may be subject to water vapor and slight seepage that is characteristic of W 2 spaces. Class 3 flooring may be submerged in clean water during periods of intenional flooding as provided by W 3 spaces. Class 4 floorings may be exposed to and/or submerged in flood waters in interior spaces and do not require special waterproofing protection. Class 5 floors are permitted for semi-inclosed or outiside uses with essentially unmitigated floor exposure.

1) Floors of a given class may be used in any application for which a lower numbered class is permitted by these Regulations unless specifically restricted by notation in the chart below. For example, concrete (a Class 5) may be used whenever floor of Class 1, 2, 3, 4 or 5 are permitted.

2) Classes Of Typical Flooring Materials. The following chart is intended as an aid to the Owner, Architect/Engineer and the Buiding Official in assessint the vulnerability of typical materials with respect to the criteria stated in 10.2 (e). In disputes arising over the merits of particular materials or methods of construction, the Building Official shall be guided by and decided on the basis of those criteria.

	Class
Asphalt tiles (A)	1
with asphaltic adhesives	3
Carpeting (glued-down types)	1
Carpeting (double-face tape)	2
Cement/bitumenous, formed-in-place	4
Cement/latex, formed-in-place	4
Ceramic tiles (A)	1
with acid and alkali-resistant grout	3
Chipboard	1
Clay tile	5
Concrete, precast or in situ	5
Concrete tile	5
Cork	1
Enamel felt-base floor coverings	1
Epoxy, formed-in-place	5
Linoleum	1
Magnesite (magnesium oxychloride)	1
Mastic felt-base flood coverings	1
Mastic flooring, formed-in-place	5
Polyurethane, formed-in-place	5
PVA emulsion cement	1
Rubber sheets (A)	1
with chemical-set adhesives (B)	5*
Rubber tiles (A)	1
with chemical-set adhesives (B)	4
Silicone floors, formed-in-place	5
Terrazzo	4
Vinyl sheets (homogeneous) (A)	1
with chemical-set adhesives (B)	5*
Vinyl tile (homogeneous) (A)	1
with chemical-set adhesives (B)	4
Vinyl tile or sheets (coated on cork or wood product backings)	1
Vinyl-asbestos tiles (semi-flexible vinyl) (A)	1
with asphaltic adhesives	4
Wood flooring or underlayments	1
Wood composition blocks, laid in cement mortar	2
Wood composition blocks, dipped and laid in hot pitch or bitumen	2

*Not permitted as Class 2 flooring

NOTES: (A) Using normally-specified suspended floor (i.e. above-grade) adhesives, including sulfite liquor (lgnin or "linoleum paste"), rubber/Asphaltic dispersions, or "alcohol" type resinous adhe-

sives (cumar, oleoresinous).

(B) e.g. epoxy - polyamide adhesives or latex-hydraulic cement.

Chapter 11
Walls and Ceilings

GENERAL

Section 11.01 - This chapter shall govern the design and use of wall and ceiling systems and their constituent materials for buildings and structures located in a Flood Hazard Area.

BASIS FOR RESTRICTION

Section 11.02 - Materials treated in this chapter are those which constitute interior walls and ceilings including their finishes and structural constructions upon which they depend such as sheathing and insulation, and are restricted according to their susceptibility to flood damage. For the purpose of these Regulations, susceptibility of a given interior material or construction is dependent on one or more of the following:

(a) Normal adhesives specified for above-grade use are water-soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.

(b) Wall or ceiling material contains wood, wood products, gypsum products, or other material which dissolves or deteriorates, loses structural integrity, or is adversely affected by water.

(c) Wall or ceiling material is not resistant to alkali or acid in water.

(d) Material is impervious but dimensionally unstable

(e) Materials absorb or retain water excessively after submergence.

WALL/CELING CLASSIFICATIONS

Section 11.03

(a) Classes Of Wall/Ceiling. Wall and ceiling systems and materials are divided into five classes according to the degree of vulnerability. Class 1 materials require conditions of dryness provided by W1 spaces. Class 2 materials require essentially dry spaces which may be subject to water vapor and slight seepage that is characteristic of W2 spaces. Class 3 wall and ceiling materials may be submerged in clean water during periods of intentional flooding as provided by W3 spaces. Class 4 materials may be exposed to and/or submerged in flood waters in interior spaces and do not require special waterproofing treatments of protection. Class 5 wall and ceiling materials are premitted for semi-inclosed or outside uses with essentially unmitigated flood exposure.

1) Materials of a given class may be used in any application for which a lower-numbered class is permitted by these Regulations. For example, concrete (a Class 5 wall/ceiling material) may be used whenever materials of Classes 1, 2, 3, 4 or 5 are permitted.

(b) Classes of Typical Wall/Ceiling Materials. The following chart is intended as an aid to the Owner, Architect/Engineer and the Building Official in assessing the vulnerability of typical materials with respect to the criteria stated in 11.02 (a-e). In disputes arising over the merits of particular products or of materials not listed below, the Building Official shall be guided by and decide on the basis of those criteria.

	Class
Asbestos-cement board	5
Brick, face or glazed	5
common	2
Cabinets, built in	
Wood	2
Metal	5
Cast stone (in waterproof mortar)	5
Chalkboard	
Slate, porcelainglass, nucite glass	5
Cement-asbestos	2
Composition, painted	2
Chipboard	1
Exterior Sheathing Grade	2
Clay tile	
Structural glazed	5
Ceramic veneer, ceramic wall tile-mortar set	4
Ceramic veneer, organic adhesives	2
Concrete	5
Concrete block	5
Corkboard	2
Doors	
Wood hollow	2
Wood, light weight panel construction	2
Wood, solid	2
Metal, hollow	5
Metal, Kalamein	2
Fiberboard panels, Vegetable types	
Sheathing grade (asphalt coated or impregnated)	2
Otherwise	1
Gypsum products	
Gypsum board	2
Keene's cement on plaster	2
Plaster, otherwise, including acoustical	2
Sheathing panels, exterior grade	2
Glass (sheets, colored tiles, panels)	4
Glass blocks	5

Hardboard	
Tempered, enamel or plastic coated	2
All other types	2
Insulation	
Foam or closed cell types	4
Batt or blanket types	1
All other types	2
Metals, non-ferrous (aluminum, copper or zinc tiles)	3
Ferrous	5
Mineral fiberboard	1
Plastic wall tiles (polystyrene, urea formaldehyde, etc.) with waterproof	
adhesives, pointed with waterproof grout	3
Set in water-soluble adhesives	2
Paint	
Polyester-epoxy and other waterproof types	4
All other types	1
Paperboard	1
Partitions, folding	
Metal	4
Wood	2
Fabric-covered types	1
Partitions, stationary	
Wood frame	4
Metal	5
Glass, unreinforced	4
Reinforced	4
Gypsum, solid or block	1
Rubber, mouldings and trim with epoxy-polyamide adhesive or latex-hydraulic cement	4
All other applications	1
Steel, (panels, trim, tile) with waterproof applications	5
With non-waterproof adhesives	2
Stone, natural solid or veneer, waterproof grout	5
Stone, artificial non-absorbent solid or veneer, waterproof grout	5
All other applications	2
Strawboard	
Exterior grade (asphalt-impregnated kraft paper)	2
All other types	1
Wall coverings	
Paper, burlap, cloth types	1
Wood	
Solid (board, sheets, or trim)	2
Plywood	
Exterior grade	2
Otherwise	1

Chapter 12
Contents of Buildings, Garages, Structures or Ancillary Spaces

GENERAL

Section 12.01 - This chapter shall govern the types of contents permitted and protection requirements for contents of spaces in buildings, garages, structures or ancillary spaces located in the Flood Hazard Area(a).

(a) The contents of an improvement consists of all items situated or placed within the confines of a space not permanently and structurally integral with the improvement. Electrical and mechanical equipment that is installed as a building services feature and/or required to be in operation during a flood is covered in Chapters 13 and 14. Contents are restricted by these Regulations whenever they are or potentially may be:

1) Hazardous to the general public welfare due to the possibility of spreading highly flammable, explosive, corrosive, or otherwise harmful substances in the event of a flood-induced spill.

2) Hazardous to the welfare of other Owners due to the creation of projectiles which could cause damage by impact.

3) Hazardous as in (1) and (2) above when stockpiled in quantity, although such items may be permitted if stored in lesser amounts for isolated or occasional use.

4) Hazardous to the health or safety of the Owner or to other persons occupying or in the vicinity of the improvement due to the possibility of explosion or electric shock caused by flood water contact with operating mechanical or electrical equipment.

5) Vulnerable as a loss to the Owner, necessitation replacement, extensive repair, and/or excessive period of inoperation resulting from prolonged exposure to moisture, clean water, flood water or the unmitigated effects of flooding.

(b) Storage of automobiles shall be allowed in garages or structures where they comply to Section 12.02 paragraph (b) and paragraph (c) of this chapter.

CLASSES OF CONTENTS

Section 12.02

(a) Applicability. Contents are divided into seven classes according to the degree of flood-proofing required to protect them from becoming hazards or losses as defined above.

1) Class XX items are extremely hazardous or vulnerable to flood conditions and require their prohibition in the Flood Hazard Area at all times.

2) Class X items are sufficiently hazardous or vulnerable to require their prohibition in all spaces below the RFD, i.e., requiring their placement at least one floor level above the RFD.

3) Class 1 items require the protection assured by W1 spaces.

4) Class 2 items require the protection assured by W2 spaces.

5) Class 3 items require only the protection assured by W3 spaces.

6) Class 4 items are generally not damageable by flood waters moving at low velocities and require the minimum protection given by W4 spaces.

7) Class 5 items are sufficiently non-hazardous and non-vulnerable to permit their placement in spaces exposed to unmitigated flooding conditions.

(b) Waiver of Restriction. Upon approval of the Owner's Contingency Plan, which shall include plans for temporary movement of items to a place of safe refuge above the RFD or in spaces below the RFD where these items are permitted, the Building Official may waive specific content restrictions for non-W1 spaces on non-hazardous items that are movable or for which the degree of water-proofing required by the flood-proofing class can be achieved upon receipt of a flood warning or alert. In no case shall a waiver of restriction be construed to permit the creation of spaces for human habitation.

(c) Contents Classes for Typical Items. The following chart is intended as an aid to the Owner, Architect/Engineer, and the Building Official of assessing the hazard potential and vulnerability to loss of typical contents of an improvement with respect to criteria listed in 12.01-(a)(1-5). In disputes arising over the classification of particular items or of items not listed below, the Building Official shall be guided by and decide on the basis of those criteria. In no case, however, shall changes of classification for items listed in Classes X and XX be permitted.

1) Contents of a given class may be situated or placed in any space for which a lower-numbered contents class is permitted by these Regulations. For example, items which are listed in Class 3 may also be placed in any spaces in which Class 1 or Class 2 contents are permitted.

2) Temporary placement of items of a given contents class in a

space with a higher-numbered flood-proofing class may be permitted in those cases where contingent removal is approved by the Building Official, and in conformance with 12.02-(b). Temporary placement may be permitted for certain items, subject further to the restrictions of 12.02-(b) as indicated by numbers in parenthesis in the list; in each case the number in parenthesis is that of the highest-numbered flood-proofing class in which temporary placement may be considered.

	Class
Acetone	XX
Acetylene gas containers	X
Ammonia	XX
Animals (pets, livestock, laboratory specimens)	X(5)
Appliances, electrical	
Washer-dryers, unit air conditioners, lamps refrigerators, sewing machines, electic clocks, etc.	2
Art works (paintings, sculpture, etc.)	1
Barrels, bouyant (emptry or non-hazardous contents)	2
Constrained and/or without tops or lids	4
Benzene	XX
Books, magazines, publications	1(3)
Cabinets,	
Solid wood or veneer	2
Metal	4
Calcuim carbide	XX
Carbon disulfide	XX
Cardboard boxes	1
Carpeting and floor rugs	1(3)
Celluloid	XX
Chlorine	XX
Clothing	2(3)
Cotton (loose)wadding or waste	2
Curtains and drapes	
Fabric (Non-Fast Dyes)	2
Fabric (Fast Dyes)	3
Plastics	4
Drugs - in quantity	X
Electrical distribution equipment (Storage only)	
Waterproof or submersible types	4
Non-waterproof	2
Protected contingently (B)	4
Electronic equipment (Storage only)	
Television, stereo equipment, radios	2(3)
Computers, etc.	1
Fabrics (Textile Raw Materials)	
Non-water-soluble dyes	3
Otherwise	2
Food Products	X
Furniture	

Upholstered	1
Unupholstered	
Wood construction (A)	2
Metal construction, painted	4
Gasoline	X
Hydrochloric acid	XX
Hyrodcyanic (Prussic) acid	XX
Magnesium	XX
Matches and sulfur products (in quantity)	X
Mattresses & box springs	1(2)
Musical instruments	
Pianos, organs, violins, etc.	1
All other types	2(3)
Nitric acid, oxides of nitrogen	XX
Oxygen	2(3)
Paints, enamels, varnishes (in quantity)	2
Paper or paper products	1
Petroleum products storage	
(unless buried and constrained)	X
Phosphorous	XX
Potassium	XX
Recreation equipment	
Sports gear, toys	2(3)
Pool tables	1
Scrap metal, constrained	5
Soaps, detergents (in quantity)	X
Sodium	XX
Sulphur	XX
Tires (open storage)	X
constrained	4
Wood products, raw or finished (in quantity)	X

NOTES: (A) Solid wood construction with pinned joints, reinforced corners, and lacquered or factory-baked finishes.
(B) Contingent protection shall be protection equal to that of 6 mils of polyethylene sealed to be watertight or "moth-balled".

Chapter 13
Electrical

GENERAL

Section 13.01 - Where buildings or parts of buildings and structures extent below the R.F.D., the electrical materials, equipment and installation shall conform to the requirements of this section of this Code, in addition to the requirements of the local, state and national electrical codes.

REQUIREMENTS AT LOCATION ABOVE AND BELOW THE R.F.D.

Section 13.02

(a) Main Power Service. The incoming main commercial power service equipment, including all metering equipment, shall be located above the R.F.D. Whenever a building or structure is not accessible by a bridge, walkway or other connecting means except by boat during periods of flooding to the R.F.D., a disconnecting means for the incoming main commercial power service shall be provided at an accessible remote location above the R.F.D.

(b) Stationary And Portable Equipment. Switchgear, control centers, transformers, distribution and main lighting panels in addition to all other stationary equipment shall be located above the R.F.D. Portable or movable electrical equipment may be located in any space below the R.F.D. provided that equipment can be disconnected by a single plug and socket assembly of the submersible type and rated by the manufacturer as submersible for not less than 72 hours for the head of water above the assembly to the R.F.D. All disconnect assemblies shall be provided with submersible seals attached to the disconnect assembly by means of a corrosion resistant metal chain for immediate use when needed to insure safety to all personnel during a flood. All portable or movable equipment should be de-energized and/or moved out of potentially flooded spaces at time of flood warning and prior to flood waters reaching floor levels where such equipment is located.

