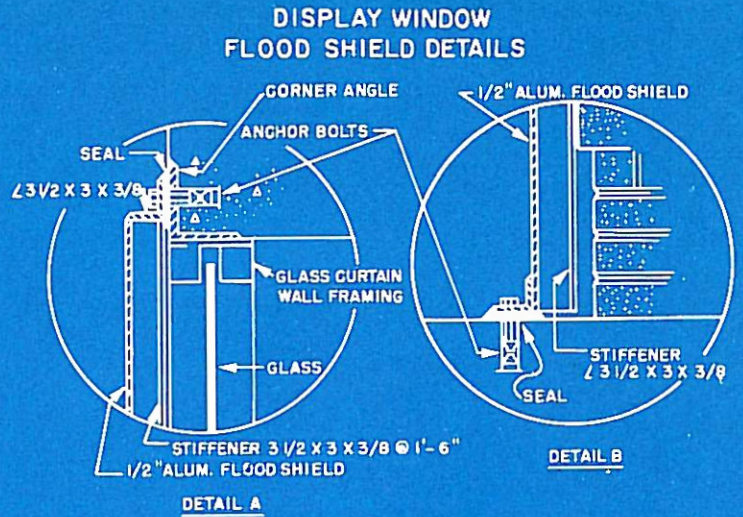


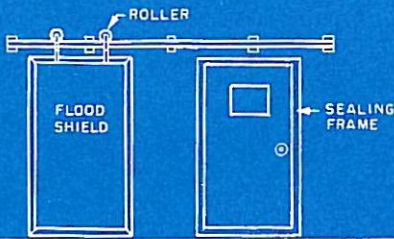
SECTION A-A  
 CLOSURE PANEL FOR BASEMENT WINDOW  
 FOR SMALL WINDOWS & SHALLOW DEPTH OF FLOODING



DETAIL A

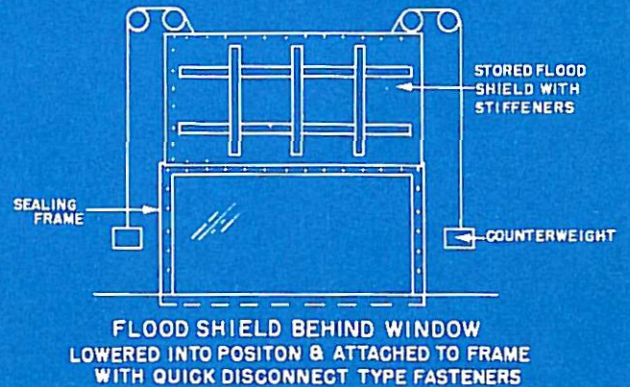
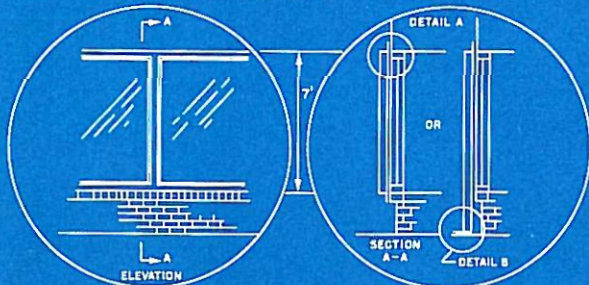
DETAIL B

SLIDING FLOOD SHIELD FOR DOOR



# FLOOD-PROOFING REGULATIONS

DISPLAY WINDOW  
 FLOOD SHIELD DETAILS



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



## PREFACE

Existing building codes and regulations do not provide the special flood-proofing requirements and minimum standards of design and construction that should be met for buildings and structures susceptible to flood damages. A need for such standards has long been recognized at all levels of government and in the private sector. However, little, if any, work has been done to develop or assemble information on flood-proofing into a workable set of standards that could have national application. Under its Flood Plain Management Services Program, the Corps of Engineers, has therefore taken the first step towards meeting this need by developing minimum standards of design and construction for flood-proofing of buildings and structures.

This publication specifies the flood-proofing measures and techniques that should be followed to regulate private and public building construction in riverine flood hazard areas. It contains implications for changes in existing building and housing codes and provides for a diversity of flood-proofing methods and techniques. Chapters 2 through 13 have been prepared in a form that could be used to supplement existing building codes and regulations. If, on the other hand, a separate "flood-proofing code" for direct adoption by States and local governments is desired, the flood-proofing information contained herein is also sufficient for that purpose.

The Corps of Engineers is distributing this publication as a means of at least partly filling the present gap in building codes and regulations. Our purpose here is to develop a set of minimum flood-proofing building standards that will be workable, concise, understandable, and reasonable for national application. We also intend that the regulations herein be sufficiently flexible to benefit from expert criticism, further research, and the experience of implementation. Together with other flood plain management tools, use of these ideas will assist in reducing the threat to life, health, and property of users of flood hazard areas and help to achieve optimal flood plain use.

We have taken the first step, however, the initiative for adoption and implementation of these standards must come from State and local interests.

J. W. MORRIS  
Major General, USA  
Director of Civil Works

This publication was drafted for the Office, Chief of Engineers (OCE) by the U.S. Army Engineer District, Pittsburgh, Pa.

## CONTENTS

	Page
CHAPTER 1—INTRODUCTION .....	1-1
Sec. 100 Flood-Proofing and Building Codes	
<b>FLOOD PROOFING REGULATIONS</b>	
CHAPTER 2—ADMINISTRATION .....	2-1
Sec. 200 Purpose	
201 Scope	
202 Alternate Materials and Methods of Construction	
203 Tests	
204 Organization and Enforcement	
205 Permits	
206 Inspections	
207 Certificate of Use and Occupancy	
208 Public Notice of Flood Hazard	
209 Provision of Safe Refuge	
210 Classification and Posting of Buildings and Structures	
CHAPTER 3—DEFINITIONS OF TERMS .....	3-1
Sec. 300 Scope	
301 Definitions	
CHAPTER 4—FLOOD-PROOFING CLASSIFICATION OF SPACES BELOW THE REGULATORY FLOOD DATUM .....	4-1
Sec. 400 Scope	
401 Descriptions of Flood-Proofing Classes	
402 The Space Classification Chart	
CHAPTER 5—WATERPROOFING .....	5-1
Sec. 500 Scope	
501 Type A Constructions	
502 Type B Constructions	
503 Type C Constructions	
CHAPTER 6—STRUCTURAL REQUIREMENTS .....	6-1
Sec. 600 Scope	
601 Classes of Loads	
602 Water Loads	
603 Impact Loads	
604 Soil Loads	
605 Hurricane and Tidal Wave Loads	
606 Loading Conditions	
607 Combined Loads	

	Page
608 Allowable Stresses	
609 Allowable Soil Pressures	
610 Stability	
611 Reduction of Uplift Pressures	
612 Requirements for Other Flood-Proofing Methods	
<b>CHAPTER 7—CLOSURE OF OPENINGS</b> .....	<b>7-1</b>
Sec. 700 Scope	
701 Types of Closures	
702 Requirements	
703 Special Applications of Closure Assemblies	
<b>CHAPTER 8—INTERNAL FLOODING AND DRAINAGE</b> .....	<b>8-1</b>
Sec. 800 Scope	
801 Intentional Flooding with Potable Water	
802 Automatic Flooding with Flood Water	
803 Emergency Flooding of Waterproofed Spaces	
<b>CHAPTER 9—FLOORING</b> .....	<b>9-1</b>
Sec. 900 Scope	
901 Flooring Classifications	
<b>CHAPTER 10—WALLS AND CEILINGS</b> .....	<b>10-1</b>
Sec. 1000 Scope	
1001 Wall/Ceiling Classifications	
<b>CHAPTER 11—CONTENTS OF BUILDINGS AND STRUCTURES</b> .....	<b>11-1</b>
Sec. 1100 Scope	
1101 Classes of Contents	
<b>CHAPTER 12—ELECTRICAL</b> .....	<b>12-1</b>
Sec. 1200 Scope	
1201 Requirements at Locations Above and Below the RFD	
<b>CHAPTER 13—MECHANICAL</b> .....	<b>13-1</b>
Sec. 1300 Scope	
1301 Heating, Air Conditioning and Ventilation Systems	
1302 Plumbing Systems	
<b>FLOOD PROOFING PROCEDURES</b>	
<b>CHAPTER 14—PROCEDURES</b> .....	<b>14-1</b>
Sec. 1400 Scope	

1401	Critical Aspects of a Flood	
1402	Flood Damages	
1403	Loads	
1404	Structural Elements	
1405	Alternate Methods of Flood-Proofing	
1406	Total Approach	

## LIST OF TABLES

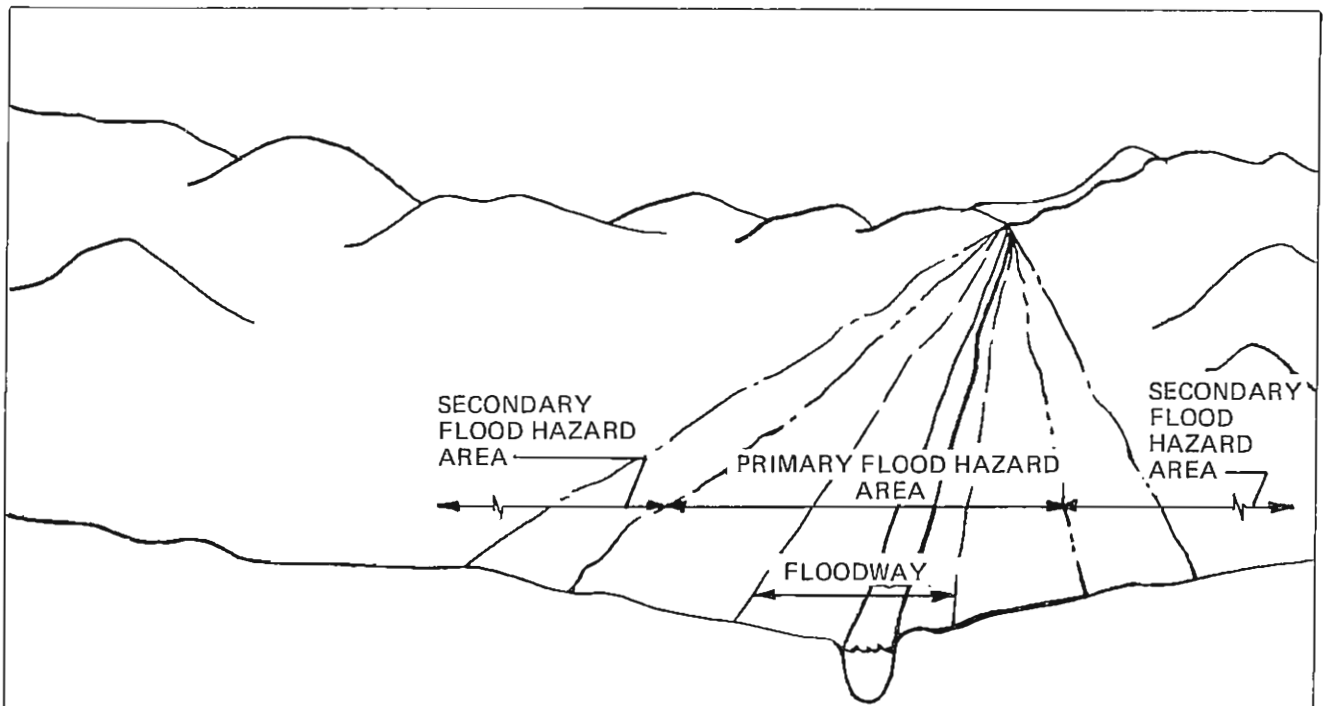
### Table

1	Classification of Buildings and Structures	2-9
2	Flood-Proofing Classification of Spaces	4-2

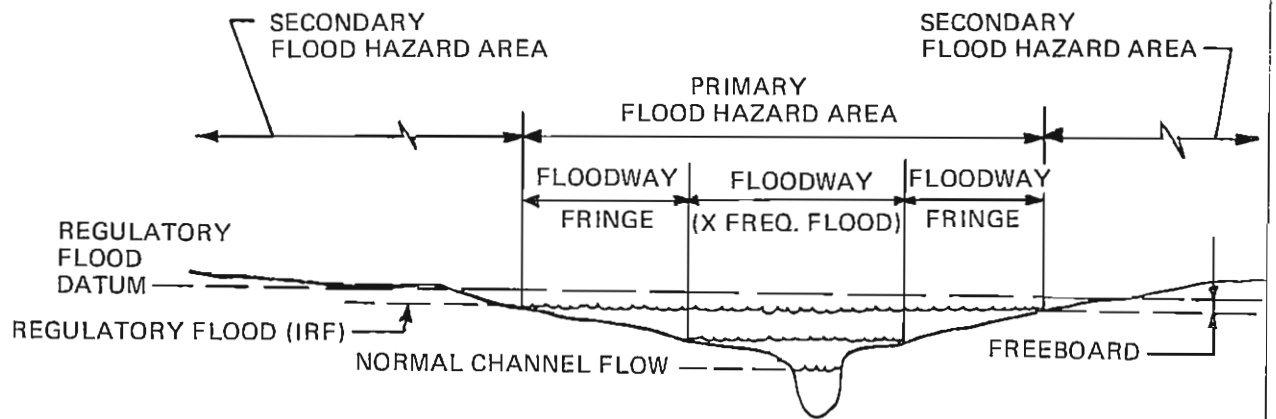
## LIST OF ILLUSTRATIONS

### Figure

i	Flood Hazard Areas and Regulatory Flood Datum	vi
1	Application for Permit	2-5
2	Placard Types	2-11
3	Type A Membrane Waterproofing in Floor Slabs	5-2
4	Non-Rigid Perimeter Wall and Floor Slab Connections	5-4
5	Typical Foundation Drainage and Waterproofing	14-5
6	Recommended Reinforcement Around Small Openings	14-8
7, 8	Typical Flood Shields for Windows	14-9
9, 10	Bond Beams & Vertical Reinforcement at Large Openings	14-10
11	Typical Door Shield	14-11
12	Display Window Flood Shield Details	14-12
13	Closures For Horizontal Openings Below RFD	14-13
14	Closure Panel Assembly Fastening Methods	14-14
15	Flood-proofing Closure For Large Horizontal Opening Below RFD	14-15
16, 17, & 18	Flood Shield Installations	14-16
19, 20	Other Flood-Protection Methods	14-17
21, 22	Flood Protection With Floodwalls and Dikes	14-19
23, 24, & 25	Dike or Levee Protection	14-20
26	Various Floodwall Types	14-22
27, 28	Structures with Restricted Use	14-23
29	Prevention of Backflow Through Sewer System	14-24
	REFERENCES	14-26



(a)



(b)

Figure i

**FLOOD HAZARD AREAS AND REGULATORY FLOOD DATUM**

# CHAPTER 1

## INTRODUCTION

### SECTION 100.0 FLOOD-PROOFING AND BUILDING CODES

**Sec. 100.1 GENERAL:** Many thousands of structures and potential building sites are located in the flood plains of our Nation and are susceptible to flooding. Flood control projects have partially protected some of these structures and building sites through reduction of the flood threat. However, the residual threat to partially protected sites and the total threat to unprotected sites remain as major problems. Evidence of this is given every year by the millions of words and hundreds of headlines that dramatically describe floods and their resulting damage and loss of life. When floods strike developed areas, whole cities may be disrupted and their productive capacities impaired. Strategic transportation lines are cut. Public service facilities are sapped, homes and crops are destroyed, and soils are eroded. Yet, in spite of this, flood vulnerable lands are the setting for continued urban growth in the United States.

Studies of flood plain use show that some encroachment is undertaken in ignorance of the hazard, that some occurs in anticipation of increased Federal protection, and that some takes place because by shifting the cost of the hazard to society it becomes profitable for private owners to do so. Even if full information on the flood hazard were available to all owners or users of flood plain property, there would still be conscious decisions for some reason or another to build in areas that are subject to flooding. In order to escape this dismal cycle of losses, partial protection, further induced development, and more unnecessary losses, old attitudes must be transformed into positive actions.

Primary among these actions is the revision of development policies and the enactment of a regulatory program to encourage and/or restrict the direction of growth or change necessary to achieve flood plain management objectives. Information programs are essential to this revision. They foster the development of more appropriate policies and involve the gathering and dissemination of data on past floods, on estimates of future floods, and information on alternate ways of dealing with flood losses in areas where intensive development has taken place or is anticipated. The latter has led to an expanded approach to flood damage reduction and prevention, recognizing the need to control or regulate the use of lands adjacent to watercourses and the need to provide guidance in the design of flood plain structures through the planned management and development of the flood hazard areas.

Regulation of the use of flood plain lands is a responsibility of State and local governments and can be accomplished by a variety of means, such as establishment of designated floodways and encroachment lines, zoning ordinances, subdivision regulations, and building codes. These land use controls, most often known as "Flood Plain Regulations", do not attempt to reduce or eliminate flooding but instead are intended to guide and regulate flood plain development to lessen the adverse affects of floods. Flood plain regulations are now being adopted by communities and used as the legal tools to control the extent and type of development permitted on flood plains.

Flood proofing standards applied through building codes and regulations to flood plain structures can permit economic development in the lower risk areas by holding flood damages and other adverse affects within acceptable limits. Flood-proofing requires adjustments both to structures and to building contents and involves keeping water out as well as reducing the effects of water entry. Such adjustments can be applied by the individual or as part of collective action either when buildings are under construction or during remodeling or expansion of existing structures. They may be permanent or temporary.

Flood proofing, like other methods of adjusting to floods has its limitations, however. For example, in addition to reducing loss potentials, a main purpose of flood proofing habitable structures is to provide for early return to normalcy after floods have receded rather than for continuity of occupancy. Through a false sense of security,



occupants may choose to remain during a flood and risk being stranded or losing their lives. Only very substantial and self-contained structures should be occupied during a flood. Also, unless correctly used, flood proofing can tend to increase uneconomical use of flood plains. Applied to structurally unsound buildings it (e.g., with closures and seals) can result in more damage than would occur without flood proofing. Generally it is applied to individual structures, so unless flood proofing is also applied to means of access, it is only partially effective in an area context. Accordingly, access ways should be passable at least in floods up to the magnitude used in setting flood proofing elevations.

Building codes and regulations presently in use throughout the nation, whether prepared by nationally recognized groups or by State and local governments, are directed primarily to the fire hazard. They do not contain special requirements, limitations, or design and construction restrictions for facilities located in flood hazard areas and susceptible to flood damage. This omission has been verified by a careful review of several national buildings codes, state and city building codes, and publications directed to flood-proofing; by numerous discussions with designers, planners, and construction contractors, and, through study of existing conditions and general building practices in known flood hazard areas. It has also brought to light the scarcity of information on flood-proofing standards. Designers of flood plain structures have either ignored the flood hazard altogether or attempted to use a "common sense" approach. The latter has, in many cases, resulted in designs that have neither prevented nor even reduced flood damages.

The lack of detailed flood hazard information and general misconceptions of the flood hazard problem have been recognized at all levels of government. Positive action at the Federal level to correct these deficiencies was initiated in 1960 and reinforced at the Presidential level in August, 1966 by issuance of Executive Order 11296. With growing impetus, detailed flood hazard information is being furnished to State and local governments to aid them in flood plain planning and development programs. Study is now being directed to the subject of flood plain regulations, but the building code implications of flood-proofing, which also warrant consideration as a means of flood damage reduction or prevention, have not been accorded similar treatment. Consequently, the Corps of Engineers has undertaken the preparation of these regulations to provide the minimum design and construction standards that would, if properly utilized, assist in safeguarding users and property in flood hazard areas.

These recommended regulations are intended for direct use or for incorporation into existing building codes which properly enforced should effectively reduce flood damages to buildings and structures located in the flood plain. Compliance should be a mandatory requirement for approval of plans or issuance of permits for construction of all new buildings and structures, and for existing buildings that will be subjected to major alterations, additions, or reconstruction in the defined flood hazard areas.

These recommended regulations neither contain nor are referenced to other regulations pertinent to flood plain management that may be provided by separate statute or involve political decisions relative to land use, zoning, subdivision regulations, occupancy restrictions, creation of flood zones, flood warning, or floodway encroachment. The intent here is to establish the special design and construction provisions that should be required for buildings, structures, and support facilities that are or may be subjected to flooding, relying upon zoning regulations to establish the areas of application. Other aspects of flood plain regulations, such as Flood Plain Zoning and Subdivision Regulations, are treated in "Regulation of Flood Hazard Areas to Reduce Flood Losses", Water Resources Council, 1971-1972, Washington, D.C.

This publication deals with the treatment of hydrostatic and hydrodynamic forces and waterproofing associated with riverine flooding only. To the extent that coastline structures are subject to these semi-static conditions, these provisions will be applicable to coastal or tidal flooding situations; however, no consideration is given to the special problems of wave impact, corrosion and erosion associated with coastal flooding. Similarly the problems of impact from floating debris and velocity introduce dynamic considerations which are not treated in detail and mud slide and high density fluid problems that are prevalent in West Coast communities are omitted entirely.