(c) Normal And Emergency Circuits. All circuits except emergency lighting circuits, extending into areas below the R.F.D. shall be energized from a common distribution panel located above the R.F.D. and be provided with ground fault circuit interrupters of the type detailed in Section 13.02-(d). All emergency lighting circuits into areas below the R.F.D. shall be energized from an independant distribution panel also located above the R.F.D. Each distribution panel shall have the capability of being de-energized by a separate single disconnecting device.

(d) Emergency Lighting Requirements. All areas of the building or structures that are below the R.F.D., where personnel may be required to conduct emergency operations or work with water present on the floor of the area during a flood, shall be provided with emergency lighting facil-

ities and electrical disconnect equipment to insure that all electrical circuits into these areas, except emergency lighting circuits, may be de-energized prior to personnel working in water. All components of emergency lighting systems installed below the R.F.D. shall be so located that no component of the emergency lighting system is within reach of personnel working at floor level in the areas where emergency lighting systems are utilized unless the emergency lighting circuits are provided with ground-fault circuit interrupters having a maximum leakage current to ground sensitivity of five (5) milliamperes. The energy of emergency lighting may be furnished by a storage battery(s), generator system, a separate service, connection ahead of the service disconnecting means, or a combination thereof, subject to the following provisions of this section.

1) Storage Battery (Including Battery Operated Lighting Units). Battery operated lighting units shall be completely self-contained and shall indicate the state of charge of the battery at all times. Lighting units shall automatically provide light when the normal source of lighting in the areas is de-energized. Sufficient number of emergency lighting units shall be provided to enable personnel to perform their assigned emergency tasks and to permit a safe exit to areas above the R.F.D.

2) Generator System. This shall be a complete self-sufficient system providing the automatic prime mover starting and transfer of emergency lighting loads to the generator upon failure of the normal power supply. When storage battery starting is used, there shall be an automatic charging means. A sufficient number of emergency lights shall be provided to enable personnel to perform their assigned emergency tasks and to permit a safe exit to areas above the R.F.D.

3) Separate Service. This source of energy shall have a degree of reliability that is satisfactory to the Building Official. This system shall provide two services separated electrically and physically to minimize the possibility of simultaneous interruptions of supply.

4) Connection Ahead Of Service Disconnecting Means. This source of energy shall have a degree of reliability that is satisfactory to the Building Official. Connections on the line side of the main service disconnecting means may be allowed if sufficiently separated from the main service disconnecting means to prevent simultaneous interruptions of supply through an occurence within the building or buildings served.

Since the degree of reliability required in dependant on many variables for each installation, the Building Official shall make the final determination on whether or not the design is adequate for each installation.

(e) Lighting Circuits Below Regulatory Floor Datum. Lighting circuits switches, receptacles and lighting fixtures operating at a maximum vol-

tage of 150 volts to ground may be installed below the R.F.D., provided that these circuits are in compliance with 13.02-(c). Should any switch, receptacle or lighting fixture be flooded, its particular circuit shall not be re-energized until such circuits and devices, and/or any part thereof, have been disassembled and thoroughly checked, cleaned or replaced, and approved for use by qualified personnel.

(f) Submersible Equipment. Except for the switches, receptacles and lighting fixtures noted herein, all other electrical equipment permanently installed below the R.F.D. shall be of the submersible type rated by the manufacturer for submergence for not less than 72 hours for a head of water above the equipment to the R.F D.

(g) Submersible Wiring Requirements. All electrical wiring systems installed below the R.F.D. shall be suitable for continuous submergence in water and shall contain no fiberous components. Only submersible type splices will be permitted in areas below the R.F.D. All conduits located below the R.F.D. shall be so installed that they will be self draining if subject to flooding conditions.

(h) Elevators. All electric power equipment and components of elevator systems shall be located above the R.F D. Automatic type elevators shall be provided with a home station to which the elevator will automatically return after use, with home station located above the R.F.D.

(i) Heating Equipment. Electric unit heaters installed below the R.F.D. shall be capable of disconnection and removal in the manner described for portable electrical equipment in 13.02-(b). Electric controls on gas and oil furnaces located below the R.F.D. shall not exceed 150 volts to ground and the control circuits shall be provided with ground fault circuit interrupters of the type detailed in 13.02-(d).

(j) Sump Pump Installation. Buildings and structures utilizing sump pumping equipment of any type to keep areas within the structure free of water shall be provided with float operated warning alarms that shall act independently of any other float actuating devices used to start and stop pumping equipment. The sump shall be supplied by a separate electrical circuit which shall be water-proofed and rated for submergence for not less than 72 hours at sufficient head.

Chapter 14
Mechanical

GENERAL

Section 14.01 - All mechanical systems, including heating, air conditioning, ventilating, plumbing, sanitary, and water systems, in or serving buildings or structures in a Flood Hazard Area shall be designed and installed to comply with the requirements of this chapter.

HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS

Section 14.02

(a) Applicability. Heating, air-conditioning, and ventilation systems, including all appurtenances, in buildings or structures in a Flood Hazard Area shall be designed and installed to comply with the requirements of these Regulations.

(b) Location. Heating, air-conditioning, and ventilating equipment should, to the maximum extent possible, be installed in areas and spaces of buildings that are above the R.F.D. When not feasible, said equipment shall be located in W 2 (below the R.F.D.) with direct access provided from a location above the R.F.D., and shall conform to all requirements of this Section.

1) Heating systems utilizing gas or oil fired furnaces shall have a manually operated gate valve provided in the fuel supply line for fuel cutoff when warning of flooding to the R.F.D. is received. The heating equipment and fuel storage tanks shall be mounted on and securely anchored to a foundation pad or pads of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. As an alternate means of protection, elevation of heating equipment and fuel storage tanks above the R.F.D. on platforms or by suspension from overhead structural systems will be permitted. All unfired pressure vessels will be accorded similar treatment. Fuel lines shall be attached to furnaces by a means of flexible or swing type couplings. All heating equipment and fuel storage tanks shall be vented to an elevation of at least two (2) feet above the R.F.D. Air supply for combustion shall be furnished if required for systems installed in W 2 spaces, and piping or duct work for such purpose shall be terminated at least two (2) feet above the R.F.D.

(a) All duct work for warm air heating systems which is located below the R.F.D. shall be provided with emergency openings for internal flooding

and drainage of the ducts with all openings having covers with gravity operators for closure during normal operation. Where duct work must pass through a water-tight wall or floor below the R.F.D., the duct work shall be protected by a mechanically operated closure assembly and shall be provided with the operator control position above the R.F.D. The closure assembly in its open position shall not impede the normal function of the heating system.

(b) Steam or hot water heating pipes located below the R.F.D., shall be provided with shut-off valves sufficient to isolate the piping system when warning of flooding to the R.F.D. is received.

(c) Electric heating systems, where utilized in Flood Hazard Areas, shall be installed in accordance with requirements in Chapter 13.

1) Air conditioning and ventilation systems that will be located below the R.F.D. shall be installed in W 2 spaces only. All installation, piping, duct work, connections, and safety features shall conform to the same requirements stated for Heating Systems in 14.02-(b)-1).

2) Where heating, air-conditioning, or ventilating systems (as defined in 14.02-(b) are installed in other than W 2 spaces, all hearings, seals, shafts, gears, clutches, valves, or controls which are not capable of withstanding water or silt damage or hydrostatic or hydrodynamic loading shall be provided with suitable protective waterproofing enclosures as may be required by the Building Official, unless they are considered expendable.

3) All fuel supply lines that originate either outside the W 2 spaces or pass through areas that would be flooded, shall be equipped with manual shut-off valves to prevent loss of fuel in the event of a line breakage. The wall opening shall be made flood-proofed by use in imbedded collars, sleeves, waterstops, or other means as may be approved by the Building Official.

PLUMBING SYSTEMS

Section 14.03

(a) Applicability. For the purpose of these Regulations, plumbing systems shall include sanitary and storm drainage, sanitary facilities, water supply, storm water and sewage disposal systems.

1) Except as otherwise provided herein, nothing in these Regulations shall require the removal, alteration, or abandonment of, not prevent the continued use of, an existing plumbing system.

2) No plumbing work shall be commenced until a permit for such work has been issued by the Building Official. Application for plumbing permits, denial of permit, time limitation on permits, and inspections shall be in accordance with requirements of this Code.

3) Plumbing materials shall be selected with due consideration given to the hydrostatic, hydrodynamic and chemical actions of flood waters on the interior of piping systems, of the soil, fill or other materials on the exterior of piping systems, on joints, connections, valves, traps, seals (and caulking), and fixtures.

(b) Below R.F.D. Sanitary sewer and storm drainage systems that have openings below the R.F.D. shall be provided with automatic back water valves or other automatic backflow devices that are installed in each discharge line passing through a building exterior wall.

1) Space in buildings that are to be protected from flood waters by implementation of the Owner's Contingency Plan may utilize standpipes attached to floor drains, cleanouts, and other openings below the R.F.D., and/or manually operated shut-off valves or closure devices.

2) Where the rate of dryness of a space is dependent on a sump pump system, or where the stability of a structure during a flood event depends on the relief of up-lift pressures on building components, all interior storm water drainage or seepage, appliance drainage, and underslab drain tile systems shall be directly connected to a sump (pump) and discharged at an elevation at least two (2) feet above the R.F.D. or into a storm drain.

(c) Sewage Disposal/Treatment. Individual sewage disposal and/or treatment facilities, except for cesspools and seepage pits, will be permitted in Flood Hazard Areas but only at locations where connections with a public sewer system is not possible or feasible. The design of such systems shall take into consideration their location with respect to wells or other sources of water supply, topography, water table, soil characteristics, available area for improvements, and the effects of flooding to the R.F.D. Installation in low swampy areas or areas with generally high water tables or which may be subject to periodic flooding will not be permitted.

1) Cesspools will not be permitted as permanent installations for sewage disposal, except that in those instances where connection to a public sewer system will be possible within one (1) year period the Building Official may approve such an installation as a temporary expedient. The one (1) year period shall expire on the anniversary date of the written approval of the Building Official. Because of the public health hazard involved, extreme care shall be exercised in locating the cesspool. Under no circumstances shall a cesspool be located closer than

150 feet to a water supply well or be permitted to penetrate the ground water stratum.

2) Seepage pits shall, for purposes of these Regulations, conform to the same requirements set forth above for cesspools.

(b) Water Supply. Potable water supply systems that are located in a Flood Hazard Area shall be designed and installed in such a manner as to prevent contamination from flood waters up to the R.F.D. No water supply well shall be located within the foundation walls of a building or structure used for human habitation, medical or educational services, food processing or public service type facilities.

1) Water supply wells, tanks, filters, softeners, heaters, and all appliances located below the R.F.D. shall be protected against contamination by covers, wells, copings, or castings. All vents shall be extended to a minimum elevation of two (2) feet above the R.F.D.

2) Approved backflow preventers or devices shall be installed on main water service lines at water wells and at all building entry locations to protect the system from backflow or back siphonage of flood waters or other contaminants in the event of a line break. Devices shall be installed at accessible locations and shall be maintained in good working condition by the person(s) responsible for maintenance of the water supply system.

3) Individual water supply wells that are utilized in Flood Hazard Areas shall be of either the drilled or driven type and located at a site slightly higher than surrounding ground levels to assure positive drainage from the well.

(a) Private potable water well supplies shall not be developed from a water table located less than 25 feet below the ground surface, nor from any deeper supply which may be polluted by contamination entering through fissured or crevice formations.

(b) Each well shall be provided with a water tight casing to a distance of at least 25 feet below the ground surface and shall extend at least one (1) feet above the well platform. Casings shall be large enough to permit installations of a separate drop pipe with a watertight seal between the drop pipe and the casing. Casings shall be sealed at the bottom in an impermeable stratum or extend several feet into the water bearing stratum.

(c) In the event that flood water contamination occurs in the water supply system, all potable water equipment, piping, water storage tanks, etc., shall be disinfected in the manner prescribed by paragraph 10.9 of the National Plumbing Code.

Chapter 15
Procedures

PURPOSE

Section 15.01 - The purpose of this chapter is to present and explain some practical aspects of flood-proofing and to show by means of examples and diagrams the effects of flood-related loads on structural elements of a building and other protective constructions. The structural elements discussed include concrete and masonry basement walls, concrete and masonry retaining walls, basement floor slabs, and closure panel assemblies. Also included are some concepts of foundation drainage, examples of floodwalls and dikes, and concepts of closure panels, devices and assemblies.

CRITICAL ASPECTS OF A FLOOD

Section 15.02

(a) General. No attempt is made here to provide an elaborate definition of the term flood nor to define a typical flood. Instead, critical aspects of a flood are listed below in the order of greatest importance as related to flood damages and their impact on flood-proofing measures.

(b) Depth. Depth of flood waters around a structure is by far the most critical element to be considered in planning and designing flood-proofing measures. The depth of flood waters determines to a great extent the strength and stability requirements for the structure as a whole and for individual structural elements below the design flood level. Except for very special structures and for massive or very high buildings, it is assumed herein that the maximum practical flood depth for which flood-proofing measures are economically effective is 10 feet of free water above grade for a building or structure having a 10 foot space or basement height below grade.

(c) Velocity. Velocity of flood water during overbank flow conditions affects scouring, sediment transportation, debris load, and dynamic loading on structures and obstructions. Flood velocities up to five (5) feet per second are not uncommon or unusual and their effects on structures may be dealt with by application of normal design methods and procedures. Velocities up to 10 feet per second could occur, particularly in close proximity to the channel, but are believed to be unusual and to require special methods and techniques. A velocity of 10 feet per second is considered to be the upper limit for which flood-proofing measures are economically effective, except for special structures and facilities built at the edge of a channel, where permitted.

(d) Duration. The duration of a flood, as measured from the time the stream overflows its banks, reaches its crest elevation, and then recedes to within its banks, is important from the standpoint of saturation of

soils and building materials, of seepage, achievement of full pressure in soils and under foundations, and other time dependent effects. In addition, the duration of the flood affects the provisions for standby utilities and services.

(e) Rate OF Rise And Fall. The rate or rise and fall of a flood to and from its crest affects the sizing of flooding and draining provisions, where such are required. It also effects in certain cases the implementation of contingent or emergency flood-proofing measures, and must be recognized in investigations of slope stability for a condition of quick drawdown.

(f) Advance Warning. The length of advance warning available from flood forecasting is all important, particularly in relation to contingent flood-proofing methods which require definite amounts of lead time for protective measures to be placed into effect.

(g) Debris Load. The amount and type of floating debris carried by the flood waters can result in substantial loads against buildings and can cause blockages of channels and passageways. Debris load includes logs, tree branches and trees, lumber, displaced sections of frame structures, drains, tanks, and runaway boats and barges. One type of floating solids borne by flood waters which is predominant in certain areas of the country during early spring floods consists of broken up ice blocks and at times of large masses of broken up ice sheets. Ice blockage of channels or ice jams that frequently occur in certain areas contribute sugnificantly to the flood hazard and related problems.