The design and construction criteria contained herein for riverine flooding conditions should be of substantial benefit to many communities. Future development of more comprehensive coverage including the treatment of special dynamic problems should be implemented where warranted by others more directly involved with the particular flood damage situations.



**CHAPTER 2**  
**ADMINISTRATION**

**SECTION 200.0 PURPOSE**

**Sec. 200.1 APPLICATION:** The provisions contained herein shall constitute the minimum building standards and requirements that are applicable to safeguard life or limb, health, property, and public welfare by regulating and controlling design, construction, and quality of materials of all buildings and structures which are or will be located in all lands shown within the Flood Hazard Area(s) indicated on the Official Flood Plain Zoning Map. Hereinafter these provisions will be referred to as the "Flood-Proofing Regulations" part of "The Building Code," or in short as "these Regulations."

**Sec. 200.2 OFFICIAL FLOOD PLAIN ZONING MAP:** The Official Flood Plain Zoning Map showing the extent and boundaries of the Primary and Secondary Flood Hazard Areas is hereby declared and established as a part of these Regulations.

**Sec. 200.3 REGULATORY FLOOD DATUM:** For the purpose of these Regulations, the Regulatory Flood Datum, or as hereinafter referred to as the "RFD", is hereby declared and established for use as the reference datum for determining the elevation above mean sea level to which flood-proofing protection shall be provided.

**SECTION 201.0 SCOPE**

**Sec. 201.1 APPLICATION:** These Regulations shall apply to the construction, alteration, and repair of any building or parts of a building or structure in the Flood Hazard Area(s) of the \_\_\_\_\_  
City, Town, Village, etc.  
Additions, alterations, repairs, and changes of use or occupancy shall comply with all provisions for new buildings and structures as otherwise required in "The Building Code," except as specifically provided in these Regulations.

**Sec. 201.2 NONCONFORMING USE:** A structure or the use of a structure or premises which was lawful before the passage or amendment of the ordinance but which is not in conformity with the provisions of these Regulations may be continued subject to the following conditions:

- (1) No such use shall be expanded, changed, enlarged or altered in a way which increases its nonconformity.
- (2) No structural alteration, addition, or repair to any conforming structure over the life of the structure shall exceed \_\_\_\_\_per cent of its value at the time of its becoming a nonconforming use, unless the structure is permanently changed to a conforming use.
- (3) If such use is discontinued for \_\_\_\_\_consecutive months, any future use of the building premises shall conform to these Regulations. The assessor shall notify the zoning administrator in writing of instances of non-conforming uses which have been discontinued for a period of \_\_\_\_\_ months.
- (4) If any nonconforming use or structure is destroyed by any means, including floods, to an extent of \_\_\_\_\_per cent or more of its \_\_\_\_\_value it shall not be reconstructed except in conformance with the provisions of these Regulations; provided, the Board of Adjustment may permit reconstruction if the use or structure is located outside the floodway and is adequately and safely flood-proofed, elevated, or otherwise protected in conformance with these Regulations.
- (5) Uses or adjuncts thereof which are or become nuisances shall not be entitled to continue as non-conforming uses.

(6) Except as provided in "The Building Code," any use which has been permitted as a special exception shall not be deemed a nonconforming use but shall be considered a conforming use.

(7) Any alteration, addition, or repair to any nonconforming structure which would result in substantially increasing its flood damage or flood hazard potential shall be protected as required by these Regulations.

(8) The Building Official shall maintain a list of nonconforming uses including the date of becoming nonconforming, assessed value at the time of its becoming a nonconforming use, and the nature and extent of nonconformity. This list shall be brought up-to-date annually.

(9) The Building Official shall prepare a list of those nonconforming uses which have been flood-proofed or otherwise protected in conformance with these Regulations. He shall present such list to the Board of Adjustment which may issue a certificate to the owner stating that such uses, as a result of these corrective measures, are in conformance with these Regulations.

## **SECTION 202.0 ALTERNATE MATERIALS AND METHODS OF CONSTRUCTION**

**Sec. 202.1 APPLICATION:** These Regulations are not intended to prevent the use of any materials or methods of construction not specifically prescribed herein or by "The Building Code"; provided, any such alternate has been approved and its use authorized by the Building Official prior to its incorporation or use in the construction.

**Sec. 202.2 APPROVAL:** The Building Official may approve any such alternate provided he finds the proposed design is satisfactory and complies with the provisions of "The Building Code" and that the material, method, or work offered is, for the purpose intended, at least equivalent of that prescribed in "The Building Code" in quality, strength, effectiveness, fire resistance, durability, and safety. The Building Official shall require that sufficient evidence or proof be submitted to substantiate any claim that may be made regarding its use. If, in the opinion of the Building Official, the evidence and/or proof is not sufficient to justify approval, the owner or his agent may refer the entire matter to the Board of Appeals.

## **SECTION 203.0 TESTS**

**Sec. 203.1 PROOF OF COMPLIANCE:** Whenever there is insufficient evidence or proof of compliance with the provisions of these Regulations, or evidence that any material or any construction does not conform to the requirements of these Regulations, or in order to substantiate claims for alternate materials or methods of construction, the Building Official may require tests or test reports as proof of compliance. Tests, if required, are to be made at the expense of the owner or his agent, by an approved testing laboratory or other approved agency, and in accordance with approved rules or accepted standards as prescribed in "The Building Code".

**Sec. 203.2 ABSENCE OF APPROVED RULES:** In the absence of approved rules or other accepted standards, the Building Official shall determine the test procedure or, at his election, shall accept duly authenticated reports from recognized testing authorities or agencies in respect to the quality and manner of use of new materials.

**Sec. 203.3 RECORDS:** Copies of such tests reports, certifications, or the results of such tests shall be kept on file in the office of the Building Official for a period of not less than \_\_\_\_\_ years after the approval and acceptance of the completed structure for beneficial occupancy.

## SECTION 204.0 ORGANIZATION AND ENFORCEMENT

**Sec. 204.1 RULES AND REGULATIONS:** The Building Official is hereby authorized and directed to enforce the provisions of these Regulations as part of "The Building Code". For such purpose he shall have the powers of a police officer.

**Sec. 204.2 DEPUTIES:** The Building Official may appoint such number of officers, inspectors, and assistants as required. He may deputize such employees as needed to perform the functions of the Building Department.

**Sec. 204.3 OFFICIAL RECORDS:** The Building Official shall establish and maintain an official record of all business and activities of the department relating to these Regulations, and all such records shall be open to public inspection. He shall keep a permanent, accurate account of all fees and other monies collected and received under these Regulations. The Building Official shall, at least once a year, submit a report to the proper city official covering the work of the Department during the preceding period. Said report shall include detailed information regarding the administration and enforcement of these Regulations.

**Sec. 204.4 RIGHT OF ENTRY:** Whenever it may be necessary to make an inspection to enforce the provisions of these Regulations, the Building Official or his authorized representative may enter such building or premises at all reasonable times to inspect all parts that are or may be subject to flooding or where the potential for flood damage exists.

**Sec. 204.5 STOP WORK ORDER:** Whenever any building work is found to be done contrary to these Regulations, the Building Official shall order the work stopped by notice in writing to the person doing the work.

**Sec. 204.6 BOARD OF APPEALS:** In order to determine the suitability of alternate materials and methods of construction and to provide reasonable interpretations of the provisions herein, there shall be and is hereby created a Board of Appeals of \_\_\_\_\_ members. Each member of the Board shall be a licensed professional architect or engineer, or a builder or superintendent of building construction, with at least ten years experience, for five years of which he shall have been in responsible charge of work. At no time shall there be more than two members from the same profession. At least one of the members shall be a licensed structural or civil engineer with architectural engineering experience. The Board shall adopt reasonable rules for its investigations and shall render written decisions to the Building Official.

**Sec 204.7 VALIDITY:** It shall be unlawful for any person, firm or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert, or demolish, any building or structure in the Flood Hazard Area(s), or cause the same to be done, contrary to or in violation of any of the provisions of these Regulations and/or "The Building Code."

**Sec. 204.8 VIOLATIONS AND PENALTIES:** Any person, firm, or corporation violating any of these provisions shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine or by imprisonment as provided in the laws of the municipality for such misdemeanor, or as specified in "The Building Code."

## SECTION 205.0 PERMITS

**Sec. 205.1 STATEMENT OF INTENTION TO IMPROVE:** The Owner or any registered architect or licensed professional engineer authorized to represent the Owner shall, before preparing final plans for any improvement in the Primary Flood Hazard Area(s), file with the Building Official a Statement of Intention to Improve, including a brief description of the type of improvement being considered and giving its precise location, on a form provided by

the Building Official. The Building Official shall note on two copies the elevation of the RFD at the location of the proposed improvement. One copy of the Statement of Intention to Improve shall be retained by the Building Official until a permit for improvement on the site is approved or one year has elapsed; a second copy shall be returned to the Owner for his use in final siting and design of his improvement. Assignments of the RFD elevations at all locations shall be made from profiles and/or cross sections provided by the (*Army Corps of Engineers, SCS, USGS*). This information shall be open to public examination at all reasonable times.

**Sec. 205.2 PERMITS REQUIRED:** No person, firm, or corporation shall erect, construct, enlarge, alter, repair, move, remove, convert, or demolish any building or structure or any part thereof, or make any other improvement within the Primary Flood Hazard Area(s), or cause same to be done, without first obtaining a separate building flood proofing permit for any such improvement from the Building Official. Ordinary minor repairs may be made with the approval of the Building Official without a permit, provided that such repairs shall not violate any provision of these Regulations or of "The Building Code."

**Sec. 205.3 APPLICATIONS:** To obtain a permit, the applicant shall first file an application therefore which shall consist of:

(1) A description of the work to be covered by the permit including a list of all spaces affected by these Regulations giving flood-proofing class, elevation of RFD, floor elevation(s), proposed uses and contents, and references to drawings and specifications which explain the flood-proofing measures that apply to each space. The description shall include an estimate of the total value of the improvement. This description shall be made on a form provided by the Building Official (Fig. 1).

(2) \_\_\_\_\_ sets of complete plans and specifications, in addition to plans and specifications required by "The Building Code", except that plans and specifications for any and all proposed improvements in the Primary Flood Hazard Area(s) shall be prepared by an engineer or architect licensed by the State to practice as such. All drawings and specifications shall bear the name of the author thereof in his true name, followed by such title as he may be lawfully authorized to use. All plans and sections shall be noted with the proposed flood-proofing class of each space below the RFD including detail drawings of walls and wall openings.

(3) \_\_\_\_\_ copies of the Owner's Contingency Plan, which shall describe in detail all procedures for temporary placement and removal or contingent protection proposed for items in spaces affected by these Regulations including:

(a) Plans and schedules for items to be removed and locations of places above the RFD to which they will be removed if these contents violate restrictions associated with the flood-proofing class of the space in which they are placed temporarily, including specific organizational responsibilities for accomplishing this removal.

(b) Procedures, materials and equipment for protecting items required to have protection by their flood-proofing class but for which this protection is proposed to be provided contingently, including specific organizational responsibilities for accomplishing this protection.

Waivers of restrictions implicitly requested by submission of the Owner's Contingency Plan may be granted by the Building Official as provided by 1101.2.

(4) Any other information as reasonably may be required by the Building Official, including computations, stress diagrams, and other data sufficient to show the correctness of the plans.

**Sec. 205.4 ACTION ON PERMIT APPLICATION:** The complete application filed by an applicant for a flood proofing permit, including all of the above listed items, shall be checked by the Building Official. Such plans may be

**BUILDING OR STRUCTURE IN FLOOD HAZARD AREA**  
(To Accompany Application for Building Permit)

Supplementary Application

City or Town \_\_\_\_\_ County \_\_\_\_\_  
 Location \_\_\_\_\_  
 Intended Use \_\_\_\_\_ Value Of Improvement \$ \_\_\_\_\_  
 Type of Construction \_\_\_\_\_ No. of Stories \_\_\_\_\_  
 Owner \_\_\_\_\_ Address \_\_\_\_\_  
 Exist. Ground Elev. \_\_\_\_\_ MSL; Fin. Ground Elev. \_\_\_\_\_ MSL; Reg. Flood Datum Elev. at Site \_\_\_\_\_ MSL; RFD Velocity \_\_\_\_\_ Ft/Sec  
 \_\_\_\_\_ Floor Elev. \_\_\_\_\_ MSL; Proposed Use \_\_\_\_\_; \_\_\_\_\_ Floor Elev. \_\_\_\_\_ MSL; Proposed Use \_\_\_\_\_  
 \_\_\_\_\_ Floor Elev. \_\_\_\_\_ MSL; Proposed Use \_\_\_\_\_; \_\_\_\_\_ Floor Elev. \_\_\_\_\_ MSL; Proposed Use \_\_\_\_\_

Maximum Loading on Walls: Non Flood Load _____ PSF Hydrostatic Load _____ PSF Hydrodynamic Load _____ PSF Impact Load _____ PSF Total Flood Load _____ PSF	Hydrostatic (Uplift) Pressure on Floor Slabs (Maximum) _____ PSF Foundation Type(s) _____ Lowest Footer Elev. (Bottom) _____ MSL Sewage Disposal: _____ Septic Tank, _____ Pub. Syst., _____ Other (Explain) Potable Water: _____ Individual Well, _____ Pub. Syst., _____ Other (Explain)
---	--

Exterior Wall Construction Type(s): Above _____ Floor _____ Above _____ Floor _____ Above _____ Floor _____ Above _____ Floor _____	Floor Construction Type(s): _____ Floor _____ _____ Floor _____ _____ Floor _____ _____ Floor _____
---	---

Types of Waterproofing \_\_\_\_\_  
 Type(s) of Joints: Walls \_\_\_\_\_ Floors \_\_\_\_\_; Waterstops/Seals (Types): Walls \_\_\_\_\_ Floor \_\_\_\_\_  
 Sump Location \_\_\_\_\_ Sump Type \_\_\_\_\_  
 All Tanks and/or Buoyant Equipment Are \_\_\_\_\_ Are Not \_\_\_\_\_ Anchored To Prevent Flotation  
 Alternate Power Source Is \_\_\_\_\_ Is Not \_\_\_\_\_ Provided For Emergency Operation Of Sump Pump  
 Sanitary, Drainage & Water Supply Facilities Are \_\_\_\_\_ Are Not \_\_\_\_\_ Protected From Contamination & Back Flow by Flood Water  
 Retaining Wall(s) Are \_\_\_\_\_ Are Not \_\_\_\_\_ Used To Protect Building/Structure  
 Intentional Flooding Is \_\_\_\_\_ Is Not \_\_\_\_\_ Planned For This Building/Structure  
 Temporary And/Or Emergency Flood Proofing Is \_\_\_\_\_ Is Not \_\_\_\_\_ Planned For This Building/Structure  
 Building Structure Is \_\_\_\_\_ Is Not \_\_\_\_\_ Protected Against Erosion By Flood Flows  
 Site Is \_\_\_\_\_ Is Not \_\_\_\_\_ Protected Against Erosion By Flood Flows  
 Classification Of Building/Structure: FP \_\_\_\_\_, Primary \_\_\_\_\_ Secondary \_\_\_\_\_ Flood Hazard Area.  
 SPACES: List below all spaces of the building or structure below the Regulatory Flood Datum including their name, room number, and proposed flood-proofing classification (i.e. W1, W2 etc.). List all contents of each space (see Chapter 10 of the Flood-Proofing Regulations). Mark all items which are to be either protected contingently or removed to safe refuge upon receipt of a flood warning with an asterisk (\*); all such items must be mentioned in the Owner's Contingency Plan. Attach additional sheets if necessary.

The applicant hereby certifies that the above information is correct and that the plans submitted herewith conform to those submitted for occupancy permit application. The applicant agrees to comply with the provisions of the Zoning Ordinance, the Building Code and all other laws and ordinances affecting the construction and occupancy of this proposed building.

Signature Of Architect/Engineer \_\_\_\_\_ Address \_\_\_\_\_  
 \_\_\_\_\_  
 The undersigned will supervise the construction of the work above.  
 \_\_\_\_\_  
 Signature \_\_\_\_\_  
 \_\_\_\_\_  
 Title \_\_\_\_\_  
 \_\_\_\_\_  
 Address \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 (Signature) \_\_\_\_\_  
 APPROVED FOR COMPLIANCE WITH BUILDING CODE  
 Clerk \_\_\_\_\_ Date \_\_\_\_\_

Figure 1



reviewed by other Departments of the \_\_\_\_\_ to check compliance with the laws and ordinances under their  
(City)  
jurisdiction. The Building Official shall determine that the RFD elevation noted in the application is correct is accordance with the Statement of Intention to Improve and that all requirements for the flood-proofing classes selected by the Owner are met. If the Building Official determines that for any space affected by these Regulations, any requirement for the particular flood-proofing class, or any other requirement of these Regulations has not been met, he shall so indicate on the drawings and a permit shall not be granted. If the Building Official is satisfied that the work described in all parts of the application conform to the requirements of these Regulations and "The Building Code" and other pertinent laws and ordinances, and that the fees specified in "The Building Code" have been paid, he shall issue a permit therefore to the applicant. When the Building Official issues the permit, he shall endorse in writing or stamp on \_\_\_\_\_ sets of written descriptions, plans and specifications, and the Owner's Contingency Plan "APPROVED" \_\_\_\_\_ . \_\_\_\_\_ sets of the complete application as approved shall be retained  
(Name and Date)

by the Building Official for a period of not less than two years after the approval or issuance of a certificate of occupancy for the completed improvement. \_\_\_\_\_ sets of the complete application as approved shall be returned to the applicant, of which one set shall be kept at the building site and available for review by the Building Official at all reasonable times.

**Sec. 205.5 ISSUANCE OF PERMIT:** The Building Official shall not issue a permit for the partial execution of any improvement until the complete application for the entire improvement has been submitted and approved. The issuance or granting of a permit or approval of an application shall not be construed to be a permit for, or approval of, any violation of these Regulations or of "The Building Code." The issuance of a permit based upon an approved application shall not prevent the Building Official from thereafter requiring correction in such application or any part thereof or from preventing work related to the execution of any improvement from being carried on thereunder when in violation of these Regulations, "The Building Code" or of any other ordinance of the \_\_\_\_\_ .  
(City)

**Sec. 205.6 EXPIRATION:** Every permit issued by the Building Official shall expire by limitation and shall become null and void if the work authorized by such permit is not commenced within 60 days after issuance date of such permit, or if the 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 is re-commenced a new permit shall first be obtained, and the fee therefore shall be one-half the amount required for the original permit for such work; and provided, further, that such suspension or abandonment has not exceeded one year, after which, a new application for permit must be submitted and the permit fee shall be based on the total value of all construction work for which the permit is issued.

**Sec. 205.7 REVOCATION OF PERMIT:** The Building Official may revoke a permit or approval issued under these Regulations in case of any false statement or misrepresentation of fact in the application or on the plans, whenever the permit is issued in error, or whenever the permit is issued in violation of any ordinance or regulation, "The Building Code," or these Regulations.

**Sec. 205.8 PERMIT FEES:** Building permit fees shall be paid to the Building Official as required and set forth in "The Building Code," and in accordance with the determination of value or valuation under any provision of these Regulations that shall be made by the Building Official.

**Sec. 205.9 POSTING OF PERMIT:** The building permit shall be posted at the site of operations in a conspicuous place open to public inspection during the entire time of prosecution of the work and until completion of the same.

## SECTION 206.0 INSPECTIONS

**Sec. 206.1 INSPECTIONS REQUIRED:** All construction or work for which a permit is required shall be subject to inspection by the Building Official.

**Sec. 206.2 PERIODIC INSPECTIONS:** Buildings or structures and parts thereof that contain or utilize contingent or emergency (temporary) type flood-proofing elements or devices shall be subject to inspection by the Building Official at intervals of three (3) years or less. The Owner or his agency shall be notified at least 10 days in advance of inspection date and shall be present at the inspection. He shall be responsible for demonstrating the availability, installation, and proper functioning, anchorage and support of all closure assemblies and other contingent or emergency (temporary) flood-proofing items. All necessary correction of deficiencies shall be performed within 90 calendar days of the inspection date and at the Owner's expense. Failure to perform the required remedial work within the prescribed time shall be a violation of these Regulations and the applicable part(s) of "The Building Code."

## SECTION 207.0 CERTIFICATE OF USE AND OCCUPANCY

**Sec. 207.1 NEW BUILDINGS AND STRUCTURES:** No building or structure hereafter constructed in the Flood Hazard Area(s), or any portion thereof, shall be used or occupied until the Building Official shall have issued a certificate of use and occupancy.

**Sec. 207.2 BUILDINGS OR STRUCTURES HEREAFTER ALTERED:** No building or structure in the Flood Hazard Area(s) hereafter enlarged, extended or altered, or any portion thereof, shall be used or occupied; and no change in use or occupancy shall be made, until the Building Official shall have issued the certificate of use and occupancy, except that; the Building Official may permit lawful use or occupancy to continue upon the submission of evidence that the flood hazard or flood vulnerability of any occupied portions of the structure and its contents will not be increased during the execution of the improvements.