(h) Wave Action. A degree of wave action is inherent to all large expenses of water under the action of the wind. For typical riverine floods, wave action is nominal and allowances can be made for it by providing a suitable freeboard. Wave action is most significant for coastal floods which are caused by persistent storms, e.g. Nor'easters, tsunami waves or hurricanes. These cases beyond the scope of the Flood-Proofing Regulations and require special design considerations and procedures.

LOADS

Section 15.03

(a) General. Flood waters surrounding a structure induce hydrostatic and hydrodynamic loads on the structure itself. Hydrostatic loads (pressures) are induced by water which is either stagnant or moving at low velocity. Hydrodynamic loads result from the flow of water against and around a structure at moderate or high velocities. Impact loads are imposed on the structure by water borne objects and their effects become greater as the velocity of flow and the weight of objects increase.

(b) Hydrostatic Loads. These loads or pressures, at any point of flood

water contact with the structure, are equal in all directions and always act perpendicular to the surface on which they are applied. Pressures increase lineraly with depth of "head" of water above the point under consideration. The summation of pressures over the surface under consideration represents the load acting on that surface. For structural analysis purposes, hydrostatic loads are defined to act vertically downward on structural elements such as roofs, decks and similar overhead members having a depth of water above them; vertically upward or in uplift when they act at the underside of generally horizontal members such as slabs and footings and the net effect is upward; laterally when they act in a horizontal direction on walls, piers, and similar vertical structural elements. For the purpose of these Regulations, it has been assumed that hydrostatic conditions prevail for still water and water moving with a velocity of less than five (5) feet per second. It is estimated that hydrodynamic effects up to the stated velocity can be conservatively recognized in the freeboard allowance.

(c) Hydrodynamic Loads. As the flood waters flow around a structure at moderate to high velocities they impose additional loads on the structure. These loads consist of frontal impact by the mass of moving water against the projected width of the obstruction represented by the structure, drag effect along the sides of the structure and eddies or negative pressures on the downstream side. For the range of velocities discussed in 15.02-(e) (0-10 feet per second), it is considered most practical to make allowances for the hydrodynamic effects by converting them into an equivalent hydrostatic condition. For special structures, conditions, and for velocities greater than 10 feet per second, a more detailed analysis and evaluation should be made utilizing basic concepts of fluid mechanics and/or hydraulic models.

(d) Impact Loads. These loads are induced on the structure by solid objects and masses carried by or floating on the moving water surface. These loads are the most difficult to predict and define with any degree of accuracy, yet reasonable allowances must be made for these loads in the design of affected buildings and structures. To arrive at a realistic allowance, a great deal of judgment must be used, along with reliance on the designers experience with debris problems at the site, and consideration of the degree of exposure of the structure.

STRUCTURAL ELEMENTS

Section 15.04

(a) General. The following sections present a discussion of loading assumptions and design criteria for structural elements of buildings, such as basement and retaining walls, floor slabs and closure panels, under the effects of flood related loads. All the examples herein assume a "structurally" flood-proofed structures, (Classification W1 or W2 of the Regulations), where flood waters are prevented from reaching interior spaces and full imbalanced hydrostatic loads attain on the exterior of the structure. Secondary loading effects associated with flood waters,

such as wave action, debris loads and hydrodynamic loads are not included in this discussion.

(b) Basement Slabs. Under flood conditions, and often under normal non-flood conditions in cases where conditions of high water table prevail, basement slabs may be subjected to high uplift pressures. To overcome this condition, the slab can be made thick enough to have sufficient weight to counteract the uplift pressures. This solution is very seldom economical.

1) For relatively large, heavy structures, a more economical solution would be to design thinner reinforced concrete slabs that are tied into the footings, walls and columns, such that the overall weight of the structure is utilized in resisting the uplift forces acting on the floor slabs. This type of construction would then provide the additional stability required to prevent flotation and overturning of the structure from other flood loads. The slab (commonly referred to as mat or raft type construction) must be capable of resisting all applied loads and distributed pressures, either when uplift pressures are acting at full intensity, as in the case during a flood, or when such loads are non-existent, as could be the case under normal condition. Integral slab construction can be utilized equally well for buildings supported on piles. In these cases, column and wall loads are supported by the piles, and the uplift pressures are transferred by the reinforced slab to the columns and walls so as to utilize the building loads (weight) as the downward resistive force.

2) In many cases, however, where uplift pressures are excessive, the most practical solution would be to relieve (or reduce) these uplift pressures under the slab by providing adequate and dependable drainage, combined where necessary with impervious blankets and cutoffs on the outside of the structure.

(c) Basement And Retaining Walls. Under normal or nonflood conditions, the primary loading on basement and retaining walls consists of lateral soil pressure caused by the backfill material. For selected granular backfills and normal heights of the wall, this load is relatively small. Other secondary or associated loads on walls are lateral loads resulting from surcharge conditions, loads resulting from frost action, and any vertical or other applied loads which the wall is intended to resist. Under flood conditions, by far the most significant load on a wall is that caused by lateral hydrostatic pressures. This load amounts to several times the intensity of the normal loads and as such will govern the strength and stability requirements of the wall. Provisions of backfill drainage are commonly used to reduce water pressure behind a wall and are known to be effective for ground water control if carefully designed, constructed and maintained. In the case of walls subject to flood loading, a reduction in water pressure behind the wall is not considered practical nor dependable. When an infinite source of water exists and free water stands above grade, the most efficient drainage

provisions are likely to be inadequate. For cases where the wall is protected by impervious membranes, blankets and cutoffs, even a minimal rupture, separation or failure of the membrane or blanket, or cuttoff, can cause the attainment of full hydrostatic pressures on the wall and cause failure of an inadequately designed wall.

(d) Closure Of Openings. All exterior wall openings and other openings located below the RFD should be closed and sealed for effective flood protection. Existing structures shall be reviewed to assure that walls and supporting members can safely support the added pressures induced by closing the openings. Under no circumstances should a building be made watertight if the additional flood loads can not be satisfactorily transferred to the walls or supporting members. Closing the openings under these conditions may lead to a structural failure that could be much more serious than the damages resulting from unrestricted flooding. In designing new structures, all openings which are not necessary for proper functioning of the structure should be omitted, or at least kept to a minimum, both in number and size.

1) Openings should be provided with either permanent closures or closure assemblies that can be easily installed or positioned in an emergency flooding situation. Openings that are no longer necessary for building operation should be permanently closed and sealed. Permament closures can be accomplished with reinforced concrete plugs, concrete masonry units, or metal assemblies that are keyed or anchored to the existing wall and supports. Additional support and strengthening may have to be provided to carry the additional loads from flood waters acting on the closure assemblies.

2) The closure or closure assembly must be designed for the full water pressure resulting from the heights calculated from the highest and lowest points of the closure to the RFD. Consideration must be given to loads resulting from debris impact and other loads as specified in these Regulations. The closure should be supported along at least three (3) edges and be capable of being secured around the opening perimeter by some self-acting means or latching devices. Bolting may be used as a means of securing the closure in place; however, it is recommended that such a procedure be avoided if at all possible and especially for closures at large and/or critical openings. A bolted type closure would generally require more lead time (flood warning) to assemble, transport, and install equipment held in storage, generally require trained personnel to affect the installation, and might well depend on the use of material handling equipment or additional personnel to handle large, heavy, or cumbersome closure panels or assemblies.

3) Whenever possible or required, the closure assembly should attach to a metal frame that surrounds the opening and be of sufficient width to provide an adequate watertight sealing sur-

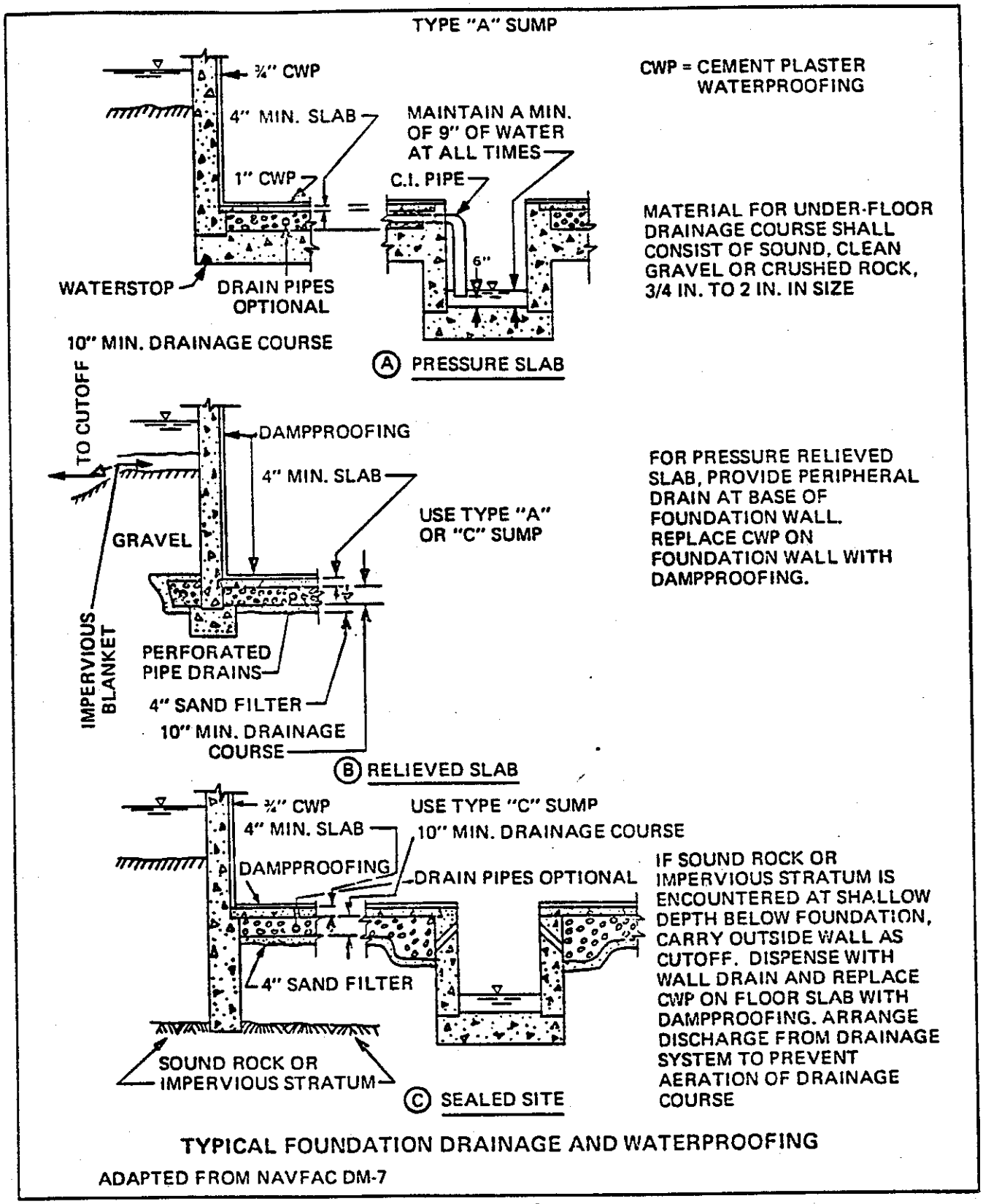

TYPE "A" SUMP
¾" CWP
4" MIN. SLAB
1" CWP
MAINTAIN A MIN. OF 9" OF WATER AT ALL TIMES
C.I. PIPE
6"
WATERSTOP
DRAIN PIPES OPTIONAL
10" MIN. DRAINAGE COURSE
CWP = CEMENT PLASTER WATERPROOFING
MATERIAL FOR UNDER-FLOOR DRAINAGE COURSE SHALL CONSIST OF SOUND, CLEAN GRAVEL OR CRUSHED ROCK, 3/4 IN. TO 2 IN. IN SIZE
Ⓐ PRESSURE SLAB
TO CUTOFF
DAMPPROOFING
4" MIN. SLAB
USE TYPE "A" OR "C" SUMP
GRAVEL
IMPERVIOUS BLANKET
PERFORATED PIPE DRAINS
4" SAND FILTER
10" MIN. DRAINAGE COURSE
FOR PRESSURE RELIEVED SLAB, PROVIDE PERIPHERAL DRAIN AT BASE OF FOUNDATION WALL. REPLACE CWP ON FOUNDATION WALL WITH DAMPPROOFING.
Ⓑ RELIEVED SLAB
¾" CWP
USE TYPE "C" SUMP
4" MIN. SLAB
10" MIN. DRAINAGE COURSE
DAMPPROOFING
DRAIN PIPES OPTIONAL
4" SAND FILTER
SOUND ROCK OR IMPERVIOUS STRATUM
IF SOUND ROCK OR IMPERVIOUS STRATUM IS ENCOUNTERED AT SHALLOW DEPTH BELOW FOUNDATION, CARRY OUTSIDE WALL AS CUTOFF. DISPENSE WITH WALL DRAIN AND REPLACE CWP ON FLOOR SLAB WITH DAMPPROOFING. ARRANGE DISCHARGE FROM DRAINAGE SYSTEM TO PREVENT AERATION OF DRAINAGE COURSE
Ⓒ SEALED SITE
TYPICAL FOUNDATION DRAINAGE AND WATERPROOFING
ADAPTED FROM NAVFAC DM-7

Figure 6

face. The frame may attach or be connected to the adjacent wall or supporting members to be constructed as an integral part thereof and be strong enough to transfer the closure loads to the building structural components without exceeding the allowable stresses. The walls are to be designed to transfer the loads to the building structural system and conform to the structural requirements to the Building Code. The seal may be attached to the closure (panel, etc.) or sealing frame and with sealing to be achieved by applying pressure through bolting or latching of the closure or some other selfacting and positive means.

4) All closures, whenever possible, should be external to the opening, such that the water pressure helps in providing a continuous seal, thereby eliminating the need for extensive anchors, blocking and bolting as would be required to reverse loading cases.

5) Horizontal closures should be designed to support the full weight of water above the closure assembly to the RFD. The closure should be supported and have a watertight seal along its entire perimeter. A frame with a smooth sealing surface and capable of transferring the load to the structure is to be provided.

6) Permanent closures of an opening may be accomplished by any structural means of system that would not require further actions during a flood. These closures may consist of walling an unneeded window, vent, chute, etc. with masonry units, reinforced concrete plugs, metal shields or other approved materials. All closure systems used shall provide the required protection to the RFD.

7) Closures for openings in existing structures that would have to be assembled and set in place in preparation for a flood would be classified as temporary or emergency flood-proofing closures. These openings are necessary for the continual operation of the building and their functions will be disrupted when the closures are set. Closures should be of metal construction and sized for easy and quick assembly and installation. Closure panels should be stored at a convenient location near the opening and should be properly marked and identified for each opening. Bolts, latches, and other equipment used to install the closures should be similarly stored and identified. Examples of emergency closures, are closures used to block doors, windows, vents, loading docks, or chutes.