**Sec. 207.3 EXISTING BUILDINGS AND STRUCTURES:** The Building Official shall issue a certificate of use and occupancy for an existing building or structure located in the Flood Hazard Area(s) upon receipt of a written request from the Owner, provided:

- (1) There are no violations of law or orders of the Building Official pending.
- (2) It is established after inspection and investigation that the alleged use or occupancy of the building or structure has heretofore existed.
- (3) There is a positive showing that the continued use or occupancy of a lawfully existing building or structure in the Flood Hazard Areas(s), and without requiring alterations, rehabilitation or reconstruction, does not endanger public safety and welfare.

The Building Official shall refuse to issue a certificate of use or occupancy for any existing building or structure in the Flood Hazard Area(s) whenever it is found that the building or structure, or any portion thereof or appurtenant thereto, is in an unsafe condition and/or would be potentially unsafe when subjected to floods up to the RFD. He shall, in writing, so notify the Owner, lessee, tenant, occupant and/or agent thereof describing said condition and ordering the abatement thereof within a reasonable length of time. Failure to comply with the order of the Building Official shall be a violation of these Regulations and the applicable part (s) of "The Building Code."

**Sec. 207.4 CONTENTS OF CERTIFICATE:** When a building or structure is entitled thereto, the Building Official shall issue a certificate of use and occupancy that shall certify compliance with the provisions of these Regulations and "The Building Code." Issuance of a certificate does not assign liability to the community.

## **SECTION 208.0 PUBLIC NOTICE OF FLOOD HAZARD**

**Sec. 208.1 PROCEDURE:** On or about the anniversary date of the flood of record, the Building Official shall alert the public of the existing flood hazard of the \_\_\_\_\_ (City). He shall publish or cause to be published a public notice which shall indicate the elevation of the flood of record together with depths and approximate area(s) of inundation (if known). Said public notice will also contain similar information about the RFD that is established for purposes of these Regulations.

**Sec. 208.2 OTHER INFORMATION:** The public notice shall emphasize the necessity for maintenance and repair of all contingent flood-proofing measures and the probability of occurrence of a flood that would reach elevations higher than the RFD. It shall advise owners and/or occupants to operate all mechanically and manually operated closure assemblies for doors, windows and utilities openings, emergency electrical generating units, sump pumps etc. and, to check the availability and condition of all temporary closure panels, gaskets and anchorage devices, etc. All organizational, volunteer or assistance groups having responsibilities to act at times of flood emergencies shall be advised to review its state of readiness for effective mobilization and implementation of the flood emergency plan.

## **SECTION 209.0 PROVISION OF SAFE REFUGE**

**Sec. 209.1 NEW BUILDING AND STRUCTURES:** Every building or structure hereafter erected, that is located in the Primary Flood Hazard Area(s) where the ground surface is \_\_\_\_\_ feet or more below the RFD, or where flood water velocities may exceed five (5) feet per second, shall be provided with an inclosed refuge space above the RFD of sufficient area to provide for the occupancy load with a minimum of 12 square feet per person. It shall be provided with one or more exits through the exterior walls above the RFD to an exterior platform and stairway not less than three (3) feet wide.

**Sec. 209.2 BUILDINGS OR STRUCTURES HEREAFTER ALTERED:** Existing buildings and structures in the Primary Flood Hazard Area(s) that are subject to flood conditions described in 209.1, and which are hereafter enlarged, extended or altered, or where change of use or occupancy shall be made, shall conform to all provisions for new buildings and structures required by 209.1.

**Sec. 209.3 USE OF SPACE BELOW THE REGULATORY FLOOD DATUM:** No flood level or portion of the building or structure that is below the RFD regardless of structure or space classification shall be used for human occupancy, or for storage of any property, materials, or equipment that might constitute a safety hazard when contacted by flood waters.

## **SECTION 210.0 CLASSIFICATION AND POSTING OF BUILDINGS AND STRUCTURES**

**Sec. 210.1 GENERAL:** For administrative purposes of coordination of zoning regulations, inspection of structures, and conduct of emergency public safety operations, all buildings or structures in the Flood Hazard Area(s), whether existing or hereafter erected, shall be classified and posted in accordance with this Section. Classification of buildings and structures (FP1, FP2, etc.) is shown in Table 1 and is based upon the flood-proofing classifications of the constituent spaces (W1, W2, etc.) of the structure below the RFD (see Chapter 4) and the means by which these classifications are achieved. Posting would be accomplished by placards mounted on internal walls at building

entrances. For public safety operations, an identification symbol, eg. FP1, would be placed on the outside of the building above the RFD so as to be readily visible.

Table 1

CLASSIFICATION OF BUILDINGS AND STRUCTURES							
Building or Structure Classification	SPACE CLASSIFICATION						
	W1		W2		W3	W4	W5
	Completely Dry		Essentially Dry		Flooded with Potable Water	Flooded with Flood Water	Non-Flood-Proofed
	Without *HI	With *HI	Without *HI	With *HI			
FP1	X		X				
FP2	X	X	X	X			
FP3	X		X		X	X	
FP4	X	X	X	X	X	X	
FP5							X

\*Human Intervention

**SEC. 210.2 COMPLETELY FLOOD-PROOFED STRUCTURES (FP1, FP2):**

**Sec. 210.2.1 FP1**—Any building or structure located in a Flood Hazard Area with no space below the RFD or in which all enclosed spaces below the RFD are classified W1 or W2 without employing any contingent closure, removal, protection, or other measure which requires human intervention for effectiveness in a flood event to obtain those classifications shall be known as a Completely Flood-Proofed Structure and classified FP1. It shall be posted by the Owner with a Type 1 placard, which shall be fastened securely to the structure in a readily visible place.

**Sec. 210.2.2 FP2**—Any Building or structure located in a Flood Hazard Area with any space below the RFD and in which all such spaces are classified W1 or W2, but for which at least one or more of the spaces employs any contingent closure, removal, protection, or other measure which requires human intervention for effectiveness in a flood event to obtain those classifications shall be classified FP2. It shall be posted by the Owner with a Type 2 placard, which shall be fastened securely to the structure in a readily visible place above the RFD.

**SEC. 210.3 PARTIALLY FLOOD-PROOFED STRUCTURES (FP3, FP4):**

**Sec. 210.3.1 FP3**—Any building or structure located in a Flood Hazard Area which contains a combination of spaces below the RFD that are classified W1 or W2 which is achieved without human intervention, and one or more spaces that will be flooded internally (W3 and/or W4), shall be known as a partially flood-proofed structure and be classified FP3. It shall be posted by the Owner with a Type 3 placard which shall be fastened securely to the structure in a readily visible place above the RFD.

**Sec. 210.3.2 FP4**—Any building or structure located in the Flood Hazard Area which contains a combination of spaces below the RFD that are classified W1 or W2 which is achieved with human intervention, and/or one or more spaces that will be flooded internally (W3 and/or W4), shall be classified FP4. It shall be posted by the Owner with a Type 4 placard which shall be fastened securely to the structure in a readily visible place above the RFD.

**Sec. 210.4 NON-FLOOD-PROOFED STRUCTURES (FP5):** Any existing building or structure located in a Flood Hazard Area which contains one or more spaces below the RFD that are not flood-proofed (WS) shall be known as a Non-Flood-Proofed Structure and classified FP5. It shall be posted by the Owner with a Type 5 placard which shall be securely fastened to the structure in a readily visible place.

**Sec. 210.5 SAFE REFUGE AREAS:** Buildings or structures located in the Primary Flood Hazard Area that are provided with area(s) of safe refuge shall have said area(s) posted by the Owner with a Type 6 placard, which shall be securely fastened to the structure in a readily visible place.

**Sec. 210.6 PLACARDS:** All placards shall be furnished by the Building Official and installed by the owner and shall be replaced immediately if removed, or defaced.

**Sec. 210.7 PLACARD TYPES:** Placards shall be white rigid plastic or other non-water susceptible material, \_\_\_\_\_ inches long and \_\_\_\_\_ inches wide, and shall have printed thereon in black letters the information shown in Figure 2.

**Sec. 210.8 VIOLATIONS:** Failure to comply with the requirements of this section shall be a violation of these Regulations and the applicable part(s) of "The Building Code."

## PLACARD TYPES

**COMPLETELY FLOOD-PROOFED STRUCTURE**

This building/structure is completely flood-proofed to withstand flooding to the RFD.

**REGULATORY FLOOD DATUM \_\_\_\_\_ FEET MSL**

Areas below RFD are authorized for \_\_\_\_\_ use  
as approved by \_\_\_\_\_ Date \_\_\_\_\_

**FLOOR ELEVATION AT THIS POINT- \_\_\_\_\_ FT MSL**

Type 1

**FLOOD-RESISTIVE STRUCTURE**

This building/structure contains areas below the RFD which require implementation of an approved contingency plan to achieve their required degree of protection

**REGULATORY FLOOD DATUM \_\_\_\_\_ FEET MSL**

Areas below RFD are authorized for \_\_\_\_\_ use  
as approved by \_\_\_\_\_ Date \_\_\_\_\_

**FLOOR ELEVATION AT THIS POINT \_\_\_\_\_ FT. MSL**

Type 2

**PARTIALLY FLOOD-PROOFED STRUCTURE**

Structural integrity during floods to the RFD will be achieved by internal flooding of \_\_\_\_\_ spaces when flood waters reach \_\_\_\_\_ feet MSL.

**REGULATORY FLOOD DATUM \_\_\_\_\_ FEET MSL**

Areas below RFD are approved for \_\_\_\_\_ use  
as approved by \_\_\_\_\_ Date \_\_\_\_\_

**FLOOR ELEVATION AT THIS POINT- \_\_\_\_\_ FT. MSL**

Type 3

**PARTIALLY FLOOD-PROOFED STRUCTURE**

Structural integrity during floods to the RFD will be achieved by internal flooding of \_\_\_\_\_ spaces when flood waters reach \_\_\_\_\_ feet MSL. Some areas require implementation of an approved contingency plan to achieve their required degree of protection.

**REGULATORY FLOOD DATUM \_\_\_\_\_ FEET MSL**

Areas below RFD are approved for \_\_\_\_\_ use  
as approved by \_\_\_\_\_ Date \_\_\_\_\_

**FLOOR ELEVATION AT THIS POINT \_\_\_\_\_ FT. MSL**

Type 4

**NON-FLOOD-PROOFED STRUCTURE**

This building/structure is not flood-proofed.

**REGULATORY FLOOD DATUM \_\_\_\_\_ FEET MSL**

Areas below RFD are authorized for \_\_\_\_\_ use  
as approved by \_\_\_\_\_ Date \_\_\_\_\_

**FLOOR ELEVATION AT THIS POINT- \_\_\_\_\_ FT. MSL**

Type 5

**AREA OF SAFE REFUGE**

This space is authorized as an area of safe refuge above the RFD and will accommodate \_\_\_\_\_ persons.

**REGULATORY FLOOD DATUM \_\_\_\_\_ FEET MSL**

Approved by \_\_\_\_\_ Date \_\_\_\_\_

**FLOOR ELEVATION AT THIS POINT- \_\_\_\_\_ FT. MSL**

Type 6

Figure 2



**CHAPTER 3**  
**DEFINITIONS OF TERMS**

**SECTION 300.0 SCOPE**

**Sec. 300.1 PURPOSE:** For the purpose of these Regulations, certain abbreviations, words, and their derivatives, shall be construed as set forth in this Chapter.

**SECTION 301.0 DEFINITIONS**

**Sec. 301.1 GENERAL:** The terms defined in this Chapter have been grouped in accordance with their main uses under the headings; Administrative, Physical, and Regulatory.

**Sec. 301.2 ADMINISTRATIVE:**

**Sec. 301.2.1 ACCESSORY USE OR STRUCTURE** — a use or structure on the same lot with, and of a nature customarily incidental and subordinate to, the principal use or structure.

**Sec. 301.2.2 BUILDING OFFICIAL** — the officer charged with the administration and enforcement of the Building Code and these Flood-proofing Regulations or his regularly authorized deputy.

**Sec. 301.2.3 ENCROACHMENT LINES** — the lateral limits or line drawn along each side and generally parallel to a watercourse or body of water, to preserve the flood carrying capacity of the stream or other body of water and its flood plain, and to assure attainment of the basic objective of improvement plans that may be considered or proposed. Their location, if along a stream, should be such that the floodway between them will effectively carry and discharge a large flood, i.e. not less than the Intermediate Regional Flood.

**Sec. 301.2.4 FLOOD HAZARD AREAS:** <sup>1</sup>

**Sec. 301.2.4.1 PRIMARY** — the lands adjoining the channel of a river, stream or watercourse, would be covered by flood water during a Regulatory Flood.

**Sec. 301.2.4.2 SECONDARY** — the land area beyond the runout line of the Regulatory Flood that could be affected by higher floods and by underground water travel, back flooding of sewerage, drainage, domestic water supply, and public utility systems, or cause other flood related problems during a Regulatory Flood.

**Sec. 301.2.5 FLOODWAY**<sup>1</sup> — the channel of the stream or body of water and those portions of the flood plains which are reasonably required to carry and discharge flood water or flood flow of a designated magnitude.

**Sec. 301.2.6 FLOOD PLAIN MANAGEMENT** — a term applied to the full range of public policy and action for insuring wise use of the flood plains. It includes everything from collection and dissemination of flood control information to actual acquisition of flood plain lands, including the enactment and administration of flood plain regulations including building codes and the building of flood modifying structures.

**Sec. 301.2.7 FLOODWAY FRINGE**<sup>1</sup> — the area of the flood plain not lying within a floodway which may hereafter be covered by flood waters up to the Regulatory Flood.

<sup>1/</sup> See illustration on Page vi – Figure i.



**Sec. 301.2.8 FREEBOARD<sup>1</sup>** – a factor of safety usually expressed in feet above a design flood level for flood protective or control works. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions such as wave action, bridge opening and floodway obstructions, and the hydrological effects of urbanization of the watershed.

**Sec. 301.2.9 HABITABLE ROOM** – 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.

**Sec. 301.2.10 NONCONFORMING USE** – a building or structure, or the use thereof, which was lawful before the passage or amendment of the (ordinance, resolution, act) but which is not in conformance with the provisions of these Regulations.

**Sec. 301.2.11 OWNER** – owner shall mean any person who has dominion over, control of, or title to an artificial or natural obstruction.

**Sec. 301.2.12 REGULATORY FLOOD<sup>1</sup>** – a flood which is representative of large floods known to have occurred generally in the area or reasonably characteristic of what can be expected to occur on a particular stream or other body of water. This flood is generally being recognized and accepted nationally by Federal and non-Federal interests as one with an average frequency of occurrence on the order of once in 100 years (see Intermediate Regional Flood).

**Sec. 301.2.13 REGULATORY FLOOD DATUM (RFD)<sup>1</sup>** – established plane of reference from which elevation and depth of flooding may be determined for specific locations of the flood plain. It is the Regulatory Flood plus a freeboard factor of safety established for each particular area which tends to compensate for the many unknown and uncalculable factors that could contribute to greater flood heights than that computed for a Regulatory Flood. (see Regulatory Flood and Freeboard definitions for clarification of cumulative definition of Regulatory Flood Datum).

**Sec. 301.2.14 SUBDIVISION** – the partitioning or dividing of a parcel or tract of land.

### **Sec. 301.3 PHYSICAL:**

**Sec. 301.3.1 ARTIFICIAL OBSTRUCTION** – artificial obstruction shall mean any obstruction which is not a natural obstruction.

**Sec. 301.3.2 CHANNEL<sup>1</sup>** – a natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water. Channel flow thus is that water which is flowing within the limits of the defined channel.

**Sec. 301.3.3 FILL** – the placing, storing, or dumping of any material, such as (by way of illustration but not of limitation) earth, clay, sand, concrete, rubble, or waste of any kind, upon the surface of the ground which results in increasing the natural ground surface elevation.

**Sec. 301.3.4 FLOOD** – an overflow of lands adjacent to a river, stream, ocean, lake, etc., not normally covered by water. Otherwise it is normally considered as any temporary rise in stream flow or stage that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, backwater effects in sewers and local drainage channels, creation of unsanitary conditions, soil erosion, deposition of materials during flood recessions, rise of ground water coincident with increased streamflow, contamination of domestic water supplies, and other problems.

<sup>1/</sup> See illustration on Page vi – Figure i.

**Sec. 301.3.5 FLOOD CREST** – the maximum stage or elevation reached by the waters of a flood at a given location.

**Sec. 301.3.6 FLOOD PLAIN** – the area, usually low lands, adjoining the channel of a river, stream or watercourse or ocean, lake, or other body of standing water, which has been or may be covered by flood water.

**Sec. 301.3.7 FLOOD PROFILE** – a graph or a longitudinal profile showing the relationship of the water surface elevation of a flood to location along a stream or river.

**Sec. 301.3.8 FLOOD-PROOFING** – a combination of structural changes and/or adjustments incorporated in the design and/or construction and alteration of individual buildings, structures or properties subject to flooding primarily for the reduction or elimination of flood damages.

**Sec. 301.3.8.1 Permanent flood-proofing** – permanent protection would be provided against the flood which do not depend upon any judgment, flood forecast, or action to put flood-protection measures into effect.

**Sec. 301.3.8.2 Contingent (or partial) flood-proofing** – contingent measures would not be effective unless, upon receipt of a warning or forecast, some minimal action would be required to make the flood-proofing measures operational.

**Sec. 301.3.8.3 Emergency (or temporary) flood-proofing** – emergency measures would be, upon receipt of a warning or forecast, either improvised just prior to or during an actual flood or carried out according to an established emergency plan of action.

**Sec. 301.3.9 INTERMEDIATE REGIONAL FLOOD (IRF)** – a flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year (a one per cent chance of being exceeded in any year). It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the “general region of the watershed.”

**Sec. 301.3.10 NATURAL OBSTRUCTION** – natural obstruction shall mean any rock, tree, gravel, or analogous natural matter that is an obstruction and has been located within the floodway by a nonhuman cause.

**Sec. 301.3.11 REACH** – a hydraulic engineering term to describe longitudinal segments of a stream or river. A reach will generally include the segment of the flood plain where flood heights are primarily controlled by man-made or natural flood plain obstructions or restrictions. In an urban area, the segment of a stream or river between two (2) physically identifiable points on the stream centerline would most likely be designated as a reach.

**Sec. 301.3.12 STRUCTURE** – anything constructed or erected on the ground, or attached to the ground, including, but not limited to the following: docks, dams, fences, mobile homes, sheds and buildings.

**Sec. 301.3.13 UNDERCLEARANCE** – the lowest point of a bridge or other structure over or across a river, stream, or watercourse that limits the opening through which water flows. This is referred to as “low steel” in some regions.

**Sec. 301.3.14 WATERCOURSE** – any natural or man-made depression with a bed and well-defined banks two feet or more below the surrounding land serving to give direction to a current of water at least nine months of the year or having a drainage area of one square mile or more.

**Sec. 301.4 REGULATORY:**

**Sec. 301.4.1 BUILDING CODE** – the regulations adopted by a local governing body setting forth standards for the construction, addition, modification and repair of buildings and other structures for the purpose of protecting the health, safety, and general welfare of the public.

**Sec. 301.4.2 FLOOD PLAIN REGULATIONS** – a general term applied to the full range of codes, ordinances and other regulations relating to the use of land and construction within flood plain limits. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws and open area (space) regulations.

**Sec. 301.4.3 SUBDIVISION REGULATIONS** – regulations and standards established by a local unit of government with authority granted under a state enabling law, for the subdivision of land in order to secure coordinated land development, including adequate building sites and land for vital community services and facilities such as streets, utilities, schools and parks.

## CHAPTER 4

### FLOOD-PROOFING CLASSIFICATION OF SPACES BELOW THE REGULATORY FLOOD DATUM

#### SECTION 400.0 SCOPE

**Sec. 400.1 GENERAL:** The flood-proofing classification of a space is determined by the degree of protection required under these Regulations to permit its intended use. (Classification of entire buildings or structures for administrative and posting purposes, which is based jointly on the flood-proofing classes of its constituent spaces and the means by which their classifications are obtained, is explained in 210.0). The flood-proofing class of a space for which temporary placement or contingent protection measures are approved assumes that these measures are in effect during a flood and defines the resulting relationship of protection to use.

**Sec. 400.2 ASSIGNMENT OF FLOOD-PROOFING CLASSES:** Assignment is made by the Owner at the time of application for a permit and is subject to the approval of the Building Official as indicated in 205.0. Every space of an improvement in a Flood Hazard Area which impinges in whole or part upon the RFD shall have a flood-proofing class assigned to it, and all requirements associated with a flood-proofing class shall be met by the space to which they apply in addition to all other requirements of these Regulations and the Building Code.

#### SECTION 401.0 DESCRIPTIONS OF FLOOD-PROOFING CLASSES

**Sec. 401.1 CLASSIFICATIONS:** The following descriptions of the five flood-proofing classes are approximate and general; more precise specification of the requirements associated with each class is given in Table 2 of the following section.

**Sec. 401.2 COMPLETELY DRY SPACES (W1):** These spaces shall remain completely dry during flooding to the RFD; 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 as provided in 209.3. Structural components shall have capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

**Sec. 401.3 ESSENTIALLY DRY SPACES (W2):** These spaces shall remain essentially dry during flooding to the RFD; 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.

**Sec. 401.4 SPACES INTENTIONALLY FLOODED WITH POTABLE WATER (W3):** 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 RFD; 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.

**Sec. 401.5 SPACES FLOODED WITH FLOOD WATER (W4):** 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. (Most spaces in existing buildings would have this classification if provided with a suitable automatic flooding system. Carports, loading platforms, open crawl spaces, porches and patios would generally fall into this classification.

**Sec. 401.6 NON-FLOOD-PROOFED SPACES (W5):** A non-flood-proofed space in an existing building or structure is defined as a space which fails to meet the requirements of any of the above described classifications.

**SECTION 402.0 THE SPACE CLASSIFICATION CHART**

**Sec. 402.1 GENERAL:** Table 2 indicates the various degrees of protection required to permit uses of spaces for each flood-proofing 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 2

**SPACE CLASSIFICATION CHART**

FLOOD-PROOFING CLASSIFICATION OF SPACES									
Flood-Proofing Classes	MINIMUM REQUIREMENTS								
	Water-Proofing	Structural Loads	Closure of Openings	Internal Flooding & Drainage	Flooring	Walls and Ceilings	Contents	Electrical	Mechanical
W1 Completely Dry	Type A	Class 1	Type 1	See Chapter 8	Class 1	Class 1	Class 1	See Chapter 12	See Chapter 13
W2 Essentially Dry	Type B	Class 1	Type 1		Class 2	Class 2	Class 2		
W3 Flooded with Potable Water	Type A	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		

**Sec. 402.2 SEPARATION OF SPACES WITH DIFFERENT FLOOD-PROOFING CLASSIFICATIONS:** Any two adjacent spaces below the RFD having different flood-proofing classes shall be separated by a barrier meeting the requirements for the space with the lower-numbered classification. In addition, any opening below the RFD between two adjoining spaces shall be provided with a closure meeting the requirements for the space with the lower-numbered classification.

## CHAPTER 5 WATERPROOFING

### SECTION 500.0 SCOPE

**Sec. 500.1 PURPOSE:** 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.

**Sec. 500.2 PERFORMANCE STANDARDS:** Three 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 501.0 TYPE A CONSTRUCTIONS

**Sec. 501.1 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 501.2, integrally waterproofed concrete satisfying 501.3, or a continuous interior lining satisfying 501.4.

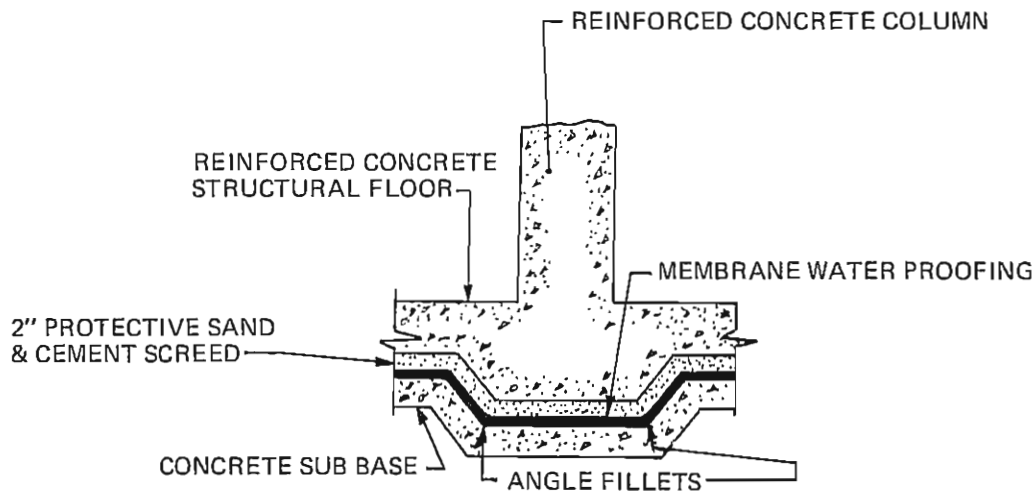
**Sec. 501.2 TYPE A MEMBRANE CONSTRUCTION:** Type A membrane water-proofing forms a continuous external impervious lining to protect a structure with a concrete floor slab and concrete or reinforced concrete masonry unit walls. It shall comply with the following requirements for structural prerequisites, materials, and installation.

#### Sec. 501.2.1 STRUCTURAL PREREQUISITES:

**Sec. 501.2.1.1 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 reinforcing steel so as to act monolithically with the wall.

**Sec. 501.2.1.2 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.

**Sec. 501.2.1.3 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

**Sec. 501.2.1.4 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.

**Sec. 501.2.1.5 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.

**Sec. 501.2.2 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 asphaltic bitumens. All applicable ASTM standards shall apply to Type A membranes and their component parts.

**Sec. 501.2.2.1 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.

**Sec. 501.2.2.2 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 501.2.1.4.

**Sec. 501.2.3 INSTALLATION:**

**Sec. 501.2.3.1 APPLICATION:** All Type A membrane waterproofing shall be applied by a certified roofing or waterproofing contractor.

**Sec. 501.2.3.2 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.

**Sec. 501.2.3.3 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.

**Sec. 501.2.3.4 PIPES:** Points where pipes or ducts penetrate water-proofed construction shall be designed to be watertight in accordance with accepted engineering practice.

**Sec. 501.2.3.5 JOINTS:** Membranes shall be continuous across expansion, control, and construction joints, which shall have waterstops of rubber, copper, plastic, or other suitable materials.

**Sec. 501.2.3.6 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.

**Sec. 501.2.3.7 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.

**Sec. 501.3 TYPE A INTEGRALLY WATERPROOFED CONCRETE CONSTRUCTION:** Type A integrally waterproofed concrete construction shall comply with the following requirements for structural prerequisites, materials, and installation.

**Sec. 501.3.1 STRUCTURAL PREREQUISITES:**

**Sec. 501.3.1.1 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.

**Sec. 501.3.1.2 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.

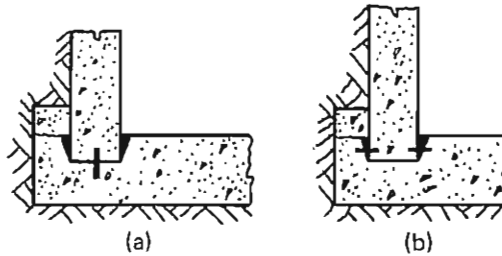
**Sec. 501.3.1.3 COLUMNS:** Where columns occur there shall be no vertical discontinuity or abrupt change in slab cross-section. Where slab cross-sections change, they shall do so gradually, and the effects of pressure distribution on the thinner portions of the slab cross-section shall be considered.

**Sec. 501.3.2 MATERIALS:**

**Sec. 501.3.2.1 STRENGTH:** All Type A integrally waterproofed concrete shall have a seven-day compressive strength of at least 3,000 psi and a 28-day compressive strength of 4000 psi.

**Sec. 501.3.2.2 WATERPROOFING ADMIXTURES:** If an approved water-proofing 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**

**Sec. 501.3.2.3 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.

**Sec. 501.3.2.4 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.

**Sec. 501.4 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.

**Sec. 501.4.1 STRUCTURAL PREREQUISITES:**

**Sec. 501.4.1.1 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 reinforcing steel so as to act monolithically with the wall.

**Sec. 501.4.1.2 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.

**Sec. 501.4.1.3 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.

**Sec. 501.4.2 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 standards shall apply to Type A interior lining materials.

**Sec. 501.4.2.1 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.

**Sec. 501.4.3 INSTALLATION:**

**Sec. 501.4.3.1 APPLICATION:** All Type A interior lining waterproofing shall be applied by a certified roofing or waterproofing contractor.

**Sec. 501.4.3.2 TURNS:** Turns at corners, both vertical and horizontal, shall be made with fillets of not less than two (2) inches dimension on any side.

**Sec. 501.4.3.3 PIPES:** Points where pipes or ducts penetrate water-proofed construction shall be designed to be watertight in accordance with accepted engineering practice.

**Sec. 501.4.3.4 JOINTS:** Interior linings shall be continuous across expansion, control, and construction joints, which shall have waterstops of rubber, copper, plastic, or other suitable material.

**Sec. 501.4.3.5 VERTICAL EXTENT:** Interior linings on walls shall extend at least 3 inches above the RFD of the protected space.

**Sec. 501.5 EXISTING SPACES:** Spaces in existing buildings or structures which become subject to these Regulations may be approved as having Type A waterproofing upon submission by the Owner of plans and specifications for these spaces prepared by a licensed architect or engineer; however, the Building Official shall make a thorough inspection of actual site conditions and may require that tests be made to demonstrate the adequacy of the work before granting this approval.

## **SECTION 502.0 TYPE B CONSTRUCTIONS**

**Sec. 502.1 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.

**Sec. 502.2 UPGRADING EXISTING SPACES:** Spaces with Type B water-proofing 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.

**Sec. 502.2.1 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 503.0 TYPE C CONSTRUCTIONS**

**Sec. 503.1 NON-WATER-PROOFED:** Type C waterproofing constructions are any which do not satisfy the requirements for Type A or B in 501.0 and 502.0, respectively.

**Sec. 503.2 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 in 501.0 and 502.0, respectively.

**Sec. Sec. 503.2.1 INSPECTIONS:** The Building Official shall make inspections prior to, during, and upon completion of this work before approving the improvement as Type A or B waterproofing, and may require tests be made to demonstrate the adequacy of the work before granting this approval.

## CHAPTER 6

### STRUCTURAL REQUIREMENTS

#### SECTION 600.0 SCOPE

**Sec. 600.1 GENERAL:** 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.

#### SECTION 601.0 CLASSES OF LOADS

**Sec. 601.1 Class 1 loads** – reflect the probable effects of flooding on structures which are waterproof (W1 or W2). These loads shall be calculated in complete accordance with this Chapter and shall include all water, impact, and soil loads specified herein.

**Sec. 601.2 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 8. These loads shall be calculated in accordance with this Chapter except that only hydrodynamic and impact loads must be considered when the interior and exterior water levels are equal.

**Sec. 601.3 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 612.2.3.

#### SECTION 602.0 WATER LOADS

**Sec. 602.1 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.

**Sec. 602.2 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 pounds 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:

**Sec. 602.2.1 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.

**Sec. 602.2.2 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.

**Sec. 602.2.3 UPLIFT:** Uplift loads are those which act in a vertically upward direction on the underside of horizontal or sloping surfaces of buildings or structures, 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.

**Sec. 602.3 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 for 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.

**Sec. 602.3.1 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 of 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:

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

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 or 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.

#### **Sec. 602.4 INTENSITY OF LOADS:**

**Sec. 602.4.1 VERTICAL LOADS:** Full intensity of hydrostatic pressures caused by a depth of water between the design level and the RFD applied on all surfaces involved.

**Sec. 602.4.2 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.

**Sec. 602.4.3 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 611.0.

**Sec. 602.4.4 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.

**Sec. 602.5 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.

## **SECTION 603.0 IMPACT LOADS**

**Sec. 603.1 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 of three basic types: normal, special and extreme.

**Sec. 603.1.1 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.

**Sec. 603.1.2 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.

**Sec. 603.1.3 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.

**Sec. 603.2 APPLICABILITY:** Impact loads shall be considered in the design of buildings, structures and parts thereof as stipulated below:

**Sec. 603.2.1 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.

**Sec. 603.2.2 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 at the RFD or at any level below it. Where natural or artificial barriers exist which would effectively prevent these special impact loads from occurring, the loads may be ignored in the design.

**Sec. 603.2.3 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.

## **SECTION 604.0 SOIL LOADS**

**Sec. 604.1 APPLICABILITY:** Full consideration shall be given in the design of buildings, structures and parts thereof, to the loads or 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 special 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.

## SECTION 605.0 HURRICANE AND TIDAL WAVE LOADS

**Sec. 605.1 APPLICABILITY:** Coverage of loads caused by flooding related to hurricanes, tidal waves and other similar natural events is beyond the scope of these Regulations and no specific or detailed treatment is provided. Concepts and requirements of these Regulations may be used as a guide in developing suitable provisions for flood-proofing of buildings exposed to flooding from these sources.

## SECTION 606.0 LOADING CONDITIONS

**Sec. 606.1 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.

## SECTION 607.0 COMBINED LOADS

**Sec. 607.1 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, beams, and flat slabs. Live loads on floors at or below the 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.

## SECTION 608.0 ALLOWABLE STRESSES

**Sec. 608.1 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.

## SECTION 609.0 ALLOWABLE SOIL PRESSURES

**Sec. 609.1 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 "liquefied", 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 \_\_\_\_%. (This reduction should be determined for each locality and soil type by the Building Official).

## SECTION 610.0 STABILITY

**Sec. 610.1 OVERTURNING:** All buildings and structures covered by these Regulations and all parts or 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 607.0. The required stability shall be provided by the normal resistive loads allowed by "The Building Code", such as frictional 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.

**Sec. 610.2 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 intensities, see 611.0. 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. Apportionment of uplift and resisting forces shall be made by a recognized method of structural analysis in accordance with accepted engineering practice.

**Sec. 610.3 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. Provision 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.

## SECTION 611.0 REDUCTION OF UPLIFT PRESSURES

**Sec. 611.1 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 basic 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 plans and design data submitted to the Building Official for approval as required by 205.0, 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.

**Sec. 611.2 IMPERVIOUS CUTOFFS:** Impervious 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 of impervious soil, grouted or injected cutoffs, impervious wall of interconnected concrete piles or panels, and similar seepage barriers, used alone or in combination.

**Sec. 611.3 FOUNDATION DRAINAGE:** Where impervious cutoffs are provided or where suitable foundation conditions exist, effective drainage and relief of uplift pressures under buildings and structures can be achieved. These foundation materials must be free-draining and have the desired degree 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 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.

**Sec. 611.4 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 drainage yield.

## **SECTION 612.0 REQUIREMENTS FOR OTHER FLOOD-PROOFING METHODS**

**Sec. 612.1 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 alone or in combination to achieve the required degree 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.

### **Sec. 612.2 FLOOD-PROOFING BY ELEVATING THE BUILDING:**

**Sec. 612.2.1 NATURAL TERRAIN:** In addition to the requirements of "The Building Code", the building shall be located not less than \_\_\_\_\_ 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.

**Sec. 612.2.2 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 combustible 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 25 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.

**Sec. 612.2.3 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 closest 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 resisting 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.

**Sec. 612.3 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.

**Sec. 612.3.1 DIKES AND LEVEES:** Dikes and levees shall be constructed of suitable selected materials, placed 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 612.2.2. 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 out over the dike. Normal surface runoff within and into the diked area during nonflood 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 612.2.2. Clearance from the toe of 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.

**Sec. 612.3.2 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 provisions of 612.3.1 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 contraction 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 coal tar epoxy coating system and periodically inspected and maintained. Steel sheet piling walls may be used as the impervious core of a dike.

## CHAPTER 7

### CLOSURE OF OPENINGS

#### SECTION 700.0 SCOPE

**Sec. 700.1 GENERAL:** 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 with waterproof closures meeting the requirements of this chapter.

#### SECTION 701.0 TYPES OF CLOSURES

**Sec. 701.1 CLASSIFICATION:** Closures shall be classified into five types according to their compatibility with the waterproofing standards of the various flood-proofing classes.

**Sec. 701.1.1 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.

**Sec. 701.1.2 Type 2 Closures** – shall form essentially dry barriers or seals, allowing only slight seepage during the hydrostatic pressure conditions of flooding to the RFD.

**Sec. 701.1.3 Type 3 Closures** – shall form barriers or seals that are impermeable to the passage of water-borne contamination under equalized pressure conditions.

**Sec. 701.1.4 Type 4 Closures** – shall form barriers to the passage of flood carried debris and the loss of floating items from the interior, but are not required to form impermeable seals.

**Sec. 701.1.5 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”.

#### SECTION 702.0 REQUIREMENTS

**Sec. 702.1 DESIGN STANDARDS 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 impede 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 annually and suitably maintained to preserve its waterproof and structural quality, or be replaced as required.

**Sec. 702.2 FRAMES FOR OPENINGS:** Each opening below the RFD shall have a metal frame suitable for providing an adequate sealing surface and for supporting the flood-proofing closure 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.

**Sec. 702.3 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 W1 or W2 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 701.0.

**Sec. 702.4 FIRE RESISTIVITY OF CLOSURE ASSEMBLIES:** All flood-proofing closure assemblies shall have a fire resistive rating that conforms to the requirements of "The Building Code" and the particular fire protection requirements for the occupancy group and building type of the structure.

## **SECTION 703.0 SPECIAL APPLICATIONS OF CLOSURE ASSEMBLIES**

**Sec. 703.1 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 flood-proofing 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 6) are constructed to prevent flood waters up to the RFD from entering the structure or space.

## CHAPTER 8

### INTERNAL FLOODING AND DRAINAGE

#### SECTION 800.0 SCOPE

**Sec. 800.1 GENERAL:** 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 pressures to protect a structure and/or its components from damage or failure during floods up to the RFD.

#### SECTION 801.0 INTENTIONAL FLOODING WITH POTABLE WATER

**Sec. 801.1 APPLICABILITY:** Spaces to be intentionally flooded (W3 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 801.2 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 801.3. 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.

**Sec. 801.2 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.

**Sec. 801.3 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 802.0.

#### SECTION 802.0 AUTOMATIC FLOODING WITH FLOOD WATER

**Sec. 802.1 APPLICABILITY:** Spaces to be intentionally flooded with flood water (W4) 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 \_\_\_\_\_ 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.

## **SECTION 803.0 EMERGENCY FLOODING OF WATERPROOFED SPACES**

**Sec. 803.1 APPLICABILITY:** Spaces which have been waterproofed (W1 or W2) to the RFD shall be provided with an automatic internal flooding system meeting all requirements of 802.0 to maintain structural integrity 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 parts 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 9

### FLOORING

#### SECTION 900.0 SCOPE

**Sec. 900.1 GENERAL:** 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.

**Sec. 900.2 BASIS FOR RESTRICTION:** 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 or floor material may result from one or more of the following:

- (1) Normal suspended-floor adhesives specified for above grade use are water-soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.
- (2) Flooring material contains wood or paper products.
- (3) Flooring material is not resistant to alkali or acid in water.
- (4) Sheet type floor coverings (linoleum, rubber, vinyl) restrict evaporation from non-W1 slabs.
- (5) Flooring material is impervious but dimensionally unstable.

#### SECTION 901.0 FLOORING CLASSIFICATIONS

**Sec. 901.1 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 W1 spaces. Class 2 floors require essentially dry spaces which may be subject to water vapor and slight seepage that is characteristic of W2 spaces. Class 3 flooring may be submerged in clean water during periods of intentional flooding as provided by W3 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-enclosed or outside uses with essentially unmitigated flood exposure.

**Sec. 901.1.1:** 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 floor) may be used whenever floors of Classes 1, 2, 3, 4, or 5 are permitted.

**Sec. 901.1.2 CLASSES OF TYPICAL FLOORING 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 900.2 (1-5). 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



	Class
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 floor 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 (lignin or "linoleum paste"), rubber/Asphaltic dispersions, or "alcohol" type resinous adhesives (cumar, oleoresinous).

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

## CHAPTER 10

### WALLS AND CEILINGS

#### SECTION 1000.0 SCOPE

**Sec. 1000.1 GENERAL:** 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.

**Sec. 1000.2 BASIS FOR RESTRICTION:** 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:

- (1) 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.
- (2) 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.
- (3) Wall or ceiling material is not resistant to alkali or acid in water.
- (4) Material is impervious but dimensionally unstable.
- (5) Materials absorb or retain water excessively after submergence.

#### SECTION 1001.0 WALL/CEILING CLASSIFICATIONS

**Sec. 1001.1 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 or protection. Class 5 wall and ceiling materials are permitted for semi-enclosed or outside uses with essentially unmitigated flood exposure.

**Sec. 1001.1.1:** 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.

**Sec. 1001.2 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 1000.2 (1-5). 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
Chalkboards	
Slate, porcelain glass, 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

	Class
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 (boards, sheets, or trim)	2
Plywood	
Exterior grade	2
Otherwise	1



## CHAPTER 11

### CONTENTS OF BUILDINGS AND STRUCTURES

#### SECTION 1100.0 SCOPE

**Sec. 1100.1 GENERAL:** This chapter shall govern the types of contents permitted and protection requirements for contents of spaces in buildings or structures located in the Flood Hazard Area(s).

**Sec. 1100.1.1:** 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 12 and 13. 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) or (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, necessitating 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.