8) Contingent closures may be set into position by either mechanical or manual operation of the assembly. Design of the assembly must take into consideration the type of placement operations, weight of the closure, space required, esthetic considerations, available work force, and total number of openings to be closed. Mechanical placement of closures can be accomplished through

rollers, cable and weights, levers, and hinges.

9) Seals on all closures should be watertight and preferable to rubber or neoprene. The entire closure and frame should be inspected and tested periodically to insure that they are still functional and in good condition.

10) Some permanent closures may be designed to protect against flood waters and still maintain the functions of the opening. A window could be designed with intermediate supports consisting of reinforced concrete beams or structural members encased in concrete. The window would then be made up of tempered plate glass sections capable of withstanding impact loads spanning between intermediate supports. Metal doors can be made to protect against floods by providing a watertight seal and adding stiffeners and latching devices to the door. Examples of opening reinforcement, fastening methods and devices, and closures for typical conditions are illustrated in Figures 7 through 19.

(e) Additional Considerations. It should be noted that the preceding design examples do not contain coverage of several structural elements and framing methods used in normal practice. Included in this category are wall and column footings, mats or rafts, integral or continuous wall and slab construction, horizontally framed walls, and other similar items. Also omitted are examples of bearing masonry walls, curtain walls, precast concrete, metal and "sandwich" panels, and similar items. These items either involve too may variables, or are too complex for tabulated treatment, or relate to highly specialized technology. In all cases, coverage of these topics did not lend itself to a simplified treatment and was thereby omitted.

ALTERNATE METHODS OF FLOOD-PROOFING

Section 15.05

(a) Site Selection. The one method of assuring complete flood hazard protection of a building or structure is to select a site or structure location which places all spaces in the structure above the "flood plain flood". This could apply to sites both inside or outside the flood plain limits. Locating a structure outside the flood plain would eliminate the need to consider flood water loads in the building design. The building could be located in the flood plain and be protected to design-flood level by dikes, levees, or floodwalls; also eliminating the need for flood load consideration in the building design for flooding to a design-flood level.

(b) Flood-Proofing By Elevating The Building.

1) Natural Terrain. Structures constructed above the RFD and outside the regulatory-flood plain will not be subject to loads from regulatory-flood waters if basements are not used. The

effect of soil saturation on basement walls and foundations may still have to be considered. Natural slopes should be investigated for stability and scour potential if the structure is to be built at the regulatory-flood-run-out line on the ground surface. A building located outside the regulatory-flood plain is shown at the left side of Figure 20.

2) Building On Fill. Buildings can be located within the flood plain or primary flood hazard area on a fill constructed to an elevation above the RFD. This method of protection can be accomplished by constructing an earth fill either partially or entirely within the flood plain, as also shown in Figure 20. Such a design should provide assurances that the fill does not restrict or obstruct the flow of flood waters or reduce the hydraulic efficiency of the channel, which in turn could cause flood water back-up and resultant higher flood water elevations upstream of the filled building site.

a) The fill material should be suitable for the intended purpose as determined by an investigation of the soil properties. The earth fill should be compacted to provide necessary permeability and resistance to erosion or scour. Where velocities of floodwaters are such as to cause scour, adequate slope protection should be provided with vegetation or stone protection as required. Slope stability should be analyzed by an experienced soils engineer to assure its adequacy.

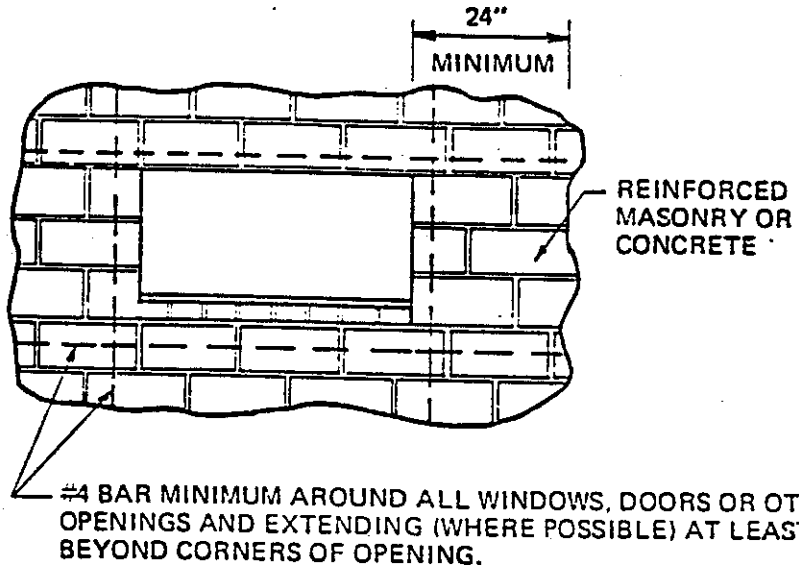
b) Where the fill is partially within the flood plain, access and utilities should be provided from the "dry" side. If the fill is entirely in the flood plain, access and utilities could be provided by constructing an access road or bridge to an elevation above the RFD.

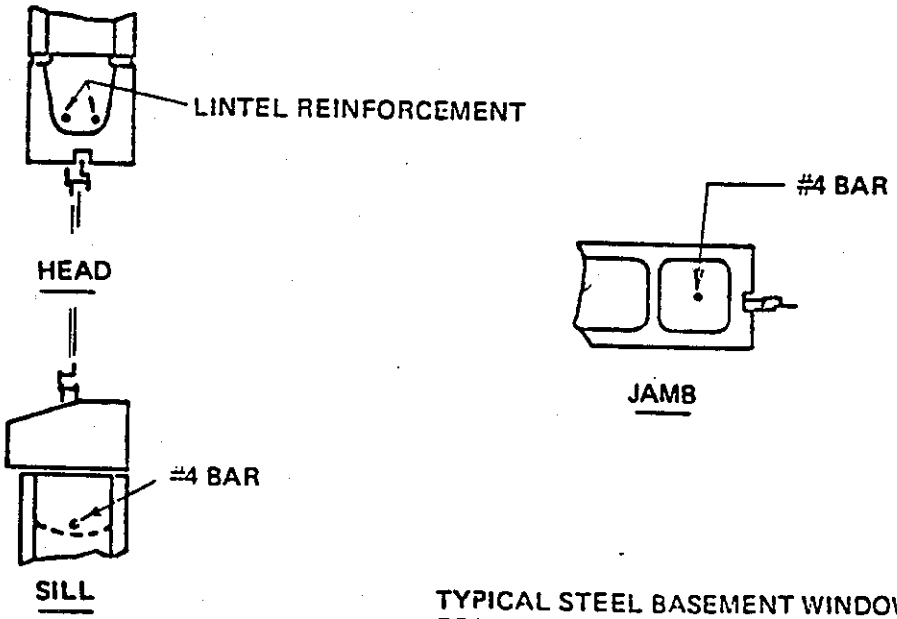
3) Building On Stilts. Often it is geographically undesireable or economically not feasible to locate a structure outside of the flood plain. Available land areas are being developed rapidly and communities are finding it necessary to permit construction in the fringe areas of floodways. In these areas, structures can be built which place all funcional aspects above the RFD by building on "stilts" as shown in Figure 21.

a) In elevating a building on "stilts", piles, columns, piers, and walls, or other similar members are used to raise the functional floors or spaces of the building above the RFD elevation. The design should consider the loads that result from possible debris blockage between supporting members and impact of floating debris.

b) The open space created at ground level below the functional floors could be used as a plaza, parking area, mat-

RECOMMENDED REINFORCEMENT AROUND SMALL OPENINGS
AND FOR SHALLOW DEPTH OF FLOODING

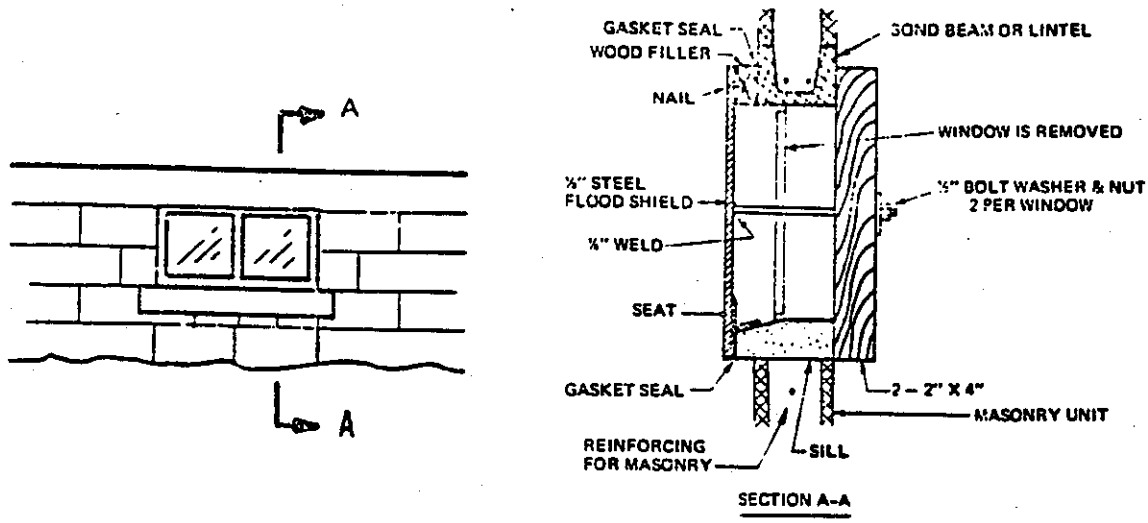




TYPICAL STEEL BASEMENT WINDOW
FOR REINFORCED MASONRY WALLS

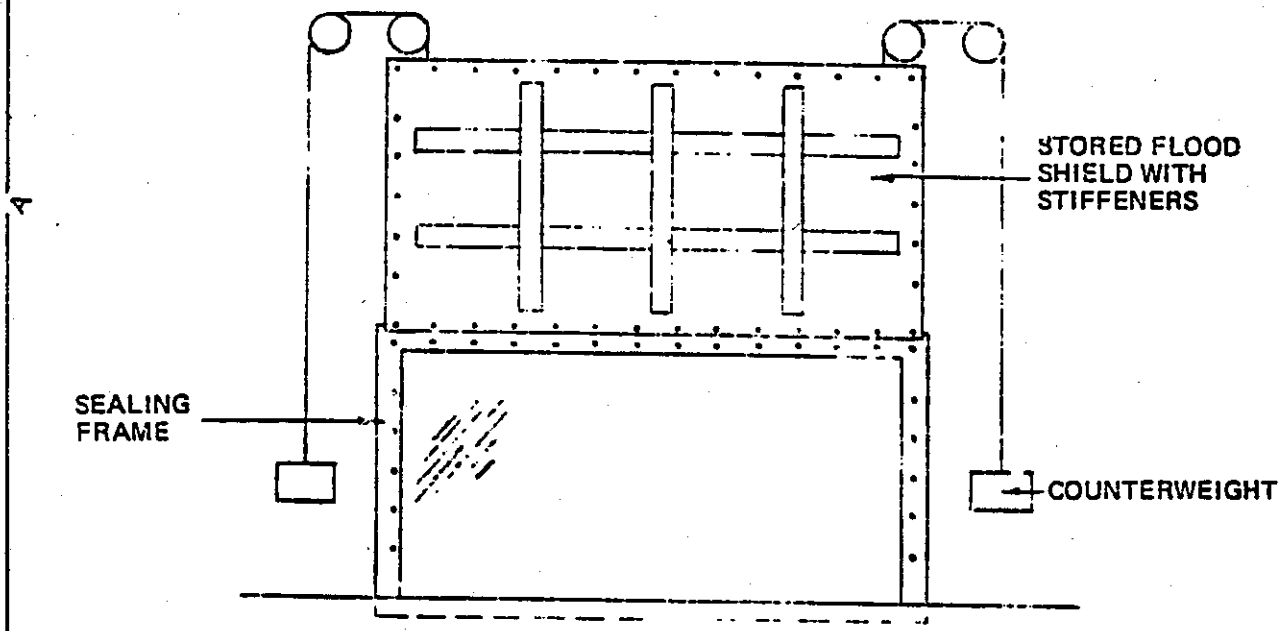
NOTE:
IF OPENING BEGINS AT THE TOP OF A FOOTING, HORIZONTAL REINFORCING SHALL BE PROVIDED AT THE TOP OF THE FOOTING.

Figure 7



CLOSURE PANEL FOR BASEMENT WINDOW
FOR SMALL WINDOWS AND SHALLOW DEPTH OF FLOODING

Figure 8



FLOOD SHIELD BEHIND WINDOW
LOWERED INTO POSITION & ATTACHED TO
FRAME WITH QUICK DISCONNECT TYPE FASTENERS.

Figure 9

BOND BEAMS & VERTICAL REINFORCEMENT AT LARGE OPENINGS

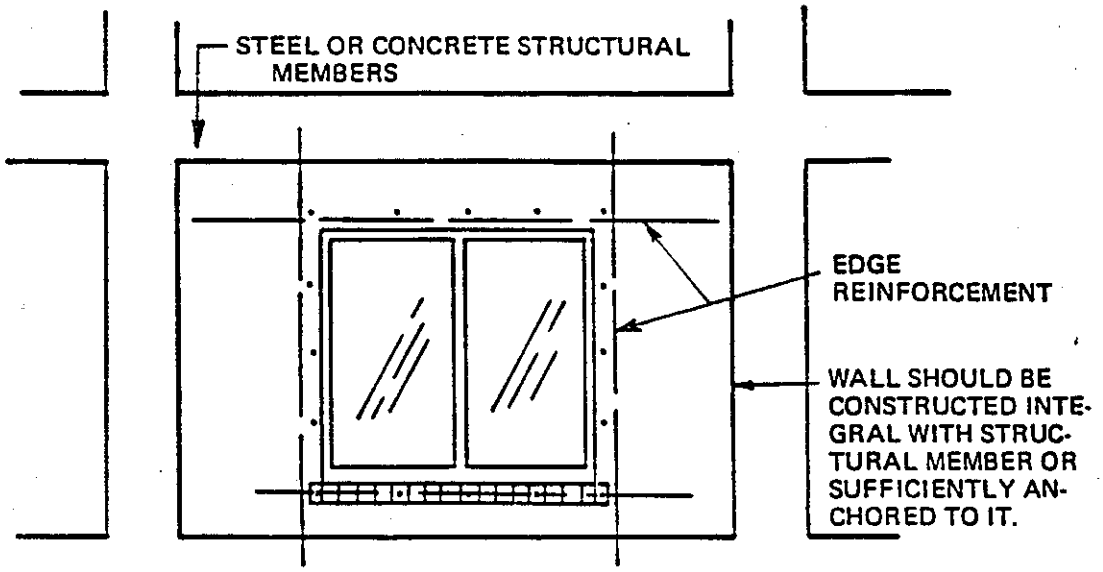
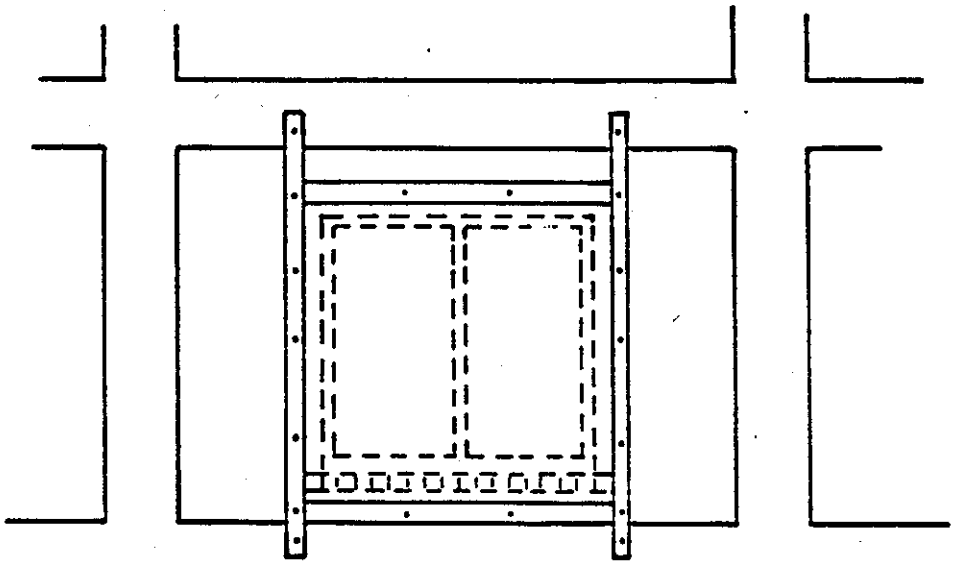