#### SECTION 1101.0 CLASSES OF CONTENTS

**Sec. 1101.1 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 Areas 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.

**Sec. 1101.2 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. This waiver of restriction, however, shall not apply to residences and their ancillary spaces; to firms, businesses, or institutions with fewer than 10 permanent employees and their ancillary spaces; or to any spaces which are or would be unoccupied and unattended in their foreseeable normal yearly operation for periods greater than 72 hours; and in no case shall a waiver of restriction be construed to permit the creation of spaces for human habitation.

**Sec. 1101.3 CONTENTS CLASSES FOR TYPICAL ITEMS:** The following chart is intended as an aid to the Owner, Architect/Engineer, and the Building Official in assessing the hazard potential and vulnerability to loss of typical contents of an improvement with respect to criteria listed in 1100.1.1 (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.

**Sec. 1101.3.1:** 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.

**Sec. 1101.3.2:** 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 1101.2. Temporary placement may be permitted for certain items, subject further to the restrictions of 1101.2 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, electric clocks, etc.	2
Art works (paintings, sculpture, etc.)	1
Barrels, bouyant (empty 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
Calcium carbide	XX

	Class
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
Hydrocyanic (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



	Class
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 water-tight or "moth-balled".

## CHAPTER 12

### ELECTRICAL

#### SECTION 1200.0 SCOPE

**Sec. 1200.1 GENERAL:** Where buildings or parts of buildings and structures extend below the RFD, the electrical materials, equipment and installation shall conform to the requirements of this section of the Regulations.

#### SECTION 1201.0 REQUIREMENTS AT LOCATIONS ABOVE AND BELOW THE RFD

**Sec. 1201.1 MAIN POWER SERVICE:** The incoming main commercial power service equipment, including all metering equipment, shall be located above the RFD. 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 RFD, a disconnecting means for the incoming main commercial power service shall be provided at an accessible remote location above the RFD.

**Sec. 1201.2 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 RFD. Portable or movable electrical equipment may be located in any space below the RFD 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 RFD. 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.

**Sec. 1201.3 NORMAL AND EMERGENCY LIGHTING CIRCUITS:** All circuits except emergency lighting circuits, extending into areas below the RFD shall be energized from a common distribution panel located above the RFD. All emergency lighting circuits into areas below the RFD shall be energized from an independent distribution panel also located above the RFD. Each distribution panel shall have the capability of being de-energized by a separate single disconnecting device.

**Sec. 1201.4 EMERGENCY LIGHTING REQUIREMENTS:** All areas of the building or structure that are below the RFD, 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 automatically operated emergency lighting facilities and automatically operated electrical disconnect equipment to insure that all electrical circuits into these areas, except emergency lighting circuits, are de-energized prior to personnel working in water. The electrical circuits shall be de-energized prior to the presence of any water on the floor of the affected area. All components of emergency lighting systems installed below the RFD 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 for emergency lighting may be furnished by a storage battery(s), prime mover-generator system, a separate commercial power supply system, the same commercial power system, or a combination thereof, subject to the following provisions of this section.

**Sec. 1201.4.1 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 RFD.

**Sec. 1201.4.2 SEPARATE COMMERCIAL POWER SUPPLY SYSTEM:** This source of energy shall have a degree of reliability satisfactory to the Building Official. A system fed from a substation other than that used for the regular supply and not on the same poles (except service pole) as the regular supply is deemed to have the required degree of reliability. A secondary circuit fed from the same primary network circuit as the regular supply shall be regarded as a separate system.

**Sec. 1201.4.3 SAME COMMERCIAL POWER SUPPLY SYSTEM:** The system shall be an underground secondary network system and a separate service shall be connected on the line side of the service switch or breaker of the regular service.

**Sec. 1201.5 LIGHTING CIRCUITS BELOW REGULATORY FLOOD DATUM:** Lighting circuit switches, receptacles and lighting fixtures operating at a maximum voltage of 120 volts to ground may be installed below the RFD, provided that these circuits shall be de-energized as noted in 1201.4. 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.

**Sec. 1201.6 SUBMERSIBLE EQUIPMENT:** Except for the switches, receptacles and lighting fixtures noted herein, all other electrical equipment permanently installed below the RFD 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 RFD.

**Sec. 1201.7 SUBMERSIBLE WIRING REQUIREMENTS:** All electrical wiring systems installed below the RFD shall be suitable for continuous submergence in water and shall contain no fibrous components. Only submersible type splices will be permitted in areas below the RFD. All conduits located below the RFD shall be so installed that they will be self draining if subject to flooding conditions.

**Sec. 1201.8 ELEVATORS:** All electric power equipment and components of elevator systems shall be located above the RFD. 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 RFD.

**Sec. 1201.9 ELECTRIC HEATING EQUIPMENT:** Electric unit heaters installed below the RFD shall be capable of disconnection and removal in the manner described for portable electrical equipment in 1201.2. Electric controls on gas and oil furnaces located below the RFD shall not exceed 120 volts to ground and the control circuits shall be automatically de-energized prior to the presence of any water on the floor of the affected area in accordance with 1201.4.

**Sec. 1201.10 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. All buildings or structures utilizing sump pumping equipment shall be provided with automatic starting standby electrical generating equipment located above the RFD. The standby generating equipment shall be capable of remaining in continuous operation for a period of 125% of the anticipated duration of the design flood.

## CHAPTER 13

### MECHANICAL

#### SECTION 1300.0 SCOPE

**Sec. 1300.1 GENERAL:** 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.

#### SECTION 1301.0 HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS

**Sec. 1301.1 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.

**Sec. 1301.2 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 RFD. When not feasible, said equipment shall be located in W1 or W2 spaces (below the RFD) with direct access provided from a location above the RFD, and shall conform to all requirements of this Section.

**Sec. 1301.2.1** Heating systems utilizing gas or oil fired furnaces shall have a float operated automatic control valve installed in the fuel supply line which shall be set to operate when flood waters reach an elevation equal to the floor level of the space where furnace equipment is installed. A manually operated gate valve that can be operated from a location above the RFD shall be provided in the fuel supply line to serve as a supplementary safety provision for fuel cutoff. 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 RFD 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 means of flexible or swing type couplings. All heating equipment and fuel storage tanks shall be vented to an elevation of at least \_\_\_\_\_ feet above the RFD. Air supply for combustion shall be furnished if required for systems installed in W1 or W2 spaces, and piping or duct work for such purpose shall be terminated at least \_\_\_\_\_ feet above the RFD.

**Sec. 1301.2.1.1:** All duct work for warm air heating systems which is located below the RFD 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 RFD, the duct work shall be protected by a mechanically operated closure assembly and shall be provided with the operator control position above the RFD. The closure assembly in its open position shall not impede the normal function of the heating system.

**Sec. 1301.2.1.2:** Steam or hot water heating pipes located below the RFD, shall be provided with shut-off valves sufficient to isolate the piping system when warning of flooding to the RFD is received.

**Sec. 1301.2.1.3:** Electric heating systems, where utilized in Flood Hazard Areas, shall be installed in accordance with requirements of Chapter 12.

Sec. 1301.2.2: Air conditioning and ventilation systems that will be located below the RFD shall be installed in W1 or W2 spaces only. All installation, piping, duct work, connections, and safety features shall conform to the same requirements stated for Heating Systems in 1301.2.1.

Sec. 1301.2.3: Where heating, air conditioning, or ventilating systems (as defined in 1301.2) are installed in other than W1 or W2 spaces, all bearings, 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.

Sec. 1301.2.4: All fuel supply lines that originate either outside of W1 or W2 spaces or pass through areas that would be flooded, shall be equipped with automatic shut-off valves to prevent loss of fuel in the event of a line breakage. The wall opening shall be made flood-proof by use of imbedded collars, sleeves, waterstops, or other means as may be approved by the Building Official.

Sec. 1301.2.5: Electrical connections to all mechanical systems covered by this chapter shall conform to the requirements of Chapter 12.

## SECTION 1302.0 PLUMBING SYSTEMS

Sec. 1302.1 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.

Sec. 1302.1.1: Except as otherwise provided herein, nothing in these Regulations shall require the removal, alteration, or abandonment of, nor prevent the continued use of, an existing plumbing system.

Sec. 1302.1.2: 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 205.0.

Sec. 1302.1.3: 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.

Sec. 1302.2: BELOW RFD: Sanitary sewer and storm drainage systems that have openings below the RFD 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. In W1 spaces, manually operated shut-off valves that can be operated from a location above the RFD shall also be installed in such lines to serve as a supplementary safety provision for preventing backflow in case of automatic backflow device failure or line break between the space(s) and the device.

Sec. 1302.2.1: Spaces 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 RFD, and/or manually operated shut-off valves or closure devices.

Sec. 1302.2.2: Where the state 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 \_\_\_\_ feet above the RFD.

**Sec. 1302.2.3:** Sanitary sewer systems, including septic systems, that are required to remain in operation during a flood shall be provided with a sealed holding tank and the necessary isolation and diversion piping, pumps, ejectors and appurtenances required to prevent sewage discharge during the flood. The holding tank shall be sized for storage of at least 150% of the anticipated demand for the duration of a flood to the RFD.

**Sec. 1302.2.3.1:** All vents shall extend to an elevation of at least \_\_\_\_ feet above the RFD.

**Sec. 1302.2.3.2:** All pipe openings through walls below the RFD shall be flood-proofed to prevent flood water backflow through spaces between pipes and wall construction materials. (See 1301.2.4).

**Sec. 1302.3 SEWAGE DISPOSAL/TREATMENT:** Individual sewage disposal and/or treatment facilities, except for cesspools and seepage pits, will be permitted in a Flood Hazard Area but only at locations where connection 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 RFD. Installations in low swampy areas or areas with generally high water tables or which may be subject to periodic flooding will not be permitted.

**Sec. 1302.3.1:** 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 a 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.

**Sec. 1302.3.2:** Seepage pits shall, for purposes of these Regulations, conform to the same requirements set forth above for cesspools.

**Sec. 1302.4 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 RFD. 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.

**Sec. 1302.4.1:** Water supply wells, tanks, filters, softeners, heaters, and all appliances located below the RFD shall be protected against contamination by covers, walls, copings, or castings. All vents shall be extended to a minimum elevation of \_\_\_\_ feet above the RFD.

**Sec. 1302.4.2:** 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.

**Sec. 1302.4.3:** 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.

**Sec. 1302.4.3.1:** 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.

**Sec. 1302.4.3.2:** 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) foot 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.

**Sec. 1302.4.4:** 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 14

### PROCEDURES

#### SECTION 1400.0 SCOPE

**Sec. 1400.1 PURPOSE:** 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.

#### SECTION 1401.0 CRITICAL ASPECTS OF A FLOOD

**Sec. 1401.1 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.

**Sec. 1401.2 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.

**Sec. 1401.3 VELOCITY:** Velocity of flood water during overbank flow conditions affects scouring, sediment transportation, debris load, and dynamic loading on structures and obstructions. Flood velocities vary from point to point in a flood plain and over the area of inundation. From a practical standpoint, 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.

**Sec. 1401.4 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.

**Sec. 1401.5 RATE OF RISE AND FALL:** The rate of 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 affects 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.

**Sec. 1401.6 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.



**Sec. 1401.7 DEBRIS LOAD:** The amount and type of floating debris carried by the flood waters can result in substantial loads against buildings and structures 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 significantly to the flood hazard and related problems.

**Sec. 1401.8 WAVE ACTION:** A degree of wave action is inherent to all large expanses 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 are beyond the scope of the Flood-Proofing Regulations and require special design considerations and procedures.

## **SECTION 1402.0 FLOOD DAMAGES**

**Sec. 1402.1 GENERAL:** Floods are a natural and inevitable part of life in communities along the rivers of our country. The transformation of tranquil rivers into destructive floods occurs hundreds of times each year. No part of the United States is spared. Every year, some 75,000 Americans are driven from their homes by floods. On the average, 80 persons are killed each year. These destructive overflows cause property damages that currently average \$1 billion a year. Damages to property, human suffering, and loss of life resulting from floods have been increasing year by year in spite of the expenditure of over seven billion dollars for flood control works. The increase in flood damages has been due primarily to the rapid growth of flood damageable improvements in the flood plains of the rivers and seacoasts. No dollar values can be assigned to human suffering and loss of life caused by a flood. Flood damages to property can be assessed and are substantial. As a rule, damages increase rapidly with depth of flooding. Damages to a building and its contents, as they relate to damage to finishes, trimwork, furniture, appliances, equipment, and storage materials represent a substantial portion of the total loss. For the purpose of this publication however, major emphasis is placed on structural damage to the building or structure or to structural elements thereof, including complete collapse or displacement of the structure.

**Sec. 1402.1.1:** When flood waters reach a structure they induce unbalanced pressures and loadings on all wetted surfaces which increase rapidly with increased depth. Once interior spaces become flooded, water pressures are automatically equalized. Unbalanced lateral pressures on walls may cause excessive lateral displacement, cracking, tilting, sliding, on and up to complete collapse of the wall. These same pressures can cause overloading and failure of vertical and horizontal framing members of the structure into which the walls are framed. Uplift pressures under basement and floor slabs can displace and collapse the slabs. Saturation of soils on which footings are supported and uplift pressures under the footings and within the soil can greatly reduce the bearing capacity of the soil and cause the footing to become unstable and fail. Uplift pressures under raft or mat foundations with integral walls can cause the entire structure to become bouyant and displace vertically upward, or to become unstable and overturn. In this latter case, unbalanced lateral pressures are also often at work. Dry, checked wooden beams and other structural materials lose their strength, swell, and deflect excessively as they become water-logged. This can cause floors and partitions to settle and sag, frames to become distorted, and plaster walls and ceilings to crack. When the beams, for example, dry up and attempt to return to their original shape, they are prevented from doing so by settled floors and partitions above, and can fail or cause the failure or displacement of other supporting members. The following sections contain examples of structural elements of buildings investigated under hydrostatic loads related to flood waters.

## SECTION 1403.0 LOADS

**Sec. 1403.1 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.

**Sec. 1403.2 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 linearly with depth or "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.

**Sec. 1403.3 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 1401.3 (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.

**Sec. 1403.4 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.

## SECTION 1404.0 STRUCTURAL ELEMENTS

**Sec. 1404.1 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 structure, (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.

**Sec. 1404.2 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.

**Sec. 1404.2.1:** 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 is 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.

**Sec. 1404.2.2:** 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. Illustrations of foundation drainage methods that may be used for relief of uplift pressures are shown on Figure 5. Where it is found impractical to stabilize the slab and structure by one of the methods shown on Figure 5, or a combination thereof, it may be more expedient to anchor the slab and/or structure to the ground (and preferably to an underlying rock formation) or to provide the required protection by means of dikes, levees, retaining walls, or floodwalls.

**Sec. 1404.3 BASEMENT AND RETAINING WALLS:** Under normal or nonflood conditions, the primary loading on basement and retaining walls consists of lateral soil pressures 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 for 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 cutoff, can cause the attainment of full hydrostatic pressures on the wall and cause failure of an inadequately designed wall.

**Sec. 1404.4 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.

**Sec. 1404.4.1:** 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. Permanent 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.

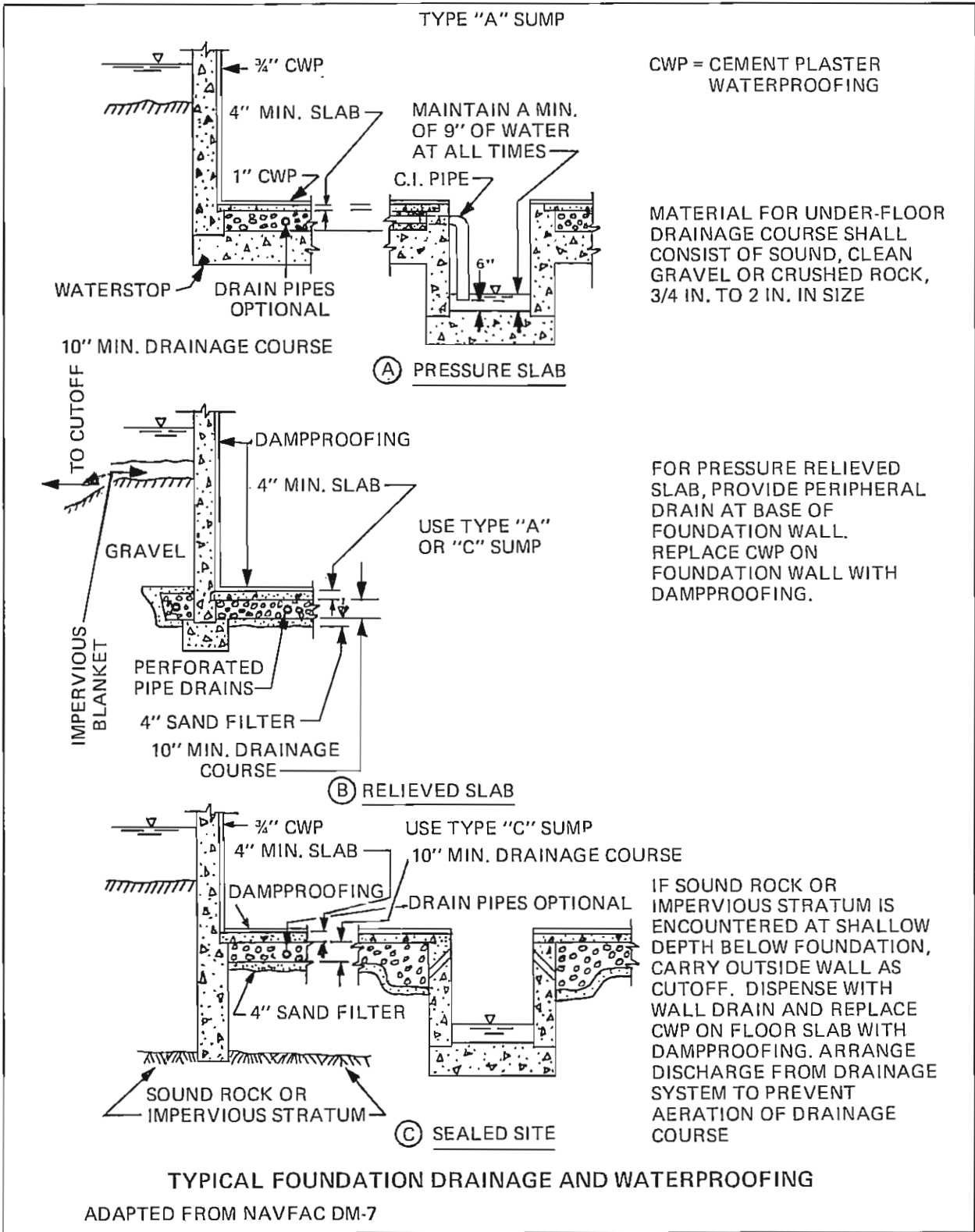


Figure 5

**Sec. 1404.4.2:** 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.

**Sec. 1404.4.3:** 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 surface. The frame may attach or be connected to the adjacent wall or supporting members or 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 of the Building Code. The seal may be attached to the closure door (panel, etc.) or sealing frame and with sealing to be achieved by applying pressure through bolting or latching of the closure or some other self-acting and positive means.

**Sec. 1404.4.4:** 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 for reverse loading cases.

**Sec. 1404.4.5:** 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.

**Sec. 1404.4.6:** Permanent closures of an opening may be accomplished by any structural means or 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.

**Sec. 1404.4.7:** 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.

**Sec. 1404.4.8:** 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.

**Sec. 1404.4.9:** Seals on all closures should be watertight and preferably of 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.

**Sec. 1404.4.10:** 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 6 through 18.

**Sec. 1404.5 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 many 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.