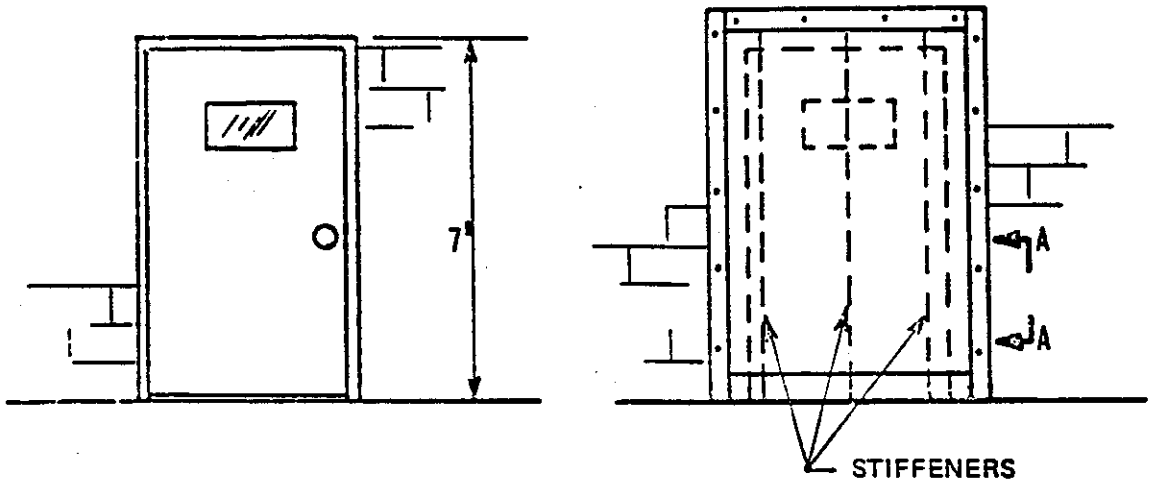
Figure 10

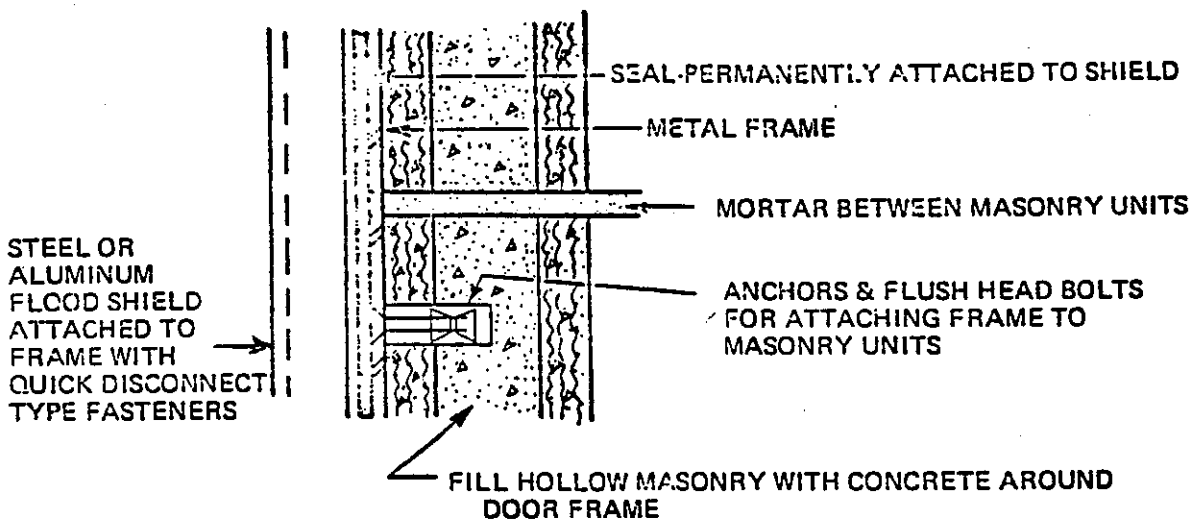


REINFORCING FOR BOND BEAMS AND VERTICAL STEEL MAY BE REDUCED IF FORCES ARE TRANSMITTED TO STRUCTURAL MEMBERS BY THE FLOOD SHIELD FRAME AS SHOWN ABOVE.

Figure 11

TYPICAL DOOR



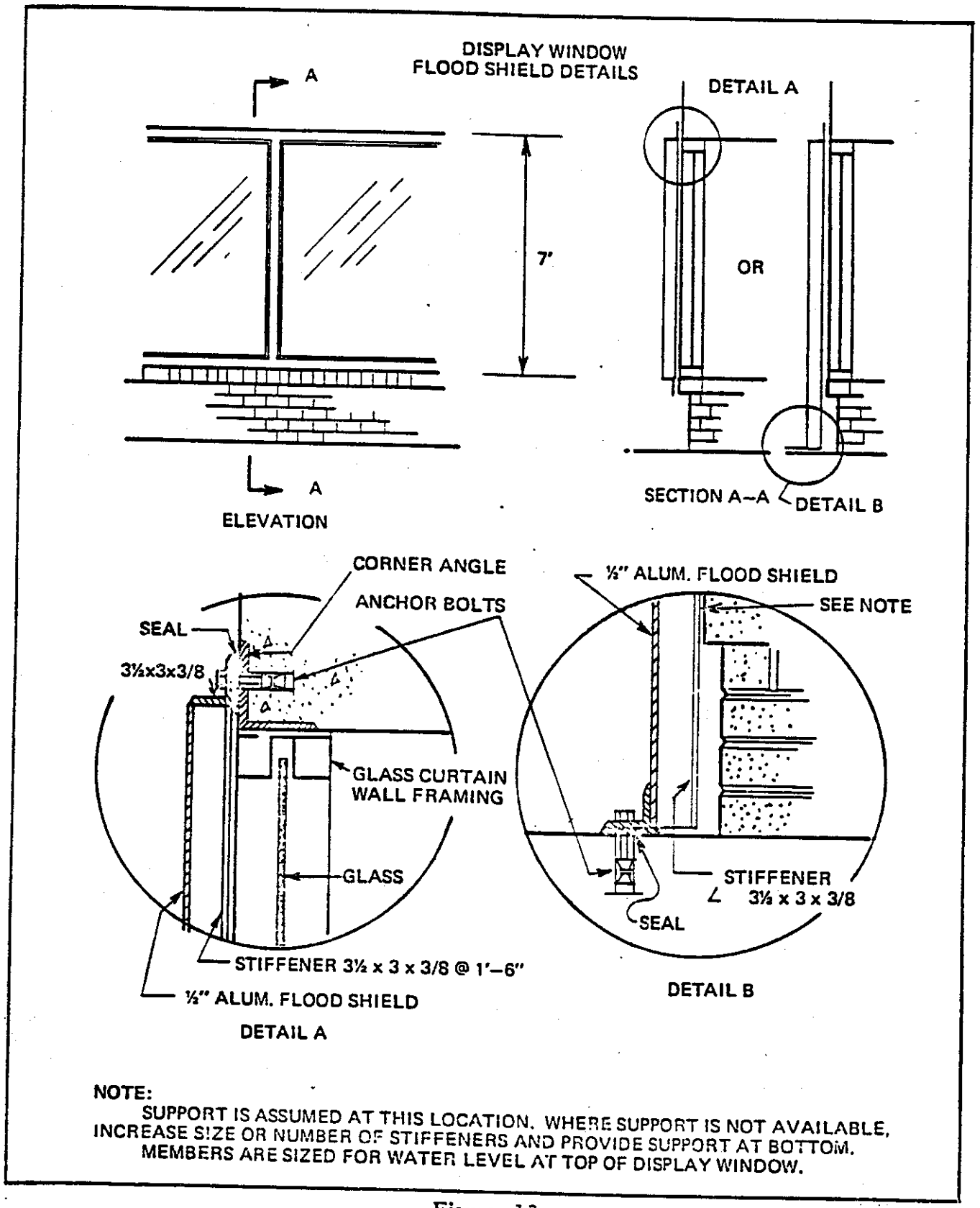


SECTION A–A

ALL CELLS AROUND OPENINGS IN HOLLOW MASONRY CONSTRUCTION SHOULD BE FILLED WITH CONCRETE. LARGE OPENINGS SHOULD HAVE BOND BEAMS, VERTICAL REINFORCEMENT, AND METAL FRAMES AROUND OPENING.

MORTAR JOINTS THAT LIE WITHIN FLOOD SHIELD SHOULD BE STRUCK FLUSH WITH THE MASONRY UNITS SO THERE WILL BE A BETTER SEAL.

Figure 12



NOTE:
SUPPORT IS ASSUMED AT THIS LOCATION. WHERE SUPPORT IS NOT AVAILABLE, INCREASE SIZE OR NUMBER OF STIFFENERS AND PROVIDE SUPPORT AT BOTTOM. MEMBERS ARE SIZED FOR WATER LEVEL AT TOP OF DISPLAY WINDOW.

Figure 13

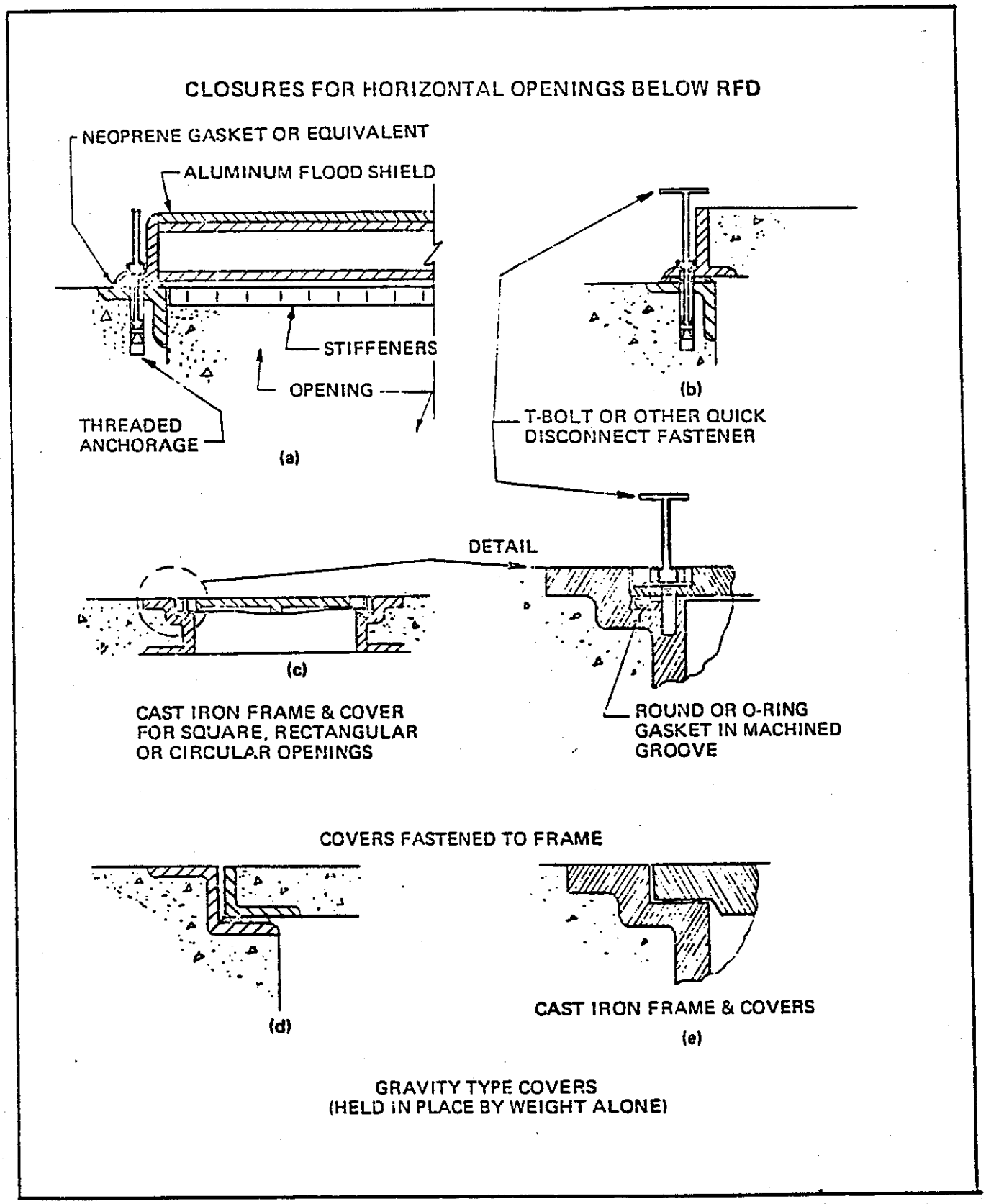

CLOSURES FOR HORIZONTAL OPENINGS BELOW RFD
NEOPRENE GASKET OR EQUIVALENT
ALUMINUM FLOOD SHIELD
STIFFENERS
OPENING
THREADED ANCHORAGE
(a)
(b)
T-BOLT OR OTHER QUICK DISCONNECT FASTENER
DETAIL
(c)
CAST IRON FRAME & COVER FOR SQUARE, RECTANGULAR OR CIRCULAR OPENINGS
ROUND OR O-RING GASKET IN MACHINED GROOVE
COVERS FASTENED TO FRAME
(d)
CAST IRON FRAME & COVERS
(e)
GRAVITY TYPE COVERS
(HELD IN PLACE BY WEIGHT ALONE)

Figure 14

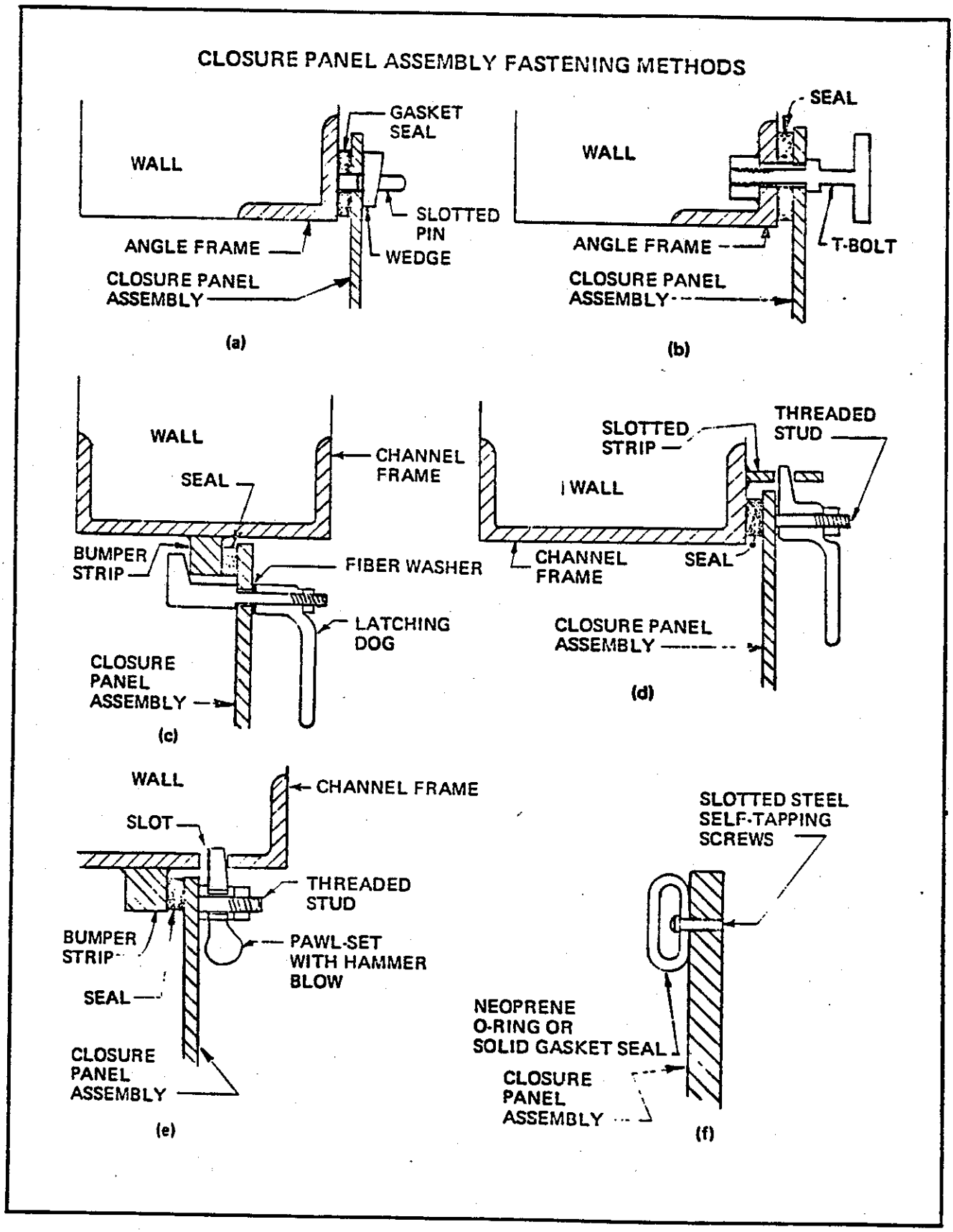
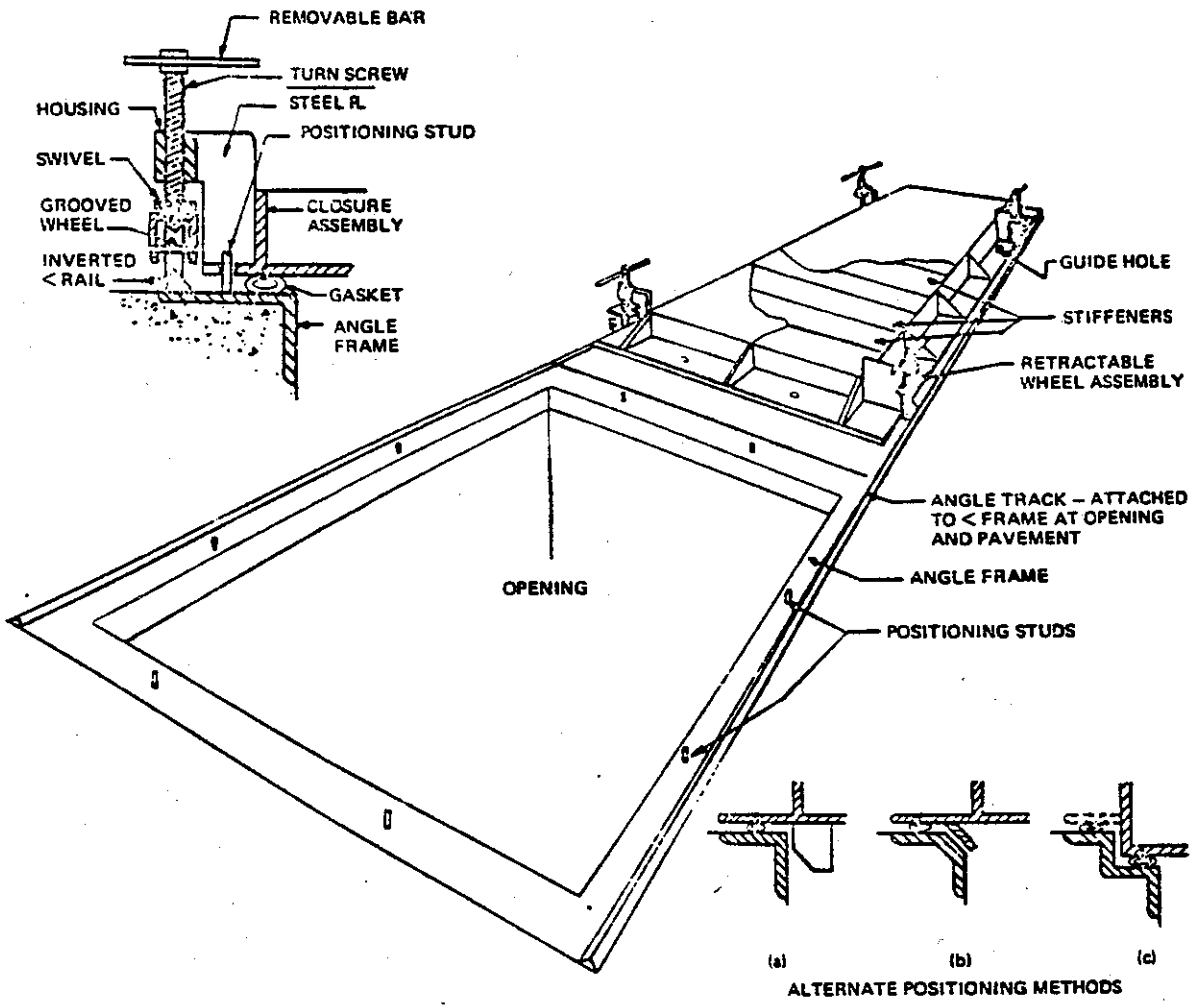

CLOSURE PANEL ASSEMBLY FASTENING METHODS
WALL
GASKET SEAL
SLOTTED PIN
WEDGE
ANGLE FRAME
CLOSURE PANEL ASSEMBLY
(a)
SEAL
WALL
ANGLE FRAME
T-BOLT
CLOSURE PANEL ASSEMBLY
(b)
WALL
CHANNEL FRAME
SEAL
BUMPER STRIP
FIBER WASHER
LATCHING DOG
CLOSURE PANEL ASSEMBLY
(c)
SLOTTED STRIP
THREADED STUD
WALL
CHANNEL FRAME
SEAL
CLOSURE PANEL ASSEMBLY
(d)
WALL
CHANNEL FRAME
SLOT
THREADED STUD
BUMPER STRIP
PAWL-SET WITH HAMMER BLOW
SEAL
CLOSURE PANEL ASSEMBLY
(e)
SLOTTED STEEL SELF-TAPPING SCREWS
NEOPRENE O-RING OR SOLID GASKET SEAL
CLOSURE PANEL ASSEMBLY
(f)

Figure 15

FLOOD-PROOFING CLOSURE FOR LARGE HORIZONTAL OPENING BELOW RFD



PROCEDURE

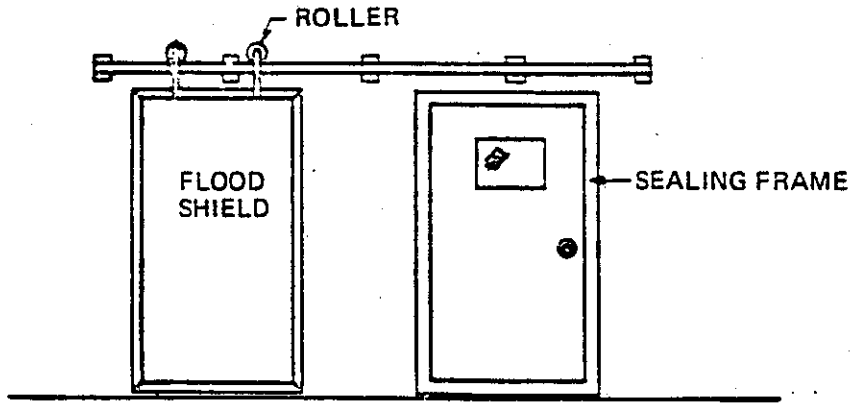
BEFORE FLOOD – Closure assembly remains in stored position and rests on blocks to keep assembly weight off O-Ring or flat sealing gasket-wheels in an up position and operating bars removed. Wheel assembly is coated with heavy grease and covered with plastic or canvas sheet.

DURING FLOOD – When flood warning is received, operating bar(s) inserted in retractable wheel assembly and wheels lowered to engage rails, raising closure assembly off storage blocks and high enough to clear positioning studs; closure assembly rolled into position where guide holes are directly over positioning studs; closure assembly lowered to engage studs until all wheels are free of guide rails and contact established between gasket and frame; operating bars then removed from wheel assembly. Positive seal is maintained during flood by weight of closure assembly and flood water weight; positioning studs prevent displacement or movement of closure assembly.

AFTER FLOOD – Closure assembly washed down to clear mud and debris, raised into rolling position, rolled to storage location and positioned, inspected for possible damage, then "moth-balled" for future use.

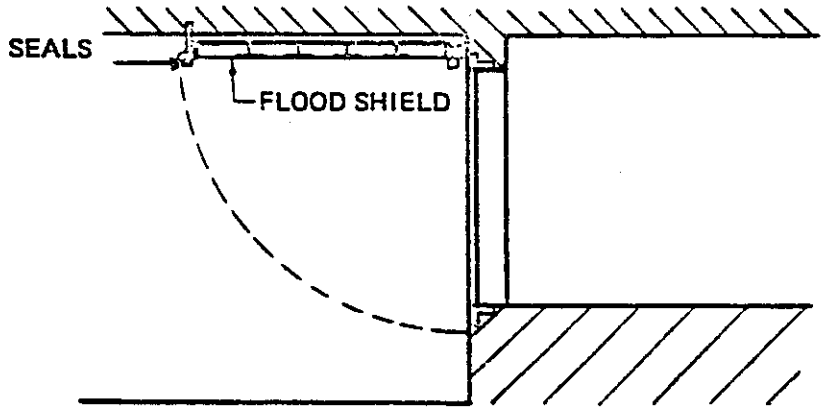
NOTE: This illustrates only one of many schemes that may be considered for horizontal opening flood-proofing. Closure assemblies should be of durable materials for repeat type use, should require minimum maintenance, and require minimal installation effort. Variations may include hinged and/or counter-balanced assemblies; lever, ratchet or hydraulic systems for movement and positioning of assembly; positioning lugs, wedges, recesses, etc. where exposed studs cannot be tolerated; and use of positive fastening methods and devices for special locations or situations. The methods, procedures, and equipment that may be utilized are limited only by the designer's imagination and the owner's pocketbook.