## **SECTION 1405.0 ALTERNATE METHODS OF FLOOD-PROOFING**

**Sec. 1405.1 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.

### **Sec. 1405.2 FLOOD-PROOFING BY ELEVATING THE BUILDING:**

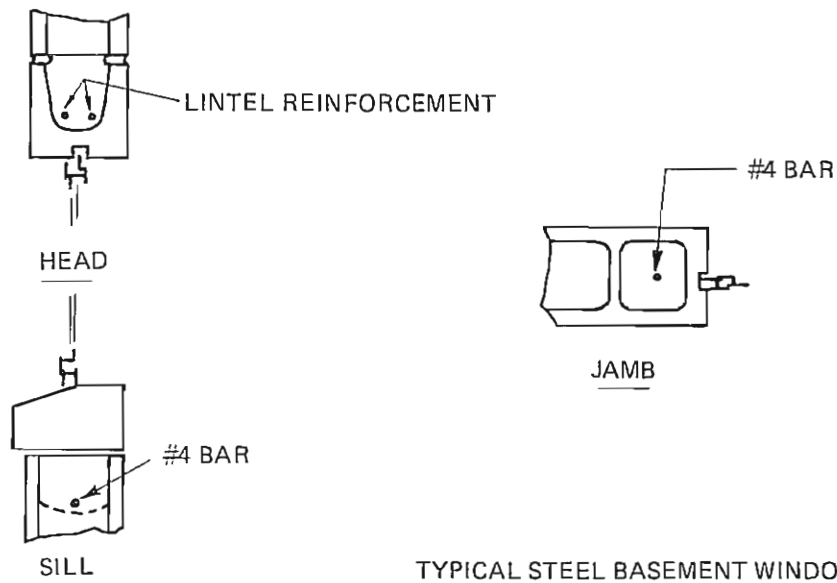
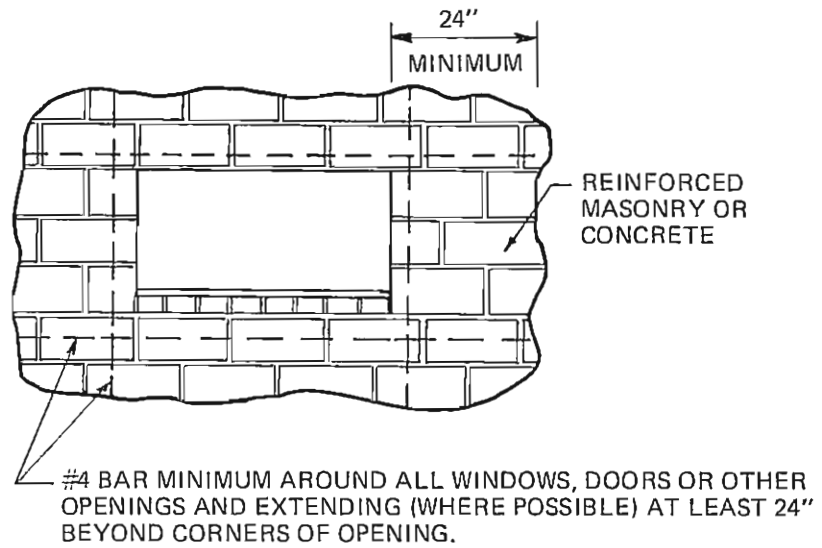
**Sec. 1405.2.1 NATURAL TERRAIN** – Structures constructed above the RFD and outside the regulatory-flood plain will not be subject to loads from regulatory-flood waters if basements are not used. The effect of soil saturation on basement walls and foundations may still have to be considered. Natural 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 in Figure 19.

**Sec. 1405.2.2 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 19. 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.

**Sec. 1405.2.2.1:** 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 the 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.

**Sec. 1405.2.2.2:** 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.

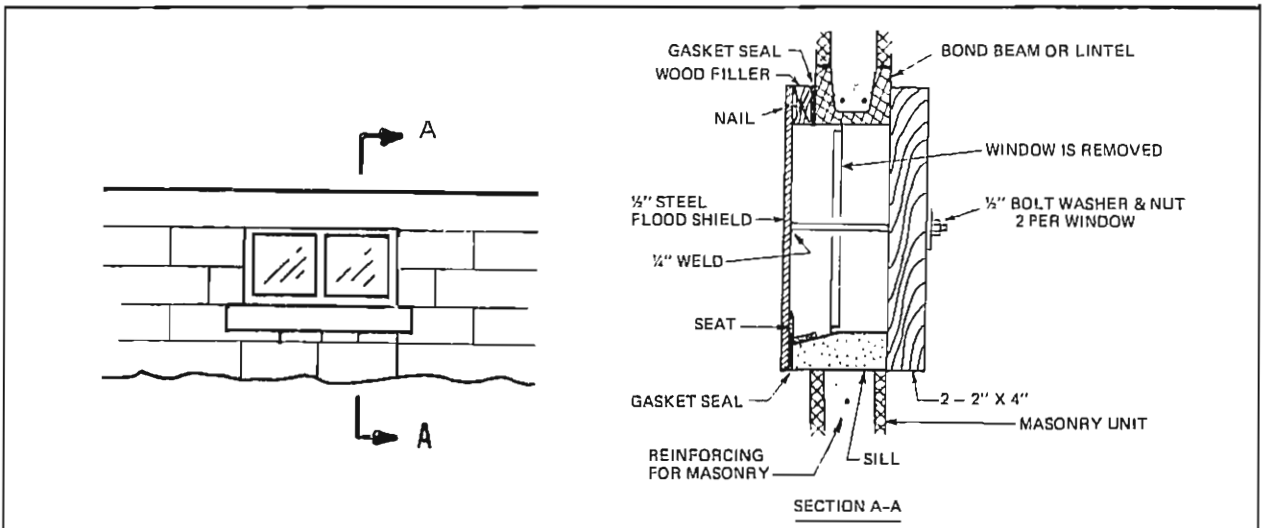
RECOMMENDED REINFORCEMENT AROUND SMALL OPENINGS  
AND FOR SHALLOW DEPTH OF FLOODING



TYPICAL STEEL BASEMENT WINDOW  
FOR REINFORCED MASONRY WALLS

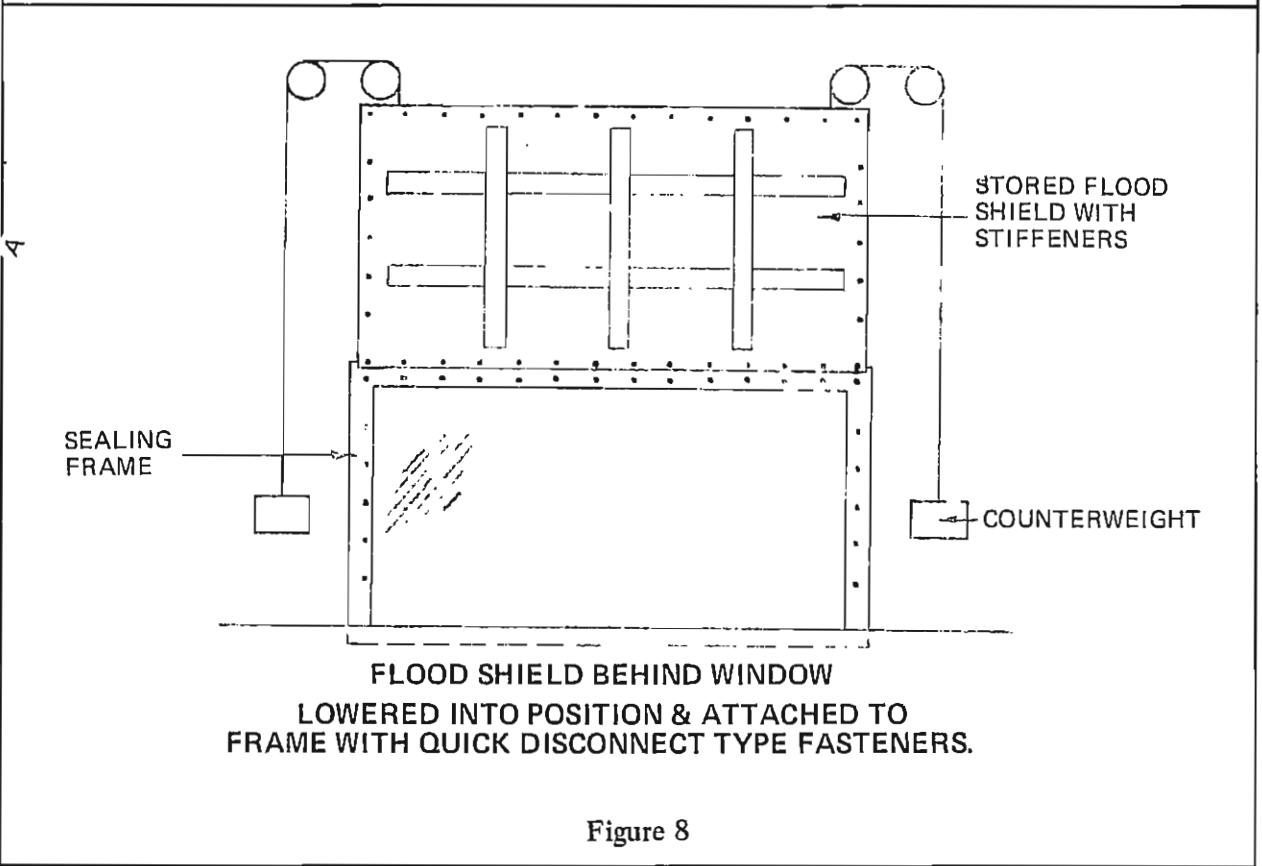
NOTE:  
IF OPENING BEGINS AT THE TOP OF A FOOTING, HORIZONTAL REINFORCING SHALL BE PROVIDED AT THE TOP OF THE FOOTING.

Figure 6



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

**Figure 7**



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

**Figure 8**



BOND BEAMS & VERTICAL REINFORCEMENT AT LARGE OPENINGS

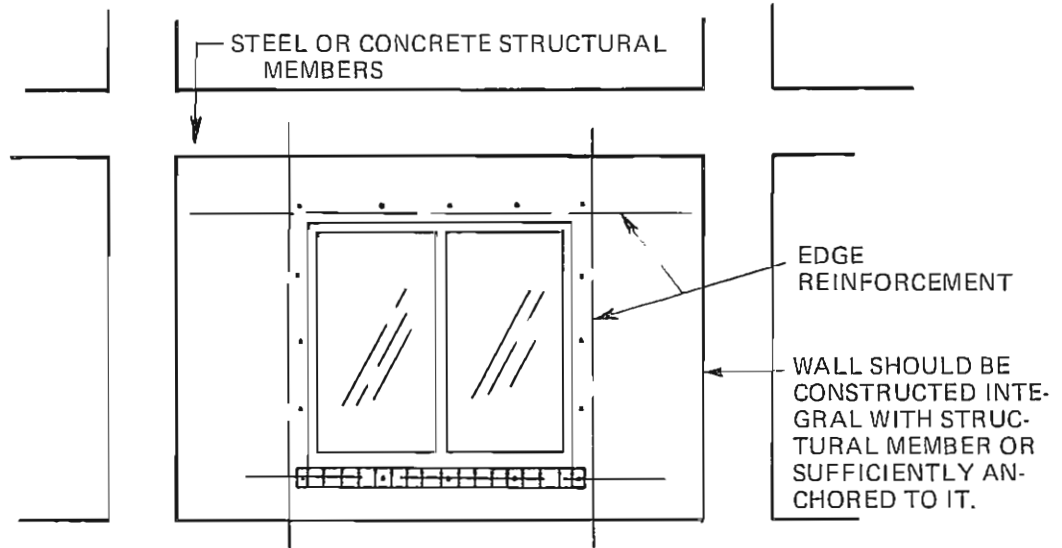
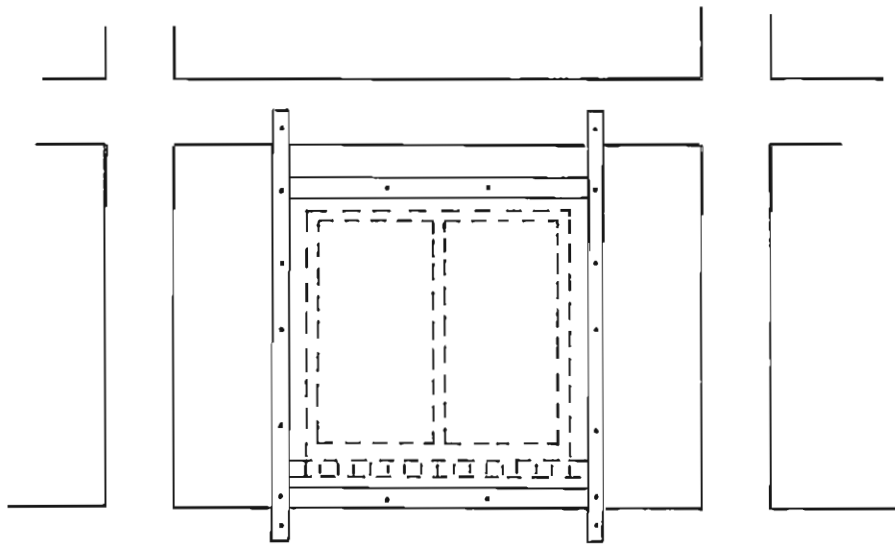