Figure 16



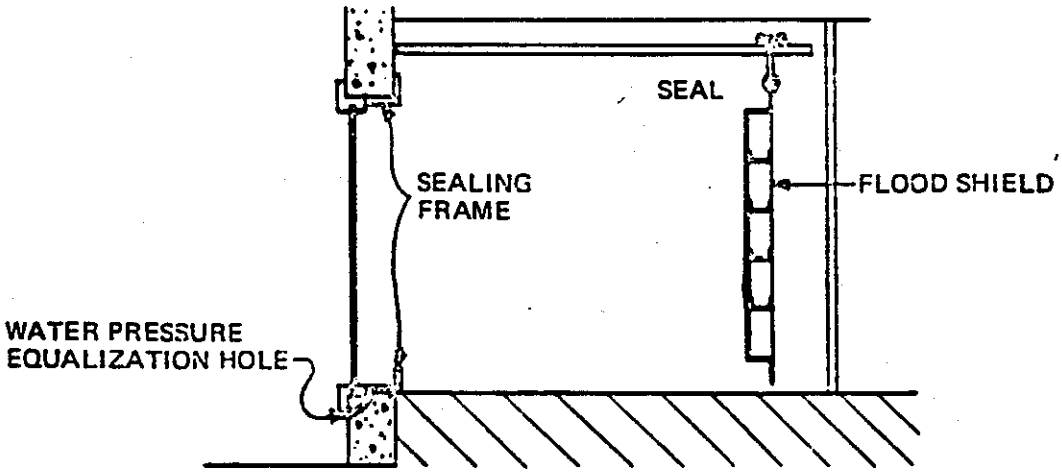
SLIDING FLOOD SHIELD FOR DOOR

Figure 17



HINGED FLOOD SHIELD FOR LOADING DOCK

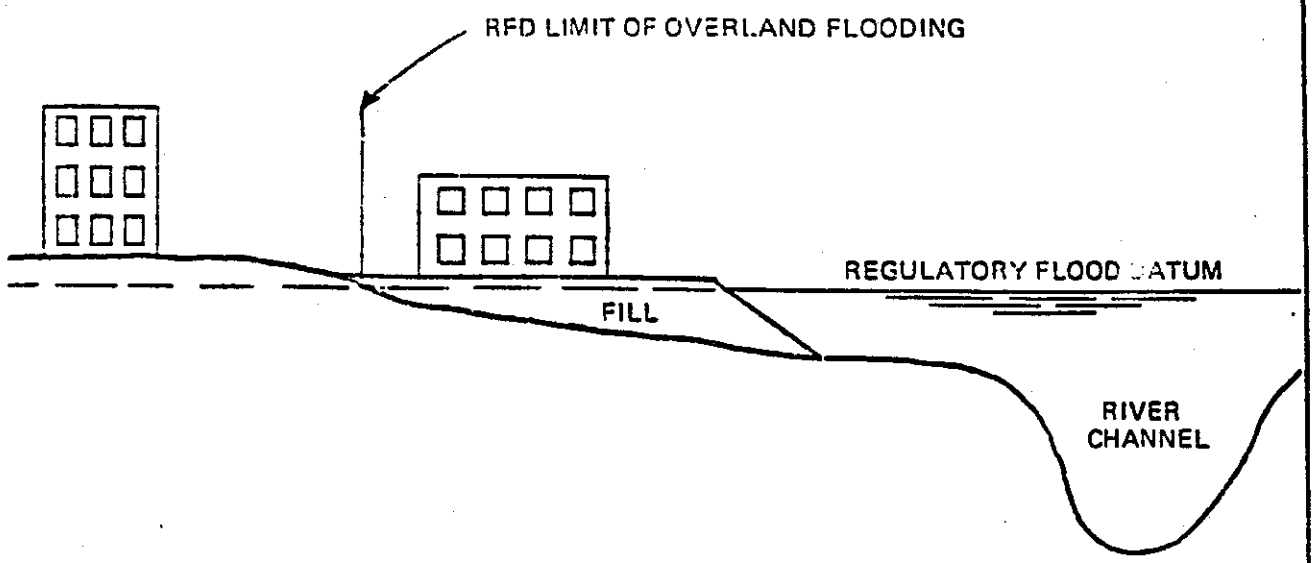
Figure 18



STORED FLOOD SHIELD BEHIND WINDOW

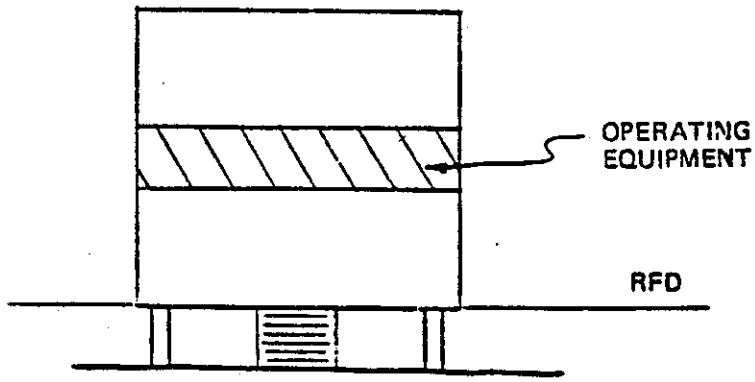
Figure 19

SECURED TO SEALING FRAME BY LATCHING DOGS, WEDGE ASSEMBLIES, OR OTHER QUICK DISCONNECT FASTENERS.



STRUCTURES ON NATURAL TERRAIN OR FILL

Figure 20



BUILDING ON STILTS

Figure 21

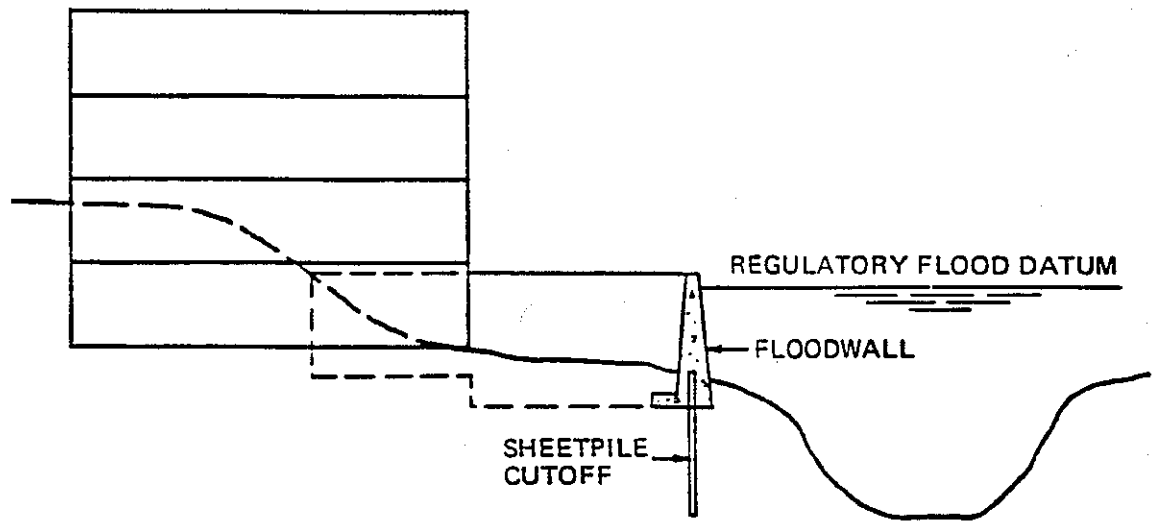
erials handling, or recreational area, or for storage of special nondamageable materials, equipment, etc. This open space would be essentially free from the damaging effects of flood water, except that lobbies and entrance would have to be protected by some approved flood-proofing method.

c) The equipment necessary to maintain building functions should be located safely above the RFD. If access to the building were provided from a location above the RFD, the normal building activities would not be disrupted and the building could continue to function during the flood elevation.

(c) Protection By Dikes' Levees And Floodwalls. As an alternate to providing through building or structure modifications, the necessary protection may be achieved by detached dikes, levees or floodwalls. The primary purpose of these constructions if to prevent the flood from reaching the structure and associated functional land areas. The choice of using a dike or floodwall is made on the basis of economic considerations when compared to structural flood-proofing modifications, the ability of a structure to be structurally modified, and the degree of protection to be provided. The type of protection barrier depends on location, availability of material, foundation conditions, and right-of-way restrictions. Floodwalls would be used in tight, restricted areas where foundation conditions are favorable. Dikes or levees would be used where adequate space and material are available. The dike or floodwall may not have to completely surround a structure. Protection may be required only on the low sides as illustrated in Figures 22 and 23. The ends of the works would be tied into the existing high ground or to the structure depending on local conditions.

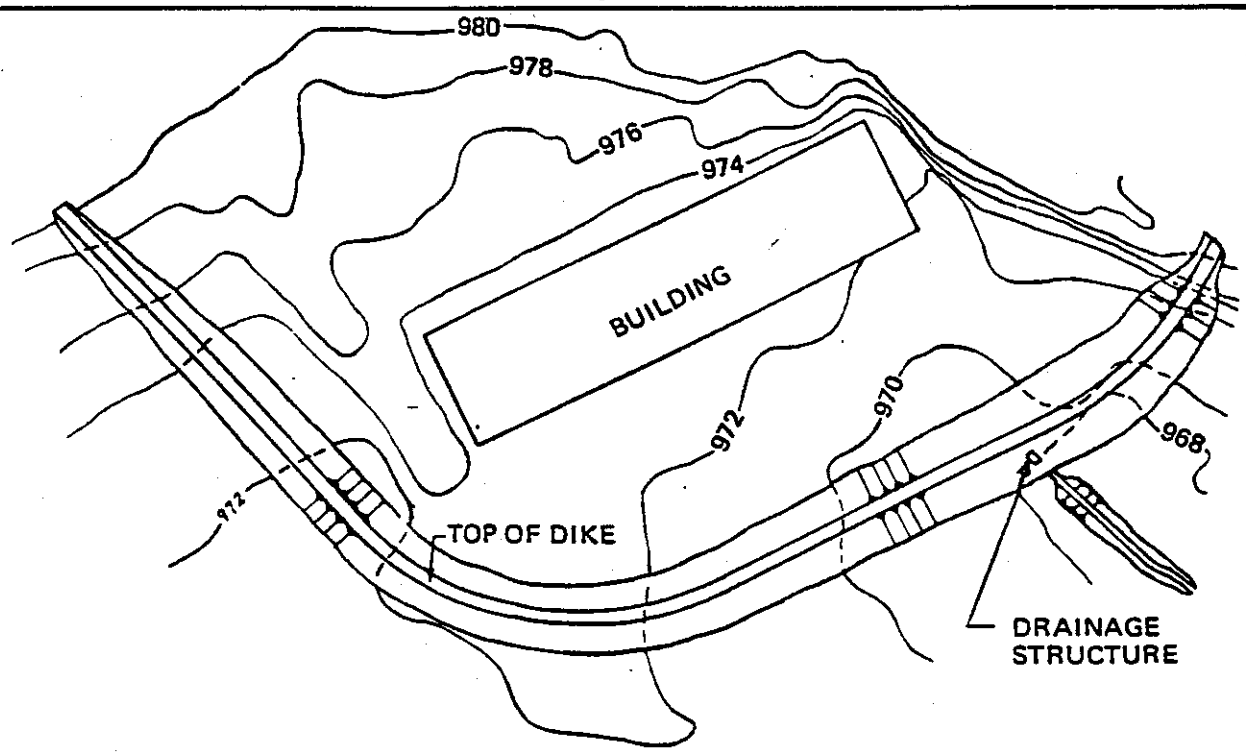
1) Dikes. If used, dikes should be constructed to a section capable of supporting the imposed loads and providing the required impermeability. Suitable material preferably should be available at the site and should be tested and approved for use prior to constructing the dike. An investigation should also be made of the foundation material to determine the presence of, locations, and extent of unsuitable materials and necessity for drainage of cutoff provisions.

a) At locations where the foundation material has a high degree of permeability, an impervious cutoff may be necessary to reduce seepage through the in-situ foundation materials. The cutoff may be a sheet pile wall, compacted barrier of impervious soil, fabric reinforced membrane, concrete wall, or grouted cutoff. As no cutoff is totally impermeable, provisions should be made to collect the excess seepage and any seepage from less permeable soils without cutoffs. The excess seepage can be collected with drainage blankets, pervious trenches, or perforated pipe drains placed at the toe of the embankment and on the dry landward side. Typical



FLOOD PROTECTION WITH FLOODWALLS

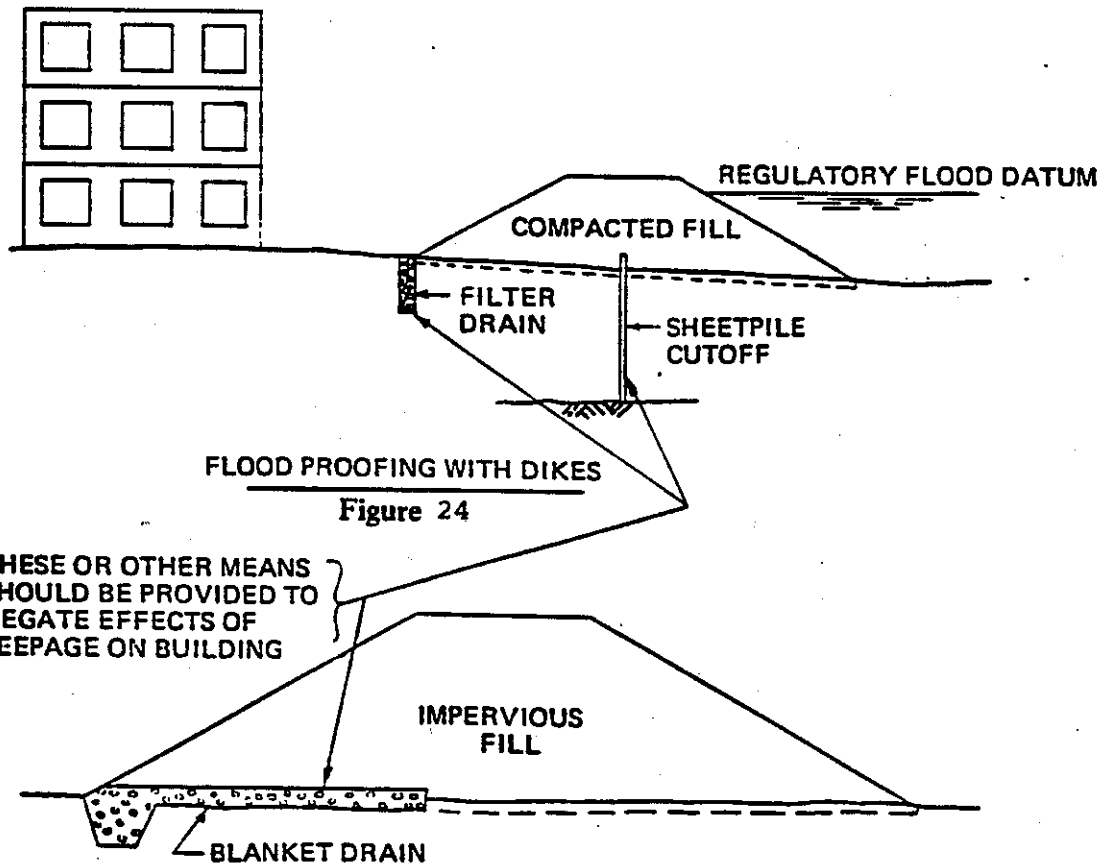
Figure 22



FLOOD PROTECTION BY DIKES

Figure 23

DIKE OR LEVEE PROTECTION

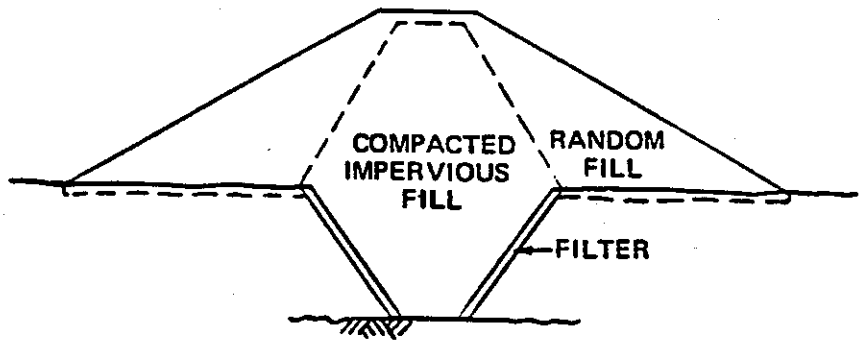


FLOOD PROOFING WITH DIKES

Figure 24

DIKE WITH BLANKET DRAIN

Figure 25



DIKE WITH IMPERVIOUS CORE

Figure 26

ROCK OR IMPERVIOUS STRATUM

dike sections, cutoffs, and drainage provisions are shown in Figures 24, 25 and 26.

b) If any drain pipes or related structures are within a dike, they should be designed to resist all applicable loads and be provided with gates to prevent backflow to the dry side. Backflow through conduits can be prevented by installing flap gates, manually operated valves, or slide gates that would be closed when flood waters would reach critical elevations.