Figure 9



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 10

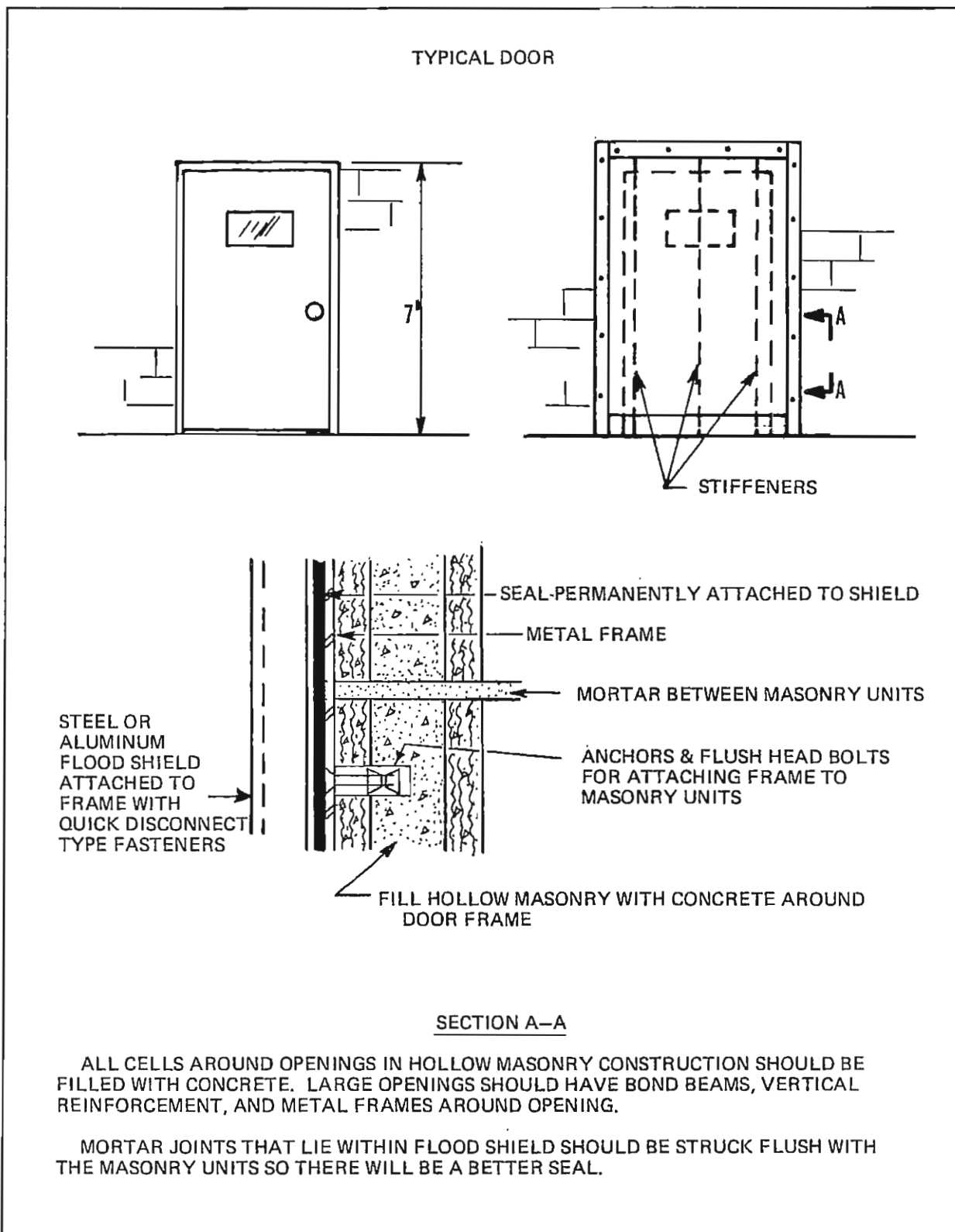


Figure 11

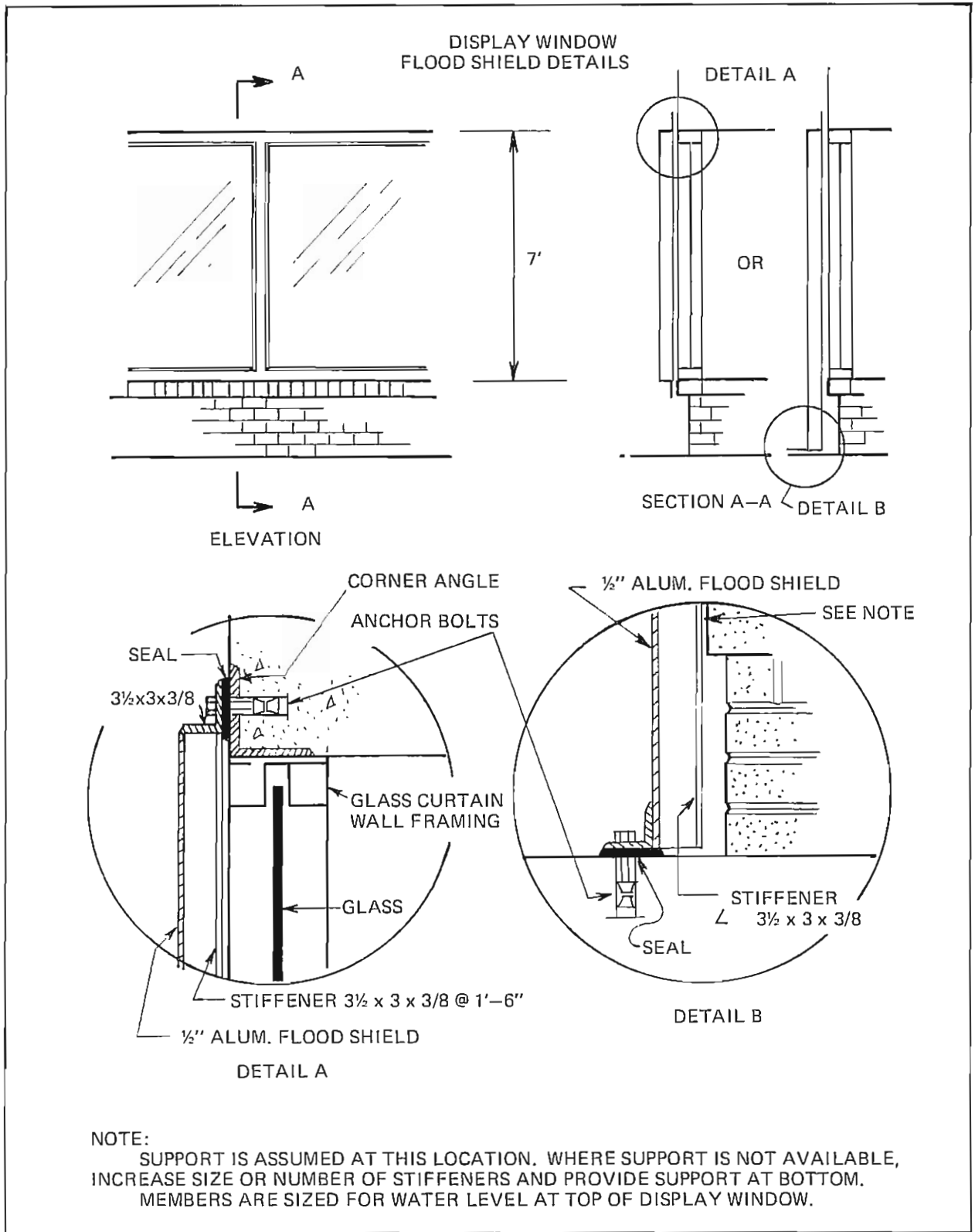


Figure 12

**CLOSURES FOR HORIZONTAL OPENINGS BELOW RFD**

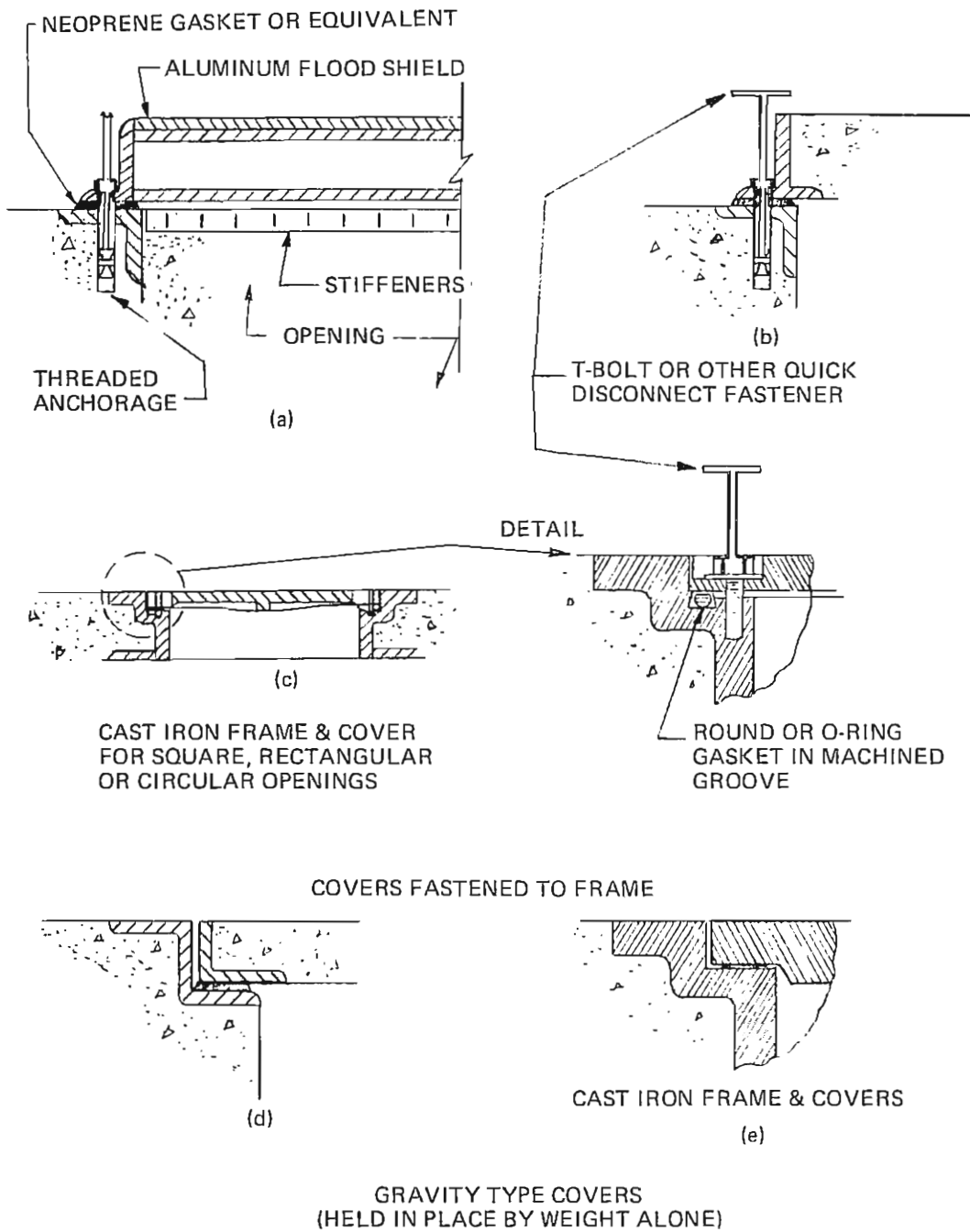


Figure 13

### CLOSURE PANEL ASSEMBLY FASTENING METHODS

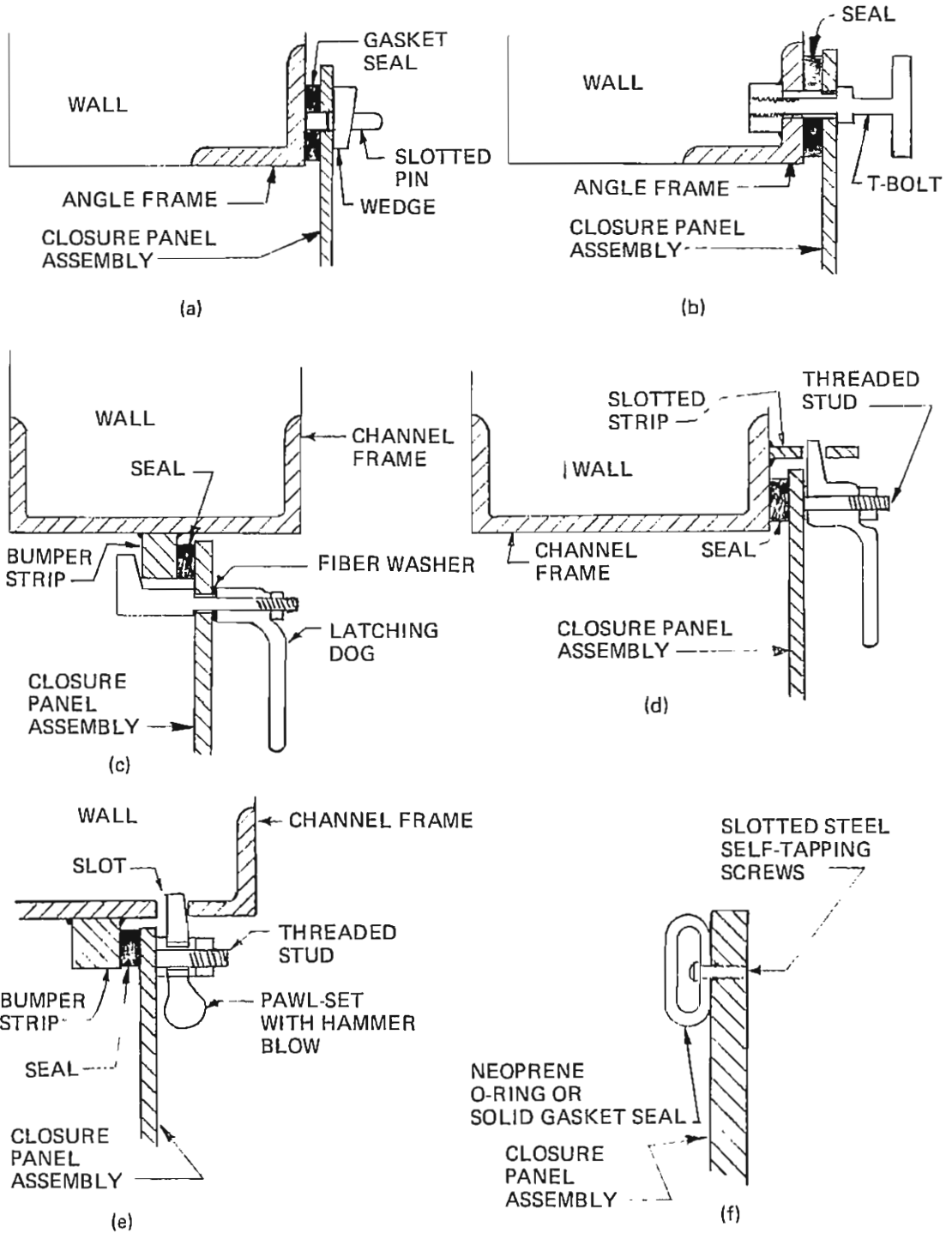
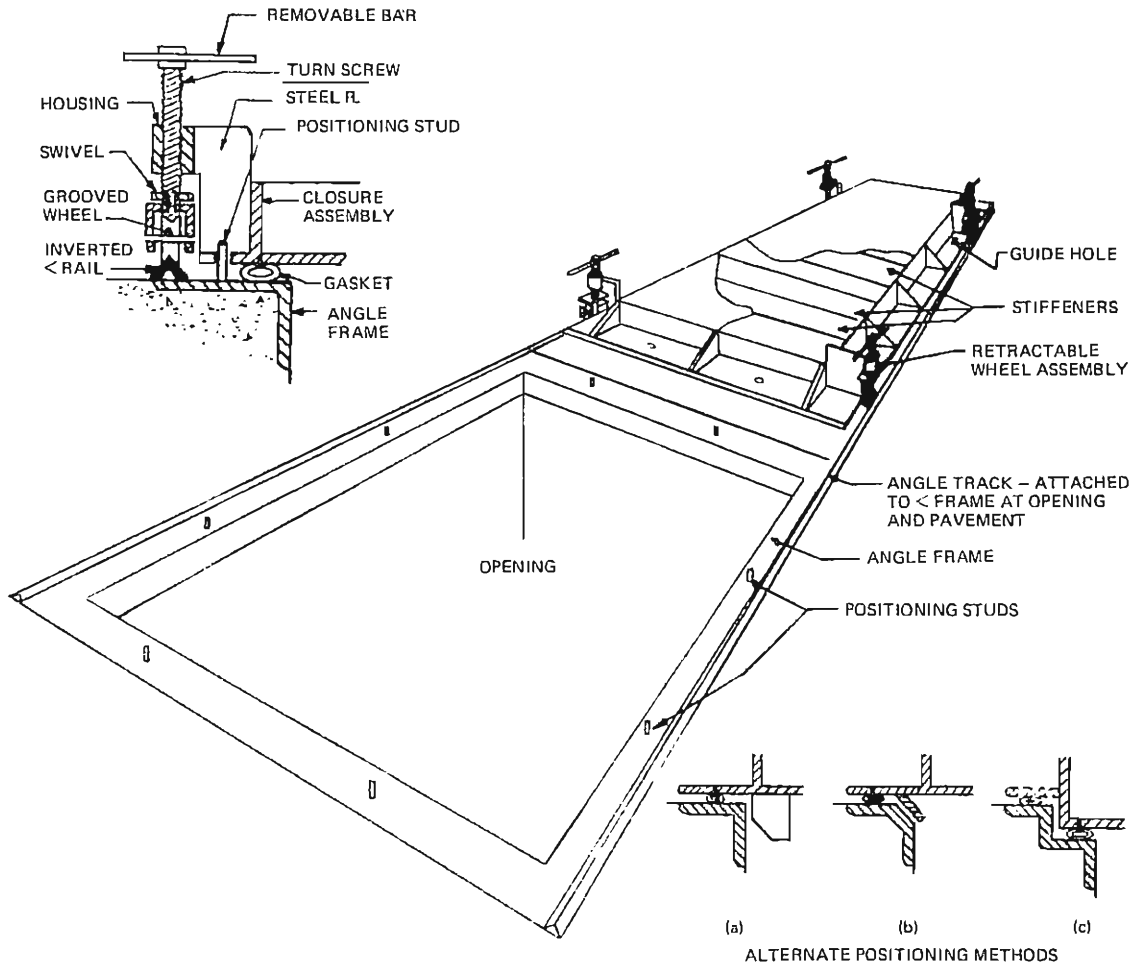


Figure 14

## 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.

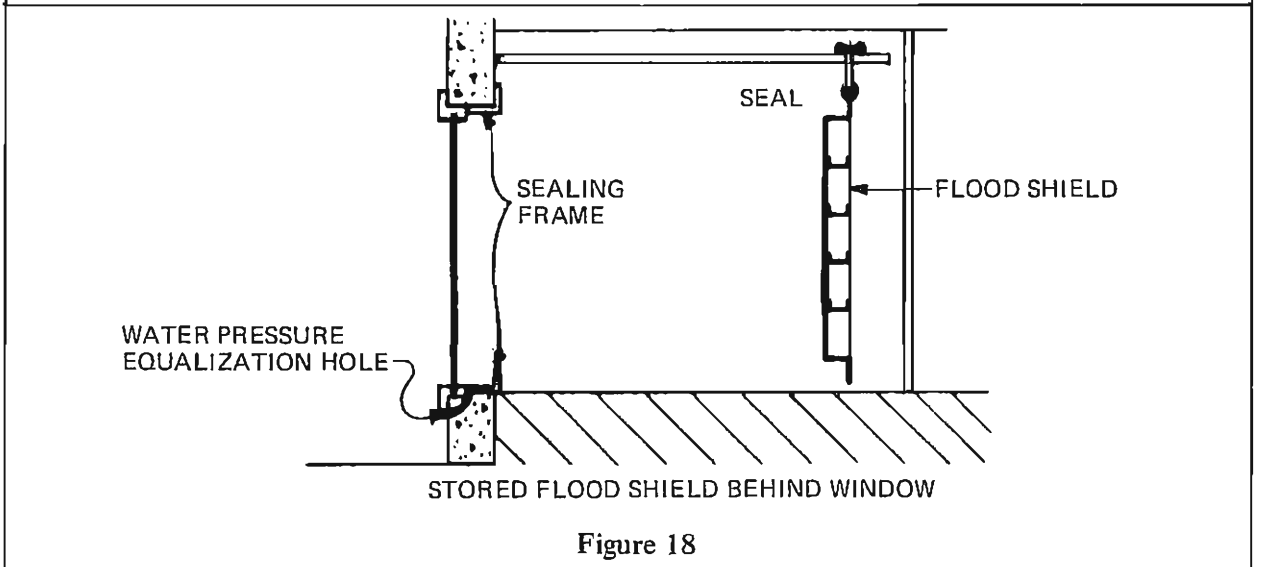
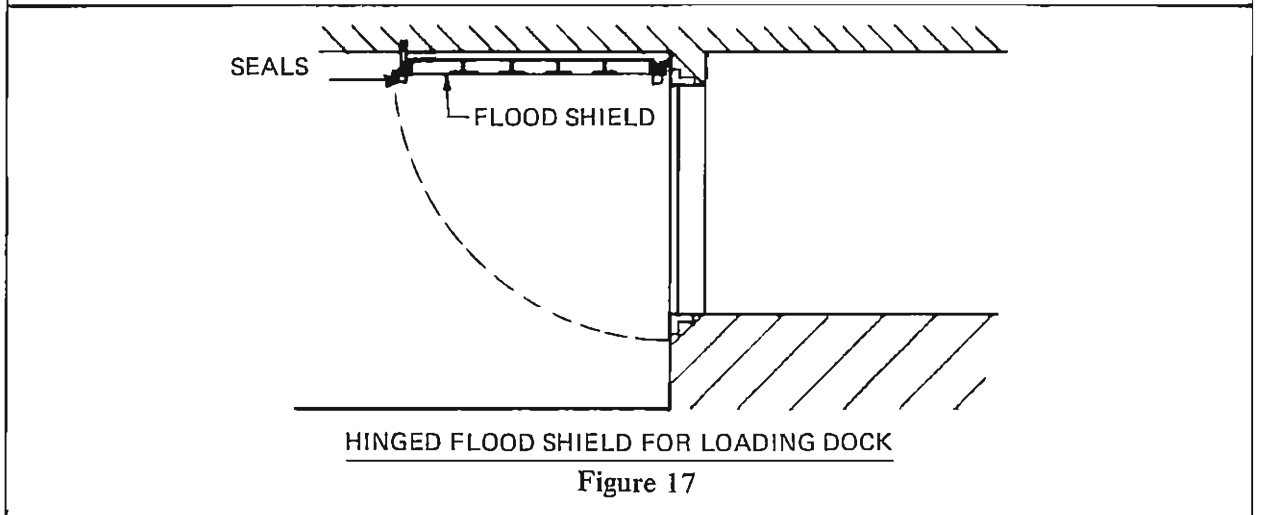
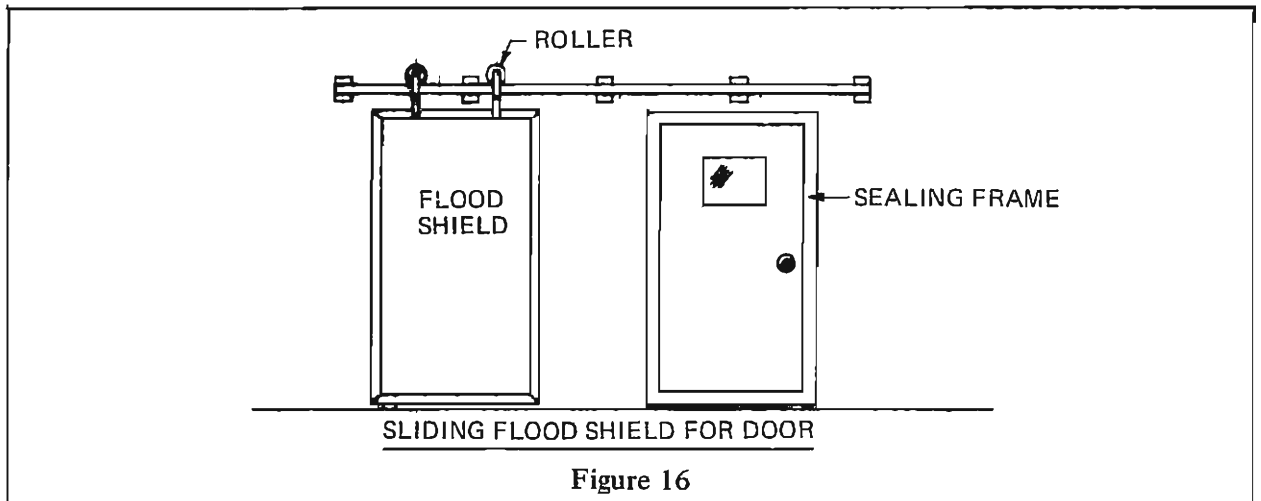
**DURING FLOOD** - When flood warning is received, operating bar(s) inserted in retractable wheel assembly and wheels lowered to engage rails, raising closure assembly off storage blocks and high enough to clear positioning studs; closure assembly rolled into position where guide holes are directly over 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 15

## FLOOD SHIELD INSTALLATIONS



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

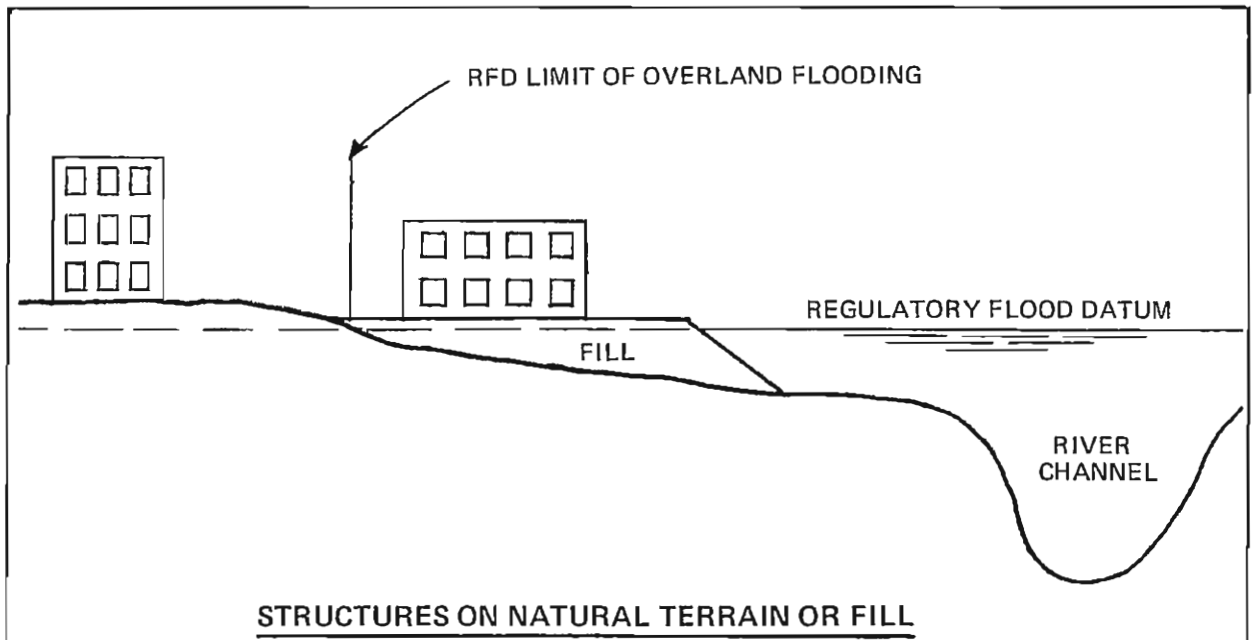


Figure 19

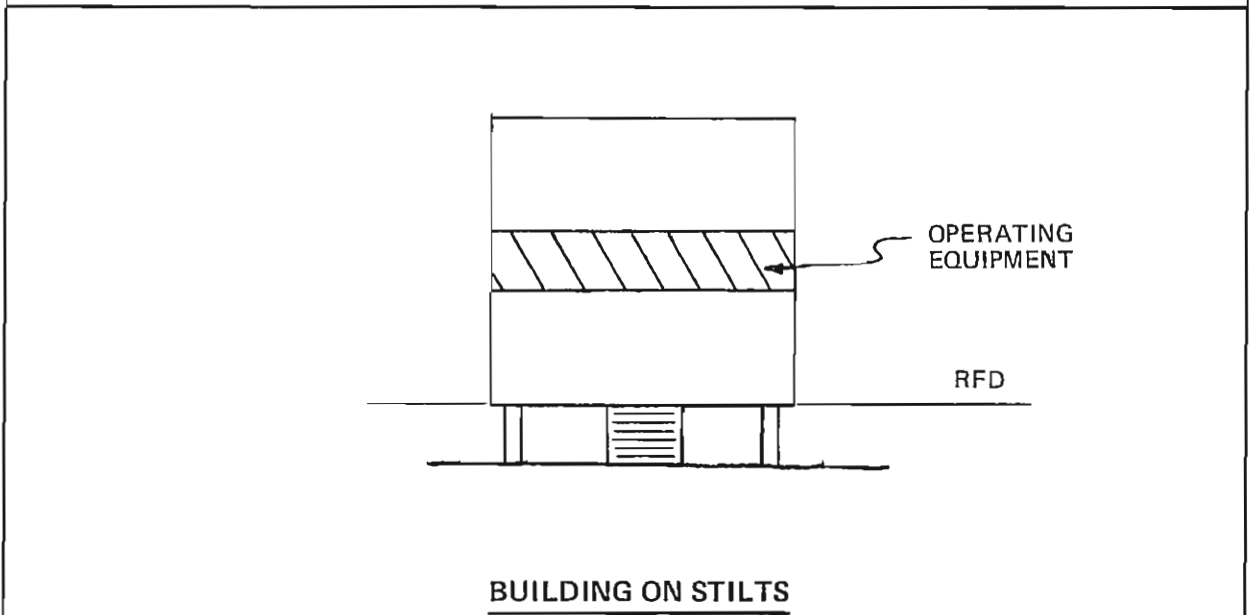


Figure 20



**Sec. 1405.2.3 BUILDING ON STILTS** – Often it is geographically undesirable or economically not feasible to locate a structure outside 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 functional aspects above the RFD by building on “stilts” as shown in figure 20.

**Sec. 1405.2.3.1:** 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.

**Sec. 1405.2.3.2:** The open space created at ground level below the functional floors could be used as a plaza, parking area, materials 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.

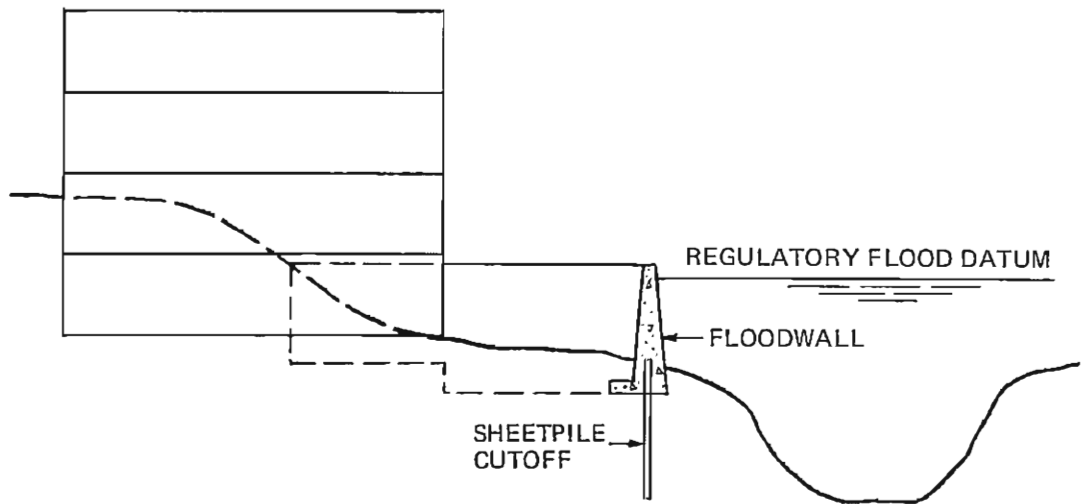
**Sec. 1405.2.3.3:** The equipment necessary to maintain building functions should be located safely above the RFD. If access to the building were provided from a location above the RFD, the normal building activities would not be disrupted and the building could continue to function during the flood emergency.

**Sec. 1405.3 PROTECTION BY DIKES, LEVEES AND FLOODWALLS:** As an alternate to providing flood protection through building or structure modifications, the necessary protection may be achieved by detached dikes, levees or floodwalls. The primary purpose of these constructions is 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 21 and 22. The ends of the works would be tied into the existing high ground or to the structure depending on local conditions.

**Sec. 1405.3.1 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, location, and extent of unsuitable materials and necessity for drainage or cutoff provisions.

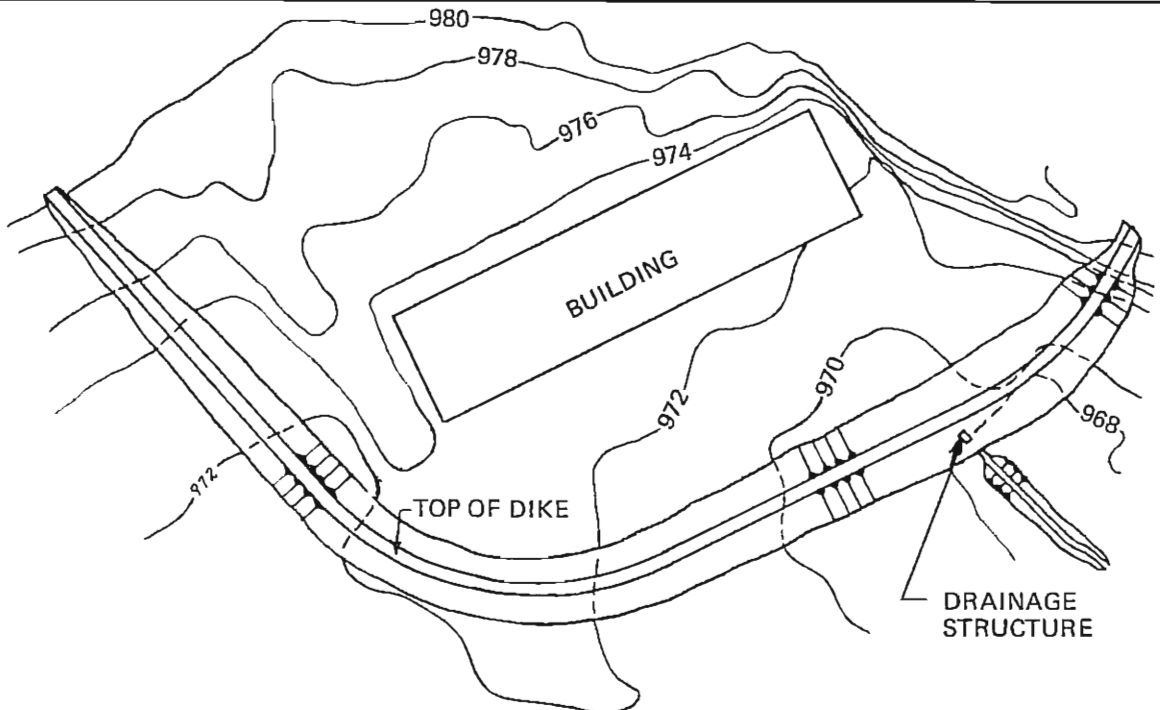
**Sec. 1405.3.1.1:** At locations where the foundation material has a high degree of permeability, an impervious cutoff may be necessary to reduce seepage through the in-situ foundation materials. The cutoff may be a sheet pile wall, compacted barrier of impervious soil, fabric reinforced membrane, concrete wall, or a 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 dike sections, cutoffs, and drainage provisions are shown in Figures 23, 24, and 25.

**Sec. 1405.3.1.2:** 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.



**FLOOD PROTECTION WITH FLOODWALLS**

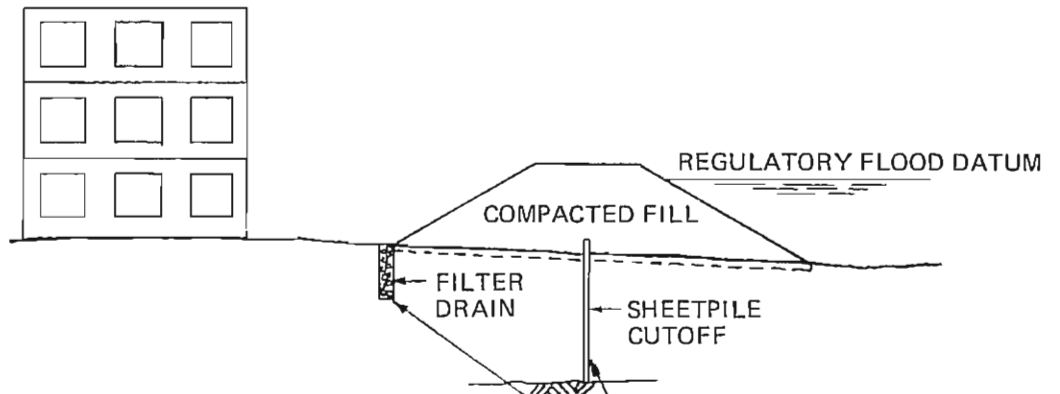
Figure 21



**FLOOD PROTECTION BY DIKES**

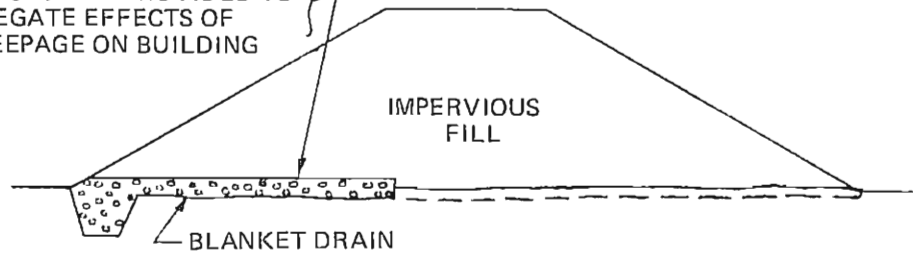
Figure 22

DIKE OR LEVEE PROTECTION

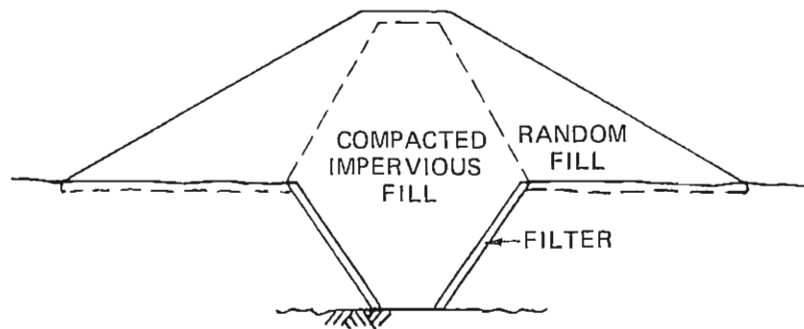


FLOOD PROOFING WITH DIKES  
Figure 23

THESE OR OTHER MEANS  
SHOULD BE PROVIDED TO  
NEGATE EFFECTS OF  
SEEPAGE ON BUILDING



DIKE WITH BLANKET DRAIN  
Figure 24



DIKE WITH IMPERVIOUS CORE  
Figure 25

ROCK OR IMPERVIOUS  
STRATUM

**Sec. 1405.3.2 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.

**Sec. 1405.3.2.1:** The walls should be founded on and 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 612.3.2. 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.

**Sec. 1405.3.2.2:** Drainage features through flood walls should be equipped with the necessary devices to prevent backflow. Typical sections of various flood wall types are shown in Figure 26.

**Sec. 1405.4 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 is, 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.

**Sec. 1405.4.1 FLOODING:** Flooding should be with potable water from a piping or storage system of adequate capacity to fill the basement 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.

**Sec. 1405.4.2 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 watertight 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.

**Sec. 1405.4.3 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 27 and 28.

**Sec. 1405.4.4 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 29.

## **SECTION 1406.0 TOTAL APPROACH**

**Sec. 1406.1 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.



Type 1

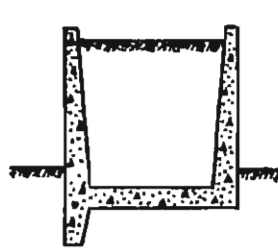


Type 2

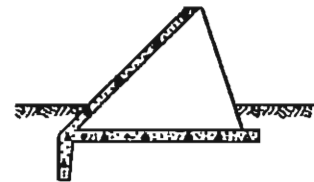
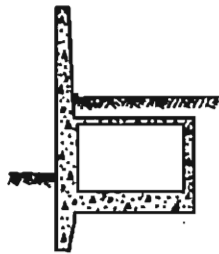


Type 3

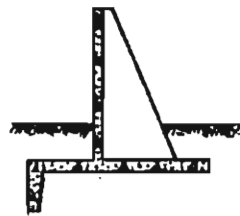
CANTILEVER 1-TYPE SHEET PILING



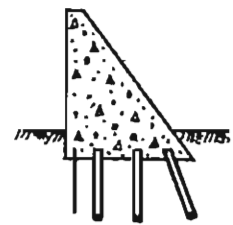
CELLULAR



FLAT DAM



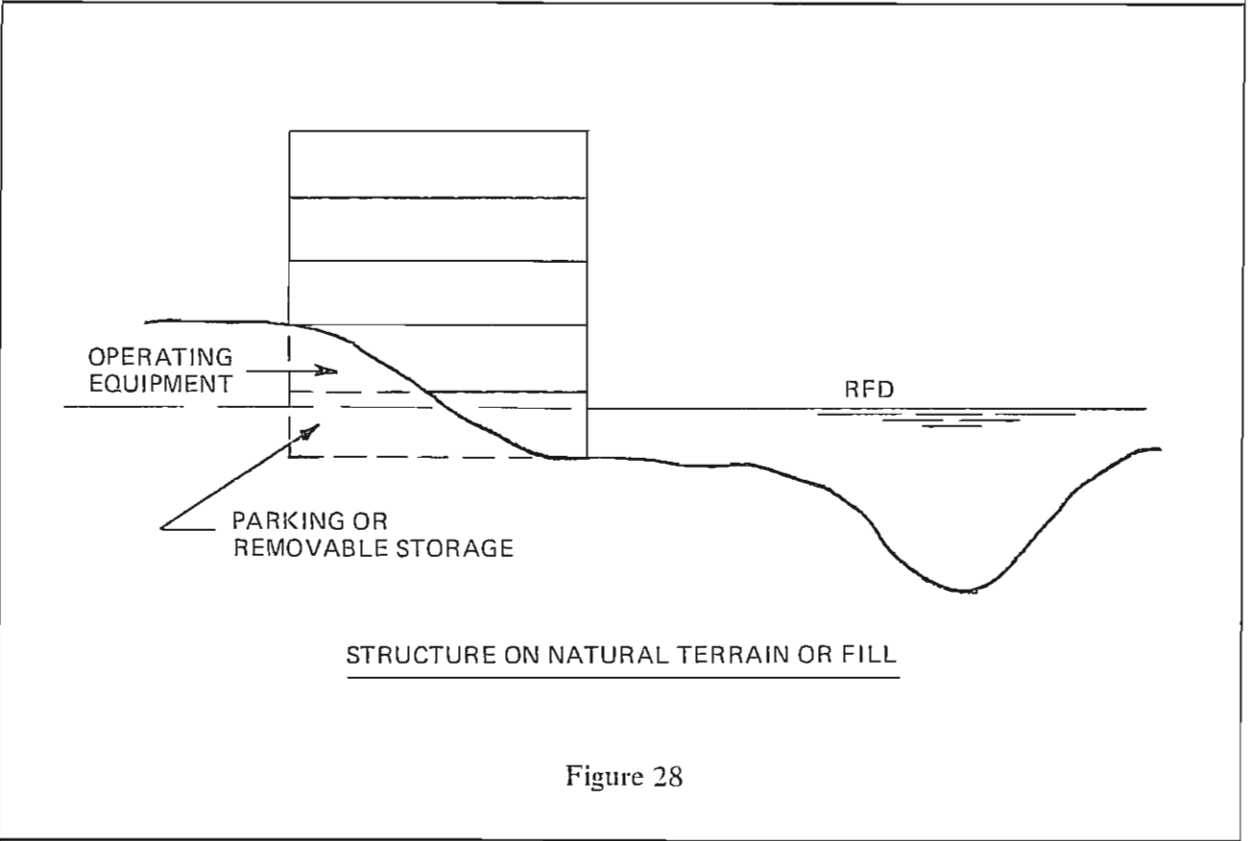
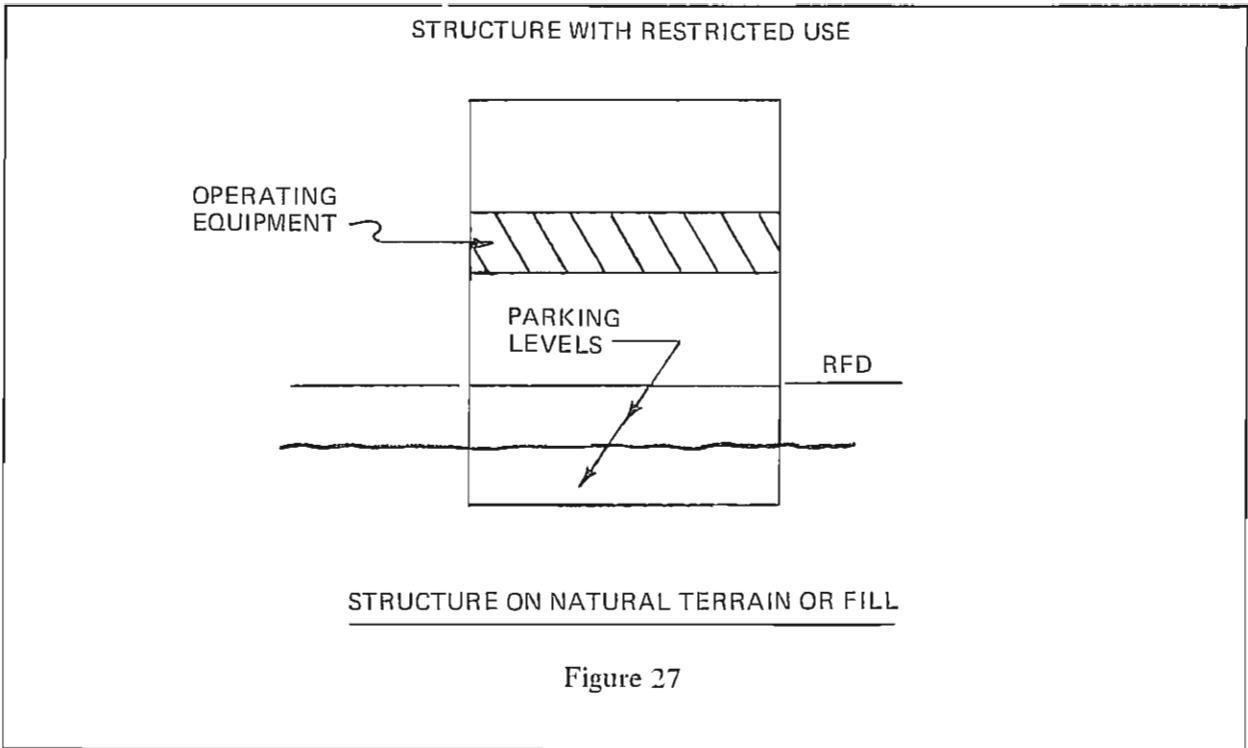
BUTTRESS AND COUNTERFORT



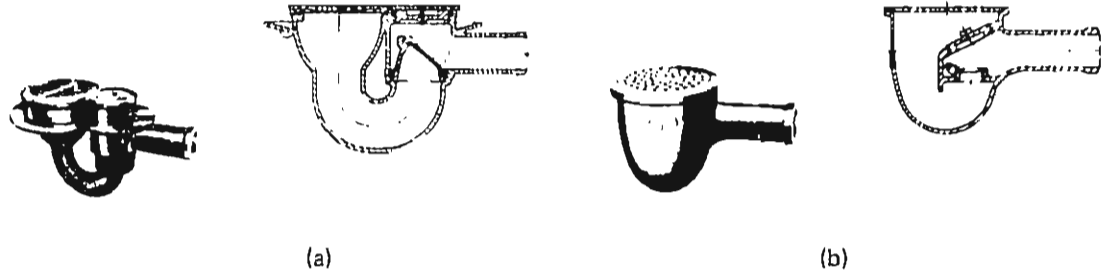
GRAVITY

VARIOUS FLOOD WALL TYPES

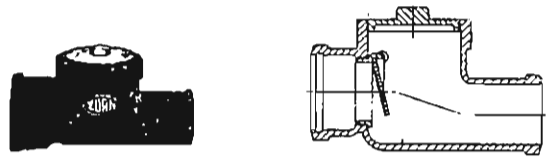
Figure 26



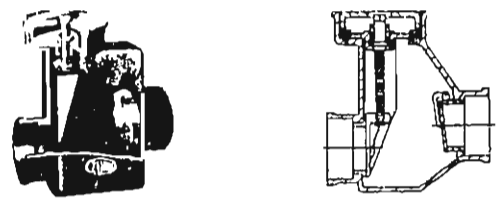
PREVENTION OF BACKFLOW THRU SEWER SYSTEM



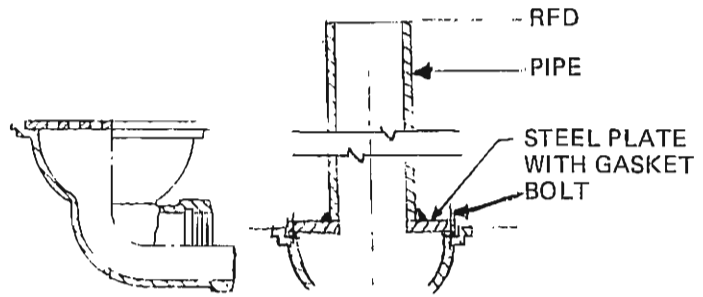
FLOOR DRAIN WITH INTEGRAL BACKWATER VALVE



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 29

**Sec. 1406.2 STANDARD OPERATING PROCEDURE:** 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 implementing 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 with 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.

**Sec. 1406.2.1:** 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.

**Sec. 1406.2.2:** 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.



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