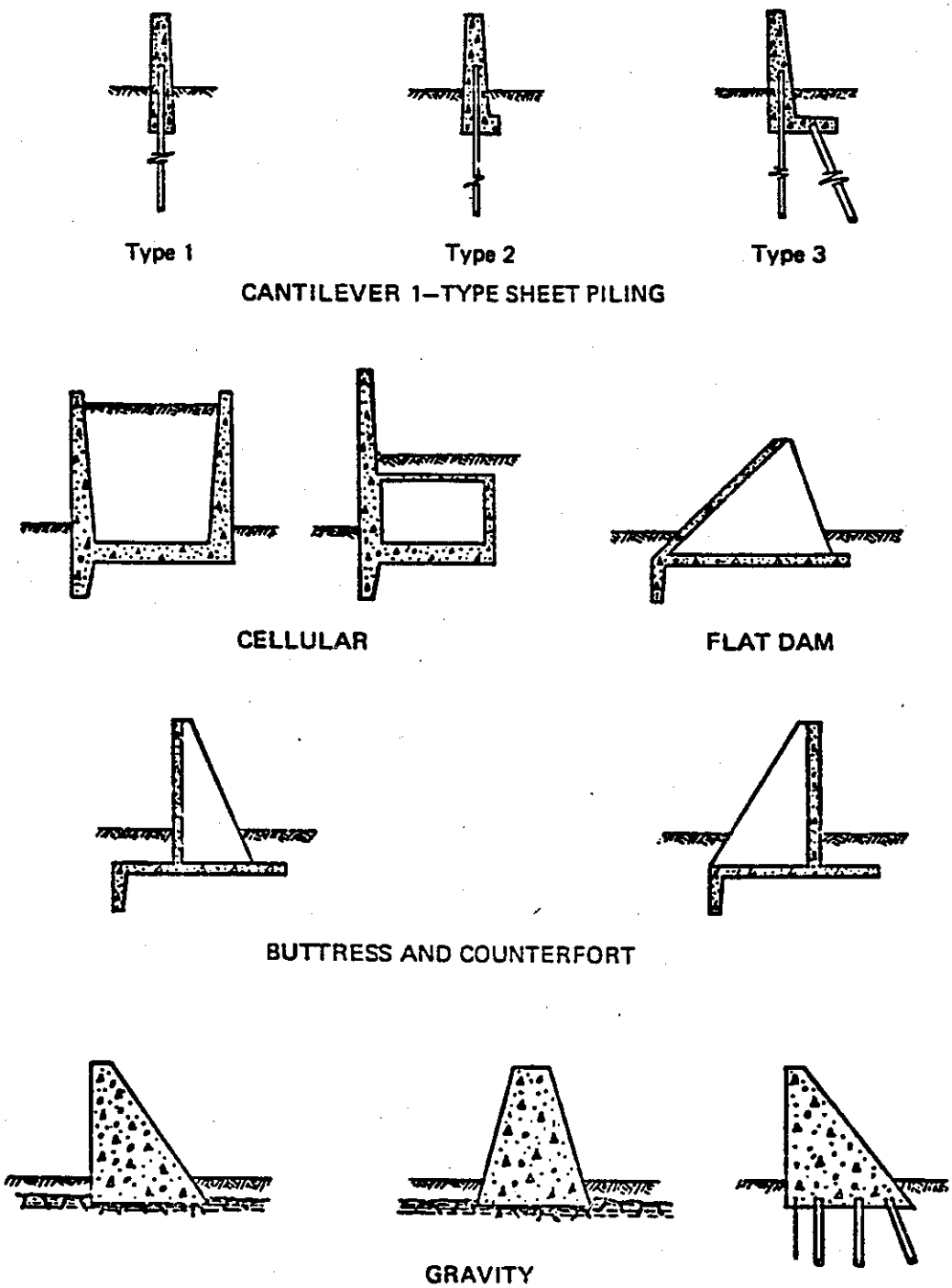
2) Floodwalls. A floodwall is subject to hydraulic loading on one side with little or no earth loading as a resisting force on the opposite side. Floodwalls can be constructed as cantilever I-type sheet piling walls, cellular walls, buttress walls, or gravity walls.

a) The walls should be founded on the keyed into rock where suitable rock is encountered reasonably close to the founding elevations. Where the soil provides inadequate bearing capacity and removal of unsuitable material and replacement is costly, an adequately designed system of piling should be considered. Cutoffs and drains should be used to intercept seepage as required in 7.12-(c)-2). Drain pipes should not be placed directly under the wall base and any drainage provided should not be considered as a factor for reduction of uplift pressures. The problem of scour should be further investigated and corrective measures provided where necessary.

b) Drainage features through flood walls should be equipped with the necessary devices to prevent backflow. Typical sections of various flood wall types are shown on Figure 26.

(d) Controlled Or Intentional Flooding. In many situations, the basement walls and floor slab(s) of existing buildings and structures lack the structural strength required to withstand flood loadings. The expense of reinforcing an existing structure or replacement with a new structure at the same location to withstand such flood loadings, in most cases, not justified. As an alternate means of flood-proofing these structures, provisions may be made for flooding of the structure interior to balance the external flood pressures on the building components. This intentional flooding would have to be accomplished in such a manner as to keep the unbalanced hydrostatic pressures safely within the load carrying capacity of the slab and walls. Provisions must be made for interconnections through and around all floors and partitions in order to prevent unbalanced filling of chambers or spaces within the structures.

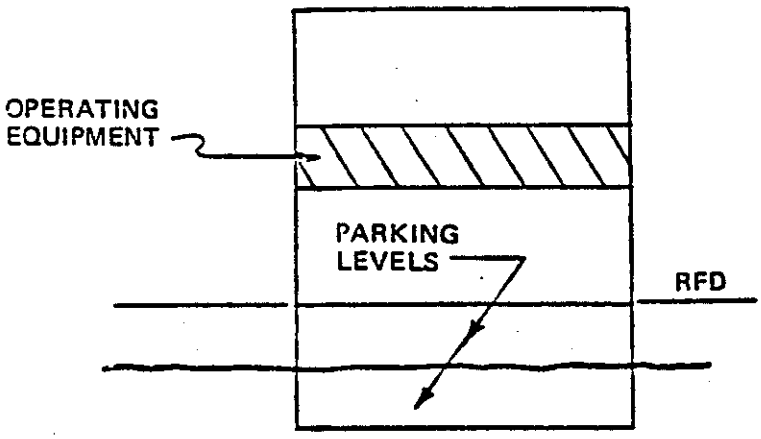
1) Flooding. Flooding should be with potable water from a piping or storage system of adequate capacity to fill the base-



VARIOUS FLOOD WALL TYPES

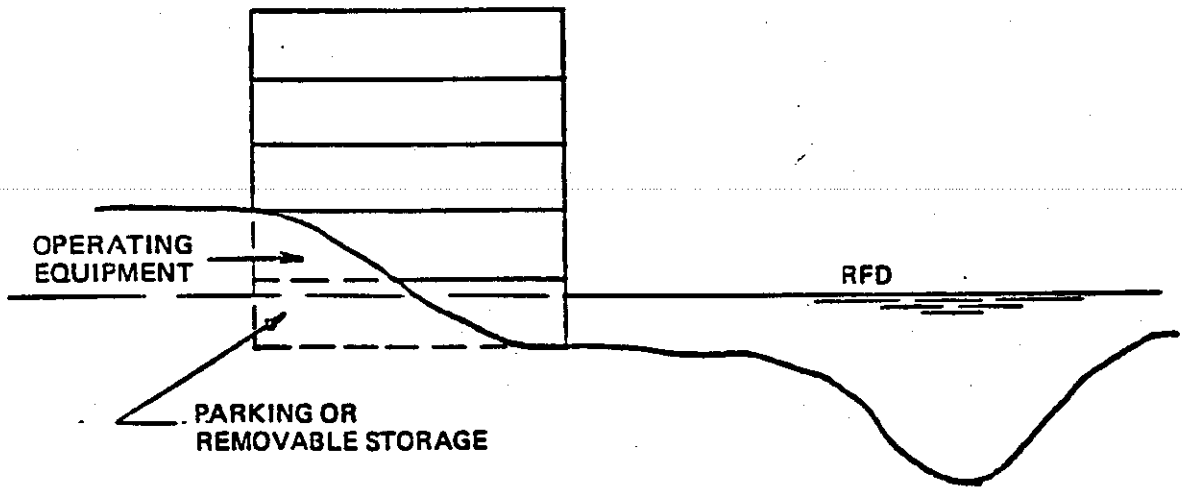
Figure 27

STRUCTURE WITH RESTRICTED USE



STRUCTURE ON NATURAL TERRAIN OR FILL

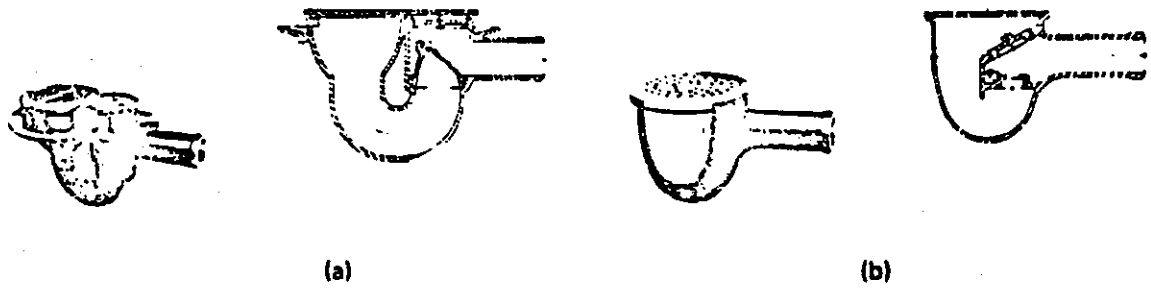
Figure 28



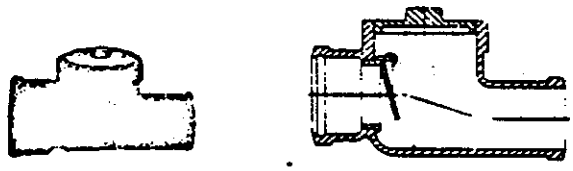
STRUCTURE ON NATURAL TERRAIN OR FILL

Figure 29

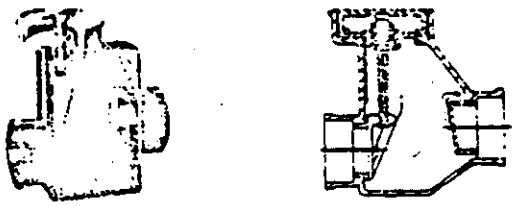
PREVENTION OF BACKFLOW THRU SEWER SYSTEM



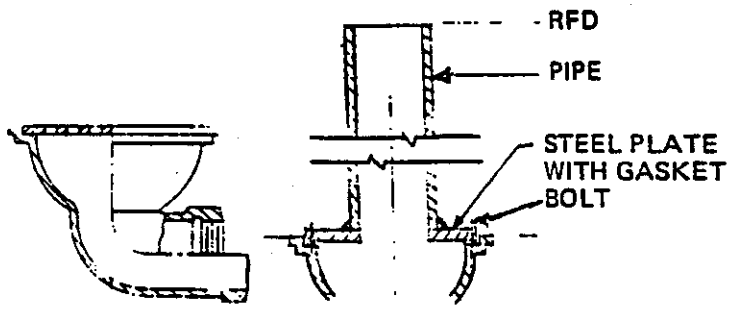
FLOOR DRAIN WITH INTEGRAL BACKWATER VALVE



BACKWATER VALVE – FLAPPER TYPE – AUTOMATIC



BACKWATER VALVE – GATE TYPE COMBINATION – MANUAL & AUTOMATIC



REMOVE GRATE AND INSTALL STANDPIPE. USE ONLY WHERE FLOOR SLAB WILL TAKE UP-LIFT PRESSURES

EXISTING BASEMENT DRAIN FLOOD-PROOFING

Figure 30

ment at a rate consistent with the anticipated flood water rise. The provisions should be such as to keep the internal water surface as nearly even with the outside as possible. All spaces should be provided with air vents to prevent the trapping of air by the rising water surface.

2) Draining. Outlets to drain the water as flood waters recede should be located to completely drain the structure and all spaces at a uniform rate corresponding to that of the receding waters. The water level in all interior spaces should be kept even and all spaces should be completely drained. Upper spaces and levels should be drained before the lower spaces. All water-tight walls should be designed for an internal hydrostatic pressure resulting when waters trapped in the building are higher than those of the receding floodwaters outside; a possibility with malfunction of required drains.

3) Use. Where provisions are made for internal flooding, all floors and spaces below the RFD should be restricted as to types of use permitted. Examples of controlled flooding of structures with restricted use are shown on Figures 28 and 29.

4) Backflow. Where intentional flooding with potable water is proposed (or where flood water backflow through the sewer system may occur), backflow preventers should be installed in the sewer lines. Various types of backflow preventers are illustrated in Figure 30.

TOTAL APPROACH

Section 15.06

(a) General. The design and implementation of flood-proofing systems and procedures requires a total approach. No element or item, regardless of how minute it might appear, should be overlooked or left to chance. The most elaborate, extensive, and expensive flood-proofing system may be rendered useless by a minor omission or by the failure of a weak link in the system.

(b) Standard Operating Procedures. The same "in toto" approach is necessary in establishing detailed procedures for making a contingently flood-proofed system ready for an expected flood. Standard operating procedure for mobilizing and implmenting the flood-proofing measures, referred to in these Regulations as "The Owner's Contingency Plan", should be developed by the original designer of the system. It requires a degree of completeness such that all details, sequences, and implementing personnel assignments are fully spelled out. The building owners and all other personnel assigned to implement the Plan should be thoroughly acquainted with all aspects of the operation and procedure. All personnel should periodically inspect the system and participate in scheduled "dry runs" or exercises of the flood-proofing plan. The standard operating

procedure should be in the format of a manual containing all descriptive information and operational sequences, along the necessary illustrations, drawings, and maintenance requirements for all measures. Personnel designated to perform each task should be noted and, if possible, alternatives should be assigned to assist during times of emergencies or to take over and act if the regularly assigned personnel are absent or unavailable for flood emergency duties. In addition, summarized procedures should be posted at prominent building locations to facilitate and expedite the operation. Color-coding of flood-proofing implements, such as closure panels, backflow valves, and similar features would be helpful in assuring the most efficient implementation of the Plan.

1) As preparation of a building for a flood event often involves auxiliary personnel, equipment, and materials, planning for simple logistics should be developed and be closely keyed to available advance time. In this respect, information from flood forecasting and warning sources must be obtained at the earliest possible time. Since floods can occur at any time of the day or night, or even on weekends or holidays, a plan for emergency readiness must be established. It should include establishment of definite lines of communications and control, and identification of key personnel who can be counted on to respond whenever needed.

2) All systems and implements of flood-proofing must be kept in a perfect state of readiness and be easily accessible at all times. The emphasis on periodic inspection, testing, and continued maintenance cannot be adequately stressed.